ABSTRACT

Title of dissertation: INTEGER PROGRAMMING-BASED HEURISTICS FOR VEHICLE ROUTING PROBLEMS

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The vehicle routing problem (VRP) has been an active field of study by operations researchers for over 50 years. Many practical applications have been presented in the literature, and many solution techniques have been developed.

We discuss, develop, and computationally test integer programming-based heuristics for several variants of the standard VRP. We use integer programming to model the split delivery VRP with minimum delivery amounts, the multi-depot split delivery VRP, the period VRP, the standard VRP, and the multi-depot VRP. We apply our heuristics to benchmark problems from the literature and generate many new problems with high-quality, visually-estimated solutions. Our heuristics produce high-quality solutions in a reasonable amount of computer time. Overall, our new IP-based heuristics are very competitive with the best methods found in the VRP literature to date.

INTEGER PROGRAMMING-BASED HEURISTICS FOR VEHICLE ROUTING PROBLEMS

by

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List of Abbreviations

BC	Balance constraints
CW	Clarke-Wright savings algorithm for the VRP
EMIP	Endpoint mixed integer program
ERTR	Enhanced record-to-record travel algorithm for the VRP
IDH	Inter-depot heuristic for the MDSDVRP
IP	Integer program(ming)
IPH	IP-based heuristic for the PVRP
LP	Linear program(ming)
MDA	Minimum delivery amounts
MDIPH	IP-based heuristic for the MDVRP
MDSDVRP	Multi-depot split delivery vehicle routing problem
MIP	Mixed integer linear program(ming)
PVRP	Period vehicle routing problem
RC	Reassignment constraints
RCH	Hard reassignment constraints
RCR	Restricted reassignment constraints
RCS	Soft reassignment constraints
SDVRP	Split delivery vehicle routing problem
VIPH	IP-based heuristic for the VRP
VRP	Vehicle routing problem

Chapter 1

Introduction

The development of high-quality vehicle routes is crucial to the bottom lines of many businesses that deliver goods or services. There are many examples of companies that rely heavily on the ability to route vehicles in a cost-effective manner such as the postal service, utilities, commercial sanitation and recycling, food delivery, and fuel oil and industrial gas delivery. The details of the routing problems faced in the real world are often company-specific, but the main objective is the same: minimize travel costs while satisfying customer demands. In the operations research literature, problems with this objective are known as vehicle routing problems (VRPs). VRPs have been studied since the mid-1950s. Over 1,000 papers on VRPs have appeared in the literature with nearly half being published in the last 10 years [36].

In this dissertation, we develop heuristics for a wide range of VRPs. Our heuristics are based on integer programming. An integer program (IP) is a variant of a linear program (LP). An LP has a linear objective function in n-variables that must be maximized (or minimized) subject to a set of linear constraints. In an IP, each variable is restricted to an integer value. In a mixed integer program (MIP), some but not all of the variables must be integers.

The history of the LP dates back to the 1820s when Joseph Fourier proposed a method for solving systems of linear equations. In 1947, George Dantzig's simplex method [30] made solving LPs much more practical. Since Dantzig's work, there have been many advancements in LP algorithms, including the development of efficient interior point methods. For more on linear programming, see the paper by Orden [74] and the text by Bertsimas and Tsitsiklis [12].

IPs and MIPs are generally much more computationally difficult to solve than LPs. Algorithms for IPs and MIPs often involve solving many LPs in a branch-and-cut or a column generation scheme [93]. There are several commercially available LP solvers that have IP and MIP capabilities, including the ILOG CPLEX software [56]. For more on IPs and MIPs, see the text by Wolsey [93].

In this dissertation, we develop IP-based heuristics for several variants of the standard VRP: the split delivery vehicle routing problem (SDVRP), the period vehicle routing problem (PVRP), and the multi-depot vehicle routing problem (MDVRP). In the SDVRP, more than one vehicle can provide service to a customer. That is, a customer's demand can be split between several routes. In the PVRP, vehicles must be routed daily over a time period. We must first assign customers to service schedules and then find vehicle routes each day servicing the customers scheduled on that day. In the MDVRP, there are multiple depots at which vehicles can begin and end their routes.

We introduce new routing problems that are motivated by real-world concerns. The split delivery vehicle routing problem with minimum delivery amounts (SDVRP-MDA) is a variant of the SDVRP in which a minimum amount of a customer's demand must be delivered by a vehicle. From a customer's point of view, a delivery takes time, involves paperwork and data processing, and can distract the customer from his or her primary activities. As a result, a customer may impose a minimum delivery amount.

We make theoretical observations about the SDVRP-MDA and develop an IP-based heuristic for the SDVRP-MDA. To test our heuristic, we construct new problems with high-quality solutions that can be visually estimated.

In the multi-depot split delivery vehicle routing problem (MDSDVRP), there are multiple depots from which vehicles can start and end their routes. Our heuristic for the SDVRP-MDA can be adapted to the MDSDVRP. We present a computational analysis on the savings attained by splitting deliveries among vehicles based at the same starting depot and splitting deliveries among vehicles based at different starting depots. We construct new test problems that have high-quality, visually estimated solutions.

We introduce the period vehicle routing problem with minimum reassignment constraints (PVRP-RC) and the period vehicle routing problem with balance constraints (PVRP-BC). In many real-world problems, companies need to improve preexisting routes without reassigning many customers to new service schedules [62]. In the PVRP-RC, we impose a customer reassignment constraint. The objective is to improve an initial solution while limiting the disruption caused by customer reassignments.

Route balance is an important consideration in real-world routing. Companies are often willing to accept longer routes if the workload among drivers is relatively equal [62]. In the PVRP-BC, we impose a balance constraint. The objective is to improve an initial solution while maintaining balance across the routes.

Our IP-based heuristic for the PVRP is easily modified to handle both the PVRP-RC and the PVRP-BC. For each problem, we present a computational analysis and demonstrate how our results could be used by routing managers to develop high-quality routes in practice.

This dissertation is organized as follows. In Chapter 2, we give a survey of the SDVRP literature. In Chapters 3 and 4, we present our work on the SDVRP-MDA and the MDSDVRP. In Chapter 5, we discuss the PVRP, PVRP-RC, and PVRP-BC. We consider the VRP in Chapter 5 and the MDVRP in Chapter 6. In Chapter 7, we give our conclusions. In Appendices A – E, we give the details of every problem used in testing and all solutions generated by our heuristics. We also provide figures illustrating the routes generated by our heuristics and the routes of the estimated solutions for all new problems with visually estimated solutions.

Chapter 2

Recent Developments in Modeling and Solving the Split Delivery Vehicle Routing Problem

2.1 Introduction

In the standard version of the vehicle routing problem (VRP), vehicles with the same capacity based at a single depot service many customers. A customer's demand is delivered in one visit by a single vehicle. We must find the minimal cost set of routes for the vehicles that start and end at the depot and do not violate vehicle capacity. The VRP has been studied for nearly 50 years. The book by Golden, Raghavan, and Wasil [46] contains 25 papers that describe the latest applications, algorithms, and computational results.

In the late 1980s, researchers considered the possibility of serving a customer by more than one vehicle in order to potentially reduce the total distance traveled by the fleet of vehicles. The split delivery vehicle routing problem (SDVRP) retains all features of the standard VRP, but allows a customer's demand to be split among several vehicles. In Figure 2.1, we give an example of the SDVRP with three customers (labeled 1, 2, 3) and a single depot. Each customer has a demand of three units, each vehicle has a capacity of four units, and distances are shown adjacent to edges. In Figure 2.1(b), the optimal solution to the standard VRP with no split deliveries has one vehicle traveling directly out to each customer, delivering three units, and returning back to the depot for a total distance of 16. In Figure 2.1(c), split deliveries are allowed. Customers 2 and 3 are now serviced by two different vehicles and the total distance has been reduced to 15.

In the last five years or so, research work on the SDVRP has increased significantly, so that there are currently more than a dozen articles in which the modeling and solving of the SDVRP and its variants (such as the SDVRP with time windows) are addressed. We believe that part of the renewed interest in the SDVRP is due to the increased costs (such as higher fuel and maintenance costs) associated with operating commercial fleets and the need for management to reduce these costs as much as possible. In addition, the availability of powerful metaheuristics has made this problem easier to study computationally. In this chapter, we summarize the open literature on the SDVRP (Section 2.2), provide details of solution procedures and report computational results on benchmark problems (Section 2.3), and suggest future research directions (Section 2.4).

2.2 Summary of the Recent Literature

The SDVRP was introduced by Dror and Trudeau [33] in 1989. For the next 15 years, there was a steady trickle of published papers and their algorithmic accomplishments and applications have been described in Chen, Golden, and Wasil [20] and Archetti and Speranza [4].

In this section, we summarize recent work on the SDVRP. We focus on the 15

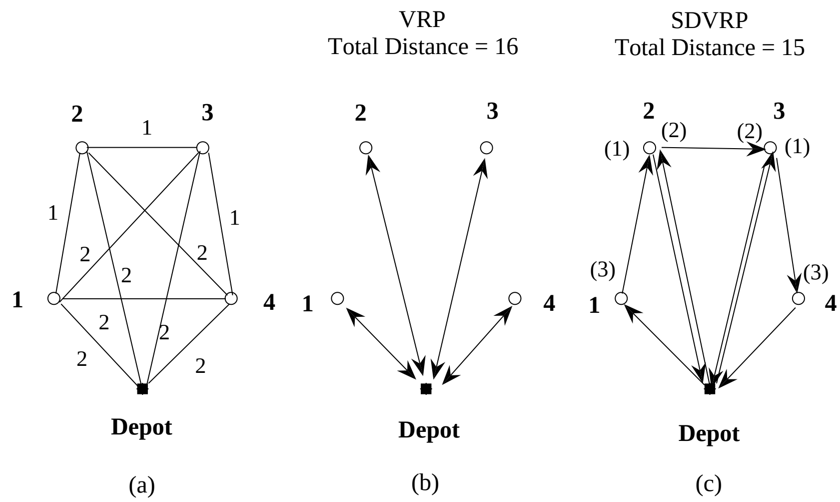


Figure 2.1: Splitting deliveries may reduce the distance traveled by a fleet. Customer demand is three units, vehicle capacity is four units, and edge labels are distances.

papers given in Table 2.1 that model and solve the SDVRP and its variants from 2004 to 2008. Our summary of each paper will fall into one of three categories: (1) Heuristics, (2) Exact methods and bound-generating procedures, and (3) SDVRP variants.

2.2.1 Heuristics

2.2.1.1 Tabu Search

Archetti, Speranza, and Hertz [6] formulate a mixed integer program for the SDVRP in which the quantity delivered on a route cannot exceed a value k (they call this problem the k-SDVRP). The authors develop a tabu search algorithm (called SPLITABU) for solving the k-SDVRP. Their algorithm has three phases: (1) Initial feasible solution phase. Make as many direct trips to customers as possible and then

Table 2.1: Summary of 15 papers that model and solve the SDVRP from 2004 to 2008.

Authors	Year	Algorithm	Variant
Ho, Haugland [55]	2004	Tabu search	Time windows
Mitra [69]	2005	Cheapest-insertion	Backhauls
Archetti, Speranza, Hertz [6]	2006	Tabu search	
Lee et al. [61]	2006	Dynamic program, shortest path	Exact algorithm
Boudia, Prins, Reghioui [14]	2007	Memetic algorithm	
Chen, Golden, Wasil [20]	2007	MIP, record-to-record travel	
Jin, Liu, Bowden [57]	2007	LP with valid inequalities	Exact algorithm
Mitra [70]	2007	Cluster and route	Backhauls
Mota, Campos, Corberán [71]	2007	Scatter search	
Tavakkoli-Moghaddam et al. [89]	2007	Simulated annealing	Heterogeneous fleet
Thangiah, Fergany, Awan [90]	2007	First insertion, local search	Real-time events
Archetti, Speranza, Savelsbergh [8]	2008	IP route optimization	
Jin, Liu, Eksioglu [58]	2008	Column generation	Bounds generation
Liu, Lei, Park [65]	2008	Greedy heuristic, bin-packing	Fixed route
Nowak, Ergun, White [73]	2008	Local search, Clarke-Wright	Pickups

solve a giant traveling salesman tour using the GENIUS algorithm [40]. (2) Tabu search phase. Remove a customer from a current set of routes and insert it on a new route or an existing route with available capacity in the cheapest way. Consider inserting a customer on a route without removing it from its current route. (3) Final improvement phase. Improve the solution from the second phase (apply the GENIUS algorithm to individual routes). SPLITABU has only two parameters that need to be set: the length of the tabu list and the maximum number of iterations. The authors also modify SPLITABU in two ways. Solutions are improved using the node interchanges of Dror and Trudeau [33] and 2-opt (this version is called SPLITABU-DT). The authors limit the run time of the second phase to one minute (this version is called FAST-SPLITABU).

Archetti, Speranza, and Hertz test their three algorithms on seven problems with 50 to 199 customers. Customer demand in each problem is generated using the rules proposed by Dror and Trudeau [33] and this results in 49 test problems. The authors run each algorithm five times on each problem and compare results to those generated by Dror and Trudeau's algorithm [33] (denoted by DT). Overall, SPLITABU-DT is the best performer. On every problem, it finds a better solution than DT. The best solutions produced by SPLITABU-DT are nearly 5.4% lower on average than the solutions produced by DT.

2.2.1.2 Genetic Algorithm

Boudia, Prins, and Reghioui [14] solve the SDVRP using a memetic algorithm with population adjustment (MA|PM) described in [86]. The authors create an initial population of VRP solutions with no splits using the Clarke-Wright algorithm [25] and the sweep method of Gillett and Miller [43]. Two parent solutions are selected and offspring are created using crossover. The offspring are converted into a solution to the SDVRP (using a procedure called Split). Solutions are improved using traditional VRP local search procedures including customer exchange and 2-opt moves. The authors also consider moves based on the k-split procedure of Dror and Trudeau [33] to split a customer or change the delivery amounts on each visit. An offspring is selected for improvement with a fixed probability. If an improved offspring is better than the current best solution, it replaces a member of the population. In addition, the authors use a threshold to promote diversity in the population, so that an improved solution can enter the population only if it is sufficiently different from existing solutions (the notion of diversity control using a distance measure in the solution space is described in [86]).

Boudia, Prins, and Reghioui apply their MA|PM algorithm to the 49 problems used by Archetti, Speranza, and Hertz [6] and compare results to SPLITABU-DT. They find that one run of MA|PM improves the SPLITABU-DT solution (average of five runs) in 37 problems and appears to be faster (although the machines are slightly different).

2.2.1.3 Mixed Integer Programming with a Routing Metaheuristic

Chen, Golden, and Wasil [20] focus on the SDVRP. First, they review applications of the SDVRP and the literature on this topic. Next, they present an innovative solution procedure that combines a mixed integer program and a routing metaheuristic (namely, the record-to-record travel algorithm). This procedure is referred to as EMIP + VRTR. In computational experiments, EMIP + VRTR clearly outperforms SPLITABU-DT on the problem set given in [6]. In addition, the authors present 21 new benchmark SDVRP instances with 8 to 288 customers as well as high-quality solutions to these new instances.

2.2.1.4 Scatter Search

Mota, Campos, and Corberán [71] present a new metaheuristic procedure to solve the SDVRP. In particular, they apply scatter search to obtain a low-cost feasible solution which uses the minimum number of routes (i.e., vehicles). This objective function is slightly different from the one minimized in [6, 8, 14, 20]. There may be a number of low-cost solutions using more than the minimum number of vehicles.

A giant tour approach is applied to ensure a set of initial feasible solutions with the minimum number of vehicles. The Clarke-Wright savings algorithm [25] is also used to generate initial feasible solutions. While there is no guarantee that these solutions minimize the number of vehicles, they often do. These initial feasible solutions are improved using a variety of standard interchange and exchange operations.

A reference set of feasible solutions is then established and rules for combining feasible solutions are specified. If a (new) combined solution is infeasible, it is repaired. If it is feasible, it is improved.

The scatter search results are compared to the results from Archetti, Speranza, and Hertz [6] over 49 instances ranging in size from 50 to 199 customers. Overall, the scatter search results are not as good as the SPLITABU-DT results. However, since the objective functions are not the same, this comparison is problematic.

2.2.1.5 Route-Optimization Heuristic using Mixed Integer Programming

Archetti, Speranza, and Savelsbergh [8] model the SDVRP as a route-optimization mixed integer program. For every feasible route, there is a binary variable in the MIP that determines whether or not a route is part of the optimal solution. It is not computationally tractable to examine all routes in order to minimize travel cost. The authors develop a technique to identify subsets of routes over which the route-optimization MIP can be solved.

Using the tabu search heuristic given in [6], edges that appear in a high percentage of solutions are identified, and a set of routes $\bar{R}$ is generated by extending routes through these identified edges. A subset R of $\bar{R}$ is then created according to three criteria: 1) routes of the best-known solution are included, 2) routes with positive value in the solution to the LP relaxation of the route-optimization MIP over $\bar{R}$ are included, and 3) routes with a high desirability are included, where the desirability measures are based on the dual variables of the LP relaxation. A route-optimization phase is then conducted by iteratively generating R and solving the route-optimization MIP.

Archetti, Speranza, and Savelsbergh track the performance of their route-optimization heuristic and their tabu search heuristic on the data set from [6]. They also provide the gap between the solution given by the route-optimization heuristic and the LP relaxation solution of the route-optimization MIP over $\bar{R}$ (this is likely to be close to a lower bound for the problem). They find that the average improvement over the tabu search heuristic is approximately 0.5%, and the average gap between the route-optimization solution and the LP relaxation solution is approximately 2.2%.

2.2.2 Exact Methods and Bound Generating Procedures

2.2.2.1 Dynamic Programming

Lee, Epelman, White, and Bozer [61] examine the multiple vehicle routing problem with split pickups (denoted by mVRPSP). Vehicles with the same capacity are based at a single depot and must pick up items at suppliers and deliver them to the depot. A supplier can be visited by more than one vehicle so that split pickups are permitted.

The authors present two mixed integer programming formulations of the mVRPSP. They then develop a dynamic programming formulation and show how to solve it using a shortest path approach (SPA).

Lee at al. perform computational tests on a set of 198 small test problems (nine geographic layouts of randomly located suppliers $\times$ 22 supply vectors) where each problem has four, five, or seven suppliers. SPA solves the problems with four and five suppliers in under a second, while the MIP solution times (the MIPs are solved with CPLEX 9.0) range from under a second to more than an hour. The problems with seven suppliers are too large to be solved as MIPs, while SPA solves them all in times that range from under one second to 513 seconds.

2.2.2.2 Linear Programming with Valid Inequalities

Jin, Liu, and Bowden [57] propose a two-stage algorithm to optimally solve the SDVRP. In the first stage, a clustering sub-problem is solved in which travel distances are ignored, but all demand is satisfied. At each iteration, this yields a lower bound.

In the second stage, a traveling salesman problem (TSP) is solved for each cluster. Since average customer demand is greater than 10% of vehicle capacity in SDVRPs of interest to the authors, these TSPs are relatively small and easy to solve to optimality. The sum of these TSP lengths over all clusters provides an upper bound on the optimal solution. The authors show how to iterate between the two stages and they develop new valid inequalities for the first stage problem.

Computational experiments demonstrate that on small problems (seven customers), the two-stage algorithm outperforms the dynamic programming approach of Lee et al. [61].

2.2.2.3 Column Generation

Jin, Liu, and Eksioglu [58] propose a column generation approach to find upper bounds (UB) and lower bounds (LB) for the SDVRP. First, the authors compute the minimum number of vehicles (K) required to satisfy total demand. They allow more than K vehicles in their solution since they seek to minimize the total distance traveled.

Next, they define their master problem and pricing sub-problem. The LP relaxation of the master problem is solved using CPLEX 9.0. A limited-search-with-bound algorithm is developed to efficiently solve the pricing sub-problem.

The proposed column generation algorithm is tested on 11 problem instances and compared with the cutting plane approach of Belenguer, Martinez, and Mota

[10]. The column generation algorithm is able to obtain gaps $(UB-LB)/UB$ which are consistently smaller than those generated by Belenguer et al.

2.2.3 SDVRP Variants

2.2.3.1 Time Windows

Ho and Haugland [55] study the VRP with time windows and split deliveries (denoted by VRPTWSD). This problem is NP-hard and they show how it can be formulated as a mixed integer program (they do not try to solve the MIP). The authors develop a three-step heuristic that uses tabu search to solve the VRPTWSD. An initial feasible solution is generated by analyzing travel time and waiting time. This solution is improved by using four different tabu move operators: (1) remove a customer from a route and relocate it to a different route, (2) relocate a customer and split its demand, (3) exchange two customers on different routes, and (4) modified 2-opt exchanges. A post-processor that is based on unstringing and stringing found in the GENIUS algorithm [41] is applied to the best solution found during the search process.

Ho and Haugland conduct computational experiments using the six sets of benchmark test problems of Solomon [85]. These problems have 100 customers that are randomly generated, clustered, or semi-clustered with Euclidean distances. The demands of the customers are modified by Ho and Haugland so that they could study how the ratio of demand to capacity affects splitting. They solve all problems using their heuristic with splitting and without splitting and report average values for the total distance traveled and the number of vehicles. Ho and Haugland find that, for the most part, splitting deliveries produces better solutions (smaller total distance, fewer vehicles).

2.2.3.2 Split Deliveries and Pickups (Backhauls)

Mitra [69] examines the VRP with split deliveries and pickups (VRPSDP). Deliveries and pickups can occur in any sequence and a customer may be visited more than once by the same vehicle. Mitra first wants to minimize the number of required vehicles and then route the vehicles to minimize the total travel cost. He formulates the VRPSDP as a mixed integer program and tries to solve problems with 19 customers and one depot to optimality in a reasonable amount of computing time (30 minutes or less). He considers 55 problems with two different sets of edge costs so that there are a total of 110 test problems. Mitra solves 28 problems to optimality and finds upper bounds to the total route cost for the remaining problems.

Mitra develops a heuristic procedure for solving the VRPSDP. The heuristic starts by determining the minimum number of vehicles needed to meet all deliveries and pickups. The routes for the vehicles are then constructed sequentially using cheapest insertion. Mitra reports the heuristic found 22 of the 28 optimal solutions in about one-quarter of the MIP's computation time on average.

In a subsequent computational study, Mitra [70] extends his earlier work on the VRPSDP. After a literature review and problem statement, Mitra formulates the VRPSDP as an MIP. Next, he presents a cluster-first, route-second heuristic.

The number of clusters is known in advance and is equal to the minimum number of vehicles required. The expression for this number is given in the paper.

Once clusters are formed, a route construction procedure is applied. Next, the proposed heuristic is compared with the author's earlier heuristic (see Mitra [69]) over a problem set of 110 instances. The new heuristic is found to perform statistically better than the earlier heuristic. Finally, Mitra applies his cluster-first, route-second heuristic to the VRP with simultaneous deliveries and pickups, runs some preliminary computational experiments, and compares his results to those found in [21].

2.2.3.3 Heterogeneous Fleet

Tavakkoli-Moghaddam, Safaei, Kah, and Rabbani [89] consider the capacitated vehicle routing problem with split services and a heterogenous fleet, denoted by CHVRPSS. In the CHVRPSS, there are Q vehicle classes each with a different capacity. Each class q contains v_q vehicles, $q = 1, ..., Q$, and the total number of available vehicles is $V = \sum_{q=1}^{Q} v_q$. The authors formulate the CHVRPSS as a mixed integer program. They use an objective function that contains travel cost, a cost per vehicle, and a penalty term for unused capacity. The MIP is solved to optimality using Lingo 8.0 on five instances with six nodes.

Tavakkoli-Moghaddam et al. propose a simulate annealing (SA) heuristic for solving the CHVRPSS. An initial solution is generated by considering vehicles ordered by capacity (largest to smallest), and adding random customers to a current route until capacity is reached. Next, the simulated annealing heuristic is applied to the problem. In the SA heuristic, a neighbor of a current solution is explored through either a one-node move or a two-node move (the move selection is random). The neighbor replaces the current solution with a probability that depends on the cost difference between the neighbor and the current solution, and the temperature of the algorithm. After a fixed number of iterations at different temperatures, the heuristic stops and returns the best solution.

Tavakkoli-Moghaddam et al. test the SA heuristic on the five instances solved to optimality. They find an average gap of 1.36%. On 19 larger problems (10 to 100 nodes), they compare the results of the SA heuristic to a lower bound obtained by solving a traveling salesman problem on all nodes. On average, the SA heuristic is approximately 26% above the lower bound.

2.2.3.4 Real-time Events

Thangiah, Fergany, and Awan [90] study the split-delivery pickup and delivery time windows problem with transfers (SDPDTWP) over a real-time horizon. In the SDPDTWP, a fleet of un-capacitated vehicles must deliver a set of shipments. Each shipment has a time window $[a, b]$, where a is the earliest time a shipment can be picked up from its origin, and b is the latest time a shipment can be dropped off at its destination. A shipment can be split or transferred to reduce travel time. A split occurs when shipments from the same origin are serviced by different vehicles. A transfer occurs when a vehicle leaves a shipment at an intermediate stop to be picked up and delivered to its destination by a different vehicle. There is no central depot in the SDPDTWP. A vehicle begins its route at one of the origin nodes, and ends its route at the last destination node on its route. The SDPDTWP is set in real-time. Events including deletion, insertion, and modification of a shipment, and deletion (breakdown) and insertion of a vehicle can occur throughout the time horizon of an SDPDTWP instance.

There are three objectives in the SDPDTWP. First, minimize the number of vehicles that is needed to make all pickups and deliveries within the specified time windows. The number of available vehicles must be determined a priori (before any routing is done), so it might not be possible to make all pickups and deliveries using the available fleet. Second, minimize the number of shipments that need to be rescheduled (these are the shipments that cannot be serviced during their time windows). Third, minimize the total travel time of the fleet.

Thangiah, Fergany, and Awan develop a heuristic for solving the SDPDTWP that is based on the work of Shang and Cuff [83]. First, the number of vehicles is determined and shipments are inserted into routes. Second, a local search is conducted. When real-time events occur throughout the time horizon, the heuristic will respond. For example, when a new shipment is introduced, the heuristic attempts to reroute the vehicles in a way that includes the new shipment while minimizing the effects on travel time and other shipments.

Thangiah, Fergany, and Awan test their heuristic on a static instance (no real-time events) of 159 shipments given by Shang and Cuff [83]. For this instance, the authors' heuristic produces a solution that services all shipments while using fewer vehicles and reducing average travel time by over 75% when compared to the results of Shang and Cuff [83]. They also test their heuristic on new instances that incorporate real-time events into the first instance. The authors examine how different real-time events affect the routes in terms of the number of unserviced customers and travel times.

2.2.3.5 Delivering Multiple Products on a Fixed Route

Liu, Lei, and Park [65] examine a variant of the SDVRP in which multiple products are delivered to a set of customers on a fixed route. They call this problem the multi-product packing-delivery problem with a fixed route, and denote the problem by P. In P, n customers have a fixed order $1, ..., n$ in which they must be visited. There are K products of varying size per unit demand, and each customer has a demand for each product. The objective is to partition the customers along the fixed sequence into feasible trips (i.e., trips that do not violate vehicle capacity) in a way that minimizes total travel cost. Service at a customer can be split between the last stop on a trip (the stop immediately preceding the return to the depot) and the first stop on the following trip.

Liu, Lei, and Park develop a heuristic for solving P. First, the optimal solution is found for the non-split case p_0 over a sequence of customers S (initially S is the entire sequence of customers). The authors show that, by converting the non-split problem to a shortest path problem, p_0 can be found in $O(n^2 log(n))$ time. Next, the first trip in p_0 with excess capacity is extended to use all of its left-over capacity, and this leads to a split delivery for a customer j. Let j^- represent customer j on the current route and j^+ represent customer j on the next route. A bin-packing routine determines the products to be delivered to node j^-. Optimal non-split solutions are determined for the segments $S_1 = \{1, 2, ..., j^-\}$ and $S_2 = \{j^+, ..., n\}$. If the sum of the costs of these two solutions is less than the cost of p_0, then the split is made. The solution from segment S_1 is added to the end of the current solution p and the process repeats with S_2 replacing S. If the sum of the costs is greater than the cost of p_0, then the split is not made and the next candidate split is considered. If there are no candidate splits to consider, then the algorithm adds p_0 to the end of p, stops, and returns p.

Liu, Lei and Park test their heuristics on instances with 1, 2, or 3 products of varying size. The instances have 50, 100, 200, 300, or 400 customers randomly generated in a 100 by 100 square in the plane. Demands all fall into a range of $[5-15\%], [10-40\%], [0-100\%]$, or $[25-75\%]$ of vehicle capacity, and are a random mix of the K products. A total of 14,000 different instances were used and the authors provide graphs illustrating that improvement in solution quality, usually between 8% and 12%, can be achieved by splitting deliveries.

2.2.3.6 Pickup and Delivery with Split Loads

Nowak, Ergun, and White [73] introduce the pickup and delivery problem with split loads (PDPSL). The PDPSL is modeled on a network of load origin nodes, load destination nodes (a node may serve as both an origin and a destination node), edges with travel costs between the nodes, and transportation requests. A transportation request is a load of goods that must be delivered from a specific origin to a specific destination. When a vehicle arrives at an origin, it can pick up any amount of any load to be delivered, up to its capacity. When a vehicle arrives at a destination, it delivers the destination's entire load. The objective of the PDPSL is to find a route for a single vehicle that meets all transportation requests while minimizing travel costs. There is no depot in the PDPSL. A vehicle begins its route at a pre-specified origin node and can end at any of the destination nodes.

Nowak, Ergun, and White develop a heuristic for solving the PDPSL with three basic steps. First, they generate an initial solution that has dedicated trips directly from the origin to the destination for each transportation request. Second, feasible splits are identified by comparing load sizes to occurrences of excess capacity along a vehicle's route. Then a split is made with a probability determined by the profitability of the split (e.g., a very profitable split has a high probability of being accepted). After a split is made, it is added to a tabu list to ensure that it is not subsequently undone, or selected again. Third, improvement procedures including a route combination routine similar to the Clarke-Wright algorithm for the VRP [25], a load swap routine, and a load insertion routine are applied and the best solution is saved.

The authors test their heuristic on two problem sets each with 120 instances of three sizes: small (5 origins, 15 destinations, and 75 requests), medium (5 origins, 20 destinations, and 100 requests), and large (5 origins, 25 destinations, and 125 requests). Origin and destination locations and load sizes are randomly generated within specified ranges. The authors also test their heuristic with the splitting step omitted on the same instances. They observe that in most instances significant savings are achieved by allowing split deliveries.

Nowak, Ergun, and White provide the results of a computational experiment performed for an anonymous third party logistic provider (3PL). To meet the real-world requirements of the 3PL, the PDPSL is modified in several ways: using a multi-vehicle fleet, penalizing one-way trips, enforcing minimum and maximum tour lengths, and imposing a financial and time-associated cost for each stop. Their heuristic for the PDPSL was modified, and run with and without splits on the 3PL data. A very modest savings of around 1% on average was achieved by splitting. The authors attribute the low level of savings to the complexity added by the real-world constraints.

2.3 Computational Issues for the SDVRP

In this section, we discuss computational issues for the standard SDVRP.

2.3.1 Problem Sets

There are three sets of benchmark problems for the SDVRP. Several papers focus on the six problems (1, 2, 4, 5, 11, 12) from Christofides and Eilon [23] and Christofides, Mingozzi, and Toth [24] with 50, 75, 100, 120, 150, and 199 customers. For each problem, a customer's demand is generated according to the six scenarios $([0.01-0.1],[0.1-0.3],[0.1-0.5],[0.1-0.9],[0.3-0.7],[0.7-0.9])$ given by Dror and Trudeau [33]. The demand for customer i in scenario $[\alpha - \beta]$ with a vehicle capacity of Q units is randomly selected from a uniform distribution on the interval $[\alpha Q, \beta Q]$ (we denote this problem set by CEMT).

Belenguer, Martinez, and Mota [10] develop a set of 14 random problems with 50, 75, and 100 customers where the vehicle capacity is 160 and the six scenarios of Dror and Trudeau [33] are used to randomly generate a customer's demand (we denote this problem set by BMM). All problems are available online at www.uv.es/belengue/sdvrp.html.

Recently, Chen, Golden, and Wasil [20] develop 21 test problems that range in size from 8 customers to 288 customers (we denote this problem set by CGW). Vehicle capacity is 100 units and customer demand is either 60 units or 90 units. The problems are generated along the lines of scenario six with very large customer demand ($[0.7 - 0.9]$) from Dror and Trudeau [33]. Each problem has a geometric symmetry (star shape) with customers located in concentric circles around the depot that allows the authors to visually estimate a near-optimal solution. The problem generator is given in [20]. The problems are given in Appendix A.

2.3.2 Reporting Computational Results

It is not a straightforward task to compare results across different papers. For example, consider the results reported by Archetti, Speranza, and Hertz [6] and Chen, Golden, and Wasil [20].

Archetti, Speranza, and Hertz [6] randomly generate problems from CEMT.

They use six demand scenarios and six problem sizes (50 customers to 199 customers) for a total of $6 \times 6 = 36$ problems. They run SPLITABU-DT five times on one instance of each scenario and provide the average percent improvement over Dror and Trudeau's results. The authors use a 2.4 GHz Pentium 4 processor with 256 MB of RAM.

Chen, Golden, and Wasil [20] randomly generate 36 problems from CEMT with the same demand scenarios and problem sizes used by Archetti, Speranza, and Hertz [6]. For each problem, they solve 30 instances on a 1.7 GHz Pentium 4 processor and 512 MB of RAM. How do you compare the results reported in both papers?

The first key issue is that the 36 problems are randomly generated, making them different in both papers. Any direct comparison is flawed from the outset. You might be thinking: Why didn't Chen, Golden, and Wasil [20] use the 36 actual problem instances solved by Archetti, Speranza, and Hertz [6] in their 2006 paper? Well, they were simply not available.

Let's take the reported results for a 50-customer problem with the $[0.01 - 0.1]$ scenario. Archetti, Speranza, and Hertz [6] solve one instance of this problem five times and report an average improvement of 5.12% over Dror and Trudeau's algorithm. Chen, Golden, and Wasil [20] solved 30 different instances of this problem and have 30 solution values. How do you compare the 5.12% to the 30 solution values?

Archetti was kind enough to provide Chen, Golden, and Wasil [20] with the actual solutions produced by SPLITABU-DT for each problem size and scenario.

These solutions are shown in Table 2.2.

These are more detailed results, but it is still not easy to make a direct comparison of five solution values to 30 solution values. The second key issue is: How do you make reasonable comparisons when the data are different?

Chen, Golden, and Wasil [20] propose a simple statistical test. If EMIP + VRTR and SPLITABU-DT are equally good with respect to solution quality, then SPLITABU-DT would beat the median EMIP + VRTR result about half the time. Using a binomial distribution with $n = 36$ (this corresponds to one run over 36 cases) and $p = 1/2$, they test the null hypothesis that the results of the two methods are equally good ($H_0 : p = 0.50$) against the alternative hypothesis that SPLITABU-DT performs worse than the median value of EMIP + VRTR ($H_a : p < 0.50$). Using a significance level of 0.01, the null hypothesis would be rejected when $(\hat{p} - 0.5)/\sqrt{(0.5)(0.5)/36} \leq -2.33$ or $\hat{p} \leq 0.3058$. If SPLITABU-DT performs better than the median value of EMIP + VRTR in $(0.3058)(36) = 11$ instances or less for a single run over 36 cases, then the null hypothesis would be rejected. The median values for EMIP + VRTR are given in Table 2.2.

For each of the five runs of SPLITABU-DT over the 36 cases, Chen, Golden, and Wasil [20] count the number of times the SPLITABU-DT solution is better than the median solution of EMIP + VRTR. For each run, the count for SPLITABU-DT is much less than 11 and, therefore, they reject the null hypothesis and conclude that SPLITABU-DT performs worse than EMIP + VRTR.

Table 2.2: Median values produced by EMIP + VRTR and actual values produced by SPLITABU-DT for a problem from CEMT.

50 customers with vehicle capacity 160		SPLITABU-DT				
Scenario	EMIP + VRTR*	1	2	3	4	5
[0.01 – 0.1]	457.21	464.64	464.64	466.19	460.79	462.54
[0.1 – 0.3]	723.57	751.60	767.46	752.84	760.57	774.56
[0.1 – 0.5]	943.86	1013.00	1015.15	997.22	1007.13	1010.86
[0.1 – 0.9]	1408.34	1461.01	1473.29	1470.11	1443.84	1501.39
[0.3 – 0.7]	1408.68	1507.60	1491.92	1490.73	1487.02	1507.25
[0.7 – 0.9]	2056.01	2166.34	2174.81	2166.11	2170.43	2148.38

* median solution value over 30 instances given in [20]

2.3.3 Summary of Computational Issues

The availability of only randomly generated problems coupled with different computing platforms makes the comparison of published computational results difficult. Most algorithms have not been run on exactly the same set of SDVRP test problems. Sometimes researchers devised clever tests or used comparison contortions to make their points. Larger problems with visually estimated solutions are now available for researchers to test their algorithms.

2.4 Conclusions and Future Directions

In recent years, the SDVRP has drawn a significant amount of attention in the operations research literature. Powerful solution methods including tabu search, simulated annealing, record-to-record travel algorithm, genetic algorithms, dynamic programming, and mixed integer programming have been applied to the SDVRP and have produced high-quality results to benchmark problems. Researchers have begun to consider interesting variants of the SDVRP that account for time windows, pickups, and backhauls.

In the future, we expect that, with rapidly rising fuel prices and increasing vehicle purchase and maintenance costs, companies with significant routing components will try to reduce costs by considering split deliveries. OR practitioners and researchers will play an important role in developing the algorithms for implementation in software and systems for solving practical applications of the SDVRP.

Chapter 3

The Split Delivery Vehicle Routing Problem with Minimum Delivery Amounts

3.1 Introduction

In the vehicle routing problem (VRP), a fleet of vehicles must service the demands of customers. A vehicle begins and ends its route at the same depot and the sum of the demands of the customers on a route cannot exceed a vehicle's capacity. A customer must have all of its demand delivered at one time by a single vehicle. The objective is to minimize the total distance traveled by the fleet.

In the split delivery vehicle routing problem (SDVRP), more than one vehicle is allowed to service a customer, so that a customer's demand can be split among several vehicles on different routes. The objective in the SDVRP is to minimize the total distance traveled by the fleet, while satisfying the demand of each customer. By allowing split deliveries, the cost of a solution can potentially be reduced by as much as 50% [5].

In this chapter, we consider the SDVRP with an additional constraint: each customer has a minimum delivery amount. The motivation for this requirement is a practical one. In general, a visit to a customer is costly to both the distributor and the customer. It takes time, involves paperwork and data processing, and often distracts the customer from primary activities. As a result, both parties want a visit to be consequential. The distributor or customer may impose a minimum delivery amount or a minimum delivery value.

For example, restaurants such as Pizza Hut [75] will deliver orders placed by telephone or online provided that the order is at least \$8.00 (approximately). In St. John's, Newfoundland, local oil delivery companies decided not to deliver fuel to homes unless the delivery value is at least \$200.00 (Canadian) [87]. In modeling the delivery of industrial gases as an inventory routing problem for PRAXAIR, Campbell, Clarke, and Savelsbergh [16] imposed a minimum total volume of gas that had to be delivered to a customer by the end of a day. In practice, there may also be minimum amounts required when delivering gasoline to service stations.

With split deliveries, the issue is exacerbated. It is especially undesirable for the customer to be interrupted and distracted twice (or more), unless the delivery is substantial in amount or value each time. Thus, we allow a customer's demand to be split among several vehicles only if each vehicle delivers at least a minimum amount when it visits the customer. We call this problem the split delivery vehicle routing problem with minimum delivery amounts and denote it by SDVRP-MDA.

We model the SDVRP-MDA on a complete graph $G = (V, E)$ in which each node (customer) $i \in V$ has demand D_i and each edge $e \in E$ has distance c_e. Let Q be the vehicle capacity and $v_0 \in V$ be the depot. Let R be a set of routes on G. Let $V(r)$ be the set of nodes, $E(r)$ be the set of edges that comprise a route $r \in R$, and d_{ir} be the amount delivered to node i on route r. Let δ_i be the minimum amount of demand that must be satisfied by each vehicle visiting customer i. We want to find a set of routes R such that

- each route begins and ends at v_0, for all $r \in R$
- $\sum_{i \in V(r)} d_{ir} \leq Q$, for all $r \in R$ (vehicle capacity restriction)
- $\sum_{r \in R} d_{ir} = D_i$, for all $i \in V$ (demand must be satisfied for each customer)
- $d_{ir} \geq \delta_i$, for all $i \in V(r)$ and for all $r \in R$ (minimum delivery amount)
- minimize $\sum_{r \in R} \sum_{e \in E(r)} c_e$ (total distance is minimized).

In our work, the minimum delivery amount is a fixed percentage of a customer's demand. That is, we let p be the minimum delivery fraction ($0 \leq p \leq 1$), and let $\delta_i = pD_i$, for customer i. However, it is possible to use any minimum delivery amount, provided $0 \leq \delta_i \leq D_i$.

In Figure 3.1, we provide an example of the SDVRP-MDA. In Figure 3.1(a), we have three customers (nodes 1, 2, and 3) and a depot (node 0). Edge labels are distances and node labels in parentheses are demands. The vehicle capacity is 120. The optimal solution to the VRP (no split deliveries allowed) has three direct round-trips for a total distance of 30. In Figure 3.1(b), we show the optimal solution to the traditional SDVRP with no minimum delivery amounts ($p = 0$). By allowing split deliveries, the total distance traveled by the fleet in the SDVRP (25 units) is smaller than the distance traveled in the VRP (30 units). In Figure 3.1(c), we set $p = .3$ so that each customer must have at least 30% of its demand delivered by a vehicle. We observe that the solution in Figure 3.1(b) is not feasible when $p = .3$

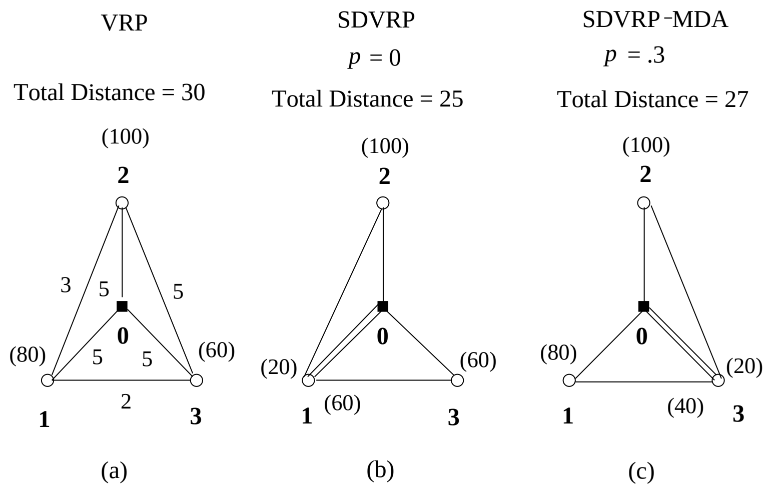


Figure 3.1: An SDVRP-MDA example with four nodes. The edge labels are distances and the node labels in parentheses are demands. The vehicle capacity is 120.

(the split delivery to customer 1 has only 25% of its demand (20 units) on one of the two routes).

The remainder of this chapter is organized as follows: In Section 3.2, we review the literature on the SDVRP. In Section 3.3, we present theoretical properties of the SDVRP-MDA. In Section 3.4, we develop an algorithm for solving the SDVRP-MDA that uses a mixed integer program and an enhanced record-to-record travel algorithm. In Section 3.5, we present computational results. In Section 3.6, we give our conclusions and suggestions for future work.

3.2 Literature Review of the SDVRP

Over the last 20 years, researchers have developed several procedures for solving the SDVRP. In the late 1980s and early 1990s, Dror and Trudeau [33, 34] used a two-stage algorithm that incorporated k-split interchanges and route additions. Recently, Archetti, Speranza, and Hertz [6] developed a tabu search algorithm for solving the SDVRP. Chen, Golden, and Wasil [20] combined an endpoint mixed integer program and a variable length record-to-record travel algorithm. Mota, Campos, and Corberán [71] used a scatter-search procedure. The papers by Archetti and Speranza [4] and Gulczynski, Golden, and Wasil [51] are good sources for recent developments in modeling and solving the SDVRP.

Researchers have constructed bounds for the SDVRP. Belenguer, Martinez, and Mota [10] considered the polyhedron formed by feasible solutions to the SDVRP and proposed a cutting-plane algorithm that produced a lower bound. They obtained an upper bound using the solution generated by an algorithm due to Martinez [66]. Jin, Liu, and Eksioglu [58] improved the bounds given in [10] with a column generation procedure.

Several variants of the traditional SDVRP have been explored in the literature including the SDVRP with time windows [31, 55], pickups and deliveries [70], and a heterogeneous fleet [89]. Real-world applications of the SDVRP include the distribution of livestock feed on a large ranch [72], routing helicopters to offshore work platforms for crew exchanges [84], collecting waste [3], and routing ships when cargo sizes are flexible [15].

3.3 Properties of the SDVRP-MDA

In this section, we present two observations about the SDVRP-MDA. The first concerns k-split cycles. A k-split cycle is a set of k customers $i_1, i_2, ..., i_k$ visited by k routes $r_1, r_2, ..., r_k$, such that the demand at customer i_j is split between routes r_j and r_{j+1}, for $j = 1, ..., k-1$, and the demand at customer i_k is split between routes r_k and r_1. Dror and Trudeau [34] proved that, when distances satisfy the triangle inequality, any SDVRP has an optimal solution without a k-split cycle (for any k). For the SDVRP-MDA, this result does not hold, as we show below.

<u>Observation 1.</u> *For p, $0 < p \leq .5$, there exists an SDVRP-MDA with a minimum delivery fraction p, for which all optimal solutions have a k-split cycle ($k = 2$).*

In Figure 3.2, we show an SDVRP-MDA that satisfies this observation. In this example, there are three customers all located 1 unit from each other and 10 units from the depot. The vehicle capacity is 1. The demand of customer 1 is $D_1 = 1 - a$, the demand of customer 2 is $D_2 = 1 - p + pa + a/2$, and the demand of customer 3 is $D_3 = p - pa + a/2$, where a is a positive number less than one, such that $a < p^2/(p^2 - p/2 + 1)$, and $D_1 > D_2 > D_3 > 0$ (more about this definition later). Since $0 < p^2/(p^2 - p/2 + 1) < 1$, and by how D_1, D_2 and D_3 are defined, such an a always exists.

To show that the example in Figure 3.2 does not have an optimal solution without a 2-split cycle, we have $D_1 + D_2 + D_3 = 2$, so an optimal solution must have at least two routes. Next, consider the solution with two identical routes, both visiting each customer. Both vehicles satisfy half of a customer's demand in

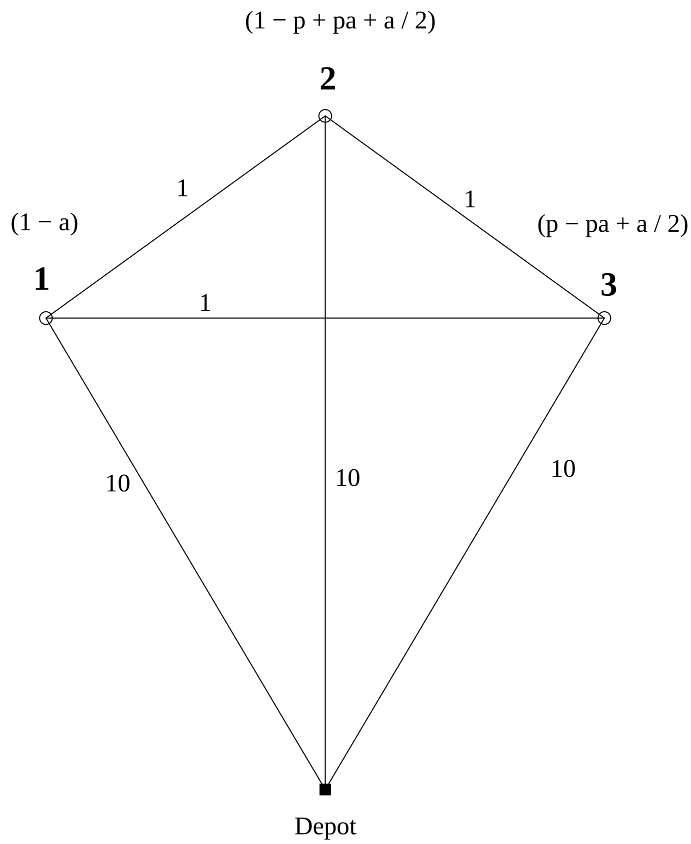


Figure 3.2: In this example, all optimal solutions have a 2-split cycle (customer demands are given in parentheses).

a visit. The solution is feasible (since $p \leq .5$ and $Q = 1$) and has a total distance of 44. Since this is less than the best solution with three routes – direct trips to each customer for a distance of 60 – an optimal solution must have two routes. Since $D_1 + D_2 + D_3 = 2$, and $D_3 < D_2 < D_1 < 1$, no pair of customers can be serviced in full on the same route without violating the vehicle capacity constraint, so an optimal solution must have at least one split delivery. Further, if an optimal solution has more than one split delivery, then, since there are only two routes, any two customers with split deliveries constitute a 2-split cycle.

We now show that all optimal solutions have more than one split delivery, verifying our observation. To generate a contradiction, assume there is an optimal solution in which only one customer is split, call it customer A. The routes of this solution are: D - A - B - D and D - A - C - D, where D is the depot and B and C are the non-split customers. Suppose customer A is customer 1 in Figure 3.2. Without loss of generality, we let customer B be customer 2. The minimum load of the route visiting customers A and B is $pD_1 + D_2 = p(1-a) + 1 - p + pa + a/2 = 1 + a/2 > 1$, which violates the vehicle capacity. Thus, customer A is not customer 1. Next, assume customer A is customer 3. Without loss of generality, let customer B be customer 1. By definition, $a < p^2/(p^2 - p/2 + 1)$, so $-a(p^2 - p/2 + 1) + p^2 > 0$. The minimum load of the route visiting customers A and B is $pD_3 + D_1 = p(p - pa + a/2) + 1 - a = -a(p^2 - p/2 + 1) + p^2 + 1 > 1$, which violates the vehicle capacity. Thus, customer A is not customer 3. Similarly, since $pD_2 + D_1 > pD_3 + D_1 > 1$, customer A is not customer 2. Hence, there is no optimal solution in which only one customer has a split delivery, so all optimal solutions have a 2-split cycle, and our observation is verified.

As a specific example, consider the SDVRP-MDA in Figure 3.2 with $p = .5$ and $a = .2$, so that $D_1 = .8, D_2 = .7$, and $D_3 = .5$. A solution with two routes and exactly one split delivery violates either the vehicle capacity constraint or the minimum delivery amount constraints.

Another well-known result for the traditional SDVRP is that, by allowing split deliveries, distance can be reduced by at most 50%. That is, if Z_{VRP} is the optimal VRP distance of an instance with no splits, and Z_{SDVRP} is the optimal SDVRP distance of the same instance, then $\frac{Z_{VRP}}{Z_{SDVRP}} \leq 2$. Archetti, Savelsbergh, and Speranza [5] have shown that this bound is tight. However, for the SDVRP-MDA this bound might not hold. If Z_{MDA} is the optimal SDVRP-MDA distance, and M is a tight upper bound for $\frac{Z_{VRP}}{Z_{MDA}}$, an exact value for M is not known at this time. We make the following observation.

<u>Observation 2.</u> *Let $p = 2/j$, for some integer $j \geq 4$. For an SDVRP-MDA with a minimum delivery fraction p, we have $2 - p \leq M \leq 2$.*

To verify this observation, since $Z_{MDA} \geq Z_{SDVRP}$ and $\frac{Z_{VRP}}{Z_{SDVRP}} \leq 2$, we have $M \leq 2$. To show that $M \geq 2 - p$, we use the example given in Figure 3.3 from Archetti, Savelsberg, and Speranza [5]. This example has $2k$ customers, where $k = 2/p - 1$. The depot is located at the center of two concentric circles with radius 1 and radius $1 + a$, where a is a positive number. There are k customers on the smaller circle, spread out at a distance of a units apart from one another, and k customers on the larger circle, perfectly aligned with the other customers. Every customer has demand $Q/2 + 1$, where $Q = 2k$ is the vehicle capacity. In Figure 3.3, we have $k = 3$ and $p = .5$.

The optimal VRP solution has direct trips to the customers for a total distance of $4k + 2ka$. Consider the SDVRP-MDA solution with k routes, each visiting two customers along a radius, delivering all $Q/2 + 1$ units to the furthest customer and $Q/2 - 1$ units to the closest customer, and a route delivering the remaining 2 units to all customers along the smaller circle. This solution has a total distance of $2k + 2ka + (k - 1)a + 2$. This solution is feasible. Since $p(Q/2 + 1) = 2$ we deliver at least the minimum amount to each customer, and since $Q = 2k$ the single route visiting the customers on the smaller circle does not exceed a vehicle's capacity. In

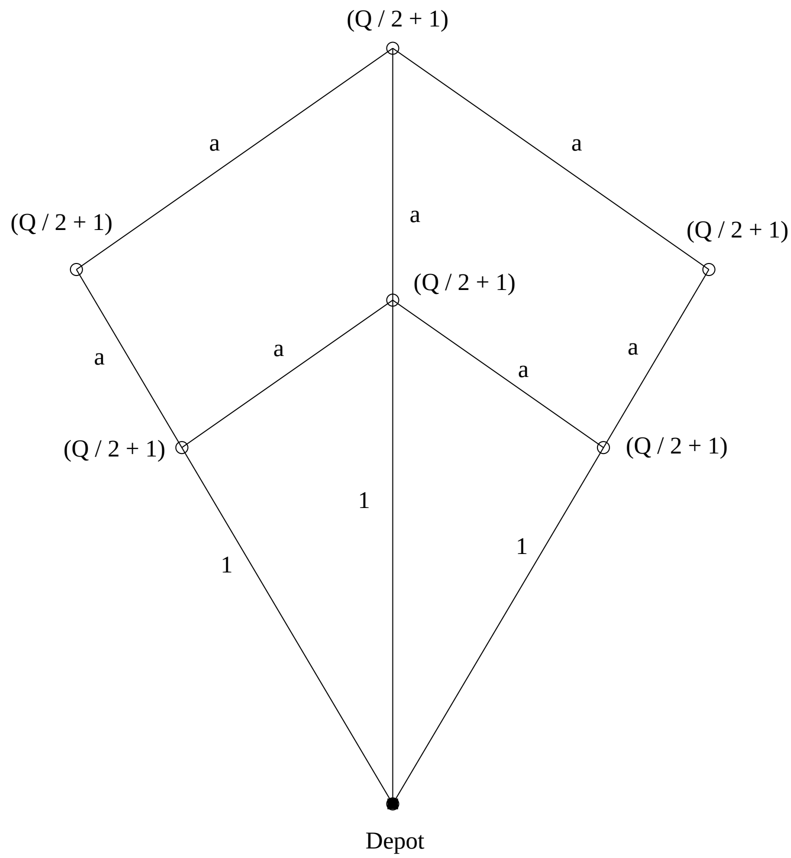


Figure 3.3: In this example, the distance of the VRP solution tends to $2 - p$ times the distance of the SDVRP-MDA solution as a tends to 0 (customer demands are given in parentheses).

this example, $\frac{Z_{VRP}}{Z_{MDA}} = (4k + 2ka)/(2k + 2ka + (k-1)a + 2)$. Since this expression goes to $4k/(2k+2)$ as a goes to 0, we have that M is at least $4k/(2k+2) = 2 - p$, and our observation is verified.

We note that, if $2/p$ is not an integer, we can use this example to obtain a similar result by setting $k = \lfloor 2/p - 1 \rfloor$. We also point out that, when $p = 0$ we have $Z_{MDA} = Z_{SDVRP}$ and when $p = 1$ we have $Z_{MDA} = Z_{VRP}$, which gives $M = 2 - p$. We wish to further explore the relationship between p and M in future work.

3.4 Solving the SDVRP-MDA

3.4.1 Formulating the SDVRP-MDA as a Mixed Integer Program

Let S be an initial solution with no split deliveries. Since two routes must be close together to efficiently split the service of a customer, we look for splits near the depot where all routes meet. We consider splitting only the endpoints of S (the endpoints are those customers adjacent to the depot). Let EP be the set of endpoints. Given an endpoint $i \in EP$, let $NE(i)$ be its neighborhood, that is, the set of endpoints closest to i. We consider moving some of the serviced demand of i to a new location immediately prior to a customer in $NE(i)$. Specifically, for each $i \in EP$ given j in $NE(i)$, there are three possibilities: (1) all of the demand of i is moved prior to j, (2) some of the demand of i is moved prior to j (we split i's delivery), and (3) none of the demand of i is moved prior to j. Let c_{uv} be the travel cost between customers u and v, and $p(u)$ and $s(u)$ be the predecessor and successor of u, respectively. The savings associated with the three possible moves are: (1) $-c_{p(j)i} - c_{ij} - c_{p(i)s(i)} + c_{p(j)j} + c_{p(i)i} + c_{is(i)}$, (2) $-c_{p(j)i} - c_{ij} + c_{p(j)j}$, and (3) zero. In Figure 3.4, we show the possible endpoint moves. In Figure 3.4(a), we have five customers (nodes 1, 2, 3, 4, and 5), a depot (node 0), and two routes. In Figure 3.4(b), all of customer 3's demand on route 1 is moved prior to node 4 on route 2, resulting in a savings of $-c_{03} - c_{34} - c_{20} + c_{04} + c_{23} + c_{30}$. In Figure 3.4(c), some of customer 3's demand on route 1 is moved prior to node 4 on route 2, resulting in a savings of $-c_{03} - c_{34} + c_{04}$.

In order to find the optimal reallocation of demand across all endpoints, we for-

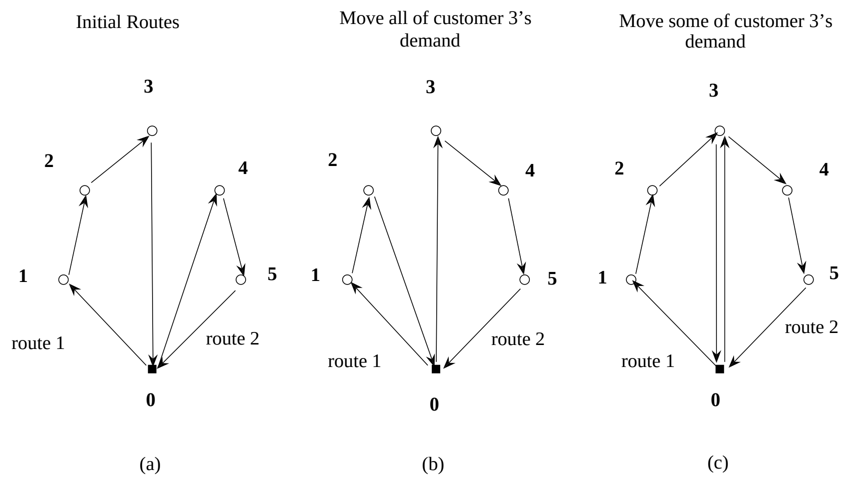


Figure 3.4: Endpoint moves.

mulate an endpoint mixed integer program with minimum delivery amounts (EMIP-MDA). Our formulation is based on the EMIP developed by Chen, Golden, and Wasil [20].

In the EMIP-MDA, let R be the set of routes of solution S. Q_r is the residual capacity of route $r \in R$ (that is, the vehicle capacity minus the total amount delivered on r), D_i is the demand of endpoint i, and δ_i is the minimum amount of demand that must be serviced at endpoint i at a visit. In our experiments, we let $\delta_i = \lceil pD_i \rceil$, where p is the minimum delivery fraction. Our formulation holds for any $\delta_i \leq D_i$.

The decision variables are defined as follows. Let b_i equal 1 if all of endpoint i's demand is moved (that is, i is removed from its current route), and 0 otherwise; a_i equals 1 if any of endpoint i's demand is moved, and 0 otherwise; m_{ij} equals 1 if endpoint i is inserted before $j \in NE(i)$, and 0 otherwise; and d_{ij} is the amount of endpoint i's demand that is moved before $j \in NE(i)$.

Our formulation of the EMIP-MDA is given by (1) to (14).

$$\text{maximize} \sum_{i \in EP} b_i(c_{p(i)i} + c_{is(i)} - c_{p(i)s(i)}) - \sum_{i \in EP} \sum_{j \in NE(i)} m_{ij}(c_{p(j)i} + c_{ij} - c_{p(j)j}) \tag{1}$$

subject to

$$\sum_{i:j \in NE(i)} d_{ij} + \sum_{q:k \in NE(q)} d_{qk} - \sum_{l \in NE(k)} d_{kl} - \sum_{t \in NE(j)} d_{jt} \leq Q_r \qquad \forall r \in R; k, j \text{ endpoints of route } r \tag{2}$$

$$\sum_{j \in NE(i)} d_{ij} \leq D_i \qquad \forall i \in EP \tag{3}$$

$$\sum_{j \in NE(i)} d_{ij} \geq D_i b_i \qquad \forall i \in EP \tag{4}$$

$$D_i m_{ij} \geq d_{ij} \qquad \forall i \in EP, \quad \forall j \in NE(i) \tag{5}$$

$$1 - b_i \geq \sum_{j:i \in NE(j)} m_{ji} \qquad \forall i \in EP \tag{6}$$

$$1 - b_{p(i)} \geq \sum_{j:i \in NE(j)} m_{ji} \qquad \forall i \in EP \text{ such that } p(i) \in EP \tag{7}$$

$$b_i + b_{p(i)} \leq 1 \qquad \forall r \in R; \quad i, p(i) \text{ both endpoints of route } r \tag{8}$$

$$a_i \leq \sum_{j \in NE(i)} m_{ij} \qquad \forall i \in EP \tag{9}$$

$$\sum_{j \in NE(i)} d_{ij} \leq D_i a_i \qquad \forall i \in EP \tag{10}$$

$$\delta_i(a_i - b_i) \leq D_i - \sum_{j \in NE(i)} d_{ij} \qquad \forall i \in EP \tag{11}$$

$$d_{ij} \geq \delta_i m_{ij} \qquad \forall i \in EP, \quad \forall j \in NE(i) \tag{12}$$

$$d_{ij} \geq 0 \qquad \forall i \in EP, \quad \forall j \in NE(i) \tag{13}$$

$$m_{ij}, b_i, a_i \in \{0, 1\} \qquad \forall i \in EP, \quad \forall j \in NE(i) \tag{14}$$

In the objective function (1), we maximize the total savings across all possible endpoint moves. Constraints (2) ensure that feasibility is maintained with respect to vehicle capacity, that is, the total amount of demand moved to a route minus the total amount moved from a route is less than the residual capacity. In constraints (3), we cannot move more than the actual demand at a customer. In constraints (4), we ensure that all demand is moved from customer i if $b_i = 1$, while in constraints (5), we ensure that $m_{ij} = 1$ if any demand is moved from customer i prior to customer j. Constraints (6) and (7) prevent any demand from being moved prior to customer i if customer i or customer $p(i)$ has been removed from its route. In constraints (8), we eliminate the possibility of removing both endpoints from a route if a route has no customers other than these endpoints, as removing a customer and its predecessor can produce inaccurate savings in the objective function. Constraints (9) and (10) guarantee that $a_i = 1$ if and only if some of customer i's demand is moved. In constraints (11), we ensure that if some, but not all of i's demand is moved, then the amount remaining will be at least the minimum delivery amount. Minimum delivery amounts are enforced in constraints (12). Constraints (13) and (14) ensure nonnegativity and 0-1 solutions. We show an EMIP-MDA formulation for a small problem in Section 3.7 (Appendix I).

3.4.2 Combining EMIP-MDA with Record-to-record Travel

Our heuristic for solving the SDVRP-MDA starts with a VRP solution (no splits) generated by applying a modified Clarke-Wright savings algorithm [95]. The savings from merging two routes at customers u and v is given by $c_{us(u)} + c_{p(v)v} - \lambda c_{uv}$. We run the modified Clarke-Wright algorithm with three different λ values ($\lambda = 0.6, 1.4, 1.6$) and select the lowest-cost solution as our initial solution.

Using this initial solution, an EMIP-MDA is formulated and solved. The neighborhood size depends on the number of customers (e.g., when the number of customers is between 24 and 120 the neighborhood size is 10). We point out that a small EMIP-MDA model can be time-consuming to solve (a 50 node instance can have as many as 550 integer variables, 500 continuous variables, and 1900 constraints) . Therefore, we set a run-time limit that takes into account the size of the problem. We solve the EMIP-MDA model and denote the solution by $S1$.

Using $S1$, a second EMIP-MDA is formulated and solved. The neighborhood size is increased, and the run-time limit is decreased. In the EMIP-MDA formulation, we consider each visit to each customer on a route in $S1$ as a distinct customer whose demand is the amount serviced at that visit. For example, if customer j with demand D_j is split in $S1$ between routes r and q with amount d_{jr} on route r and amount d_{jq} on route q, where $d_{jr} + d_{jq} = D_j$, then we proceed as if there are two customers at the same location as j, one with demand d_{jr} on route r and one with demand d_{jq} on route q. To ensure feasibility, we set the minimum delivery amount of both customers to $\lceil pD_j \rceil$, where p is the minimum delivery fraction. We denote the solution of the second EMIP-MDA by $S2$.

Finally, we apply a post processor. Using $S2$, we create a VRP instance, denoted by I, by considering each visit to each customer on a route in $S2$ as a distinct customer in I whose demand is the amount serviced at that visit. We apply an enhanced record-to-record travel algorithm (ERTR) to I. ERTR is a VRP heuristic developed by Groër, Golden, and Wasil [50]. It is an enhanced version of the variable length record-to-record travel algorithm (VRTR) developed by Li, Golden, and Wasil [63]. VRTR improves a solution by performing one-point and two-point node exchanges, as well as two-opt edge exchanges. ERTR considers

Table 3.1: Enhanced record-to-record travel algorithm.

$\lambda_1 = .6, \lambda_2 = 1.4, \lambda_3 = 1.6, deviation = 1\%, count = 0, C = 10, K = 70$
For $x = 0$ to 3
If $(x = 0)$, $S = S2$
Else S = modified Clarke-Wright solution on I with parameter λ_x
Initialize the record for this iteration, $S^* = S$
Uphill:
For $k = 1$ to K
Apply each of one-point moves, two-point moves, and three-point moves
Apply both two-opt edge exchanges and OR-opt edge exchanges
Update S if result is within *deviation* of cost of S^*
Update S^* if necessary
End-For
Downhill:
Apply both two-opt edge exchanges and OR-opt edge exchanges
Apply each of one-point moves, two-point moves, and three-point moves
If (cost decreases), update S and go to Downhill
Else Update S^* if necessary, otherwise $count = count + 1$
If $(count < C)$ go to Uphill
Perturb solutions once and go to Uphill
End-For
Return the best S^* from the four iterations

additional moves including three-point node exchanges and OR-opt edge exchanges. Uphill moves are allowed when a solution is within a pre-specified tolerance of the record (best) solution. We apply ERTR to four different solutions: $S2$ and the results from the modified Clarke-Wright algorithm on I with three values of λ. The details of ERTR are given in Table 3.1. The complete description of the EMIP-MDA + ERTR is given in Table 3.2.

Table 3.2: EMIP-MDA + ERTR algorithm for solving the SDVRP-MDA.

S = best of three modified Clarke-Wright solutions, $\lambda = .6, 1.4, 1.6$
If (the number of customers n is less than 24)
Set max neighborhood size L to be $n - 1$
Set MIP time limit T to be 800 seconds
Else-if ($n < 120$), $L = 10$, $T = 400$
Else $L = 8, T = 1000$
$S1$ = EMIP-MDA solution on S with parameters L and T
$S2$ = EMIP-MDA solution on $S1$ with parameters $\lfloor \frac{3}{2} L \rfloor$ and $.6 \times T$
S^* = solution after the ERTR is applied
Return S^*

3.5 Computational Experiments

3.5.1 Establishing the Quality of EMIP-MDA + ERTR on Standard VRPs

We want to establish the accuracy and speed of EMIP-MDA + ERTR with respect to solving standard VRPs. We applied it to six benchmark problems (1, 2, 4, 5, 11, 12) from Christofides and Eilon [23] and Christofides, Mingozzi, and Toth [24]. These problems have 50 to 199 customers with no minimum delivery amounts. We solved the mixed integer program with ILOG CPLEX 10.0 and Visual C++ (version 6.0) using a 3.0 GHz Pentium 4 processor and 512MB of RAM.

In Table 3.3, we give the solution values and running times generated by EMIP-MDA + ERTR, EMIP + VRTR (Chen, Golden, and Wasil [20]), SPLITABU-DT (an average of five runs as provided by Archetti and reported in [20]), and the best-known solutions. We see that EMIP-MDA + ERTR and EMIP + VRTR generated very similar, high-quality results. On average, EMIP-MDA + ERTR is 0.71% above the best-known solution, while EMIP + VRTR is 0.54% above the best-known

Table 3.3: Computational results for three algorithms on six capacitated VRPs.

Customers	EMIP-MDA + ERTR[1] Solution	Time (s)	EMIP + VRTR[2] Solution	Time (s)	SPLIT-TABU[3] Solution	Time (s)	Best-known Solution
50	524.61	18.2	524.61	1.8	533.55	13.2	524.61[a]
75	839.77	32.2	840.18	4.0	849.54	35.8	835.26[a]
100	819.56	74.7	819.56	3.7	835.62	57.6	819.56[a]
120	1042.24	90.7	1043.18	5.6	1056.01	38.4	1042.11[a]
150	1047.40	91.5	1041.99	10.0	1069.84	389.0	1028.42[a]
199	1315.70	106.3	1307.40	18.1	1342.85	386.4	1291.29[b]
Average Deviation[4]	0.71%		0.54%		2.45%		

[1] 3.0 GHz Pentium 4 processor

[2] 1.7 GHz Pentium 4 processor

[3] 2.4 GHz Pentium 4 processor

[4] Average deviation from the best-known solution

[a] Rochat and Taillard [79]; [b] Mester and Bräysy [68]

solution. EMIP-MDA + ERTR (total of 413.6 seconds) was slower than EMIP + VRTR (43.2 seconds) in solving these six problems, even though EMIP-MDA + ERTR was run on a faster machine. This is due to the time-consuming OR-opt edge exchanges and three-point node exchanges in our algorithm.

3.5.2 Establishing the quality of EMIP-MDA + ERTR on Standard SDVRPs

First, we applied EMIP-MDA + ERTR to the 11 benchmark SDVRPs from Belenguer, Martinez, and Mota [10] that are available at www.uv.es/belengue/sdvrp.html. These problems have 51, 76, and 101 nodes including the depot. The demand at each customer is a randomly selected integer from the uniform distribution on the interval $[aQ, bQ]$, where Q is the vehicle capacity and the demand range is $[a, b]$. For example, the problem denoted by S51D2 (in Table 3.4) has 51 nodes including the depot and customer demands are randomly generated along the lines of scenario 2 from Dror and Trudeau [33] which has demand range $[0.1, 0.3]$.

In Table 3.4(a), we give the solution values and running times generated by EMIP-MDA + ERTR, EMIP + VRTR, CGA (column generation algorithm of Jin, Liu, and Eksioglu [58]), and CP (cutting-plane algorithm of Belenguer, Martinez, and Mota [10]). In Table 3.4(b), we give the best lower bound for each problem from [10] and [58] and the percent deviation of each solution from the lower bound. On average, EMIP-MDA + ERTR is 4.01% above the lower bound (on all 11 problems), closely followed by EMIP + VRTR at 4.60% (on five problems). On average, CGA and CP are more than 8% and 7%, respectively, above the lower bound. On average, over all 11 problems, EMIP-MDA + ERTR takes 487.9 seconds to solve a problem, and CGA takes 7296.0 seconds. EMIP + VRTR takes 390.6 seconds over five problems.

Second, we applied EMIP-MDA + ERTR to 21 benchmark problems developed by Chen, Golden, and Wasil [20]. These problems have 8 to 288 customers and are available at www.rhsmith.umd.edu/faculty/bgolden/vrp_data.htm. A near-optimal solution can be visually estimated for each problem.

In Table 3.5, we give the solution values and running times generated by EMIP-MDA + ERTR and EMIP + VRTR and the values of the estimated solutions. The estimated solution and the solution produced by EMIP-MDA + ERTR are the same on eight problems; they are the same on four problems for EMIP + VRTR. EMIP-MDA + ERTR finds three new best solutions. On average, EMIP-MDA

Table 3.4: Computational results for four algorithms on 11 benchmark SDVRPs.

(a) Solution values and running times

	EMIP-MDA + ERTR[1]		EMIP+VRTR[2]		CGA[3]		CP[4]
Problem	Solution	Time (s)	Solution	Time (s)	Solution	Time (s)	Solution
S51D2	**717.34**	60.8	NC		723.37	5987	726
S51D3	969.18	56.6	NC		**968.85**	607	972
S51D4	**1580.79**	662.6	1586.5	201.7	1657.61	260	1677
S51D5	1356.37	660.0	**1355.5**	201.6	1439.92	46	1440
S51D6	**2186.29**	677.8	2197.8	301.9	2300.21	243	2327
S76D2	**1105.19**	31.4	NC		1185.72	12806	1147
S76D3	**1442.61**	164.7	NC		1504.94	2030	1474
S76D4	**2104.87**	980.0	2136.4	601.9	2219.07	1813	2257
S101D2	1397.38	402.0	NC		1474.51	47658	**1393**
S101D3	**1921.67**	961.1	NC		2012.86	7959	1975
S101D5	2852.01	709.8	**2846.2**	646.0	2954.96	847	2915

[1] 3.0 GHz Pentium 4 processor

[2] 1.7 GHz Pentium 4 processor

[3] 2.8 GHz Pentium 4 processor

[4] No times reported

NC Not considered

Bold indicates the best solution

(b) Lower bounds and percent deviations

		Percent Deviation[2]			
Problem	Lower Bound[1]	EMIP-MDA + ERTR	EMIP + VRTR	CGA	CP
S51D2	694.98	3.22		4.08	4.46
S51D3	922.72	5.04		5.00	5.34
S51D4	1520.67	3.95	4.33	9.01	10.28
S51D5	1297.46	4.54	4.47	10.98	10.99
S51D6	2113.03	3.47	4.01	8.86	10.13
S76D2	1066.17	3.66		11.21	7.58
S76D3	1397.43	3.23		7.69	5.48
S76D4	2019.91	4.21	5.77	9.86	11.74
S101D2	1349.77	3.53		9.24	3.20
S101D3	1837.33	4.59		9.55	7.49
S101D5	2725.50	4.64	4.43	8.42	6.95
Average Deviation		4.01%	4.60%	8.53%	7.60%

[1] Best lower bound from [10] and [58]

[2] Deviation = 100[(Solution − Lower bound)/Lower bound]%

+ ERTR and EMIP + VRTR are 0.25% and 1.38%, respectively, above the best solution for each problem. We point out that the run times of both algorithms are highly dependent on the number of customers. Both algorithms solve an MIP that terminates if an optimal solution is not returned within a pre-specified time limit. Solving the MIP accounts for most of the run time, and the time limit is based on the size of the problem. For example, for problems with more than 120 customers, the time limit for EMIP-MDA is 1600 seconds (1000 seconds to solve the MIP associated with the initial solution and 600 seconds to solve the second MIP), and it is 5000 seconds for EMIP.

3.5.3 Establishing the quality of EMIP-MDA + ERTR on SDVRP-MDAs

The SDVRP-MDA is new in the literature and there are no problems available for testing solution procedures. We needed to create problems that have very good estimated solutions. To illustrate our procedure for generating test problems, consider the layout given in Figure 3.5. We show an example with four customers (nodes 1, 2, 3, and 4), one depot (node 0), a vehicle capacity of 100 units, and two values of p (.1 and .2). In Figures 3.5(a), (b), and (c), the demand is 56 units at customers 1 and 2 and 94 units at customers 3 and 4, $p = .1$ (a vehicle must deliver at least 10% of a customer's demand on a visit), and there are three routes – 0-1-3-0, 0-1-2-0, and 0-2-4-0. The demand at customer 1 is split with 6 units and 50 units delivered on two different routes. The delivery of 6 units meets the minimum

Table 3.5: Computational results for two algorithms on 21 benchmark SDVRPs.

Problem	Estimated Solution[1]	EMIP-MDA + ERTR[2] Solution	EMIP-MDA + ERTR[2] Time (s)	EMIP+VRTR[3] Solution	EMIP+VRTR[3] Time (s)
SD1	**228.28**	**228.28**	3.1	**228.28**	0.7
SD2	**708.28**	**708.28**	424.1	714.40	54.4
SD3	**430.61**	**430.58**	20.8	**430.61**	67.3
SD4	**631.06**	**631.05**	454.7	**631.06**	400.0
SD5	**1390.61**	**1390.57**	655.5	1408.12	402.7
SD6	**831.21**	**831.24**	656.0	**831.21**	408.3
SD7	**3640.00**	**3640.00**	669.9	3714.40	403.2
SD8	**5068.28**	5092.36	678.3	5200.00	404.1
SD9	**2044.23**	**2044.20**	662.3	2059.84	404.3
SD10	**2684.85**	2704.69	700.9	2749.11	400.0
SD11	**13280.00**	13358.31	709.0	13612.12	400.1
SD12	7280.00	**7256.77**	729.0	7399.06	408.3
SD13	**10110.60**	10141.79	729.2	10367.06	404.5
SD14	10920.00	**10780.03**	1718.1	11023.00	5021.7
SD15	**15151.10**	15216.29	1664.6	15271.77	5042.3
SD16	**3381.32**	3382.16	1654.8	3449.05	5014.7
SD17	**26560.00**	26640.69	1785.3	26665.76	5023.6
SD18	14380.30	**14357.77**	1723.0	14546.58	5028.6
SD19	**20191.20**	20348.16	1787.6	20559.21	5034.2
SD20	**39840.00**	39902.76	1839.8	40408.22	5053.0
SD21	**11271.10**	11436.70	1825.1	11491.67	5051.0
Average Deviation[4]		0.25%		1.38%	

[1] Solution value from [20]

[2] 3.0 GHz Pentium 4 processor

[3] 1.7 GHz Pentium 4 processor

[4] Average deviation from the best solution

Bold indicates the best solution

Note. For SD3, SD4, SD5, SD6, and SD9, the solutions for EMIP-MDA + ERTR and EMIP + VRTR are the same with the differences due to rounding.

delivery of $0.10 \times 56 = 5.6$ units. Of course, this particular split at customer 1 would be infeasible for larger values of p. For example, if $p = .2$, then a vehicle must deliver at least $.20 \times 56 = 11.2$ units to customer 1. If the vehicle covering the route 0-1-3-0 in the *estimated solution* delivered 12 units to customer 1, then not all 94 units of customer 3 would fit in the vehicle (capacity is 100 units). The 94 units of customer 3 would need to be split among vehicles subject to $p = .2$ or delivered entirely by one vehicle. In either case, we no longer have the routes given by the estimated solution.

In order to preserve the three routes given in the estimated solution for $p = .1$, we proceed in the following way. Consider the case when $p = .2$. We change the demand to 63 units at customers 1 and 2 and 87 units at customers 3 and 4. We show the routes in Figures 3.5(d), (e), and (f). These are the *same* routes as in Figures 3.5(a), (b), and (c), except that the demand at customer 1 is now split with 13 units and 50 units delivered on two different routes. By changing the demands in this way, we can use the same routes given by the estimated solution for different values of p. In Section 3.8 (Appendix II), we provide our generator and specifications for 21 new test problems with minimum delivery amounts that are based on the problems from Chen, Golden, and Wasil [20].

We apply EMIP-MDA + ERTR to the 21 test problems. In Table 3.6, we give the solutions using four values of p (.1, .2, .3 and .4), the estimated solutions, and the run times for $p = .1$ (the run times for the other values of p are similar).

Over all four values of p and all 21 problems, EMIP-MDA + ERTR produces high-quality solutions that are, at most, 1.71% above the best solutions on average. Our algorithm performs very well on the first eight problems (MDA1 to MDA8) where it generates solutions that are the same or nearly the same as the estimated solutions and slightly better for one problem (MDA6 with $p = .4$). For each problem, the run time of EMIP-MDA + ERTR varied little across the four values of p. We point out that a time limit was set for solving each MIP (see Table 3.2) and, for many problems, the maximum allotted time was used to find a solution to each MIP.

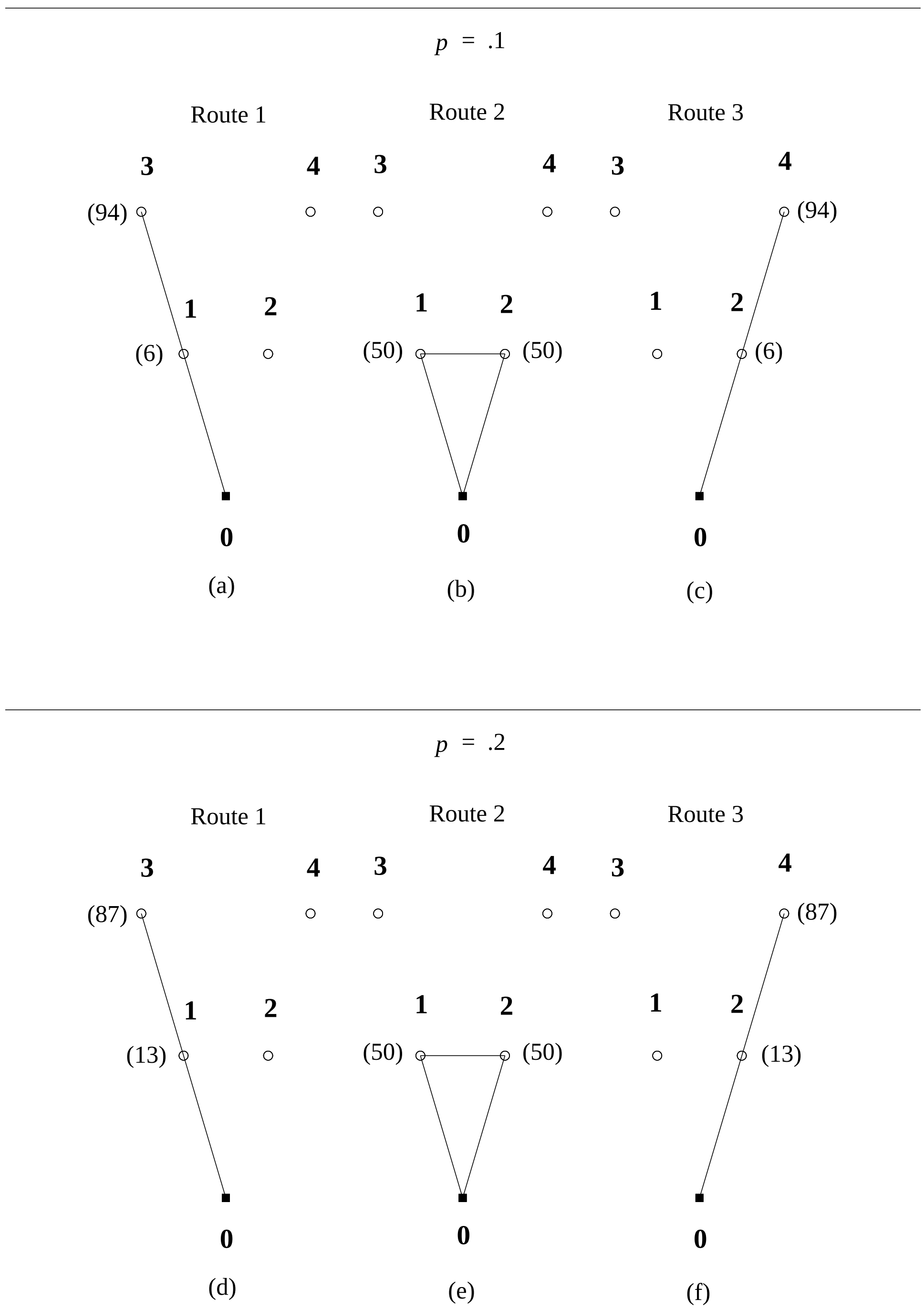


Figure 3.5: Routes from a visually estimated solution for two values of p. Delivery amounts are given in parentheses.

Table 3.6: Computational results on 21 problems with four minimum delivery fractions.

Problem	N	EMIP-MDA + ERTR $p = .1$	$p = .2$	$p = .3$	$p = .4$	Estimated Solution	Time[1] (s)
MDA1	8	**228.28**	**228.28**	**228.28**	**228.28**	**228.28**	1.06
MDA2	16	**720.00**	**720.00**	**720.00**	**720.00**	**720.00**	291.81
MDA3	16	**430.58**	**430.58**	**430.58**	**430.58**	**430.58**	5.52
MDA4	24	**631.05**	**631.05**	**631.05**	**631.05**	**631.05**	227.62
MDA5	32	1402.43	**1402.40**	**1402.40**	1414.75	**1402.40**	644.03
MDA6	32	831.24	831.24	831.24	**830.26**	831.24	644.95
MDA7	40	**3588.28**	**3588.28**	**3588.28**	**3588.28**	**3588.28**	645.52
MDA8	48	5060.00	5060.00	**5040.00**	**5040.00**	**5040.00**	646.91
MDA9	48	2074.12	2063.50	2063.50	2059.03	**2044.20**	645.16
MDA10	64	2691.69	2704.89	2710.64	2708.80	**2684.88**	648.84
MDA11	80	13220.00	13280.00	13334.14	13240.00	**13200.00**	662.44
MDA12	80	7182.93	7182.93	7170.58	7260.01	**7150.58**	659.81
MDA13	96	10111.79	10130.57	10112.44	10233.50	**10042.40**	667.02
MDA14	120	10845.91	10733.07	10836.25	10865.15	**10711.07**	1644.98
MDA15	144	15180.73	15116.39	15172.11	15202.85	**15004.22**	1640.47
MDA16	144	3755.70	3865.24	3962.67	**3445.50**	3631.30	1625.83
MDA17	160	26628.38	26519.45	26646.46	26904.73	**26362.36**	1654.72
MDA18	160	14477.78	14559.20	14420.21	14447.59	**14200.92**	1639.72
MDA19	192	20432.18	20300.41	20355.71	20608.91	**19964.86**	1649.31
MDA20	240	40202.48	40102.34	40018.33	40551.37	**39484.21**	1691.84
MDA21	288	12014.61	12438.63	12652.93	11909.12	**11645.47**	1656.14
Average Deviation[2]		1.20%	1.45%	1.71%	1.00%		

[1] Time for $p = .1$

[2] Average deviation from the best solution

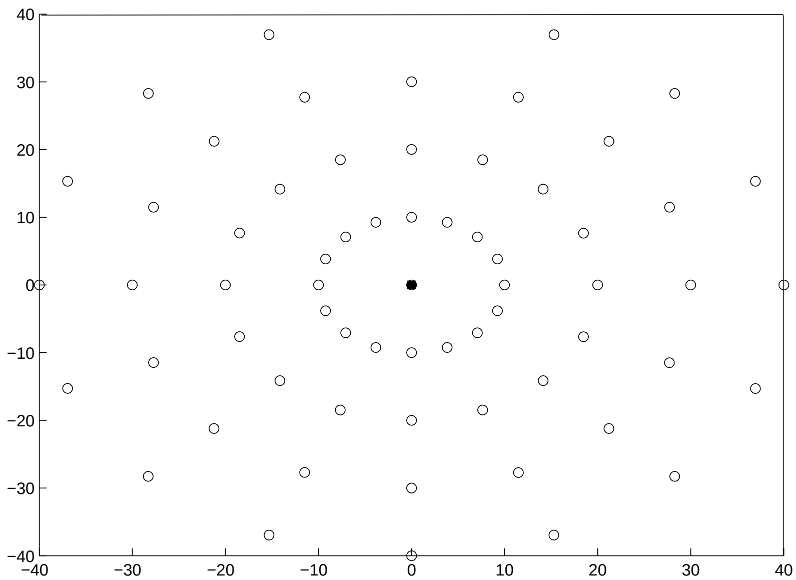
Bold indicates the best solution

N is the number of customers

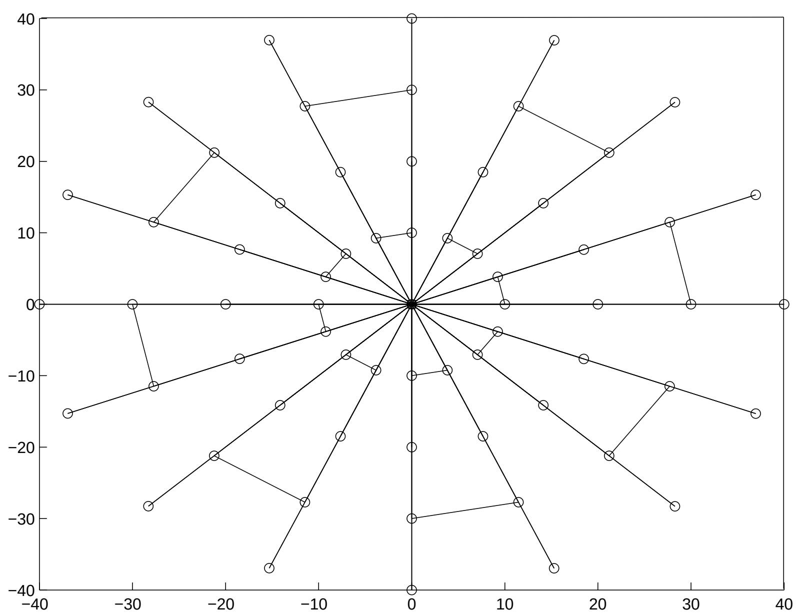
In Figure 3.6, we show the visually estimated solution and the solutions produced by EMIP-MDA + ERTR for two values of p to problem MDA10. The visually estimated solution has 48 routes. There are 32 customers with a delivery split between two vehicles, and 32 customers with a delivery made by a single vehicle. When $p = .1$, the EMIP-MDA + ERTR solution also has 48 routes, but there is one customer with a delivery split between three vehicles, 30 customers with a delivery split between two vehicles, and 33 customers with a delivery made by a single vehicle. When $p = .4$, the EMIP-MDA + ERTR solution has 50 routes. There are 26 customers with a delivery split between two vehicles, and 38 customers with a delivery made by a single vehicle. The detailed structure of the routes in the estimated solution is similar to that of the routes in Figure 3.5.

In our final computational experiment, we applied EMIP-MDA + ERTR to the 11 problems from [10] with five different values of p. We held demand fixed at each customer for the different p values. This allows us to evaluate the effect of p on solution quality. The results are given in Table 3.7. When $p = 0$, splits are allowed with no minimum delivery amounts. As the value of p increases across a row (problem), we see that the solution value also increases. The overall average deviations from the $p = 0$ solutions increase from 0.60% to 2.10% as the value of p increases from .1 to .4. This behavior makes sense as a solution for a small value of p may not be feasible for a larger value of p.

We observe that when the demand at a customer is small, say 10% to 50% of vehicle capacity, there are very few delivery splits that improve the solution quality because our algorithm can find good routes that fill vehicles to near full capacity without splits (the same observation has been made in [7]). This behavior occurs in problems S51D2, S76D2, and S101D2. In Table 3.7, the solutions for these three problems are nearly the same for all five values of p. In contrast, when the demand at a customer is large, say 70% to 90% of vehicle capacity, many of the routes have only one or two customers and it becomes difficult to find split deliveries that are feasible as p increases in value. This behavior occurs in problem S51D6. In Table 3.7, the solution value for this problem deteriorates rapidly as p increases from .1

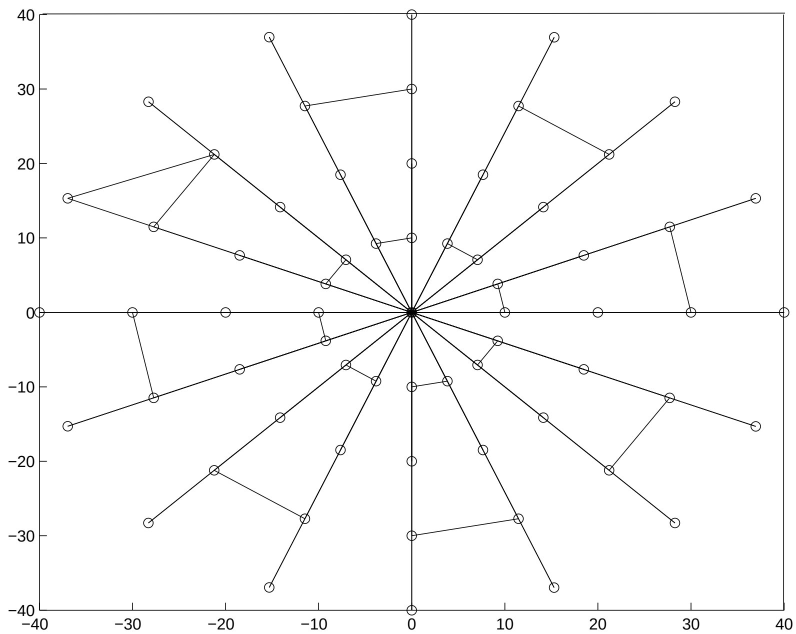


(a) Problem MDA10 with 64 customers

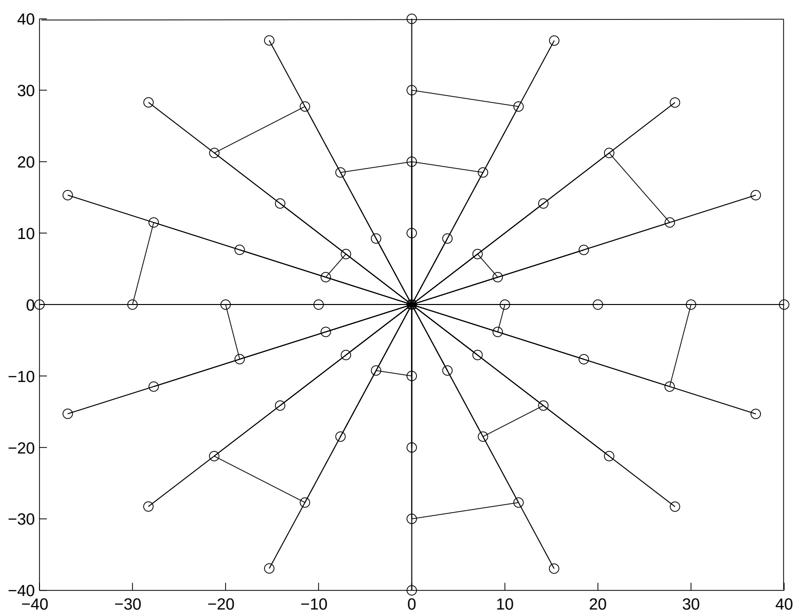


(b) Visually estimated solution. Total distance of 2684.88 with 48 vehicles.

Figure 3.6: Problem MDA10 with visually estimated solution and EMIP-MDA + ERTR solutions.



(c) EMIP - MDA + ERTR solution with p = .1. Total distance is 2691.69 with 48 vehicles.



(d) EMIP - MDA + ERTR solution with p = .4. Total distance is 2708.80 with 50 vehicles.

Figure 3.6 (continued)

Table 3.7: Computational results on 11 problems with four minimum delivery fractions.

Name	N	$p = 0$	$p = .1$	$p = .2$	$p = .3$	$p = .4$
S51D2	51	717.34	717.34	717.34	717.34	717.34
S51D3	51	969.18	969.99	969.99	969.99	978.41
S51D4	51	1580.79	1588.91	1593.69	1597.89	1612.30
S51D5	51	1356.37	1373.98	1377.99	1383.71	1389.32
S51D6	51	2186.29	2225.51	2285.37	2301.51	2402.35
S76D2	76	1105.19	1106.86	1116.64	1116.64	1116.64
S76D3	76	1442.61	1457.40	1446.48	1453.25	1453.17
S76D4	76	2104.87	2123.16	2118.86	2151.49	2167.27
S101D2	101	1397.38	1398.13	1398.87	1401.85	1398.88
S101D3	101	1921.67	1930.86	1929.96	1939.96	1942.94
S101D5	101	2852.01	2862.34	2862.14	2901.76	2904.61
Average Deviation[1]			0.60%	0.90%	1.41%	2.10%

[1] Average deviation from the $p = 0$ solution

to .4 (the solution value at $p = .4$ is nearly 8% worse than the solution value at $p = .1$). For example, in S51D6, one customer with a demand of 122 units is split on three routes, with deliveries of 20 units, 24 units, and 78 units, when $p = .1$ (vehicle capacity is 150). However, when $p = .2, .3, .4$ this customer is no longer split because the deliveries of 20 units and 24 units violate the minimum delivery constraint ($20/122 = .164$ and $24/122 = .197$).

In Appendix A, we give all problems used in computational testing, all solutions generated by EMIP-MDA+ERTR, and all new visually estimated solutions.

3.6 Conclusions

In this chapter, we contributed a new problem to the VRP literature – the split delivery vehicle routing problem with minimum delivery amounts. As discussed, this problem is motivated by real-world considerations. We presented theoretical properties of the SDVRP-MDA and demonstrated that some well-known results of the traditional SDVRP do not hold if minimum delivery amounts are imposed. We developed a solution procedure for solving the SDVRP-MDA that combined an endpoint mixed integer program with an enhanced record-to-record travel algorithm. We applied EMIP-MDA + ERTR to six standard VRPs and 32 SDVRPs from the literature and found that it produced high-quality solutions (some of these were new best-known solutions).

We generated a set of 21 new test problems with minimum delivery amounts that can be used as benchmarks in future studies. These problems have near-optimal solutions that can be visually estimated. EMIP-MDA + ERTR produced very good solutions to the new test problems with different minimum delivery fractions.

Overall, our solution procedure was very effective in solving a wide range of problems. It was competitive with the best heuristics in the literature for solving VRPs and SDVRPs, and it performed very well on our SDVRP-MDAs.

3.7 Appendix I

We present the EMIP-MDA formulation of the example given in Figure 3.1 with $p = .3$. The initial solution makes direct trips to each customer.

maximize $2b_1c_{01} + 2b_2c_{02} + 2b_3c_{03} - m_{12}(c_{01} + c_{12} - c_{02}) - m_{13}(c_{01} + c_{13} - c_{03})$
$-m_{21}(c_{02}+c_{21}-c_{01})-m_{23}(c_{02}+c_{23}-c_{03})-m_{31}(c_{03}+c_{31}-c_{01})-m_{32}(c_{03}+c_{32}-c_{02})$

subject to
$d_{21} + d_{31} - d_{12} - d_{13} \leq Q_1$
$d_{12} + d_{32} - d_{21} - d_{23} \leq Q_2$
$d_{13} + d_{23} - d_{31} - d_{32} \leq Q_3$

$d_{12} + d_{13} \leq D_1$
$d_{21} + d_{23} \leq D_2$
$d_{31} + d_{32} \leq D_3$

$d_{12} + d_{13} \geq D_1b_1$
$d_{21} + d_{23} \geq D_2b_2$
$d_{31} + d_{32} \geq D_3b_3$

$D_1m_{12} \geq d_{12}$
$D_1m_{13} \geq d_{13}$
$D_2m_{21} \geq d_{21}$
$D_2m_{23} \geq d_{23}$
$D_3m_{31} \geq d_{31}$
$D_3m_{32} \geq d_{32}$

$1 - b_1 \geq m_{21} + m_{31}$
$1 - b_2 \geq m_{12} + m_{32}$
$1 - b_3 \geq m_{23} + m_{13}$

$a_1 \leq m_{12} + m_{13}$
$a_2 \leq m_{21} + m_{23}$
$a_3 \leq m_{31} + m_{32}$

$d_{12} + d_{13} \leq D_1a_1$
$d_{21} + d_{23} \leq D_2a_2$
$d_{31} + d_{32} \leq D_3a_3$

$\delta_1(a_1 - b_1) \leq D_1 - d_{12} - d_{13}$
$\delta_2(a_2 - b_2) \leq D_2 - d_{21} - d_{23}$
$\delta_3(a_3 - b_3) \leq D_3 - d_{31} - d_{32}$

$d_{12} \geq \delta_1m_{12}$
$d_{13} \geq \delta_1m_{13}$
$d_{21} \geq \delta_2m_{21}$
$d_{23} \geq \delta_2m_{23}$
$d_{31} \geq \delta_3m_{31}$

$d_{32} \geq \delta_3 m_{32}$

$d_{ij} \geq 0 \quad$ for $\quad i, j = 1, 2, 3$
$b_i = 0, 1 \quad$ for $\quad i = 1, 2, 3$
$m_{ij} = 0, 1 \quad$ for $\quad i, j = 1, 2, 3$
$a_i = 0, 1 \quad$ for $\quad i = 1, 2, 3$

In this example, we have $Q_1 = 40$, $Q_2 = 20$, $Q_3 = 60$, $D_1 = 80$, $D_2 = 100$, and $D_3 = 60$. The distances are given by $c_{01} = c_{02} = c_{03} = 5$, $c_{10} = 5, c_{12} = 3, c_{13} = 2$, $c_{20} = 5, c_{21} = 3, c_{23} = 5$, $c_{30} = 5, c_{31} = 2$, and $c_{32} = 5$. The objective function is given by

maximize $10b_1 + 10b_2 + 10b3 - 3m_{12} - 2m_{13} - 3m_{21} - 5m_{23} - 2m_{31} - 5m_{32}$.

Since all routes of the initial solution have only one endpoint, constraints (7) and (8) are omitted from this example. The objective function is maximized when $b_3 = 1$, $a_3 = 1$, $m_{31} = 1$, $m_{32} = 1$, $d_{31} = 40$, $d_{32} = 20$, and all other decision variables are 0. A maximum savings of three units is produced by removing endpoint 3 from its route, and reallocating 40 units of its demand before endpoint 1, and 20 units of its demand before endpoint 2. This solution is given in Figure 3.1(c).

3.8 Appendix II

Generator for 21 test problems with minimum delivery amounts

(x_i, y_i) are the coordinates of customer i, where $i = 0$ is the depot.

D_i is the demand of customer i.

A and B are parameters that determine the number of customers N, where $N = AB$.

Vehicle capacity is 100 units. p is the minimum fraction of a customer's demand that must be satisfied by a vehicle.

Table 3.8: Generator for SDVRP-MDAs.

$i = 0, x_i = 0, y_i = 0, D_i = 0$
For $k = 1$ to B
  $\gamma = 10k$
  For $\omega = 1$ to A
    $i = i + 1$
    $x_i = \gamma \cos[2(\omega - 1)\pi/A]$
    $y_i = \gamma \sin[2(\omega - 1)\pi/A]$
    If $(\text{mod}(k, 2) = 1)$, $D_i = \lceil \frac{50}{1-p} \rceil$
    Else $D_i = 150 - \lceil \frac{50}{1-p} \rceil$
  End-For
End-For

Table 3.9: Dimensions of SDVRP-MDAs.

Problem	A	B	N
MDA1	4	2	8
MDA2	4	4	16
MDA3	8	2	16
MDA4	12	2	24
MDA5	8	4	32
MDA6	16	2	32
MDA7	4	10	40
MDA8	4	12	48
MDA9	12	4	48
MDA10	16	4	64
MDA11	4	20	80
MDA12	8	10	80
MDA13	8	12	96
MDA14	12	10	120
MDA15	12	12	144
MDA16	72	2	144
MDA17	8	20	160
MDA18	16	10	160
MDA19	16	12	192
MDA20	12	20	240
MDA21	72	4	288

Chapter 4

The Multi-depot Split Delivery Vehicle Routing Problem

4.1 Introduction

In the vehicle routing problem (VRP), a fleet of vehicles must service the demands of customers. All vehicles begin and end their routes at the same depot. The sum of the demands of the customers on a route cannot exceed a vehicle's capacity. A customer must have all of its demand delivered at one time by a single vehicle. The objective is to minimize the total distance traveled by the fleet.

In the split delivery vehicle routing problem (SDVRP), more than one vehicle is allowed to service a customer, so that a customer's demand can be split among several vehicles on different routes. The objective in the SDVRP is to minimize the total distance traveled by the fleet, while satisfying the demand of each customer.

In the multi-depot vehicle routing problem (MDVRP), there are multiple depots. A vehicle starts and ends its route at the same depot. The objective is to minimize the total distance traveled by the fleet across all depots.

In the multi-depot split delivery vehicle routing problem (MDSDVRP), there are multiple depots and more than one vehicle is allowed to service a customer. Vehicles providing split service to a customer can be from the same depot, or they can be from different depots. The objective in the MDSDVRP is to minimize the total distance traveled by the fleet across all depots, while satisfying the demand of each customer.

Let $V = \{v_1, ..., v_N\}$ be the set of customers and let $W = \{w_1, ..., w_M\}$ be the set of depots. Let D_i be the demand of customer i, and let Q be the capacity of a vehicle. Let the distance between a pair of nodes $e = (i, j)$ be denoted by c_e (or c_{ij}). Given route r, let $V(r)$ be the set of nodes and $E(r)$ the set of travel edges on r. Let d_{ir} be the amount delivered to customer i on r. We want to find a set of routes R such that

- route r begins and ends at w_k, for some $k \in \{1, ..., M\}$, for all $r \in R$ (a route starts and ends at the same depot),
- $\sum_{i \in V(r)} d_{ir} \leq Q$, for all $r \in R$ (vehicle capacity restriction),
- $\sum_{r \in R} d_{ir} = D_i$, for all $i \in V$ (demand must be satisfied for each customer),
- minimize $\sum_{r \in R} \sum_{e \in E(r)} c_e$ (total distance is minimized).

In Figure 4.1, we show an MDSDVRP. We have five customers (nodes 1 through 5) and two depots. Edge labels are distances and node labels in parentheses are delivery amounts. All customers have a demand of 10 units and the vehicle capacity is 25 units. There are two routes: one starting and ending at depot 1 and one starting and ending at depot 2. The delivery at node 3 is split between the two routes. The total distance traveled is 16 units.

The remainder of this chapter is organized as follows. In Section 4.2, we review the literature on the MDVRP and the SDVRP. In Section 4.3, we develop an integer programming-based heuristic for the MDSDVRP. In Section 4.4, we present

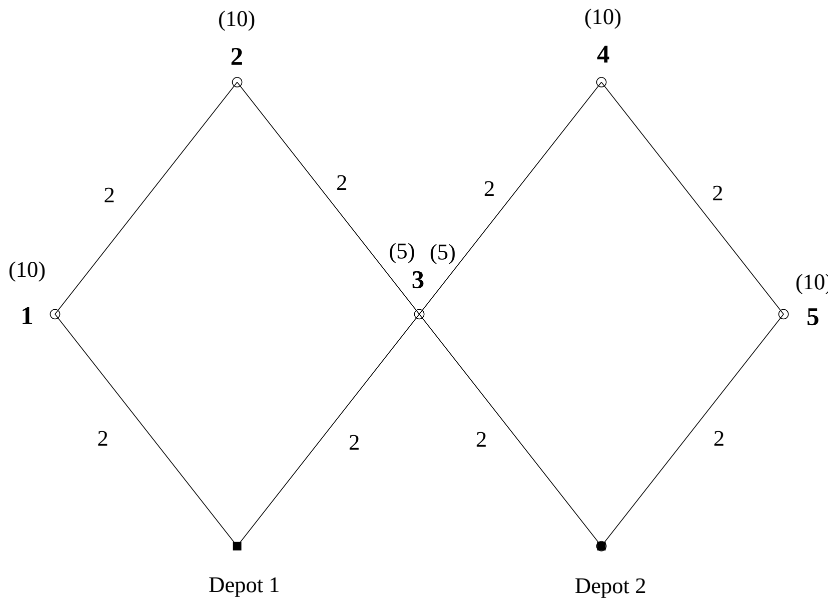


Figure 4.1: In this MDSDVRP, there are five customers and two depots. Node labels in parentheses are delivery amounts and edge labels are distances. The vehicle capacity is 25. In this solution, the total distance traveled is 16 units.

computational results. In Section 4.5, we give our conclusions.

4.2 Literature Review of the MDVRP and the SDVRP

The literature for the MDVRP dates back over 35 years, and the literature for the SDVRP dates back over 20 years. To our knowledge, we are the first researchers to consider the MDSDVRP.

Early heuristics for the MDVRP were developed by Tillman and Cain [92], Wren and Holliday [94], Gillett and Johnson [43], Golden, Magnanti, and Nguyen [45], and Raft [77]. In the 1990s, Chao, Golden, and Wasil [18] developed a record-to-record travel algorithm for the MDVRP. Renaud, Boctor, and Laporte [78] and Cordeau, Gendreau, and Laporte [26] used tabu search. Recently, Thangiah and

Salhi [91] developed a genetic clustering heuristic. A procedure for solving small MDVRPs exactly was developed by Laporte, Nobert, and Taillefer [59].

The first heuristics for the SDVRP were developed by Dror and Trudeau [33, 34]. They used a two-stage algorithm that incorporated k-split interchanges and route additions. Recently, Archetti, Speranza, and Hertz [6] developed a tabu search algorithm. Chen, Golden, and Wasil [20] combined an endpoint mixed integer program and a variable length record-to-record travel algorithm. Mota, Campos, and Corberán [71] used scatter-search. Gulczynski, Golden, and Wasil [52] expanded on the work of Chen, Golden, and Wasil [20]. The papers by Archetti and Speranza [4] and Gulczynski, Golden, and Wasil [51] are good sources for recent developments in modeling and solving the SDVRP.

Two practical applications for both the MDVRP and the SDVRP are delivering groceries [28, 47] and collecting waste [2, 3].

4.3 An Integer Programming-based Heuristic for the MDSDVRP

4.3.1 Assigning Customers to Depots

We describe a heuristic for the MDSDVRP. First, we assign customers to depots using a procedure developed by Golden, Magnanti, and Nguyen [45]. For each customer i, we let λ_i be the distance between i and the closest depot to i and λ_i' be the distance between i and the second closest depot to i. If $\frac{\lambda_i}{\lambda_i'}$ is less than a tolerance ϵ, then customer i is immediately assigned to its closest depot. If $\frac{\lambda_i}{\lambda_i'} \geq \epsilon$, then i is temporarily left unassigned. In this way, a customer that is much closer to one depot than to other depots will be immediately assigned to its closest depot. A customer that is nearly equidistant from several depots will be assigned using cheapest insertion.

After the initial assignment phase, unassigned customers are assigned to depots based on a cheapest insertion criterion. For each unassigned customer i and each depot w, we calculate the cost of inserting i between each pair of customers already assigned to w (we consider w as a customer assigned to itself). We then assign i to the same depot as the pair giving the cheapest insertion. That is, we assign customer i to the same depot as customers j and k where $c_{ij}+c_{ik}-c_{jk}$ is the smallest value over all pairs of customers already assigned to a depot.

4.3.2 Solving the SDVRP on Each Depot Separately

After all customers have been assigned to depots, we solve the SDVRP on each depot and its assigned customers separately using the EMIP-MDA + ERTR heuristic developed by Gulczynski, Golden, and Wasil [52].

EMIP-MDA + ERTR is a two-stage heuristic that improves an initial solution to the VRP with no splits. The initial solution is generated using a modified Clarke-Wright (CW) algorithm [95]. In the first stage, an endpoint mixed integer program with minimum delivery amounts (EMIP-MDA) is formulated and solved. The EMIP-MDA maximizes the savings from splitting deliveries at certain customers and reallocating some (or all) of their demands to new routes. A time limit T is set for the EMIP-MDA. If a solution is not returned after T seconds, EMIP-MDA

Table 4.1: Enhanced record-to-record travel algorithm (ERTR) for the VRP.

S_d = VRP solution with depot $d, deviation = 1\%, count = 0, L = 10, K = 70$
Initialize the record, $S_d^* = S_d$
Uphill:
For ($k = 1$ to K)
    Apply one-point moves, apply two-point moves, apply three-point moves
    Apply two-opt edge exchanges, apply Or-opt edge exchanges
    Update S_d if result is within *deviation* of cost of S_d^*
    Update S_d^* if necessary
End-For
Downhill:
Apply Or-opt edge exchanges, apply two-opt edge exchanges
Apply one-point moves, apply two-point moves, apply three-point moves
If (cost decreases), update S_d and go to Downhill
Else Update S_d^* if necessary, otherwise $count = count + 1$
If ($count < L$), go to Uphill
Perturb solutions once and go to Uphill
Return S_d^*

terminates, and the best solution found up to that point is returned.

In the second stage, the enhanced record-to-record travel algorithm (ERTR) is applied to reduce the distance traveled. ERTR is a heuristic developed by Groër, Golden, and Wasil [50] for the VRP that does not produce any new split deliveries. It is a modified version of the variable length record-to-record travel algorithm (VRTR) developed by Li, Golden, and Wasil [63]. VRTR improves a VRP solution by performing one-point and two-point node exchanges, as well as two-opt edge exchanges. ERTR considers additional moves such as three-point node exchanges and Or-opt edge exchanges. Uphill moves are allowed when a solution is within a preset tolerance of the record solution. The details of ERTR are given in Table 4.1.

In Table 4.2, we give an outline of EMIP-MDA + ERTR. A complete description can be found in Chapter 3 or in [52].

Table 4.2: EMIP-MDA + ERTR algorithm for the SDVRP.

S = initial VRP solution (no splits) from modified Clarke-Wright algorithm
S_1 = EMIP-MDA solution on S (make distance-reducing splits)
S^* = solution after ERTR is applied to S_1 (improve routes)
Return S^*

4.3.3 Formulating the MDSDVRP as a Mixed Integer Program

By applying EMIP-MDA + ERTR to each depot and the customers assigned to it, we generate an initial solution to the MDSDVRP. We denote the initial solution by S. In S, there are no deliveries split between vehicles from different depots. We now describe a mixed integer program (MIP) that attempts to improve S by considering additional split deliveries, including inter-depot split deliveries.

For each customer i on each route r, we calculate the cost of inserting i immediately prior to customer j on route q, where q does not begin and end at the same depot as r. Let φ denote the minimum insertion cost of i across all j and q. For each route, we add the two customers with the smallest values of φ to the inter-depot candidate set denoted by ID. If a route has only one customer, it is added to ID. The customers in ID are called id-nodes.

Let $NE(i)$ be the neighborhood of customer $i \in ID$. This neighborhood is the set of id-nodes j for which c_{ij} is the smallest. Each neighborhood contains L customers, where L is a preset parameter. We consider moving some (or all) of the demands serviced at id-nodes to new locations. For each $i \in ID$ and j in $NE(i)$, there are three possible moves: 1) move all of the demand of i immediately prior to j, 2) move some of the demand of i immediately prior to j (split i's delivery),

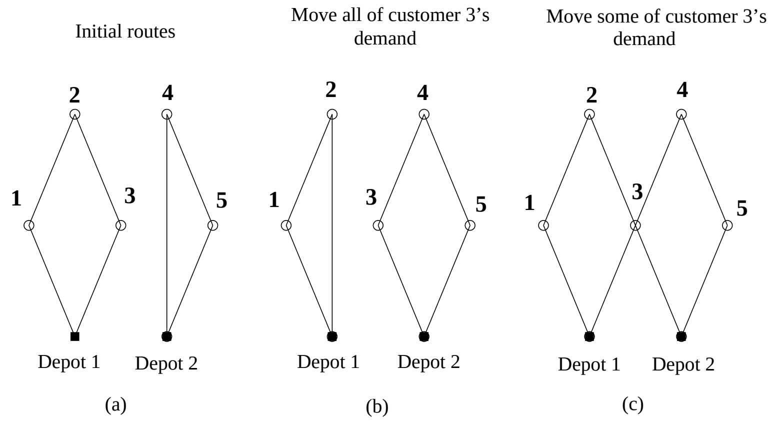


Figure 4.2: Three possible customer moves.

and 3) move none of the demand of i immediately prior to j. Let $p(v)$ and $s(v)$ be the predecessor and successor of customer v, respectively. The savings associated with the three possible moves are: 1)$-c_{p(j)i} - c_{ij} - c_{p(i)s(i)} + c_{p(j)j} + c_{p(i)i} + c_{is(i)}$, 2) $-c_{p(j)i} - c_{ij} + c_{p(j)j}$, and 3) zero. In Figure 4.2, we show the possible moves.

In order to find the optimal reallocation of demand across all id-nodes, we formulate an inter-depot mixed integer program (IDMIP). Our formulation is based on the endpoint mixed integer program with minimum delivery amounts (EMIP-MDA) developed by Gulczynski, Golden, and Wasil [52]. The EMIP was originally developed by Chen, Golden, and Wasil [20].

In the IDMIP, let R be the set of routes of solution S. Let Q_r be the residual capacity of route $r \in R$ (that is, the vehicle capacity minus the total amount delivered on r). Let D_i be the demand of endpoint i.

The decision variables are defined as follows. Let b_i equal 1 if all of id-node i's demand is moved (that is, i is removed from its current route), and 0 otherwise; m_{ij} equals 1 if id-node i is inserted before $j \in NE(i)$, and 0 otherwise; and d_{ij} is the amount of id-node i's demand that is moved before $j \in NE(i)$.

Our formulation of the IDMIP is given by the following objective function and constraints.

$$\text{maximize} \sum_{i \in ID} b_i(c_{p(i)i} + c_{is(i)} - c_{p(i)s(i)}) - \sum_{i \in ID} \sum_{j \in NE(i)} m_{ij}(c_{p(j)i} + c_{ij} - c_{p(j)j}) \qquad (1)$$

subject to

$$\sum_{i:j \in NE(i)} d_{ij} + \sum_{q:k \in NE(q)} d_{qk} - \sum_{l \in NE(k)} d_{kl} - \sum_{t \in NE(j)} d_{jt} \leq Q_r$$

$$\forall r \in R; \quad k, j \text{ id-nodes of route } r \qquad (2)$$

$$\sum_{j \in NE(i)} d_{ij} \leq D_i \qquad \forall i \in ID \qquad (3)$$

$$\sum_{j \in NE(i)} d_{ij} \geq D_i b_i \qquad \forall i \in ID \qquad (4)$$

$$D_i m_{ij} \geq d_{ij} \qquad \forall i \in ID, \quad \forall j \in NE(i) \qquad (5)$$

$$1 - b_i \geq \sum_{j:i \in NE(j)} m_{ji} \qquad \forall i \in ID \qquad (6)$$

$$1 - b_{p(i)} \geq \sum_{j:i \in NE(j)} m_{ji} \qquad \forall i \in ID \qquad (7)$$

$$b_k + b_{p(k)} \leq 1 \qquad \forall r \in R; \quad k, p(k) \text{ id-nodes of route } r \qquad (8)$$

$$d_{ij} \geq 0 \qquad \forall i \in ID, \quad \forall j \in NE(i) \qquad (9)$$

$$m_{ij}, b_i \in \{0, 1\} \qquad \forall i \in ID, \quad \forall j \in NE(i) \qquad (10)$$

In the objective function (1), we maximize the total savings across all possible endpoint moves. Constraints (2) ensure that feasibility is maintained with respect to vehicle capacity, that is, the total amount of demand moved to a route minus the total amount moved from a route is less than the residual capacity. In constraints (3), we cannot move more than the actual demand at a customer. In constraints (4), we ensure that all demand is moved from customer i if $b_i = 1$, while in constraints (5), we ensure that $m_{ij} = 1$ if any demand is moved from customer i prior to customer j. Constraints (6) and (7) prevent any demand from being moved prior to customer i if i or $p(i)$ has been removed from its route. In constraints (8), we eliminate the possibility of removing both customers k and $p(k)$. Constraints (6)–(8) ensure the objective value reflects the savings accurately, as the coefficients in the objective function depend on a customer and its predecessor. Constraints (9) and (10) ensure nonnegativity and 0-1 solutions.

To illustrate, we apply IDMIP to the solution given in Figure 4.3. Initially, there are three routes: w_1-2-1-w_1, w_1-3-w_1, and w_2-4-5-w_2 (w_1 and w_2 represent depots 1 and 2, respectively). The solution returned by IDMIP is given in Figure 4.1. It has two routes. A savings of two units is achieved by removing customer 3 from its route, moving 5 units of its demand immediately prior to customer 2, and moving 5 units of its demand immediately prior to customer 4. The IDMIP formulation for this example is given in Section 4.6 (Appendix I).

4.3.4 Improving Routes with an Inter-depot Routing Algorithm

By solving the SDVRP for each depot and the customers assigned to it, we generate an initial solution S to the MDSDVRP. Using S, an IDMIP is formulated and solved. We point out that a small IDMIP can be time-consuming to solve (a 50-node problem can have as many as 550 integer variables, 500 continuous variables, and 1,800 constraints). Therefore, we set a run-time limit that takes into account the size of the problem. We solve the IDMIP and denote the solution by S_1.

Finally, we perform a route clean-up procedure. Using S_1, we create an MD-

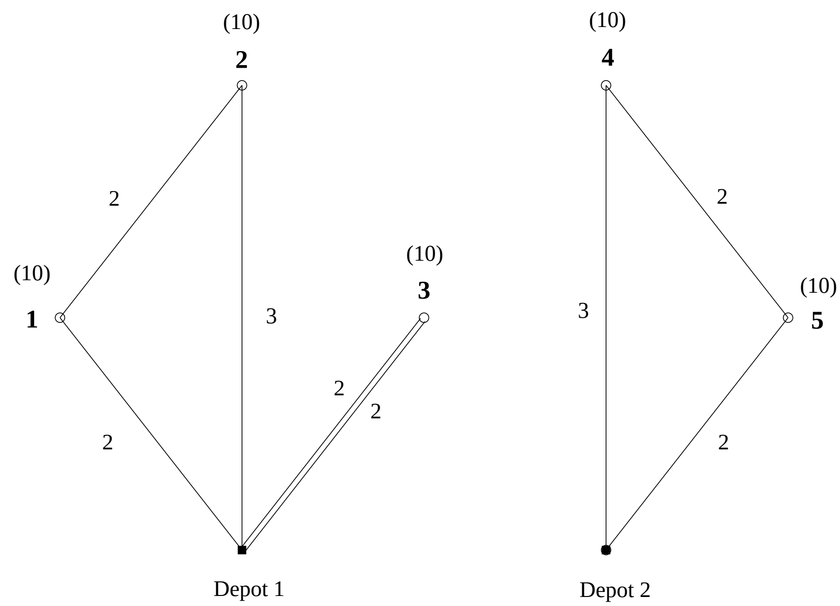


Figure 4.3: In this MDSDVRP, there are five nodes and two depots. Node labels in parentheses are delivery amounts and edge labels are distances. The vehicle capacity is 25. In this solution, the total distance is 18 units.

VRP instance, denoted by I, by considering each visit to each customer on a route in S_1 as a distinct customer in I whose demand is the amount serviced on that visit. For example, if there is a split delivery at customer i, with d_r units being delivered on route r and d_q units being delivery on route q ($d_r + d_q = D_i$), then in I, we create two distinct customers at the same location as i, one with demand d_r and one with demand d_q.

We apply an inter-depot routing algorithm (IDR) to I using S_1 as the initial solution. IDR is strictly a routing heuristic (no new splits are created during its execution). IDR improves the routes of each depot separately using ERTR (see Table 4.1), and then performs one-point node moves across all routes, including those of different depots. The details of IDR are given in Table 4.3. The complete

Table 4.3: Inter-depot routing algorithm.

```
S = current MDSDVRP solution, M = number of depots
maxCount = 20, cntr = 1
Repeat
    For w = 1 to M
        Let S_w be the VRP solution with depot w
        Apply ERTR to S_w
    End-For
    Apply one-point moves across all routes of all depots
    cntr = cntr + 1
Until (cntr > maxCount) or (no improvement of S)
Return S
```

Table 4.4: The IDH for solving MDSDVRPs.

```
M = number of depots
Assign customers to depots
If (the number of customers N is less than 120)
    Set MIP time limit T_1 to 250/M seconds
    Set MIP time limit T_2 to 250 seconds
Else T_1 = 400/M, T_2 = 400
Set max neighborhood size L = 10
Solve the SDVRP for each depot and its assigned customers separately
  using EMIP-MDA + ERTR with time limit T_1, denote solution by S
S_1 = IDMIP solution on S with time limit T_2 and neighborhood size L
S_2 = solution after IDR is performed on S_1
Return S_2
```

description of our heuristic for the MDSDVRP (denoted by IDH) is given in Table 4.4.

4.4 Computational Experiment with IDH

4.4.1 Analysis on Modified MDVRPs

Since the MDSDVRP is a new problem, there are no benchmark problems we could use to analyze the performance of IDH. We created new MDSDVRPs by modifying 10 MDVRPs originally proposed by Christofides and Eilon [23] and Gillett and Johnson [42]. We used the node locations from these problems and changed the customer demands. We let the demand at a customer be a random integer generated uniformly in the interval $[aQ, bQ]$, where Q is the vehicle capacity and $[a, b]$ $(0 < a < b < 1)$ is the fractional demand range. We used three fractional demand ranges ($[.1, .9]$, $[.3, .7]$, and $[.7, .9]$) giving a total of $10 \times 3 = 30$ problems.

We changed the customer demands because, in the original MDVRPs, the demands are too small, relative to vehicle capacity, for split deliveries to have a significant effect on the solution. When customer demands are small, there is little advantage to splitting deliveries, so the solutions with and without split deliveries are basically the same [7].

We applied IDH to these 30 problems. We measured the improvements to solutions by allowing split deliveries, and the improvements by allowing inter-depot split deliveries. In Table 4.5, we give our computational results. In column one, we give the problem number. In columns two through four, we give the number of customers (N), the number of depots (M), and the fractional demand range. In column five, we give the solution values generated by IDH without applying the EMIP-MDA and the IDMIP (no split deliveries). In column six, we give the solution values generated by IDH without the IDMIP (no split deliveries between routes of different depots). In column seven, we give the solution values generated by IDH. In the last column, we give the run times of IDH in seconds. The integer programs in IDMIP are solved with ILOG CPLEX 10.0 and Visual C++ (version 6.0) using a 3.0 GHz Pentium 4 processor and 512MB of RAM.

Table 4.5: Computational results for IDH on 30 MDSDVRPs.

Problem	N	M	Demand Range	IDH Solution No Splits	IDH Solution No ID Splits	IDH Solution	Time[1] (s)
MDSD1	50	4	[.1, .9]	1067.36	1018.22	1018.22	634.97
			[.3, .7]	1027.65	1008.91	990.85	614.86
			[.7, .9]	1422.68	1365.75	1344.99	614.63
MDSD2	75	5	[.1, .9]	1365.26	1297.76	1289.06	687.64
			[.3, .7]	1290.35	1240.82	1223.57	681.98
			[.7, .9]	1808.49	1728.80	1705.98	680.52
MDSD3	100	2	[.1, .9]	2749.47	2636.54	2624.41	654.56
			[.3, .7]	2703.78	2604.16	2558.33	657.76
			[.7, .9]	4378.35	3919.89	3878.34	660.55
MDSD4	100	2	[.1, .9]	2514.22	2393.23	2393.23	639.72
			[.3, .7]	2507.00	2337.59	2336.65	651.33
			[.7, .9]	3922.66	3525.24	3525.24	645.45
MDSD5	100	3	[.1, .9]	2121.28	1966.67	1963.13	656.05
			[.3, .7]	1990.83	1876.73	1871.47	665.25
			[.7, .9]	3007.21	2793.81	2772.58	649.44
MDSD6	100	4	[.1, .9]	2090.91	1985.72	1963.68	657.05
			[.3, .7]	2014.99	1908.28	1887.48	689.08
			[.7, .9]	2896.41	2707.57	2696.47	664.06
MDSD7	249	2	[.1, .9]	17145.99	16376.96	16096.91	953.58
			[.3, .7]	17637.26	16410.12	16136.07	944.08
			[.7, .9]	28993.25	25988.47	25502.49	937.56
MDSD8	249	3	[.1, .9]	14114.66	13458.80	13258.26	969.70
			[.3, .7]	14675.92	13707.36	13444.18	948.76
			[.7, .9]	23629.23	21326.62	20915.02	987.36
MDSD9	249	4	[.1, .9]	12784.86	12044.79	11959.27	960.80
			[.3, .7]	13473.88	12330.74	12176.61	942.39
			[.7, .9]	21223.79	19048.59	18844.77	987.05
MDSD10	249	5	[.1, .9]	12161.69	11572.88	11377.30	938.83
			[.3, .7]	12934.74	11960.70	11831.52	980.63
			[.7, .9]	19841.86	17959.15	17777.76	961.67
Average Deviation					6.32[2]	1.04[3]	

[1] 3.0 GHz Pentium 4 processor

[2] 100[1 − (IDH Solution No ID Splits / IDH Solution No Splits)]%

[3] 100[1 − (IDH Solution / IDH Solution No ID Splits)]%

In Table 4.5, we see that, on these 30 problems, we reduced the distance traveled by 6.32%, on average, by allowing split deliveries between routes of the same depot. We reduced the distance traveled by an additional 1.04%, on average, by allowing split deliveries between routes of different depots. The total improvement between the IDH solutions with and without split deliveries is 7.30%, on average.

4.4.2 Performance on MDSDVRPs with Visually Estimated Solutions

To compare the solutions of IDH against benchmark solutions, we created 12 MDSDVRPs (SQ1–SQ12) that have very good visually estimated solutions. We call SQ1–SQ12 square problems, because the customers are located on concentric squares centered at the depots. The square problems vary in size from 32 customers to 240 customers and from two depots to five depots. In Figure 4.4, we show an example square problem (SQ3) with 64 customers and four depots. The algorithm used to generate the square problems is given in Section 4.7 (Appendix II).

In Figure 4.5, we show a portion of the visually estimated solution for SQ3. There are eight customers (nodes 1 through 8) and two depots. Customers 1 and 7 have demand 90, customers 2 and 8 have demand 60, customer 3 has demand 85, customer 4 has demand 55, customer 5 has demand 95, and customer 6 has demand 65. The vehicle capacity is 100 units.

In Figure 4.5, there are six routes. Three routes use depot 1. One vehicle starts at depot 1, delivers 80 units to customer 1, delivers 20 units to customer 2, and returns to depot 1. A second vehicle starts at depot 1, delivers 10 units to customer 1, delivers 85 units to customer 3, delivers 5 units to customer 5, and returns to depot 1. (For the sake of simplicity, we assume the vehicle travels back through customers 3 and 1 on its path from customer 5 to depot 1. The added distance from this assumption is very small.) A third vehicle starts at depot 1, delivers 40 units to customer 2, delivers 55 units to customer 4, delivers 5 units to

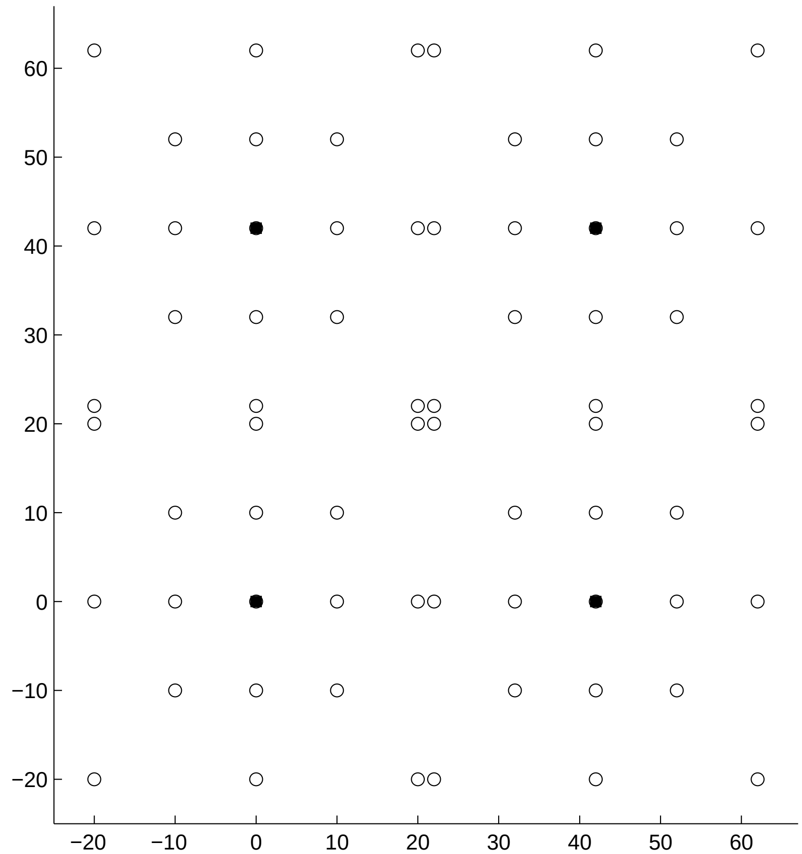


Figure 4.4: SQ3 has 64 customers and four depots. The solid dots are the depots and the open dots are the customers.

customer 6, and returns to depot 1. Three routes use depot 2. One vehicle starts at depot 2, delivers 80 units to customer 7, delivers 20 units to customer 8, and returns to depot 2. A second vehicle starts at depot 2, delivers 10 units to customer 7, delivers 90 units to customer 5, and returns to depot 2. A third vehicle starts at depot 2, delivers 40 units to customer 8, delivers 60 units to customer 6, and returns to depot 2.

In Figure 4.5, the deliveries to customers 1 and 2 are split between vehicles using depot 1. The deliveries to customers 7 and 8 are split between vehicles using

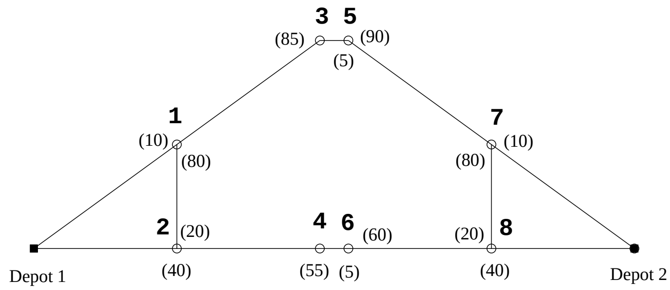


Figure 4.5: A portion of a visually estimated solution.

depot 2. The deliveries to customers 5 and 6 are split between a vehicle using depot 1 and a vehicle using depot 2. The routes of the visually estimated solutions for all square problems follow this basic structure.

In Table 4.6, we give the results of applying IDH to the 12 square problems. IDH performs very well on these problems generating an average solution 0.43% above the estimated solution.

In Figure 4.6, we show the visually estimated solution and the solution produced by IDH for problem SQ3. The visually estimated solution has 48 routes, 42 total split deliveries, and 10 split deliveries among vehicles using different depots. The IDH solution has 51 routes, 25 total split deliveries, and 2 split deliveries between vehicles using different depots. The IDH solution is 0.50% larger than the estimated solution. The detailed structure of the routes in the estimated solution is shown in Figure 4.5.

Table 4.6: Computational results for IDH on 12 problems.

Problem	N	M	IDH Solution	Estimated Solution	Time[1] (s)
SQ1	32	2	1063.08	1057.69	638.21
SQ2	48	3	1601.02	1588.53	634.49
SQ3	64	4	2142.11	2131.37	559.59
SQ4	80	5	2684.02	2662.21	604.27
SQ5	64	2	3434.71	3422.19	646.75
SQ6	96	3	5142.06	5135.29	653.13
SQ7	128	4	6869.14	6860.39	924.82
SQ8	160	5	8600.60	8573.48	928.18
SQ9	96	2	7109.71	7050.62	696.69
SQ10	144	3	10586.51	10577.93	939.77
SQ11	192	4	14135.80	14117.24	947.85
SQ12	240	5	17739.64	17644.55	940.91
Average Deviation			0.43[2]		

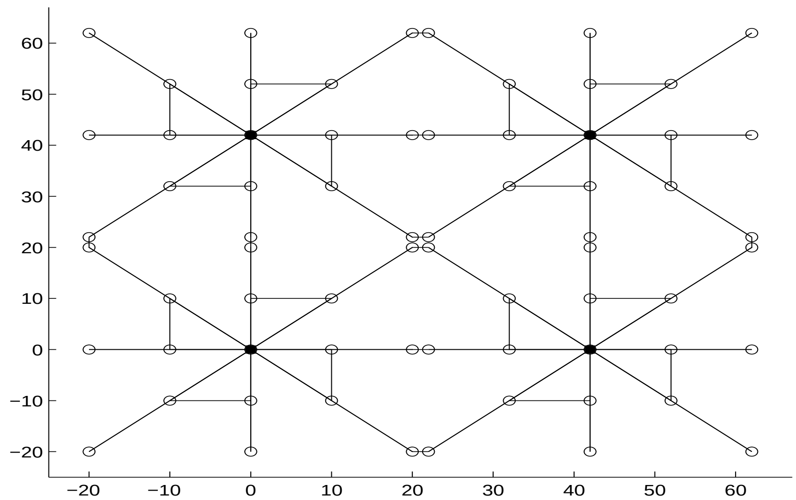
[1] 3.0 GHz Pentium 4 processor

[2] 100[(IDH Solution − Estimated Solution) / Estimated Solution]%

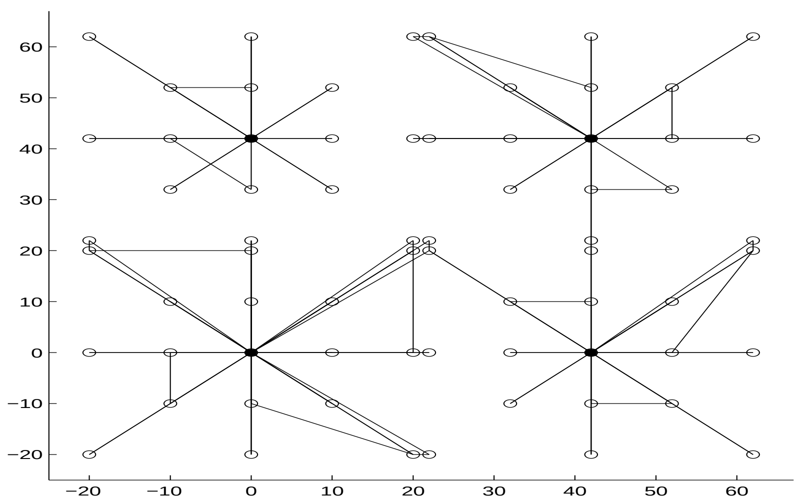
4.5 Conclusions

In this chapter, we described the multi-depot split delivery vehicle routing problem which is a new problem in the VRP literature. We developed a heuristic for the MDSDVRP that combined an algorithm for the traditional SDVRP with an inter-depot mixed integer program and an inter-depot routing algorithm. We applied our heuristic to 30 modified MDVRPs and measured the improvements achieved by splitting deliveries between routes of the same depot and splitting deliveries between routes of different depots.

We generated 12 new test problems that have high-quality visually estimated solutions. Our heuristic produced very good solutions to these 12 problems. Overall, our solution procedure was very effective in solving a wide range of problems.



(a) Visually estimated solution for SQ3. Total distance is 2131.37.



(b) IDH solution for SQ3. Total distance is 2142.11.

Figure 4.6: Problem SQ3 with visually estimated and IDH solutions.

4.6 Appendix I

We present the IDMIP formulation using the example given in Figure 4.3 as the initial solution. The routes of the initial solution are 1) 0-2-1-0, 2) 0-3-0, and 3) 6-4-5-8-6, where nodes 0 and 6 represent depot 1 and depot 2, respectively. In this example, for simplicity, we omit the decision variables for customers 1 and 5. These variables are zero in the optimal solution. The IDMIP formulation is as follows.

maximize $b_2(c_{02} + c_{21} - c_{01}) + 2b_3c_{03} + b_4(c_{64} + c_{45} - c_{65}) - m_{23}(c_{02} + c_{23} - c_{03}) - m_{24}(c_{62} + c_{24} - c_{64})$
$-m_{32}(c_{03}+c_{32}-c_{02})-m_{34}(c_{63}+c_{34}-c_{64})-m_{42}(c_{04}+c_{42}-c_{02})-m_{43}(c_{04}+c_{43}-c_{03})$

subject to
$d_{32} + d_{42} - d_{23} - d_{24} \leq Q_1$
$d_{23} + d_{43} - d_{32} - d_{34} \leq Q_2$
$d_{24} + d_{34} - d_{42} - d_{43} \leq Q_3$

$d_{23} + d_{24} \leq D_2$
$d_{32} + d_{34} \leq D_3$
$d_{42} + d_{43} \leq D_4$

$d_{23} + d_{24} \geq D_2b_2$
$d_{32} + d_{34} \geq D_3b_3$
$d_{42} + d_{43} \geq D_4b_4$

$D_2m_{23} \geq d_{23}$
$D_2m_{24} \geq d_{24}$
$D_3m_{32} \geq d_{32}$
$D_3m_{34} \geq d_{34}$
$D_4m_{42} \geq d_{42}$
$D_4m_{43} \geq d_{43}$

$1 - b_2 \geq m_{32} + m_{42}$
$1 - b_3 \geq m_{23} + m_{43}$
$1 - b_4 \geq m_{24} + m_{34}$

$d_{ij} \geq 0 \quad$ for $\quad i, j = 2, 3, 4$
$b_i = 0, 1 \quad$ for $\quad i = 2, 3, 4$
$m_{ij} = 0, 1 \quad$ for $\quad i, j = 2, 3, 4$

In this example, we have $Q_1 = 5$, $Q_2 = 15$, $Q_3 = 5$, and $D_2 = D_3 = D_4 = 10$. The symmetric distances are given by $c_{02} = 3, c_{03} = 2, c_{04} = 4$, $c_{23} = 2, c_{24} = 3, c_{26} = 4$, $c_{34} = c_{36} = 2$, and $c_{46} = 3$. The objective function is given by

maximize $3b_2 + 4b_3 + 3b_4 - 3m_{23} - 4m_{24} - m_{32} - m_{34} - 4m_{43} - 4m_{42}$.

Since the decision variables for customers 1 and 5 are omitted in this example, constraints (7) and (8) are not applicable, so they are not presented. The objective function is maximized when $b_3 = 1$, $m_{32} = 1$, $m_{34} = 1$, $d_{32} = 5$, $d_{34} = 5$, and all other decision variables are 0. A maximum savings of two units is produced by removing customer 3 from its route, reallocating 5 units of its demand before customer 2, and reallocating 5 units of its demand before customer 4. This solution is given in Figure 4.1.

4.7 Appendix II

Generator for the 12 square problems

N is the number of customers.

M is the number of depots.

$2G$ is the number of concentric squares of customers centered at a depot.

$N = 16MG$. (There are 8 customers on each square.)

(u_m, v_m) are the coordinates of depot m.

(x_i, y_i) are the coordinates of customer i.

D_i is the demand of customer i.

Vehicle capacity is 100 units.

ϕ_m^-, ϕ_m^+, ω_m^-, ω_m^+ are variables defined as follows. Given depot m with coordinates (u_m, v_m), if there is a depot located at (x, v_m), where $x < u_m$, then $\phi_m^- = 1$, otherwise $\phi_m^- = 0$. If there is a depot located at (x, v_m), where $x > u_m$, then $\phi_m^+ = 1$, otherwise $\phi_m^+ = 0$. If there is a depot located at (u_m, y), where $y < v_m$, then $\omega_m^- = 1$, otherwise $\omega_m^- = 0$. If there is a depot located at (u_m, y), where $y > v_m$, then $\omega_m^+ = 1$, otherwise $\omega_m^+ = 0$.

Table 4.7: Generator for MDSDVRPs.

```
(Get depot coordinates)
For m = 1 to M
    p = ⌊√m⌋, q = p^2
    If (m − q ≤ p), a = p, b = m − q
    Else a = (p + 1)^2 − m − 1, b = p
    u_m = (40G + 2)a, v_m = (40G + 2)b
End-For

(Get customer coordinates and demands)
i = 1
For m = 1 to M
    For g = 1 to 2G
        For j = −1 to 1
            For k = −1 to 1
                If (j ≠ 0) or (k ≠ 0)
                    x_i = 10gj + u_m, y_i = 10gk + v_m
                    If (|j| − |k| = 0), D_i = 90
                    Else D_i = 60
                    If (g = 2G)
                        If (j = −1) and (φ_m^− = 1) and (m mod 2 = 0)
                            D_i = D_i − 5
                        Else If (j = −1) and (φ_m^− = 1) and (m mod 2 = 1)
                            D_i = D_i + 5
                        Else If (j = 1) and (φ_m^+ = 1) and (m mod 2 = 0)
                            D_i = D_i − 5
                        Else If (j = 1) and (φ_m^+ = 1) and (m mod 2 = 1)
                            D_i = D_i + 5
                        Else If (k = −1) and (ω_m^− = 1) and (m mod 2 = 0)
                            D_i = D_i − 5
                        Else If (k = −1) and (ω_m^− = 1) and (m mod 2 = 1)
                            D_i = D_i + 5
                        Else If (k = 1) and (ω_m^+ = 1)and (m mod 2 = 0)
                            D_i = D_i − 5
                        Else If (k = 1) and (ω_m^+ = 1)and (m mod 2 = 1)
                            D_i = D_i + 5
                    End-If
                    i = i + 1
                End-If
            End-For (k loop)
        End-For (j loop)
    End-For (g loop)
End-For (m loop)
```

Chapter 5

The Period Vehicle Routing Problem

5.1 Introduction

In the vehicle routing problem (VRP), a fleet of vehicles must service the demands of customers. A vehicle begins and ends its route at the same depot, and the sum of the demands of the customers on a route cannot exceed a vehicle's capacity. A customer must have all of its demand delivered at one time by a single vehicle. The objective is to minimize the total distance traveled by the fleet.

In the standard period vehicle routing problem (PVRP), customers may require service on multiple days during a time period. Customers must first be assigned to service patterns (for example, customers requiring three visits might be assigned a Monday-Wednesday-Friday service pattern), and then a VRP is solved for each day of the time period for all customers scheduled on that day. The objective is to minimize the total distance traveled by the fleet across all days of the time period.

Let $T = \{1, ..., P\}$ be the P days in the time period, and let Λ be the set of subsets of T giving the allowable service patterns. For example, $\{1, 2, ..., P\}$ would be a service pattern in Λ where a customer is serviced every day during the time period. $V = \{v_1, ..., v_N\}$ is the set of customers, and v_0 is the depot. Let q_i be the demand of customer i that must be satisfied by a vehicle at a visit, and let $\Lambda_i \subset \Lambda$ be the allowable service patterns of customer i. Let the distance between a pair of customers $e = (i, j)$ be denoted by c_e (or c_{ij}), and let Q be the vehicle capacity. Let R_t be a set of routes on day t, let $V(r)$ be the set of nodes and $E(r)$ the set of edges for route $r \in R_t$. We want to assign each customer i to a pattern $\lambda_i \in \Lambda_i$ and, for each day $t \in T$, we want to find a set of routes R_t, such that

- each route begins and ends at v_0, for all $r \in R_t$, $t \in T$,
- $i \in V(r)$, for some $r \in R_t$, for all $i \in V$, $t \in \lambda_i$ (customer demand is fully satisfied),
- $\sum_{i \in V(r)} q_i \leq Q$, for all $r \in R_t$, $t \in T$ (vehicle capacity restriction), and
- minimize $\sum_{t \in T} \sum_{r \in R_t} \sum_{e \in E(r)} c_e$ (total distance traveled by the fleet is minimized).

In Figure 5.1, we provide an example of the PVRP. The time period is two days, $T = \{1, 2\}$, and the set of allowable service patterns is $\Lambda = \{\{1\}, \{2\}, \{1, 2\}\}$. There are three customers (nodes 1, 2, 3) and a single depot (node 0). Node labels in parentheses are demands, and edge labels are travel distances. The vehicle capacity is 30 units. Customer 1 must be visited twice, on days 1 and 2 ($\Lambda_1 = \{\{1, 2\}\}$), and customers 2 and 3 must be visited once, on either day 1 or day 2 ($\Lambda_2 = \Lambda_3 = \{\{1\}, \{2\}\}$). In Figure 5.1(a), we show a route on day 1 and, in Figure 5.1(b), we show a route on day 2. In this example, the customer assignments are $\lambda_1 = \{1, 2\}$, $\lambda_2 = \{1\}$, and $\lambda_3 = \{2\}$, and the total distance traveled over both days is 34.

In this chapter, we consider the standard PVRP and two variants that are encountered in practice. In the first variant, we want to improve an existing solu-

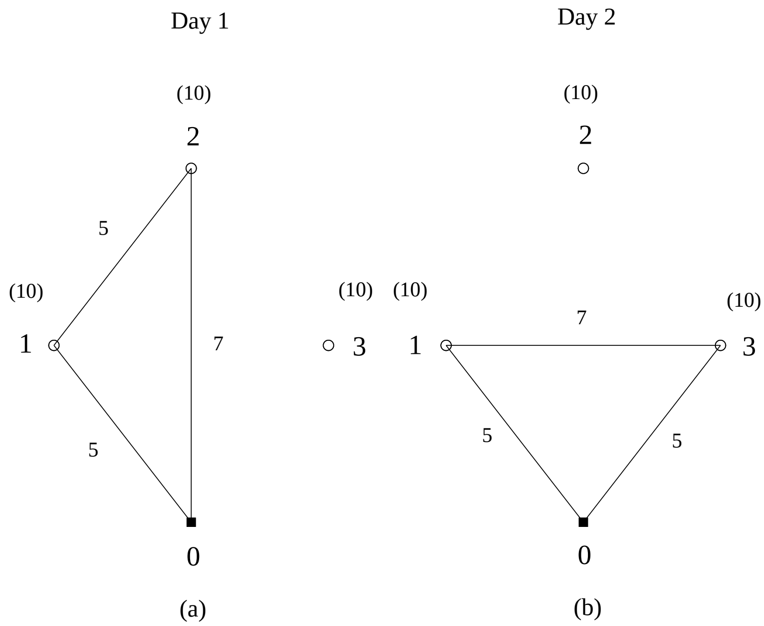


Figure 5.1: An example of a PVRP with a two-day time period. Node labels in parentheses are customer demands and edge labels are distances. Vehicle capacity is 30. The total distance traveled is 34.

tion while constraining the amount of disruption caused by reassigning customers to new service patterns. This variant is the period vehicle routing problem with reassignment constraints (PVRP-RC). In the second variant, we want to improve an existing solution and maintain a balanced workload among the drivers. This variant is the period vehicle routing problem with balance constraints (PVRP-BC).

The remainder of this chapter is organized as follows. In Section 5.2, we review the literature on the PVRP. In Section 5.3, we develop an integer programming-based heuristic for the PVRP and provide computational results. In Section 5.4, we discuss the PVRP-RC and the PVRP-BC and show how our heuristic for the PVRP can be adapted to these problems. In Section 5.5, we give our conclusions.

5.2 Literature Review of the PVRP

The literature for the standard PVRP dates back to the 1970s, with solution procedures developed by Beltrami and Bodin [11] and Russell and Igo [81]. In the 1980s and early 1990s, solution procedures were developed by Tan and Beasley [88], Christofides and Beasley [22], and Russell and Gribbin [80]. In the mid 1990s, Chao, Golden, and Wasil [19] developed a two phase, record-to-record travel algorithm for the PVRP, and Cordeau, Gendreau, and Laporte [26] used a tabu search heuristic. In 2001, Drummond, Ochi, and Vianna [35] used a parallel genetic algorithm for the PVRP. Recently, Alegre, Laguna, and Pacheco [1] developed a scatter search algorithm designed especially for problems with long time periods, and Hemmelmayr, Doerner, and Hartl [54] implemented a variable neighborhood search heuristic.

Several variants of the PVRP have been presented in the literature. Baptista, Oliveira, and Zúquete [9] considered the PVRP in which customer demand is a random variable and the objective function is modified to treat demand as profit. Gonçalves, Ochi, and Martins [49] considered a variant in which customer frequency is a decision variable and the objective is to maximize service, not minimize travel distance. Angelelli and Speranza [2] generalized the PVRP by allowing intermediate facilities. Hadjiconstantinou and Baldacci [53] considered multiple depots, while Francis, Smilowitz, and Tzur [38] modeled the PVRP with service choice.

Many real-world problems have been modeled as PVRPs including waste and recycled goods collection [9, 11, 81], grocery and soft drink distribution [17, 47], fuel oil and industrial gas delivery [32], internal transport installation and maintenance

[13], utility services [53], automobile parts distribution [1], and oil collection from onshore wells [49].

5.3 An Integer Programming-based Heuristic for the PVRP

5.3.1 Generating an Initial Solution

We describe a heuristic for the PVRP. We generate an initial solution with a method that is similar to one developed by Chao, Golden, and Wasil [19]. First, we assign customers to service patterns by solving a mixed integer program (MIP) that minimizes the maximum amount of demand serviced on a specific day of the time period. For each $k \in \Lambda$ and $t \in T$, let the parameter a_{kt} equal 1 if day t is in pattern k, and 0 otherwise. The decision variables of this assignment MIP are M, the maximum amount of demand serviced on a single day and u_{ik}, which is equal to 1 if customer i is assigned to pattern k, and 0 otherwise. The assignment MIP is given by (1) to (5).

$$\text{minimize } M \tag{1}$$

subject to

$$\sum_{k \in \Lambda_i} u_{ik} = 1 \qquad \forall i \in V \tag{2}$$

$$\sum_{i \in V} \sum_{k \in \Lambda} a_{kt} q_i u_{ik} \leq M \qquad \forall t \in T \tag{3}$$

$$u_{ik} \in \{0, 1\} \qquad \forall i \in V, \forall k \in \Lambda_i \tag{4}$$

$$M \geq 0 \tag{5}$$

In the objective function (1), we minimize the maximum amount of demand serviced on a day. In (2), each customer is assigned to exactly one feasible pattern.

In (3), the demand serviced on a given day must be less than the maximum amount.

Second, using the solution from the assignment MIP, we generate routes on each day $t \in T$ by applying a modified Clarke-Wright savings algorithm [95] to the customers assigned to day t. The result is our initial solution to the PVRP which we denote by S.

5.3.2 Improving the Initial Solution Using Integer Programming

To improve our initial solution S, we formulate and solve an improvement integer program (IIP). In the IIP, customers are reassigned to new schedules and moved to new routes in order to decrease the total distance traveled. By using integer programming, many moves can be considered simultaneously. This is generally an advantage over algorithms that move customers one at a time. Also, it is easy to modify the IIP to model the PVRP-RC and the PVRP-BC (see Section 5.4).

Given a customer i, let $V(i)$ be the neighborhood of i, that is, the set of L customers j for which c_{ij} is the smallest. The neighborhood size L is a preset parameter. Let $\lambda_i \in \Lambda_i$ be the service pattern to which i is assigned in S. We consider reassigning i to a new service pattern $k \in \Lambda_i$, removing i from its current route(s), and moving i immediately prior to a customer j on each day $t \in k$. In order to find the optimal reassignment, we formulate the IIP given below.

Let Q_r be the residual capacity of route r (that is, the vehicle capacity minus the total amount delivered on r). Let $p(i)$ and $s(i)$ be the predecessor and successor of customer i on a route in S. The decision variables are defined as follows. Let

$x_{ijt} = 1$ if customer i is moved immediately prior to customer j on day t and 0 otherwise; $y_{it} = 1$ if customer i is removed from its route on day t and 0 otherwise; and $w_{ik} = 1$ if customer i is reassigned to service pattern k and 0 otherwise.

Our formulation of the IIP is given by (6) to (20).

$$\text{maximize} \sum_{i\in V}\sum_{t\in T}(c_{p(i)i} + c_{is(i)} - c_{p(i)s(i)})y_{it} - \sum_{i\in V}\sum_{j\in V}\sum_{t\in T}(c_{p(j)i} + c_{ij} - c_{p(j)j})x_{ijt} \tag{6}$$

subject to

$$\sum_{t\in T} y_{it} = \sum_{j\in V}\sum_{t\in T} x_{ijt} \qquad \forall i \in V \tag{7}$$

$$\sum_{j\in V} x_{ijt} \leq \sum_{k\in\Lambda:t\in k} w_{ik} \qquad \forall i \in V, \forall t \in T/\lambda_i \tag{8}$$

$$\sum_{j\in V} x_{ijt} \leq y_{it} \qquad \forall i \in V, \forall t \in \lambda_i \tag{9}$$

$$w_{ik} \leq \sum_{j\in V} x_{ijt} \qquad \forall i \in V, \forall k \in \Lambda_i, \forall t \in k/\lambda_i \tag{10}$$

$$w_{ik} \leq 1 - y_{it} + \sum_{j\in V} x_{ijt} \qquad \forall i \in V, \forall k \in \Lambda_i, \forall t \in k \cap \lambda_i \tag{11}$$

$$\sum_{i\in V}\sum_{j \text{ on } r} q_i x_{ijt} - \sum_{i \text{ on } r} q_i y_{it} \leq Q_r \qquad \forall t \in T, \forall r \in R_t \tag{12}$$

$$y_{it} + \sum_{j\in V} x_{jit} \leq 1 \qquad \forall i \in V, \forall t \in \lambda_i \tag{13}$$

$$y_{p(i)t} + \sum_{j\in V} x_{jit} \leq 1 \qquad \forall i \in V, \forall t \in \lambda_i \tag{14}$$

$$y_{it} + y_{p(i)t} \leq 1 \qquad \forall i \in V, \forall t \in \lambda_i \tag{15}$$

$$\sum_{k\in\Lambda_i} w_{ik} \leq 1 \qquad \forall i \in V \tag{16}$$

$$x_{ijt} = 0 \qquad \forall i \in V, \forall j \notin V(i), \forall t \notin \lambda_j \tag{17}$$

$$y_{it} = 0 \qquad \forall i \in V, \forall t \notin \lambda_i \tag{18}$$

$$w_{ik} = 0 \qquad \forall i \in V, \forall k \notin \Lambda_i \text{ and for } k = \lambda_i \tag{19}$$

$$x_{ijt}, y_{it}, w_{ik} \in \{0, 1\} \qquad \forall i \in V, \forall j \in V, \forall t \in T, \forall k \in \Lambda \tag{20}$$

In the objective function (6), we maximize the total savings across all customer moves. Constraints (7) ensure that we remove a customer from a route if and only if we reinsert the customer elsewhere. In constraints (8), if we insert customer i on day t not in i's current service pattern, then we reassign i to a new service pattern containing day t. In constraints (9), we move customer i to a new spot on day t in i's current service pattern, only if we remove it from its current spot on day t. Constraints (8) and (9) also ensure that we do not insert a customer more than once on a given day. Constraints (10) ensure that if we reassign customer i to a new service pattern, then we insert i on each day in the new service pattern not in i's current service pattern. In constraints (11), if we move customer i to a new service pattern k, then for each day t in the intersection of pattern k and i's current service pattern, we reinsert i on day t if we remove it from its current spot. Constraints (12) ensure that feasibility is maintained with respect to vehicle capacity, that is, the total amount of demand moved to a route minus the total amount moved from a route is less than the residual capacity. Constraints (13) and (14) ensure that if customer i or the predecessor of i is removed from a route, then no customers are inserted immediately prior to i on this route. These constraints also ensure that at most one customer is inserted immediately prior to i. In constraints (15), we remove either customer i or its predecessor but not both. Constraints (13), (14), and (15) ensure that the objective function value accurately represents the reassignment savings, as the coefficients in the objective function depend on the distance between a customer and its predecessor. Constraints (16) ensure that a customer is reassigned to at most one new service pattern. In constraints (17), (18), and (19), we do not allow customer i to be inserted prior to customer j on day t if j is not a neighbor of i or if j is not serviced on day t. We do not allow customer i to be removed from a route on day t if day t is not in i's current service pattern.

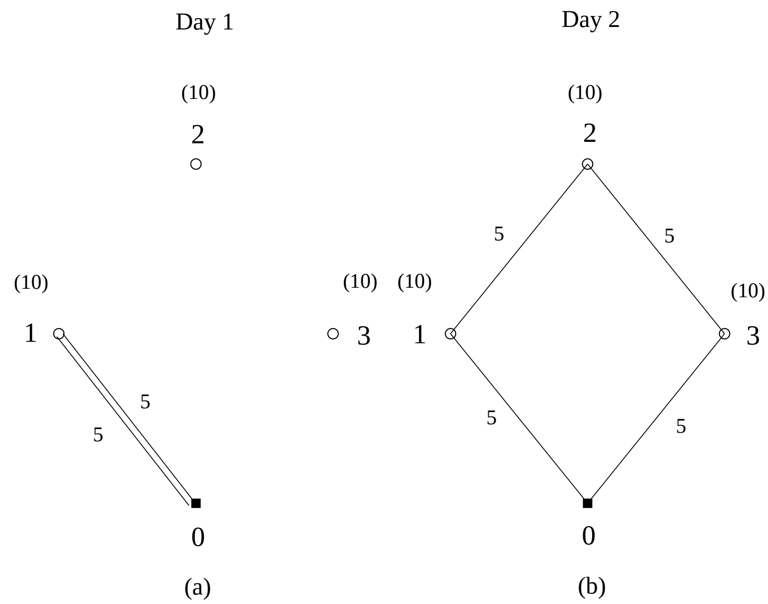


Figure 5.2: The optimal solution of the IIP for the example in Figure 5.1. The total distance is 30 units.

We do not allow customer i to be reassigned to an infeasible service pattern or to its current service pattern.

In Figure 5.2, we give the optimal solution of the IIP for the PVRP shown in Figure 5.1. Customer 2 is reassigned to pattern $\{2\}$, removed from its route on day 1, and inserted immediately prior to customer 3 on day 2. The total travel distance is 30 units, a savings of four units over the solution in Figure 5.1. In Section 5.6 (Appendix I), we give the complete IIP formulation for this example.

5.3.3 Improving Daily Routes Using Record-to-record Travel

Vehicle routes for a specific day of the time period are treated as a VRP solution. We improve this solution using an enhanced record-to-record travel algorithm (ERTR) developed by Groër, Golden, and Wasil [50]. ERTR is a modified version of the variable length record-to-record travel algorithm (VRTR) developed by Li,

Table 5.1: Enhanced record-to-record travel algorithm.

```
S = initial solution, deviation = 1%, count = 0, C = 10, A = 70
Initialize the record, S* = S
Uphill:
For a = 1 to A
    Apply one-point moves, apply two-point moves, apply three-point moves
    Apply two-opt edge exchanges, apply Or-opt edge exchanges
    Update S if result is within deviation of cost of S*
    Update S* if necessary
End-For
Downhill:
Apply Or-opt edge exchanges, apply two-opt edge exchanges
Apply one-point moves, apply two-point moves, apply three-point moves
If (cost decreases), update S and go to Downhill
Else Update S* if necessary, otherwise count = count + 1
If (count < C) go to Uphill
Perturb solutions once and go to Uphill
Return S*
```

Golden, and Wasil [63]. VRTR improves a solution by performing one-point and two-point node exchanges, as well as two-opt edge exchanges. ERTR considers additional moves including three-point node exchanges and Or-opt edge exchanges. Uphill moves are allowed when a solution is within a pre-specified tolerance of the record (best) solution. The details of ERTR are given in Table 5.1.

5.3.4 Customer Removal and Reinsertion

Given a current solution S, we apply IIP and ERTR repeatedly. We stop when either i) there is no improvement in the current iteration, or ii) the improvement is less than a minimum value and S is not within a maximum deviation of the record (best) solution. Rule ii) allows us to exit an iteration in which we are unlikely to find a new record solution. Next, we re-initialize S by removing some customers of S and reinserting them elsewhere. This allows us to explore the solution space from a different (new) solution.

For each customer i, we remove i from S with a pre-set probability. Let C be the set of customers removed from S. We use the IIP to reinsert the customers in C. Given the time period, $T = \{1, ..., P\}$, we create a fictitious day $P + 1$, assign each customer $j \in C$ to the fictitious service pattern $\{P + 1\}$, and create a round-trip route from the depot to j on day $P + 1$. We then solve the IIP with constraints that ensure each customer in C is reassigned from $\{P + 1\}$ to a new feasible service pattern. That is, for the customers of C, we modify constraints (16) in the IIP so that $\sum_{k \in \Lambda_j} w_{jk} = 1, \forall j \in C$. We also eliminate constraints (13) and (14) for all customers. Eliminating these constraints produces more customer moves that are feasible and helps to generate a feasible solution in a reasonable amount of run time. However, the objective function now provides only an estimate of the true savings.

After performing this re-initialization step, we again apply the IIP and daily ERTR. We repeat this process until a stopping condition is reached and return the best solution. We set a run-time limit for each execution of the IIP. If the IIP is not solved optimally when the run-time limit is reached, the best solution that had been found is returned. The details of our integer programming-based heuristic (IPH) for the PVRP are given in Table 5.2.

5.3.5 Computational Experiment with IPH

We applied IPH to 32 benchmark problems. Ten problems (P1 to P10) were developed by Eilon, Watson-Gandy, and Christofides [37] for the VRP and adapted

Table 5.2: The IPH algorithm for solving the PVRP.

S = current solution, $maxRecord = 40$, $maxIter = 80$, $p = .7$
f_i = number of days customer i is serviced throughout the time period
$runTime$ = the current number of seconds elapsed in the algorithm's execution
$minImprove = .05\%$, $maxDeviation = .05\%$
Set the IIP time limit to 30 seconds
If (number of customers N is less than 50)
    Set the neighborhood size L to $N - 1$
    Set the run-time limit $maxTime$ to 400 seconds
Else-if ($N < 100$), $L = N - 1$, $maxTime = 600$
Else $L = 10$, $maxTime = 900$
Set $recCntr = 0$ (number of iterations since the last record solution was found)
Set $iterCntr = 0$ (total number of iterations)
Generate initial solution S, set best solution $S^* = S$
Apply ERTR to each day of S
Repeat
    Repeat
        Apply the IIP to S
        Apply ERTR to each day of S
        If (improvement of $S < minImprove$) and (deviation of S from $S^* > maxDeviation$)
            Break Repeat-Until
    Until (no improvement of S is achieved)
    Update S^* and set $recCntr = 0$ if necessary, otherwise $recCntr = recCntr + 1$
    For $i = 1$ to N
        Remove customer i from S with probability p/f_i
        Add i to set C if i is removed from S
    End-For
    Reinsert the customers of C onto routes of S using the IIP (re-initialization)
    Apply ERTR to each day of S
    $iterCntr = iterCntr + 1$
Until ($recCntr > maxRecord$) or ($iterCntr > maxIter$) or ($runTime > maxTime$)
Return S^*

---

to the PVRP by Christofides and Beasley [22]. One problem (P11) is from Russell and Igo [81]. In its original form, this problem has 125 customers, some with different demands on different days. For these customers, we created several customers all at the same location with constant demands. Our problem has 131 customers. Two problems (P12, P13) were developed by Russell and Gribbin [80]. Nineteen problems (P14 to P32) are taken from Chao, Golden, and Wasil [19]. These 32 problems vary in size from 50 customers to 417 customers with time periods from 2 days to 10 days. In six problems (P1, P3, P4, P6, P7, P9), all customers require only one visit, so these problems are VRPs. The integer programs in IPH are solved with ILOG CPLEX 10.0 and Visual C++ (version 6.0) using a 3.0 GHz Pentium 4 processor and 512MB of RAM.

In Table 5.3, we give our computational results. In column one, we give the problem number. In columns two and three, we give the number of customers (N) and the length of the time period (P). Columns four through eight give the solution values produced by our algorithm (IPH) and the solution values generated by the algorithms of Chao, Golden, and Wasil (CGW) [19], Cordeau, Gendreau, and Laporte (CGL) [26], Alegre, Laguna, and Pacheco (ALP) [1] (problem P13 was not solved), and Hemmelmayr, Doerner, and Hartl (HDH) [54]. We report the results from these algorithms using the default parameter settings given by the authors. In column nine, we give the value of the best-known solution found by these algorithms using any parameter setting during computational experiments. The best-known solution values are given in [54]. Although Drummond, Ochi, and Vianna [35] report results for these problems, we have not included them in Table 5.3 because they contain "evident errors" according to [1]. For the problems in Table 5.3, the number of vehicles available each day is fixed at a constant K. Although we do not explicitly limit the number of vehicles in IPH, for no problem did our solution require more than K vehicles on a day.

In Table 5.3, we see that IPH performs very well among the five algorithms. IPH generated the best solutions to 16 problems (there are ties) and had the smallest average deviation from the best-known solutions (1.16%). IPH matched the

Table 5.3: Computational results for five algorithms on 32 PVRPs.

Problem	N	P	IPH	CGW	CGL	ALP	HDH	Best-known Solution
P1	50	2	**524.61**	**524.6**	**524.61**	531.02	**524.61**	524.61
P2	50	5	1334.11	1337.2	1330.09	**1324.74**	1332.01	1322.87
P3	50	5	**524.61**	**524.6**	**524.61**	537.37	528.97	524.61
P4	75	2	849.44	860.9	**837.94**	845.97	847.48	835.26
P5	75	5	2064.62	2089.0	2061.36	**2043.75**	2059.74	2027.99
P6	75	10	**839.93**	881.1	840.30	840.10	884.69	835.45
P7	100	2	829.44	832.0	**829.37**	829.65	829.92	826.14
P8	100	5	2054.25	2075.1	2054.90	**2052.21**	2058.36	2034.15
P9	100	8	**829.44**	829.9	829.45	829.65	834.92	826.14
P10	100	5	1645.42	1633.2	1629.96	**1621.21**	1629.76	1593.45
P11	131	5	**781.68**	791.3	817.56	782.17	791.18	779.06
P12	163	5	1266.39	1237.4	1239.58	**1230.95**	1258.46	1195.88
P13	417	7	3624.77	3629.8	**3602.76**	NS	3835.90	3511.62
P14	20	4	**954.81**	**954.8**	**954.81**	**954.81**	**954.81**	954.81
P15	38	4	**1862.63**	**1862.6**	**1862.63**	**1862.63**	**1862.63**	1862.63
P16	56	4	**2875.10**	2875.2	2875.24	2875.24	2875.24	2875.10
P17	40	4	**1597.66**	1614.4	1597.75	1597.75	1601.75	1597.66
P18	76	4	3215.43	3217.7	3159.22	3157.00	**3147.91**	3136.69
P19	112	4	**4845.97**	4846.5	4902.64	4846.49	4851.41	4834.34
P20	184	4	8369.72	**8367.4**	**8367.40**	8412.02	**8367.40**	8367.40
P21	60	4	2189.90	2216.1	2184.04	**2173.58**	2180.33	2170.61
P22	114	4	4327.96	4436.4	4307.19	4330.59	**4218.46**	4193.95
P23	168	4	6683.29	6769.0	**6620.50**	6813.45	6644.93	6420.71
P24	51	6	3741.98	3773.0	3704.11	**3702.02**	3704.60	3687.46
P25	51	6	3817.08	3826.0	**3781.38**	**3781.38**	**3781.38**	3777.15
P26	51	6	3833.64	3834.0	**3795.32**	3795.33	**3795.32**	3795.32
P27	102	6	**21946.89**	23401.6	23017.45	22561.33	22153.31	21946.89
P28	102	6	**22384.04**	23105.1	22569.40	22562.44	22418.52	22305.34
P29	102	6	**22668.10**	24248.2	24012.92	23752.15	22864.23	22639.85
P30	153	6	**75238.50**	80982.1	77179.33	76793.99	75579.23	74464.26
P31	153	6	**77263.61**	80279.1	79382.35	77944.79	77459.14	76552.25
P32	153	6	**78794.46**	83838.7	80908.95	81055.52	79487.97	78072.88
Average Deviation[1]			1.16	2.71	1.58	1.36	1.39	

[1] Deviation is 100[(Solution / Best-known Solution) − 1]%

Bold indicates the best solution among the five algorithms.

NS Not Solved

best-known solutions to seven problems listed in column nine and produced three new best-known solution (P16, P17, and P27). ALP was next with the best solutions to 10 problems and an average deviation of 1.36% on 31 problems. In this

Table 5.4: Run times (seconds) for five algorithms on 32 PVRPs.

Problem	N	P	IPH[1]	CGW[2]	CGL[3]	ALP[4]	HDH[5]
P1	50	2	231.03	66	29.4	268	98.3
P2	50	5	615.75	408	35.4	494	81.6
P3	50	5	282.05	36	32.4	45	100.5
P4	75	2	629.75	462	46.8	1426	67.2
P5	75	5	625.92	324	52.8	1280	68.0
P6	75	10	644.03	180	57.0	1797	76.0
P7	100	2	564.58	330	76.8	199	183.2
P8	100	5	939.13	910	123.6	3584	142.9
P9	100	8	656.39	258	95.4	970	193.1
P10	100	5	943.16	1082	123.6	9467	170.0
P11	131	5	970.13	12324	206.4	6492	253.7
P12	163	5	967.44	714	236.4	515	354.7
P13	417	7	911.11	2022	1491.6	NS	127.6
P14	20	4	79.94	12	9.6	5	37.3
P15	38	4	202.41	30	23.4	1	93.9
P16	56	4	323.26	18	41.4	2	217.7
P17	40	4	293.80	318	22.2	96	56.7
P18	76	4	572.65	666	64.2	401	142.5
P19	112	4	952.99	3636	135.6	20	258.2
P20	184	4	976.18	9030	232.2	60	889.1
P21	60	4	621.79	6	33.0	373	72.5
P22	114	4	940.20	816	132.0	528	169.6
P23	168	4	985.60	4200	342.0	42	341.4
P24	51	6	474.47	198	31.8	114	52.2
P25	51	6	351.53	18	31.2	69	46.9
P26	51	6	463.13	66	31.2	8	45.2
P27	102	6	930.37	120	82.8	219	66.0
P28	102	6	931.72	174	80.4	435	64.6
P29	102	6	934.79	66	76.2	19	59.3
P30	153	6	983.15	270	171.0	20	78.0
P31	153	6	977.68	354	160.8	7650	77.1
P32	153	6	974.68	204	145.8	8316	70.4
Average			685.97	1229	139.2	1449	148.6

[1] 3.0 GHz Pentium 4 processor

[2] SUN 4/370 workstation

[3] 3.2 GHz Pentium 3 processor (times are from [54])

[4] 600 MHz Pentium 3 processor

[5] 3.2 GHz Pentium 3 processor

NS Not solved

computational experiment, IIP accounts for a substantial amount of improvement to a solution. For example, on P2, a single execution of IIP improved a solution by

1.39%, while a single execution of ERTR improved a solution by 0.44%.

In Table 5.4, we provide the run times in seconds for the five algorithms. Each algorithm is run on a different machine. CGL and HDH are the two fastest algorithms, on average, followed by IPH. IPH is slower due to the large number of integer programs that it solves during a run.

In Appendix C, we give all problems used in testing and all solutions generated by IPH.

5.4 PVRP in Practice

In this section, we formulate new models that take real-world routing considerations into account in two ways. First, we try to improve an existing solution by reassigning customers to new routes. We use three different types of constraints to limit the number of customer reassignments: a hard limit, a soft limit, and a restricted limit (detailed explanations are given in the sections that follow). In the case of soft and restricted limits, we show how a routing manager could develop effective routes in practice. Second, we show how to achieve a balanced workload among drivers across different routes.

5.4.1 The PVRP with Reassignment Constraints

5.4.1.1 Formulation

In the PVRP-RC, we improve a solution S' while constraining the amount of disruption to the routes of S' caused by customer reassignments. We consider three types of constraints. First, we set a hard constraint on the total number of customer reassignments. Given S', the objective is to find the solution S^* with the smallest total distance traveled such that the number of customers assigned to different service patterns in S' and S^* is less than a specified limit. Second, we set a soft constraint. We incur a penalty for each customer that has a pattern different than its pattern in S'. The objective is to find the solution S^* with the smallest total objective value, i.e., we minimize total routing distance *plus* total reassignment penalty cost. Third, we allow the customers visited once during the time period (one-day customers) to be reassigned, but no other customers can be reassigned. One-day customers are usually the easiest to move so, in many cases, they can be reassigned without causing wide-scale disruption [62].

The PVRP-RC is a more realistic model than the traditional PVRP. In practice, companies have existing routes that, over time, have become inefficient due to adding and deleting customers from routes and other modifications. There may be economical, logistical, and contractual issues that prevent a company from constructing new routes entirely from scratch. When customers are assigned to new routes on new days, the company may incur costs due to paperwork and processing, as well as learning-curve costs because drivers have to visit new customers on new days. Some companies have thousands of vehicles in their fleets and visit millions of customers annually [13]. Generating new routes for these companies would take a lot of time and would be very costly. Also, some customers rely on being serviced on certain days and view reassignments as an inconvenience. In practice, it is desirable to minimize (limit) the number of customer reassignments in order to maintain good customer relations [62].

5.4.1.2 Hard Reassignment Constraints

In the PVRP with a hard reassignment constraint (PVRP-RCH), we start with a solution S' and a customer reassignment limit W. We seek the solution S^* with the smallest travel distance such that the number of customers reassigned to different patterns in S' and S^* is at most W.

We modify the IIP to model the PVRP-RCH by including the constraint $\sum_{i \in V, k \in \Lambda_i} w_{ik} \leq W$ to ensure that no more than W customers are reassigned.

In preliminary computational experiments, we found that better results can occur when the IIP is solved several times rather than being solved once because more moves are possible. In our experiments, we set the reassignment limit in the IIP to $\lceil \frac{W}{L} \rceil$, where L is a parameter. We solve the IIP until no feasible improvements are possible. We track customers as they are reassigned so that they do not count against the reassignment limit in IIPs that are subsequently solved. When solving daily VRPs, no customers are reassigned to new patterns, and we can apply the daily ERTR without affecting the number of reassignments. In Table 5.5, we give the details of an IIP-based heuristic (denoted IPH-RCH) for solving the PVRP-RCH.

We also develop a greedy heuristic to solve the PVRP-RCH and compare its solutions to the solutions generated by IPH-RCH. Given a current solution S, we consider the savings produced by reassigning a single customer i to a new pattern

Table 5.5: The IPH-RCH algorithm for solving the PVRP-RCH.

S' = an existing solution, S = current solution, $L = 4$
W = number of allowable customer reassignments
w = IIP customer reassignment limit
a = number of customers assigned to different patterns in $S'$and S
Initialize $S = S'$, $w = \lceil \frac{W}{L} \rceil$
Repeat
Apply the IIP to S with a reassignment limit of w and a time limit of 100 s
Apply ERTR to each day of S
Calculate a from S' and S
$w = \min\{W - a, \lceil \frac{W}{L} \rceil\}$
Until ($w = 0$) or (no improvement of S)
Return S

k. We remove i from its routes in S and consider inserting i in a feasible, least-cost manner into routes on each of the days in k. We order the customers from largest possible savings to smallest possible savings and consider the three customers (denoted i_1, i_2, and i_3) with the largest positive savings on the list. We reassign one of the customers i_1, i_2, and i_3, with probabilities π_1, π_2, and π_3 ($\pi_1 + \pi_2 + \pi_3 = 1$), respectively. This process is repeated until the maximum number of customer reassignments W has been reached or no customer reassignments produce positive savings. The details of the greedy heuristic (GH) are given in Table 5.6.

For 26 PVRPs (we omitted the six problems with customers visited only on one day), we ran IPH-RCH once and GH 150 times on each problem. We use the same initial solution for both algorithms (the procedure for generating an initial solution is given in Section 5.3.1). We set the reassignment limit to 10% of the number of customers ($W = \lceil .1N \rceil$). The solutions produced by IPH-RCH and GH are given in Table 5.7. In column one, we give the problem number. In columns two through four, we give the number of customers (N), the number of days in the time

Table 5.6: The GH algorithm for solving the PVRP-RCH.

```
S' = an existing solution, S = current solution, π1 = .5, π2 = .3
W = maximum number of allowable customer reassignments
N = number of customers
Initialize Cntr = 1
Initialize S = S'
Repeat
    Order customers i1, i2, ..., iN according to possible savings attained from reassignment
    If (reassigning i1 gives positive savings)
        Let u be a random variable uniformly distributed in [0,1]
        If (u ≤ π1) or (reassigning i2 gives negative savings)
            reassign customer i1
        Else-if (u ≤ π1 + π2) or (reassigning i3 gives negative savings)
            reassign customer i2
        Else
            reassign customer i3
        Cntr = Cntr + 1
    Else
        Break Repeat-Until
Until (Cntr = W)
Return S
```

period (P), and the number of allowable customer reassignments (W). In column five, we give the solution generated by IPH-RCH. In column six, we give the best solution produced by GH over the 150 runs. In columns seven and eight, we give run times (in seconds) for the two heuristics, where the value for GH is the total time for all 150 runs.

In Table 5.7, we see that, on average, IPH-RCH produces solutions that are 0.11% above the best solutions generated by the two heuristics. For the best GH solution, the deviation is 1.90%, on average. For 18 of the 26 problems, the IPH-RCH solution is better than the best GH solution. For five problems, the best GH solution is better than the IPH-RCH solution and, for three problems, both methods generated the same solution. IPH-RCH averaged 63.90 seconds for one run. GH averaged 701.10 seconds for 150 runs.

Table 5.7: Results for two algorithms on 26 PVRP-RCs with a hard constraint.

Problem	N	P	W	IPH-RCH	GH Best Solution	IPH-RCH Run Time (s)[1]	GH Run Time (s)[2]
P2	50	5	5	**1460.94**	1474.33	9.10	260.01
P5	75	5	8	**2222.10**	2257.46	173.21	455.29
P8	100	5	10	**2218.95**	2293.78	77.58	684.37
P10	100	5	10	**1843.01**	1915.76	32.94	644.70
P11	131	5	14	**852.96**	856.25	177.13	684.44
P12	163	5	17	**1479.19**	**1479.19**	71.00	771.85
P13	417	7	42	**4353.27**	4632.46	301.67	2057.16
P14	20	4	2	1001.08	**993.96**	0.78	99.34
P15	38	4	4	**2085.71**	**2085.71**	5.72	183.19
P16	56	4	6	3315.50	**3264.39**	6.55	2986.47
P17	40	4	4	**1693.11**	1707.58	1.58	209.60
P18	76	4	8	**3376.73**	**3376.73**	16.56	530.47
P19	112	4	12	5240.44	**5227.35**	27.67	843.38
P20	184	4	19	**9557.63**	9587.68	64.05	1646.77
P21	60	4	6	2302.54	**2301.80**	15.77	359.78
P22	114	4	12	**4593.37**	4616.20	34.19	808.29
P23	168	4	17	**7073.15**	7094.98	75.58	1335.44
P24	51	6	6	**4265.28**	4304.03	5.20	214.05
P25	51	6	6	**4264.28**	4278.95	5.09	200.57
P26	51	6	6	4328.92	**4314.00**	5.28	199.03
P27	102	6	11	**23269.58**	24615.63	30.55	598.21
P28	102	6	11	**24407.57**	25842.37	45.48	560.23
P29	102	6	11	**24927.55**	25739.63	34.33	631.81
P30	153	6	16	**79801.93**	83537.31	128.03	1235.76
P31	153	6	16	**82537.45**	87882.83	115.63	1345.23
P32	153	6	16	**83793.91**	86697.54	200.61	1202.99
Average Deviation[3]				0.11	1.90		

[1] 3.0 GHz Pentium 4 processor

[2] 3.0 GHz Pentium 4 processor (total for all runs)

[3] Deviation is 100[(Solution / Best Solution) − 1]%

.

Bold indicates the best solution.

5.4.1.3 Soft Reassignment Constraints

We can limit the number of customer reassignments by penalizing them in the objective function. In the PVRP with a soft reassignment constraint (PVRP-RCS), we start with a solution S' and try to minimize $\sum_{t\in T}\sum_{r\in R_t}\sum_{e\in E(r)} c_e + \sum_{i\in V} p_i u_i$. The first term is the routing distance described in Section 5.1 and the second term is the reassignment penalty. Here, p_i is the penalty for reassigning customer i to a new pattern and u_i is a binary variable equal to 1 if customer i is assigned to a different pattern than its pattern in S' and equal to 0 otherwise.

To solve the PVRP-RCS, we add a penalty term to the objective function (6) of the IIP. Let S and S' be the current solution and initial solution, respectively. Let μ_{ik} be a parameter equal to 1 if customer i is assigned to pattern k in S' and 0 otherwise. Let η_i be a parameter equal to 1 if customer i is assigned to the same pattern in S as in S' and 0 otherwise. We maximize the savings from reassigning and rerouting customers:

$$\sum_{i\in V}\sum_{t\in T}(c_{p(i)i} + c_{is(i)} - c_{p(i)s(i)})y_{it} - \sum_{i\in V}\sum_{j\in V}\sum_{t\in T}(c_{p(j)i} + c_{ij} - c_{jp(j)})x_{ijt}$$
$$+\sum_{i\in V}\sum_{k\in\Lambda}(\mu_{ik} - \eta_i)p_i w_{ik}. \tag{21}$$

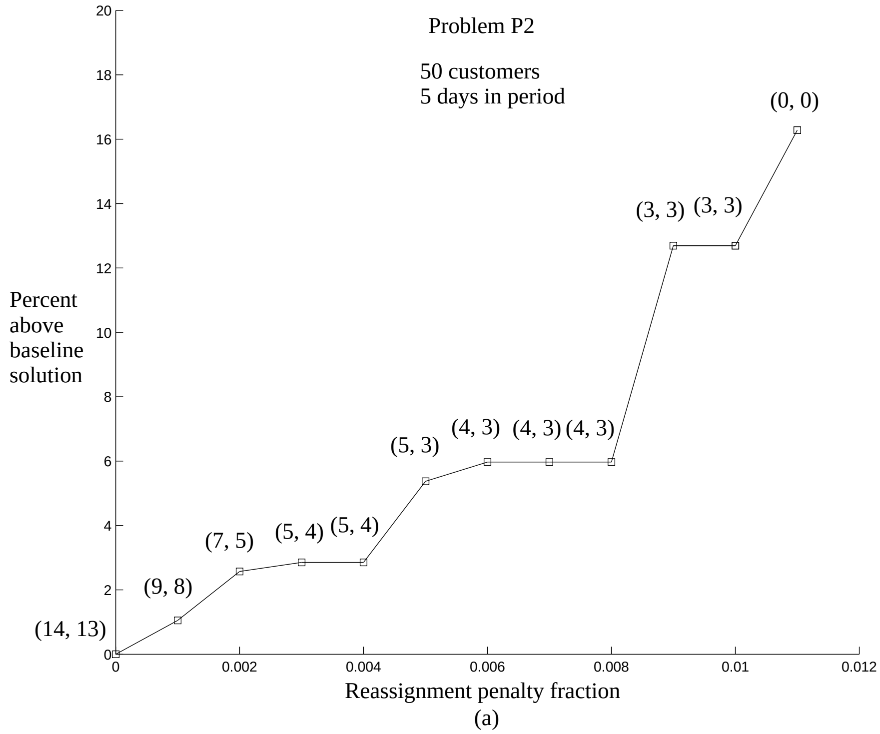
The first two terms are the savings in routing and the third term is the savings from reassignments. The third term is explained in more detail in Section 5.7 (Appendix II).

Using (21) in the IIP, we apply IPH to solve the PVRP-RCS and denote the heuristic by IPH-RCS. We set p_i equal to a fraction of the distance traveled in the initial solution that is proportional to the frequency of customer i. That is,

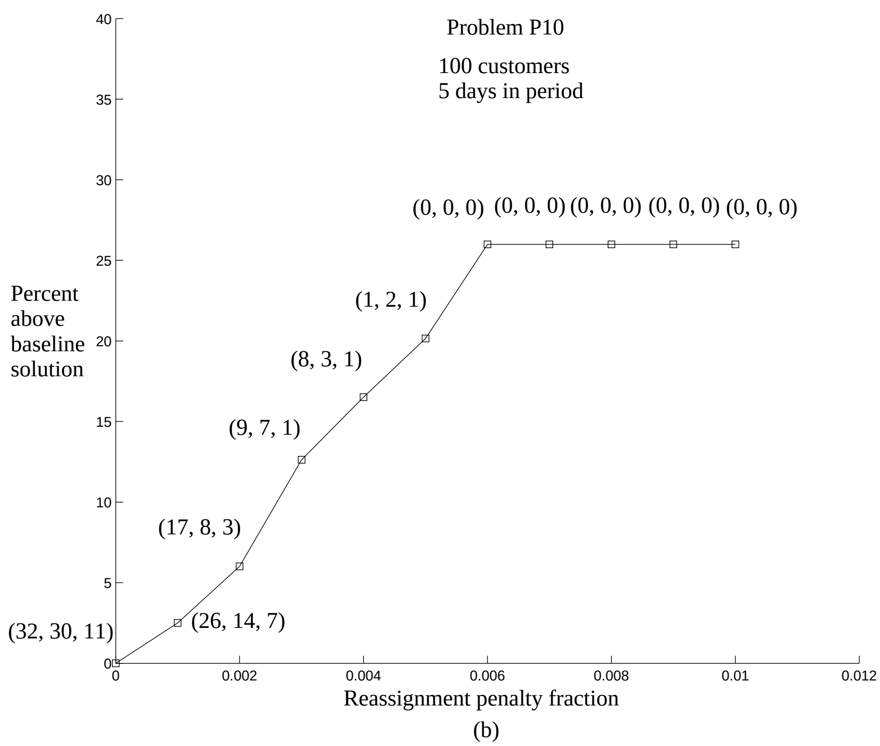
$p_i = \rho C f_i$ where $0 < \rho < 1$ is the constant reassignment penalty fraction, f_i is the number of times customer i is visited throughout the time period, and C is the distance traveled in S'.

We are interested in studying how the total routing distance of a solution generated by IPH-RCS changes as the value of ρ is varied. In Figure 5.3, we show plots for two representative problems (P2 and P10) selected from all 26 problems. On the x-axis, we give the value of ρ. On the y-axis, we give the percent above the baseline solution for the total routing distance of the IPH-RCS solution. The baseline solution is the IPH solution ($\rho = 0$) given in Table 5.3. In Figure 5.3(a), there is an ordered pair adjacent to each plotted point that gives the number of one-day customer reassignments and the number of two-day customer reassignments for the IPH-RCS solution (in P2 only one-day and two-day customers can be reassigned). To illustrate in Figure 5.3(a), when $\rho = 0$ (baseline solution), there are 14 one-day customers and 13 two-day customers that have been reassigned from the initial solution. When $\rho = 0.001$, the solution generated by IPH-RCS is 1.05% above the baseline solution. There are nine one-day customers and eight two-day customers that have been reassigned from the initial solution. In Figure 5.3(b), there is an ordered triple adjacent to each plotted point that gives the number of one-day, two-day, and three-day customer reassignments for P10. To illustrate, for P10 when $\rho = 0$ (baseline solution), there are 32 one-day customers, 30 two-day customers, and 11 three-day customers that have been reassigned from the initial solution.

In Figure 5.3(a), we see the basic shape of a step graph. At each value of ρ, IPH-RCS reassigns customers. The total routing distance of a solution is approxi-



(a)



(b)

Figure 5.3: The percent above baseline solutions changes as the customer reassignment penalty fraction (ρ) is varied for problems P2 and P10 with soft reassignment constraints.

mately the same until we reach a value of ρ that causes the number of reassigned customers to decrease and the total routing distance to increase a step.

In Figure 5.3(b), the step-function shape is less pronounced. We see a steady incline until no reassignments are made and the solutions level off at approximately 26% above the baseline solution. In our experience, the shapes of the plots given in Figure 3 reflect the type of behavior we have seen in other benchmark problems.

Based on Figure 5.3, it would be easy for a routing manager to determine the solution that represents the best tradeoff between distance and disruption. For P2, a manager might decide that a solution with five one-day customer reassignments and four two-day customer reassignments (5, 4) is the ideal choice. This solution has a travel distance that is only 2.85% above the travel distance of the baseline solution and yet it requires one-third the number of reassignments.

5.4.1.4 Restricted Reassignment Constraints

Customers visited only once during the time period are generally the least costly to reassign and the least inconvenienced by reassignments [62]. Because of this, it is worthwhile to consider the PVRP in which multi-day customers are fixed to their initial patterns and one-day customers are allowed to be reassigned. We call this problem the PVRP with restricted reassignment constraints (PVRP-RCR).

To model the PVRP-RCR, we set the decision variable $w_{ik} = 0$ for all multi-day customers i and all $k \in \Lambda$ in the IIP. We apply IPH to this model and denote this heuristic IPH-RCR.

We want to examine how solutions with restricted reassignment constraints compare to solutions in which we can reassign a fixed number of customers. We selected a representative set of 10 problems and applied IPH-RCR to each problem. We tracked the number of customers reassigned (ω) from the initial solution S' to the final solution. Using the same initial solution as in IPH-RCR, we run IPH-RCH with the reassignment limit W set at ω. The computational results are given in Table 5.8.

In Table 5.8, we see that the solutions produced by IPH-RCH are better than the solutions produced by IPH-RCR for all 10 problems. The ability to reassign multi-day customers as well as one-day customers is highly desirable in an algorithm. For example, in Problem P2, by allowing only one-day customers to be reassigned, the final solution produced by IPH-RCR is 10.27% above the baseline (IPH) solution (10 customers are reassigned). If we allow any 10 customers to be reassigned, the solution is 6.75% above the baseline solution (four one-day customers and six multi-day customers are reassigned). By allowing multi-day customers to be reassigned, in all 10 problems, IPH-RCH does much better on average (3.30%) than IPH-RCR (5.38%) which allows only one-day customers to be reassigned. This type of analysis could be very useful to a routing manager seeking a high-quality solution that tries to improve a current solution while minimizing disruption.

Table 5.8: Results from the IPH-RCR and IPH-RCH on 10 PVRP-RCs.

Problem	N	P	W	IPH	IPH-RCR	IPH-RCH
P2	50	5	10	1334.11	1471.09	1424.22
P5	75	5	21	2064.62	2167.67	2161.07
P8	100	5	25	2054.25	2212.91	2160.38
P11	131	5	70	781.68	811.67	800.17
P12	163	5	110	1266.39	1311.17	1291.61
P18	76	4	26	3215.43	3308.77	3289.77
P23	168	4	55	6683.29	6936.54	6782.89
P25	51	6	31	3817.08	4041.72	3944.48
P29	102	6	61	22668.10	23686.57	23062.03
P31	153	6	81	77293.61	82200.85	79705.58
Average Deviation[1]					5.38	3.30

[1] Deviation is 100[(Solution / IPH Solution) − 1]%.

5.4.2 The PVRP with Balance Constraints

In practice, routing managers try to generate routes that minimize distance and have a balanced workload (e.g., number of customers serviced) among drivers. They are willing to consider longer routes if the workload across the fleet of vehicles is evenly distributed [62]. Motivated by this industry consideration, we model the period vehicle routing problem with balance constraints (PVRP-BC).

In the PVRP with balance constraints (PVRP-BC), we try to improve the routes of a solution S', while penalizing imbalance. That is, we seek to minimize $\sum_{t\in T}\sum_{r\in R_t}\sum_{e\in E(r)} c_e + \varphi(U - L)$. The first term is the routing distance. The second term gives the imbalance penalty term, where φ is a constant scalar, U is the largest number of customers on a route in a solution, and L is the smallest number of customers on a route in a solution. We use the number of customers on a route to measure balance. In practical routing applications such as commercial sanitation, the number of customers on a route is the main determinant of workload [29]. We point out that we could model the PVRP-RC and the PVRP-BC together. We could constrain the number of reassignments (using any of the constraints in Section 5.4.1) and account for route balance simultaneously.

We modify the IIP to model the PVRP-BC. We add decision variables U and L, the parameter φ, and use the new objective function:

$$\text{maximize} \sum_{i\in V}\sum_{t\in T}(c_{p(i)i} + c_{is(i)} - c_{p(i)s(i)})y_{it}$$
$$-\sum_{i\in V}\sum_{j\in V}\sum_{t\in T}(c_{p(j)i} + c_{ij} - c_{p(j)j})x_{ijt} - \varphi(U - L). \tag{22}$$

Let $N(r)$ be the number of customers on route r. We add the constraints

$$\sum_{i\in V}\sum_{j \text{ on } r} x_{ijt} - \sum_{i \text{ on } r} y_{it} + N(r) \le U \qquad \forall t \in T, \forall r \in R_t \tag{23}$$
$$\sum_{i\in V}\sum_{j \text{ on } r} x_{ijt} - \sum_{i \text{ on } r} y_{it} + N(r) \ge L \qquad \forall t \in T, \forall r \in R_t. \tag{24}$$

In (22), we maximize total savings from reassigning and rerouting customers minus the penalty from the route imbalance incurred. In (23) and (24), we ensure that a route has at most U customers and at least L customers.

Using this modified IIP, we apply IPH to solve the PVRP-BC. In solving daily VRPs, we do not allow moves in ERTR that result in routes with more than U customers or less than L customers, so that route balance is not affected. We apply customer removal and reinsertion with our modified IIP. We denote this heuristic by IPH-BC.

In computational experiments, we ran IPH-BC using two types of initial solutions. First, we used an initial solution that is well-balanced, that is, $U - L$ is minimized. To obtain a well-balanced initial solution, we applied the balance routine given in Table 5.9 to each day of the solution generated by the procedure described

Table 5.9: A routine for balancing the routes on a given day.

$R =$ current set of routes
$r_{max} =$ the route in R with the largest number of customers
$U =$ number of customers on r_{max}
$L =$ smallest number of customers on a route in R
$\hat{R} =$ set of routes from which a customer has been removed
Set $\hat{R} = \emptyset$
While $(U - L > 1)$
Add r_{max} to $\hat{R}$
For each customer i on r_{max} and each customer j on each route of $R/\hat{R}$
Calculate the cost of removing i from r_{max} and inserting it immediately prior to j
Store as the best move if it is feasible and has a new smallest cost
End-For
If no feasible move was found break from the loop
Else make the best move found above
Update r_{max}, U and L
End-While
Return R

in Section 5.3.1. The balance routine minimizes imbalance by moving customers from routes with many customers to routes with few customers. In all our computations, this routine returned a solution in which $U - L$ was minimized. That is, $U - L = 0$ if the number of vehicles evenly divided the number of customers, and $U - L = 1$, otherwise. Second, we used the IPH solution as an initial solution (in this solution, travel distance is nearly minimized). We set the value of the imbalance penalty scalar φ equal to ρC, where ρ is the imbalance penalty fraction and C is the cost of the initial solution.

We are interested in studying how the total routing distance of a solution generated by IPH-BC changes as the value of ρ is varied. In Figure 5.4, we show plots for two representative problems (P2 and P10) from all 26 problems. We used maximally balanced initial solutions ($U - L$ is minimized). On the x-axis, we give the value of ρ. On the y-axis, we give the percent above the baseline solution for the total routing distance of the solution generated by IPH-BC. The baseline solution is the solution obtained when $\rho = 0$ (1355.27 for P2 and 1731.99 for P10). The baseline solution is different from the IPH solution because we start from a different (maximally balanced) initial solution. In Figure 5.4, we give the imbalance measure $(U - L)$ in parentheses next to each plotted point. To illustrate, for problem P2, when $\rho = 0$ (baseline solution) the route imbalance is six customers. When $\rho = .01$, the solution produced by IPH-BC is 3.07% above the baseline solution and the route imbalance is two customers.

In Figure 5.5, we show plots of P2 and P10 using the solutions generated by IPH as the initial solutions (these are also the baseline solutions).

In Figure 5.4(a), we see the basic shape of a step function. At each value of ρ, IPH-BC generates a solution with a specific route imbalance measure. The total routing distance of a solution is approximately the same until we reach a value of ρ that causes the route imbalance measure to decrease and the total routing distance to increase a step. In Figure 5.4(b) and Figure 5.5(a), we see the basic shape of a step function with a single step. The solutions generated by IPH-BC quickly become maximally balanced as ρ increases (i.e., $U - L$ is minimized for relatively small values of ρ.) In Figure 5.5(b), the shape is not obvious. We see that the solution generated by IPH-BC with $\rho = .02$ has a smaller deviation from the baseline solution (.11%) and a smaller route imbalance measure (2) than the solution with $\rho = .005$ (deviation is .34% and route imbalance measure is 4). This type of behavior can occur because IPH-BC is a heuristic procedure and not an optimal algorithm. In our experience, the shapes of the plots given in Figure 5.4 and Figure

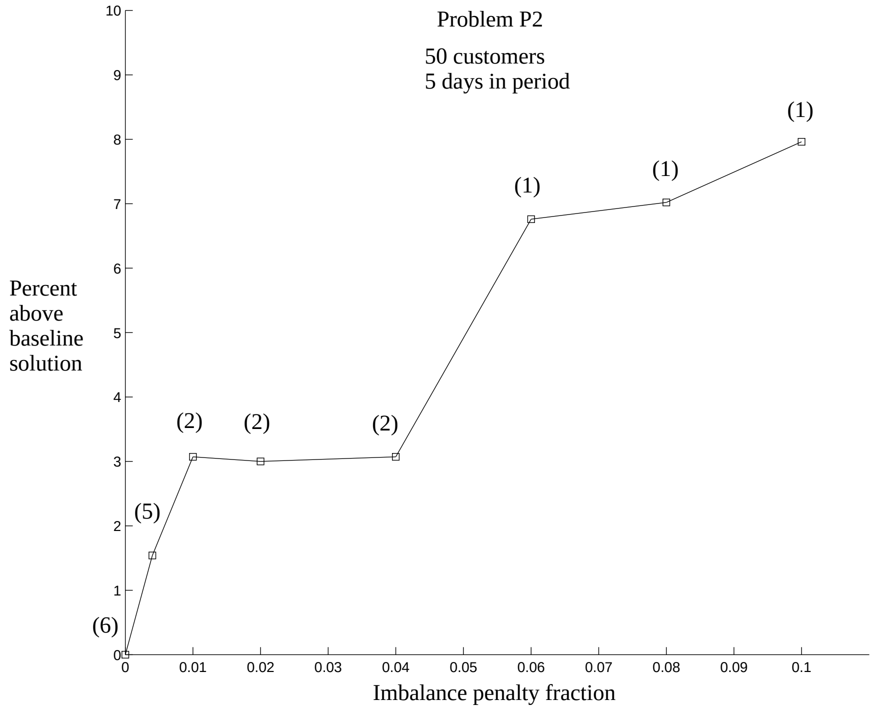
5.5(a) reflect the type of behavior we have seen in other benchmark problems, while the shape of the plot in Figure 5.5(b) is atypical.

Based on Figures 5.4 and 5.5, it would be easy for a routing manager to determine the solution that represents the best tradeoff between distance and balance. For example, if a manager were presented with Figure 5.4(a), the solution with $\rho = 0.01$, an imbalance measure of 2, and a travel distance about 3% above the travel distance of the baseline solution might be the ideal choice in practice. This type of analysis could be very useful when trying to find a good compromise between distance and route balance.

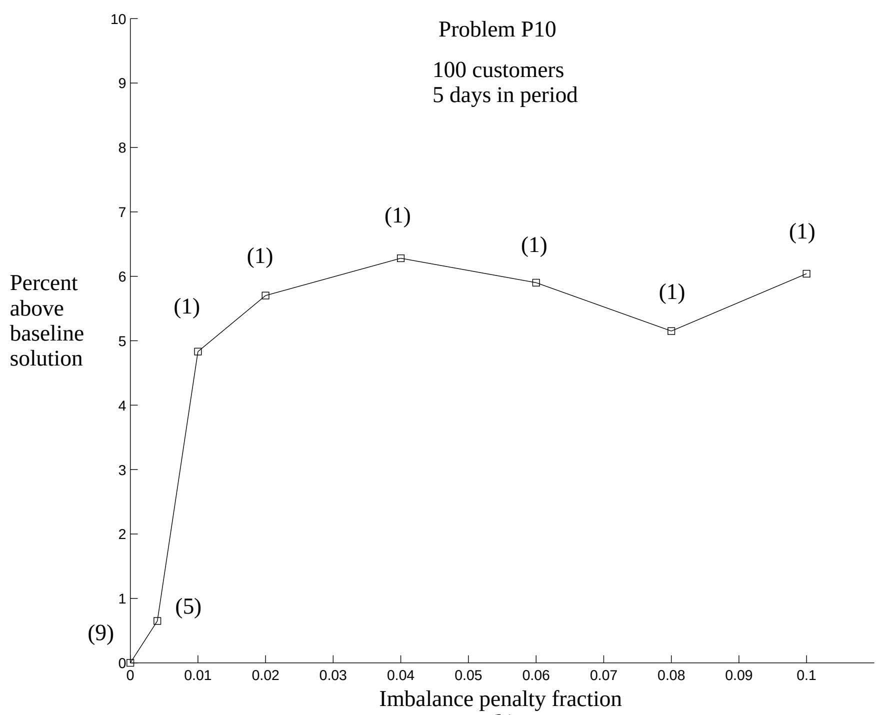
5.5 Conclusions

We developed a new heuristic for the PVRP that combined integer programming and an enhanced version of the record-to-record travel algorithm. When applied to standard benchmark PVRPs, our heuristic produced results that were very accurate and were better on average than the results for four algorithms reported in the literature.

We formulated new variants of the PVRP that tried to reassign customers to new routes to improve solutions or achieve a balanced workload. By varying the value of a simple reassignment or imbalance parameter, it would be easy for a routing manager to develop routes that are cost effective and balanced in practice.



(a)



(b)

Figure 5.4: The percent above baseline solutions changes as the balance penalty fraction (ρ) is varied for problems P2 and P10 with balance constraints and maximally balanced initial solutions.

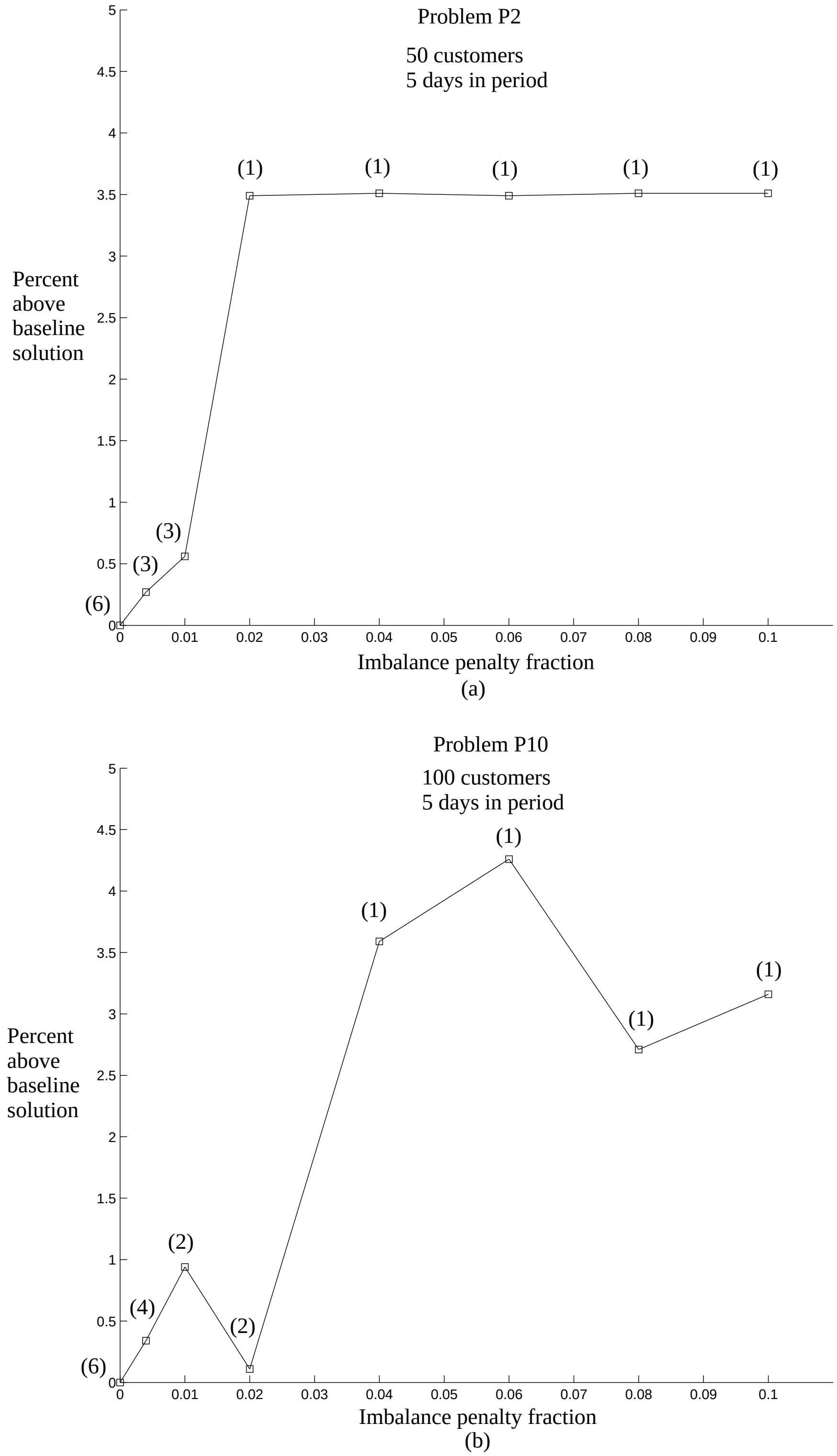


Figure 5.5: The percent above baseline solutions changes as the balance penalty fraction (ρ) is varied for problems P2 and P10 with balance constraints and IPH initial solutions.

5.6 Appendix I

We present the IIP formulation using the example given in Figure 5.1 as the initial solution. In indexing the w variables, we let schedule 1 be $\{1\}$, schedule 2 be $\{2\}$ and schedule 3 be $\{1, 2\}$. To allow customers to be moved immediately prior to the depot at the end of a route, we create a dummy customer (node 4) in the same location as the depot, and insert it into our initial solution at the end of the route on each day. We do not allow this customer to be moved. Variables that are set to 0 in constraints (17)–(19) are omitted from the formulation below.

maximize $(c_{01} + c_{12} - c_{02})y_{11} + (c_{01} + c_{13} - c_{03})y_{12} + (c_{21} + c_{20} - c_{10})y_{21}$
$+ (c_{31} + c_{30} - c_{10})y_{32} - (c_{02} + c_{21} - c_{01})x_{212} - (c_{12} + c_{23} - c_{13})x_{232}$
$-(c_{32}+c_{24}-c_{34})x_{242}-(c_{03}+c_{31}-c_{01})x_{311}-(c_{13}+c_{32}-c_{12})x_{321}-(c_{23}+c_{34}-c_{24})x_{341}$

subject to
$y_{11} + y_{12} = x_{121} + x_{131} + x_{141} + x_{122} + x_{132} + x_{142}$
$y_{21} + y_{22} = x_{211} + x_{231} + x_{241} + x_{212} + x_{232} + x_{242}$
$y_{31} + y_{32} = x_{311} + x_{321} + x_{341} + x_{312} + x_{322} + x_{142}$

$x_{212} + x_{232} + x_{242} \leq w_{22}$
$x_{311} + x_{321} + x_{341} \leq w_{31}$

$x_{121} + x_{131} + x_{141} \leq y_{11}$
$x_{122} + x_{132} + x_{142} \leq y_{12}$
$x_{211} + x_{231} + x_{241} \leq y_{21}$
$x_{312} + x_{322} + x_{342} \leq y_{32}$

$w_{22} \leq x_{212} + x_{232} + x_{242}$
$w_{31} \leq x_{311} + x_{321} + x_{341}$

$q_3x_{311} + q_3x_{321} + q_3x_{341} - q_1y_{11} - q_2y_{21} \leq Q_1$
$q_2x_{212} + q_2x_{232} + q_2x_{242} - q_1y_{12} - q_2y_{32} \leq Q_2$

$y_{11} + x_{211} + x_{311} \leq 1$
$y_{12} + x_{212} + x_{312} \leq 1$
$y_{21} + x_{121} + x_{321} \leq 1$
$y_{32} + x_{232} + x_{132} \leq 1$

$$y_{11} + x_{121} + x_{321} \leq 1$$
$$y_{12} + x_{232} + x_{132} \leq 1$$

$$y_{11} + y_{21} \leq 1$$
$$y_{12} + x_{32} \leq 1$$

$$w_{22} \leq 1$$
$$w_{31} \leq 1$$

$$x_{ijt} = 0, 1 \quad \text{for} \quad i, j = 1, 2, 3, 4 \quad t = 1, 2$$
$$y_{it} = 0, 1 \quad \text{for} \quad i = 1, 2, 3, 4 \quad t = 1, 2$$
$$w_{ik} = 0, 1 \quad \text{for} \quad i = 1, 2, 3, 4 \quad k = 1, 2, 3$$

In this example, constraints (11) and (17)-(19) are not applicable, so they are omitted. The residual capacities for the routes on day 1 and day 2 are given by $Q_1 = 10$ and $Q_2 = 10$. The distances are symmetrical and given by $c_{01} = c_{12} = c_{23} = c_{03} = c_{14} = c_{34} = 5$, $c_{02} = c_{13} = c_{24} = 7$, and $c_{04} = 0$. The objective function is given by

maximize $3y_{11} + 7y_{12} + 7y_{21} + 7y_{32} - 7x_{212} - 3x_{232} - 7x_{242} - 7x_{311} - 7x_{321} - 3x_{341}$.

The objective function is maximized when $x_{232} = y_{21} = w_{22} = 1$ and all other decision variables are 0. A maximum savings of four units is produced by reassigning customer 2 to pattern 2, removing it from its route on day 1, and inserting it immediately prior to customer 3 on day 2. This solution is given in Figure 5.2.

5.7 Appendix II

Let S' be the initial solution and S the current solution. Let customer i be assigned to pattern λ' in S' and pattern λ in S. In Table 5.10, we give the possible savings attained by reassigning customer i from its current pattern (λ) to a new pattern (k) in IPH-RCS. That is, we give the savings attained when $w_{ik} = 1$ in (21). There are four possibilities. 1) If customer i is assigned to pattern k in S' and in S ($\lambda' = \lambda = k$), then no savings are possible. Customer i cannot be reassigned to pattern k because k is i's current service pattern. 2) If customer i is assigned to the same pattern in S' and S, and this pattern is not k ($\lambda' = \lambda \neq k$), then reassigning customer i to pattern k gives a savings of $-p_i$. We are penalized for moving customer i from its initial pattern (λ') to a new pattern (k). 3) If customer i is assigned to pattern k in S' and not in S ($\lambda' = k \neq \lambda$), then reassigning customer i to pattern k gives a savings of p_i. We are rewarded for moving customer i from its current pattern (λ) back to its initial pattern (k). 4) If customer i is assigned to different patterns in S' and S, and customer i is not assigned to pattern k in S' ($\lambda' \neq \lambda$ and $\lambda' \neq k$), then there is no reward and no penalty for reassigning customer i to pattern k.

Table 5.10: Savings from reassigning customer i to pattern k in IPH-RCS.

		Is customer i assigned to pattern k in S'? Yes ($\mu_{ik} = 1$)	No ($\mu_{ik} = 0$)
Is customer i assigned to the same pattern in S' and S?	Yes ($\eta_i = 1$)	1) $\mu_{ik} - \eta_i = 0$ No savings	2) $\mu_{ik} - \eta_i = -1$ Savings of $-p_i$
	No ($\eta_i = 0$)	3) $\mu_{ik} - \eta_i = 1$ Savings of p_i	4) $\mu_{ik} - \eta_i = 0$ No savings

Chapter 6

The Vehicle Routing Problem

6.1 Introduction

In the vehicle routing problem (VRP), a fleet of vehicles must service the demands of customers. All vehicles begin and end their routes at the same depot. The sum of the demands of the customers on a route cannot exceed a vehicle's capacity. The total cost of a route cannot exceed the maximum cost. A customer must have all of its demand delivered at one time by a single vehicle. The objective is to minimize the total distance traveled by the fleet.

Let $V = \{v_1, ..., v_N\}$ be the set of customers and let v_0 be the depot. Let K be the number of available vehicles in the fleet. Let q_i be the demand of customer i that must be serviced by a vehicle and let Q be the capacity of a vehicle. Let the distance between a pair of nodes $e = (i, j)$ be denoted by c_e (or c_{ij}). Let the travel cost between a pair of nodes be the distance between them. Let c_i be the cost of servicing customer i. Let C be the maximum route cost. Given route r, let $V(r)$ be the set of nodes and $E(r)$ the set of travel edges on route r. We want to find a set R of no more than K routes such that

- route r begins and ends at v_0, for all $r \in R$ (a route starts and ends at the depot),

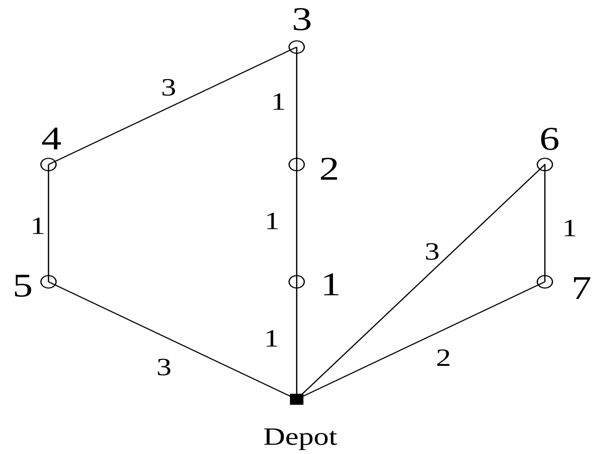


Figure 6.1: In this VRP instance, all customers have demand 1 and service cost 1. Edge labels are distances. The vehicle capacity is 5 and the maximum route cost is 15. The total distance traveled is 16 units.

- $i \in V(r)$, for some $r \in R$, for all $i \in V$ (each customer is serviced),
- $\sum_{i \in V(r)} q_i \leq Q$, for all $r \in R$ (vehicle capacity restriction),
- $\sum_{e \in E(r)} c_e + \sum_{i \in V(r)} c_i \leq C$, for all $r \in R$ (maximum cost restriction), and
- minimize $\sum_{r \in R} \sum_{e \in E(r)} c_e$ (total distance traveled across all routes is minimized).

In Figure 6.1, we give a VRP instance with seven customers (nodes 1 through 7). Each customer has demand 1 and service cost 1. The edge labels represent distances between nodes. The vehicle capacity is 5 and the maximum route cost is 15. There are two routes in the solution. The total distance traveled is 16 units.

We review the literature for the VRP in Section 6.2. In Section 6.3, we develop an integer programming-based heuristic for the VRP. In Section 6.4, we describe a heuristic for the VRP developed by Groër, Golden, and Wasil [50]. In Section

6.5, we report and discuss results from a computational experiment. We give our conclusions in Section 6.6.

6.2 Literature Review of the VRP

The literature for the VRP dates back over 50 years. Since 1954, there have been more than 1,000 papers on the VRP published in refereed journals, nearly half of which appeared in the last 10 years [36]. Many heuristics have been developed for the VRP. Two early heuristics are by Clarke and Wright [25] and Christofides and Eilon [23]. In the mid-1990s, Rochat and Taillard [79] used local search for the VRP. Recently, Li, Golden, and Wasil [63] and Mester and Bräysy [68] considered VRPs with many customers. Groër, Golden, and Wasil [50] used parallel computing to obtain high-quality solutions to the VRP.

Researchers have explored many variants of the VRP, including the multi-depot VRP [18, 26, 78], the split delivery VRP [6, 20, 33, 34], the period VRP [1, 19, 26, 54], and the VRP with time windows [39, 67, 85].

The book edited by Golden, Raghavan, and Wasil [46] is a good source for recent developments in modeling and solving VRPs. A recent taxonomical review of the VRP is provided in the paper by Eksioglu, Vural, and Reisman [36].

6.3 An Integer Programming-based Heuristic for the VRP

6.3.1 Generating and Improving an Initial Solution

We describe a heuristic for the VRP. First, we generate an initial solution using a modified Clarke-Wright (CW) savings algorithm [95]. In the modified CW algorithm, the savings from merging two routes at customers u and v is given by $c_{us_1(u)} + c_{p_1(v)v} - \lambda c_{uv}$, where $p_1(i)$ and $s_1(i)$ denote the predecessor and successor of customer i on a route, respectively. We run the modified CW algorithm with three different λ values (based on our testing, we use $\lambda = 0.6, 1.4, 1.6$) and use the best solution (the solution with the smallest total distance traveled) as our initial solution S.

To improve S, we formulate and solve an integer program (IP) in which strings of one, two, or three consecutive customers are relocated in a way that reduces the total distance traveled.

For each customer i on a route r in S, let $p_k(i)$ be the k-th predecessor of i on r. That is, $p_1(i)$ is the predecessor of i, $p_2(i)$ is the predecessor of $p_1(i)$, and so on. Similarly, let $s_k(i)$ be the k-th successor of i on r. In the IP, for customer i, we have three possibilities for relocation: 1) move customer i to a new location immediately prior to customer j, 2) move customers i and $s_1(i)$ immediately prior to customer j, and 3) move customers i, $s_1(i)$, and $s_2(i)$ immediately prior to customer j. The net savings associated with the three possible relocations are: 1) $(c_{p_1(i)i} + c_{is_1(i)} - c_{p_1(i)s_1(i)}) - (c_{p_1(j)i} + c_{ij} - c_{p_1(j)j})$, 2) $(c_{p_1(i)i} + c_{s_1(i)s_2(i)} - c_{p_1(i)s_2(i)}) - (c_{p_1(j)i} + c_{s_1(i)j} - c_{p_1(j)j})$, and 3) $(c_{p_1(i)i} + c_{s_2(i)s_3(i)} - c_{p_1(i)s_3(i)}) - (c_{p_1(j)i} + c_{s_2(i)j} - c_{p_1(j)j})$.

We note that relocations 2) and 3) may not be possible for all customers. For example, if the successor of customer i is the depot, then neither relocation 2) nor relocation 3) is possible.

In Figure 6.2, we show the three possible relocations. In Figure 6.2(a), we show the two routes of the initial solution. In Figure 6.2(b), customer 1 has been relocated immediately prior to customer 6. The associated savings is $(c_{d1} + c_{12} - c_{d2}) - (c_{d1} + c_{16} - c_{d6})$, where d represents the depot. In Figure 6.2(c), customers 1 and 2 have been relocated immediately prior to customer 6. The associated savings is $(c_{d1} + c_{23} - c_{d3}) - (c_{d1} + c_{26} - c_{d6})$. In Figure 6.2(d), customers 1, 2, and 3 have been relocated immediately prior to customer 6. The associated savings is $(c_{d1} + c_{34} - c_{d4}) - (c_{d1} + c_{36} - c_{d6})$.

In order to find the optimal relocations of strings of customers across all routes, we formulate an improvement IP (VIIP) for an initial VRP solution.

Let V be the set of customers. Let q_i^0 be the demand and c_i^0 the service cost of customer $i \in V$. Let $q_i^1 = q_i^0 + q_{s_1(i)}^0$, $q_i^2 = q_i^0 + q_{s_1(i)}^0 + q_{s_2(i)}^0$, $c_i^1 = c_i^0 + c_{s_1(i)}^0$, and $c_i^2 = c_i^0 + c_{s_1(i)}^0 + c_{s_2(i)}^0$. Let $\varphi_i^0 = c_{p_1(i)i} + c_{is_1(i)} - c_{p_1(i)s_1(i)}$ be the savings of removing and relocating customer i. Let $\varphi_i^1 = c_{p_1(i)i} + c_{s_1(i)s_2(i)} - c_{p_1(i)s_2(i)}$ be the savings of removing and relocating customers i and $s_1(i)$. Let $\varphi_i^2 = c_{p_1(i)i} + c_{s_2(i)s_3(i)} - c_{p_1(i)s_3(i)}$ be the savings of removing and relocating customers i, $s_1(i)$, and $s_2(i)$.

Let $\eta_{ij}^0 = c_{p_1(j)i} + c_{ij} - c_{p_1(j)j}$ be the cost of inserting customer i immediately prior to customer j. Let $\eta_{ij}^1 = c_{p_1(j)i} + c_{s_1(i)j} - c_{p_1(j)j}$ be the cost of inserting customers i and $s_1(i)$ immediately prior to customer j. Let $\eta_{ij}^2 = c_{p_1(j)i} + c_{s_2(i)j} - c_{p_1(j)j}$ be the cost of inserting customers i, $s_1(i)$, and $s_2(i)$ immediately prior to customer j.

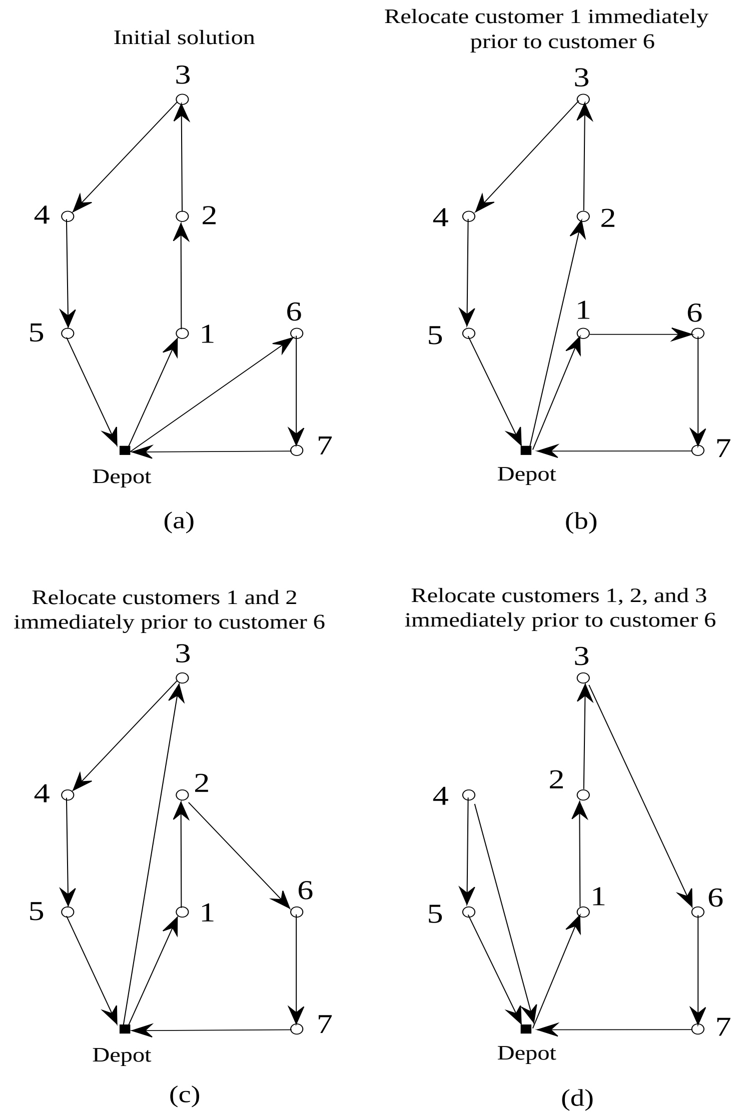


Figure 6.2: Three customer relocations.

Let V_0 be the subset of V containing the customers with the largest savings from removal. That is, V_0 is the set of the K_0 customers i for which φ_i^0 is the largest, where K_0 is a preset parameter. Similarly, let V_1 be the set of the K_1 customers i for which φ_i^1 is the largest, and let V_2 be the set of the K_2 customers i for which φ_i^2 is the largest. To reduce the number of variables and constraints in the VIIP so that it can be solved in a reasonable run time, we only allow customer i to be relocated if $i \in V_0$. We only allow customers i and $s_1(i)$ to be relocated if $i \in V_1$, and we only allow customers i, $s_1(i)$, and $s_2(i)$ to be relocated if $i \in V_2$. Strings of customers given by V_0, V_1, and V_2 are called candidates for relocation.

Let $V_0(i)$ be the neighborhood of customer i. That is, $V_0(i)$ is the set of the L_0 customers j for which η^0_{ij} is the smallest, where L_0 is a preset parameter. Similarly, let $V_1(i)$ be the set of the L_1 customers j for which η^1_{ij} is the smallest, and let $V_2(i)$ be the set of the L_2 customers j for which η^2_{ij} is the smallest. To reduce the number of variables and constraints in the VIIP, we consider relocating customer i immediately prior to customer j only if $j \in V_0(i)$. We consider relocating customers i and $s_1(i)$ immediately prior to customer j only if $j \in V_1(i)$, and we consider relocating customers i, $s_1(i)$, and $s_2(i)$ immediately prior to customer j only if $j \in V_2(i)$.

The set of routes is given by R. The residual capacity of route $r \in R$ (vehicle capacity minus total demand serviced on r) is given by Q_r, and the residual cost of route r (maximum route cost minus cost of r) is given by C_r.

The decision variables of the VIIP are defined as follows. Let $x^0_{ij} = 1$ if we insert customer i immediately prior to customer j, and 0 otherwise; $x^1_{ij} = 1$ if we insert customers i and $s_1(i)$ immediately prior to customer j, and 0 otherwise; $x^2_{ij} = 1$ if we insert customers i, $s_1(i)$, and $s_2(i)$ immediately prior to customer j, and 0 otherwise; $y^0_i = 1$ if we relocate customer i, and 0 otherwise; $y^1_i = 1$ if we relocate customers i and $s_1(i)$, and 0 otherwise; and $y^2_i = 1$ if we relocate customers i, $s_1(i)$, and $s_2(i)$, and 0 otherwise.

The VIIP formulation is given by (1)–(14) below.

$$\text{maximize} \sum_{i \in V} (\varphi_i^0 y_i^0 + \varphi_i^1 y_i^1 + \varphi_i^2 y_i^2) - (\sum_{j \in V} \eta_{ij}^0 x_{ij}^0 + \eta_{ij}^1 x_{ij}^1 + \eta_{ij}^2 x_{ij}^2) \tag{1}$$

subject to

$$\sum_{j \text{ on } R} (\sum_{i \in V} q_i^0 x_{ij}^0 + q_i^1 x_{ij}^1 + q_i^2 x_{ij}^2) - (q_j^0 y_j^0 + q_j^1 y_j^1 + q_j^2 y_j^2) \leq Q_r \qquad \forall r \in R \tag{2}$$

$$\sum_{j \text{ on } R} \left(\sum_{i \in V} (\eta_{ij}^0 + c_i^0) x_{ij}^0 + (\eta_{ij}^1 + c_{is_1(i)} + c_i^1) x_{ij}^1 + (\eta_{ij}^2 + c_{is_1(i)} + c_{s_1(i)s_2(i)} + c_i^2) x_{ij}^2 \right) -$$
$$\Big((\varphi_j^0 + c_j^0) y_j^0 + (\varphi_j^1 + c_{js_1(j)} + c_j^1) y_j^1 + (\varphi_j^2 + c_{js_1(j)} + c_{s_1(j)s_2(j)} + c_j^2) y_j^2 \Big) \leq C_r$$
$$\forall r \in R \tag{3}$$

$$\sum_{i \in V} x_{ij}^0 + x_{ij}^1 + x_{ij}^2 + y_j^0 + y_{p_1(j)}^0 + y_j^1 + y_{p_1(j)}^1 + y_{p_2(j)}^1 +$$
$$y_j^2 + y_{p_1(j)}^2 + y_{p_2(j)}^2 + y_{p_3(j)}^2 \leq 1 \qquad \forall j \in V \tag{4}$$

$$\sum_{j \in V} x_{ij}^0 = y_i^0 \qquad \forall i \in V \tag{5}$$

$$\sum_{j \in V} x_{ij}^1 = y_i^1 \qquad \forall i \in V \tag{6}$$

$$\sum_{j \in V} x_{ij}^2 = y_i^2 \qquad \forall i \in V \tag{7}$$

$$y_i^0 = 0 \qquad \forall i \notin V_0 \tag{8}$$

$$y_i^1 = 0 \qquad \forall i \notin V_1 \tag{9}$$

$$y_i^2 = 0 \qquad \forall i \notin V_2 \tag{10}$$

$$x_{ij}^0 = 0 \qquad \forall j \notin V_0(i), \forall i \in V \tag{11}$$

$$x_{ij}^1 = 0 \qquad \forall j \notin V_1(i), \forall i \in V \tag{12}$$

$$x_{ij}^2 = 0 \qquad \forall j \notin V_2(i), \forall i \in V \tag{13}$$

$$x_{ij}^0, x_{ij}^1, x_{ij}^2, y_i^0, y_i^1, y_i^2 \in \{0, 1\} \qquad \forall i, j \in V \tag{14}$$

The objective function (1) gives the net savings attained by relocating strings of one, two, and three consecutive customers. In constraints (2), we ensure that the amount of demand relocated to a route minus the amount of demand relocated from a route does not exceed the residual capacity of the route. In constraints (3), we ensure that the net increase in the length of a route due to relocations does not exceed the residual length of the route. In constraints (4), if we relocate a string of customers immediately prior to customer j, then we do not remove any string of customers containing j or $p_1(j)$. Also, we do not insert more than one string of customers immediately prior to customer j, and we remove either j or $p_1(j)$ but not both. Constraints (4) ensure the objective value accurately reflects the savings, as the coefficients in the objective function depend on j and $p_1(j)$. In constraints (5)–(7), we relocate a string of customers if and only if we insert it immediately prior to some other customer. In constraints (8)–(13), we allow a string of customers starting at i to be moved immediately prior to j only if the string is a candidate for relocation and j is in the appropriate neighborhood of i. Constraints 14 ensure all decision variables are 0 or 1.

We apply the VIIP to the solution given in Figure 6.1 and show the improved solution in Figure 6.3. A savings of two units is achieved by relocating customers 1, 2, and 3 immediately prior to customer 6.

6.3.2 Customer Removal and Reinsertion

Given a current solution S, we apply the VIIP repeatedly. We stop when either i) there is no improvement in the current iteration, or ii) the improvement is less than a minimum value and S is not within a maximum deviation of the record (best) solution. Rule ii) allows us to exit an iteration in which we are unlikely to

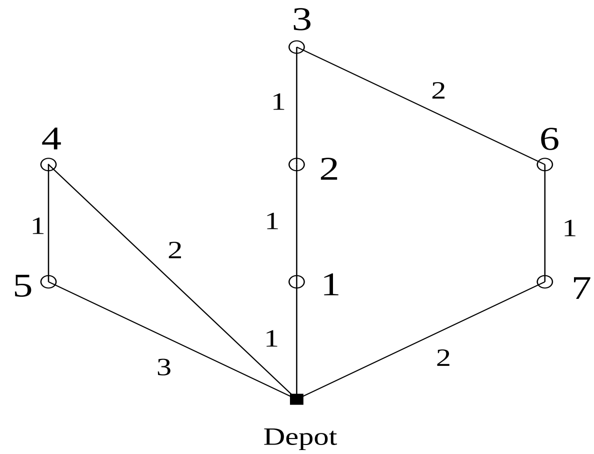


Figure 6.3: By applying the VIIP to the solution in Figure 6.1, we decrease the distance traveled from 16 units to 14 units.

find a new record solution. Next, we re-initialize S by removing some customers of S and reinserting them elsewhere. This allows us to explore the solution space from a different (new) solution.

For each customer i, we remove i from its route in S with probability p. Let W be the set of customers removed from S. For each customer $i \in W$ and each customer j on a route in S, we determine whether or not inserting i immediately prior to j is feasible. If it is, we record the insertion cost $c_{p_1(j)i} + c_{ij} - c_{p_1(j)j}$. We then insert i randomly immediately prior to one of the three customers (j_1, j_2, or j_3) that give the three smallest insertion costs. If customer i cannot be feasibly reinserted anywhere, we create an out-and-back route from the depot to customer i. This might cause the number of routes of the solution to exceed the number of available vehicles. In our computational experiment, this happened very rarely and, when it did, our heuristic moved the customer on the out-and-back route to a different route in subsequent iterations.

Table 6.1: The VIPH algorithm for the VRP.

```
S = current solution, maxRecord = 50, π1 = .5, π2 = .3, π3 = .2
runTime = the current number of seconds elapsed in the algorithm's execution
minImprove = .05%,   maxDeviation = .05%
Set the VIIP time limit to 30 seconds
If (number of customers N is at most 120)
        Set candidate sizes L0 = L1 = L2 = N
        Set neighborhood sizes K0 = K1 = K2 = 25
        Set run-time limit maxTime to 400 seconds
        Set removal probability p = .3
Else
        L0 = ⌈.75N⌉, L1 = L2 = ⌈.5N⌉
        K0 = K1 = K2 = 15
        maxTime = 800, p = .15
End If-Else
Set recCntr = 0 (number of iterations since the last record solution was found)
Generate initial solution S, set best solution S* = S
Repeat
       Repeat
              Apply the VIIP to S
              If (improvement of S < minImprove) and (deviation of S from S* > maxDeviation)
                     Break Repeat-Until
       Until (no improvement of S is achieved )
       Update S* and set recCntr = 0 if necessary, otherwise recCntr = recCntr + 1
       For customer i = 1 to N
              Remove customer i from its route in S with probability p
              Add i to set W if i is removed from S
       End-For
       For each customer i ∈ W
              Find three smallest feasible insertion spots j1, j2, j3
              Insert i immediately prior to jx with probability πx
              If (no feasible insertion for i), create out-and-back route for i
       End-For
Until (recCntr > maxRecord) or (runTime > maxTime)
Return S*
```

After performing this re-initialization step, we again apply the VIIP. We repeat this process until a stopping condition is reached and return the best solution. We set a run-time limit for each execution of the VIIP. If the VIIP is not solved optimally when the run-time limit is reached, the best solution that was found is returned. The details of our integer programming-based heuristic (VIPH) for the VRP are given in Table 6.1.

6.4 The Enhanced Record-to-record Travel Algorithm

We describe the enhanced record-to-record travel algorithm (ERTR). ERTR is a heuristic for the VRP developed by Groër, Golden, and Wasil [50]. We will compare the results produced by VIPH to those produced by ERTR in a computational experiment (Section 6.5).

ERTR is a modified version of the variable length record-to-record travel algorithm (VRTR) developed by Li, Golden, and Wasil [63]. VRTR improves an initial solution by performing one-point and two-point node exchanges, as well as two-opt edge exchanges. ERTR considers additional moves such as three-point node exchanges and Or-opt edge exchanges. Uphill moves are allowed when a solution is within a preset tolerance of the record solution. In ERTR, three initial solutions are generated using the modified CW algorithm [95]. The initial solutions are improved and the best solution of the three is returned. The details of ERTR are given in Table 6.2.

6.5 Computational Experiment with VIPH

We applied both VIPH and ERTR to 15 benchmark problems (VRP1-VRP15) originally proposed by Christofides and Eilon [23] and Golden et al. [48]. These problems vary in size from 50 customers to 240 customers. They are available at www.rhsmith.umd.edu/faculty/bgolden/vrp_data.htm. Both algorithms were coded using Visual C++ and run on the same machine with a 3.0 GHz Pentium 4 processor and 512MB of RAM. The IPs in VIPH were solved with ILOG CPLEX 10.0.

Table 6.2: Enhanced record-to-record travel algorithm.

```
λ1 = .6, λ2 = 1.4, λ3 = 1.6, deviation = 1%, count = 0, maxCount = 10, A = 70
For x = 1 to 3
    S = modified Clarke-and-Wright solution with parameter λx
    Initialize the record for this iteration, S* = S
Uphill:
    For a = 1 to A
        Apply each of one-point moves, two-point moves, and three-point moves
        Apply both two-opt edge exchanges and OR-opt edge exchanges
        Update S if result is within deviation of cost of S*
        Update S* if necessary
    End-For
Downhill:
    Apply both two-opt edge exchanges and OR-opt edge exchanges
    Apply each of one-point moves, two-point moves, and three-point moves
    If (cost decreases), update S and go to Downhill
    Else Update S* if necessary, otherwise count = count + 1
    If (count < maxCount) go to Uphill
    Perturb solutions once and go to Uphill
End-For
Return the best S* from the three iterations
```

In Table 6.3, we give our computational results. In column one, we give the problem number. In columns two and three, we give the number of customers (N) and the number of vehicles (K). In column four, we give the service cost (c) of a customer. In each problem, the service cost is the same for all customers ($c_i = c$ for all i). Columns five and six give the maximum route cost (C) and the vehicle capacity (Q). In columns six through ten, we give solution values and run times for VIPH and ERTR.

In Table 6.3, we see that ERTR performed better than VIPH. ERTR generated the best solutions to 14 of 15 problems (there are four ties). VIPH generated the best solution to one problem (VRP9). On average, VIPH was 1.05% above the best solution generated by the two algorithms. For ERTR, the average deviation was 0.01%. ERTR was more than 10 times faster than VIPH on average (30.46 seconds

Table 6.3: Computational results for VIPH and ERTR on 15 VRPs.

Problem	N	K	c	C	Q	VIPH Solution	Run Time (s)	ERTR Solution	Run Time (s)
VRP1	50	5	0	∞	160	**524.61**	115.97	**524.61**	5.94
VRP2	75	10	0	∞	140	848.57	425.27	**844.88**	10.36
VRP3	100	8	0	∞	200	840.73	406.98	**827.39**	24.49
VRP4	150	12	0	∞	200	1058.81	803.25	**1036.57**	33.72
VRP5	199	17	0	∞	200	1340.70	875.59	**1315.71**	44.19
VRP6	50	6	10	200	160	560.24	144.83	**558.99**	5.92
VRP7	75	11	10	160	140	**909.68**	403.21	**909.68**	13.28
VRP8	100	9	10	230	200	900.84	416.09	**867.41**	18.38
VRP9	150	14	10	200	200	**1170.01**	829.21	1170.90	40.83
VRP10	199	18	10	200	200	1432.83	881.50	**1412.97**	85.48
VRP11	120	7	0	∞	200	1049.96	410.60	**1042.12**	20.30
VRP12	100	10	0	∞	200	**819.56**	176.73	**819.56**	14.34
VRP13	120	11	50	720	200	1558.96	443.55	**1546.62**	30.58
VRP14	100	11	90	1040	200	**866.37**	406.48	**866.37**	15.45
VRP15	240	10	0	650	550	5801.46	632.96	**5653.04**	93.65
Average						1.05[1]	491.48[2]	0.01[1]	30.46[2]

[1] Mean deviation (100[(Solution / Best Solution) − 1]%)

[2] Mean run time

Best solution given in bold

to 497.73 seconds).

The disparity in performance between ERTR and VIPH on these 15 problems suggests that integer programming is not the most effective method for VRPs. Integer programming is inefficient in sequencing customers on a route. In the VIIP, we are restricted to relocating strings of one, two, or three consecutive customers. If customer i is part of a relocated string, then we cannot relocate any string of customers containing $p_1(i)$, and we cannot insert any string of customers immediately following $p_1(i)$. Because of these restrictions, the VIIP often cannot improve a route even though the customers are visited in an order that is not optimal. It might take many iterations and reinitializations of the VIIP to reorder customers on a route in a near-optimal manner. This can be very time consuming. By contrast, a sequencing procedure like two-opt can reorder many customers by performing a single edge exchange. Many possible edge exchanges can be considered in a relatively short run time.

Integer programming seems to be most effective for multi-level routing problems with an upper level (assignment level) and a lower level (routing level). Integer programming-based heuristics have been shown to work very well for the split delivery vehicle routing problem (SDVRP) (Chapter 3), the split-delivery vehicle routing problem with minimum delivery amounts (SDVRP-MDA) (Chapter 3), the multi-depot split delivery vehicle routing problem (MDSDVRP) (Chapter 4), the period vehicle routing problem (PVRP) (Chapter 5), and the multi-depot vehicle routing problem (MDVRP) (Chapter 7). In each of these problems, there is an assignment level and a routing level. In the SDVRP and SDVRP-MDA, we must assign portions of customer demands (delivery amounts) to vehicles. In the PVRP, we must assign customers to service patterns. In the MDSDVRP and MDVRP, we must assign customers to depots. In the heuristics for each of these problems, integer programming is used to improve an initial solution by making distance-reducing reassignments, and then distance is further reduced using a routing procedure. In general, the IPs focusing on the upper level of the problem account for a substantial amount of the improvement to a solution.

Since integer programming seems to work better on multi-level routing problems than on pure routing problems, we would expect VIPH to do better on VRPs with small vehicle capacities relative to customer demands. For small-capacity VRPs, the number of customers on a route will be relatively few, so sequencing customers will be less important than in standard VRPs. There will be more routes, so assigning customers to routes will be more important. For small-capacity VRPs, the assignment (upper) level is emphasized and the routing (lower) level is de-emphasized.

For testing, we halved the capacities of problems VRP1–VRP15 and changed the number of vehicles, customer service costs, and maximum route costs, accordingly. We applied VIPH and ERTR to the small-capacity problems (denoted VRP1-SC–VRP15-SC). Our results are given in Table 6.4.

In Table 6.4, we see that ERTR is still better than VIPH, but the performance of VIPH relative to ERTR is better on the small-capacity VRPs than on the standard VRPs. VIPH finds better solutions than ERTR to four of the 15 small-capacity VRPs and finds the same solution as ERTR once. On the standard VRPs in Table 6.3, these numbers were one and four, respectively. VIPH has a better average deviation from the best solution on the small-capacity VRPs (0.88%) than on the standard VRPs (1.05%). The results in Table 6.3 and Table 6.4 support the notion that integer programming is better suited for multi-level routing problems than for pure routing problems.

In Appendix D, we give all problems used in testing and all solutions generated by VIPH and ERTR.

Table 6.4: Computational results for VIPH and ERTR on 15 small-capacity VRPs.

Problem	N	K	c	C	Q	VIPH Solution	Run Time (s)	ERTR Solution	Run Time (s)
VRP1-SC	50	10	0	∞	80	**741.50**	179.21	742.97	5.73
VRP2-SC	75	21	0	∞	70	1309.83	411.02	**1298.85**	11.95
VRP3-SC	100	16	0	∞	100	**1175.96**	419.26	1181.94	17.14
VRP4-SC	150	24	0	∞	100	1614.12	804.13	**1580.31**	41.69
VRP5-SC	199	34	0	∞	100	2099.89	818.88	**2080.72**	46.92
VRP6-SC	50	12	3	100	80	834.84	178.21	**816.03**	6.36
VRP7-SC	75	22	1	100	70	1321.00	403.47	**1314.04**	12.13
VRP8-SC	100	18	2	115	100	1227.02	413.45	**1206.08**	36.42
VRP9-SC	150	28	2	105	100	1709.95	808.76	**1685.11**	57.84
VRP10-SC	199	36	2	105	100	2208.18	800.52	**2168.22**	99.67
VRP11-SC	120	14	0	∞	100	1777.12	441.64	**1763.47**	23.56
VRP12-SC	100	20	0	∞	100	**1374.44**	179.57	1375.14	22.61
VRP13-SC	120	22	12	360	100	1780.59	431.73	**1770.06**	27.52
VRP14-SC	100	22	22	520	100	**1374.44**	400.14	1375.73	15.42
VRP15-SC	240	20	0	400	275	**7764.91**	805.39	**7764.91**	24.50
Average						0.88[1]	499.69[2]	0.06[1]	29.96[2]

[1] Mean deviation (100[(Solution / Best Solution) − 1]%)

[2] Mean run time

Best solution given in bold

6.6 Conclusions

We developed a new integer programming-based heuristic for the VRP and compared it to a record-to-record travel algorithm. When applied to benchmark VRPs, the record-to-record travel algorithm outperformed our heuristic. Based on the results, it seems that integer programming is better suited for multi-level routing problems, with an assignment level and a routing level, than for pure routing problems.

Chapter 7

The Multi-depot Vehicle Routing Problem

7.1 Introduction

In the vehicle routing problem (VRP), a fleet of vehicles must service the demands of customers. All vehicles begin and end their routes at the same depot. The sum of the demands of the customers on a route cannot exceed a vehicle's capacity. The total distance traveled by a vehicle on a route cannot exceed a maximum route length. A customer must have all of its demand delivered at one time by a single vehicle. The objective is to minimize the total distance traveled by the fleet.

In the multi-depot vehicle routing problem (MDVRP), there can be multiple depots at which vehicles start and end routes. A vehicle starting a route from a depot must end its route at the same depot. The objective is to minimize the total distance traveled by the fleet across all depots.

Let $V = \{v_1, ..., v_N\}$ be the set of customers and let $W = \{w_1, ..., w_M\}$ be the set of depots. Let q_i be the demand of customer i that must be serviced by a vehicle, and let Q be the capacity of a vehicle. Let the distance between a pair of nodes $e = (i, j)$ be denoted by c_e (or c_{ij}). Let C be the maximum route length. Given route r, let $V(r)$ be the set of nodes and $E(r)$ the set of travel edges on r. We want to find a set of routes R such that

- route r begins and ends at w_k, for some $k \in \{1, ..., M\}$, for all $r \in R$ (a route

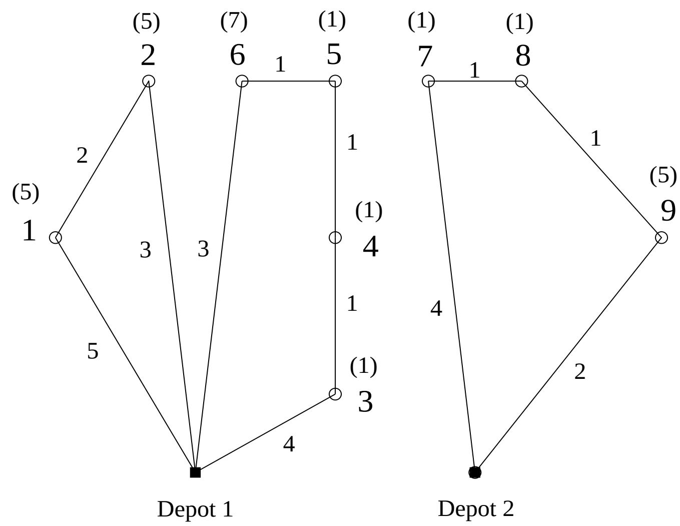


Figure 7.1: In this MDVRP, there are nine customers and two depots. Node labels in parentheses are customer demands and edge labels are distances. Vehicle capacity is 10. Maximum route length is 10. In this solution, the total distance traveled by three vehicles is 28.

starts and ends at the same depot),

- $i \in V(r)$, for some $r \in R$, for all $i \in V$ (each customer is serviced),
- $\sum_{i \in V(r)} q_i \leq Q$, for all $r \in R$ (vehicle capacity restriction),
- $\sum_{e \in E(r)} c_e \leq C$, for all $r \in R$ (route length restriction), and
- minimize $\sum_{r \in R} \sum_{e \in E(r)} c_e$ (total distance traveled across all routes minimized).

In Figure 7.1, we give an MDVRP with nine customers (nodes 1 through 9) and two depots. There are three routes with two beginning and ending at depot 1 and one beginning and ending at depot 2. The total distance traveled is 28 units.

The remainder of this chapter is organized as follows. In Section 7.2, we review the literature on the MDVRP. In Section 7.3, we develop an integer programming-based heuristic for the MDVRP and provide computational results. In Section 7.4, we give our conclusions.

7.2 Literature Review of the MDVRP

The literature for the MDVRP dates back over 35 years. Early heuristics were developed by Tillman and Cain [92], Wren and Holliday [94], Gillett and Johnson [42], Golden, Magnanti, and Nguyen [45], and Raft [77]. In the 1990s, Chao, Golden, and Wasil [18] developed a record-to-record travel algorithm for the MDVRP. Renaud, Laporte, and Boctor [78] and Cordeau, Gendreau, and Laporte [26] used tabu search. Recently, Thangiah and Salhi [91] developed a genetic clustering heuristic and Lau et al. [60] used a fuzzy logic controlled genetic algorithm. A procedure for solving small MDVRPs exactly was developed by Laporte, Nobert, and Taillefer [59].

Researchers have explored several variants of the MDVRP. Salhi and Nagy [82] considered the MDVRP with pickups (backhauls) in addition to deliveries. The MDVRP with time windows was addressed by Giosa, Tansini, and Viera [44], Cordeau, Laporte, and Mercier [27], and Polacek et al. [76]. Lim and Wang [64] modeled and solved a variant of the MDVRP in which the number of routes starting and ending at a depot cannot exceed a preset limit. Crevier, Cordeau, and Laporte [28] considered the MDVRP with inter-depot routes.

7.3 An Integer Programming-based Heuristic for the MDVRP

7.3.1 Generating an Initial Solution

We describe a heuristic for the MDVRP. We generate an initial solution by quickly finding three feasible solutions and selecting the best one (the one with the smallest total distance traveled).

To generate a feasible solution to the MDVRP, we first assign customers to depots using a procedure developed by Golden, Magnanti, and Nguyen [45]. Initially, all customers are unassigned. For each customer i, we let δ_i be the distance between i and the closest depot to i and δ_i' be the distance between i and the second closest depot to i. If the ratio $\frac{\delta_i}{\delta_i'}$ is less than a tolerance ϵ, then customer i is immediately assigned to its closest depot. If $\frac{\delta_i}{\delta_i'} \geq \epsilon$, then i is temporarily left unassigned. In this way, a customer that is much closer to one depot than other depots will immediately be assigned to its closest depot. A customer that is nearly equidistant from several depots will be assigned using cheapest insertion.

After the initial assignment phase, unassigned customers are assigned to depots based on a cheapest insertion criterion. For each unassigned customer i and each depot d, we calculate the cost of inserting i between each pair of customers already assigned to d (we consider d as a customer assigned to itself). We then assign i to the same depot as the pair giving the cheapest insertion. That is, we assign customer i to the same depot as customers j and k where $c_{ij} + c_{ik} - c_{jk}$ is the smallest value over all pairs of customers already assigned to a depot.

After all customers have been assigned to a depot, we generate a VRP solution for each depot and its assigned customers separately, using a modified Clarke–Wright (CW) savings algorithm [95]. In the modified CW algorithm, the savings from merging two routes at customers u and v is given by $c_{us(u)} + c_{p(v)v} - \lambda c_{uv}$, where $p(i)$ and $s(i)$ denote the predecessor and successor of customer i on a route, respectively. We run the modified CW algorithm with three different λ values (based on our testing, we used $\lambda = 0.6, 1.4, 1.6$) and use the best solution as the VRP solution. By finding a VRP solution for each depot and its assigned customers separately, we generate a feasible solution to the MDVRP.

We find three MDVRP solutions using different ϵ values ($\epsilon = 0.7, 0.8, 0.9$) and select the best as our initial solution. We give the details of our procedure for generating an initial solution in Table 7.1.

7.3.2 Improving a Solution Using Integer Programming

To improve an MDVRP solution S, we formulate and solve an integer program (IP) in which strings of one, two, or three consecutive customers are relocated in a way that reduces the total distance traveled.

For each customer i on a route r in S, let $p_k(i)$ be the k-th predecessor of i on r. That is, $p_1(i)$ is the predecessor of i, $p_2(i)$ is the predecessor of $p_1(i)$, and so on. Similarly, let $s_k(i)$ be the k-th successor of i on r. In the IP, for customer i, we have three possibilities for relocation: 1) move customer i to a new location immediately to prior to customer j, 2) move customers i and $s_1(i)$ immediately prior to customer j, and 3) move customers i, $s_1(i)$, and $s_2(i)$ immediately prior to

Table 7.1: Procedure for generating an initial solution to the MDVRP.

S = current initial MDVRP solution, S^* = best initial MDVRP solution
V_d = set of customers assigned to depot d (including d)
S_d = VRP solution on V_d
δ_i = distance between customer i and its closest depot
δ'_i = distance between customer i and its second closest depot
$\lambda_1 = .6, \lambda_2 = 1.4, \lambda_3 = 1.6, \epsilon_1 = .7, \epsilon_2 = .8, \epsilon_3 = .9$
d^* = best depot
$minInCost$ = smallest insertion cost
Set $V_d = \{d\}$, for $d = 1, ..., M$
For ($a = 1$ to 3)
    For (each customer i)
        If ($\frac{\delta_i}{\delta'_i} < \epsilon_a$), add i to V_d, where d is the closest depot to i
    End-For
    For (each unassigned customer i)
        $minInCost = \infty$
        For (each pair of customers (j, k) assigned to each depot d)
            If ($c_{ij} + c_{ik} - c_{jk} < minInCost$)
                $minInCost = c_{ij} + c_{ik} - c_{jk}$
                $d^* = d$
            End-If
        End-For
        Add i to V_{d^*}
    End-For
    For (each depot d)
        S_d = best of three modified CW solutions $(\lambda_1, \lambda_2, \lambda_3)$ on V_d
        Add S_d to S
    End-For
    If (S is the new best solution), $S^* = S$
End-For
Return S^*

---

customer j. The net savings associated with the three possible relocations are: 1) $(c_{p_1(i)i} + c_{is_1(i)} - c_{p_1(i)s_1(i)}) - (c_{p_1(j)i} + c_{ij} - c_{p_1(j)j})$, 2) $(c_{p_1(i)i} + c_{s_1(i)s_2(i)} - c_{p_1(i)s_2(i)}) - (c_{p_1(j)i} + c_{s_1(i)j} - c_{p_1(j)j})$, and 3) $(c_{p_1(i)i} + c_{s_2(i)s_3(i)} - c_{p_1(i)s_3(i)}) - (c_{p_1(j)i} + c_{s_2(i)j} - c_{p_1(j)j})$. We note that relocations 2) and 3) may not be possible for all customers. For example, if the successor of customer i is a depot then neither relocation 2) nor relocation 3) is possible.

In Figure 7.2, we show the possible relocations. In Figure 7.2(a), we show the two routes of the initial solution. In Figure 7.2(b), customer 1 has been relocated immediately prior to customer 6. The associated savings is $(c_{d_1 1} + c_{12} - c_{d_1 2}) - (c_{d_2 1} + c_{16} - c_{d_2 6})$, where d_1 and d_2 represent depots 1 and 2, respectively. In Figure 7.2(c), customers 1 and 2 have been relocated immediately prior to customer 6. The associated savings is $(c_{d_1 1}+c_{23}-c_{d_1 3})-(c_{d_2 1}+c_{26}-c_{d_2 6})$. In Figure 7.2(d), customers 1, 2, and 3 have been relocated immediately prior to customer 6. The associated savings is $(c_{d_1 1} + c_{34} - c_{d_1 4}) - (c_{d_2 1} + c_{36} - c_{d_2 6})$.

In order to find the optimal set of relocations of strings of customers across all routes of all depots, we formulate a multi-depot improvement IP (MDIIP).

Let V be the set of customers and let q_i^0 be the demand of customer $i \in V$. Let $q_i^1 = q_i^0 + q_{s_1(i)}^0$ and $q_i^2 = q_i^0 + q_{s_1(i)}^0 + q_{s_2(i)}^0$. Let $\varphi_i^0 = c_{p_1(i)i} + c_{is_1(i)} - c_{p_1(i)s_1(i)}$ be the savings of removing and relocating customer i. Let $\varphi_i^1 = c_{p_1(i)i} + c_{s_1(i)s_2(i)} - c_{p_1(i)s_2(i)}$ be the savings of removing and relocating customers i and $s_1(i)$. Let $\varphi_i^2 = c_{p_1(i)i} + c_{s_2(i)s_3(i)} - c_{p_1(i)s_3(i)}$ be the savings of removing and relocating customers i, $s_1(i)$, and $s_2(i)$.

Let $\eta_{ij}^0 = c_{p_1(j)i} + c_{ij} - c_{p_1(j)j}$ be the cost of inserting customer i immediately prior to customer j. Let $\eta_{ij}^1 = c_{p_1(j)i}+c_{s_1(i)j}-c_{p_1(j)j}$ be the cost of inserting customers i and $s_1(i)$ immediately prior to customer j. Let $\eta_{ij}^2 = c_{p_1(j)i} + c_{s_2(i)j} - c_{p_1(j)j}$ be the cost of inserting customers i, $s_1(i)$, and $s_2(i)$ immediately prior to customer j.

Let V_0 be the subset of V containing the customers with the largest savings from removal. That is, V_0 is the set of the K_0 customers i for which φ_i^0 is the largest, where K_0 is a preset parameter. Similarly, let V_1 be the set of the K_1 customers i for which φ_i^1 is the largest, and let V_2 be the set of the K_2 customers i for which

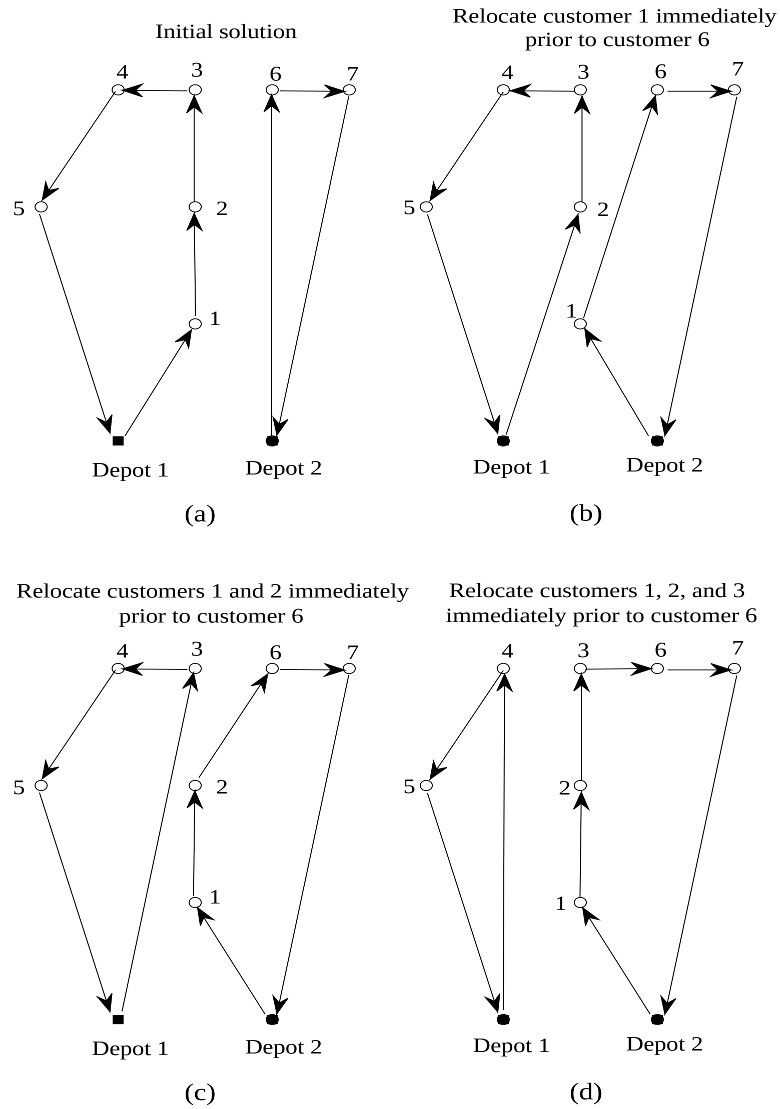


Figure 7.2: Possible customer relocations.

φ_i^2 is the largest. To reduce the number of variables and constraints in the MDIIP so that it can be solved in a reasonable run time, we only allow customer i to be relocated if $i \in V_0$. We only allow customers i and $s_1(i)$ to be relocated if $i \in V_1$, and we only allow customers i, $s_1(i)$, and $s_2(i)$ to be relocated if $i \in V_2$. Strings of customers given by V_0, V_1 and V_2 are called candidates for relocation.

Let $V_0(i)$ be the neighborhood of customer i. That is, $V_0(i)$ is the set of the L_0

customers j for which η_{ij}^0 is the smallest, where L_0 is a preset parameter. Similarly, let $V_1(i)$ be the set of the L_1 customers j for which η_{ij}^1 is the smallest, and let $V_2(i)$ be the set of the L_2 customers j for which η_{ij}^2 is the smallest. To reduce the number of variables and constraints in the MDIIP, we consider relocating customer i immediately prior to customer j only if $j \in V_0(i)$. We consider relocating customers i and $s_1(i)$ immediately prior to customer j only if $j \in V_1(i)$, and we consider relocating customers i, $s_1(i)$, and $s_2(i)$ immediately prior to customer j only if $j \in V_2(i)$.

The set of routes is given by R. The residual capacity of route $r \in R$ (vehicle capacity minus total demand serviced on r) is given by Q_r, and the residual length of route r (maximum route length minus length of r) is given by C_r.

The decision variables of the MDIIP are defined as follows. Let $x_{ij}^0 = 1$ if we insert customer i immediately prior to customer j, and 0 otherwise; $x_{ij}^1 = 1$ if we insert customers i and $s_1(i)$ immediately prior to customer j, and 0 otherwise; $x_{ij}^2 = 1$ if we insert customers i, $s_1(i)$, and $s_2(i)$ immediately prior to customer j, and 0 otherwise; $y_i^0 = 1$ if we relocate customer i, and 0 otherwise; $y_i^1 = 1$ if we relocate customers i and $s_1(i)$, and 0 otherwise; and $y_i^2 = 1$ if we relocate customers i, $s_1(i)$, and $s_2(i)$, and 0 otherwise.

The MDIIP formulation is given by (1)–(14) below.

$$\text{maximize} \sum_{i \in V}(\varphi_i^0 y_i^0 + \varphi_i^1 y_i^1 + \varphi_i^2 y_i^2) - (\sum_{j \in V} \eta_{ij}^0 x_{ij}^0 + \eta_{ij}^1 x_{ij}^1 + \eta_{ij}^2 x_{ij}^2) \tag{1}$$

subject to

$$\sum_{j \text{ on } R} (\sum_{i \in V} q_i^0 x_{ij}^0 + q_i^1 x_{ij}^1 + q_i^2 x_{ij}^2) - (q_j^0 y_j^0 + q_j^1 y_j^1 + q_j^2 y_j^2) \le Q_r \qquad \forall r \in R \tag{2}$$

$$\sum_{j \text{ on } R} \left(\sum_{i \in V} \eta_{ij}^0 x_{ij}^0 + (\eta_{ij}^1 + c_{is_1(i)}) x_{ij}^1 + (\eta_{ij}^2 + c_{is_1(i)} + c_{s_1(i)s_2(i)}) x_{ij}^2 \right) -$$
$$\left(\varphi_j^0 y_j^0 + (\varphi_j^1 + c_{js_1(j)}) y_j^1 + (\varphi_j^2 + c_{js_1(j)} + c_{s_1(j)s_2(j)}) y_j^2 \right) \leq C_r \qquad \forall r \in R \tag{3}$$

$$\sum_{i \in V} x_{ij}^0 + x_{ij}^1 + x_{ij}^2 + y_j^0 + y_{p_1(j)}^0 + y_j^1 + y_{p_1(j)}^1 + y_{p_2(j)}^1 +$$
$$y_j^2 + y_{p_1(j)}^2 + y_{p_2(j)}^2 + y_{p_3(j)}^2 \leq 1 \qquad \forall j \in V \tag{4}$$

$$\sum_{j \in V} x_{ij}^0 = y_i^0 \qquad \forall i \in V \tag{5}$$
$$\sum_{j \in V} x_{ij}^1 = y_i^1 \qquad \forall i \in V \tag{6}$$
$$\sum_{j \in V} x_{ij}^2 = y_i^2 \qquad \forall i \in V \tag{7}$$
$$y_i^0 = 0 \qquad \forall i \notin V_0 \tag{8}$$
$$y_i^1 = 0 \qquad \forall i \notin V_1 \tag{9}$$
$$y_i^2 = 0 \qquad \forall i \notin V_2 \tag{10}$$
$$x_{ij}^0 = 0 \qquad \forall j \notin V_0(i), \forall i \in V \tag{11}$$
$$x_{ij}^1 = 0 \qquad \forall j \notin V_1(i), \forall i \in V \tag{12}$$
$$x_{ij}^2 = 0 \qquad \forall j \notin V_2(i), \forall i \in V \tag{13}$$
$$x_{ij}^0, x_{ij}^1, x_{ij}^2, y_i^0, y_i^1, y_i^2 \in \{0, 1\} \qquad \forall i, j \in V \tag{14}$$

The objective function (1) gives the net savings attained by relocating strings of one, two, and three consecutive customers. In constraints (2), we ensure that the amount of demand relocated to a route minus the amount of demand relocated from a route does not exceed the residual capacity of the route. In constraints (3), we ensure that the net increase in the length of a route due to relocations does not exceed the residual length of the route. In constraints (4), if we relocate a string of customers immediately prior to customer j, then we do not remove any string

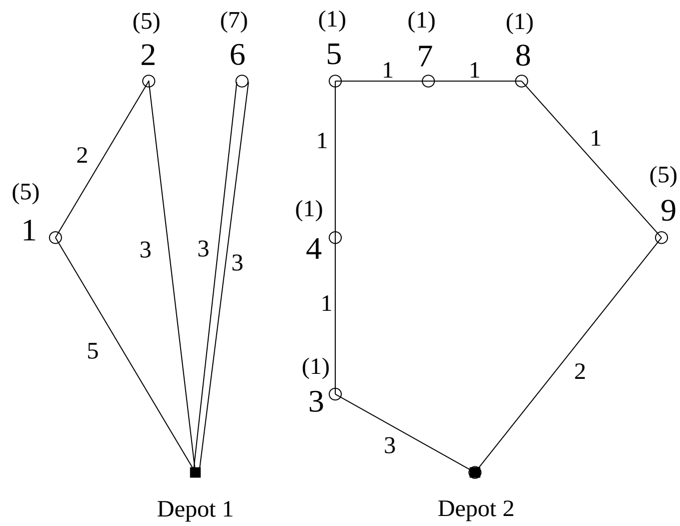


Figure 7.3: By applying the MDIIP to the solution in Figure 7.1, we decrease the distance traveled from 28 units to 26 units.

of customers containing j or $p_1(j)$. Also, we do not insert more than one string of customers immediately prior to customer j, and we remove either j or $p_1(j)$ but not both. Constraints (4) ensure the objective value accurately reflects the savings, as the coefficients in the objective function depend on j and $p_1(j)$. In constraints (5)–(7), we relocate a string of customers if and only if we insert it immediately prior to some other customer. In constraints (8)–(13), we allow a string of customers starting at i to be moved immediately prior to j only if the string is a candidate for relocation and j is in the appropriate neighborhood of i. Constraints 14 ensure all decision variables are binary.

We apply the MDIIP to the solution given in Figure 7.1 and show the improved solution in Figure 7.3. A savings of two units is achieved by relocating customers 3, 4, and 5 immediately prior to customer 7. The MDIIP formulation for this example is given in Section 7.5 (Appendix I).

7.3.3 Improving the Routes of Each Depot Separately Using Record-to-record Travel

In our heuristic, each time a new record (best) solution is found, we attempt to improve this solution by considering the routes of each depot separately. Vehicle routes starting and ending at a specific depot are treated as a single-depot VRP solution. We improve this solution using an enhanced record-to-record travel algorithm (ERTR) developed by Groër, Golden, and Wasil [50]. ERTR is a modified version of the variable length record-to-record travel algorithm (VRTR) developed by Li, Golden, and Wasil [63]. VRTR improves a VRP solution by performing one-point and two-point node exchanges, as well as two-opt edge exchanges. ERTR considers additional moves such as three-point node exchanges and Or-opt edge exchanges. Uphill moves are allowed when a solution is within a preset tolerance of the record solution. The details of ERTR are given in Table 7.2.

7.3.4 Reinitializing a Solution

Given a current solution S, we apply the MDIIP repeatedly. We stop when either i) there is no improvement in the current iteration, or ii) the improvement is less than a minimum value and S is not within a maximum deviation of the record (best) solution. Rule ii) allows us to exit an iteration in which we are unlikely to find a new record solution. Next, we reinitialize S. This allows us to explore the solution space from a different (new) solution.

To reinitialize S, we select two depots d_1 and d_2 randomly. We create a

Table 7.2: Enhanced record-to-record travel algorithm for the VRP.

S_d = VRP solution with depot $d, deviation = 1\%, count = 0, L = 10, A = 70$
Initialize the record, $S_d^* = S_d$
Uphill:
For ($a = 1$ to A)
  Apply one-point moves, apply two-point moves, apply three-point moves
  Apply two-opt edge exchanges, apply Or-opt edge exchanges
  Update S_d if result is within *deviation* of cost of S_d^*
  Update S_d^* if necessary
End-For
Downhill:
Apply Or-opt edge exchanges, apply two-opt edge exchanges
Apply one-point moves, apply two-point moves, apply three-point moves
If (cost decreases), update S_d and go to Downhill
Else Update S_d^* if necessary, otherwise $count = count + 1$
If ($count < L$), go to Uphill
Perturb solutions once and go to Uphill
Return S_d^*

fictitious depot d' located somewhere on the line segment connecting d_1 and d_2. That is, we let $P' = \gamma P_1 + (1-\gamma)P_2$, where P', P_1, and P_2 are the locations in the plane of d', d_1, and d_2, respectively, and γ is a random number generated uniformly in $[0,1]$. (We assume Euclidean distances, but this step could easily be modified for the case of a general distance matrix by, say, letting $c_{d'i} = \gamma c_{d_1 i} + (1-\gamma)c_{d_2 i}$ for each customer i on a route of depot d_1 or d_2.) We then create a single-depot VRP solution $S_{d'}$ from the routes of depots d_1 and d_2 by removing d_1 and d_2 from the routes and inserting d' in their places. In Figure 7.4, we illustrate this. In Figure 7.4(a), we show the routes of d_1 and d_2. In Figure 7.4(b), we show the routes with d' inserted in place of d_1 and d_2.

In replacing d_1 and d_2 with d', a route might violate the maximum route length constraint. If this is the case, we set a new maximum route length equal to the length of the longest route in $S_{d'}$. We then apply a modified (fast) version of ERTR to $S_{d'}$

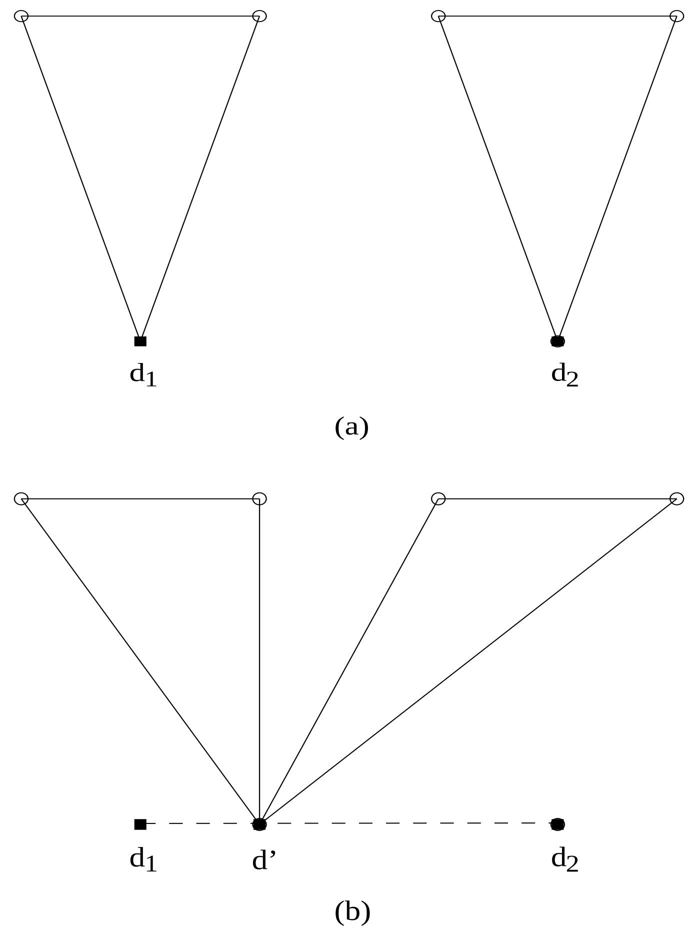


Figure 7.4: We remove depots d_1 and d_2 and insert the fictitious depot d'.

in which we consider edge moves (two-opt and OR-opt), but not node moves (one-, two-, and three-point moves). We denote the modified ERTR by MERTR.

Next, we remove d' from all routes of $S_{d'}$ and reinsert depot d_1 or d_2 in a least-cost way, creating new single-depot solutions for d_1 and d_2, denoted S_{d_1} and S_{d_2}, respectively. If a route in S_{d_1} or S_{d_2} is longer than the original maximum route length, we apply a make-feasible routine that moves customers off the violating routes onto new routes. The details of the make-feasible routine are given in Table 7.3. Finally, we apply ERTR to S_{d_1} and S_{d_2} separately. We give the details of the

Table 7.3: A routine for making a VRP solution feasible.

```
S_d = VRP solution with depot d
C = maximum route length
φ_i = c_{p1(i)i} + c_{is1(i)} − c_{p1(i)s1(i)} (removal savings)
φ* = largest removal savings
i* = best customer to relocate
j* = best node to relocate i* immediately prior to
For (each route r of S_d)
    While (the length of r is greater than C)
        Set φ* = −1
        For (all customers i on r and all nodes j on each route p)
            If (relocating i immediately prior to j on p is feasible) and (φ_i > φ*)
                φ* = φ_i
                i* = i
                j* = j
            End-If
        End-For
        If (φ* ≥ 0), relocate i* immediately prior to j*
        Else
            Remove the customer i* on r with the largest removal savings
            Create a round-trip route from d to i*
        End-If-Else
    End-While
End-For
Return S_d
```

entire reinitialization procedure in Table 7.4.

After performing the reinitialization procedure, we apply the MDIIP. We repeat this process until a stopping condition is reached and the best solution is returned. Each time a new best solution is found, we apply ERTR to the routes of each depot separately. We set a run-time limit for each execution of the MDIIP. If the MDIIP is not solved optimally when the run-time limit is reached, the best solution that was found is returned. The details of our integer programming-based heuristic (MDIPH) for the MDVRP are given in Table 7.5.

Table 7.4: A procedure for reinitializing an MDVRP solution.

```
S = MDVRP solution,  S_{d'} = VRP solution with depot d'
S_{d1} = VRP solution with depot d1,  S_{d2} = VRP solution with depot d2
C = maximum route length
η_ij = c_{p1(j)i} + c_ij − c_{p1(j)j}   (insertion cost)
η* = smallest insertion cost
d* = best depot to insert
j* = best node to insert d* immediately prior to
Chose depots d1 and d2 randomly from all depots
Create fictitious depot d' on the line segment connecting d1 and d2
Create S_{d'} by replacing d1 and d2 with d' on all routes of d1 and d2
Set C equal to the length of the longest route of S_{d'} (if necessary)
Apply MERTR to S_{d'}
For (each route r in S_{d'})
    Remove d' from r
    Set η* = ∞
    For (all customers j on r and each depot d = d1, d2)
        If (η_dj < η*)
            η* = η_dj
            d* = d
            j* = j
        End-If
    End-For
    Insert d* immediately prior to j*
End-For
Reset C to the original maximum route length
Apply the make-feasible routine and ERTR to S_{d1} and S_{d2}
Return S
```

7.3.5 Computational Experiment with MDIPH

7.3.5.1 Performance on Benchmark Problems

We applied MDIPH to 23 benchmark problems. Seven problems (MD1–MD7) were developed by Christofides and Eilon [23]. Four problems (MD8–MD11) are from Gillett and Johnson [42], and 12 problems (MD12–MD23) are from Chao, Golden, and Wasil [18]. These 23 problems vary in size from 50 customers to 360 customers and from 2 depots to 9 depots. The integer programs in MDIPH are solved with ILOG CPLEX 10.0 and Visual C++ (version 6.0) using a 3.0 GHz

Table 7.5: The MDIPH algorithm for solving the MDVRP.

```
S = current MDVRP solution, S* = record solution
runTime = current number of seconds elapsed in the algorithm's execution
maxTime = run-time limit of the algorithm
minImp = .05%, maxDev = .05%, maxRec = 50
Set the MDIIP time limit to 30 seconds
L_x = size of candidate set x
K_x = size of neighborhood x
If (number of customers N is at most 100)
    L_0 = L_1 = L_2 = N
    K_0 = K_1 = K_2 = 25
    maxTime = 500 seconds
Else-If (N <= 200)
    L_0 = ⌊.9N⌋, L_1 = L_2 = ⌊.75N⌋
    K_0 = K_1 = K_2 = 25
    maxTime = 1000 seconds
Else
    L_0 = ⌊.75N⌋, L_1 = L_2 = ⌊.5N⌋
    K_0 = 20, K_1 = K_2 = 10
    If (N <= 300), maxTime = 1500 seconds
    Else maxTime = 2500 seconds
End-If-Else
Set recCntr = 0 (number of iterations since the last record solution was found)
Generate initial solution S, set S* = S
Apply ERTR to the routes of each depot of S separately
Repeat
    Repeat
        Apply the MDIIP to S
        If (improvement of S < minImp) and (deviation of S from S* > maxDev)
            Set S = S*
            Break Repeat-Until
        End-If
    Until (no improvement of S is achieved )
    If (S is the new best solution)
        Apply ERTR to the routes of each depot of S separately
        Set S* = S
        recCntr = 0
    Else recCntr = recCntr + 1
    End-If-Else
    Apply reinitialization procedure to S
Until (recCntr > maxRec) or (runTime > maxTime)
Return S*
```

Pentium 4 processor and 512MB of RAM.

In Table 7.6, we give our computational results. In column one, we give the problem number. In columns two through five, we give the number of customers (N), the number of depots (M), the maximum route length (C), and the vehicle capacity (Q). Columns six through ten give the solution values produced by our algorithm (MDIPH) and the solution values generated by the algorithms of Chao, Golden, and Wasil (CGW) [18], Renaud, Laporte, and Boctor (RLB) [78], Cordeau, Gendreau,

Table 7.6: Computational results for five algorithms on 23 MDVRPs.

Problem	N	M	C	Q	MDIPH[1]	CGW[1]	RLB[1]	CGL[1]	LAU[2]
MD1	50	4	∞	80	**576.87**	582.4	**576.87**	**576.87**	**576.87**
MD2	50	4	∞	160	**473.53**	476.6	476.66	473.87	**473.53**
MD3	75	5	∞	140	644.46	**641.2**	645.14	645.15	**641.19**
MD4	100	2	∞	100	**999.21**	1026.9	1016.13	1006.66	1001.59
MD5	100	2	∞	200	**751.89**	756.6	754.20	753.34	752.08
MD6	100	3	∞	100	880.57	883.6	**876.50**	877.84	882.73
MD7	100	4	∞	100	898.20	898.5	897.86	**891.95**	887.94
MD8	249	2	310	500	**4414.99**	4511.6	4500.48	4482.44	4438.15
MD9	249	3	310	500	**3879.06**	3950.9	3969.31	3920.85	3916.32
MD10	249	4	310	500	3689.47	3815.6	3720.88	3714.65	**3669.76**
MD11	249	5	310	500	3601.26	3733.0	3670.25	**3580.84**	3581.88
MD12	80	2	∞	60	**1318.95**	1327.3	**1318.95**	**1318.95**	**1318.95**
MD13	80	2	200	60	**1318.95**	1345.9	**1318.95**	**1318.95**	**1318.95**
MD14	80	2	180	60	**1360.12**	1372.5	1365.69	**1360.12**	**1360.12**
MD15	160	4	∞	60	**2511.92**	2610.3	2551.46	2534.13	2514.06
MD16	160	4	200	60	**2572.23**	2605.3	**2572.23**	**2572.23**	2578.37
MD17	160	4	180	60	**2709.09**	2816.6	2731.37	2720.23	**2709.09**
MD18	240	6	∞	60	3731.37	3877.4	3786.96	**3710.49**	3728.44
MD19	240	6	200	60	**3827.06**	3863.9	**3827.06**	**3827.06**	3840.53
MD20	240	6	180	60	4063.64	4272.0	4097.06	**4058.07**	4063.26
MD21	360	9	∞	60	**5516.40**	5791.5	5678.50	5535.99	5525.68
MD22	360	9	200	60	5735.40	5857.4	5718.00	**5716.01**	5733.13
MD23	360	9	180	60	6112.17	6494.6	6145.58	6139.73	**6098.75**

[1]Solutions generated using default parameter settings

[2]Average solutions from 50 runs

Bold indicates the best solution.

and Laporte (CGL) [26], and Lau et al. (LAU) [60]. These four algorithms have been applied to MD1–MD23 and have produced the best-known solutions to these 23 problems. The results reported in Table 7.6 were generated by MDIPH, CGW, RLB, and CGL using the default settings of their parameters. The results generated by LAU are the average solutions from 50 runs of their genetic algorithm.

MDIPH performed very well on the 23 problems. It generated the best solutions to 6 problems and matched the best solutions to eight problems. CGL and LAU were the next best algorithms. CGL generated the best solutions to five prob-

Table 7.7: Best solutions generated by five algorithms to 23 MDVRPs.

Problem	N	M	C	Q	MDIPH[1]	CGW[1]	RLB[1]	CGL[1]	LAU[2]
MD1	50	4	∞	80	**576.87**	**576.9**	**576.87**	**576.87**	**576.87**
MD2	50	4	∞	160	**473.53**	474.6	**473.53**	**473.53**	**473.53**
MD3	75	5	∞	140	644.46	**641.2**	**641.19**	**641.19**	**641.19**
MD4	100	2	∞	100	**999.21**	1012.0	1003.87	1001.59	1001.59
MD5	100	2	∞	200	**750.03**	756.5	750.26	**750.03**	**750.03**
MD6	100	3	∞	100	**876.50**	879.1	**876.50**	**876.50**	**876.50**
MD7	100	4	∞	100	**881.97**	893.8	892.58	885.80	885.80
MD8	249	2	310	500	**4414.99**	4511.6	4485.09	4437.68	4429.51
MD9	249	3	310	500	**3871.91**	3950.9	3937.82	3900.22	3900.22
MD10	249	4	310	500	**3646.06**	3727.1	3669.38	3663.02	3663.02
MD11	249	5	310	500	**3550.78**	3670.2	3648.95	3554.18	3552.67
MD12	80	2	∞	60	**1318.95**	1327.3	**1318.95**	**1318.95**	**1318.95**
MD13	80	2	200	60	**1318.95**	1345.9	**1318.95**	**1318.95**	**1318.95**
MD14	80	2	180	60	**1360.12**	1372.5	1365.69	**1360.12**	**1360.12**
MD15	160	4	∞	60	**2505.42**	2610.3	2551.46	**2505.42**	**2505.42**
MD16	160	4	200	60	**2572.23**	2605.3	**2572.23**	**2572.23**	**2572.23**
MD17	160	4	180	60	**2709.09**	2816.6	2731.37	**2709.09**	**2709.09**
MD18	240	6	∞	60	**3702.85**	3877.4	3781.04	**3702.85**	**3702.85**
MD19	240	6	200	60	**3827.06**	3863.9	**3827.06**	**3827.06**	**3827.06**
MD20	240	6	180	60	**4058.07**	4272.0	4097.06	**4058.07**	**4058.07**
MD21	360	9	∞	60	**5474.84**	5791.5	5656.47	**5474.84**	**5474.84**
MD22	360	9	200	60	**5702.16**	5857.4	5718.00	**5702.16**	**5702.16**
MD23	360	9	180	60	6101.03	6494.6	6145.58	6095.46	**6087.65**

[1]Best solutions generated using different parameter settings

[2]Best solutions from 50 runs

Bold indicates the best-known solution.

lems and matched the best solutions to six problems. LAU generated two best solutions and matched the best solutions to seven problems.

The authors of MDIPH, CGW, RLB, and CGL also report the very best solutions to MD1–MD23 generated by their algorithms while testing different parameter settings. In Table 7.7, we give these solutions. Many of these solutions were generated using parameter settings different than the default settings, so they are not presented in Table 7.6. The results for LAU in Table 7.7 are the best solutions from 50 runs of their algorithm. The bold entries in Table 7.7 represent the best-known

Table 7.8: Run times (seconds) for four algorithms on 23 MDVRPs.

Problem	N	M	C	Q	MDIPH[1]	CGW[2]	RLB[3]	CGL[3]
MD1	50	4	∞	80	141.86	66	192	194.4
MD2	50	4	∞	160	108.07	72	288	207.6
MD3	75	5	∞	140	209.52	108	348	339.6
MD4	100	2	∞	100	534.45	132	684	467.4
MD5	100	2	∞	200	510.98	144	768	492.6
MD6	100	3	∞	100	531.32	126	504	459.0
MD7	100	4	∞	100	536.78	288	408	462.6
MD8	249	2	310	500	1512.12	1446	4164	1525.8
MD9	249	3	310	500	1507.20	1254	2472	1603.8
MD10	249	4	310	500	1506.19	432	2580	1530.0
MD11	249	5	310	500	1519.98	1002	2184	1554.6
MD12	80	2	∞	60	255.40	168	324	334.2
MD13	80	2	200	60	255.21	42	288	334.8
MD14	80	2	180	60	257.72	78	156	326.4
MD15	160	4	∞	60	1002.23	138	930	843.6
MD16	160	4	200	60	1007.13	366	666	843.0
MD17	160	4	180	60	1010.89	390	348	822.0
MD18	240	6	∞	60	1519.92	516	1392	1491.0
MD19	240	6	200	60	1505.01	1338	1320	1512.0
MD20	240	6	180	60	1503.07	876	600	1483.2
MD21	360	9	∞	60	2503.72	4710	2922	2889.6
MD22	360	9	200	60	2502.17	7944	2010	2934.0
MD23	360	9	180	60	2507.23	1464	1038	2871.6
Average					1062.96	1004.35	1155.91	1109.69

[1] 3.0 GHz Pentium 4 processor

[2] SUN 4/370 workstation

[3] Sun Sparcstation 10

solutions to MD1–MD23.

We see that MDIPH generated the best-known solutions to 21 of 23 problems, six of these were new best-known solutions. LAU generated the best-known solutions to 17 problems, one of these is strictly the best-known. CGL generated the best-known solutions to 16 problems.

In Table 7.8, we provide the run times in seconds for MDIHP, CGW, RLB, and

CGL using the default settings of their parameters. CGW has the smallest average run time (1004.35 seconds) followed by MDIPH (1062.96 seconds). Each algorithm has an average run time within 155 seconds of the others. The authors of LAU do not report average run times. They only report run times "corresponding to the best objective value". For example, they report a single run time of 269.43 seconds on problem MD23. Since they select the best solution from 50 runs of their genetic algorithm, their total computational effort for problem MD23 is approximately 50 times as large, or nearly 13,500 seconds. Given that we do not have exact run times for LAU, we do not report them in Table 7.8. Also, they do not give the specifications of the machine on which their algorithm was run.

In Appendix E, we give all problems used in testing and all solutions generated by MDIPH.

7.3.5.2 Improvement Analysis

Next, we performed an analysis to determine how much each subroutine of MDIPH improves a solution. MDIPH has three subroutines, MDIIP, ERTR, and Reinitialization. In the MDIIP subroutine, the MDIIP (Section 7.3.2) is applied to the current solution repeatedly until no improvement is achieved. In the ERTR subroutine, we perform ERTR (Section 7.3.3) on the routes of each individual depot. In the Reinitialization subroutine, we reinitialize a solution using the procedure given in Section 7.3.4.

On 10 sample problems selected from MD1–MD23, we recorded the improvement to a solution each time a subroutine was executed in MDIPH. Improvement is given by $100(1-D/D')\%$, where D' is the distance of a solution before a subroutine is applied, and D is the distance of the solution after the subroutine is applied. In Table 7.9, we present our results. For each problem and each subroutine, we give the number (No.) of times the subroutine was executed in MDIPH and the average improvement (Imp.) to a solution from the subroutine.

Table 7.9: Average improvements to solutions from three subroutines of MDIPH.

	MDIIP		ERTR		Reinit.	
Problem	No.	Imp.	No.	Imp.	No.	Imp.
MD1	323	0.93	5	0.00	322	-1.16
MD3	67	1.51	5	0.00	66	-1.69
MD6	18	1.23	4	0.17	17	-2.32
MD9	30	0.95	2	0.31	29	-2.62
MD12	71	1.27	2	0.00	70	-3.17
MD14	63	1.96	1	0.00	62	-4.59
MD17	81	1.31	3	0.00	80	-3.01
MD19	200	1.22	6	0.00	199	-1.76
MD21	211	0.99	11	0.05	210	-1.63
MD23	212	0.45	6	0.00	211	-1.04

In Table 7.9, we see that MDIIP accounts for almost all the total improvement to an initial solution. On the 10 problems, an execution of MDIIP improved a solution by between 0.45% and 1.96%, on average. An execution of ERTR improved a solution by between 0.00% and 0.31%, on average. ERTR failed to improve a solution to seven of 10 problems. ERTR is applied only when a new record solution has been found. These solutions are usually very good, so there is not much room for improvement. The improvements from Reinitialization are negative. On average, the solution after Reinitialization is applied is worse than the solution before Reinitialization is applied. The purpose of Reinitialization is not necessarily to improve

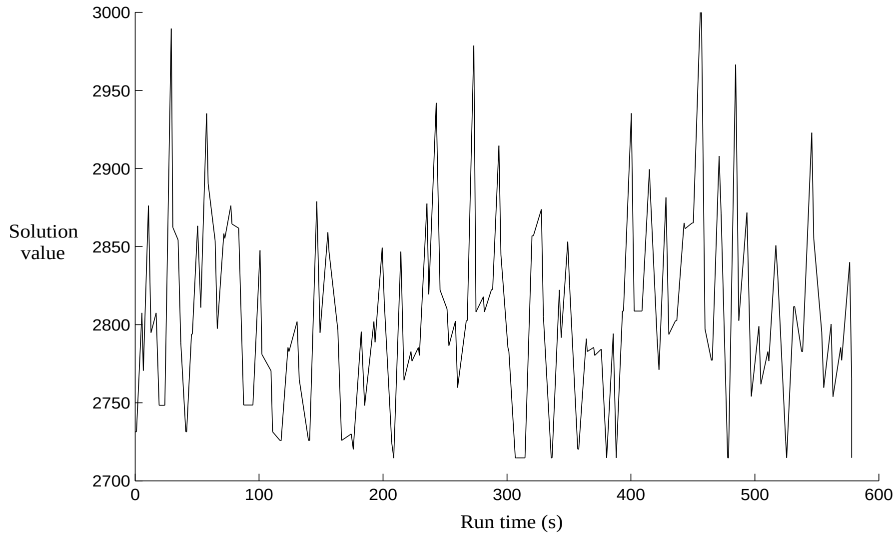


Figure 7.5: The value of the current solution to MD17 changes in time.

a solution, but to find a new starting solution that is sufficiently different from the current solution (so that cycling is avoided), but still retains many features of the current high-quality solution.

In Figure 7.5, we give a graph of solution value (total distance traveled) versus run time for a run of MDIPH on MD17. In the graph, each long descent is due to MDIIP. If a new record (minimum) is achieved, ERTR is performed. If ERTR does not improve the current solution, we see a short horizontal line segment in the graph. For example, from run time 310 to 321 the graph is constant at a solution value of 2709.09. Reinitialization is then applied causing the upward spikes seen in the graph. The shape of the graph in Figure 7.5 reflects the type of behavior we have seen for MDIPH on other benchmark problems.

7.4 Conclusions

We developed a new heuristic for the MDVRP that combined integer programming and an enhanced version of the record-to-record travel algorithm. When applied to standard benchmark MDVRPs, our heuristic produced results that were very accurate and were better on average than the results for four algorithms reported in the literature in comparable run times. In addition, using different parameter settings, our algorithm produced the best solutions to 21 of 23 problems.

7.5 Appendix I

We present the MDIIP formulation using the example given in Figure 7.1 as the initial solution. The three routes of the initial solution are 1) 0-1-2-0, 2) 0-3-4-5-6-0, and 3) 10-7-8-9-10, where node 0 represents depot 1 and node 10 represents depot 2. In this example, for simplicity, we let $V_0 = \{3, 4, 5\}$, $V_1 = \{3, 4\}$, and $V_2 = \{3\}$, and we only consider relocations immediately prior to customer 7 (each neighborhood is $\{7\}$). The MDIIP formulation is as follows.

maximize $\varphi_3^0 y_3^0 + \varphi_4^0 y_4^0 + \varphi_5^0 y_5^0 + \varphi_3^1 y_3^1 + \varphi_4^1 y_4^1 + \varphi_3^2 y_3^2 - \eta_{37}^0 x_{37}^0 - \eta_{47}^0 x_{47}^0 - \eta_{57}^0 x_{57}^0 - \eta_{37}^1 x_{37}^1 - \eta_{47}^1 x_{47}^1 - \eta_{37}^2 x_{37}^2$

subject to

$q_3^0 x_{37}^0 + q_4^0 x_{47}^0 + q_5^0 x_{57}^0 + q_3^1 x_{37}^1 + q_4^1 x_{47}^1 + q_3^2 y_{37}^2 <= Q_3$

$\eta_{37}^0 x_{37}^0 + \eta_{47}^0 x_{47}^0 + \eta_{57}^0 x_{57}^0 + (\eta_{37}^1 + c_{34}) x_{37}^1 + (\eta_{47}^1 + c_{45}) x_{47}^1 + (\eta_{37}^2 + c_{34} + c_{45}) x_{37}^2 <= C_3$

$x_{37}^0 + x_{47}^0 + x_{57}^0 + x_{37}^1 + x_{47}^1 + x_{37}^2 \leq 1$

$x_{37}^0 = y_3^0$

$x_{47}^0 = y_4^0$

$x^0_{57} = y^0_5$

$x^1_{37} = y^1_3$
$x^1_{47} = y^1_4$

$x^2_{37} = y^2_3$

$y^0_1 = y^0_2 = y^0_6 = y^0_7 = y^0_8 = y^0_9 = 0$

$y^1_1 = y^1_2 = y^1_5 = y^1_6 = y^1_7 = y^1_8 = y^1_9 = 0$

$y^2_1 = y^2_2 = y^2_4 = y^2_5 = y^2_6 = y^2_7 = y^2_8 = y^2_9 = 0$

$x^0_{12} = x^0_{13} = x^0_{14} = x^0_{15} = x^0_{16} = x^0_{17} = x^0_{18} = x^0_{19} = 0$
$x^0_{21} = x^0_{23} = x^0_{24} = x^0_{25} = x^0_{26} = x^0_{27} = x^0_{28} = x^0_{29} = 0$
$x^0_{31} = x^0_{32} = x^0_{34} = x^0_{35} = x^0_{36} = x^0_{38} = x^0_{39} = 0$
$x^0_{41} = x^0_{42} = x^0_{43} = x^0_{45} = x^0_{46} = x^0_{48} = x^0_{49} = 0$
$x^0_{51} = x^0_{52} = x^0_{53} = x^0_{54} = x^0_{56} = x^0_{58} = x^0_{59} = 0$
$x^0_{61} = x^0_{62} = x^0_{63} = x^0_{64} = x^0_{65} = x^0_{67} = x^0_{68} = x^0_{69} = 0$
$x^0_{71} = x^0_{72} = x^0_{73} = x^0_{74} = x^0_{75} = x^0_{76} = x^0_{78} = x^0_{79} = 0$
$x^0_{81} = x^0_{82} = x^0_{83} = x^0_{84} = x^0_{85} = x^0_{86} = x^0_{87} = x^0_{89} = 0$
$x^0_{91} = x^0_{92} = x^0_{93} = x^0_{94} = x^0_{95} = x^0_{96} = x^0_{97} = x^0_{98} = 0$

$x^1_{12} = x^1_{13} = x^1_{14} = x^1_{15} = x^1_{16} = x^1_{17} = x^1_{18} = x^1_{19} = 0$
$x^1_{21} = x^1_{23} = x^1_{24} = x^1_{25} = x^1_{26} = x^1_{27} = x^1_{28} = x^1_{29} = 0$
$x^1_{31} = x^1_{32} = x^1_{34} = x^1_{35} = x^1_{36} = x^1_{38} = x^1_{39} = 0$
$x^1_{41} = x^1_{42} = x^1_{43} = x^1_{45} = x^1_{46} = x^1_{48} = x^1_{49} = 0$
$x^1_{51} = x^1_{52} = x^1_{53} = x^1_{54} = x^1_{56} = x^1_{57} = x^1_{58} = x^1_{59} = 0$
$x^1_{61} = x^1_{62} = x^1_{63} = x^1_{64} = x^1_{65} = x^1_{67} = x^1_{68} = x^1_{69} = 0$
$x^1_{71} = x^1_{72} = x^1_{73} = x^1_{74} = x^1_{75} = x^1_{76} = x^1_{78} = x^1_{79} = 0$
$x^1_{81} = x^1_{82} = x^1_{83} = x^1_{84} = x^1_{85} = x^1_{86} = x^1_{87} = x^1_{89} = 0$
$x^1_{91} = x^1_{92} = x^1_{93} = x^1_{94} = x^1_{95} = x^1_{96} = x^1_{97} = x^1_{98} = 0$

$x^2_{12} = x^2_{13} = x^2_{14} = x^2_{15} = x^2_{16} = x^2_{17} = x^2_{18} = x^2_{19} = 0$
$x^2_{21} = x^2_{23} = x^2_{24} = x^2_{25} = x^2_{26} = x^2_{27} = x^2_{28} = x^2_{29} = 0$
$x^2_{31} = x^2_{32} = x^2_{34} = x^2_{35} = x^2_{36} = x^2_{38} = x^2_{39} = 0$
$x^2_{41} = x^2_{42} = x^2_{43} = x^2_{45} = x^2_{46} = x^2_{47} = x^2_{48} = x^2_{49} = 0$
$x^2_{51} = x^2_{52} = x^2_{53} = x^2_{54} = x^2_{56} = x^2_{57} = x^2_{58} = x^2_{59} = 0$
$x^2_{61} = x^2_{62} = x^2_{63} = x^2_{64} = x^2_{65} = x^2_{67} = x^2_{68} = x^2_{69} = 0$
$x^2_{71} = x^2_{72} = x^2_{73} = x^2_{74} = x^2_{75} = x^2_{76} = x^2_{78} = x^2_{79} = 0$
$x^2_{81} = x^2_{82} = x^2_{83} = x^2_{84} = x^2_{85} = x^2_{86} = x^2_{87} = x^2_{89} = 0$
$x^2_{91} = x^2_{92} = x^2_{93} = x^2_{94} = x^2_{95} = x^2_{96} = x^2_{97} = x^2_{98} = 0$

$y^0_3, y^0_4, y^0_5, y^1_3, y^1_4, y^2_3, x^0_{37}, x^0_{47}, x^0_{57}, x^1_{37}, x^1_{47}, y^2_{37} \in \{0, 1\}$

In this example, the residual capacity for route 3 is given by $Q_3 = 3$ and the residual length is given by $C_3 = 2$. The demands are given by $q_3^0 = q_4^0 = q_5^0 = 1$, $q_3^1 = q_4^1 = 2$, and $q_3^2 = 3$. The symmetric distances are given by $c_{03} = 4, c_{04} = 5, c_{05} = 4, c_{06} = 3, c_{34} = 1, c_{35} = 2, c_{36} = c_{37} = c_{3(10)} = 3, c_{45} = 1, c_{46} = 2, c_{47} = 2, c_{4(10)} = 4, c_{56} = c_{57} = 1, c_{5(10)} = 5$, and $c_{7(10)} = 4$. Thus, $\varphi_3^0 = c_{03} + c_{34} - c_{04} = 0, \varphi_4^0 = c_{34} + c_{45} - c_{35} = 0, \varphi_5^0 = c_{45} + c_{56} - c_{46} = 0, \varphi_3^1 = c_{03} + c_{45} - c_{05} = 1, \varphi_4^1 = c_{34} + c_{56} - c_{36} = -1, \varphi_3^2 = c_{03} + c_{56} - c_{06} = 2, \eta_{37}^0 = c_{(10)3} + c_{37} - c_{(10)7} = 2, \eta_{47}^0 = c_{(10)4} + c_{47} - c_{(10)7} = 2, \eta_{57}^0 = c_{(10)5} + c_{57} - c_{(10)7} = 2, \eta_{37}^1 = c_{(10)3} + c_{47} - c_{(10)7} = 1, \eta_{47}^1 = c_{(10)4} + c_{57} - c_{(10)7} = 1$, and $\eta_{37}^2 = c_{(10)3} + c_{57} - c_{(10)7} = 0$. The objective function is given by

maximize $y_3^1 - y_4^1 + 2y_3^2 - 2x_{37}^0 - 2x_{47}^0 - 2x_{57}^0 - x_{37}^1 - x_{47}^1$.

The objective function is maximized when $y_3^2 = x_{37}^2 = 1$ and all other decision variables are 0. A maximum savings of two units is produced by relocating customers 3, 4, and 5 immediately prior to customer 7. This solution is given in Figure 7.3.

Chapter 8

Conclusions

In this dissertation, we developed integer programming-based heuristics for variants of the standard VRP. We modeled two new variants of the split delivery vehicle routing problem; the SDVRP with minimum delivery amounts and the multi-depot SDVRP. We developed IP-based heuristics for each variant and constructed new test problems that have have high-quality, visually estimated solutions. For the SDVRP-MDA, we constructed 21 new test problems with four minimum delivery fractions. For the MDSDVRP, we constructed 12 new test problems. For both variants, the solutions generated by our heuristics compared favorably with the estimated solutions.

We developed an IP-based heuristic for the period vehicle routing problem that generated very good solutions to 32 benchmark problems. On these problems, our heuristic was competitive with the best algorithms found in the literature. We adapted our heuristic to two new PVRP variants: the PVRP with reassignment constraints and the PVRP with balance constraints. We performed computational analyses on these variants and demonstrated how a routing manager could use our results to develop effective routes in practice.

We applied integer programming to 15 traditional VRPs and compared our results to a record-to-record travel algorithm. Record-to-record travel outperformed our IP-based approach. We then applied the two algorithms to 15 VRPs with small vehicle capacities. Record-to-record travel still outperformed our heuristic, but the performance of our heuristic was better on the small-capacity VRPs than on the standard VRPs. Based on our results, we concluded that integer programming is not the most effective method for the traditional VRP. IP-based heuristics seem to be best suited for multi-level routing problems.

We modified our IP-based heuristic to handle the multi-depot VRP. We applied our heuristic to 23 benchmark problems and generated solutions that were better than those reported in the literature. We matched the previous best-known solutions to 21 of 23 problems and generated new best-known solutions to six problems.

Finally, we provided documentation for our collection of new benchmark test problems and make these problems available to the operations research community.

In summary, we found integer programming to be a valuable way to improve the quality of solutions to vehicle routing problems. We estimate that an average solution can be improved by 1% to 2% using an IP-based method. Based on the results in this dissertation, we encourage researchers to consider integer programming methods when developing new solution procedures for variants of the VRP.

Appendix A

SDVRP-MDA: Problems and Solutions

Table A.1: Symbol key.

N	Number of customers in a problem
Q	Vehicle capacity
No.	Customer or route number
x	x-coordinate of a node's location
y	y-coordinate of a node's location
D	Customer demand
p	Minimum delivery fraction

Note: node 0 is the depot.

Table A.2: Number of customers and vehicle capacities for six capacitated VRPs.

Problem	N	Q
CH1	50	160
CH2	75	140
CH4	150	200
CH5	199	200
CH11	120	200
CH12	100	200

Table A.3: Number of customers and vehicle capacities for 11 SDVRPs.

Problem	N	Q
S51D2	50	160
S51D3	50	160
S51D4	50	160
S51D5	50	160
S51D6	50	160
S76D2	75	160
S76D3	75	160
S76D4	75	160
S101D2	100	160
S101D3	100	160
S101D5	100	160

Table A.4: Number of customers and vehicle capacities for 21 SDVRPs.

Problem	N	Q
SD1	8	100
SD2	16	100
SD3	16	100
SD4	24	100
SD5	32	100
SD6	32	100
SD7	40	100
SD8	48	100
SD9	48	100
SD10	64	100
SD11	80	100
SD12	80	100
SD13	96	100
SD14	120	100
SD15	144	100
SD16	144	100
SD17	160	100
SD18	160	100
SD19	192	100
SD20	240	100
SD21	288	100

Table A.5: Node locations and demands for CH1.

No.	x	y	D	No.	x	y	D	No.	x	y	D	No.	x	y	D
0	30.00	40.00	0	13	5.00	25.00	23	26	27.00	68.00	7	39	59.00	15.00	14
1	37.00	52.00	7	14	12.00	42.00	21	27	30.00	48.00	15	40	5.00	6.00	7
2	49.00	49.00	30	15	36.00	16.00	10	28	43.00	67.00	14	41	10.00	17.00	27
3	52.00	64.00	16	16	52.00	41.00	15	29	58.00	48.00	6	42	21.00	10.00	13
4	20.00	26.00	9	17	27.00	23.00	3	30	58.00	27.00	19	43	5.00	64.00	11
5	40.00	30.00	21	18	17.00	33.00	41	31	37.00	69.00	11	44	30.00	15.00	16
6	21.00	47.00	15	19	13.00	13.00	9	32	38.00	46.00	12	45	39.00	10.00	10
7	17.00	63.00	19	20	57.00	58.00	28	33	46.00	10.00	23	46	32.00	39.00	5
8	31.00	62.00	23	21	62.00	42.00	8	34	61.00	33.00	26	47	25.00	32.00	25
9	52.00	33.00	11	22	42.00	57.00	8	35	62.00	63.00	17	48	25.00	55.00	17
10	51.00	21.00	5	23	16.00	57.00	16	36	63.00	69.00	6	49	48.00	28.00	18
11	42.00	41.00	19	24	8.00	52.00	10	37	32.00	22.00	9	50	56.00	37.00	10
12	31.00	32.00	29	25	7.00	38.00	28	38	45.00	35.00	15				

Table A.6: Node locations and demands for CH2.

No.	x	y	D	No.	x	y	D	No.	x	y	D	No.	x	y	D
0	40.00	40.00	0	19	62.00	48.00	15	38	47.00	66.00	24	57	65.00	27.00	14
1	22.00	22.00	18	20	66.00	14.00	22	39	30.00	60.00	16	58	40.00	60.00	21
2	36.00	26.00	26	21	44.00	13.00	28	40	30.00	50.00	33	59	70.00	64.00	24
3	21.00	45.00	11	22	26.00	13.00	12	41	12.00	17.00	15	60	64.00	4.00	13
4	45.00	35.00	30	23	11.00	28.00	6	42	15.00	14.00	11	61	36.00	6.00	15
5	55.00	20.00	21	24	7.00	43.00	27	43	16.00	19.00	18	62	30.00	20.00	18
6	33.00	34.00	19	25	17.00	64.00	14	44	21.00	48.00	17	63	20.00	30.00	11
7	50.00	50.00	15	26	41.00	46.00	18	45	50.00	30.00	21	64	15.00	5.00	28
8	55.00	45.00	16	27	55.00	34.00	17	46	51.00	42.00	27	65	50.00	70.00	9
9	26.00	59.00	29	28	35.00	16.00	29	47	50.00	15.00	19	66	57.00	72.00	37
10	40.00	66.00	26	29	52.00	26.00	13	48	48.00	21.00	20	67	45.00	42.00	30
11	55.00	65.00	37	30	43.00	26.00	22	49	12.00	38.00	5	68	38.00	33.00	10
12	35.00	51.00	16	31	31.00	76.00	25	50	15.00	56.00	22	69	50.00	4.00	8
13	62.00	35.00	12	32	22.00	53.00	28	51	29.00	39.00	12	70	66.00	8.00	11
14	62.00	57.00	31	33	26.00	29.00	27	52	54.00	38.00	19	71	59.00	5.00	3
15	62.00	24.00	8	34	50.00	40.00	19	53	55.00	57.00	22	72	35.00	60.00	1
16	21.00	36.00	19	35	55.00	50.00	10	54	67.00	41.00	16	73	27.00	24.00	6
17	33.00	44.00	20	36	54.00	10.00	12	55	10.00	70.00	7	74	40.00	20.00	10
18	9.00	56.00	13	37	60.00	15.00	14	56	6.00	25.00	26	75	40.00	37.00	20

Table A.7: Node locations and demands for CH4.

No.	x	y	D	No.	x	y	D	No.	x	y	D	No.	x	y	D
0	35.00	35.00	0	38	45.00	35.00	15	76	45.00	30.00	17	114	15.00	77.00	9
1	37.00	52.00	7	39	59.00	15.00	14	77	35.00	40.00	16	115	62.00	77.00	20
2	49.00	49.00	30	40	5.00	6.00	7	78	41.00	37.00	16	116	49.00	73.00	25
3	52.00	64.00	16	41	10.00	17.00	27	79	64.00	42.00	9	117	67.00	5.00	25
4	20.00	26.00	9	42	21.00	10.00	13	80	40.00	60.00	21	118	56.00	39.00	36
5	40.00	30.00	21	43	5.00	64.00	11	81	31.00	52.00	27	119	37.00	47.00	6
6	21.00	47.00	15	44	30.00	15.00	16	82	35.00	69.00	23	120	37.00	56.00	5
7	17.00	63.00	19	45	39.00	10.00	10	83	53.00	52.00	11	121	57.00	68.00	15
8	31.00	62.00	23	46	32.00	39.00	5	84	65.00	55.00	14	122	47.00	16.00	25
9	52.00	33.00	11	47	25.00	32.00	25	85	63.00	65.00	8	123	44.00	17.00	9
10	51.00	21.00	5	48	25.00	55.00	17	86	2.00	60.00	5	124	46.00	13.00	8
11	42.00	41.00	19	49	48.00	28.00	18	87	20.00	20.00	8	125	49.00	11.00	18
12	31.00	32.00	29	50	56.00	37.00	10	88	5.00	5.00	16	126	49.00	42.00	13
13	5.00	25.00	23	51	41.00	49.00	10	89	60.00	12.00	31	127	53.00	43.00	14
14	12.00	42.00	21	52	35.00	17.00	7	90	40.00	25.00	9	128	61.00	52.00	3
15	36.00	16.00	10	53	55.00	45.00	13	91	42.00	7.00	5	129	57.00	48.00	23
16	52.00	41.00	15	54	55.00	20.00	19	92	24.00	12.00	5	130	56.00	37.10	6
17	27.00	23.00	3	55	15.00	30.00	26	93	23.00	3.00	7	131	55.00	54.00	26
18	17.00	33.00	41	56	25.00	30.00	3	94	11.00	14.00	18	132	15.00	47.00	16
19	13.00	13.00	9	57	20.00	50.00	5	95	6.00	38.00	16	133	14.00	37.00	11
20	57.00	58.00	28	58	10.00	43.00	9	96	2.00	48.00	1	134	11.00	31.00	7
21	62.00	42.00	8	59	55.00	60.00	16	97	8.00	56.00	27	135	16.00	22.00	41
22	42.00	57.00	8	60	30.00	60.00	16	98	13.00	52.00	36	136	4.00	18.00	35
23	16.00	57.00	16	61	20.00	65.00	12	99	6.00	68.00	30	137	28.00	18.00	26
24	8.00	52.00	10	62	50.00	35.00	19	100	47.00	47.00	13	138	26.00	52.00	9
25	7.00	38.00	28	63	30.00	25.00	23	101	49.00	58.00	10	139	26.00	35.00	15
26	27.00	68.00	7	64	15.00	10.00	20	102	27.00	43.00	9	140	31.00	67.00	3
27	30.00	48.00	15	65	30.00	5.00	8	103	37.00	31.00	14	141	15.00	19.00	1
28	43.00	67.00	14	66	10.00	20.00	19	104	57.00	29.00	18	142	22.00	22.00	2
29	58.00	48.00	6	67	5.00	30.00	2	105	63.00	23.00	2	143	18.00	24.00	22
30	58.00	27.00	19	68	20.00	40.00	12	106	53.00	12.00	6	144	26.00	27.00	27
31	37.00	69.00	11	69	15.00	60.00	17	107	32.00	12.00	7	145	25.00	24.00	20
32	38.00	46.00	12	70	45.00	65.00	9	108	36.00	26.00	18	146	22.00	27.00	11
33	46.00	10.00	23	71	45.00	20.00	11	109	21.00	24.00	28	147	25.00	21.00	12
34	61.00	33.00	26	72	45.00	10.00	18	110	17.00	34.00	3	148	19.00	21.00	10
35	62.00	63.00	17	73	55.00	5.00	29	111	12.00	24.00	13	149	20.00	26.10	9
36	63.00	69.00	6	74	65.00	35.00	3	112	24.00	58.00	19	150	18.00	18.00	17
37	32.00	22.00	9	75	65.00	20.00	6	113	27.00	69.00	10				

Table A.8: Node locations and demands for CH5.

No.	x	y	D	No.	x	y	D	No.	x	y	D	No.	x	y	D
0	35.00	35.00	0	35	55.00	50.00	10	70	62.00	42.00	8	105	25.00	30.00	3
1	22.00	22.00	18	36	54.00	10.00	12	71	42.00	57.00	8	106	20.00	50.00	5
2	36.00	26.00	26	37	60.00	15.00	14	72	16.00	57.00	16	107	10.00	43.00	9
3	21.00	45.00	11	38	47.00	66.00	24	73	8.00	52.00	10	108	55.00	60.00	16
4	45.00	35.00	30	39	30.00	60.00	16	74	7.00	38.00	28	109	30.00	60.10	16
5	55.00	20.00	21	40	30.00	50.00	33	75	27.00	68.00	7	110	20.00	65.00	12
6	33.00	34.00	19	41	12.00	17.00	15	76	30.00	48.00	15	111	50.00	35.00	19
7	50.00	50.00	15	42	15.00	14.00	11	77	43.00	67.00	14	112	30.00	25.00	23
8	55.00	45.00	16	43	16.00	19.00	18	78	58.00	48.00	6	113	15.00	10.00	20
9	26.00	59.00	29	44	21.00	48.00	17	79	58.00	27.00	19	114	30.00	5.00	8
10	40.00	66.00	26	45	50.00	30.00	21	80	37.00	69.00	11	115	10.00	20.00	19
11	55.00	65.00	37	46	51.00	42.00	27	81	38.00	46.00	12	116	5.00	30.00	2
12	35.00	51.00	16	47	50.00	15.00	19	82	46.00	10.00	23	117	20.00	40.00	12
13	62.00	35.00	12	48	48.00	21.00	20	83	61.00	33.00	26	118	15.00	60.00	17
14	62.00	57.00	31	49	12.00	38.00	5	84	62.00	63.00	17	119	45.00	65.00	9
15	62.00	24.00	8	50	37.00	52.00	7	85	63.00	69.00	6	120	45.00	20.00	11
16	21.00	36.00	19	51	49.00	49.00	30	86	32.00	22.00	9	121	45.00	10.00	18
17	33.00	44.00	20	52	52.00	64.00	16	87	45.00	35.10	15	122	55.00	5.00	29
18	9.00	56.00	13	53	20.00	26.00	9	88	59.00	15.00	14	123	65.00	35.00	3
19	62.00	48.00	15	54	40.00	30.00	21	89	5.00	6.00	7	124	65.00	20.00	6
20	66.00	14.00	22	55	21.00	47.00	15	90	10.00	17.00	27	125	45.00	30.00	17
21	44.00	13.00	28	56	17.00	63.00	19	91	21.00	10.00	13	126	35.00	40.00	16
22	26.00	13.00	12	57	31.00	62.00	23	92	5.00	64.00	11	127	41.00	37.00	16
23	11.00	28.00	6	58	52.00	33.00	11	93	30.00	15.00	16	128	64.00	42.00	9
24	7.00	43.00	27	59	51.00	21.00	5	94	39.00	10.00	10	129	40.00	60.00	21
25	17.00	64.00	14	60	42.00	41.00	19	95	32.00	39.00	5	130	31.00	52.00	27
26	41.00	46.00	18	61	31.00	32.00	29	96	25.00	32.00	25	131	35.00	69.00	23
27	55.00	34.00	17	62	5.00	25.00	23	97	25.00	55.00	17	132	53.00	52.00	11
28	35.00	16.00	29	63	12.00	42.00	21	98	48.00	28.00	18	133	65.00	55.00	14
29	52.00	26.00	13	64	36.00	16.00	10	99	56.00	37.00	10	134	63.00	65.00	8
30	43.00	26.00	22	65	52.00	41.00	15	100	41.00	49.00	10	135	2.00	60.00	5
31	31.00	76.00	25	66	27.00	23.00	3	101	35.00	17.00	7	136	20.00	20.00	8
32	22.00	53.00	28	67	17.00	33.00	41	102	55.00	45.10	13	137	5.00	5.00	16
33	26.00	29.00	27	68	13.00	13.00	9	103	55.00	20.10	19	138	60.00	12.00	31
34	50.00	40.00	19	69	57.00	58.00	28	104	15.00	30.00	26	139	40.00	25.00	9

(cont.)

Table A.8 continued.

No.	x	y	D	No.	x	y	D	No.	x	y	D	No.	x	y	D
140	42.00	7.00	5	155	53.00	12.00	6	170	57.00	68.00	15	185	4.00	18.00	35
141	24.00	12.00	5	156	32.00	12.00	7	171	47.00	16.00	25	186	28.00	18.00	26
142	23.00	3.00	7	157	36.00	26.10	18	172	44.00	17.00	9	187	26.00	52.00	9
143	11.00	14.00	18	158	21.00	24.00	28	173	46.00	13.00	8	188	26.00	35.00	15
144	6.00	38.00	16	159	17.00	34.00	3	174	49.00	11.00	18	189	31.00	67.00	3
145	2.00	48.00	1	160	12.00	24.00	13	175	49.00	42.00	13	190	15.00	19.00	1
146	8.00	56.00	27	161	24.00	58.00	19	176	53.00	43.00	14	191	22.00	22.10	2
147	13.00	52.00	36	162	27.00	69.00	10	177	61.00	52.00	3	192	18.00	24.00	22
148	6.00	68.00	30	163	15.00	77.00	9	178	57.00	48.00	23	193	26.00	27.00	27
149	47.00	47.00	13	164	62.00	77.00	20	179	56.00	37.10	6	194	25.00	24.00	20
150	49.00	58.00	10	165	49.00	73.00	25	180	55.00	54.00	26	195	22.00	27.00	11
151	27.00	43.00	9	166	67.00	5.00	25	181	15.00	47.00	16	196	25.00	21.00	12
152	37.00	31.00	14	167	56.00	39.00	36	182	14.00	37.00	11	197	19.00	21.00	10
153	57.00	29.00	18	168	37.00	47.00	6	183	11.00	31.00	7	198	20.00	26.10	9
154	63.00	23.00	2	169	37.00	56.00	5	184	16.00	22.00	41	199	18.00	18.00	17

Table A.9: Node locations and demands for CH11.

No.	x	y	D	No.	x	y	D	No.	x	y	D	No.	x	y	D
0	10.00	45.00	0	31	84.00	5.00	10	62	93.00	84.00	7	93	20.00	44.00	7
1	25.00	1.00	25	32	84.00	9.00	3	63	93.00	89.00	16	94	22.00	44.00	10
2	25.00	3.00	7	33	85.00	1.00	7	64	94.00	86.00	14	95	16.00	45.00	9
3	31.00	5.00	13	34	87.00	5.00	2	65	95.00	80.00	17	96	20.00	45.00	11
4	32.00	5.00	6	35	85.00	8.00	4	66	99.00	89.00	13	97	25.00	45.00	17
5	31.00	7.00	14	36	87.00	7.00	4	67	37.00	83.00	17	98	30.00	55.00	12
6	32.00	9.00	5	37	86.00	41.00	18	68	50.00	80.00	13	99	20.00	50.00	11
7	34.00	9.00	11	38	86.00	44.00	14	69	35.00	85.00	14	100	22.00	51.00	7
8	46.00	9.00	19	39	86.00	46.00	12	70	35.00	87.00	16	101	18.00	49.00	9
9	35.00	7.00	5	40	85.00	55.00	17	71	44.00	86.00	7	102	16.00	48.00	11
10	34.00	6.00	15	41	89.00	43.00	20	72	46.00	89.00	13	103	20.00	55.00	12
11	35.00	5.00	15	42	89.00	46.00	14	73	46.00	83.00	9	104	18.00	53.00	7
12	47.00	6.00	17	43	89.00	52.00	16	74	46.00	87.00	11	105	14.00	50.00	8
13	40.00	5.00	13	44	92.00	42.00	10	75	46.00	89.10	35	106	15.00	51.00	6
14	39.00	3.00	12	45	92.00	52.00	9	76	48.00	83.00	5	107	16.00	54.00	5
15	36.00	3.00	18	46	94.00	42.00	11	77	50.00	85.00	28	108	28.00	33.00	12
16	73.00	6.00	13	47	94.00	44.00	7	78	50.00	88.00	7	109	33.00	38.00	13
17	73.00	8.00	18	48	94.00	48.00	13	79	54.00	86.00	3	110	30.00	50.00	7
18	24.00	36.00	12	49	96.00	42.00	5	80	54.00	90.00	10	111	13.00	40.00	7
19	76.00	6.00	17	50	99.00	46.00	4	81	10.00	35.00	7	112	15.00	36.00	8
20	76.00	10.00	4	51	99.00	50.00	21	82	10.00	40.00	12	113	18.00	31.00	11
21	76.00	13.00	7	52	83.00	80.00	13	83	18.00	30.00	11	114	25.00	37.00	13
22	78.00	3.00	12	53	83.00	83.00	11	84	17.00	35.00	10	115	30.00	46.00	11
23	78.00	9.00	13	54	85.00	81.00	12	85	16.00	38.00	8	116	25.00	52.00	10
24	79.00	3.00	8	55	85.00	85.00	14	86	14.00	40.00	11	117	16.00	33.00	7
25	79.00	5.00	16	56	85.00	89.00	10	87	15.00	42.00	21	118	25.00	35.00	4
26	79.00	11.00	15	57	87.00	80.00	8	88	11.00	42.00	4	119	5.00	40.00	20
27	82.00	3.00	6	58	87.00	86.00	16	89	18.00	40.00	15	120	5.00	50.00	13
28	82.00	7.00	5	59	90.00	77.00	19	90	21.00	39.00	16				
29	90.00	15.00	9	60	90.00	88.00	5	91	20.00	40.00	4				
30	84.00	3.00	11	61	93.00	82.00	17	92	18.00	41.00	16				

Table A.10: Node locations and demands for CH12.

No.	x	y	D	No.	x	y	D	No.	x	y	D	No.	x	y	D
0	40.00	50.00	0	26	25.00	55.00	10	52	25.00	35.00	10	78	88.00	35.00	20
1	45.00	68.00	10	27	23.00	52.00	10	53	44.00	5.00	20	79	87.00	30.00	10
2	45.00	70.00	30	28	23.00	55.00	20	54	42.00	10.00	40	80	85.00	25.00	10
3	42.00	66.00	10	29	20.00	50.00	10	55	42.00	15.00	10	81	85.00	35.00	30
4	42.00	68.00	10	30	20.00	55.00	10	56	40.00	5.00	30	82	75.00	55.00	20
5	42.00	65.00	10	31	10.00	35.00	20	57	40.00	15.00	40	83	72.00	55.00	10
6	40.00	69.00	20	32	10.00	40.00	30	58	38.00	5.00	30	84	70.00	58.00	20
7	40.00	66.00	20	33	8.00	40.00	40	59	38.00	15.00	10	85	68.00	60.00	30
8	38.00	68.00	20	34	8.00	45.00	20	60	35.00	5.00	20	86	66.00	55.00	10
9	38.00	70.00	10	35	5.00	35.00	10	61	50.00	30.00	10	87	65.00	55.00	20
10	35.00	66.00	10	36	5.00	45.00	10	62	50.00	35.00	20	88	65.00	60.00	30
11	35.00	69.00	10	37	2.00	40.00	20	63	50.00	40.00	50	89	63.00	58.00	10
12	25.00	85.00	20	38	0.00	40.00	30	64	48.00	30.00	10	90	60.00	55.00	10
13	22.00	75.00	30	39	0.00	45.00	20	65	48.00	40.00	10	91	60.00	60.00	10
14	22.00	85.00	10	40	35.00	30.00	10	66	47.00	35.00	10	92	67.00	85.00	20
15	20.00	80.00	40	41	35.00	32.00	10	67	47.00	40.00	10	93	65.00	85.00	40
16	20.00	85.00	40	42	33.00	32.00	20	68	45.00	30.00	10	94	65.00	82.00	10
17	18.00	75.00	20	43	33.00	35.00	10	69	45.00	35.00	10	95	62.00	80.00	30
18	15.00	75.00	20	44	32.00	30.00	10	70	95.00	30.00	30	96	60.00	80.00	10
19	15.00	80.00	10	45	30.00	30.00	10	71	95.00	35.00	20	97	60.00	85.00	30
20	30.00	50.00	10	46	30.00	32.00	30	72	53.00	30.00	10	98	58.00	75.00	20
21	30.00	52.00	20	47	30.00	35.00	10	73	92.00	30.00	10	99	55.00	80.00	10
22	28.00	52.00	20	48	28.00	30.00	10	74	53.00	35.00	50	100	55.00	85.00	20
23	28.00	55.00	10	49	28.00	35.00	10	75	45.00	65.00	20				
24	25.00	50.00	10	50	26.00	32.00	10	76	90.00	35.00	10				
25	25.00	52.00	40	51	25.00	30.00	10	77	88.00	30.00	10				

Table A.11: Node locations and demands for S51D2–S51D6.

No.	x	y	D_2	D_3	D_4	D_5	D_6	No.	x	y	D_2	D_3	D_4	D_5	D_6
0	30.00	40.00	0	0	0	0	0	26	27.00	68.00	18	52	124	51	139
1	37.00	52.00	33	20	43	59	118	27	30.00	48.00	24	21	58	52	122
2	49.00	49.00	23	27	43	69	118	28	43.00	67.00	23	78	127	108	139
3	52.00	64.00	46	30	25	56	114	29	58.00	48.00	33	25	118	60	137
4	20.00	26.00	28	71	143	108	143	30	58.00	27.00	18	26	108	70	135
5	40.00	30.00	21	20	35	49	116	31	37.00	69.00	37	32	70	52	125
6	21.00	47.00	21	31	89	94	130	32	38.00	46.00	23	79	142	111	143
7	17.00	63.00	47	31	27	54	114	33	46.00	10.00	19	28	136	56	142
8	31.00	62.00	22	51	131	96	140	34	61.00	33.00	18	33	92	91	131
9	52.00	33.00	24	20	23	53	113	35	62.00	63.00	45	43	84	54	129
10	51.00	21.00	20	56	122	109	138	36	63.00	69.00	22	76	141	100	143
11	42.00	41.00	46	31	30	53	115	37	32.00	22.00	25	32	143	49	143
12	31.00	32.00	17	25	94	78	131	38	45.00	35.00	18	57	77	104	127
13	5.00	25.00	37	20	25	59	114	39	59.00	15.00	47	56	100	55	133
14	12.00	42.00	19	74	139	111	142	40	5.00	6.00	20	69	127	79	139
15	36.00	16.00	41	29	34	52	116	41	10.00	17.00	36	37	136	55	142
16	52.00	41.00	18	32	42	53	118	42	21.00	10.00	18	72	63	111	123
17	27.00	23.00	45	20	45	62	119	43	5.00	64.00	43	68	117	58	137
18	17.00	33.00	18	79	143	99	143	44	30.00	15.00	17	61	106	51	134
19	13.00	13.00	32	25	40	52	118	45	39.00	10.00	43	43	112	66	136
20	57.00	58.00	21	54	45	69	119	46	32.00	39.00	19	79	52	111	121
21	62.00	42.00	47	21	69	64	125	47	25.00	32.00	33	76	131	61	140
22	42.00	57.00	18	72	137	78	142	48	25.00	55.00	19	53	81	71	128
23	16.00	57.00	20	18	48	52	120	49	48.00	28.00	47	51	70	78	125
24	8.00	52.00	23	70	93	93	131	50	56.00	37.00	20	78	43	106	118
25	7.00	38.00	43	23	94	63	131								

Note: demands are denoted by D_2 for S51D2, D_3 for S51D3, and so on.

Table A.12: Node locations and demands for S76D2–S76D4.

No.	x	y	D_2	D_3	D_4	No.	x	y	D_2	D_3	D_4
0	40.00	40.00	0	0	0	38	47.00	66.00	47	72	25
1	22.00	22.00	44	27	86	39	30.00	60.00	31	23	143
2	36.00	26.00	22	37	46	40	30.00	50.00	37	47	33
3	21.00	45.00	22	24	139	41	12.00	17.00	43	23	96
4	45.00	35.00	18	76	65	42	15.00	14.00	46	79	27
5	55.00	20.00	47	17	36	43	16.00	19.00	27	26	126
6	33.00	34.00	20	62	39	44	21.00	48.00	41	19	20
7	50.00	50.00	34	22	143	45	50.00	30.00	38	34	126
8	55.00	45.00	18	64	41	46	51.00	42.00	40	79	31
9	26.00	59.00	44	21	51	47	50.00	15.00	25	29	86
10	40.00	66.00	17	77	33	48	48.00	21.00	44	39	28
11	55.00	65.00	42	21	138	49	12.00	38.00	32	46	141
12	35.00	51.00	19	46	22	50	15.00	56.00	29	74	35
13	62.00	35.00	35	27	102	51	29.00	39.00	23	33	32
14	62.00	57.00	18	79	29	52	54.00	38.00	47	61	49
15	62.00	24.00	46	20	118	53	55.00	57.00	26	59	143
16	21.00	36.00	20	21	25	54	67.00	41.00	16	67	41
17	33.00	44.00	22	30	135	55	10.00	70.00	21	38	55
18	9.00	56.00	23	67	26	56	6.00	25.00	47	75	73
19	62.00	48.00	47	20	82	57	65.00	27.00	20	70	135
20	66.00	14.00	22	37	37	58	40.00	60.00	29	59	49
21	44.00	13.00	23	32	143	59	70.00	64.00	20	45	101
22	26.00	13.00	29	46	25	60	64.00	4.00	45	79	98
23	11.00	28.00	46	20	35	61	36.00	6.00	16	78	121
24	7.00	43.00	24	61	44	62	30.00	20.00	40	51	60
25	17.00	64.00	35	31	124	63	20.00	30.00	19	52	131
26	41.00	46.00	35	19	24	64	15.00	5.00	38	77	121
27	55.00	34.00	43	20	50	65	50.00	70.00	19	79	105
28	35.00	16.00	26	76	47	66	57.00	72.00	47	44	72
29	52.00	26.00	43	28	84	67	45.00	42.00	18	61	143
30	43.00	26.00	41	38	24	68	38.00	33.00	28	68	138
31	31.00	76.00	39	20	100	69	50.00	4.00	22	73	89
32	22.00	53.00	29	79	47	70	66.00	8.00	46	37	87
33	26.00	29.00	47	24	31	71	59.00	5.00	18	69	139
34	50.00	40.00	46	59	24	72	35.00	60.00	16	57	143
35	55.00	50.00	35	22	133	73	27.00	24.00	23	58	74
36	54.00	10.00	33	68	42	74	40.00	20.00	40	32	103
37	60.00	15.00	47	17	52	75	40.00	37.00	18	75	124

Note: demands are denoted by D_2 for S76D2, D_3 for S76D3, and D_4 for S76D4.

Table A.13: Node locations and demands for S101D2, S101D3, and S101D5.

No.	x	y	D_2	D_3	D_5	No.	x	y	D_2	D_3	D_5
0	35.00	35.00	0	0	0	35	63.00	65.00	41	29	75
1	41.00	49.00	38	21	52	36	2.00	60.00	39	79	108
2	35.00	17.00	18	33	59	37	20.00	20.00	40	33	64
3	55.00	45.00	31	79	62	38	5.00	5.00	28	22	89
4	55.00	20.00	24	29	103	39	60.00	12.00	46	25	88
5	15.00	30.00	26	37	52	40	40.00	25.00	44	78	101
6	25.00	30.00	18	45	63	41	42.00	7.00	36	22	69
7	20.00	50.00	41	75	63	42	24.00	12.00	31	49	104
8	10.00	43.00	23	33	83	43	23.00	3.00	47	23	100
9	55.00	60.00	18	60	52	44	11.00	14.00	47	71	93
10	30.00	60.00	18	58	88	45	6.00	38.00	32	17	75
11	20.00	65.00	47	68	63	46	2.00	48.00	35	70	111
12	50.00	35.00	21	38	57	47	8.00	56.00	45	21	108
13	30.00	25.00	30	74	52	48	13.00	52.00	47	57	85
14	15.00	10.00	18	69	106	49	6.00	68.00	28	24	83
15	30.00	5.00	46	60	61	50	47.00	47.00	39	79	110
16	10.00	20.00	18	44	64	51	49.00	58.00	40	20	111
17	5.00	30.00	40	79	52	52	27.00	43.00	42	35	77
18	20.00	40.00	19	77	111	53	37.00	31.00	26	29	91
19	15.00	60.00	39	52	57	54	57.00	29.00	43	75	102
20	45.00	65.00	16	52	86	55	63.00	23.00	34	20	107
21	45.00	20.00	45	77	53	56	53.00	12.00	33	22	71
22	45.00	10.00	20	79	104	57	32.00	12.00	23	31	99
23	55.00	5.00	27	44	50	58	36.00	26.00	46	59	91
24	65.00	35.00	21	60	102	59	21.00	24.00	28	20	94
25	65.00	20.00	47	69	55	60	17.00	34.00	20	48	65
26	45.00	30.00	21	74	84	61	12.00	24.00	21	31	106
27	35.00	40.00	18	38	53	62	24.00	58.00	47	34	79
28	41.00	37.00	27	68	110	63	27.00	69.00	22	20	72
29	64.00	42.00	47	58	57	64	15.00	77.00	25	69	61
30	40.00	60.00	23	59	58	65	62.00	77.00	20	30	111
31	31.00	52.00	31	33	64	66	49.00	73.00	46	24	67
32	35.00	69.00	33	75	111	67	67.00	5.00	17	20	50
33	53.00	52.00	44	45	60	68	56.00	39.00	37	79	58
34	65.00	55.00	25	36	65	69	37.00	47.00	19	26	111

(cont.)

Table A.13 continued.

No.	x	y	D_2	D_3	D_5	No.	x	y	D_2	D_3	D_5
70	37.00	56.00	41	48	56	86	4.00	18.00	37	77	63
71	57.00	68.00	18	21	77	87	28.00	18.00	23	31	94
72	47.00	16.00	45	76	55	88	26.00	52.00	19	50	52
73	44.00	17.00	18	21	105	89	26.00	35.00	18	52	77
74	46.00	13.00	32	66	48	90	31.00	67.00	45	71	64
75	49.00	11.00	21	22	99	91	15.00	19.00	22	35	70
76	49.00	42.00	47	60	54	92	22.00	22.00	25	68	52
77	53.00	43.00	18	18	91	93	18.00	24.00	18	64	98
78	61.00	52.00	20	76	55	94	26.00	27.00	47	64	62
79	57.00	48.00	23	24	111	95	25.00	24.00	20	41	52
80	56.00	37.00	43	35	53	96	22.00	27.00	36	78	52
81	55.00	54.00	18	28	71	97	25.00	21.00	18	74	110
82	15.00	47.00	24	79	60	98	19.00	21.00	43	55	59
83	14.00	37.00	23	27	109	99	20.00	26.00	17	48	77
84	11.00	31.00	32	24	52	100	18.00	18.00	43	79	53
85	16.00	22.00	18	40	50						

Note: demands are denoted by D_2 for S101D2, D_3 for S101D3, and D_5 for S101D5.

Table A.14: Node locations and demands for SD1 and MDA1.

No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$	No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$
0	0.00	0.00	0	0	0	0	0	5	20.00	0.00	60	94	87	78	66
1	10.00	0.00	60	56	63	72	84	6	0.00	20.00	90	94	87	78	66
2	0.00	10.00	90	56	63	72	84	7	-20.00	0.00	60	94	87	78	66
3	-10.00	0.00	60	56	63	72	84	8	0.00	-20.00	90	94	87	78	66
4	0.00	-10.00	90	56	63	72	84								

Note: demands are denoted by D for SD1 and D_p for MDA1 with p = .1, .2, .3, .4.

Table A.15: Node locations and demands for SD2 and MDA2.

No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$	No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$
0	0.00	0.00	0	0	0	0	0	9	30.00	0.00	60	56	63	72	84
1	10.00	0.00	60	56	63	72	84	10	0.00	30.00	90	56	63	72	84
2	0.00	10.00	90	56	63	72	84	11	-30.00	0.00	60	56	63	72	84
3	-10.00	0.00	60	56	63	72	84	12	0.00	-30.00	90	56	63	72	84
4	0.00	-10.00	90	56	63	72	84	13	40.00	0.00	60	94	87	78	66
5	20.00	0.00	60	94	87	78	66	14	0.00	40.00	90	94	87	78	66
6	0.00	20.00	90	94	87	78	66	15	-40.00	0.00	60	94	87	78	66
7	-20.00	0.00	60	94	87	78	66	16	-0.01	-40.00	90	94	87	78	66
8	0.00	-20.00	90	94	87	78	66								

Note: demands are denoted by D for SD2 and D_p for MDA2 with $p = .1, .2, .3, .4$.

Table A.16: Node locations and demands for SD3 and MDA3.

No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$	No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$
0	0.00	0.00	0	0	0	0	0	9	20.00	0.00	60	94	87	78	66
1	10.00	0.00	60	56	63	72	84	10	14.14	14.14	90	94	87	78	66
2	7.07	7.07	90	56	63	72	84	11	0.00	20.00	60	94	87	78	66
3	0.00	10.00	60	56	63	72	84	12	-14.14	14.14	90	94	87	78	66
4	-7.07	7.07	90	56	63	72	84	13	-20.00	0.00	60	94	87	78	66
5	-10.00	0.00	60	56	63	72	84	14	-14.14	-14.14	90	94	87	78	66
6	-7.07	-7.07	90	56	63	72	84	15	0.00	-20.00	60	94	87	78	66
7	0.00	-10.00	60	56	63	72	84	16	14.14	-14.14	90	94	87	78	66
8	7.07	-7.07	90	56	63	72	84								

Note: demands are denoted by D for SD3 and D_p for MDA3 with $p = .1, .2, .3, .4$.

Table A.17: Node locations and demands for SD4 and MDA4.

No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$	No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$
0	0.00	0.00	0	0	0	0	0	13	20.00	0.00	60	94	87	78	66
1	10.00	0.00	60	56	63	72	84	14	17.32	10.00	90	94	87	78	66
2	8.66	5.00	90	56	63	72	84	15	10.00	17.32	60	94	87	78	66
3	5.00	8.66	60	56	63	72	84	16	0.00	20.00	90	94	87	78	66
4	0.00	10.00	90	56	63	72	84	17	-10.00	17.32	60	94	87	78	66
5	-5.00	8.66	60	56	63	72	84	18	-17.32	10.00	90	94	87	78	66
6	-8.66	5.00	90	56	63	72	84	19	-20.00	0.00	60	94	87	78	66
7	-10.00	0.00	60	56	63	72	84	20	-17.32	-10.00	90	94	87	78	66
8	-8.66	-5.00	90	56	63	72	84	21	-10.00	-17.32	60	94	87	78	66
9	-5.00	-8.66	60	56	63	72	84	22	0.00	-20.00	90	94	87	78	66
10	0.00	-10.00	90	56	63	72	84	23	10.00	-17.32	60	94	87	78	66
11	5.00	-8.66	60	56	63	72	84	24	17.32	-10.00	90	94	87	78	66
12	8.66	-5.00	90	56	63	72	84								

Note: demands are denoted by D for SD4 and D_p for MDA4 with $p = .1, .2, .3, .4$.

Table A.18: Node locations and demands for SD5 and MDA5.

No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$	No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$
0	0.00	0.00	0	0	0	0	0	17	30.00	0.00	60	56	63	72	84
1	10.00	0.00	60	56	63	72	84	18	21.21	21.21	90	56	63	72	84
2	7.07	7.07	90	56	63	72	84	19	0.00	30.00	60	56	63	72	84
3	0.00	10.00	60	56	63	72	84	20	-21.21	21.21	90	56	63	72	84
4	-7.07	7.07	90	56	63	72	84	21	-30.00	0.00	60	56	63	72	84
5	-10.00	0.00	60	56	63	72	84	22	-21.22	-21.21	90	56	63	72	84
6	-7.07	-7.07	90	56	63	72	84	23	0.00	-30.00	60	56	63	72	84
7	0.00	-10.00	60	56	63	72	84	24	21.21	-21.22	90	56	63	72	84
8	7.07	-7.07	90	56	63	72	84	25	40.00	0.00	60	94	87	78	66
9	20.00	0.00	60	94	87	78	66	26	28.28	28.28	90	94	87	78	66
10	14.14	14.14	90	94	87	78	66	27	0.00	40.00	60	94	87	78	66
11	0.00	20.00	60	94	87	78	66	28	-28.28	28.29	90	94	87	78	66
12	-14.14	14.14	90	94	87	78	66	29	-40.00	0.00	60	94	87	78	66
13	-20.00	0.00	60	94	87	78	66	30	-28.29	-28.28	90	94	87	78	66
14	-14.14	-14.14	90	94	87	78	66	31	-0.01	-40.00	60	94	87	78	66
15	0.00	-20.00	60	94	87	78	66	32	28.28	-28.29	90	94	87	78	66
16	14.14	-14.14	90	94	87	78	66								

Note: demands are denoted by D for SD5 and D_p for MDA5 with $p = .1, .2, .3, .4$.

Table A.19: Node locations and demands for SD6 and MDA6.

No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$	No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$
0	0.00	0.00	0	0	0	0	0	17	20.00	0.00	60	94	94	78	66
1	10.00	0.00	60	56	63	72	84	18	18.48	7.65	90	94	94	78	66
2	9.24	3.83	90	56	63	72	84	19	14.14	14.14	60	94	94	78	66
3	7.07	7.07	60	56	63	72	84	20	7.65	18.48	90	94	94	78	66
4	3.83	9.24	90	56	63	72	84	21	0.00	20.00	60	94	94	78	66
5	0.00	10.00	60	56	63	72	84	22	-7.65	18.48	90	94	94	78	66
6	-3.83	9.24	90	56	63	72	84	23	-14.14	14.14	60	94	94	78	66
7	-7.07	7.07	60	56	63	72	84	24	-18.48	7.66	90	94	94	78	66
8	-9.24	3.83	90	56	63	72	84	25	-20.00	0.00	60	94	94	78	66
9	-10.00	0.00	60	56	63	72	84	26	-18.48	-7.65	90	94	94	78	66
10	-9.24	-3.83	90	56	63	72	84	27	-14.14	-14.14	60	94	94	78	66
11	-7.07	-7.07	60	56	63	72	84	28	-7.66	-18.48	90	94	94	78	66
12	-3.83	-9.24	90	56	63	72	84	29	0.00	-20.00	60	94	94	78	66
13	0.00	-10.00	60	56	63	72	84	30	7.65	-18.48	90	94	94	78	66
14	3.83	-9.24	90	56	63	72	84	31	14.14	-14.14	60	94	94	78	66
15	7.07	-7.07	60	56	63	72	84	32	18.48	-7.66	90	94	94	78	66
16	9.24	-3.83	90	56	63	72	84								

Note: demands are denoted by D for SD6 and D_p for MDA6 with $p = .1, .2, .3, .4$.

Table A.20: Node locations and demands for SD7 and MDA7.

No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$	No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$
0	0.00	0.00	0	0	0	0	0	21	60.00	0.00	60	94	87	78	66
1	10.00	0.00	60	56	63	72	84	22	0.00	60.00	90	94	87	78	66
2	0.00	10.00	90	56	63	72	84	23	-60.00	0.01	60	94	87	78	66
3	-10.00	0.00	60	56	63	72	84	24	-0.01	-60.00	90	94	87	78	66
4	0.00	-10.00	90	56	63	72	84	25	70.00	0.00	60	56	63	72	84
5	20.00	0.00	60	94	87	78	66	26	0.00	70.00	90	56	63	72	84
6	0.00	20.00	90	94	87	78	66	27	-70.00	0.01	60	56	63	72	84
7	-20.00	0.00	60	94	87	78	66	28	-0.01	-70.00	90	56	63	72	84
8	0.00	-20.00	90	94	87	78	66	29	80.00	0.00	60	94	87	78	66
9	30.00	0.00	60	56	63	72	84	30	0.00	80.00	90	94	87	78	66
10	0.00	30.00	90	56	63	72	84	31	-80.00	0.01	60	94	87	78	66
11	-30.00	0.00	60	56	63	72	84	32	-0.01	-80.00	90	94	87	78	66
12	0.00	-30.00	90	56	63	72	84	33	90.00	0.00	60	56	63	72	84
13	40.00	0.00	60	94	87	78	66	34	0.00	90.00	90	56	63	72	84
14	0.00	40.00	90	94	87	78	66	35	-90.00	0.01	60	56	63	72	84
15	-40.00	0.00	60	94	87	78	66	36	-0.01	-90.00	90	56	63	72	84
16	-0.01	-40.00	90	94	87	78	66	37	100.00	0.00	60	94	87	78	66
17	50.00	0.00	60	56	63	72	84	38	0.00	100.00	90	94	87	78	66
18	0.00	50.00	90	56	63	72	84	39	-100.00	0.01	60	94	87	78	66
19	-50.00	0.00	60	56	63	72	84	40	-0.01	-100.00	90	94	87	78	66
20	-0.01	-50.00	90	56	63	72	84								

Note: demands are denoted by D for SD7 and D_p for MDA7 with $p = .1, .2, .3, .4$.

Table A.21: Node locations and demands for SD8 and MDA8.

No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$	No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$
0	0.00	0.00	0	0	0	0	0	25	70.00	0.00	60	56	63	72	84
1	10.00	0.00	60	56	63	72	84	26	0.00	70.00	90	56	63	72	84
2	0.00	10.00	90	56	63	72	84	27	-70.00	0.01	60	56	63	72	84
3	-10.00	0.00	60	56	63	72	84	28	-0.01	-70.00	90	56	63	72	84
4	0.00	-10.00	90	56	63	72	84	29	80.00	0.00	60	94	87	78	66
5	20.00	0.00	60	94	87	78	66	30	0.00	80.00	90	94	87	78	66
6	0.00	20.00	90	94	87	78	66	31	-80.00	0.01	60	94	87	78	66
7	-20.00	0.00	60	94	87	78	66	32	-0.01	-80.00	90	94	87	78	66
8	0.00	-20.00	90	94	87	78	66	33	90.00	0.00	60	56	63	72	84
9	30.00	0.00	60	56	63	72	84	34	0.00	90.00	90	56	63	72	84
10	0.00	30.00	90	56	63	72	84	35	-90.00	0.01	60	56	63	72	84
11	-30.00	0.00	60	56	63	72	84	36	-0.01	-90.00	90	56	63	72	84
12	0.00	-30.00	90	56	63	72	84	37	100.00	0.00	60	94	87	78	66
13	40.00	0.00	60	94	87	78	66	38	0.00	100.00	90	94	87	78	66
14	0.00	40.00	90	94	87	78	66	39	-100.00	0.01	60	94	87	78	66
15	-40.00	0.00	60	94	87	78	66	40	-0.01	-100.00	90	94	87	78	66
16	-0.01	-40.00	90	94	87	78	66	41	110.00	0.00	60	56	63	72	84
17	50.00	0.00	60	56	63	72	84	42	0.01	110.00	90	56	63	72	84
18	0.00	50.00	90	56	63	72	84	43	-110.00	0.01	60	56	63	72	84
19	-50.00	0.00	60	56	63	72	84	44	-0.02	-110.00	90	56	63	72	84
20	-0.01	-50.00	90	56	63	72	84	45	120.00	0.00	60	94	87	78	66
21	60.00	0.00	60	94	87	78	66	46	0.01	120.00	90	94	87	78	66
22	0.00	60.00	90	94	87	78	66	47	-120.00	0.01	60	94	87	78	66
23	-60.00	0.01	60	94	87	78	66	48	-0.02	-120.00	90	94	87	78	66
24	-0.01	-60.00	90	94	87	78	66								

Note: demands are denoted by D for SD8 and D_p for MDA8 with $p = .1, .2, .3, .4$.

Table A.22: Node locations and demands for SD9 and MDA9.

No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$	No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$
0	0.00	0.00	0	0	0	0	0	25	30.00	0.00	60	56	63	72	84
1	10.00	0.00	60	56	63	72	84	26	25.98	15.00	90	56	63	72	84
2	8.66	5.00	90	56	63	72	84	27	15.00	25.98	60	56	63	72	84
3	5.00	8.66	60	56	63	72	84	28	0.00	30.00	90	56	63	72	84
4	0.00	10.00	90	56	63	72	84	29	-15.00	25.98	60	56	63	72	84
5	-5.00	8.66	60	56	63	72	84	30	-25.98	15.00	90	56	63	72	84
6	-8.66	5.00	90	56	63	72	84	31	-30.00	0.00	60	56	63	72	84
7	-10.00	0.00	60	56	63	72	84	32	-25.98	-15.00	90	56	63	72	84
8	-8.66	-5.00	90	56	63	72	84	33	-15.00	-25.98	60	56	63	72	84
9	-5.00	-8.66	60	56	63	72	84	34	0.00	-30.00	90	56	63	72	84
10	0.00	-10.00	90	56	63	72	84	35	15.00	-25.98	60	56	63	72	84
11	5.00	-8.66	60	56	63	72	84	36	25.98	-15.00	90	56	63	72	84
12	8.66	-5.00	90	56	63	72	84	37	40.00	0.00	60	94	87	78	66
13	20.00	0.00	60	94	87	78	66	38	34.64	20.00	90	94	87	78	66
14	17.32	10.00	90	94	87	78	66	39	20.00	34.64	60	94	87	78	66
15	10.00	17.32	60	94	87	78	66	40	0.00	40.00	90	94	87	78	66
16	0.00	20.00	90	94	87	78	66	41	-20.00	34.64	60	94	87	78	66
17	-10.00	17.32	60	94	87	78	66	42	-34.64	20.00	90	94	87	78	66
18	-17.32	10.00	90	94	87	78	66	43	-40.00	0.00	60	94	87	78	66
19	-20.00	0.00	60	94	87	78	66	44	-34.64	-20.00	90	94	87	78	66
20	-17.32	-10.00	90	94	87	78	66	45	-20.00	-34.64	60	94	87	78	66
21	-10.00	-17.32	60	94	87	78	66	46	-0.01	-40.00	90	94	87	78	66
22	0.00	-20.00	90	94	87	78	66	47	19.99	-34.64	60	94	87	78	66
23	10.00	-17.32	60	94	87	78	66	48	34.64	-20.01	90	94	87	78	66
24	17.32	-10.00	90	94	87	78	66								

Note: demands are denoted by D for SD9 and D_p for MDA9 with $p = .1, .2, .3, .4$.

Table A.23: Node locations and demands for SD10 and MDA10.

No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$	No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$
0	0.00	0.00	0	0	0	0	0	33	30.00	0.00	60	56	63	72	84
1	10.00	0.00	60	56	63	72	84	34	27.72	11.48	90	56	63	72	84
2	9.24	3.83	90	56	63	72	84	35	21.21	21.21	60	56	63	72	84
3	7.07	7.07	60	56	63	72	84	36	11.48	27.72	90	56	63	72	84
4	3.83	9.24	90	56	63	72	84	37	0.00	30.00	60	56	63	72	84
5	0.00	10.00	60	56	63	72	84	38	-11.48	27.72	90	56	63	72	84
6	-3.83	9.24	90	56	63	72	84	39	-21.21	21.21	60	56	63	72	84
7	-7.07	7.07	60	56	63	72	84	40	-27.72	11.48	90	56	63	72	84
8	-9.24	3.83	90	56	63	72	84	41	-30.00	0.00	60	56	63	72	84
9	-10.00	0.00	60	56	63	72	84	42	-27.72	-11.48	90	56	63	72	84
10	-9.24	-3.83	90	56	63	72	84	43	-21.22	-21.21	60	56	63	72	84
11	-7.07	-7.07	60	56	63	72	84	44	-11.48	-27.71	90	56	63	72	84
12	-3.83	-9.24	90	56	63	72	84	45	0.00	-30.00	60	56	63	72	84
13	0.00	-10.00	60	56	63	72	84	46	11.48	-27.72	90	56	63	72	84
14	3.83	-9.24	90	56	63	72	84	47	21.21	-21.22	60	56	63	72	84
15	7.07	-7.07	60	56	63	72	84	48	27.71	-11.49	90	56	63	72	84
16	9.24	-3.83	90	56	63	72	84	49	40.00	0.00	60	94	87	78	66
17	20.00	0.00	60	94	87	78	66	50	36.96	15.31	90	94	87	78	66
18	18.48	7.65	90	94	87	78	66	51	28.28	28.28	60	94	87	78	66
19	14.14	14.14	60	94	87	78	66	52	15.31	36.95	90	94	87	78	66
20	7.65	18.48	90	94	87	78	66	53	0.00	40.00	60	94	87	78	66
21	0.00	20.00	60	94	87	78	66	54	-15.31	36.96	90	94	87	78	66
22	-7.65	18.48	90	94	87	78	66	55	-28.28	28.29	60	94	87	78	66
23	-14.14	14.14	60	94	87	78	66	56	-36.95	15.31	90	94	87	78	66
24	-18.48	7.66	90	94	87	78	66	57	-40.00	0.00	60	94	87	78	66
25	-20.00	0.00	60	94	87	78	66	58	-36.96	-15.30	90	94	87	78	66
26	-18.48	-7.65	90	94	87	78	66	59	-28.29	-28.28	60	94	87	78	66
27	-14.14	-14.14	60	94	87	78	66	60	-15.31	-36.95	90	94	87	78	66
28	-7.66	-18.48	90	94	87	78	66	61	-0.01	-40.00	60	94	87	78	66
29	0.00	-20.00	60	94	87	78	66	62	15.30	-36.96	90	94	87	78	66
30	7.65	-18.48	90	94	87	78	66	63	28.28	-28.29	60	94	87	78	66
31	14.14	-14.14	60	94	87	78	66	64	36.95	-15.31	90	94	87	78	66
32	18.48	-7.66	90	94	87	78	66								

Note: demands are denoted by D for SD10 and D_p for MDA10 with $p = .1, .2, .3, .4$.

Table A.24: Node locations and demands for SD11 and MDA11.

No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$	No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$
0	0.00	0.00	0	0	0	0	0	35	-90.00	0.01	60	56	63	72	84
1	10.00	0.00	60	56	63	72	84	36	-0.01	-90.00	90	56	63	72	84
2	0.00	10.00	90	56	63	72	84	37	100.00	0.00	60	94	87	78	66
3	-10.00	0.00	60	56	63	72	84	38	0.00	100.00	90	94	87	78	66
4	0.00	-10.00	90	56	63	72	84	39	-100.00	0.01	60	94	87	78	66
5	20.00	0.00	60	94	87	78	66	40	-0.01	-100.00	90	94	87	78	66
6	0.00	20.00	90	94	87	78	66	41	110.00	0.00	60	56	63	72	84
7	-20.00	0.00	60	94	87	78	66	42	0.01	110.00	90	56	63	72	84
8	0.00	-20.00	90	94	87	78	66	43	-110.00	0.01	60	56	63	72	84
9	30.00	0.00	60	56	63	72	84	44	-0.02	-110.00	90	56	63	72	84
10	0.00	30.00	90	56	63	72	84	45	120.00	0.00	60	94	87	78	66
11	-30.00	0.00	60	56	63	72	84	46	0.01	120.00	90	94	87	78	66
12	0.00	-30.00	90	56	63	72	84	47	-120.00	0.01	60	94	87	78	66
13	40.00	0.00	60	94	87	78	66	48	-0.02	-120.00	90	94	87	78	66
14	0.00	40.00	90	94	87	78	66	49	130.00	0.00	60	56	63	72	84
15	-40.00	0.00	60	94	87	78	66	50	0.01	130.00	90	56	63	72	84
16	-0.01	-40.00	90	94	87	78	66	51	-130.00	0.01	60	56	63	72	84
17	50.00	0.00	60	56	63	72	84	52	-0.02	-130.00	90	56	63	72	84
18	0.00	50.00	90	56	63	72	84	53	140.00	0.00	60	94	87	78	66
19	-50.00	0.00	60	56	63	72	84	54	0.01	140.00	90	94	87	78	66
20	-0.01	-50.00	90	56	63	72	84	55	-140.00	0.01	60	94	87	78	66
21	60.00	0.00	60	94	87	78	66	56	-0.02	-140.00	90	94	87	78	66
22	0.00	60.00	90	94	87	78	66	57	150.00	0.00	60	56	63	72	84
23	-60.00	0.01	60	94	87	78	66	58	0.01	150.00	90	56	63	72	84
24	-0.01	-60.00	90	94	87	78	66	59	-150.00	0.01	60	56	63	72	84
25	70.00	0.00	60	56	63	72	84	60	-0.02	-150.00	90	56	63	72	84
26	0.00	70.00	90	56	63	72	84	61	160.00	0.00	60	94	87	78	66
27	-70.00	0.01	60	56	63	72	84	62	0.01	160.00	90	94	87	78	66
28	-0.01	-70.00	90	56	63	72	84	63	-160.00	0.01	60	94	87	78	66
29	80.00	0.00	60	94	87	78	66	64	-0.02	-160.00	90	94	87	78	66
30	0.00	80.00	90	94	87	78	66	65	170.00	0.00	60	56	63	72	84
31	-80.00	0.01	60	94	87	78	66	66	0.01	170.00	90	56	63	72	84
32	-0.01	-80.00	90	94	87	78	66	67	-170.00	0.02	60	56	63	72	84
33	90.00	0.00	60	56	63	72	84	68	-0.02	-170.00	90	56	63	72	84
34	0.00	90.00	90	56	63	72	84	69	180.00	0.00	60	94	87	78	66

(cont.)

Table A.24 continued.

No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$	No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$
70	0.01	180.00	90	94	87	78	66	76	-0.03	-190.00	90	56	63	72	84
71	-180.00	0.02	60	94	87	78	66	77	200.00	0.00	60	94	87	78	66
72	-0.03	-180.00	90	94	87	78	66	78	0.01	200.00	90	94	87	78	66
73	190.00	0.00	60	56	63	72	84	79	-200.00	0.02	60	94	87	78	66
74	0.01	190.00	90	56	63	72	84	80	-0.03	-200.00	90	94	87	78	66
75	-190.00	0.02	60	56	63	72	84								

Note: demands are denoted by D for SD11 and D_p for MDA11 with $p = .1, .2, .3, .4$.

Table A.25: Node locations and demands for SD12 and MDA12.

No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$	No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$
0	0.00	0.00	0	0	0	0	0	35	0.00	50.00	60	56	63	72	84
1	10.00	0.00	60	56	63	72	84	36	-35.35	35.36	90	56	63	72	84
2	7.07	7.07	90	56	63	72	84	37	-50.00	0.00	60	56	63	72	84
3	0.00	10.00	60	56	63	72	84	38	-35.36	-35.35	90	56	63	72	84
4	-7.07	7.07	90	56	63	72	84	39	-0.01	-50.00	60	56	63	72	84
5	-10.00	0.00	60	56	63	72	84	40	35.35	-35.36	90	56	63	72	84
6	-7.07	-7.07	90	56	63	72	84	41	60.00	0.00	60	94	87	78	66
7	0.00	-10.00	60	56	63	72	84	42	42.43	42.43	90	94	87	78	66
8	7.07	-7.07	90	56	63	72	84	43	0.00	60.00	60	94	87	78	66
9	20.00	0.00	60	94	87	78	66	44	-42.42	42.43	90	94	87	78	66
10	14.14	14.14	90	94	87	78	66	45	-60.00	0.01	60	94	87	78	66
11	0.00	20.00	60	94	87	78	66	46	-42.43	-42.42	90	94	87	78	66
12	-14.14	14.14	90	94	87	78	66	47	-0.01	-60.00	60	94	87	78	66
13	-20.00	0.00	60	94	87	78	66	48	42.42	-42.43	90	94	87	78	66
14	-14.14	-14.14	90	94	87	78	66	49	70.00	0.00	60	56	63	72	84
15	0.00	-20.00	60	94	87	78	66	50	49.50	49.50	90	56	63	72	84
16	14.14	-14.14	90	94	87	78	66	51	0.00	70.00	60	56	63	72	84
17	30.00	0.00	60	56	63	72	84	52	-49.49	49.50	90	56	63	72	84
18	21.21	21.21	90	56	63	72	84	53	-70.00	0.01	60	56	63	72	84
19	0.00	30.00	60	56	63	72	84	54	-49.50	-49.49	90	56	63	72	84
20	-21.21	21.21	90	56	63	72	84	55	-0.01	-70.00	60	56	63	72	84
21	-30.00	0.00	60	56	63	72	84	56	49.49	-49.51	90	56	63	72	84
22	-21.22	-21.21	90	56	63	72	84	57	80.00	0.00	60	94	87	78	66
23	0.00	-30.00	60	56	63	72	84	58	56.57	56.57	90	94	87	78	66
24	21.21	-21.22	90	56	63	72	84	59	0.00	80.00	60	94	87	78	66
25	40.00	0.00	60	94	87	78	66	60	-56.56	56.57	90	94	87	78	66
26	28.28	28.28	90	94	87	78	66	61	-80.00	0.01	60	94	87	78	66
27	0.00	40.00	60	94	87	78	66	62	-56.58	-56.56	90	94	87	78	66
28	-28.28	28.29	90	94	87	78	66	63	-0.01	-80.00	60	94	87	78	66
29	-40.00	0.00	60	94	87	78	66	64	56.56	-56.58	90	94	87	78	66
30	-28.29	-28.28	90	94	87	78	66	65	90.00	0.00	60	56	63	72	84
31	-0.01	-40.00	60	94	87	78	66	66	63.64	63.64	90	56	63	72	84
32	28.28	-28.29	90	94	87	78	66	67	0.00	90.00	60	56	63	72	84
33	50.00	0.00	60	56	63	72	84	68	-63.64	63.64	90	56	63	72	84
34	35.36	35.35	90	56	63	72	84	69	-90.00	0.01	60	56	63	72	84

(cont.)

Table A.25 continued.

No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$	No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$
70	-63.65	-63.63	90	56	63	72	84	76	-70.71	70.72	90	94	87	78	66
71	-0.01	-90.00	60	56	63	72	84	77	-100.00	0.01	60	94	87	78	66
72	63.63	-63.65	90	56	63	72	84	78	-70.72	-70.70	90	94	87	78	66
73	100.00	0.00	60	94	87	78	66	79	-0.01	-100.00	60	94	87	78	66
74	70.71	70.71	90	94	87	78	66	80	70.70	-70.72	90	94	87	78	66
75	0.00	100.00	60	94	87	78	66								

Note: demands are denoted by D for SD12 and D_p for MDA12 with $p = .1, .2, .3, .4$.

Table A.26: Node locations and demands for SD13 and MDA13.

No.	x	y	D	$D_{\cdot 1}$	$D_{\cdot 2}$	$D_{\cdot 3}$	$D_{\cdot 4}$	No.	x	y	D	$D_{\cdot 1}$	$D_{\cdot 2}$	$D_{\cdot 3}$	$D_{\cdot 4}$
0	0.00	0.00	0	0	0	0	0	35	0.00	50.00	60	56	63	72	84
1	10.00	0.00	60	56	63	72	84	36	-35.35	35.36	90	56	63	72	84
2	7.07	7.07	90	56	63	72	84	37	-50.00	0.00	60	56	63	72	84
3	0.00	10.00	60	56	63	72	84	38	-35.36	-35.35	90	56	63	72	84
4	-7.07	7.07	90	56	63	72	84	39	-0.01	-50.00	60	56	63	72	84
5	-10.00	0.00	60	56	63	72	84	40	35.35	-35.36	90	56	63	72	84
6	-7.07	-7.07	90	56	63	72	84	41	60.00	0.00	60	94	87	78	66
7	0.00	-10.00	60	56	63	72	84	42	42.43	42.43	90	94	87	78	66
8	7.07	-7.07	90	56	63	72	84	43	0.00	60.00	60	94	87	78	66
9	20.00	0.00	60	94	87	78	66	44	-42.42	42.43	90	94	87	78	66
10	14.14	14.14	90	94	87	78	66	45	-60.00	0.01	60	94	87	78	66
11	0.00	20.00	60	94	87	78	66	46	-42.43	-42.42	90	94	87	78	66
12	-14.14	14.14	90	94	87	78	66	47	-0.01	-60.00	60	94	87	78	66
13	-20.00	0.00	60	94	87	78	66	48	42.42	-42.43	90	94	87	78	66
14	-14.14	-14.14	90	94	87	78	66	49	70.00	0.00	60	56	63	72	84
15	0.00	-20.00	60	94	87	78	66	50	49.50	49.50	90	56	63	72	84
16	14.14	-14.14	90	94	87	78	66	51	0.00	70.00	60	56	63	72	84
17	30.00	0.00	60	56	63	72	84	52	-49.49	49.50	90	56	63	72	84
18	21.21	21.21	90	56	63	72	84	53	-70.00	0.01	60	56	63	72	84
19	0.00	30.00	60	56	63	72	84	54	-49.50	-49.49	90	56	63	72	84
20	-21.21	21.21	90	56	63	72	84	55	-0.01	-70.00	60	56	63	72	84
21	-30.00	0.00	60	56	63	72	84	56	49.49	-49.51	90	56	63	72	84
22	-21.22	-21.21	90	56	63	72	84	57	80.00	0.00	60	94	87	78	66
23	0.00	-30.00	60	56	63	72	84	58	56.57	56.57	90	94	87	78	66
24	21.21	-21.22	90	56	63	72	84	59	0.00	80.00	60	94	87	78	66
25	40.00	0.00	60	94	87	78	66	60	-56.56	56.57	90	94	87	78	66
26	28.28	28.28	90	94	87	78	66	61	-80.00	0.01	60	94	87	78	66
27	0.00	40.00	60	94	87	78	66	62	-56.58	-56.56	90	94	87	78	66
28	-28.28	28.29	90	94	87	78	66	63	-0.01	-80.00	60	94	87	78	66
29	-40.00	0.00	60	94	87	78	66	64	56.56	-56.58	90	94	87	78	66
30	-28.29	-28.28	90	94	87	78	66	65	90.00	0.00	60	56	63	72	84
31	-0.01	-40.00	60	94	87	78	66	66	63.64	63.64	90	56	63	72	84
32	28.28	-28.29	90	94	87	78	66	67	0.00	90.00	60	56	63	72	84
33	50.00	0.00	60	56	63	72	84	68	-63.64	63.64	90	56	63	72	84
34	35.36	35.35	90	56	63	72	84	69	-90.00	0.01	60	56	63	72	84

(cont.)

Table A.26 continued.

No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$	No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$
70	-63.65	-63.63	90	56	63	72	84	84	-77.78	77.79	90	56	63	72	84
71	-0.01	-90.00	60	56	63	72	84	85	-110.00	0.01	60	56	63	72	84
72	63.63	-63.65	90	56	63	72	84	86	-77.79	-77.77	90	56	63	72	84
73	100.00	0.00	60	94	87	78	66	87	-0.02	-110.00	60	56	63	72	84
74	70.71	70.71	90	94	87	78	66	88	77.77	-77.79	90	56	63	72	84
75	0.00	100.00	60	94	87	78	66	89	120.00	0.00	60	94	87	78	66
76	-70.71	70.72	90	94	87	78	66	90	84.85	84.85	90	94	87	78	66
77	-100.00	0.01	60	94	87	78	66	91	0.01	120.00	60	94	87	78	66
78	-70.72	-70.70	90	94	87	78	66	92	-84.85	84.86	90	94	87	78	66
79	-0.01	-100.00	60	94	87	78	66	93	-120.00	0.01	60	94	87	78	66
80	70.70	-70.72	90	94	87	78	66	94	-84.86	-84.84	90	94	87	78	66
81	110.00	0.00	60	56	63	72	84	95	-0.02	-120.00	60	94	87	78	66
82	77.78	77.78	90	56	63	72	84	96	84.84	-84.87	90	94	87	78	66
83	0.01	110.00	60	56	63	72	84								

Note: demands are denoted by D for SD13 and D_p for MDA13 with $p = .1, .2, .3, .4$.

Table A.27: Node locations and demands for SD14 and MDA14.

No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$	No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$
0	0.00	0.00	0	0	0	0	0	35	15.00	-25.98	60	56	63	72	84
1	10.00	0.00	60	56	63	72	84	36	25.98	-15.00	90	56	63	72	84
2	8.66	5.00	90	56	63	72	84	37	40.00	0.00	60	94	87	78	66
3	5.00	8.66	60	56	63	72	84	38	34.64	20.00	90	94	87	78	66
4	0.00	10.00	90	56	63	72	84	39	20.00	34.64	60	94	87	78	66
5	-5.00	8.66	60	56	63	72	84	40	0.00	40.00	90	94	87	78	66
6	-8.66	5.00	90	56	63	72	84	41	-20.00	34.64	60	94	87	78	66
7	-10.00	0.00	60	56	63	72	84	42	-34.64	20.00	90	94	87	78	66
8	-8.66	-5.00	90	56	63	72	84	43	-40.00	0.00	60	94	87	78	66
9	-5.00	-8.66	60	56	63	72	84	44	-34.64	-20.00	90	94	87	78	66
10	0.00	-10.00	90	56	63	72	84	45	-20.00	-34.64	60	94	87	78	66
11	5.00	-8.66	60	56	63	72	84	46	-0.01	-40.00	90	94	87	78	66
12	8.66	-5.00	90	56	63	72	84	47	19.99	-34.64	60	94	87	78	66
13	20.00	0.00	60	94	87	78	66	48	34.64	-20.01	90	94	87	78	66
14	17.32	10.00	90	94	87	78	66	49	50.00	0.00	60	56	63	72	84
15	10.00	17.32	60	94	87	78	66	50	43.30	25.00	90	56	63	72	84
16	0.00	20.00	90	94	87	78	66	51	25.00	43.30	60	56	63	72	84
17	-10.00	17.32	60	94	87	78	66	52	0.00	50.00	90	56	63	72	84
18	-17.32	10.00	90	94	87	78	66	53	-25.00	43.30	60	56	63	72	84
19	-20.00	0.00	60	94	87	78	66	54	-43.30	25.00	90	56	63	72	84
20	-17.32	-10.00	90	94	87	78	66	55	-50.00	0.00	60	56	63	72	84
21	-10.00	-17.32	60	94	87	78	66	56	-43.30	-25.00	90	56	63	72	84
22	0.00	-20.00	90	94	87	78	66	57	-25.01	-43.30	60	56	63	72	84
23	10.00	-17.32	60	94	87	78	66	58	-0.01	-50.00	90	56	63	72	84
24	17.32	-10.00	90	94	87	78	66	59	24.99	-43.31	60	56	63	72	84
25	30.00	0.00	60	56	63	72	84	60	43.30	-25.01	90	56	63	72	84
26	25.98	15.00	90	56	63	72	84	61	60.00	0.00	60	94	87	78	66
27	15.00	25.98	60	56	63	72	84	62	51.96	30.00	90	94	87	78	66
28	0.00	30.00	90	56	63	72	84	63	30.00	51.96	60	94	87	78	66
29	-15.00	25.98	60	56	63	72	84	64	0.00	60.00	90	94	87	78	66
30	-25.98	15.00	90	56	63	72	84	65	-30.00	51.96	60	94	87	78	66
31	-30.00	0.00	60	56	63	72	84	66	-51.96	30.00	90	94	87	78	66
32	-25.98	-15.00	90	56	63	72	84	67	-60.00	0.01	60	94	87	78	66
33	-15.00	-25.98	60	56	63	72	84	68	-51.96	-29.99	90	94	87	78	66
34	0.00	-30.00	90	56	63	72	84	69	-30.01	-51.96	60	94	87	78	66

(cont.)

Table A.27 continued.

No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$	No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$
70	-0.01	-60.00	90	94	87	78	66	96	69.28	-40.01	90	94	87	78	66
71	29.99	-51.97	60	94	87	78	66	97	90.00	0.00	60	56	63	72	84
72	51.96	-30.01	90	94	87	78	66	98	77.94	45.00	90	56	63	72	84
73	70.00	0.00	60	56	63	72	84	99	45.00	77.94	60	56	63	72	84
74	60.62	35.00	90	56	63	72	84	100	0.00	90.00	90	56	63	72	84
75	35.00	60.62	60	56	63	72	84	101	-45.00	77.95	60	56	63	72	84
76	0.00	70.00	90	56	63	72	84	102	-77.94	45.01	90	56	63	72	84
77	-35.00	60.62	60	56	63	72	84	103	-90.00	0.01	60	56	63	72	84
78	-60.62	35.00	90	56	63	72	84	104	-77.95	-44.99	90	56	63	72	84
79	-70.00	0.01	60	56	63	72	84	105	-45.01	-77.94	60	56	63	72	84
80	-60.63	-34.99	90	56	63	72	84	106	-0.01	-90.00	90	56	63	72	84
81	-35.01	-60.62	60	56	63	72	84	107	44.99	-77.95	60	56	63	72	84
82	-0.01	-70.00	90	56	63	72	84	108	77.93	-45.01	90	56	63	72	84
83	34.99	-60.63	60	56	63	72	84	109	100.00	0.00	60	94	87	78	66
84	60.62	-35.01	90	56	63	72	84	110	86.60	50.00	90	94	87	78	66
85	80.00	0.00	60	94	87	78	66	111	50.00	86.60	60	94	87	78	66
86	69.28	40.00	90	94	87	78	66	112	0.00	100.00	90	94	87	78	66
87	40.00	69.28	60	94	87	78	66	113	-49.99	86.61	60	94	87	78	66
88	0.00	80.00	90	94	87	78	66	114	-86.60	50.01	90	94	87	78	66
89	-40.00	69.28	60	94	87	78	66	115	-100.00	0.01	60	94	87	78	66
90	-69.28	40.01	90	94	87	78	66	116	-86.61	-49.99	90	94	87	78	66
91	-80.00	0.01	60	94	87	78	66	117	-50.01	-86.60	60	94	87	78	66
92	-69.29	-39.99	90	94	87	78	66	118	-0.01	-100.00	90	94	87	78	66
93	-40.01	-69.28	60	94	87	78	66	119	49.99	-86.61	60	94	87	78	66
94	-0.01	-80.00	90	94	87	78	66	120	86.59	-50.01	90	94	87	78	66
95	39.99	-69.29	60	94	87	78	66								

Note: demands are denoted by D for SD14 and D_p for MDA14 with p = .1, .2, .3, .4.

Table A.28: Node locations and demands for SD15 and MDA15.

No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$	No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$
0	0.00	0.00	0	0	0	0	0	35	15.00	-25.98	60	56	63	72	84
1	10.00	0.00	60	56	63	72	84	36	25.98	-15.00	90	56	63	72	84
2	8.66	5.00	90	56	63	72	84	37	40.00	0.00	60	94	87	78	66
3	5.00	8.66	60	56	63	72	84	38	34.64	20.00	90	94	87	78	66
4	0.00	10.00	90	56	63	72	84	39	20.00	34.64	60	94	87	78	66
5	-5.00	8.66	60	56	63	72	84	40	0.00	40.00	90	94	87	78	66
6	-8.66	5.00	90	56	63	72	84	41	-20.00	34.64	60	94	87	78	66
7	-10.00	0.00	60	56	63	72	84	42	-34.64	20.00	90	94	87	78	66
8	-8.66	-5.00	90	56	63	72	84	43	-40.00	0.00	60	94	87	78	66
9	-5.00	-8.66	60	56	63	72	84	44	-34.64	-20.00	90	94	87	78	66
10	0.00	-10.00	90	56	63	72	84	45	-20.00	-34.64	60	94	87	78	66
11	5.00	-8.66	60	56	63	72	84	46	-0.01	-40.00	90	94	87	78	66
12	8.66	-5.00	90	56	63	72	84	47	19.99	-34.64	60	94	87	78	66
13	20.00	0.00	60	94	87	78	66	48	34.64	-20.01	90	94	87	78	66
14	17.32	10.00	90	94	87	78	66	49	50.00	0.00	60	56	63	72	84
15	10.00	17.32	60	94	87	78	66	50	43.30	25.00	90	56	63	72	84
16	0.00	20.00	90	94	87	78	66	51	25.00	43.30	60	56	63	72	84
17	-10.00	17.32	60	94	87	78	66	52	0.00	50.00	90	56	63	72	84
18	-17.32	10.00	90	94	87	78	66	53	-25.00	43.30	60	56	63	72	84
19	-20.00	0.00	60	94	87	78	66	54	-43.30	25.00	90	56	63	72	84
20	-17.32	-10.00	90	94	87	78	66	55	-50.00	0.00	60	56	63	72	84
21	-10.00	-17.32	60	94	87	78	66	56	-43.30	-25.00	90	56	63	72	84
22	0.00	-20.00	90	94	87	78	66	57	-25.01	-43.30	60	56	63	72	84
23	10.00	-17.32	60	94	87	78	66	58	-0.01	-50.00	90	56	63	72	84
24	17.32	-10.00	90	94	87	78	66	59	24.99	-43.31	60	56	63	72	84
25	30.00	0.00	60	56	63	72	84	60	43.30	-25.01	90	56	63	72	84
26	25.98	15.00	90	56	63	72	84	61	60.00	0.00	60	94	87	78	66
27	15.00	25.98	60	56	63	72	84	62	51.96	30.00	90	94	87	78	66
28	0.00	30.00	90	56	63	72	84	63	30.00	51.96	60	94	87	78	66
29	-15.00	25.98	60	56	63	72	84	64	0.00	60.00	90	94	87	78	66
30	-25.98	15.00	90	56	63	72	84	65	-30.00	51.96	60	94	87	78	66
31	-30.00	0.00	60	56	63	72	84	66	-51.96	30.00	90	94	87	78	66
32	-25.98	-15.00	90	56	63	72	84	67	-60.00	0.01	60	94	87	78	66
33	-15.00	-25.98	60	56	63	72	84	68	-51.96	-29.99	90	94	87	78	66
34	0.00	-30.00	90	56	63	72	84	69	-30.01	-51.96	60	94	87	78	66

(cont.)

Table A.28 continued.

No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$	No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$
70	-0.01	-60.00	90	94	87	78	66	108	77.93	-45.01	90	56	63	72	84
71	29.99	-51.97	60	94	87	78	66	109	100.00	0.00	60	94	87	78	66
72	51.96	-30.01	90	94	87	78	66	110	86.60	50.00	90	94	87	78	66
73	70.00	0.00	60	56	63	72	84	111	50.00	86.60	60	94	87	78	66
74	60.62	35.00	90	56	63	72	84	112	0.00	100.00	90	94	87	78	66
75	35.00	60.62	60	56	63	72	84	113	-49.99	86.61	60	94	87	78	66
76	0.00	70.00	90	56	63	72	84	114	-86.60	50.01	90	94	87	78	66
77	-35.00	60.62	60	56	63	72	84	115	-100.00	0.01	60	94	87	78	66
78	-60.62	35.00	90	56	63	72	84	116	-86.61	-49.99	90	94	87	78	66
79	-70.00	0.01	60	56	63	72	84	117	-50.01	-86.60	60	94	87	78	66
80	-60.63	-34.99	90	56	63	72	84	118	-0.01	-100.00	90	94	87	78	66
81	-35.01	-60.62	60	56	63	72	84	119	49.99	-86.61	60	94	87	78	66
82	-0.01	-70.00	90	56	63	72	84	120	86.59	-50.01	90	94	87	78	66
83	34.99	-60.63	60	56	63	72	84	121	110.00	0.00	60	56	63	72	84
84	60.62	-35.01	90	56	63	72	84	122	95.26	55.00	90	56	63	72	84
85	80.00	0.00	60	94	87	78	66	123	55.00	95.26	60	56	63	72	84
86	69.28	40.00	90	94	87	78	66	124	0.01	110.00	90	56	63	72	84
87	40.00	69.28	60	94	87	78	66	125	-54.99	95.27	60	56	63	72	84
88	0.00	80.00	90	94	87	78	66	126	-95.26	55.01	90	56	63	72	84
89	-40.00	69.28	60	94	87	78	66	127	-110.00	0.01	60	56	63	72	84
90	-69.28	40.01	90	94	87	78	66	128	-95.27	-54.99	90	56	63	72	84
91	-80.00	0.01	60	94	87	78	66	129	-55.01	-95.26	60	56	63	72	84
92	-69.29	-39.99	90	94	87	78	66	130	-0.02	-110.00	90	56	63	72	84
93	-40.01	-69.28	60	94	87	78	66	131	54.99	-95.27	60	56	63	72	84
94	-0.01	-80.00	90	94	87	78	66	132	95.25	-55.02	90	56	63	72	84
95	39.99	-69.29	60	94	87	78	66	133	120.00	0.00	60	94	87	78	66
96	69.28	-40.01	90	94	87	78	66	134	103.92	60.00	90	94	87	78	66
97	90.00	0.00	60	56	63	72	84	135	60.00	103.92	60	94	87	78	66
98	77.94	45.00	90	56	63	72	84	136	0.01	120.00	90	94	87	78	66
99	45.00	77.94	60	56	63	72	84	137	-59.99	103.93	60	94	87	78	66
100	0.00	90.00	90	56	63	72	84	138	-103.92	60.01	90	94	87	78	66
101	-45.00	77.95	60	56	63	72	84	139	-120.00	0.01	60	94	87	78	66
102	-77.94	45.01	90	56	63	72	84	140	-103.93	-59.99	90	94	87	78	66
103	-90.00	0.01	60	56	63	72	84	141	-60.01	-103.92	60	94	87	78	66
104	-77.95	-44.99	90	56	63	72	84	142	-0.02	-120.00	90	94	87	78	66
105	-45.01	-77.94	60	56	63	72	84	143	59.98	-103.93	60	94	87	78	66
106	-0.01	-90.00	90	56	63	72	84	144	103.91	-60.02	90	94	87	78	66
107	44.99	-77.95	60	56	63	72	84								

Note: demands are denoted by D for SD15 and D_p for MDA15 with p = .1, .2, .3, .4.

Table A.29: Node locations and demands for SD16 and MDA16.

No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$	No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$
0	0.00	0.00	0	0	0	0	0	35	-9.85	1.74	60	56	63	72	84
1	10.00	0.00	60	56	63	72	84	36	-9.96	0.87	90	56	63	72	84
2	9.96	0.87	90	56	63	72	84	37	-10.00	0.00	60	56	63	72	84
3	9.85	1.74	60	56	63	72	84	38	-9.96	-0.87	90	56	63	72	84
4	9.66	2.59	90	56	63	72	84	39	-9.85	-1.74	60	56	63	72	84
5	9.40	3.42	60	56	63	72	84	40	-9.66	-2.59	90	56	63	72	84
6	9.06	4.23	90	56	63	72	84	41	-9.40	-3.42	60	56	63	72	84
7	8.66	5.00	60	56	63	72	84	42	-9.06	-4.23	90	56	63	72	84
8	8.19	5.74	90	56	63	72	84	43	-8.66	-5.00	60	56	63	72	84
9	7.66	6.43	60	56	63	72	84	44	-8.19	-5.73	90	56	63	72	84
10	7.07	7.07	90	56	63	72	84	45	-7.66	-6.43	60	56	63	72	84
11	6.43	7.66	60	56	63	72	84	46	-7.07	-7.07	90	56	63	72	84
12	5.74	8.19	90	56	63	72	84	47	-6.43	-7.66	60	56	63	72	84
13	5.00	8.66	60	56	63	72	84	48	-5.74	-8.19	90	56	63	72	84
14	4.23	9.06	90	56	63	72	84	49	-5.00	-8.66	60	56	63	72	84
15	3.42	9.40	60	56	63	72	84	50	-4.23	-9.06	90	56	63	72	84
16	2.59	9.66	90	56	63	72	84	51	-3.42	-9.40	60	56	63	72	84
17	1.74	9.85	60	56	63	72	84	52	-2.59	-9.66	90	56	63	72	84
18	0.87	9.96	90	56	63	72	84	53	-1.74	-9.85	60	56	63	72	84
19	0.00	10.00	60	56	63	72	84	54	-0.87	-9.96	90	56	63	72	84
20	-0.87	9.96	90	56	63	72	84	55	0.00	-10.00	60	56	63	72	84
21	-1.74	9.85	60	56	63	72	84	56	0.87	-9.96	90	56	63	72	84
22	-2.59	9.66	90	56	63	72	84	57	1.74	-9.85	60	56	63	72	84
23	-3.42	9.40	60	56	63	72	84	58	2.59	-9.66	90	56	63	72	84
24	-4.23	9.06	90	56	63	72	84	59	3.42	-9.40	60	56	63	72	84
25	-5.00	8.66	60	56	63	72	84	60	4.22	-9.06	90	56	63	72	84
26	-5.74	8.19	90	56	63	72	84	61	5.00	-8.66	60	56	63	72	84
27	-6.43	7.66	60	56	63	72	84	62	5.73	-8.19	90	56	63	72	84
28	-7.07	7.07	90	56	63	72	84	63	6.43	-7.66	60	56	63	72	84
29	-7.66	6.43	60	56	63	72	84	64	7.07	-7.07	90	56	63	72	84
30	-8.19	5.74	90	56	63	72	84	65	7.66	-6.43	60	56	63	72	84
31	-8.66	5.00	60	56	63	72	84	66	8.19	-5.74	90	56	63	72	84
32	-9.06	4.23	90	56	63	72	84	67	8.66	-5.00	60	56	63	72	84
33	-9.40	3.42	60	56	63	72	84	68	9.06	-4.23	90	56	63	72	84
34	-9.66	2.59	90	56	63	72	84	69	9.40	-3.42	60	56	63	72	84

(cont.)

Table A.29 continued.

No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$	No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$
70	9.66	-2.59	90	56	63	72	84	108	-19.92	1.74	90	94	87	78	66
71	9.85	-1.74	60	56	63	72	84	109	-20.00	0.00	60	94	87	78	66
72	9.96	-0.87	90	56	63	72	84	110	-19.92	-1.74	90	94	87	78	66
73	20.00	0.00	60	94	87	78	66	111	-19.70	-3.47	60	94	87	78	66
74	19.92	1.74	90	94	87	78	66	112	-19.32	-5.17	90	94	87	78	66
75	19.70	3.47	60	94	87	78	66	113	-18.79	-6.84	60	94	87	78	66
76	19.32	5.18	90	94	87	78	66	114	-18.13	-8.45	90	94	87	78	66
77	18.79	6.84	60	94	87	78	66	115	-17.32	-10.00	60	94	87	78	66
78	18.13	8.45	90	94	87	78	66	116	-16.38	-11.47	90	94	87	78	66
79	17.32	10.00	60	94	87	78	66	117	-15.32	-12.85	60	94	87	78	66
80	16.38	11.47	90	94	87	78	66	118	-14.14	-14.14	90	94	87	78	66
81	15.32	12.86	60	94	87	78	66	119	-12.86	-15.32	60	94	87	78	66
82	14.14	14.14	90	94	87	78	66	120	-11.47	-16.38	90	94	87	78	66
83	12.86	15.32	60	94	87	78	66	121	-10.00	-17.32	60	94	87	78	66
84	11.47	16.38	90	94	87	78	66	122	-8.45	-18.13	90	94	87	78	66
85	10.00	17.32	60	94	87	78	66	123	-6.84	-18.79	60	94	87	78	66
86	8.45	18.13	90	94	87	78	66	124	-5.18	-19.32	90	94	87	78	66
87	6.84	18.79	60	94	87	78	66	125	-3.48	-19.70	60	94	87	78	66
88	5.18	19.32	90	94	87	78	66	126	-1.75	-19.92	90	94	87	78	66
89	3.47	19.70	60	94	87	78	66	127	0.00	-20.00	60	94	87	78	66
90	1.74	19.92	90	94	87	78	66	128	1.74	-19.92	90	94	87	78	66
91	0.00	20.00	60	94	87	78	66	129	3.47	-19.70	60	94	87	78	66
92	-1.74	19.92	90	94	87	78	66	130	5.17	-19.32	90	94	87	78	66
93	-3.47	19.70	60	94	87	78	66	131	6.84	-18.79	60	94	87	78	66
94	-5.18	19.32	90	94	87	78	66	132	8.45	-18.13	90	94	87	78	66
95	-6.84	18.79	60	94	87	78	66	133	10.00	-17.32	60	94	87	78	66
96	-8.45	18.13	90	94	87	78	66	134	11.47	-16.38	90	94	87	78	66
97	-10.00	17.32	60	94	87	78	66	135	12.85	-15.32	60	94	87	78	66
98	-11.47	16.38	90	94	87	78	66	136	14.14	-14.14	90	94	87	78	66
99	-12.85	15.32	60	94	87	78	66	137	15.32	-12.86	60	94	87	78	66
100	-14.14	14.14	90	94	87	78	66	138	16.38	-11.47	90	94	87	78	66
101	-15.32	12.86	60	94	87	78	66	139	17.32	-10.00	60	94	87	78	66
102	-16.38	11.47	90	94	87	78	66	140	18.12	-8.46	90	94	87	78	66
103	-17.32	10.00	60	94	87	78	66	141	18.79	-6.84	60	94	87	78	66
104	-18.13	8.45	90	94	87	78	66	142	19.32	-5.18	90	94	87	78	66
105	-18.79	6.84	60	94	87	78	66	143	19.70	-3.48	60	94	87	78	66
106	-19.32	5.18	90	94	87	78	66	144	19.92	-1.75	90	94	87	78	66
107	-19.70	3.47	60	94	87	78	66								

Note: demands are denoted by D for SD16 and D_p for MDA16 with $p = .1, .2, .3, .4$.

Table A.30: Node locations and demands for SD17 and MDA17.

No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$	No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$
0	0.00	0.00	0	0	0	0	0	35	0.00	50.00	60	56	63	84	84
1	10.00	0.00	60	56	63	84	84	36	-35.35	35.36	90	56	63	84	84
2	7.07	7.07	90	56	63	84	84	37	-50.00	0.00	60	56	63	84	84
3	0.00	10.00	60	56	63	84	84	38	-35.36	-35.35	90	56	63	84	84
4	-7.07	7.07	90	56	63	84	84	39	-0.01	-50.00	60	56	63	84	84
5	-10.00	0.00	60	56	63	84	84	40	35.35	-35.36	90	56	63	84	84
6	-7.07	-7.07	90	56	63	84	84	41	60.00	0.00	60	94	87	66	66
7	0.00	-10.00	60	56	63	84	84	42	42.43	42.43	90	94	87	66	66
8	7.07	-7.07	90	56	63	84	84	43	0.00	60.00	60	94	87	66	66
9	20.00	0.00	60	94	87	66	66	44	-42.42	42.43	90	94	87	66	66
10	14.14	14.14	90	94	87	66	66	45	-60.00	0.01	60	94	87	66	66
11	0.00	20.00	60	94	87	66	66	46	-42.43	-42.42	90	94	87	66	66
12	-14.14	14.14	90	94	87	66	66	47	-0.01	-60.00	60	94	87	66	66
13	-20.00	0.00	60	94	87	66	66	48	42.42	-42.43	90	94	87	66	66
14	-14.14	-14.14	90	94	87	66	66	49	70.00	0.00	60	56	63	84	84
15	0.00	-20.00	60	94	87	66	66	50	49.50	49.50	90	56	63	84	84
16	14.14	-14.14	90	94	87	66	66	51	0.00	70.00	60	56	63	84	84
17	30.00	0.00	60	56	63	84	84	52	-49.49	49.50	90	56	63	84	84
18	21.21	21.21	90	56	63	84	84	53	-70.00	0.01	60	56	63	84	84
19	0.00	30.00	60	56	63	84	84	54	-49.50	-49.49	90	56	63	84	84
20	-21.21	21.21	90	56	63	84	84	55	-0.01	-70.00	60	56	63	84	84
21	-30.00	0.00	60	56	63	84	84	56	49.49	-49.51	90	56	63	84	84
22	-21.22	-21.21	90	56	63	84	84	57	80.00	0.00	60	94	87	66	66
23	0.00	-30.00	60	56	63	84	84	58	56.57	56.57	90	94	87	66	66
24	21.21	-21.22	90	56	63	84	84	59	0.00	80.00	60	94	87	66	66
25	40.00	0.00	60	94	87	66	66	60	-56.56	56.57	90	94	87	66	66
26	28.28	28.28	90	94	87	66	66	61	-80.00	0.01	60	94	87	66	66
27	0.00	40.00	60	94	87	66	66	62	-56.58	-56.56	90	94	87	66	66
28	-28.28	28.29	90	94	87	66	66	63	-0.01	-80.00	60	94	87	66	66
29	-40.00	0.00	60	94	87	66	66	64	56.56	-56.58	90	94	87	66	66
30	-28.29	-28.28	90	94	87	66	66	65	90.00	0.00	60	56	63	84	84
31	-0.01	-40.00	60	94	87	66	66	66	63.64	63.64	90	56	63	84	84
32	28.28	-28.29	90	94	87	66	66	67	0.00	90.00	60	56	63	84	84
33	50.00	0.00	60	56	63	84	84	68	-63.64	63.64	90	56	63	84	84
34	35.36	35.35	90	56	63	84	84	69	-90.00	0.01	60	56	63	84	84

(cont.)

Table A.30 continued.

No.	x	y	D	$D_{\cdot 1}$	$D_{\cdot 2}$	$D_{\cdot 3}$	$D_{\cdot 4}$	No.	x	y	D	$D_{\cdot 1}$	$D_{\cdot 2}$	$D_{\cdot 3}$	$D_{\cdot 4}$
70	-63.65	-63.63	90	56	63	84	84	105	140.00	0.00	60	94	87	66	66
71	-0.01	-90.00	60	56	63	84	84	106	99.00	98.99	90	94	87	66	66
72	63.63	-63.65	90	56	63	84	84	107	0.01	140.00	60	94	87	66	66
73	100.00	0.00	60	94	87	66	66	108	-98.99	99.00	90	94	87	66	66
74	70.71	70.71	90	94	87	66	66	109	-140.00	0.01	60	94	87	66	66
75	0.00	100.00	60	94	87	66	66	110	-99.01	-98.98	90	94	87	66	66
76	-70.71	70.72	90	94	87	66	66	111	-0.02	-140.00	60	94	87	66	66
77	-100.00	0.01	60	94	87	66	66	112	98.98	-99.01	90	94	87	66	66
78	-70.72	-70.70	90	94	87	66	66	113	150.00	0.00	60	56	63	84	84
79	-0.01	-100.00	60	94	87	66	66	114	106.07	106.06	90	56	63	84	84
80	70.70	-70.72	90	94	87	66	66	115	0.01	150.00	60	56	63	84	84
81	110.00	0.00	60	56	63	84	84	116	-106.06	106.07	90	56	63	84	84
82	77.78	77.78	90	56	63	84	84	117	-150.00	0.01	60	56	63	84	84
83	0.01	110.00	60	56	63	84	84	118	-106.08	-106.05	90	56	63	84	84
84	-77.78	77.79	90	56	63	84	84	119	-0.02	-150.00	60	56	63	84	84
85	-110.00	0.01	60	56	63	84	84	120	106.05	-106.08	90	56	63	84	84
86	-77.79	-77.77	90	56	63	84	84	121	160.00	0.00	60	94	87	66	66
87	-0.02	-110.00	60	56	63	84	84	122	113.14	113.13	90	94	87	66	66
88	77.77	-77.79	90	56	63	84	84	123	0.01	160.00	60	94	87	66	66
89	120.00	0.00	60	94	87	66	66	124	-113.13	113.14	90	94	87	66	66
90	84.85	84.85	90	94	87	66	66	125	-160.00	0.01	60	94	87	66	66
91	0.01	120.00	60	94	87	66	66	126	-113.15	-113.12	90	94	87	66	66
92	-84.85	84.86	90	94	87	66	66	127	-0.02	-160.00	60	94	87	66	66
93	-120.00	0.01	60	94	87	66	66	128	113.12	-113.16	90	94	87	66	66
94	-84.86	-84.84	90	94	87	66	66	129	170.00	0.00	60	56	63	84	84
95	-0.02	-120.00	60	94	87	66	66	130	120.21	120.21	90	56	63	84	84
96	84.84	-84.87	90	94	87	66	66	131	0.01	170.00	60	56	63	84	84
97	130.00	0.00	60	56	63	84	84	132	-120.20	120.22	90	56	63	84	84
98	91.93	91.92	90	56	63	84	84	133	-170.00	0.02	60	56	63	84	84
99	0.01	130.00	60	56	63	84	84	134	-120.22	-120.19	90	56	63	84	84
100	-91.92	91.93	90	56	63	84	84	135	-0.02	-170.00	60	56	63	84	84
101	-130.00	0.01	60	56	63	84	84	136	120.19	-120.23	90	56	63	84	84
102	-91.93	-91.91	90	56	63	84	84	137	180.00	0.00	60	94	87	66	66
103	-0.02	-130.00	60	56	63	84	84	138	127.28	127.28	90	94	87	66	66
104	91.91	-91.94	90	56	63	84	84	139	0.01	180.00	60	94	87	66	66

(cont.)

Table A.30 continued.

No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$	No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$
140	-127.27	127.29	90	94	87	66	66	151	-0.03	-190.00	60	56	63	84	84
141	-180.00	0.02	60	94	87	66	66	152	134.33	-134.37	90	56	63	84	84
142	-127.29	-127.26	90	94	87	66	66	153	200.00	0.00	60	94	87	66	66
143	-0.03	-180.00	60	94	87	66	66	154	141.42	141.42	90	94	87	66	66
144	127.26	-127.30	90	94	87	66	66	155	0.01	200.00	60	94	87	66	66
145	190.00	0.00	60	56	63	84	84	156	-141.41	141.43	90	94	87	66	66
146	134.35	134.35	90	56	63	84	84	157	-200.00	0.02	60	94	87	66	66
147	0.01	190.00	60	56	63	84	84	158	-141.44	-141.40	90	94	87	66	66
148	-134.34	134.36	90	56	63	84	84	159	-0.03	-200.00	60	94	87	66	66
149	-190.00	0.02	60	56	63	84	84	160	141.40	-141.44	90	94	87	66	66
150	-134.37	-134.33	90	56	63	84	84								

Note: demands are denoted by D for SD17 and D_p for MDA17 with $p = .1, .2, .3, .4$.

Table A.31: Node locations and demands for SD18 and MDA18.

No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$	No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$
0	0.00	0.00	0	0	0	0	0	35	21.21	21.21	60	56	63	72	84
1	10.00	0.00	60	56	63	72	84	36	11.48	27.72	90	56	63	72	84
2	9.24	3.83	90	56	63	72	84	37	0.00	30.00	60	56	63	72	84
3	7.07	7.07	60	56	63	72	84	38	-11.48	27.72	90	56	63	72	84
4	3.83	9.24	90	56	63	72	84	39	-21.21	21.21	60	56	63	72	84
5	0.00	10.00	60	56	63	72	84	40	-27.72	11.48	90	56	63	72	84
6	-3.83	9.24	90	56	63	72	84	41	-30.00	0.00	60	56	63	72	84
7	-7.07	7.07	60	56	63	72	84	42	-27.72	-11.48	90	56	63	72	84
8	-9.24	3.83	90	56	63	72	84	43	-21.22	-21.21	60	56	63	72	84
9	-10.00	0.00	60	56	63	72	84	44	-11.48	-27.71	90	56	63	72	84
10	-9.24	-3.83	90	56	63	72	84	45	0.00	-30.00	60	56	63	72	84
11	-7.07	-7.07	60	56	63	72	84	46	11.48	-27.72	90	56	63	72	84
12	-3.83	-9.24	90	56	63	72	84	47	21.21	-21.22	60	56	63	72	84
13	0.00	-10.00	60	56	63	72	84	48	27.71	-11.49	90	56	63	72	84
14	3.83	-9.24	90	56	63	72	84	49	40.00	0.00	60	94	87	78	66
15	7.07	-7.07	60	56	63	72	84	50	36.96	15.31	90	94	87	78	66
16	9.24	-3.83	90	56	63	72	84	51	28.28	28.28	60	94	87	78	66
17	20.00	0.00	60	94	87	78	66	52	15.31	36.95	90	94	87	78	66
18	18.48	7.65	90	94	87	78	66	53	0.00	40.00	60	94	87	78	66
19	14.14	14.14	60	94	87	78	66	54	-15.31	36.96	90	94	87	78	66
20	7.65	18.48	90	94	87	78	66	55	-28.28	28.29	60	94	87	78	66
21	0.00	20.00	60	94	87	78	66	56	-36.95	15.31	90	94	87	78	66
22	-7.65	18.48	90	94	87	78	66	57	-40.00	0.00	60	94	87	78	66
23	-14.14	14.14	60	94	87	78	66	58	-36.96	-15.30	90	94	87	78	66
24	-18.48	7.66	90	94	87	78	66	59	-28.29	-28.28	60	94	87	78	66
25	-20.00	0.00	60	94	87	78	66	60	-15.31	-36.95	90	94	87	78	66
26	-18.48	-7.65	90	94	87	78	66	61	-0.01	-40.00	60	94	87	78	66
27	-14.14	-14.14	60	94	87	78	66	62	15.30	-36.96	90	94	87	78	66
28	-7.66	-18.48	90	94	87	78	66	63	28.28	-28.29	60	94	87	78	66
29	0.00	-20.00	60	94	87	78	66	64	36.95	-15.31	90	94	87	78	66
30	7.65	-18.48	90	94	87	78	66	65	50.00	0.00	60	56	63	72	84
31	14.14	-14.14	60	94	87	78	66	66	46.19	19.13	90	56	63	72	84
32	18.48	-7.66	90	94	87	78	66	67	35.36	35.35	60	56	63	72	84
33	30.00	0.00	60	56	63	72	84	68	19.14	46.19	90	56	63	72	84
34	27.72	11.48	90	56	63	72	84	69	0.00	50.00	60	56	63	72	84

(cont.)

Table A.31 continued.

No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$	No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$
70	-19.13	46.20	90	56	63	72	84	105	-70.00	0.01	60	56	63	72	84
71	-35.35	35.36	60	56	63	72	84	106	-64.67	-26.78	90	56	63	72	84
72	-46.19	19.14	90	56	63	72	84	107	-49.50	-49.49	60	56	63	72	84
73	-50.00	0.00	60	56	63	72	84	108	-26.80	-64.67	90	56	63	72	84
74	-46.20	-19.13	90	56	63	72	84	109	-0.01	-70.00	60	56	63	72	84
75	-35.36	-35.35	60	56	63	72	84	110	26.78	-64.68	90	56	63	72	84
76	-19.14	-46.19	90	56	63	72	84	111	49.49	-49.51	60	56	63	72	84
77	-0.01	-50.00	60	56	63	72	84	112	64.67	-26.80	90	56	63	72	84
78	19.13	-46.20	90	56	63	72	84	113	80.00	0.00	60	94	87	78	66
79	35.35	-35.36	60	56	63	72	84	114	73.91	30.61	90	94	87	78	66
80	46.19	-19.14	90	56	63	72	84	115	56.57	56.57	60	94	87	78	66
81	60.00	0.00	60	94	87	78	66	116	30.62	73.91	90	94	87	78	66
82	55.43	22.96	90	94	87	78	66	117	0.00	80.00	60	94	87	78	66
83	42.43	42.43	60	94	87	78	66	118	-30.61	73.91	90	94	87	78	66
84	22.96	55.43	90	94	87	78	66	119	-56.56	56.57	60	94	87	78	66
85	0.00	60.00	60	94	87	78	66	120	-73.91	30.62	90	94	87	78	66
86	-22.96	55.43	90	94	87	78	66	121	-80.00	0.01	60	94	87	78	66
87	-42.42	42.43	60	94	87	78	66	122	-73.91	-30.61	90	94	87	78	66
88	-55.43	22.97	90	94	87	78	66	123	-56.58	-56.56	60	94	87	78	66
89	-60.00	0.01	60	94	87	78	66	124	-30.62	-73.91	90	94	87	78	66
90	-55.44	-22.96	90	94	87	78	66	125	-0.01	-80.00	60	94	87	78	66
91	-42.43	-42.42	60	94	87	78	66	126	30.60	-73.91	90	94	87	78	66
92	-22.97	-55.43	90	94	87	78	66	127	56.56	-56.58	60	94	87	78	66
93	-0.01	-60.00	60	94	87	78	66	128	73.91	-30.63	90	94	87	78	66
94	22.95	-55.44	90	94	87	78	66	129	90.00	0.00	60	56	63	72	84
95	42.42	-42.43	60	94	87	78	66	130	83.15	34.44	90	56	63	72	84
96	55.43	-22.97	90	94	87	78	66	131	63.64	63.64	60	56	63	72	84
97	70.00	0.00	60	56	63	72	84	132	34.44	83.15	90	56	63	72	84
98	64.67	26.79	90	56	63	72	84	133	0.00	90.00	60	56	63	72	84
99	49.50	49.50	60	56	63	72	84	134	-34.44	83.15	90	56	63	72	84
100	26.79	64.67	90	56	63	72	84	135	-63.64	63.64	60	56	63	72	84
101	0.00	70.00	60	56	63	72	84	136	-83.15	34.45	90	56	63	72	84
102	-26.78	64.67	90	56	63	72	84	137	-90.00	0.01	60	56	63	72	84
103	-49.49	49.50	60	56	63	72	84	138	-83.15	-34.43	90	56	63	72	84
104	-64.67	26.79	90	56	63	72	84	139	-63.65	-63.63	60	56	63	72	84

(cont.)

Table A.31 continued.

No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$	No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$
140	-34.45	-83.14	90	56	63	72	84	151	-70.71	70.72	60	94	87	78	66
141	-0.01	-90.00	60	56	63	72	84	152	-92.38	38.28	90	94	87	78	66
142	34.43	-83.15	90	56	63	72	84	153	-100.00	0.01	60	94	87	78	66
143	63.63	-63.65	60	56	63	72	84	154	-92.39	-38.26	90	94	87	78	66
144	83.14	-34.46	90	56	63	72	84	155	-70.72	-70.70	60	94	87	78	66
145	100.00	0.00	60	94	87	78	66	156	-38.28	-92.38	90	94	87	78	66
146	92.39	38.27	90	94	87	78	66	157	-0.01	-100.00	60	94	87	78	66
147	70.71	70.71	60	94	87	78	66	158	38.25	-92.39	90	94	87	78	66
148	38.27	92.39	90	94	87	78	66	159	70.70	-70.72	60	94	87	78	66
149	0.00	100.00	60	94	87	78	66	160	92.38	-38.28	90	94	87	78	66
150	-38.26	92.39	90	94	87	78	66								

Note: demands are denoted by D for SD18 and D_p for MDA18 with $p = .1, .2, .3, .4$.

Table A.32: Node locations and demands for SD19 and MDA19.

No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$	No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$
0	0.00	0.00	0	0	0	0	0	35	21.21	21.21	60	56	63	72	84
1	10.00	0.00	60	56	63	72	84	36	11.48	27.72	90	56	63	72	84
2	9.24	3.83	90	56	63	72	84	37	0.00	30.00	60	56	63	72	84
3	7.07	7.07	60	56	63	72	84	38	-11.48	27.72	90	56	63	72	84
4	3.83	9.24	90	56	63	72	84	39	-21.21	21.21	60	56	63	72	84
5	0.00	10.00	60	56	63	72	84	40	-27.72	11.48	90	56	63	72	84
6	-3.83	9.24	90	56	63	72	84	41	-30.00	0.00	60	56	63	72	84
7	-7.07	7.07	60	56	63	72	84	42	-27.72	-11.48	90	56	63	72	84
8	-9.24	3.83	90	56	63	72	84	43	-21.22	-21.21	60	56	63	72	84
9	-10.00	0.00	60	56	63	72	84	44	-11.48	-27.71	90	56	63	72	84
10	-9.24	-3.83	90	56	63	72	84	45	0.00	-30.00	60	56	63	72	84
11	-7.07	-7.07	60	56	63	72	84	46	11.48	-27.72	90	56	63	72	84
12	-3.83	-9.24	90	56	63	72	84	47	21.21	-21.22	60	56	63	72	84
13	0.00	-10.00	60	56	63	72	84	48	27.71	-11.49	90	56	63	72	84
14	3.83	-9.24	90	56	63	72	84	49	40.00	0.00	60	94	87	78	66
15	7.07	-7.07	60	56	63	72	84	50	36.96	15.31	90	94	87	78	66
16	9.24	-3.83	90	56	63	72	84	51	28.28	28.28	60	94	87	78	66
17	20.00	0.00	60	94	87	78	66	52	15.31	36.95	90	94	87	78	66
18	18.48	7.65	90	94	87	78	66	53	0.00	40.00	60	94	87	78	66
19	14.14	14.14	60	94	87	78	66	54	-15.31	36.96	90	94	87	78	66
20	7.65	18.48	90	94	87	78	66	55	-28.28	28.29	60	94	87	78	66
21	0.00	20.00	60	94	87	78	66	56	-36.95	15.31	90	94	87	78	66
22	-7.65	18.48	90	94	87	78	66	57	-40.00	0.00	60	94	87	78	66
23	-14.14	14.14	60	94	87	78	66	58	-36.96	-15.30	90	94	87	78	66
24	-18.48	7.66	90	94	87	78	66	59	-28.29	-28.28	60	94	87	78	66
25	-20.00	0.00	60	94	87	78	66	60	-15.31	-36.95	90	94	87	78	66
26	-18.48	-7.65	90	94	87	78	66	61	-0.01	-40.00	60	94	87	78	66
27	-14.14	-14.14	60	94	87	78	66	62	15.30	-36.96	90	94	87	78	66
28	-7.66	-18.48	90	94	87	78	66	63	28.28	-28.29	60	94	87	78	66
29	0.00	-20.00	60	94	87	78	66	64	36.95	-15.31	90	94	87	78	66
30	7.65	-18.48	90	94	87	78	66	65	50.00	0.00	60	56	63	72	84
31	14.14	-14.14	60	94	87	78	66	66	46.19	19.13	90	56	63	72	84
32	18.48	-7.66	90	94	87	78	66	67	35.36	35.35	60	56	63	72	84
33	30.00	0.00	60	56	63	72	84	68	19.14	46.19	90	56	63	72	84
34	27.72	11.48	90	56	63	72	84	69	0.00	50.00	60	56	63	72	84

(cont.)

Table A.32 continued.

No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$	No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$
70	-19.13	46.20	90	56	63	72	84	105	-70.00	0.01	60	56	63	72	84
71	-35.35	35.36	60	56	63	72	84	106	-64.67	-26.78	90	56	63	72	84
72	-46.19	19.14	90	56	63	72	84	107	-49.50	-49.49	60	56	63	72	84
73	-50.00	0.00	60	56	63	72	84	108	-26.80	-64.67	90	56	63	72	84
74	-46.20	-19.13	90	56	63	72	84	109	-0.01	-70.00	60	56	63	72	84
75	-35.36	-35.35	60	56	63	72	84	110	26.78	-64.68	90	56	63	72	84
76	-19.14	-46.19	90	56	63	72	84	111	49.49	-49.51	60	56	63	72	84
77	-0.01	-50.00	60	56	63	72	84	112	64.67	-26.80	90	56	63	72	84
78	19.13	-46.20	90	56	63	72	84	113	80.00	0.00	60	94	87	78	66
79	35.35	-35.36	60	56	63	72	84	114	73.91	30.61	90	94	87	78	66
80	46.19	-19.14	90	56	63	72	84	115	56.57	56.57	60	94	87	78	66
81	60.00	0.00	60	94	87	78	66	116	30.62	73.91	90	94	87	78	66
82	55.43	22.96	90	94	87	78	66	117	0.00	80.00	60	94	87	78	66
83	42.43	42.43	60	94	87	78	66	118	-30.61	73.91	90	94	87	78	66
84	22.96	55.43	90	94	87	78	66	119	-56.56	56.57	60	94	87	78	66
85	0.00	60.00	60	94	87	78	66	120	-73.91	30.62	90	94	87	78	66
86	-22.96	55.43	90	94	87	78	66	121	-80.00	0.01	60	94	87	78	66
87	-42.42	42.43	60	94	87	78	66	122	-73.91	-30.61	90	94	87	78	66
88	-55.43	22.97	90	94	87	78	66	123	-56.58	-56.56	60	94	87	78	66
89	-60.00	0.01	60	94	87	78	66	124	-30.62	-73.91	90	94	87	78	66
90	-55.44	-22.96	90	94	87	78	66	125	-0.01	-80.00	60	94	87	78	66
91	-42.43	-42.42	60	94	87	78	66	126	30.60	-73.91	90	94	87	78	66
92	-22.97	-55.43	90	94	87	78	66	127	56.56	-56.58	60	94	87	78	66
93	-0.01	-60.00	60	94	87	78	66	128	73.91	-30.63	90	94	87	78	66
94	22.95	-55.44	90	94	87	78	66	129	90.00	0.00	60	56	63	72	84
95	42.42	-42.43	60	94	87	78	66	130	83.15	34.44	90	56	63	72	84
96	55.43	-22.97	90	94	87	78	66	131	63.64	63.64	60	56	63	72	84
97	70.00	0.00	60	56	63	72	84	132	34.44	83.15	90	56	63	72	84
98	64.67	26.79	90	56	63	72	84	133	0.00	90.00	60	56	63	72	84
99	49.50	49.50	60	56	63	72	84	134	-34.44	83.15	90	56	63	72	84
100	26.79	64.67	90	56	63	72	84	135	-63.64	63.64	60	56	63	72	84
101	0.00	70.00	60	56	63	72	84	136	-83.15	34.45	90	56	63	72	84
102	-26.78	64.67	90	56	63	72	84	137	-90.00	0.01	60	56	63	72	84
103	-49.49	49.50	60	56	63	72	84	138	-83.15	-34.43	90	56	63	72	84
104	-64.67	26.79	90	56	63	72	84	139	-63.65	-63.63	60	56	63	72	84

(cont.)

Table A.32 continued.

No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$	No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$
140	-34.45	-83.14	90	56	63	72	84	167	-77.78	77.79	60	56	63	72	84
141	-0.01	-90.00	60	56	63	72	84	168	-101.62	42.10	90	56	63	72	84
142	34.43	-83.15	90	56	63	72	84	169	-110.00	0.01	60	56	63	72	84
143	63.63	-63.65	60	56	63	72	84	170	-101.63	-42.08	90	56	63	72	84
144	83.14	-34.46	90	56	63	72	84	171	-77.79	-77.77	60	56	63	72	84
145	100.00	0.00	60	94	87	78	66	172	-42.11	-101.62	90	56	63	72	84
146	92.39	38.27	90	94	87	78	66	173	-0.02	-110.00	60	56	63	72	84
147	70.71	70.71	60	94	87	78	66	174	42.08	-101.63	90	56	63	72	84
148	38.27	92.39	90	94	87	78	66	175	77.77	-77.79	60	56	63	72	84
149	0.00	100.00	60	94	87	78	66	176	101.62	-42.11	90	56	63	72	84
150	-38.26	92.39	90	94	87	78	66	177	120.00	0.00	60	94	87	78	66
151	-70.71	70.72	60	94	87	78	66	178	110.87	45.92	90	94	87	78	66
152	-92.38	38.28	90	94	87	78	66	179	84.85	84.85	60	94	87	78	66
153	-100.00	0.01	60	94	87	78	66	180	45.93	110.86	90	94	87	78	66
154	-92.39	-38.26	90	94	87	78	66	181	0.01	120.00	60	94	87	78	66
155	-70.72	-70.70	60	94	87	78	66	182	-45.92	110.87	90	94	87	78	66
156	-38.28	-92.38	90	94	87	78	66	183	-84.85	84.86	60	94	87	78	66
157	-0.01	-100.00	60	94	87	78	66	184	-110.86	45.93	90	94	87	78	66
158	38.25	-92.39	90	94	87	78	66	185	-120.00	0.01	60	94	87	78	66
159	70.70	-70.72	60	94	87	78	66	186	-110.87	-45.91	90	94	87	78	66
160	92.38	-38.28	90	94	87	78	66	187	-84.86	-84.84	60	94	87	78	66
161	110.00	0.00	60	56	63	72	84	188	-45.94	-110.86	90	94	87	78	66
162	101.63	42.09	90	56	63	72	84	189	-0.02	-120.00	60	94	87	78	66
163	77.78	77.78	60	56	63	72	84	190	45.91	-110.87	90	94	87	78	66
164	42.10	101.63	90	56	63	72	84	191	84.84	-84.87	60	94	87	78	66
165	0.01	110.00	60	56	63	72	84	192	110.86	-45.94	90	94	87	78	66
166	-42.09	101.63	90	56	63	72	84								

Note: demands are denoted by D for SD19 and D_p for MDA19 with $p = .1, .2, .3, .4$.

Table A.33: Node locations and demands for SD20 and MDA20.

No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$	No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$
0	0.00	0.00	0	0	0	0	0	35	15.00	-25.98	60	56	63	72	84
1	10.00	0.00	60	56	63	72	84	36	25.98	-15.00	90	56	63	72	84
2	8.66	5.00	90	56	63	72	84	37	40.00	0.00	60	94	87	78	66
3	5.00	8.66	60	56	63	72	84	38	34.64	20.00	90	94	87	78	66
4	0.00	10.00	90	56	63	72	84	39	20.00	34.64	60	94	87	78	66
5	-5.00	8.66	60	56	63	72	84	40	0.00	40.00	90	94	87	78	66
6	-8.66	5.00	90	56	63	72	84	41	-20.00	34.64	60	94	87	78	66
7	-10.00	0.00	60	56	63	72	84	42	-34.64	20.00	90	94	87	78	66
8	-8.66	-5.00	90	56	63	72	84	43	-40.00	0.00	60	94	87	78	66
9	-5.00	-8.66	60	56	63	72	84	44	-34.64	-20.00	90	94	87	78	66
10	0.00	-10.00	90	56	63	72	84	45	-20.00	-34.64	60	94	87	78	66
11	5.00	-8.66	60	56	63	72	84	46	-0.01	-40.00	90	94	87	78	66
12	8.66	-5.00	90	56	63	72	84	47	19.99	-34.64	60	94	87	78	66
13	20.00	0.00	60	94	87	78	66	48	34.64	-20.01	90	94	87	78	66
14	17.32	10.00	90	94	87	78	66	49	50.00	0.00	60	56	63	72	84
15	10.00	17.32	60	94	87	78	66	50	43.30	25.00	90	56	63	72	84
16	0.00	20.00	90	94	87	78	66	51	25.00	43.30	60	56	63	72	84
17	-10.00	17.32	60	94	87	78	66	52	0.00	50.00	90	56	63	72	84
18	-17.32	10.00	90	94	87	78	66	53	-25.00	43.30	60	56	63	72	84
19	-20.00	0.00	60	94	87	78	66	54	-43.30	25.00	90	56	63	72	84
20	-17.32	-10.00	90	94	87	78	66	55	-50.00	0.00	60	56	63	72	84
21	-10.00	-17.32	60	94	87	78	66	56	-43.30	-25.00	90	56	63	72	84
22	0.00	-20.00	90	94	87	78	66	57	-25.01	-43.30	60	56	63	72	84
23	10.00	-17.32	60	94	87	78	66	58	-0.01	-50.00	90	56	63	72	84
24	17.32	-10.00	90	94	87	78	66	59	24.99	-43.31	60	56	63	72	84
25	30.00	0.00	60	56	63	72	84	60	43.30	-25.01	90	56	63	72	84
26	25.98	15.00	90	56	63	72	84	61	60.00	0.00	60	94	87	78	66
27	15.00	25.98	60	56	63	72	84	62	51.96	30.00	90	94	87	78	66
28	0.00	30.00	90	56	63	72	84	63	30.00	51.96	60	94	87	78	66
29	-15.00	25.98	60	56	63	72	84	64	0.00	60.00	90	94	87	78	66
30	-25.98	15.00	90	56	63	72	84	65	-30.00	51.96	60	94	87	78	66
31	-30.00	0.00	60	56	63	72	84	66	-51.96	30.00	90	94	87	78	66
32	-25.98	-15.00	90	56	63	72	84	67	-60.00	0.01	60	94	87	78	66
33	-15.00	-25.98	60	56	63	72	84	68	-51.96	-29.99	90	94	87	78	66
34	0.00	-30.00	90	56	63	72	84	69	-30.01	-51.96	60	94	87	78	66

(cont.)

Table A.33 continued.

No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$	No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$
70	-0.01	-60.00	90	94	87	78	66	105	-45.01	-77.94	60	56	63	72	84
71	29.99	-51.97	60	94	87	78	66	106	-0.01	-90.00	90	56	63	72	84
72	51.96	-30.01	90	94	87	78	66	107	44.99	-77.95	60	56	63	72	84
73	70.00	0.00	60	56	63	72	84	108	77.93	-45.01	90	56	63	72	84
74	60.62	35.00	90	56	63	72	84	109	100.00	0.00	60	94	87	78	66
75	35.00	60.62	60	56	63	72	84	110	86.60	50.00	90	94	87	78	66
76	0.00	70.00	90	56	63	72	84	111	50.00	86.60	60	94	87	78	66
77	-35.00	60.62	60	56	63	72	84	112	0.00	100.00	90	94	87	78	66
78	-60.62	35.00	90	56	63	72	84	113	-49.99	86.61	60	94	87	78	66
79	-70.00	0.01	60	56	63	72	84	114	-86.60	50.01	90	94	87	78	66
80	-60.63	-34.99	90	56	63	72	84	115	-100.00	0.01	60	94	87	78	66
81	-35.01	-60.62	60	56	63	72	84	116	-86.61	-49.99	90	94	87	78	66
82	-0.01	-70.00	90	56	63	72	84	117	-50.01	-86.60	60	94	87	78	66
83	34.99	-60.63	60	56	63	72	84	118	-0.01	-100.00	90	94	87	78	66
84	60.62	-35.01	90	56	63	72	84	119	49.99	-86.61	60	94	87	78	66
85	80.00	0.00	60	94	87	78	66	120	86.59	-50.01	90	94	87	78	66
86	69.28	40.00	90	94	87	78	66	121	110.00	0.00	60	56	63	72	84
87	40.00	69.28	60	94	87	78	66	122	95.26	55.00	90	56	63	72	84
88	0.00	80.00	90	94	87	78	66	123	55.00	95.26	60	56	63	72	84
89	-40.00	69.28	60	94	87	78	66	124	0.01	110.00	90	56	63	72	84
90	-69.28	40.01	90	94	87	78	66	125	-54.99	95.27	60	56	63	72	84
91	-80.00	0.01	60	94	87	78	66	126	-95.26	55.01	90	56	63	72	84
92	-69.29	-39.99	90	94	87	78	66	127	-110.00	0.01	60	56	63	72	84
93	-40.01	-69.28	60	94	87	78	66	128	-95.27	-54.99	90	56	63	72	84
94	-0.01	-80.00	90	94	87	78	66	129	-55.01	-95.26	60	56	63	72	84
95	39.99	-69.29	60	94	87	78	66	130	-0.02	-110.00	90	56	63	72	84
96	69.28	-40.01	90	94	87	78	66	131	54.99	-95.27	60	56	63	72	84
97	90.00	0.00	60	56	63	72	84	132	95.25	-55.02	90	56	63	72	84
98	77.94	45.00	90	56	63	72	84	133	120.00	0.00	60	94	87	78	66
99	45.00	77.94	60	56	63	72	84	134	103.92	60.00	90	94	87	78	66
100	0.00	90.00	90	56	63	72	84	135	60.00	103.92	60	94	87	78	66
101	-45.00	77.95	60	56	63	72	84	136	0.01	120.00	90	94	87	78	66
102	-77.94	45.01	90	56	63	72	84	137	-59.99	103.93	60	94	87	78	66
103	-90.00	0.01	60	56	63	72	84	138	-103.92	60.01	90	94	87	78	66
104	-77.95	-44.99	90	56	63	72	84	139	-120.00	0.01	60	94	87	78	66

(cont.)

Table A.33 continued.

No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$	No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$
140	-103.93	-59.99	90	94	87	78	66	175	-150.00	0.01	60	56	63	72	84
141	-60.01	-103.92	60	94	87	78	66	176	-129.91	-74.99	90	56	63	72	84
142	-0.02	-120.00	90	94	87	78	66	177	-75.02	-129.89	60	56	63	72	84
143	59.98	-103.93	60	94	87	78	66	178	-0.02	-150.00	90	56	63	72	84
144	103.91	-60.02	90	94	87	78	66	179	74.98	-129.92	60	56	63	72	84
145	130.00	0.00	60	56	63	72	84	180	129.89	-75.02	90	56	63	72	84
146	112.58	65.00	90	56	63	72	84	181	160.00	0.00	60	94	87	78	66
147	65.00	112.58	60	56	63	72	84	182	138.57	80.00	90	94	87	78	66
148	0.01	130.00	90	56	63	72	84	183	80.00	138.56	60	94	87	78	66
149	-64.99	112.59	60	56	63	72	84	184	0.01	160.00	90	94	87	78	66
150	-112.58	65.01	90	56	63	72	84	185	-79.99	138.57	60	94	87	78	66
151	-130.00	0.01	60	56	63	72	84	186	-138.56	80.01	90	94	87	78	66
152	-112.59	-64.99	90	56	63	72	84	187	-160.00	0.01	60	94	87	78	66
153	-65.01	-112.58	60	56	63	72	84	188	-138.57	-79.99	90	94	87	78	66
154	-0.02	-130.00	90	56	63	72	84	189	-80.02	-138.55	60	94	87	78	66
155	64.98	-112.59	60	56	63	72	84	190	-0.02	-160.00	90	94	87	78	66
156	112.57	-65.02	90	56	63	72	84	191	79.98	-138.58	60	94	87	78	66
157	140.00	0.00	60	94	87	78	66	192	138.55	-80.02	90	94	87	78	66
158	121.24	70.00	90	94	87	78	66	193	170.00	0.00	60	56	63	72	84
159	70.00	121.24	60	94	87	78	66	194	147.23	85.00	90	56	63	72	84
160	0.01	140.00	90	94	87	78	66	195	85.00	147.22	60	56	63	72	84
161	-69.99	121.25	60	94	87	78	66	196	0.01	170.00	90	56	63	72	84
162	-121.24	70.01	90	94	87	78	66	197	-84.99	147.23	60	56	63	72	84
163	-140.00	0.01	60	94	87	78	66	198	-147.22	85.01	90	56	63	72	84
164	-121.25	-69.99	90	94	87	78	66	199	-170.00	0.02	60	56	63	72	84
165	-70.01	-121.23	60	94	87	78	66	200	-147.23	-84.98	90	56	63	72	84
166	-0.02	-140.00	90	94	87	78	66	201	-85.02	-147.21	60	56	63	72	84
167	69.98	-121.25	60	94	87	78	66	202	-0.02	-170.00	90	56	63	72	84
168	121.23	-70.02	90	94	87	78	66	203	84.98	-147.24	60	56	63	72	84
169	150.00	0.00	60	56	63	72	84	204	147.21	-85.03	90	56	63	72	84
170	129.90	75.00	90	56	63	72	84	205	180.00	0.00	60	94	87	78	66
171	75.00	129.90	60	56	63	72	84	206	155.89	90.00	90	94	87	78	66
172	0.01	150.00	90	56	63	72	84	207	90.00	155.88	60	94	87	78	66
173	-74.99	129.91	60	56	63	72	84	208	0.01	180.00	90	94	87	78	66
174	-129.90	75.01	90	56	63	72	84	209	-89.99	155.89	60	94	87	78	66

(cont.)

Table A.33 continued.

No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$	No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$
210	-155.88	90.01	90	94	87	78	66	226	-0.03	-190.00	90	56	63	72	84
211	-180.00	0.02	60	94	87	78	66	227	94.97	-164.56	60	56	63	72	84
212	-155.89	-89.98	90	94	87	78	66	228	164.53	-95.03	90	56	63	72	84
213	-90.02	-155.87	60	94	87	78	66	229	200.00	0.00	60	94	87	78	66
214	-0.03	-180.00	90	94	87	78	66	230	173.21	100.00	90	94	87	78	66
215	89.98	-155.90	60	94	87	78	66	231	100.01	173.20	60	94	87	78	66
216	155.87	-90.03	90	94	87	78	66	232	0.01	200.00	90	94	87	78	66
217	190.00	0.00	60	56	63	72	84	233	-99.99	173.21	60	94	87	78	66
218	164.55	95.00	90	56	63	72	84	234	-173.20	100.01	90	94	87	78	66
219	95.01	164.54	60	56	63	72	84	235	-200.00	0.02	60	94	87	78	66
220	0.01	190.00	90	56	63	72	84	236	-173.22	-99.98	90	94	87	78	66
221	-94.99	164.55	60	56	63	72	84	237	-100.02	-173.19	60	94	87	78	66
222	-164.54	95.01	90	56	63	72	84	238	-0.03	-200.00	90	94	87	78	66
223	-190.00	0.02	60	56	63	72	84	239	99.97	-173.22	60	94	87	78	66
224	-164.56	-94.98	90	56	63	72	84	240	173.19	-100.03	90	94	87	78	66
225	-95.02	-164.53	60	56	63	72	84								

Note: demands are denoted by D for SD20 and D_p for MDA20 with $p = .1, .2, .3, .4$.

Table A.34: Node locations and demands for SD21 and MDA21.

No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$	No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$
0	0.00	0.00	0	0	0	0	0	35	-9.85	1.74	60	56	63	72	84
1	10.00	0.00	60	56	63	72	84	36	-9.96	0.87	90	56	63	72	84
2	9.96	0.87	90	56	63	72	84	37	-10.00	0.00	60	56	63	72	84
3	9.85	1.74	60	56	63	72	84	38	-9.96	-0.87	90	56	63	72	84
4	9.66	2.59	90	56	63	72	84	39	-9.85	-1.74	60	56	63	72	84
5	9.40	3.42	60	56	63	72	84	40	-9.66	-2.59	90	56	63	72	84
6	9.06	4.23	90	56	63	72	84	41	-9.40	-3.42	60	56	63	72	84
7	8.66	5.00	60	56	63	72	84	42	-9.06	-4.23	90	56	63	72	84
8	8.19	5.74	90	56	63	72	84	43	-8.66	-5.00	60	56	63	72	84
9	7.66	6.43	60	56	63	72	84	44	-8.19	-5.73	90	56	63	72	84
10	7.07	7.07	90	56	63	72	84	45	-7.66	-6.43	60	56	63	72	84
11	6.43	7.66	60	56	63	72	84	46	-7.07	-7.07	90	56	63	72	84
12	5.74	8.19	90	56	63	72	84	47	-6.43	-7.66	60	56	63	72	84
13	5.00	8.66	60	56	63	72	84	48	-5.74	-8.19	90	56	63	72	84
14	4.23	9.06	90	56	63	72	84	49	-5.00	-8.66	60	56	63	72	84
15	3.42	9.40	60	56	63	72	84	50	-4.23	-9.06	90	56	63	72	84
16	2.59	9.66	90	56	63	72	84	51	-3.42	-9.40	60	56	63	72	84
17	1.74	9.85	60	56	63	72	84	52	-2.59	-9.66	90	56	63	72	84
18	0.87	9.96	90	56	63	72	84	53	-1.74	-9.85	60	56	63	72	84
19	0.00	10.00	60	56	63	72	84	54	-0.87	-9.96	90	56	63	72	84
20	-0.87	9.96	90	56	63	72	84	55	0.00	-10.00	60	56	63	72	84
21	-1.74	9.85	60	56	63	72	84	56	0.87	-9.96	90	56	63	72	84
22	-2.59	9.66	90	56	63	72	84	57	1.74	-9.85	60	56	63	72	84
23	-3.42	9.40	60	56	63	72	84	58	2.59	-9.66	90	56	63	72	84
24	-4.23	9.06	90	56	63	72	84	59	3.42	-9.40	60	56	63	72	84
25	-5.00	8.66	60	56	63	72	84	60	4.22	-9.06	90	56	63	72	84
26	-5.74	8.19	90	56	63	72	84	61	5.00	-8.66	60	56	63	72	84
27	-6.43	7.66	60	56	63	72	84	62	5.73	-8.19	90	56	63	72	84
28	-7.07	7.07	90	56	63	72	84	63	6.43	-7.66	60	56	63	72	84
29	-7.66	6.43	60	56	63	72	84	64	7.07	-7.07	90	56	63	72	84
30	-8.19	5.74	90	56	63	72	84	65	7.66	-6.43	60	56	63	72	84
31	-8.66	5.00	60	56	63	72	84	66	8.19	-5.74	90	56	63	72	84
32	-9.06	4.23	90	56	63	72	84	67	8.66	-5.00	60	56	63	72	84
33	-9.40	3.42	60	56	63	72	84	68	9.06	-4.23	90	56	63	72	84
34	-9.66	2.59	90	56	63	72	84	69	9.40	-3.42	60	56	63	72	84

(cont.)

Table A.34 continued.

No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$	No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$
70	9.66	-2.59	90	56	63	72	84	105	-18.79	6.84	60	94	87	78	66
71	9.85	-1.74	60	56	63	72	84	106	-19.32	5.18	90	94	87	78	66
72	9.96	-0.87	90	56	63	72	84	107	-19.70	3.47	60	94	87	78	66
73	20.00	0.00	60	94	87	78	66	108	-19.92	1.74	90	94	87	78	66
74	19.92	1.74	90	94	87	78	66	109	-20.00	0.00	60	94	87	78	66
75	19.70	3.47	60	94	87	78	66	110	-19.92	-1.74	90	94	87	78	66
76	19.32	5.18	90	94	87	78	66	111	-19.70	-3.47	60	94	87	78	66
77	18.79	6.84	60	94	87	78	66	112	-19.32	-5.17	90	94	87	78	66
78	18.13	8.45	90	94	87	78	66	113	-18.79	-6.84	60	94	87	78	66
79	17.32	10.00	60	94	87	78	66	114	-18.13	-8.45	90	94	87	78	66
80	16.38	11.47	90	94	87	78	66	115	-17.32	-10.00	60	94	87	78	66
81	15.32	12.86	60	94	87	78	66	116	-16.38	-11.47	90	94	87	78	66
82	14.14	14.14	90	94	87	78	66	117	-15.32	-12.85	60	94	87	78	66
83	12.86	15.32	60	94	87	78	66	118	-14.14	-14.14	90	94	87	78	66
84	11.47	16.38	90	94	87	78	66	119	-12.86	-15.32	60	94	87	78	66
85	10.00	17.32	60	94	87	78	66	120	-11.47	-16.38	90	94	87	78	66
86	8.45	18.13	90	94	87	78	66	121	-10.00	-17.32	60	94	87	78	66
87	6.84	18.79	60	94	87	78	66	122	-8.45	-18.13	90	94	87	78	66
88	5.18	19.32	90	94	87	78	66	123	-6.84	-18.79	60	94	87	78	66
89	3.47	19.70	60	94	87	78	66	124	-5.18	-19.32	90	94	87	78	66
90	1.74	19.92	90	94	87	78	66	125	-3.48	-19.70	60	94	87	78	66
91	0.00	20.00	60	94	87	78	66	126	-1.75	-19.92	90	94	87	78	66
92	-1.74	19.92	90	94	87	78	66	127	0.00	-20.00	60	94	87	78	66
93	-3.47	19.70	60	94	87	78	66	128	1.74	-19.92	90	94	87	78	66
94	-5.18	19.32	90	94	87	78	66	129	3.47	-19.70	60	94	87	78	66
95	-6.84	18.79	60	94	87	78	66	130	5.17	-19.32	90	94	87	78	66
96	-8.45	18.13	90	94	87	78	66	131	6.84	-18.79	60	94	87	78	66
97	-10.00	17.32	60	94	87	78	66	132	8.45	-18.13	90	94	87	78	66
98	-11.47	16.38	90	94	87	78	66	133	10.00	-17.32	60	94	87	78	66
99	-12.85	15.32	60	94	87	78	66	134	11.47	-16.38	90	94	87	78	66
100	-14.14	14.14	90	94	87	78	66	135	12.85	-15.32	60	94	87	78	66
101	-15.32	12.86	60	94	87	78	66	136	14.14	-14.14	90	94	87	78	66
102	-16.38	11.47	90	94	87	78	66	137	15.32	-12.86	60	94	87	78	66
103	-17.32	10.00	60	94	87	78	66	138	16.38	-11.47	90	94	87	78	66
104	-18.13	8.45	90	94	87	78	66	139	17.32	-10.00	60	94	87	78	66

(cont.)

Table A.34 continued.

No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$	No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$
140	18.12	-8.46	90	94	87	78	66	175	-25.98	15.00	60	56	63	72	84
141	18.79	-6.84	60	94	87	78	66	176	-27.19	12.68	90	56	63	72	84
142	19.32	-5.18	90	94	87	78	66	177	-28.19	10.26	60	56	63	72	84
143	19.70	-3.48	60	94	87	78	66	178	-28.98	7.77	90	56	63	72	84
144	19.92	-1.75	90	94	87	78	66	179	-29.54	5.21	60	56	63	72	84
145	30.00	0.00	60	56	63	72	84	180	-29.89	2.62	90	56	63	72	84
146	29.89	2.61	90	56	63	72	84	181	-30.00	0.00	60	56	63	72	84
147	29.54	5.21	60	56	63	72	84	182	-29.89	-2.61	90	56	63	72	84
148	28.98	7.76	90	56	63	72	84	183	-29.54	-5.21	60	56	63	72	84
149	28.19	10.26	60	56	63	72	84	184	-28.98	-7.76	90	56	63	72	84
150	27.19	12.68	90	56	63	72	84	185	-28.19	-10.26	60	56	63	72	84
151	25.98	15.00	60	56	63	72	84	186	-27.19	-12.68	90	56	63	72	84
152	24.57	17.21	90	56	63	72	84	187	-25.98	-15.00	60	56	63	72	84
153	22.98	19.28	60	56	63	72	84	188	-24.58	-17.20	90	56	63	72	84
154	21.21	21.21	90	56	63	72	84	189	-22.98	-19.28	60	56	63	72	84
155	19.28	22.98	60	56	63	72	84	190	-21.22	-21.21	90	56	63	72	84
156	17.21	24.57	90	56	63	72	84	191	-19.29	-22.98	60	56	63	72	84
157	15.00	25.98	60	56	63	72	84	192	-17.21	-24.57	90	56	63	72	84
158	12.68	27.19	90	56	63	72	84	193	-15.00	-25.98	60	56	63	72	84
159	10.26	28.19	60	56	63	72	84	194	-12.68	-27.19	90	56	63	72	84
160	7.77	28.98	90	56	63	72	84	195	-10.26	-28.19	60	56	63	72	84
161	5.21	29.54	60	56	63	72	84	196	-7.77	-28.98	90	56	63	72	84
162	2.62	29.89	90	56	63	72	84	197	-5.21	-29.54	60	56	63	72	84
163	0.00	30.00	60	56	63	72	84	198	-2.62	-29.89	90	56	63	72	84
164	-2.61	29.89	90	56	63	72	84	199	0.00	-30.00	60	56	63	72	84
165	-5.21	29.54	60	56	63	72	84	200	2.61	-29.89	90	56	63	72	84
166	-7.76	28.98	90	56	63	72	84	201	5.21	-29.54	60	56	63	72	84
167	-10.26	28.19	60	56	63	72	84	202	7.76	-28.98	90	56	63	72	84
168	-12.68	27.19	90	56	63	72	84	203	10.26	-28.19	60	56	63	72	84
169	-15.00	25.98	60	56	63	72	84	204	12.67	-27.19	90	56	63	72	84
170	-17.21	24.58	90	56	63	72	84	205	15.00	-25.98	60	56	63	72	84
171	-19.28	22.98	60	56	63	72	84	206	17.20	-24.58	90	56	63	72	84
172	-21.21	21.21	90	56	63	72	84	207	19.28	-22.98	60	56	63	72	84
173	-22.98	19.29	60	56	63	72	84	208	21.21	-21.22	90	56	63	72	84
174	-24.57	17.21	90	56	63	72	84	209	22.98	-19.29	60	56	63	72	84

(cont.)

Table A.34 continued.

No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$	No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$
210	24.57	-17.21	90	56	63	72	84	245	-30.64	25.71	60	94	87	78	66
211	25.98	-15.00	60	56	63	72	84	246	-32.76	22.95	90	94	87	78	66
212	27.19	-12.68	90	56	63	72	84	247	-34.64	20.00	60	94	87	78	66
213	28.19	-10.27	60	56	63	72	84	248	-36.25	16.91	90	94	87	78	66
214	28.98	-7.77	90	56	63	72	84	249	-37.59	13.68	60	94	87	78	66
215	29.54	-5.21	60	56	63	72	84	250	-38.64	10.36	90	94	87	78	66
216	29.89	-2.62	90	56	63	72	84	251	-39.39	6.95	60	94	87	78	66
217	40.00	0.00	60	94	87	78	66	252	-39.85	3.49	90	94	87	78	66
218	39.85	3.49	90	94	87	78	66	253	-40.00	0.00	60	94	87	78	66
219	39.39	6.95	60	94	87	78	66	254	-39.85	-3.48	90	94	87	78	66
220	38.64	10.35	90	94	87	78	66	255	-39.39	-6.94	60	94	87	78	66
221	37.59	13.68	60	94	87	78	66	256	-38.64	-10.35	90	94	87	78	66
222	36.25	16.90	90	94	87	78	66	257	-37.59	-13.68	60	94	87	78	66
223	34.64	20.00	60	94	87	78	66	258	-36.25	-16.90	90	94	87	78	66
224	32.77	22.94	90	94	87	78	66	259	-34.64	-20.00	60	94	87	78	66
225	30.64	25.71	60	94	87	78	66	260	-32.77	-22.94	90	94	87	78	66
226	28.28	28.28	90	94	87	78	66	261	-30.64	-25.71	60	94	87	78	66
227	25.71	30.64	60	94	87	78	66	262	-28.29	-28.28	90	94	87	78	66
228	22.94	32.77	90	94	87	78	66	263	-25.72	-30.64	60	94	87	78	66
229	20.00	34.64	60	94	87	78	66	264	-22.95	-32.76	90	94	87	78	66
230	16.91	36.25	90	94	87	78	66	265	-20.00	-34.64	60	94	87	78	66
231	13.68	37.59	60	94	87	78	66	266	-16.91	-36.25	90	94	87	78	66
232	10.35	38.64	90	94	87	78	66	267	-13.69	-37.59	60	94	87	78	66
233	6.95	39.39	60	94	87	78	66	268	-10.36	-38.64	90	94	87	78	66
234	3.49	39.85	90	94	87	78	66	269	-6.95	-39.39	60	94	87	78	66
235	0.00	40.00	60	94	87	78	66	270	-3.49	-39.85	90	94	87	78	66
236	-3.48	39.85	90	94	87	78	66	271	-0.01	-40.00	60	94	87	78	66
237	-6.94	39.39	60	94	87	78	66	272	3.48	-39.85	90	94	87	78	66
238	-10.35	38.64	90	94	87	78	66	273	6.94	-39.39	60	94	87	78	66
239	-13.68	37.59	60	94	87	78	66	274	10.35	-38.64	90	94	87	78	66
240	-16.90	36.25	90	94	87	78	66	275	13.68	-37.59	60	94	87	78	66
241	-20.00	34.64	60	94	87	78	66	276	16.90	-36.25	90	94	87	78	66
242	-22.94	32.77	90	94	87	78	66	277	19.99	-34.64	60	94	87	78	66
243	-25.71	30.64	60	94	87	78	66	278	22.94	-32.77	90	94	87	78	66
244	-28.28	28.29	90	94	87	78	66	279	25.71	-30.65	60	94	87	78	66

(cont.)

Table A.34 continued.

No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$	No.	x	y	D	$D_{.1}$	$D_{.2}$	$D_{.3}$	$D_{.4}$
280	28.28	-28.29	90	94	87	78	66	285	37.59	-13.69	60	94	87	78	66
281	30.64	-25.72	60	94	87	78	66	286	38.64	-10.36	90	94	87	78	66
282	32.76	-22.95	90	94	87	78	66	287	39.39	-6.95	60	94	87	78	66
283	34.64	-20.01	60	94	87	78	66	288	39.85	-3.49	90	94	87	78	66
284	36.25	-16.91	90	94	87	78	66								

Note: demands are denoted by D for SD21 and D_p for MDA21 with $p = .1, .2, .3, .4$.

Table A.35: EMIP-MDA+ERTR solution to CH1.

No.	Route	Load	Distance
1	0 27(15) 48(17) 23(16) 7(19) 43(11) 24(10) 25(28) 14(21) 6(15) 0	152	98.45
2	0 11(19) 2(30) 29(6) 21(8) 16(15) 50(10) 34(26) 30(19) 9(11) 38(15) 0	159	99.33
3	0 8(23) 26(7) 31(11) 28(14) 3(16) 36(6) 35(17) 20(28) 22(8) 1(7) 32(12) 0	149	118.52
4	0 46(5) 5(21) 49(18) 10(5) 39(14) 33(23) 45(10) 15(10) 44(16) 37(9) 12(29) 0	160	99.25
5	0 18(41) 13(23) 41(27) 40(7) 19(9) 42(13) 17(3) 4(9) 47(25) 0	157	109.06
		Total Distance	524.61

Table A.36: EMIP-MDA+ERTR solution to CH2.

No.	Route	Load	Distance
1	0 38(24) 65(9) 66(37) 11(37) 53(22) 0	129	77.16
2	0 68(10) 2(26) 74(10) 21(28) 47(19) 48(20) 30(22) 0	135	63.87
3	0 4(30) 45(21) 27(17) 52(19) 46(27) 34(19) 0	133	41.90
4	0 62(18) 28(29) 61(15) 22(12) 1(18) 33(27) 6(19) 0	138	86.75
5	0 57(14) 15(8) 37(14) 20(22) 70(11) 60(13) 71(3) 69(8) 36(12) 5(21) 29(13) 0	139	114.76
6	0 8(16) 13(12) 54(16) 19(15) 59(24) 14(31) 35(10) 7(15) 0	139	101.99
7	0 58(21) 10(26) 31(25) 55(7) 25(14) 9(29) 39(16) 72(1) 0	139	110.55
8	0 75(20) 67(30) 26(18) 12(16) 40(33) 17(20) 0	137	43.41
9	0 51(12) 49(5) 24(27) 18(13) 50(22) 32(28) 44(17) 3(11) 0	135	89.66
10	0 16(19) 63(11) 23(6) 56(26) 41(15) 64(28) 42(11) 43(18) 73(6) 0	140	109.72
		Total Distance	839.77

Table A.37: EMIP-MDA+ERTR solution to CH4.

No.	Route	Load	Distance
1	0 142(2) 87(8) 150(17) 141(1) 41(27) 94(18) 19(9) 64(20) 88(16) 40(7) 136(35) 66(19) 111(13) 56(3) 0	195	102.11
2	0 11(19) 100(13) 2(30) 83(11) 131(26) 129(23) 53(13) 127(14) 16(15) 78(16) 0	180	60.71
3	0 32(12) 51(10) 22(8) 80(21) 70(9) 28(14) 31(11) 82(23) 8(23) 60(16) 81(27) 27(15) 0	189	81.95
4	0 46(5) 138(9) 48(17) 112(19) 61(12) 7(19) 69(17) 23(16) 98(36) 132(16) 57(5) 6(15) 102(9) 0	195	82.81
5	0 144(27) 145(20) 109(28) 148(10) 135(41) 143(22) 4(9) 149(9) 146(11) 0	177	49.19
6	0 123(9) 125(18) 106(6) 73(29) 117(25) 89(31) 39(14) 75(6) 105(2) 54(19) 10(5) 49(18) 76(17) 0	199	110.88
7	0 68(12) 14(21) 58(9) 96(1) 24(10) 97(27) 86(5) 43(11) 99(30) 114(9) 113(10) 26(7) 140(3) 120(5) 1(7) 119(6) 77(16) 0	189	129.36
8	0 139(15) 18(41) 110(3) 133(11) 25(28) 95(16) 67(2) 13(23) 134(7) 55(26) 47(25) 0	197	77.84
9	0 12(29) 63(23) 17(3) 147(12) 92(5) 42(13) 93(7) 65(8) 107(7) 44(16) 137(26) 37(9) 0	158	79.22
10	0 9(11) 104(18) 30(19) 34(26) 74(3) 79(9) 21(8) 118(36) 130(6) 50(10) 62(19) 38(15) 0	180	76.04
11	0 126(13) 29(6) 128(3) 84(14) 35(17) 85(8) 36(6) 115(20) 121(15) 116(25) 3(16) 59(16) 20(28) 101(10) 0	197	131.28
12	0 103(14) 108(18) 52(7) 15(10) 45(10) 91(5) 72(18) 33(23) 124(8) 122(25) 71(11) 90(9) 5(21) 0	179	66.01
		Total Distance	1047.40

Table A.38: EMIP-MDA+ERTR solution to CH5.

No.	Route	Load	Distance
1	0 149(13) 51(30) 7(15) 132(11) 180(26) 35(10) 102(13) 8(16) 176(14) 46(27) 175(13) 0	188	59.36
2	0 3(11) 55(15) 44(17) 106(5) 147(36) 73(10) 145(1) 24(27) 107(9) 63(21) 117(12) 16(19) 188(15) 0	198	80.71
3	0 81(12) 50(7) 71(8) 129(21) 10(26) 77(14) 119(9) 38(24) 165(25) 52(16) 150(10) 100(10) 26(18) 0	200	93.43
4	0 197(10) 41(15) 90(27) 143(18) 68(9) 42(11) 113(20) 137(16) 89(7) 185(35) 115(19) 160(13) 0	200	103.47
5	0 69(28) 108(16) 11(37) 170(15) 164(20) 85(6) 134(8) 84(17) 14(31) 133(14) 177(3) 0	195	113.53
6	0 66(3) 196(12) 191(2) 1(18) 136(8) 199(17) 43(18) 190(1) 184(41) 192(22) 158(28) 53(9) 198(9) 195(11) 0	199	58.22
7	0 61(29) 6(19) 0	48	10.06
8	0 96(25) 67(41) 159(3) 182(11) 49(5) 74(28) 144(16) 116(2) 62(23) 23(6) 183(7) 104(26) 105(3) 0	196	80.06
9	0 60(19) 178(23) 78(6) 19(15) 70(8) 128(9) 123(3) 13(12) 83(26) 153(18) 45(21) 98(18) 125(17) 0	195	81.42
10	0 95(5) 187(9) 97(17) 161(19) 9(29) 109(16) 39(16) 40(33) 76(15) 17(20) 126(16) 0	195	58.60
11	0 181(16) 18(13) 146(27) 135(5) 92(11) 148(30) 163(9) 31(25) 131(23) 80(11) 169(5) 12(16) 168(6) 0	197	125.32
12	0 112(23) 86(9) 93(16) 156(7) 114(8) 142(7) 91(13) 141(5) 22(12) 186(26) 194(20) 193(27) 33(27) 0	200	81.43
13	0 87(15) 4(30) 111(19) 58(11) 27(17) 99(10) 179(6) 167(36) 65(15) 34(19) 127(16) 0	194	48.77
14	0 152(14) 120(11) 171(25) 174(18) 122(29) 36(12) 155(6) 47(19) 48(20) 30(22) 54(21) 0	197	73.46
15	0 157(18) 2(26) 101(7) 28(29) 64(10) 94(10) 140(5) 121(18) 82(23) 173(8) 21(28) 172(9) 139(9) 0	200	65.43
16	0 59(5) 103(19) 5(21) 88(14) 37(14) 138(31) 166(25) 20(22) 124(6) 154(2) 15(8) 79(19) 29(13) 0	199	96.24
17	0 151(9) 32(28) 72(16) 118(17) 56(19) 25(14) 110(12) 75(7) 162(10) 189(3) 57(23) 130(27) 0	185	86.19
		Total Distance	1315.70

Table A.39: EMIP-MDA+ERTR solution to CH11.

No.	Route	Load	Distance
1	0 88(4) 2(7) 1(25) 3(13) 4(6) 5(14) 6(5) 7(11) 9(5) 10(15) 11(15) 15(18) 14(12) 13(13) 12(17) 8(19) 0	199	134.96
2	0 17(18) 16(13) 19(17) 25(16) 22(12) 24(8) 27(6) 33(7) 30(11) 31(10) 34(2) 36(4) 29(9) 35(4) 32(3) 28(5) 26(15) 23(13) 20(4) 21(7) 109(13) 0	197	207.94
3	0 87(21) 92(16) 93(7) 96(11) 94(10) 97(17) 115(11) 110(7) 98(12) 116(10) 103(12) 104(7) 99(11) 101(9) 102(11) 105(8) 120(13) 0	193	74.56
4	0 100(7) 53(11) 55(14) 58(16) 56(10) 60(5) 63(16) 66(13) 64(14) 62(7) 61(17) 65(17) 59(19) 57(8) 54(12) 52(13) 0	199	213.63
5	0 107(5) 67(17) 69(14) 70(16) 71(7) 74(11) 72(13) 75(35) 78(7) 80(10) 79(3) 77(28) 68(13) 76(5) 73(9) 106(6) 0	199	144.55
6	0 40(17) 43(16) 45(9) 48(13) 51(21) 50(4) 49(5) 47(7) 46(11) 44(10) 41(20) 42(14) 39(12) 38(14) 37(18) 95(9) 0	200	199.63
7	0 119(20) 81(7) 112(8) 84(10) 117(7) 113(11) 83(11) 108(12) 118(4) 18(12) 114(13) 90(16) 91(4) 89(15) 85(8) 86(11) 111(7) 82(12) 0	188	66.96
		Total Distance	1042.24

Table A.40: EMIP-MDA+ERTR solution to CH12.

No.	Route	Load	Distance
1	0 98(20) 96(10) 95(30) 94(10) 92(20) 93(40) 97(30) 100(20) 99(10) 0	190	95.94
2	0 75(20) 1(10) 2(30) 4(10) 6(20) 9(10) 11(10) 8(20) 7(20) 3(10) 5(10) 0	170	56.17
3	0 20(10) 24(10) 25(40) 27(10) 29(10) 30(10) 28(20) 26(10) 23(10) 22(20) 21(20) 0	170	50.80
4	0 34(20) 36(10) 39(20) 38(30) 37(20) 35(10) 31(20) 33(40) 32(30) 0	200	97.23
5	0 47(10) 49(10) 52(10) 50(10) 51(10) 48(10) 45(10) 46(30) 44(10) 40(10) 41(10) 42(20) 43(10) 0	160	64.81
6	0 57(40) 59(10) 60(20) 58(30) 56(30) 53(20) 54(40) 55(10) 0	200	101.88
7	0 67(10) 65(10) 63(50) 74(50) 62(20) 66(10) 0	150	43.59
8	0 81(30) 78(20) 76(10) 71(20) 70(30) 73(10) 77(10) 79(10) 80(10) 72(10) 61(10) 64(10) 68(10) 69(10) 0	200	137.02
9	0 91(10) 89(10) 88(30) 85(30) 84(20) 82(20) 83(10) 86(10) 87(20) 90(10) 0	170	76.07
10	0 10(10) 12(20) 14(10) 16(40) 15(40) 19(10) 18(20) 17(20) 13(30) 0	200	96.04
		Total Distance	819.56

Table A.41: EMIP-MDA+ERTR solution to S51D2.

No.	Route	Load	Distance
1	0 8(22) 26(18) 31(37) 28(23) 22(18) 1(33) 0	151	76.62
2	0 32(23) 20(21) 35(45) 36(22) 3(46) 0	157	90.27
3	0 11(46) 16(18) 50(20) 9(24) 49(47) 0	155	61.39
4	0 46(19) 0	19	4.47
5	0 13(37) 41(36) 40(20) 19(32) 42(18) 12(17) 0	160	102.07
6	0 24(23) 43(43) 7(47) 23(20) 48(19) 0	152	80.58
7	0 27(24) 6(21) 14(19) 25(43) 18(18) 47(33) 0	158	62.43
8	0 38(18) 30(18) 34(18) 21(47) 29(33) 2(23) 0	157	84.13
9	0 45(43) 33(19) 39(47) 10(20) 5(21) 0	150	90.60
10	0 4(28) 17(45) 44(17) 15(41) 37(25) 0	156	64.77
		Total Distance	717.34

Table A.42: EMIP-MDA+ERTR solution to S51D3.

No.	Route	Load	Distance
1	0 7(31) 43(68) 23(18) 6(31) 0	148	74.08
2	0 19(25) 40(69) 41(37) 13(20) 25(9) 0	160	100.29
3	0 18(79) 4(71) 0	150	39.59
4	0 27(21) 31(32) 28(78) 1(20) 0	151	66.51
5	0 14(74) 25(14) 24(70) 0	158	63.61
6	0 32(79) 22(72) 0	151	42.51
7	0 9(20) 30(26) 39(56) 10(56) 0	158	81.93
8	0 8(51) 26(52) 48(53) 0	156	58.20
9	0 12(25) 37(32) 15(29) 45(43) 33(28) 0	157	73.03
10	0 2(27) 20(54) 29(25) 21(21) 34(33) 0	160	91.16
11	0 44(61) 42(72) 17(20) 0	153	66.88
12	0 35(43) 36(76) 3(30) 0	149	90.13
13	0 38(57) 49(51) 5(20) 0	128	45.82
14	0 47(76) 46(79) 0	155	21.57
15	0 50(78) 16(32) 11(31) 0	141	53.87
		Total Distance	969.18

Table A.43: EMIP-MDA+ERTR solution to S51D4.

No.	Route	Load	Distance
1	0 41(136) 4(24) 0	160	61.14
2	0 7(27) 43(117) 6(9) 0	153	73.21
3	0 2(18) 29(118) 11(24) 0	160	59.59
4	0 48(20) 26(124) 0	144	57.12
5	0 1(23) 22(137) 0	160	41.77
6	0 47(131) 0	131	18.87
7	0 30(64) 34(92) 0	156	69.36
8	0 38(77) 9(23) 49(54) 0	154	51.13
9	0 44(106) 37(54) 0	160	50.39
10	0 36(141) 3(19) 0	160	88.57
11	0 18(143) 0	143	29.53
12	0 32(142) 0	142	20.00
13	0 50(43) 21(69) 16(42) 11(6) 0	160	66.07
14	0 17(6) 19(40) 42(63) 37(51) 0	160	77.40
15	0 33(136) 15(24) 0	160	70.40
16	0 6(80) 14(73) 0	153	39.81
17	0 23(48) 24(93) 0	141	56.52
18	0 27(58) 8(102) 0	160	44.06
19	0 31(70) 8(29) 48(61) 0	160	64.08
20	0 13(25) 40(127) 0	152	90.36
21	0 14(66) 25(94) 0	160	47.60
22	0 45(112) 15(10) 37(38) 0	160	63.35
23	0 30(44) 39(100) 49(16) 0	160	81.57
24	0 1(20) 28(127) 0	147	60.01
25	0 4(119) 17(39) 0	158	42.08
26	0 3(6) 35(84) 20(45) 2(25) 0	160	82.74
27	0 46(52) 12(94) 0	146	17.37
28	0 5(35) 10(122) 0	157	56.67
		Total Distance	1580.79

Table A.44: EMIP-MDA+ERTR solution to S51D5.

No.	Route	Load	Distance
1	0 46(111) 0	111	4.47
2	0 30(36) 34(91) 16(33) 0	160	71.64
3	0 47(61) 18(99) 0	160	32.26
4	0 2(53) 22(39) 1(59) 0	151	52.62
5	0 20(69) 3(52) 22(39) 0	160	73.28
6	0 32(111) 0	111	20.00
7	0 31(52) 28(108) 0	160	66.12
8	0 4(108) 17(13) 12(39) 0	160	42.73
9	0 3(4) 36(100) 35(54) 0	158	90.13
10	0 10(71) 39(55) 30(34) 0	160	81.23
11	0 45(66) 33(56) 10(38) 0	160	78.72
12	0 12(6) 37(49) 44(51) 15(52) 0	158	56.21
13	0 42(111) 17(49) 0	160	62.90
14	0 43(58) 24(93) 0	151	72.08
15	0 19(52) 40(79) 41(17) 0	148	85.10
16	0 38(104) 11(53) 0	157	34.56
17	0 41(38) 13(59) 25(63) 0	160	76.15
18	0 6(48) 23(52) 7(54) 0	154	55.08
19	0 26(51) 8(96) 0	147	57.39
20	0 49(78) 5(49) 12(33) 0	160	47.16
21	0 48(71) 27(52) 0	123	32.41
22	0 2(16) 29(60) 21(64) 16(20) 0	160	69.36
23	0 6(46) 14(111) 0	157	39.81
24	0 9(53) 50(106) 0	159	54.92
		Total Distance	1356.37

Table A.45: EMIP-MDA+ERTR solution to S51D6.

No.	Route	Load	Distance
1	0 3(17) 36(143) 0	160	88.57
2	0 29(137) 2(23) 0	160	59.20
3	0 6(29) 24(131) 0	160	50.39
4	0 15(18) 33(142) 0	160	70.40
5	0 1(23) 28(137) 0	160	60.01
6	0 15(24) 45(136) 0	160	62.77
7	0 27(18) 8(140) 0	158	44.06
8	0 30(27) 39(133) 0	160	81.20
9	0 2(8) 20(88) 3(64) 0	160	73.43
10	0 41(96) 19(64) 0	160	67.39
11	0 47(140) 0	140	18.87
12	0 12(131) 0	131	16.12
13	0 34(131) 9(29) 0	160	63.87
14	0 20(31) 35(129) 0	160	78.93
15	0 4(143) 0	143	34.41
16	0 32(143) 0	143	20.00
17	0 17(119) 37(31) 0	150	40.47
18	0 18(143) 0	143	29.53
19	0 31(125) 28(2) 3(33) 0	160	78.20
20	0 16(35) 21(125) 0	160	64.14
21	0 27(21) 48(128) 0	149	32.41
22	0 6(15) 43(137) 0	152	69.40
23	0 46(121) 0	121	4.47
24	0 9(52) 30(108) 0	160	62.44
25	0 49(125) 5(35) 0	160	44.02
26	0 40(139) 19(17) 0	156	84.74
27	0 19(37) 42(123) 0	160	71.77
28	0 10(138) 5(22) 0	160	56.67
29	0 16(10) 50(118) 9(32) 0	160	56.42
30	0 6(40) 23(120) 0	160	44.60
31	0 14(142) 0	142	36.22
32	0 27(63) 1(95) 0	158	29.95
33	0 38(82) 5(59) 0	141	37.02
34	0 25(131) 0	131	46.17
35	0 6(46) 7(114) 0	160	54.31

(cont.)

Table A.45 continued.

No.	Route	Load	Distance
36	0 27(20) 26(139) 0	159	56.38
37	0 38(45) 11(115) 0	160	34.56
38	0 22(142) 0	142	41.62
39	0 16(73) 2(87) 0	160	51.59
40	0 44(134) 37(26) 0	160	50.39
41	0 15(74) 37(86) 0	160	50.06
42	0 41(46) 13(114) 0	160	69.07
		Total Distance	2186.29

Table A.46: EMIP-MDA+ERTR solution to S76D2.

No.	Route	Load	Distance
1	0 17(22) 3(11) 44(41) 32(29) 40(37) 26(20) 0	160	54.53
2	0 51(23) 16(20) 63(19) 33(47) 6(20) 68(28) 0	157	52.74
3	0 73(23) 1(44) 22(29) 62(40) 2(22) 0	158	66.96
4	0 13(35) 57(20) 15(46) 5(16) 29(43) 0	160	68.56
5	0 75(4) 64(38) 42(46) 41(43) 43(27) 0	158	93.21
6	0 7(34) 53(23) 14(18) 59(20) 19(47) 54(16) 0	158	93.88
7	0 3(11) 24(24) 49(32) 56(47) 23(46) 0	160	92.39
8	0 12(6) 9(44) 25(35) 55(21) 18(23) 50(29) 0	158	93.36
9	0 75(14) 4(18) 45(38) 27(43) 52(47) 0	160	40.12
10	0 30(41) 48(13) 21(23) 61(16) 28(26) 74(40) 0	159	77.42
11	0 5(24) 37(47) 36(33) 47(25) 48(31) 0	160	73.22
12	0 12(13) 72(16) 39(31) 31(39) 10(17) 58(29) 26(15) 0	160	81.69
13	0 67(18) 35(35) 8(18) 46(40) 34(46) 0	157	40.43
14	0 69(22) 71(18) 60(45) 70(46) 20(22) 5(7) 0	160	99.52
15	0 53(3) 11(42) 66(47) 65(19) 38(47) 0	158	77.16
		Total Distance	1105.19

Table A.47: EMIP-MDA+ERTR solution to S76D3.

No.	Route	Load	Distance
1	0 60(79) 70(37) 20(37) 29(7) 0	160	90.62
2	0 46(79) 34(59) 0	138	23.42
3	0 69(73) 71(69) 37(17) 0	159	88.48
4	0 48(39) 47(29) 36(68) 5(17) 0	153	68.39
5	0 8(64) 35(22) 53(59) 7(6) 0	151	50.56
6	0 58(55) 72(57) 12(46) 0	158	46.08
7	0 30(38) 2(37) 6(47) 51(33) 0	155	47.31
8	0 16(21) 49(46) 24(61) 3(24) 0	152	69.50
9	0 27(20) 13(12) 54(67) 52(61) 0	160	58.52
10	0 6(15) 33(8) 63(52) 1(27) 73(58) 0	160	58.15
11	0 68(68) 75(75) 0	143	14.75
12	0 65(79) 66(44) 11(21) 0	144	75.34
13	0 74(32) 28(76) 62(51) 0	159	55.17
14	0 22(46) 61(78) 21(32) 0	156	80.55
15	0 50(74) 18(67) 44(19) 0	160	70.72
16	0 23(20) 56(75) 41(23) 43(26) 33(16) 0	160	83.63
17	0 9(21) 25(31) 55(38) 31(20) 39(23) 26(19) 0	152	104.87
18	0 45(34) 29(21) 15(20) 57(70) 13(15) 0	160	64.16
19	0 4(76) 67(61) 0	137	19.46
20	0 42(79) 64(77) 0	156	88.08
21	0 38(72) 10(77) 58(4) 0	153	59.93
22	0 19(20) 59(45) 14(79) 7(16) 0	160	79.96
23	0 40(47) 32(79) 17(30) 0	156	44.96
		Total Distance	1442.61

Table A.48: EMIP-MDA+ERTR solution to S76D4.

No.	Route	Load	Distance
1	0 11(104) 53(49) 7(7) 0	160	59.90
2	0 9(51) 31(100) 10(3) 0	154	80.77
3	0 1(86) 73(74) 0	160	51.46
4	0 21(96) 74(64) 0	160	55.36
5	0 75(124) 0	124	60
6	0 32(47) 25(80) 40(33) 0	160	67.53
7	0 72(143) 12(5) 0	148	41.70
8	0 51(30) 63(91) 6(39) 0	160	46.59
9	0 8(41) 19(82) 35(37) 0	160	48.74
10	0 68(138) 0	138	14.56
11	0 7(136) 26(24) 0	160	30.07
12	0 38(25) 65(105) 10(30) 0	160	68.70
13	0 39(143) 12(17) 0	160	44.74
14	0 35(66) 53(94) 0	160	47.70
15	0 61(121) 74(39) 0	160	68.79
16	0 3(139) 44(20) 0	159	43.26
17	0 22(25) 64(121) 0	146	87.03
18	0 58(49) 66(72) 11(34) 0	155	77.24
19	0 62(60) 28(47) 2(46) 0	153	53.37
20	0 35(30) 14(29) 59(101) 0	160	76.98
21	0 17(135) 0	135	16.12
22	0 67(143) 0	143	10.77
23	0 36(21) 69(89) 21(47) 30(3) 0	160	78.49
24	0 24(44) 56(73) 23(35) 16(6) 51(2) 0	160	89.39
25	0 57(135) 15(25) 0	160	59.62
26	0 29(25) 47(86) 48(28) 30(21) 0	160	57.33
27	0 20(37) 70(87) 5(36) 0	160	84.05
28	0 34(17) 54(41) 13(102) 0	160	57.40
29	0 49(141) 16(19) 0	160	56.71
30	0 4(23) 27(50) 52(49) 46(31) 34(7) 0	160	38.48
31	0 45(126) 4(34) 0	160	28.28
32	0 25(44) 55(55) 18(26) 50(35) 0	160	92.18
33	0 43(37) 41(96) 42(27) 0	160	76.67
34	0 15(93) 29(59) 4(8) 0	160	55.87
35	0 63(40) 43(89) 33(31) 0	160	66.01
36	0 71(139) 36(21) 0	160	80.00
37	0 60(98) 37(52) 0	150	86.99
		Total Distance	2104.87

Table A.49: EMIP-MDA+ERTR solution to S101D2.

No.	Route	Load	Distance
1	0 87(23) 42(19) 43(47) 15(46) 57(23) 0	158	72.41
2	0 95(20) 92(25) 37(40) 98(43) 59(28) 0	156	44.12
3	0 63(22) 64(25) 49(28) 36(39) 47(45) 0	159	112.44
4	0 40(44) 21(45) 73(18) 58(46) 0	153	42.51
5	0 16(18) 86(37) 38(28) 44(47) 14(18) 42(12) 0	160	99.71
6	0 2(18) 41(36) 22(20) 74(32) 72(45) 0	151	63.25
7	0 50(39) 33(44) 81(18) 3(31) 77(18) 0	150	59.14
8	0 60(20) 83(23) 45(32) 46(35) 8(23) 18(19) 0	152	76.79
9	0 53(26) 13(30) 94(47) 6(18) 0	121	32.51
10	0 19(39) 11(47) 62(47) 88(19) 0	152	72.71
11	0 31(31) 70(41) 1(38) 69(19) 27(18) 0	147	49.49
12	0 79(23) 78(20) 34(25) 29(47) 24(21) 12(21) 0	157	86.32
13	0 9(18) 35(41) 71(18) 65(20) 66(46) 20(16) 0	159	112.62
14	0 96(36) 93(18) 85(18) 91(22) 100(43) 97(18) 0	155	54.24
15	0 89(18) 5(26) 84(32) 17(40) 61(21) 99(17) 0	154	66.25
16	0 10(18) 90(45) 32(33) 30(23) 51(40) 0	159	83.48
17	0 82(24) 48(47) 7(41) 52(42) 0	154	57.20
18	0 54(43) 55(34) 25(47) 4(15) 26(21) 0	160	70.22
19	0 4(9) 39(46) 67(17) 23(27) 56(33) 75(21) 0	153	95.52
20	0 80(43) 68(37) 76(47) 28(27) 0	154	46.47
		Total Distance	1397.38

Table A.50: EMIP-MDA+ERTR solution to S101D3.

No.	Route	Load	Distance
1	0 80(35) 24(60) 29(58) 0	153	67.22
2	0 77(18) 3(79) 76(60) 0	157	44.89
3	0 28(68) 0	68	12.65
4	0 92(68) 97(74) 0	142	38.75
5	0 73(21) 72(61) 21(77) 0	159	45.79
6	0 95(41) 100(79) 37(33) 0	153	48.13
7	0 51(20) 9(60) 81(28) 33(45) 0	153	66.84
8	0 32(75) 90(71) 10(11) 0	157	71.04
9	0 50(79) 69(26) 27(38) 0	143	39.25
10	0 20(52) 66(24) 65(30) 71(21) 35(29) 0	156	112.21
11	0 68(79) 54(75) 0	154	54.23
12	0 49(24) 64(69) 63(20) 10(47) 0	160	106.06
13	0 52(35) 7(75) 88(50) 0	160	46.77
14	0 22(79) 74(66) 72(15) 0	160	55.72
15	0 62(34) 11(68) 19(52) 0	154	72.64
16	0 26(74) 40(78) 53(3) 0	155	29.43
17	0 13(74) 58(59) 53(26) 0	159	26.83
18	0 36(79) 47(21) 48(57) 0	157	82.82
19	0 6(31) 99(48) 96(78) 0	157	35.08
20	0 2(33) 57(31) 15(60) 87(31) 0	155	62.65
21	0 42(11) 14(69) 44(71) 91(7) 0	158	72.39
22	0 30(59) 70(48) 31(33) 0	140	55.17
23	0 1(21) 34(36) 78(76) 79(24) 0	157	76.18
24	0 60(48) 17(79) 84(24) 0	151	61.09
25	0 86(77) 38(22) 43(23) 42(38) 0	160	101.05
26	0 98(55) 85(40) 93(64) 0	159	47.50
27	0 12(38) 55(20) 25(69) 4(29) 0	156	71.30
28	0 8(33) 46(70) 45(17) 83(27) 0	147	75.61
29	0 82(79) 18(77) 0	156	47.74
30	0 59(20) 91(28) 16(44) 61(31) 5(37) 0	160	62.51
31	0 75(22) 56(22) 39(25) 67(20) 23(44) 41(22) 0	155	102.82
32	0 94(64) 6(14) 89(52) 0	130	29.30
		Total Distance	1921.67

Table A.51: EMIP-MDA+ERTR solution to S101D5.

No.	Route	Load	Distance
1	0 31(64) 70(56) 69(28) 0	148	45.84
2	0 97(47) 42(104) 87(9) 0	160	51.86
3	0 97(63) 87(85) 13(11) 0	159	39.91
4	0 52(77) 18(74) 0	151	34.74
5	0 14(106) 100(53) 0	159	64.60
6	0 72(52) 75(99) 74(9) 0	160	56.06
7	0 60(54) 17(52) 84(52) 0	158	61.09
8	0 18(37) 83(109) 60(11) 0	157	44.79
9	0 10(40) 32(111) 30(9) 0	160	71.58
10	0 73(17) 74(39) 22(104) 0	160	54.68
11	0 59(45) 99(77) 96(30) 0	152	37.54
12	0 28(110) 0	110	12.65
13	0 44(93) 16(64) 0	157	67.13
14	0 66(67) 20(86) 0	153	81.06
15	0 71(28) 35(75) 9(52) 0	155	87.82
16	0 77(91) 76(54) 0	145	39.47
17	0 3(62) 81(71) 33(27) 0	160	58.95
18	0 27(53) 69(83) 0	136	24.45
19	0 43(5) 38(89) 86(63) 0	157	100.68
20	0 10(24) 62(79) 88(52) 0	155	57.38
21	0 50(30) 79(111) 0	141	52.57
22	0 6(63) 89(77) 0	140	25.28
23	0 72(3) 23(50) 67(50) 25(55) 0	158	96.75
24	0 41(69) 73(88) 0	157	59.18
25	0 29(57) 24(102) 0	159	66.90
26	0 45(75) 8(83) 0	158	61.81
27	0 1(52) 50(80) 0	132	38.53
28	0 59(49) 93(98) 0	147	41.05
29	0 30(49) 51(111) 0	160	61.64
30	0 43(95) 15(61) 0	156	71.87
31	0 98(44) 37(64) 92(52) 0	160	43.89
32	0 10(24) 63(72) 90(64) 0	160	71.70
33	0 54(49) 80(53) 68(58) 0	160	54.24
34	0 56(71) 39(88) 0	159	70.18
35	0 47(52) 36(108) 0	160	82.82

(cont.)

Table A.51 continued.

No.	Route	Load	Distance
36	0 11(63) 19(57) 7(40) 0	160	73.01
37	0 13(41) 95(52) 94(62) 0	155	31.48
38	0 98(15) 91(70) 85(50) 96(22) 0	157	51.97
39	0 7(8) 47(40) 46(111) 0	159	80.10
40	0 21(53) 4(103) 0	156	53.03
41	0 55(107) 54(53) 0	160	61.75
42	0 61(106) 5(52) 0	158	52.82
43	0 33(33) 34(65) 78(55) 0	153	73.19
44	0 7(15) 48(85) 82(60) 0	160	57.20
45	0 53(32) 40(101) 0	133	22.36
46	0 47(16) 49(83) 64(61) 0	160	105.62
47	0 2(59) 57(99) 0	158	47.03
48	0 71(49) 65(111) 0	160	99.89
49	0 53(59) 58(91) 0	150	18.63
50	0 26(84) 12(57) 0	141	33.25
		Total Distance	2852.01

Table A.52: EMIP-MDA+ERTR solution to SD1.

No.	Route	Load	Distance
1	0 5(60) 1(40) 0	100	40.00
2	0 3(20) 2(80) 0	100	34.14
3	0 1(20) 4(80) 0	100	34.14
4	0 2(10) 6(90) 0	100	40.00
5	0 3(40) 7(60) 0	100	40.00
6	0 4(10) 8(90) 0	100	40.00
		Total Distance	228.28

Table A.53: EMIP-MDA+ERTR solution to SD2.

No.	Route	Load	Distance
1	0 4(60) 1(40) 0	100	34.14
2	0 6(80) 2(20) 0	100	40.00
3	0 2(60) 3(40) 0	100	34.14
4	0 1(20) 9(20) 5(60) 0	100	60.00
5	0 14(90) 6(10) 0	100	80.00
6	0 11(60) 7(40) 0	100	60.00
7	0 4(10) 8(90) 0	100	40.00
8	0 2(10) 10(90) 0	100	60.00
9	0 4(10) 12(90) 0	100	60.00
10	0 9(40) 13(60) 0	100	80.00
11	0 3(20) 7(20) 15(60) 0	100	80.00
12	0 4(10) 16(90) 0	100	80.00
		Total Distance	708.28

Table A.54: EMIP-MDA+ERTR solution to SD3.

No.	Route	Load	Distance
1	0 3(20) 2(80) 0	100	27.65
2	0 5(20) 4(80) 0	100	27.65
3	0 13(60) 5(40) 0	100	40.00
4	0 7(20) 6(80) 0	100	27.65
5	0 15(60) 7(40) 0	100	40.00
6	0 1(20) 8(80) 0	100	27.65
7	0 1(40) 9(60) 0	100	40.00
8	0 2(10) 10(90) 0	100	39.99
9	0 3(40) 11(60) 0	100	40.00
10	0 4(10) 12(90) 0	100	39.99
11	0 6(10) 14(90) 0	100	39.99
12	0 8(10) 16(90) 0	100	39.99
		Total Distance	430.58

Table A.55: EMIP-MDA+ERTR solution to SD4.

No.	Route	Load	Distance
1	0 2(80) 1(20) 0	100	25.18
2	0 14(90) 2(10) 0	100	40.00
3	0 4(80) 3(20) 0	100	25.18
4	0 16(90) 4(10) 0	100	40.00
5	0 6(80) 5(20) 0	100	25.18
6	0 18(90) 6(10) 0	100	40.00
7	0 8(80) 7(20) 0	100	25.18
8	0 20(90) 8(10) 0	100	40.00
9	0 9(20) 10(80) 0	100	25.18
10	0 12(80) 11(20) 0	100	25.18
11	0 24(90) 12(10) 0	100	40.00
12	0 1(40) 13(60) 0	100	40.00
13	0 3(40) 15(60) 0	100	40.00
14	0 5(40) 17(60) 0	100	40.00
15	0 7(40) 19(60) 0	100	40.00
16	0 9(40) 21(60) 0	100	40.00
17	0 10(10) 22(90) 0	100	40.00
18	0 11(40) 23(60) 0	100	40.00
		Total Distance	631.05

Table A.56: EMIP-MDA+ERTR solution to SD5.

No.	Route	Load	Distance
1	0 3(40) 2(60) 0	100	27.65
2	0 10(70) 2(30) 0	100	39.99
3	0 5(40) 4(60) 0	100	27.65
4	0 14(20) 22(80) 0	100	60.01
5	0 7(40) 6(60) 0	100	27.65
6	0 1(40) 8(60) 0	100	27.65
7	0 16(20) 24(80) 0	100	60.01
8	0 27(60) 19(40) 0	100	80.00
9	0 4(30) 12(70) 0	100	39.99
10	0 29(60) 21(20) 5(20) 0	100	80.00
11	0 6(30) 14(70) 0	100	39.99
12	0 23(20) 15(60) 7(20) 0	100	60.00
13	0 8(30) 16(70) 0	100	39.99
14	0 25(60) 17(20) 1(20) 0	100	80.00
15	0 18(80) 10(20) 0	100	59.99
16	0 12(20) 20(80) 0	100	59.99
17	0 3(20) 11(60) 19(20) 0	100	60.00
18	0 17(40) 9(60) 0	100	60.00
19	0 18(10) 26(90) 0	100	79.99
20	0 28(90) 20(10) 0	100	80.00
21	0 21(40) 13(60) 0	100	60.00
22	0 30(90) 22(10) 0	100	80.00
23	0 23(40) 31(60) 0	100	80.00
24	0 32(90) 24(10) 0	100	80.00
		Total Distance	1390.57

Table A.57: EMIP-MDA+ERTR solution to SD6.

No.	Route	Load	Distance
1	0 2(80) 1(20) 0	100	23.91
2	0 19(60) 3(40) 0	100	39.99
3	0 3(20) 4(80) 0	100	23.90
4	0 6(80) 5(20) 0	100	23.91
5	0 22(90) 6(10) 0	100	40.00
6	0 8(80) 7(20) 0	100	23.90
7	0 24(90) 8(10) 0	100	40.01
8	0 9(20) 10(80) 0	100	23.91
9	0 12(80) 11(20) 0	100	23.90
10	0 28(90) 12(10) 0	100	40.01
11	0 14(80) 13(20) 0	100	23.91
12	0 15(20) 16(80) 0	100	23.90
13	0 1(40) 17(60) 0	100	40.00
14	0 2(10) 18(90) 0	100	40.00
15	0 4(10) 20(90) 0	100	40.00
16	0 5(40) 21(60) 0	100	40.00
17	0 7(40) 23(60) 0	100	39.99
18	0 9(40) 25(60) 0	100	40.00
19	0 10(10) 26(90) 0	100	40.00
20	0 11(40) 27(60) 0	100	39.99
21	0 13(40) 29(60) 0	100	40.00
22	0 14(10) 30(90) 0	100	40.00
23	0 15(40) 31(60) 0	100	39.99
24	0 16(10) 32(90) 0	100	40.01
		Total Distance	831.24

Table A.58: EMIP-MDA+ERTR solution to SD7.

No.	Route	Load	Distance
1	0 6(20) 2(80) 0	100	40.00
2	0 8(90) 4(10) 0	100	40.00
3	0 5(20) 13(20) 9(60) 0	100	80.00
4	0 2(10) 6(55) 14(30) 10(5) 0	100	80.00
5	0 5(40) 1(60) 0	100	40.00
6	0 6(15) 10(85) 0	100	60.00
7	0 3(60) 7(40) 0	100	40.00
8	0 4(10) 12(90) 0	100	60.00
9	0 18(40) 14(60) 0	100	100.00
10	0 7(20) 11(20) 15(60) 0	100	80.00
11	0 4(70) 16(30) 0	100	80.00
12	0 22(50) 18(50) 0	100	120.00
13	0 16(60) 20(40) 0	100	100.00
14	0 13(40) 17(60) 0	100	100.00
15	0 26(60) 22(40) 0	100	140.00
16	0 11(40) 19(60) 0	100	100.00
17	0 20(50) 24(50) 0	100	120.00
18	0 21(40) 25(60) 0	100	140.00
19	0 23(60) 27(40) 0	100	140.00
20	0 24(40) 28(60) 0	100	140.00
21	0 21(3) 33(37) 29(60) 0	100	180.00
22	0 26(30) 30(70) 0	100	160.00
23	0 28(30) 32(70) 0	100	160.00
24	0 30(15) 34(85) 0	100	180.00
25	0 35(20) 31(60) 27(20) 0	100	180.00
26	0 32(20) 36(80) 0	100	180.00
27	0 21(17) 33(23) 37(60) 0	100	200.00
28	0 30(5) 34(5) 38(90) 0	100	200.00
29	0 35(40) 39(60) 0	100	200.00
30	0 36(10) 40(90) 0	100	200.00
		Total Distance	3640.00

Table A.59: EMIP-MDA+ERTR solution to SD8.

No.	Route	Load	Distance
1	0 38(90) 22(10) 0	100	200.00
2	0 17(20) 21(60) 9(20) 0	100	120.00
3	0 14(50) 22(50) 0	100	120.00
4	0 8(90) 4(10) 0	100	40.00
5	0 15(60) 11(40) 0	100	80.00
6	0 34(90) 22(10) 0	100	180.00
7	0 41(40) 37(60) 0	100	220.00
8	0 14(20) 42(80) 0	100	220.00
9	0 29(60) 33(40) 0	100	180.00
10	0 22(10) 30(90) 0	100	160.00
11	0 1(60) 0	60	20.00
12	0 2(10) 6(90) 0	100	40.00
13	0 18(90) 14(10) 0	100	100.00
14	0 36(80) 32(20) 0	100	180.00
15	0 25(60) 17(40) 0	100	140.00
16	0 3(60) 7(40) 0	100	40.00
17	0 46(90) 42(10) 0	100	240.00
18	0 27(60) 23(40) 0	100	140.00
19	0 2(80) 7(20) 0	100	52.36
20	0 12(90) 16(10) 0	100	80.00
21	0 28(30) 32(70) 0	100	160.00
22	0 20(70) 24(30) 0	100	120.00
23	0 39(40) 43(60) 0	100	220.00
24	0 45(60) 41(20) 33(20) 0	100	240.00
25	0 23(20) 19(60) 11(20) 0	100	120.00
26	0 31(60) 35(40) 0	100	180.00
27	0 5(60) 0	60	40.00
28	0 13(60) 9(40) 0	100	80.00
29	0 10(90) 14(10) 0	100	80.00
30	0 44(90) 24(10) 0	100	220.00
31	0 47(60) 39(20) 35(20) 0	100	240.00
32	0 40(90) 36(10) 0	100	200.00
33	0 16(80) 20(20) 0	100	100.00
34	0 48(90) 28(10) 0	100	240.00
35	0 28(50) 24(50) 0	100	140.00
36	0 4(80) 0	80	20.00
37	0 26(90) 22(10) 0	100	140.00
		Total Distance	5092.36

Table A.60: EMIP-MDA+ERTR solution to SD9.

No.	Route	Load	Distance
1	0 2(80) 1(20) 0	100	25.18
2	0 14(90) 2(10) 0	100	40.00
3	0 4(80) 3(20) 0	100	25.18
4	0 6(80) 5(20) 0	100	25.18
5	0 18(90) 6(10) 0	100	40.00
6	0 8(80) 7(20) 0	100	25.18
7	0 20(90) 8(10) 0	100	40.00
8	0 9(20) 10(80) 0	100	25.18
9	0 12(80) 11(20) 0	100	25.18
10	0 1(40) 13(60) 0	100	40.00
11	0 3(40) 15(60) 0	100	40.00
12	0 4(10) 16(90) 0	100	40.00
13	0 5(40) 17(60) 0	100	40.00
14	0 7(40) 19(60) 0	100	40.00
15	0 9(40) 21(60) 0	100	40.00
16	0 10(10) 22(90) 0	100	40.00
17	0 11(40) 23(60) 0	100	40.00
18	0 12(10) 24(90) 0	100	40.00
19	0 37(60) 25(40) 0	100	80.00
20	0 25(20) 26(80) 0	100	75.53
21	0 28(80) 27(20) 0	100	75.53
22	0 40(90) 28(10) 0	100	80.00
23	0 30(80) 29(20) 0	100	75.53
24	0 42(90) 30(10) 0	100	80.00
25	0 31(20) 32(80) 0	100	75.53
26	0 33(20) 34(80) 0	100	75.53
27	0 36(80) 35(20) 0	100	75.53
28	0 48(90) 36(10) 0	100	80.01
29	0 26(10) 38(90) 0	100	80.00
30	0 27(40) 39(60) 0	100	80.00
31	0 29(40) 41(60) 0	100	80.00
32	0 31(40) 43(60) 0	100	80.00
33	0 32(10) 44(90) 0	100	80.00
34	0 33(40) 45(60) 0	100	80.00
35	0 34(10) 46(90) 0	100	80.00
36	0 35(40) 47(60) 0	100	79.99
		Total Distance	2044.20

Table A.61: EMIP-MDA+ERTR solution to SD10.

No.	Route	Load	Distance
1	0 16(80) 1(20) 0	100	23.91
2	0 2(80) 3(20) 0	100	23.90
3	0 4(90) 0	90	20.00
4	0 22(90) 5(10) 0	100	41.42
5	0 6(90) 0	90	20.00
6	0 8(40) 7(60) 0	100	23.90
7	0 24(90) 8(10) 0	100	40.01
8	0 8(40) 25(60) 0	100	41.42
9	0 11(60) 10(40) 0	100	23.90
10	0 12(90) 0	90	20.00
11	0 13(60) 0	60	20.00
12	0 14(90) 0	90	20.00
13	0 15(20) 31(60) 15(20) 0	100	39.99
14	0 32(90) 16(10) 0	100	40.01
15	0 1(40) 17(60) 0	100	40.00
16	0 2(10) 18(90) 0	100	40.00
17	0 3(40) 19(60) 0	100	39.99
18	0 5(10) 20(90) 0	100	41.42
19	0 5(40) 21(60) 0	100	40.00
20	0 55(60) 23(20) 0	80	80.00
21	0 9(60) 10(40) 0	100	23.91
22	0 10(10) 26(90) 0	100	40.00
23	0 27(60) 28(40) 0	100	47.80
24	0 28(40) 29(60) 0	100	47.81
25	0 15(20) 30(80) 0	100	41.42
26	0 49(60) 33(40) 0	100	80.00
27	0 33(20) 34(80) 0	100	71.71
28	0 36(80) 35(20) 0	100	71.71
29	0 38(80) 37(20) 0	100	71.71
30	0 54(90) 38(10) 0	100	80.01
31	0 23(40) 39(60) 0	100	59.99
32	0 41(20) 40(80) 0	100	71.71
33	0 57(60) 41(40) 0	100	80.00
34	0 43(20) 42(80) 0	100	71.71
35	0 59(60) 43(40) 0	100	80.00

(cont.)

Table A.61 continued.

No.	Route	Load	Distance
36	0 28(10) 44(90) 0	100	59.99
37	0 30(10) 46(90) 0	100	60.01
38	0 48(10) 64(90) 0	100	79.99
39	0 47(20) 48(80) 0	100	71.70
40	0 34(10) 50(90) 0	100	80.01
41	0 35(40) 51(60) 0	100	79.99
42	0 36(10) 52(90) 0	100	79.99
43	0 37(40) 53(60) 0	100	80.00
44	0 40(10) 56(90) 0	100	79.99
45	0 42(10) 58(90) 0	100	80.00
46	0 45(10) 60(90) 0	100	86.81
47	0 45(40) 61(60) 0	100	80.00
48	0 45(10) 62(90) 0	100	86.81
49	0 47(40) 63(60) 0	100	80.00
		Total Distance	2704.69

Table A.62: EMIP-MDA+ERTR solution to SD11.

No.	Route	Load	Distance
1	0 10(21) 14(79) 0	100	80.00
2	0 43(20) 55(60) 51(20) 0	100	280.00
3	0 16(40) 4(60) 0	100	80.00
4	0 10(20) 19(60) 11(20) 0	100	138.31
5	0 7(60) 0	60	40.00
6	0 37(40) 33(60) 0	100	200.00
7	0 24(10) 28(10) 36(80) 0	100	180.00
8	0 28(10) 32(90) 0	100	160.00
9	0 77(60) 69(20) 61(20) 0	100	400.00
10	0 43(40) 47(60) 0	100	240.00
11	0 31(60) 35(40) 0	100	180.00
12	0 18(40) 14(11) 10(49) 0	100	100.00
13	0 4(10) 20(90) 0	100	100.00
14	0 12(90) 4(10) 0	100	60.00
15	0 1(40) 5(60) 0	100	40.00
16	0 59(20) 71(6) 79(60) 75(14) 0	100	400.00
17	0 2(90) 0	90	20.00
18	0 29(60) 37(20) 21(20) 0	100	200.00
19	0 24(30) 28(70) 0	100	140.00
20	0 22(50) 18(50) 0	100	120.00
21	0 26(30) 30(70) 0	100	160.00
22	0 22(40) 26(60) 0	100	140.00
23	0 41(40) 45(60) 0	100	240.00
24	0 49(40) 53(60) 0	100	280.00
25	0 30(10) 38(90) 0	100	200.00
26	0 59(40) 63(60) 0	100	320.00
27	0 23(40) 27(60) 0	100	140.00
28	0 46(10) 42(90) 0	100	240.00
29	0 48(10) 44(90) 0	100	240.00
30	0 6(90) 0	90	40.00
31	0 30(10) 34(90) 0	100	180.00
32	0 49(20) 57(60) 41(20) 0	100	300.00
33	0 52(70) 56(30) 0	100	280.00
34	0 50(20) 46(80) 0	100	260.00
35	0 3(60) 0	60	20.00

(cont.)

Table A.62 continued.

No.	Route	Load	Distance
36	0 1(20) 17(20) 9(60) 0	100	100.00
37	0 17(40) 13(60) 0	100	100.00
38	0 66(60) 62(40) 0	100	340.00
39	0 8(90) 4(10) 0	100	40.00
40	0 48(80) 52(20) 0	100	260.00
41	0 61(40) 65(60) 0	100	340.00
42	0 50(70) 54(30) 0	100	280.00
43	0 60(70) 56(30) 0	100	300.00
44	0 69(40) 73(60) 0	100	380.00
45	0 62(50) 58(50) 0	100	320.00
46	0 21(40) 25(60) 0	100	140.00
47	0 72(20) 76(80) 0	100	380.00
48	0 54(60) 58(40) 0	100	300.00
49	0 51(40) 67(60) 0	100	340.00
50	0 36(10) 40(90) 0	100	200.00
51	0 64(10) 68(90) 0	100	340.00
52	0 66(30) 70(70) 0	100	360.00
53	0 11(40) 15(60) 0	100	80.00
54	0 56(30) 72(70) 0	100	360.00
55	0 23(20) 39(60) 35(20) 0	100	200.00
56	0 70(20) 74(80) 0	100	380.00
57	0 71(54) 75(46) 0	100	380.00
58	0 60(20) 64(80) 0	100	320.00
59	0 16(50) 24(50) 0	100	120.00
60	0 74(10) 78(90) 0	100	400.00
61	0 76(10) 80(90) 0	100	400.00
		Total Distance	13358.31

Table A.63: EMIP-MDA+ERTR solution to SD12.

No.	Route	Load	Distance
1	0 12(10) 20(90) 0	100	59.99
2	0 24(80) 0	80	60.01
3	0 70(10) 78(90) 0	100	200.00
4	0 18(20) 35(60) 27(20) 0	100	115.75
5	0 9(20) 25(20) 17(60) 0	100	80.00
6	0 62(70) 38(30) 0	100	160.00
7	0 24(10) 56(90) 0	100	140.01
8	0 38(40) 37(60) 0	100	138.26
9	0 40(80) 32(20) 0	100	100.00
10	0 49(20) 73(60) 65(20) 0	100	200.00
11	0 18(20) 26(80) 0	100	79.99
12	0 3(40) 11(60) 0	100	40.00
13	0 72(90) 32(10) 0	100	180.00
14	0 40(10) 64(90) 0	100	160.00
15	0 26(10) 42(90) 0	100	120.01
16	0 38(20) 46(80) 0	100	120.00
17	0 62(20) 70(80) 0	100	180.00
18	0 65(40) 57(60) 0	100	180.00
19	0 9(40) 1(60) 0	100	40.00
20	0 15(40) 32(60) 0	100	89.47
21	0 21(60) 13(20) 0	80	60.00
22	0 48(90) 0	90	120.00
23	0 4(70) 0	70	20.00
24	0 52(70) 44(30) 0	100	139.99
25	0 55(40) 47(60) 0	100	140.00
26	0 50(10) 58(90) 0	100	160.00
27	0 71(40) 63(60) 0	100	180.00
28	0 77(60) 69(40) 0	100	200.00
29	0 44(10) 68(90) 0	100	180.00
30	0 13(40) 5(60) 0	100	40.00
31	0 46(10) 54(90) 0	100	139.99
32	0 7(60) 0	60	20.00
33	0 36(40) 29(60) 0	100	125.66
34	0 41(40) 49(40) 41(20) 0	100	140.00
35	0 53(40) 45(60) 0	100	140.00

(cont.)

Table A.63 continued.

No.	Route	Load	Distance
36	0 44(50) 36(50) 0	100	120.00
37	0 8(10) 16(90) 0	100	39.99
38	0 22(90) 0	90	60.01
39	0 12(80) 4(20) 0	100	39.99
40	0 6(80) 0	80	20.00
41	0 69(20) 61(60) 53(20) 0	100	180.00
42	0 43(40) 51(40) 43(20) 0	100	140.00
43	0 51(20) 67(60) 59(20) 0	100	180.00
44	0 18(10) 34(90) 0	100	100.00
45	0 60(10) 76(90) 0	100	200.01
46	0 28(90) 0	90	80.00
47	0 2(80) 3(20) 0	100	27.65
48	0 66(10) 74(90) 0	100	200.00
49	0 50(60) 18(40) 0	100	140.01
50	0 59(40) 75(60) 0	100	200.00
51	0 30(90) 0	90	80.00
52	0 6(10) 14(90) 0	100	39.99
53	0 27(40) 19(60) 0	100	80.00
54	0 71(20) 79(60) 55(20) 0	100	200.00
55	0 33(60) 25(40) 0	100	100.00
56	0 52(20) 60(80) 0	100	159.99
57	0 80(90) 0	90	200.00
58	0 50(20) 66(80) 0	100	180.00
59	0 2(10) 10(90) 0	100	39.99
60	0 31(40) 39(60) 0	100	100.00
61	0 8(80) 0	80	20.00
62	0 15(20) 23(60) 31(20) 0	100	80.00
		Total Distance	7256.77

Table A.64: EMIP-MDA+ERTR solution to SD13.

No.	Route	Load	Distance
1	0 21(60) 29(40) 0	100	80.00
2	0 38(30) 46(70) 0	100	120.00
3	0 47(40) 55(60) 0	100	140.00
4	0 36(40) 44(60) 0	100	120.00
5	0 56(40) 64(60) 0	100	160.00
6	0 69(40) 61(60) 0	100	180.00
7	0 35(40) 51(60) 0	100	140.00
8	0 45(20) 37(60) 29(20) 0	100	120.00
9	0 86(90) 54(10) 0	100	220.00
10	0 85(40) 93(60) 0	100	240.00
11	0 78(10) 94(90) 0	100	239.99
12	0 38(40) 62(60) 0	100	160.00
13	0 1(60) 0	60	20.00
14	0 33(40) 49(60) 0	100	140.00
15	0 66(20) 74(80) 0	100	200.00
16	0 90(90) 74(10) 0	100	239.99
17	0 44(20) 52(80) 0	100	139.99
18	0 46(20) 54(80) 0	100	139.99
19	0 58(70) 50(30) 0	100	160.00
20	0 84(10) 92(90) 0	100	240.01
21	0 64(20) 72(80) 0	100	180.00
22	0 40(20) 48(80) 0	100	120.00
23	0 83(60) 75(40) 0	100	220.00
24	0 70(70) 62(30) 0	100	180.00
25	0 31(20) 47(20) 39(60) 0	100	120.00
26	0 2(80) 0	80	20.00
27	0 81(40) 89(60) 0	100	240.00
28	0 58(20) 66(60) 50(20) 0	100	180.00
29	0 8(90) 0	90	20.00
30	0 63(40) 71(60) 0	100	180.00
31	0 36(40) 28(60) 0	100	100.00
32	0 50(40) 42(60) 0	100	140.01
33	0 28(20) 84(80) 0	100	220.01
34	0 16(90) 0	90	39.99
35	0 59(60) 67(40) 0	100	180.00

(cont.)

Table A.64 continued.

No.	Route	Load	Distance
36	0 63(20) 95(60) 87(20) 0	100	240.00
37	0 32(10) 24(90) 0	100	80.00
38	0 70(20) 78(80) 0	100	200.00
39	0 66(10) 82(90) 0	100	220.00
40	0 3(20) 11(60) 0	80	40.00
41	0 64(10) 80(90) 0	100	200.00
42	0 81(20) 73(60) 65(20) 0	100	220.00
43	0 28(10) 20(90) 0	100	80.00
44	0 87(40) 79(60) 0	100	220.00
45	0 4(90) 0	90	20.00
46	0 48(10) 88(90) 0	100	220.00
47	0 5(60) 0	60	20.00
48	0 40(50) 56(50) 0	100	140.01
49	0 2(10) 10(90) 0	100	39.99
50	0 43(60) 35(20) 27(20) 0	100	120.00
51	0 3(40) 9(60) 0	100	52.36
52	0 65(40) 57(60) 0	100	180.00
53	0 30(10) 22(90) 0	100	80.00
54	0 12(90) 0	90	39.99
55	0 60(90) 36(10) 0	100	159.99
56	0 6(40) 13(60) 0	100	44.74
57	0 31(40) 23(60) 0	100	80.00
58	0 76(90) 44(10) 0	100	200.01
59	0 6(10) 14(90) 0	100	39.99
60	0 72(10) 96(90) 0	100	240.01
61	0 45(40) 53(60) 0	100	140.00
62	0 26(70) 42(30) 0	100	120.01
63	0 67(20) 75(20) 91(60) 0	100	240.00
64	0 85(20) 77(60) 69(20) 0	100	220.00
65	0 38(20) 30(80) 0	100	100.00
66	0 27(40) 19(60) 0	100	80.00
67	0 40(20) 32(80) 0	100	100.00
68	0 41(60) 33(20) 17(20) 0	100	120.00
69	0 18(10) 34(90) 0	100	100.00
70	0 7(60) 0	60	20.00

(cont.)

Table A.64 continued.

No.	Route	Load	Distance
71	0 52(10) 68(90) 0	100	180.00
72	0 17(40) 25(60) 0	100	80.00
73	0 6(40) 15(60) 0	100	44.74
74	0 26(20) 18(80) 0	100	79.99
		Total Distance	10141.79

Table A.65: EMIP-MDA+ERTR solution to SD14.

No.	Route	Load	Distance
1	0 112(90) 100(10) 0	100	200.00
2	0 75(40) 63(60) 0	100	140.00
3	0 98(80) 39(20) 0	100	188.86
4	0 116(90) 104(10) 0	100	200.00
5	0 82(80) 70(20) 0	100	140.00
6	0 7(60) 8(40) 0	100	25.18
7	0 6(90) 0	90	20.00
8	0 31(60) 19(40) 0	100	60.00
9	0 78(90) 54(10) 0	100	140.00
10	0 36(80) 35(20) 0	100	75.53
11	0 32(10) 44(90) 0	100	80.00
12	0 11(60) 21(40) 0	100	47.32
13	0 8(40) 9(60) 0	100	25.18
14	0 56(80) 55(20) 0	100	125.88
15	0 27(60) 15(40) 0	100	60.00
16	0 74(80) 62(20) 0	100	140.00
17	0 54(40) 43(60) 0	100	115.22
18	0 69(60) 81(40) 0	100	140.01
19	0 10(90) 0	90	20.00
20	0 85(40) 97(60) 0	100	180.00
21	0 64(90) 52(10) 0	100	120.00
22	0 33(60) 21(20) 0	80	60.00
23	0 1(60) 2(40) 0	100	25.18
24	0 15(20) 26(80) 0	100	66.15
25	0 94(80) 57(20) 0	100	174.41
26	0 47(60) 35(40) 0	100	79.99
27	0 37(20) 49(60) 25(20) 0	100	100.00
28	0 71(60) 83(40) 0	100	140.00
29	0 120(90) 84(10) 0	100	199.99
30	0 90(70) 66(30) 0	100	160.01
31	0 20(90) 8(10) 0	100	40.00
32	0 62(70) 50(30) 0	100	120.00
33	0 14(90) 2(10) 0	100	40.00
34	0 34(40) 23(60) 0	100	66.15
35	0 70(70) 58(30) 0	100	120.00

(cont.)

Table A.65 continued.

No.	Route	Load	Distance
36	0 108(90) 72(10) 0	100	179.99
37	0 40(20) 52(80) 0	100	100.00
38	0 26(10) 38(90) 0	100	80.00
39	0 83(20) 95(60) 107(20) 0	100	180.00
40	0 30(80) 5(20) 0	100	61.92
41	0 61(20) 85(20) 109(60) 0	100	200.00
42	0 42(90) 30(10) 0	100	80.00
43	0 77(60) 65(40) 0	100	140.00
44	0 67(60) 55(40) 0	100	120.00
45	0 29(60) 17(40) 0	100	60.00
46	0 4(90) 0	90	20.00
47	0 102(80) 90(20) 0	100	180.01
48	0 111(60) 87(40) 0	100	200.00
49	0 13(60) 25(40) 0	100	60.00
50	0 80(60) 79(40) 0	100	176.23
51	0 16(90) 0	90	40.00
52	0 96(90) 84(10) 0	100	160.01
53	0 46(50) 34(50) 0	100	80.00
54	0 81(20) 93(60) 105(20) 0	100	180.01
55	0 79(20) 91(60) 103(20) 0	100	180.00
56	0 73(60) 61(40) 0	100	140.00
57	0 72(30) 84(70) 0	100	140.01
58	0 106(90) 82(10) 0	100	180.00
59	0 22(90) 0	90	40.00
60	0 88(90) 76(10) 0	100	160.00
61	0 39(40) 51(60) 0	100	100.00
62	0 37(40) 50(60) 0	100	115.22
63	0 101(20) 89(60) 65(20) 0	100	180.01
64	0 80(30) 92(70) 0	100	160.00
65	0 60(50) 72(50) 0	100	120.01
66	0 107(40) 119(60) 0	100	200.00
67	0 45(60) 57(40) 0	100	100.01
68	0 12(90) 0	90	20.00
69	0 113(60) 101(40) 0	100	200.00
70	0 17(20) 76(80) 0	100	143.62

(cont.)

Table A.65 continued.

No.	Route	Load	Distance
71	0 48(90) 36(10) 0	100	80.01
72	0 2(40) 3(60) 0	100	25.18
73	0 66(60) 54(40) 0	100	120.00
74	0 24(90) 0	90	40.00
75	0 98(10) 110(90) 0	100	200.00
76	0 100(80) 41(20) 0	100	188.86
77	0 117(60) 105(40) 0	100	200.01
78	0 28(30) 40(70) 0	100	80.00
79	0 28(60) 5(40) 0	100	61.92
80	0 118(90) 94(10) 0	100	200.00
81	0 115(60) 103(40) 0	100	200.00
82	0 74(10) 86(90) 0	100	160.00
83	0 68(90) 56(10) 0	100	119.99
84	0 58(60) 46(40) 0	100	100.00
85	0 102(10) 114(90) 0	100	200.01
86	0 18(90) 0	90	40.00
87	0 75(20) 99(60) 87(20) 0	100	180.00
88	0 59(60) 60(40) 0	100	125.89
89	0 32(80) 19(20) 0	100	66.15
90	0 41(40) 53(60) 0	100	100.00
91	0 104(80) 92(20) 0	100	180.00
		Total Distance	10780.03

Table A.66: EMIP-MDA+ERTR solution to SD15.

No.	Route	Load	Distance
1	0 18(80) 19(20) 0	100	50.35
2	0 112(90) 100(10) 0	100	200.00
3	0 91(60) 103(40) 0	100	180.00
4	0 41(60) 42(40) 0	100	100.70
5	0 12(80) 0	80	20.00
6	0 1(20) 49(60) 25(20) 0	100	100.00
7	0 48(80) 23(20) 0	100	84.79
8	0 33(60) 34(40) 0	100	75.53
9	0 62(40) 74(60) 0	100	140.00
10	0 92(70) 80(30) 0	100	160.00
11	0 6(90) 0	90	20.00
12	0 29(60) 17(40) 0	100	60.00
13	0 56(60) 43(40) 0	100	115.22
14	0 99(60) 87(40) 0	100	180.00
15	0 85(20) 121(20) 133(60) 0	100	240.00
16	0 109(60) 121(40) 0	100	220.00
17	0 57(60) 45(40) 0	100	100.01
18	0 31(60) 19(40) 0	100	60.00
19	0 26(80) 0	80	60.00
20	0 139(60) 127(40) 0	100	240.00
21	0 13(60) 1(40) 0	100	40.00
22	0 93(60) 105(40) 0	100	180.01
23	0 38(90) 26(10) 0	100	80.00
24	0 53(60) 52(40) 0	100	125.88
25	0 46(50) 34(50) 0	100	80.00
26	0 24(90) 0	90	40.00
27	0 60(90) 0	90	100.01
28	0 113(40) 125(60) 0	100	220.00
29	0 14(90) 0	90	40.00
30	0 110(10) 122(90) 0	100	220.00
31	0 105(20) 117(20) 129(60) 0	100	220.01
32	0 98(90) 86(10) 0	100	180.00
33	0 77(20) 126(80) 0	100	240.52
34	0 11(60) 0	60	20.00
35	0 124(90) 0	90	220.00

(cont.)

Table A.66 continued.

No.	Route	Load	Distance
36	0 68(70) 56(30) 0	100	119.99
37	0 123(40) 135(60) 0	100	239.99
38	0 44(90) 32(10) 0	100	80.00
39	0 86(80) 15(20) 0	100	163.47
40	0 116(90) 104(10) 0	100	200.00
41	0 10(90) 0	90	20.00
42	0 106(90) 70(10) 0	100	180.00
43	0 50(50) 62(50) 0	100	120.00
44	0 4(90) 0	90	20.00
45	0 113(20) 137(60) 89(20) 0	100	240.00
46	0 27(60) 39(40) 0	100	80.00
47	0 138(90) 126(10) 0	100	240.00
48	0 83(60) 71(40) 0	100	140.00
49	0 81(60) 69(40) 0	100	140.01
50	0 141(60) 117(40) 0	100	240.00
51	0 120(90) 84(10) 0	100	199.99
52	0 43(20) 55(60) 67(20) 0	100	120.00
53	0 23(40) 35(60) 0	100	60.00
54	0 84(10) 96(90) 0	100	160.01
55	0 89(40) 101(60) 0	100	180.01
56	0 32(80) 21(20) 0	100	66.15
57	0 28(90) 0	90	60.00
58	0 47(20) 71(20) 94(60) 0	100	181.06
59	0 131(60) 119(20) 95(20) 0	100	220.00
60	0 82(90) 46(10) 0	100	140.00
61	0 66(20) 102(80) 0	100	180.01
62	0 45(20) 69(20) 80(60) 0	100	165.01
63	0 5(60) 7(40) 0	100	30.00
64	0 74(30) 110(70) 0	100	200.00
65	0 47(40) 59(60) 0	100	100.01
66	0 61(60) 72(40) 0	100	151.07
67	0 142(90) 130(10) 0	100	240.00
68	0 140(90) 128(10) 0	100	240.00
69	0 97(60) 85(40) 0	100	180.00
70	0 127(20) 115(60) 103(20) 0	100	220.00

(cont.)

Table A.66 continued.

No.	Route	Load	Distance
71	0 52(20) 100(80) 0	100	180.00
72	0 58(70) 46(30) 0	100	100.00
73	0 88(90) 76(10) 0	100	160.00
74	0 87(20) 111(60) 123(20) 0	100	220.00
75	0 132(80) 72(20) 0	100	220.00
76	0 76(80) 64(20) 0	100	140.00
77	0 128(80) 68(20) 0	100	220.00
78	0 3(60) 15(40) 0	100	40.00
79	0 144(90) 132(10) 0	100	240.00
80	0 9(60) 21(40) 0	100	40.00
81	0 2(90) 0	90	20.00
82	0 94(20) 130(80) 0	100	220.00
83	0 30(90) 18(10) 0	100	60.00
84	0 143(60) 119(40) 0	100	239.99
85	0 78(90) 42(10) 0	100	140.00
86	0 108(90) 48(10) 0	100	179.99
87	0 37(60) 25(40) 0	100	80.00
88	0 51(40) 63(60) 0	100	120.00
89	0 36(90) 12(10) 0	100	60.00
90	0 107(60) 95(40) 0	100	180.00
91	0 90(90) 0	90	160.01
92	0 84(70) 72(30) 0	100	140.01
93	0 67(40) 79(60) 0	100	140.00
94	0 22(90) 0	90	40.00
95	0 114(90) 102(10) 0	100	200.01
96	0 50(40) 73(60) 0	100	156.58
97	0 64(70) 52(30) 0	100	120.00
98	0 8(80) 7(20) 0	100	25.18
99	0 94(10) 118(90) 0	100	200.00
100	0 134(90) 110(10) 0	100	239.99
101	0 104(80) 92(20) 0	100	180.00
102	0 42(20) 54(80) 0	100	100.00
103	0 75(60) 51(20) 39(20) 0	100	140.00
104	0 66(70) 54(10) 42(20) 0	100	120.00
105	0 40(10) 136(90) 0	100	240.00

(cont.)

Table A.66 continued.

No.	Route	Load	Distance
106	0 20(90) 8(10) 0	100	40.00
107	0 17(20) 40(80) 0	100	84.79
108	0 65(60) 77(40) 0	100	140.00
109	0 70(80) 58(20) 0	100	120.00
110	0 16(90) 0	90	40.00
		Total Distance	15216.29

Table A.67: EMIP-MDA+ERTR solution to SD16.

No.	Route	Load	Distance
1	0 103(10) 102(90) 0	100	41.74
2	0 100(40) 101(60) 0	100	41.74
3	0 112(50) 111(50) 0	100	41.75
4	0 99(50) 100(50) 0	100	41.74
5	0 140(40) 141(60) 0	100	41.75
6	0 144(40) 73(60) 0	100	41.75
7	0 65(60) 64(40) 0	100	20.87
8	0 106(90) 107(10) 0	100	41.76
9	0 47(10) 46(90) 0	100	20.87
10	0 116(40) 117(60) 0	100	41.73
11	0 71(10) 70(90) 0	100	20.87
12	0 99(10) 98(90) 0	100	41.73
13	0 88(40) 89(60) 0	100	41.76
14	0 139(50) 140(50) 0	100	41.73
15	0 119(50) 120(50) 0	100	41.75
16	0 8(40) 9(60) 0	100	20.87
17	0 131(10) 130(90) 0	100	41.75
18	0 116(50) 115(50) 0	100	41.74
19	0 143(50) 144(50) 0	100	41.75
20	0 40(40) 41(60) 0	100	20.87
21	0 120(40) 121(60) 0	100	41.74
22	0 87(10) 86(90) 0	100	41.74
23	0 123(10) 122(90) 0	100	41.74
24	0 128(50) 127(50) 0	100	41.74
25	0 5(10) 4(90) 0	100	20.87
26	0 8(50) 7(50) 0	100	20.88
27	0 60(40) 61(60) 0	100	20.87
28	0 51(50) 52(50) 0	100	20.87
29	0 112(40) 113(60) 0	100	41.75
30	0 93(60) 92(40) 0	100	41.74
31	0 52(40) 53(60) 0	100	20.87
32	0 76(50) 75(50) 0	100	41.76
33	0 135(10) 134(90) 0	100	41.73
34	0 55(50) 56(50) 0	100	20.87
35	0 91(10) 90(90) 0	100	41.74

(cont.)

Table A.67 continued.

No.	Route	Load	Distance
36	0 110(90) 111(10) 0	100	41.74
37	0 44(50) 43(50) 0	100	20.86
38	0 97(60) 96(40) 0	100	41.75
39	0 15(10) 14(90) 0	100	20.88
40	0 127(10) 126(90) 0	100	41.75
41	0 20(40) 21(60) 0	100	20.88
42	0 104(40) 105(60) 0	100	41.74
43	0 75(10) 74(90) 0	100	41.74
44	0 136(40) 137(60) 0	100	41.74
45	0 132(40) 133(60) 0	100	41.75
46	0 44(40) 45(60) 0	100	20.87
47	0 69(60) 68(40) 0	100	20.88
48	0 43(10) 42(90) 0	100	20.87
49	0 55(10) 54(90) 0	100	20.87
50	0 80(40) 81(60) 0	100	41.75
51	0 32(50) 31(50) 0	100	20.87
52	0 67(10) 66(90) 0	100	20.88
53	0 68(50) 67(50) 0	100	20.87
54	0 83(10) 82(90) 0	100	41.74
55	0 33(60) 32(40) 0	100	20.88
56	0 139(10) 138(90) 0	100	41.74
57	0 143(10) 142(90) 0	100	41.75
58	0 51(10) 50(90) 0	100	20.88
59	0 37(60) 36(40) 0	100	20.87
60	0 59(10) 58(90) 0	100	20.87
61	0 19(10) 18(90) 0	100	20.87
62	0 24(50) 23(50) 0	100	20.88
63	0 24(40) 25(60) 0	100	20.87
64	0 48(50) 47(50) 0	100	20.87
65	0 59(50) 60(50) 0	100	20.87
66	0 27(10) 26(90) 0	100	20.87
67	0 40(50) 39(50) 0	100	20.87
68	0 5(50) 3(50) 0	100	21.74
69	0 92(50) 91(50) 0	100	41.74
70	0 39(10) 38(90) 0	100	20.88

(cont.)

Table A.67 continued.

No.	Route	Load	Distance
71	0 20(50) 19(50) 0	100	20.87
72	0 135(50) 136(50) 0	100	41.74
73	0 35(10) 34(90) 0	100	20.87
74	0 48(40) 49(60) 0	100	20.88
75	0 27(50) 28(50) 0	100	20.87
76	0 95(10) 94(90) 0	100	41.74
77	0 36(50) 35(50) 0	100	20.88
78	0 96(50) 95(50) 0	100	41.74
79	0 7(10) 6(90) 0	100	20.87
80	0 16(50) 15(50) 0	100	20.87
81	0 13(60) 12(40) 0	100	20.88
82	0 31(10) 30(90) 0	100	20.88
83	0 123(50) 124(50) 0	100	41.74
84	0 3(10) 2(90) 0	100	20.88
85	0 108(50) 107(50) 0	100	41.74
86	0 103(50) 104(50) 0	100	41.75
87	0 115(10) 114(90) 0	100	41.75
88	0 79(10) 78(90) 0	100	41.75
89	0 64(50) 63(50) 0	100	20.87
90	0 72(50) 71(50) 0	100	20.88
91	0 56(40) 57(60) 0	100	20.88
92	0 63(10) 62(90) 0	100	20.87
93	0 132(50) 131(50) 0	100	41.74
94	0 80(50) 79(50) 0	100	41.74
95	0 23(10) 22(90) 0	100	20.87
96	0 11(10) 10(90) 0	100	20.87
97	0 128(40) 129(60) 0	100	41.74
98	0 84(50) 83(50) 0	100	41.75
99	0 124(40) 125(60) 0	100	41.75
100	0 12(50) 11(50) 0	100	20.87
101	0 16(40) 17(60) 0	100	20.87
102	0 76(40) 77(60) 0	100	41.74
103	0 28(40) 29(60) 0	100	20.87
104	0 119(10) 118(90) 0	100	41.74
105	0 72(40) 1(60) 0	100	20.87

(cont.)

Table A.67 continued.

No.	Route	Load	Distance
106	0 108(40) 109(60) 0	100	41.74
107	0 84(40) 85(60) 0	100	41.74
108	0 88(50) 87(50) 0	100	41.74
		Total Distance	3382.16

Table A.68: EMIP-MDA+ERTR solution to SD17.

No.	Route	Load	Distance
1	0 86(10) 158(90) 0	100	400.00
2	0 1(20) 33(60) 25(20) 0	100	100.00
3	0 40(20) 64(80) 0	100	160.00
4	0 131(20) 139(60) 147(20) 0	100	380.00
5	0 144(90) 112(10) 0	100	360.00
6	0 119(60) 111(20) 103(20) 0	100	300.00
7	0 20(90) 0	90	59.99
8	0 1(40) 7(60) 0	100	34.14
9	0 81(60) 89(40) 0	100	240.00
10	0 146(80) 138(20) 0	100	380.00
11	0 89(20) 113(60) 97(20) 0	100	300.00
12	0 86(60) 94(40) 0	100	239.99
13	0 111(40) 87(60) 0	100	280.00
14	0 24(40) 15(60) 0	100	71.25
15	0 35(60) 19(40) 0	100	100.00
16	0 69(20) 61(60) 53(20) 0	100	180.00
17	0 108(10) 124(90) 0	100	319.99
18	0 160(90) 152(10) 0	100	400.00
19	0 4(40) 5(60) 0	100	27.65
20	0 26(10) 50(90) 0	100	140.01
21	0 21(20) 29(60) 0	80	80.00
22	0 127(20) 159(60) 151(20) 0	100	400.00
23	0 112(10) 128(90) 0	100	320.01
24	0 83(40) 91(60) 0	100	240.00
25	0 34(90) 0	90	100.00
26	0 42(30) 58(70) 0	100	160.00
27	0 151(40) 143(60) 0	100	380.00
28	0 121(40) 129(60) 0	100	340.00
29	0 104(30) 112(70) 0	100	280.00
30	0 94(10) 150(90) 0	100	380.00
31	0 100(30) 108(70) 0	100	280.00
32	0 69(40) 77(60) 0	100	200.00
33	0 136(90) 104(10) 0	100	340.01
34	0 44(30) 52(70) 0	100	139.99
35	0 140(70) 92(30) 0	100	360.00

(cont.)

Table A.68 continued.

No.	Route	Load	Distance
36	0 154(90) 146(10) 0	100	400.00
37	0 75(60) 51(40) 0	100	200.00
38	0 18(90) 0	90	59.99
39	0 55(20) 71(20) 63(60) 0	100	180.00
40	0 16(90) 0	90	39.99
41	0 11(20) 19(20) 27(60) 0	100	80.00
42	0 73(60) 41(40) 0	100	200.00
43	0 31(40) 23(60) 0	100	80.00
44	0 117(60) 109(20) 85(20) 0	100	300.00
45	0 66(90) 58(10) 0	100	180.00
46	0 132(90) 100(10) 0	100	340.01
47	0 68(90) 0	90	180.00
48	0 38(40) 37(60) 0	100	138.26
49	0 48(90) 0	90	120.00
50	0 103(40) 95(60) 0	100	260.00
51	0 148(10) 156(90) 0	100	400.00
52	0 28(90) 0	90	80.00
53	0 133(20) 149(20) 157(60) 0	100	400.00
54	0 138(70) 130(30) 0	100	360.00
55	0 6(80) 0	80	20.00
56	0 140(20) 148(80) 0	100	380.00
57	0 46(60) 38(40) 0	100	120.00
58	0 108(10) 116(90) 0	100	300.00
59	0 49(20) 65(60) 41(20) 0	100	180.00
60	0 100(50) 84(50) 0	100	260.00
61	0 49(40) 57(60) 0	100	160.00
62	0 88(60) 96(40) 0	100	240.01
63	0 14(90) 0	90	39.99
64	0 102(20) 134(80) 0	100	339.99
65	0 107(40) 99(60) 0	100	280.00
66	0 12(50) 4(50) 0	100	39.99
67	0 88(30) 120(70) 0	100	300.00
68	0 8(90) 0	90	20.00
69	0 42(60) 26(40) 0	100	120.01
70	0 118(10) 126(90) 0	100	319.99

(cont.)

Table A.68 continued.

No.	Route	Load	Distance
71	0 70(90) 46(10) 0	100	180.00
72	0 22(90) 0	90	60.01
73	0 82(10) 90(90) 0	100	239.99
74	0 104(50) 96(50) 0	100	260.00
75	0 60(10) 76(90) 0	100	200.01
76	0 40(60) 24(40) 0	100	100.00
77	0 84(40) 92(60) 0	100	240.01
78	0 71(40) 79(60) 0	100	200.00
79	0 59(60) 51(20) 43(20) 0	100	160.00
80	0 152(80) 120(20) 0	100	380.00
81	0 24(10) 32(90) 0	100	80.00
82	0 122(90) 106(10) 0	100	319.99
83	0 125(60) 133(40) 0	100	340.00
84	0 67(60) 43(40) 0	100	180.00
85	0 2(90) 0	90	20.00
86	0 123(60) 131(40) 0	100	340.00
87	0 55(40) 47(60) 0	100	140.00
88	0 97(40) 105(60) 0	100	280.00
89	0 52(20) 60(80) 0	100	159.99
90	0 102(70) 94(30) 0	100	259.99
91	0 121(20) 137(60) 145(20) 0	100	380.00
92	0 25(40) 17(60) 0	100	80.00
93	0 134(10) 142(90) 0	100	359.99
94	0 58(10) 74(90) 0	100	200.00
95	0 64(10) 80(90) 0	100	200.00
96	0 130(60) 98(40) 0	100	340.01
97	0 98(30) 106(70) 0	100	280.00
98	0 155(60) 147(40) 0	100	400.00
99	0 40(10) 56(90) 0	100	140.01
100	0 21(40) 13(60) 0	100	60.00
101	0 98(20) 82(80) 0	100	260.00
102	0 107(20) 115(60) 83(20) 0	100	300.00
103	0 11(40) 3(60) 0	100	40.00
104	0 145(40) 153(60) 0	100	400.00
105	0 36(90) 0	90	100.00

(cont.)

Table A.68 continued.

No.	Route	Load	Distance
106	0 54(90) 46(10) 0	100	139.99
107	0 127(40) 135(60) 0	100	340.00
108	0 72(90) 0	90	180.00
109	0 86(20) 118(80) 0	100	300.00
110	0 39(60) 31(20) 0	80	100.00
111	0 53(40) 45(60) 0	100	140.00
112	0 10(90) 0	90	39.99
113	0 85(40) 93(60) 0	100	240.00
114	0 46(10) 78(90) 0	100	200.00
115	0 30(90) 6(10) 0	100	80.00
116	0 38(10) 62(90) 0	100	160.00
117	0 141(60) 149(40) 0	100	380.00
118	0 26(40) 9(60) 0	100	89.46
119	0 114(90) 106(10) 0	100	300.00
120	0 94(10) 110(90) 0	100	280.00
121	0 12(40) 44(60) 0	100	120.00
122	0 109(40) 101(60) 0	100	280.00
		Total Distance	26640.69

Table A.69: EMIP-MDA+ERTR solution to SD18.

No.	Route	Load	Distance
1	0 10(10) 42(90) 0	100	60.01
2	0 120(90) 104(10) 0	100	160.00
3	0 130(90) 114(10) 0	100	180.00
4	0 126(90) 0	90	159.99
5	0 66(90) 18(10) 0	100	99.99
6	0 40(90) 0	90	60.01
7	0 74(30) 106(70) 0	100	139.99
8	0 28(90) 0	90	40.01
9	0 54(90) 0	90	80.01
10	0 61(60) 77(40) 0	100	100.00
11	0 62(90) 30(10) 0	100	80.00
12	0 37(20) 100(80) 0	100	143.81
13	0 18(80) 19(20) 0	100	47.81
14	0 113(60) 129(40) 0	100	180.00
15	0 146(90) 50(10) 0	100	200.01
16	0 13(60) 15(40) 0	100	27.65
17	0 33(20) 50(80) 0	100	86.82
18	0 148(90) 116(10) 0	100	200.01
19	0 39(60) 22(40) 0	100	63.83
20	0 98(90) 0	90	140.00
21	0 16(80) 0	80	20.00
22	0 156(90) 140(10) 0	100	199.99
23	0 59(40) 43(60) 0	100	80.00
24	0 154(90) 138(10) 0	100	200.00
25	0 38(90) 0	90	60.01
26	0 64(90) 48(10) 0	100	79.99
27	0 128(80) 112(20) 0	100	160.01
28	0 99(60) 83(40) 0	100	140.01
29	0 83(20) 131(20) 115(60) 0	100	180.00
30	0 46(90) 0	90	60.01
31	0 86(90) 0	90	119.99
32	0 5(60) 4(40) 0	100	23.91
33	0 8(90) 0	90	20.00
34	0 147(60) 131(40) 0	100	200.00
35	0 72(90) 24(10) 0	100	100.00

(cont.)

Table A.69 continued.

No.	Route	Load	Distance
36	0 85(60) 69(40) 0	100	120.00
37	0 75(60) 74(40) 0	100	119.51
38	0 53(60) 37(40) 0	100	80.00
39	0 119(40) 135(60) 0	100	180.00
40	0 7(20) 24(80) 0	100	41.43
41	0 138(80) 106(20) 0	100	179.99
42	0 60(90) 0	90	79.99
43	0 56(60) 57(40) 0	100	95.61
44	0 136(90) 56(10) 0	100	180.01
45	0 82(90) 0	90	119.99
46	0 142(80) 63(20) 0	100	185.20
47	0 108(90) 92(10) 0	100	140.01
48	0 78(80) 31(20) 0	100	102.45
49	0 157(60) 141(20) 109(20) 0	100	200.00
50	0 140(80) 77(20) 0	100	187.79
51	0 68(90) 4(10) 0	100	100.00
52	0 67(60) 51(40) 0	100	100.00
53	0 51(20) 114(80) 0	100	165.68
54	0 76(90) 0	90	100.00
55	0 125(60) 141(40) 0	100	180.00
56	0 1(60) 17(40) 0	100	40.00
57	0 103(60) 87(40) 0	100	139.99
58	0 97(20) 129(20) 145(60) 0	100	200.00
59	0 34(90) 0	90	60.01
60	0 20(90) 0	90	40.00
61	0 12(90) 0	90	20.00
62	0 32(90) 16(10) 0	100	40.01
63	0 3(60) 4(40) 0	100	23.90
64	0 44(80) 29(20) 0	100	63.82
65	0 132(90) 100(10) 0	100	180.00
66	0 35(60) 19(40) 0	100	59.99
67	0 49(60) 33(40) 0	100	80.00
68	0 58(90) 0	90	80.00
69	0 74(20) 90(80) 0	100	120.01
70	0 84(90) 0	90	119.99

(cont.)

Table A.69 continued.

No.	Route	Load	Distance
71	0 26(90) 0	90	40.00
72	0 80(50) 96(50) 0	100	120.00
73	0 30(80) 15(20) 0	100	41.42
74	0 123(60) 139(40) 0	100	180.00
75	0 124(90) 44(10) 0	100	160.00
76	0 118(90) 102(10) 0	100	160.00
77	0 91(20) 155(60) 139(20) 0	100	200.00
78	0 122(90) 90(10) 0	100	160.00
79	0 21(60) 22(40) 0	100	47.80
80	0 134(80) 133(20) 0	100	215.11
81	0 81(60) 97(40) 0	100	140.00
82	0 45(60) 29(40) 0	100	60.00
83	0 9(60) 0	60	20.00
84	0 36(90) 0	90	60.01
85	0 110(90) 78(10) 0	100	140.01
86	0 143(20) 127(60) 111(20) 0	100	180.00
87	0 94(90) 0	90	120.00
88	0 149(60) 133(40) 0	100	200.00
89	0 88(80) 56(20) 0	100	120.00
90	0 11(60) 10(40) 0	100	23.90
91	0 144(90) 112(10) 0	100	180.00
92	0 23(60) 7(40) 0	100	39.99
93	0 150(90) 134(10) 0	100	200.00
94	0 27(60) 10(40) 0	100	41.41
95	0 107(60) 91(40) 0	100	139.99
96	0 95(60) 111(40) 0	100	140.01
97	0 92(80) 59(20) 0	100	127.67
98	0 93(60) 109(40) 0	100	140.00
99	0 160(90) 128(10) 0	100	199.99
100	0 159(60) 143(40) 0	100	200.00
101	0 158(90) 142(10) 0	100	199.99
102	0 102(80) 69(20) 0	100	150.53
103	0 6(90) 0	90	20.00
104	0 101(20) 116(80) 0	100	180.87
105	0 121(40) 153(60) 0	100	200.00

(cont.)

Table A.69 continued.

No.	Route	Load	Distance
106	0 79(60) 63(40) 0	100	100.00
107	0 104(80) 55(20) 0	100	146.42
108	0 65(60) 80(40) 0	100	119.51
109	0 48(80) 17(20) 0	100	63.83
110	0 71(60) 55(40) 0	100	100.00
111	0 47(60) 31(40) 0	100	60.01
112	0 137(60) 121(20) 105(20) 0	100	180.00
113	0 25(20) 73(60) 57(20) 0	100	100.00
114	0 14(90) 0	90	20.00
115	0 112(60) 96(40) 0	100	140.01
116	0 151(60) 119(20) 87(20) 0	100	200.01
117	0 41(60) 25(40) 0	100	60.00
118	0 89(60) 105(40) 0	100	140.00
119	0 2(90) 0	90	20.00
120	0 52(90) 0	90	79.99
121	0 70(90) 22(10) 0	100	100.01
122	0 117(60) 101(40) 0	100	160.00
123	0 152(90) 88(10) 0	100	199.99
		Total Distance	14357.77

Table A.70: EMIP-MDA+ERTR solution to SD19.

No.	Route	Load	Distance
1	0 181(60) 165(40) 0	100	240.00
2	0 191(60) 176(40) 0	100	275.94
3	0 90(20) 122(80) 0	100	160.00
4	0 24(10) 40(90) 0	100	60.01
5	0 10(90) 0	90	20.00
6	0 127(20) 143(60) 159(20) 0	100	200.00
7	0 125(60) 141(40) 0	100	180.00
8	0 130(80) 99(20) 0	100	196.87
9	0 11(10) 27(40) 11(50) 0	100	39.99
10	0 34(90) 0	90	60.01
11	0 120(10) 152(90) 0	100	199.99
12	0 14(40) 13(60) 0	100	23.91
13	0 131(60) 147(40) 0	100	200.00
14	0 124(90) 108(10) 0	100	160.00
15	0 120(10) 136(90) 0	100	180.01
16	0 33(60) 49(40) 0	100	80.00
17	0 55(20) 56(80) 0	100	95.61
18	0 162(10) 178(90) 0	100	240.01
19	0 94(40) 61(60) 0	100	127.67
20	0 167(40) 183(60) 0	100	240.01
21	0 117(40) 133(40) 117(20) 0	100	180.00
22	0 59(40) 43(60) 0	100	80.00
23	0 169(40) 185(60) 0	100	240.00
24	0 96(90) 0	90	120.00
25	0 39(60) 22(40) 0	100	63.83
26	0 86(20) 118(80) 0	100	160.00
27	0 112(10) 128(90) 0	100	160.01
28	0 3(20) 4(80) 0	100	23.90
29	0 168(10) 184(90) 0	100	240.00
30	0 36(10) 84(90) 0	100	119.99
31	0 186(90) 170(10) 0	100	240.00
32	0 95(60) 79(20) 47(20) 0	100	120.00
33	0 73(20) 89(60) 74(20) 0	100	133.60
34	0 85(60) 101(40) 0	100	140.00
35	0 163(20) 164(80) 0	100	262.92

(cont.)

Table A.70 continued.

No.	Route	Load	Distance
36	0 74(20) 106(80) 0	100	139.99
37	0 47(40) 31(60) 0	100	60.01
38	0 7(50) 6(50) 0	100	23.90
39	0 76(80) 93(20) 0	100	133.59
40	0 65(20) 112(80) 0	100	150.56
41	0 82(10) 98(90) 0	100	140.00
42	0 29(20) 46(80) 0	100	63.84
43	0 132(10) 148(90) 0	100	200.01
44	0 38(90) 22(10) 0	100	60.01
45	0 179(60) 163(40) 0	100	239.99
46	0 164(10) 180(90) 0	100	240.00
47	0 17(60) 16(40) 0	100	41.42
48	0 133(20) 149(60) 165(20) 0	100	220.00
49	0 16(10) 32(90) 0	100	40.01
50	0 69(20) 132(80) 0	100	187.80
51	0 110(20) 142(80) 0	100	179.99
52	0 25(20) 24(80) 0	100	47.81
53	0 22(40) 21(60) 0	100	47.80
54	0 108(40) 109(60) 0	100	167.32
55	0 151(60) 167(20) 119(20) 0	100	220.01
56	0 156(20) 172(80) 0	100	220.00
57	0 103(60) 102(40) 0	100	167.30
58	0 91(40) 107(60) 0	100	139.99
59	0 172(10) 188(90) 0	100	240.00
60	0 53(60) 69(40) 0	100	100.00
61	0 30(90) 0	90	40.00
62	0 104(40) 105(60) 0	100	167.30
63	0 79(40) 63(60) 0	100	100.00
64	0 3(40) 19(60) 0	100	39.99
65	0 101(20) 166(80) 0	100	232.65
66	0 2(90) 0	90	20.00
67	0 108(40) 140(60) 0	100	179.99
68	0 114(90) 50(10) 0	100	160.00
69	0 54(30) 86(70) 0	100	119.99
70	0 80(90) 0	90	100.00

(cont.)

Table A.70 continued.

No.	Route	Load	Distance
71	0 45(60) 29(40) 0	100	60.00
72	0 97(20) 145(10) 161(20) 145(50) 0	100	220.00
73	0 127(40) 111(60) 0	100	160.00
74	0 175(60) 159(40) 0	100	220.00
75	0 76(10) 92(90) 0	100	120.00
76	0 14(40) 15(60) 0	100	23.90
77	0 51(50) 35(50) 0	100	79.99
78	0 6(40) 5(60) 0	100	23.91
79	0 9(40) 23(60) 0	100	44.73
80	0 147(20) 162(80) 0	100	252.13
81	0 46(10) 62(90) 0	100	80.00
82	0 160(90) 0	90	199.99
83	0 144(90) 0	90	180.00
84	0 42(10) 58(90) 0	100	80.00
85	0 82(80) 49(20) 0	100	127.66
86	0 116(90) 35(10) 0	100	163.53
87	0 67(40) 83(60) 0	100	120.01
88	0 100(90) 0	90	140.00
89	0 54(60) 37(40) 0	100	86.82
90	0 190(90) 174(10) 0	100	240.00
91	0 8(90) 0	90	20.00
92	0 9(10) 88(90) 0	100	120.91
93	0 140(30) 156(70) 0	100	199.99
94	0 166(10) 182(90) 0	100	240.01
95	0 146(90) 130(10) 0	100	200.01
96	0 60(90) 0	90	79.99
97	0 1(60) 16(40) 0	100	23.91
98	0 102(50) 70(50) 0	100	139.99
99	0 55(40) 71(60) 0	100	100.00
100	0 70(40) 87(60) 0	100	133.60
101	0 110(60) 94(40) 0	100	140.01
102	0 26(90) 9(10) 0	100	41.42
103	0 50(10) 66(90) 0	100	99.99
104	0 137(40) 121(60) 0	100	180.00
105	0 48(90) 0	90	60.00

(cont.)

Table A.70 continued.

No.	Route	Load	Distance
106	0 64(90) 0	90	79.99
107	0 120(20) 168(80) 0	100	219.99
108	0 18(90) 0	90	40.00
109	0 68(90) 4(10) 0	100	100.00
110	0 77(60) 93(40) 0	100	120.00
111	0 91(20) 75(60) 59(20) 0	100	120.00
112	0 141(20) 157(60) 189(20) 0	100	240.00
113	0 20(90) 0	90	40.00
114	0 7(10) 150(90) 0	100	200.84
115	0 106(10) 138(90) 0	100	179.99
116	0 94(10) 158(90) 0	100	199.99
117	0 73(40) 57(60) 0	100	100.00
118	0 171(40) 155(60) 0	100	220.00
119	0 56(10) 72(90) 0	100	100.00
120	0 37(20) 36(80) 0	100	71.71
121	0 51(10) 67(20) 50(70) 0	100	110.11
122	0 142(10) 174(80) 110(10) 0	100	219.99
123	0 12(90) 0	90	20.00
124	0 113(60) 97(40) 0	100	160.00
125	0 25(40) 41(60) 0	100	60.00
126	0 189(40) 173(60) 0	100	240.00
127	0 44(90) 0	90	59.99
128	0 135(60) 119(40) 0	100	180.00
129	0 27(20) 42(80) 0	100	63.84
130	0 52(90) 0	90	79.99
131	0 90(20) 170(80) 0	100	219.99
132	0 192(90) 176(10) 0	100	240.00
133	0 126(90) 0	90	159.99
134	0 74(50) 90(50) 0	100	120.01
135	0 139(40) 123(60) 0	100	180.00
136	0 134(90) 118(10) 0	100	180.00
137	0 99(40) 115(60) 0	100	160.00
138	0 177(60) 161(40) 0	100	240.00
139	0 14(10) 78(90) 0	100	100.01
140	0 176(40) 129(60) 0	100	243.68

(cont.)

Table A.70 continued.

No.	Route	Load	Distance
141	0 81(60) 65(40) 0	100	120.00
142	0 122(10) 154(90) 0	100	200.00
143	0 120(50) 104(50) 0	100	160.00
144	0 169(20) 153(60) 137(20) 0	100	220.00
145	0 139(20) 187(60) 171(20) 0	100	239.99
146	0 28(90) 0	90	40.01
		Total Distance	20348.16

Table A.71: EMIP-MDA+ERTR solution to SD20.

No.	Route	Load	Distance
1	0 220(80) 208(20) 0	100	380.00
2	0 86(10) 98(90) 0	100	180.00
3	0 10(90) 0	90	20.00
4	0 179(40) 191(60) 0	100	320.01
5	0 186(80) 162(20) 0	100	320.00
6	0 74(90) 2(10) 0	100	140.00
7	0 53(40) 40(60) 0	100	115.22
8	0 131(20) 167(60) 155(20) 0	100	279.99
9	0 43(30) 31(50) 19(20) 0	100	80.00
10	0 19(40) 7(60) 0	100	40.00
11	0 60(10) 108(90) 0	100	179.99
12	0 75(60) 63(40) 0	100	140.00
13	0 126(90) 138(10) 0	100	240.00
14	0 124(90) 136(10) 0	100	240.00
15	0 176(80) 164(20) 0	100	300.00
16	0 111(60) 99(40) 0	100	200.00
17	0 110(90) 86(10) 0	100	200.00
18	0 173(60) 149(40) 0	100	300.00
19	0 52(90) 28(10) 0	100	100.00
20	0 18(80) 6(20) 0	100	40.00
21	0 24(70) 13(30) 0	100	50.35
22	0 176(10) 188(90) 0	100	320.00
23	0 161(60) 149(20) 125(20) 0	100	280.00
24	0 235(60) 223(40) 0	100	400.00
25	0 71(60) 83(40) 0	100	140.00
26	0 40(30) 88(70) 0	100	160.00
27	0 67(60) 91(40) 0	100	160.00
28	0 47(40) 59(60) 0	100	100.01
29	0 32(40) 55(60) 0	100	108.32
30	0 56(40) 57(60) 0	100	125.88
31	0 217(40) 229(60) 0	100	400.00
32	0 231(60) 219(40) 0	100	400.00
33	0 12(20) 47(20) 35(60) 0	100	81.73
34	0 11(50) 46(50) 0	100	81.74
35	0 81(20) 93(60) 105(20) 0	100	180.01

(cont.)

Table A.71 continued.

No.	Route	Load	Distance
36	0 94(90) 82(10) 0	100	160.00
37	0 36(90) 24(10) 0	100	60.00
38	0 221(40) 209(60) 0	100	380.00
39	0 169(60) 157(40) 0	100	300.00
40	0 63(20) 87(60) 99(20) 0	100	180.00
41	0 148(20) 136(80) 0	100	260.00
42	0 5(30) 6(70) 0	100	25.18
43	0 121(20) 157(20) 145(60) 0	100	280.00
44	0 51(60) 27(20) 15(20) 0	100	100.00
45	0 54(90) 42(10) 0	100	100.00
46	0 49(20) 84(80) 0	100	156.59
47	0 200(90) 152(10) 0	100	339.99
48	0 196(60) 184(40) 0	100	340.00
49	0 12(30) 23(60) 11(10) 0	100	42.39
50	0 139(20) 163(20) 175(60) 0	100	300.00
51	0 70(90) 0	90	120.00
52	0 12(40) 9(60) 0	100	34.14
53	0 112(90) 100(10) 0	100	200.00
54	0 102(90) 90(10) 0	100	180.01
55	0 118(90) 34(10) 0	100	200.00
56	0 39(60) 27(40) 0	100	80.00
57	0 237(60) 213(40) 0	100	399.99
58	0 97(40) 85(60) 0	100	180.00
59	0 131(40) 143(60) 0	100	239.99
60	0 50(60) 49(40) 0	100	125.88
61	0 34(80) 33(20) 0	100	75.53
62	0 227(20) 239(60) 179(20) 0	100	400.00
63	0 44(90) 32(10) 0	100	80.00
64	0 201(60) 189(40) 0	100	340.00
65	0 1(30) 2(70) 0	100	25.18
66	0 65(60) 77(40) 0	100	140.00
67	0 25(40) 37(60) 0	100	80.00
68	0 147(40) 159(60) 0	100	279.99
69	0 223(20) 211(20) 199(60) 0	100	380.00
70	0 45(60) 33(40) 0	100	80.00

(cont.)

Table A.71 continued.

No.	Route	Load	Distance
71	0 185(40) 197(60) 0	100	340.00
72	0 50(30) 86(70) 0	100	160.00
73	0 150(40) 138(60) 0	100	260.00
74	0 22(90) 0	90	40.00
75	0 103(40) 115(60) 0	100	200.00
76	0 222(80) 174(20) 0	100	380.00
77	0 8(90) 0	90	20.00
78	0 61(60) 73(40) 0	100	140.00
79	0 107(40) 95(60) 0	100	180.00
80	0 219(20) 207(60) 195(20) 0	100	380.00
81	0 236(90) 224(10) 0	100	400.01
82	0 62(90) 26(10) 0	100	120.00
83	0 17(60) 29(40) 0	100	60.00
84	0 187(60) 211(40) 0	100	360.00
85	0 81(40) 69(60) 0	100	140.01
86	0 150(30) 162(70) 0	100	280.00
87	0 46(30) 82(70) 0	100	140.00
88	0 38(90) 26(10) 0	100	80.00
89	0 43(30) 78(70) 0	100	150.62
90	0 42(10) 66(90) 0	100	120.00
91	0 106(90) 82(10) 0	100	180.00
92	0 163(40) 151(60) 0	100	280.00
93	0 104(80) 92(20) 0	100	180.00
94	0 165(40) 129(60) 0	100	279.99
95	0 212(90) 152(10) 0	100	359.99
96	0 28(20) 64(80) 0	100	120.00
97	0 96(90) 24(10) 0	100	160.01
98	0 217(20) 205(60) 181(20) 0	100	380.00
99	0 30(90) 18(10) 0	100	60.00
100	0 26(70) 13(30) 0	100	66.15
101	0 182(70) 134(30) 0	100	320.01
102	0 160(30) 148(70) 0	100	280.00
103	0 132(90) 144(10) 0	100	240.00
104	0 4(90) 0	90	20.00
105	0 100(80) 88(20) 0	100	180.00

(cont.)

Table A.71 continued.

No.	Route	Load	Distance
106	0 113(60) 101(20) 77(20) 0	100	200.00
107	0 29(20) 41(60) 53(20) 0	100	100.00
108	0 122(90) 134(10) 0	100	239.99
109	0 214(20) 226(80) 0	100	380.00
110	0 155(40) 203(60) 0	100	340.01
111	0 156(20) 144(80) 0	100	260.00
112	0 104(10) 116(90) 0	100	200.00
113	0 134(50) 146(50) 0	100	259.99
114	0 220(10) 232(90) 0	100	400.00
115	0 153(20) 165(20) 177(60) 0	100	300.00
116	0 48(90) 0	90	80.01
117	0 164(70) 152(30) 0	100	280.00
118	0 178(30) 214(70) 0	100	360.00
119	0 80(90) 68(10) 0	100	140.00
120	0 180(30) 192(70) 0	100	320.00
121	0 146(40) 158(60) 0	100	279.99
122	0 130(90) 142(10) 0	100	240.00
123	0 123(60) 135(40) 0	100	239.99
124	0 121(40) 133(60) 0	100	240.00
125	0 152(20) 140(80) 0	100	260.00
126	0 68(80) 56(20) 0	100	119.99
127	0 31(10) 114(90) 0	100	205.53
128	0 178(40) 166(60) 0	100	300.00
129	0 180(40) 168(60) 0	100	300.00
130	0 28(60) 15(40) 0	100	66.15
131	0 158(30) 170(70) 0	100	299.99
132	0 135(20) 147(20) 171(60) 0	100	299.99
133	0 184(50) 172(50) 0	100	320.00
134	0 16(90) 0	90	40.00
135	0 20(90) 0	90	40.00
136	0 120(90) 84(10) 0	100	199.99
137	0 153(40) 141(60) 0	100	260.00
138	0 195(40) 183(60) 0	100	339.99
139	0 142(80) 154(20) 0	100	260.00
140	0 227(40) 215(60) 0	100	380.00

(cont.)

Table A.71 continued.

No.	Route	Load	Distance
141	0 204(80) 180(20) 0	100	340.01
142	0 60(80) 25(20) 0	100	108.33
143	0 230(90) 218(10) 0	100	400.01
144	0 172(40) 160(60) 0	100	300.00
145	0 196(30) 208(70) 0	100	360.00
146	0 174(60) 150(20) 138(20) 0	100	300.00
147	0 234(90) 222(10) 0	100	400.00
148	0 2(10) 14(90) 0	100	40.00
149	0 46(10) 58(90) 0	100	100.00
150	0 224(80) 152(20) 0	100	380.01
151	0 238(90) 226(10) 0	100	400.00
152	0 79(60) 91(20) 103(20) 0	100	180.00
153	0 168(30) 156(70) 0	100	280.00
154	0 56(30) 92(70) 0	100	160.00
155	0 89(60) 101(40) 0	100	180.01
156	0 42(70) 5(30) 0	100	81.73
157	0 198(90) 186(10) 0	100	340.00
158	0 128(90) 140(10) 0	100	240.00
159	0 76(90) 64(10) 0	100	140.00
160	0 166(30) 154(70) 0	100	280.00
161	0 83(20) 107(20) 119(60) 0	100	200.00
162	0 109(60) 97(20) 73(20) 0	100	200.00
163	0 182(10) 206(90) 0	100	360.01
164	0 174(10) 210(90) 0	100	360.00
165	0 193(60) 181(40) 0	100	340.00
166	0 78(20) 90(80) 0	100	160.01
167	0 192(10) 240(90) 0	100	400.00
168	0 139(40) 127(60) 0	100	240.00
169	0 170(20) 218(80) 0	100	380.01
170	0 32(40) 21(60) 0	100	66.15
171	0 125(40) 137(60) 0	100	240.00
172	0 233(60) 221(20) 185(20) 0	100	400.00
173	0 178(20) 190(80) 0	100	320.00
174	0 204(10) 216(90) 0	100	360.00
175	0 182(10) 194(90) 0	100	340.01

(cont.)

Table A.71 continued.

No.	Route	Load	Distance
176	0 72(90) 0	90	120.01
177	0 1(30) 3(60) 0	90	30.00
178	0 117(60) 105(40) 0	100	200.01
179	0 190(10) 202(90) 0	100	340.00
180	0 225(60) 213(20) 189(20) 0	100	379.99
181	0 192(10) 228(90) 0	100	380.00
		Total Distance	39902.76

Table A.72: EMIP-MDA+ERTR solution to SD21.

No.	Route	Load	Distance
1	0 65(10) 136(90) 0	100	40.07
2	0 15(50) 18(50) 0	100	22.61
3	0 61(50) 60(50) 0	100	20.87
4	0 23(10) 96(90) 0	100	40.08
5	0 206(40) 205(60) 0	100	62.61
6	0 111(10) 184(90) 0	100	60.23
7	0 9(10) 8(90) 0	100	20.87
8	0 44(40) 41(60) 0	100	22.61
9	0 285(60) 213(40) 0	100	80.01
10	0 228(40) 227(60) 0	100	83.49
11	0 48(50) 49(50) 0	100	20.88
12	0 47(60) 48(40) 0	100	20.87
13	0 196(40) 195(60) 0	100	62.61
14	0 213(10) 284(90) 0	100	80.45
15	0 256(50) 254(50) 0	100	86.98
16	0 55(50) 56(50) 0	100	20.87
17	0 216(50) 145(50) 0	100	62.63
18	0 36(90) 0	90	20.00
19	0 175(10) 174(90) 0	100	62.62
20	0 100(40) 101(60) 0	100	41.74
21	0 127(20) 126(80) 0	100	41.75
22	0 193(60) 191(40) 0	100	65.24
23	0 82(40) 83(60) 0	100	41.74
24	0 111(50) 110(50) 0	100	41.74
25	0 3(10) 76(90) 0	100	40.08
26	0 156(50) 228(50) 0	100	80.00
27	0 216(40) 215(60) 0	100	62.61
28	0 247(60) 246(40) 0	100	83.50
29	0 225(50) 224(50) 0	100	83.49
30	0 38(40) 37(60) 0	100	20.87
31	0 93(10) 92(90) 0	100	41.74
32	0 91(60) 90(40) 0	100	41.74
33	0 187(10) 258(90) 0	100	80.44
34	0 19(10) 20(90) 0	100	20.87
35	0 256(40) 255(60) 0	100	83.49

(cont.)

Table A.72 continued.

No.	Route	Load	Distance
36	0 183(60) 182(40) 0	100	62.62
37	0 102(40) 103(60) 0	100	41.74
38	0 82(50) 81(50) 0	100	41.74
39	0 134(40) 135(60) 0	100	41.73
40	0 182(50) 114(50) 0	100	63.14
41	0 6(40) 7(60) 0	100	20.87
42	0 32(90) 0	90	20.00
43	0 180(40) 179(60) 0	100	62.61
44	0 29(60) 30(40) 0	100	20.87
45	0 87(60) 86(40) 0	100	41.74
46	0 163(40) 164(60) 0	100	62.62
47	0 265(50) 266(50) 0	100	83.48
48	0 141(40) 143(60) 0	100	43.48
49	0 78(50) 77(50) 0	100	41.74
50	0 287(10) 286(90) 0	100	83.49
51	0 160(50) 161(50) 0	100	62.62
52	0 237(10) 236(90) 0	100	83.49
53	0 35(10) 108(90) 0	100	40.07
54	0 63(60) 64(40) 0	100	20.87
55	0 26(40) 27(60) 0	100	20.87
56	0 224(40) 223(60) 0	100	83.48
57	0 189(50) 187(50) 0	100	65.22
58	0 278(40) 279(60) 0	100	83.49
59	0 162(90) 89(10) 0	100	60.23
60	0 119(10) 118(90) 0	100	41.74
61	0 129(10) 128(90) 0	100	41.74
62	0 21(10) 22(90) 0	100	20.87
63	0 53(20) 51(60) 0	80	21.74
64	0 119(10) 120(90) 0	100	41.75
65	0 203(40) 275(60) 0	100	80.00
66	0 115(20) 186(20) 257(60) 0	100	80.68
67	0 58(90) 0	90	20.00
68	0 158(10) 230(90) 0	100	80.00
69	0 130(40) 131(60) 0	100	41.75
70	0 123(20) 122(80) 0	100	41.74

(cont.)

Table A.72 continued.

No.	Route	Load	Distance
71	0 141(20) 142(80) 0	100	41.74
72	0 287(50) 288(50) 0	100	83.49
73	0 139(10) 140(90) 0	100	41.73
74	0 42(90) 0	90	20.00
75	0 232(40) 231(60) 0	100	83.50
76	0 166(20) 165(60) 164(20) 0	100	65.24
77	0 173(10) 172(90) 0	100	62.61
78	0 104(90) 0	90	40.00
79	0 243(60) 242(40) 0	100	83.49
80	0 115(40) 117(60) 0	100	43.48
81	0 97(50) 98(50) 0	100	41.74
82	0 221(10) 222(90) 0	100	83.49
83	0 109(60) 110(40) 0	100	41.74
84	0 39(10) 112(90) 0	100	40.07
85	0 56(40) 57(60) 0	100	20.88
86	0 274(90) 203(10) 0	100	80.45
87	0 102(50) 100(50) 0	100	43.48
88	0 206(40) 207(60) 0	100	62.62
89	0 77(10) 150(90) 0	100	60.23
90	0 86(50) 85(50) 0	100	41.75
91	0 85(10) 84(90) 0	100	41.74
92	0 260(10) 259(60) 185(30) 0	100	85.17
93	0 245(10) 244(90) 0	100	83.50
94	0 39(50) 38(50) 0	100	20.88
95	0 130(50) 129(50) 0	100	41.75
96	0 127(40) 199(60) 0	100	60.00
97	0 138(40) 137(60) 0	100	41.75
98	0 99(60) 98(40) 0	100	41.73
99	0 5(10) 4(90) 0	100	20.87
100	0 219(10) 220(90) 0	100	83.48
101	0 12(40) 11(60) 0	100	20.87
102	0 191(10) 192(90) 0	100	62.62
103	0 138(50) 139(50) 0	100	41.74
104	0 269(50) 270(50) 0	100	83.49
105	0 72(50) 1(50) 0	100	20.87

(cont.)

Table A.72 continued.

No.	Route	Load	Distance
106	0 106(50) 105(50) 0	100	41.74
107	0 270(40) 271(60) 0	100	83.49
108	0 238(40) 239(60) 0	100	83.50
109	0 233(50) 232(50) 0	100	83.48
110	0 33(60) 34(40) 0	100	20.87
111	0 73(50) 75(50) 0	100	43.49
112	0 282(40) 283(60) 0	100	83.49
113	0 147(10) 218(90) 0	100	80.45
114	0 3(50) 5(50) 0	100	21.74
115	0 281(10) 280(90) 0	100	83.49
116	0 18(40) 17(60) 0	100	20.88
117	0 43(10) 188(90) 0	100	60.06
118	0 59(60) 60(40) 0	100	20.87
119	0 225(10) 226(90) 0	100	83.48
120	0 250(50) 249(50) 0	100	83.49
121	0 153(40) 151(60) 0	100	65.22
122	0 28(90) 0	90	20.00
123	0 153(10) 152(90) 0	100	62.60
124	0 126(10) 124(90) 0	100	43.48
125	0 191(10) 263(60) 262(30) 0	100	83.49
126	0 68(50) 67(50) 0	100	20.87
127	0 145(10) 146(90) 0	100	62.62
128	0 16(90) 0	90	20.00
129	0 189(10) 190(90) 0	100	62.61
130	0 67(10) 66(90) 0	100	20.88
131	0 40(90) 0	90	20.00
132	0 90(50) 89(50) 0	100	41.74
133	0 210(40) 211(60) 0	100	62.62
134	0 24(90) 0	90	20.00
135	0 175(40) 177(60) 0	100	65.23
136	0 52(90) 0	90	20.00
137	0 23(50) 25(50) 0	100	21.75
138	0 61(10) 62(90) 0	100	20.86
139	0 121(60) 119(40) 0	100	43.49
140	0 71(60) 72(40) 0	100	20.88

(cont.)

Table A.72 continued.

No.	Route	Load	Distance
141	0 181(60) 180(40) 0	100	62.63
142	0 10(90) 0	90	20.00
143	0 53(40) 45(60) 0	100	26.84
144	0 1(10) 2(90) 0	100	20.87
145	0 75(10) 74(90) 0	100	41.74
146	0 12(50) 14(50) 0	100	21.74
147	0 116(90) 0	90	39.99
148	0 261(60) 260(40) 0	100	83.49
149	0 142(10) 214(90) 0	100	60.01
150	0 133(50) 134(50) 0	100	41.74
151	0 153(10) 154(90) 0	100	62.61
152	0 167(30) 166(70) 0	100	62.62
153	0 159(60) 160(40) 0	100	62.61
154	0 200(40) 201(60) 0	100	62.62
155	0 198(90) 197(10) 0	100	62.61
156	0 272(50) 200(50) 0	100	80.00
157	0 180(10) 252(90) 0	100	80.01
158	0 132(90) 133(10) 0	100	41.75
159	0 197(50) 196(50) 0	100	62.62
160	0 175(10) 176(90) 0	100	62.62
161	0 55(10) 54(90) 0	100	20.87
162	0 49(10) 50(90) 0	100	20.87
163	0 233(10) 234(90) 0	100	83.49
164	0 25(10) 97(10) 169(60) 168(20) 0	100	62.62
165	0 65(50) 64(50) 0	100	20.87
166	0 281(50) 282(50) 0	100	83.49
167	0 14(40) 13(60) 0	100	20.87
168	0 240(90) 241(10) 0	100	83.49
169	0 144(90) 73(10) 0	100	41.75
170	0 70(90) 0	90	20.00
171	0 266(40) 267(60) 0	100	83.49
172	0 81(10) 80(90) 0	100	41.75
173	0 147(50) 148(50) 0	100	62.61
174	0 164(10) 163(20) 235(60) 161(10) 0	100	84.30
175	0 122(10) 194(90) 0	100	60.00

(cont.)

Table A.72 continued.

No.	Route	Load	Distance
176	0 95(60) 94(40) 0	100	41.74
177	0 229(60) 157(40) 0	100	80.00
178	0 46(90) 0	90	20.00
179	0 213(10) 212(90) 0	100	62.61
180	0 34(50) 35(50) 0	100	20.87
181	0 114(40) 113(60) 0	100	41.74
182	0 94(50) 93(50) 0	100	41.76
183	0 206(10) 204(90) 0	100	65.23
184	0 237(50) 238(50) 0	100	83.49
185	0 185(30) 186(70) 0	100	62.62
186	0 250(40) 251(60) 0	100	83.49
187	0 69(60) 68(40) 0	100	20.88
188	0 106(40) 107(60) 0	100	41.76
189	0 156(40) 155(60) 0	100	62.60
190	0 277(10) 276(90) 0	100	83.47
191	0 31(60) 0	60	20.00
192	0 260(40) 262(60) 0	100	86.97
193	0 246(50) 245(50) 0	100	83.48
194	0 157(20) 158(80) 0	100	62.62
195	0 123(40) 125(60) 0	100	43.48
196	0 178(90) 105(10) 0	100	60.23
197	0 253(60) 254(40) 0	100	83.48
198	0 167(30) 168(70) 0	100	62.62
199	0 88(90) 15(10) 0	100	40.08
200	0 30(50) 26(50) 0	100	23.47
201	0 203(10) 202(90) 0	100	62.62
202	0 19(50) 21(50) 0	100	21.75
203	0 249(10) 248(90) 0	100	83.50
204	0 6(50) 9(50) 0	100	22.61
205	0 209(10) 208(90) 0	100	62.62
206	0 264(90) 265(10) 0	100	83.50
207	0 78(40) 79(60) 0	100	41.75
208	0 242(50) 241(50) 0	100	83.48
209	0 272(40) 273(60) 0	100	83.49
210	0 268(90) 269(10) 0	100	83.49

(cont.)

Table A.72 continued.

No.	Route	Load	Distance
211	0 210(50) 209(50) 0	100	62.62
212	0 171(50) 173(50) 0	100	65.23
213	0 44(50) 43(50) 0	100	20.86
214	0 277(50) 278(50) 0	100	83.49
215	0 217(60) 288(40) 0	100	83.50
216	0 148(40) 149(60) 0	100	62.62
217	0 170(90) 171(10) 0	100	62.62
218	0 221(50) 219(50) 0	100	86.97
		Total Distance	11436.70

Table A.73: EMIP-MDA+ERTR solution to MDA1 with $p = .1$.

No.	Route	Load	Distance
1	0 4(50) 1(50) 0	100	34.14
2	0 2(50) 3(50) 0	100	34.14
3	0 8(94) 4(6) 0	100	40.00
4	0 1(6) 5(94) 0	100	40.00
5	0 2(6) 6(94) 0	100	40.00
6	0 3(6) 7(94) 0	100	40.00
		Total Distance	228.28

Table A.74: EMIP-MDA+ERTR solution to MDA2 with $p = .1$.

No.	Route	Load	Distance
1	0 6(44) 2(56) 0	100	40.00
2	0 15(94) 3(6) 0	100	80.00
3	0 8(94) 4(6) 0	100	40.00
4	0 1(6) 5(94) 0	100	40.00
5	0 3(50) 7(50) 0	100	40.00
6	0 1(50) 9(50) 0	100	60.00
7	0 6(50) 10(50) 0	100	60.00
8	0 7(44) 11(56) 0	100	60.00
9	0 4(44) 12(56) 0	100	60.00
10	0 9(6) 13(94) 0	100	80.00
11	0 10(6) 14(94) 0	100	80.00
12	0 4(6) 16(94) 0	100	80.00
		Total Distance	720.00

Table A.75: EMIP-MDA+ERTR solution to MDA3 with $p = .1$.

No.	Route	Load	Distance
1	0 9(94) 1(6) 0	100	40.00
2	0 3(50) 2(50) 0	100	27.65
3	0 11(94) 3(6) 0	100	40.00
4	0 4(50) 5(50) 0	100	27.65
5	0 14(94) 6(6) 0	100	39.99
6	0 6(50) 7(50) 0	100	27.65
7	0 1(50) 8(50) 0	100	27.65
8	0 2(6) 10(94) 0	100	39.99
9	0 4(6) 12(94) 0	100	39.99
10	0 5(6) 13(94) 0	100	40.00
11	0 7(6) 15(94) 0	100	40.00
12	0 8(6) 16(94) 0	100	39.99
		Total Distance	430.58

Table A.76: EMIP-MDA+ERTR solution to MDA4 with $p = .1$.

No.	Route	Load	Distance
1	0 12(50) 1(50) 0	100	25.18
2	0 3(50) 2(50) 0	100	25.18
3	0 15(94) 3(6) 0	100	40.00
4	0 16(94) 4(6) 0	100	40.00
5	0 4(50) 5(50) 0	100	25.18
6	0 6(50) 7(50) 0	100	25.18
7	0 9(50) 8(50) 0	100	25.18
8	0 11(50) 10(50) 0	100	25.18
9	0 23(94) 11(6) 0	100	40.00
10	0 24(94) 12(6) 0	100	40.00
11	0 1(6) 13(94) 0	100	40.00
12	0 2(6) 14(94) 0	100	40.00
13	0 5(6) 17(94) 0	100	40.00
14	0 6(6) 18(94) 0	100	40.00
15	0 7(6) 19(94) 0	100	40.00
16	0 8(6) 20(94) 0	100	40.00
17	0 9(6) 21(94) 0	100	40.00
18	0 10(6) 22(94) 0	100	40.00
		Total Distance	631.05

Table A.77: EMIP-MDA+ERTR solution to MDA5 with $p = .1$.

No.	Route	Load	Distance
1	0 9(94) 1(6) 0	100	40.00
2	0 3(50) 2(50) 0	100	27.65
3	0 11(94) 3(6) 0	100	40.00
4	0 4(50) 5(50) 0	100	27.65
5	0 14(94) 6(6) 0	100	39.99
6	0 6(50) 7(50) 0	100	27.65
7	0 1(50) 8(50) 0	100	27.65
8	0 2(6) 10(94) 0	100	39.99
9	0 4(6) 12(94) 0	100	39.99
10	0 5(6) 13(94) 0	100	40.00
11	0 7(6) 15(94) 0	100	40.00
12	0 8(6) 16(94) 0	100	39.99
13	0 24(50) 17(50) 0	100	82.97
14	0 26(94) 18(6) 0	100	79.99
15	0 18(50) 19(50) 0	100	82.95
16	0 21(50) 20(50) 0	100	82.95
17	0 30(94) 22(6) 0	100	80.00
18	0 22(50) 23(50) 0	100	82.97
19	0 17(6) 25(94) 0	100	80.00
20	0 19(6) 27(94) 0	100	80.00
21	0 20(6) 28(94) 0	100	80.00
22	0 21(6) 29(94) 0	100	80.00
23	0 23(6) 31(94) 0	100	80.00
24	0 24(6) 32(94) 0	100	80.00
		Total Distance	1402.43

Table A.78: EMIP-MDA+ERTR solution to MDA6 with $p = .1$.

No.	Route	Load	Distance
1	0 17(94) 1(6) 0	100	40.00
2	0 1(50) 2(50) 0	100	23.91
3	0 4(50) 3(50) 0	100	23.90
4	0 20(94) 4(6) 0	100	40.00
5	0 5(50) 6(50) 0	100	23.91
6	0 23(94) 7(6) 0	100	39.99
7	0 7(50) 8(50) 0	100	23.90
8	0 10(50) 9(50) 0	100	23.91
9	0 12(50) 11(50) 0	100	23.90
10	0 14(50) 13(50) 0	100	23.91
11	0 30(94) 14(6) 0	100	40.00
12	0 31(94) 15(6) 0	100	39.99
13	0 15(50) 16(50) 0	100	23.90
14	0 2(6) 18(94) 0	100	40.00
15	0 3(6) 19(94) 0	100	39.99
16	0 5(6) 21(94) 0	100	40.00
17	0 6(6) 22(94) 0	100	40.00
18	0 8(6) 24(94) 0	100	40.01
19	0 9(6) 25(94) 0	100	40.00
20	0 10(6) 26(94) 0	100	40.00
21	0 11(6) 27(94) 0	100	39.99
22	0 12(6) 28(94) 0	100	40.01
23	0 13(6) 29(94) 0	100	40.00
24	0 16(6) 32(94) 0	100	40.01
		Total Distance	831.24

Table A.79: EMIP-MDA+ERTR solution to MDA7 with $p = .1$.

No.	Route	Load	Distance
1	0 2(50) 1(50) 0	100	34.14
2	0 7(94) 3(6) 0	100	40.00
3	0 3(50) 4(50) 0	100	34.14
4	0 1(6) 5(94) 0	100	40.00
5	0 2(6) 6(94) 0	100	40.00
6	0 4(6) 8(94) 0	100	40.00
7	0 14(94) 10(6) 0	100	80.00
8	0 23(94) 11(6) 0	100	120.00
9	0 9(6) 13(94) 0	100	80.00
10	0 11(50) 15(50) 0	100	80.00
11	0 12(56) 16(44) 0	100	80.00
12	0 9(50) 17(50) 0	100	100.00
13	0 10(44) 18(56) 0	100	100.00
14	0 15(44) 19(56) 0	100	100.00
15	0 16(50) 20(50) 0	100	100.00
16	0 17(6) 21(94) 0	100	120.00
17	0 10(6) 22(94) 0	100	120.00
18	0 20(6) 24(94) 0	100	120.00
19	0 29(44) 25(56) 0	100	160.00
20	0 34(50) 26(50) 0	100	180.00
21	0 31(44) 27(56) 0	100	160.00
22	0 32(44) 28(56) 0	100	160.00
23	0 26(6) 30(94) 0	100	160.00
24	0 35(50) 31(50) 0	100	180.00
25	0 36(50) 32(50) 0	100	180.00
26	0 29(50) 33(50) 0	100	180.00
27	0 40(94) 36(6) 0	100	200.00
28	0 33(6) 37(94) 0	100	200.00
29	0 34(6) 38(94) 0	100	200.00
30	0 35(6) 39(94) 0	100	200.00
		Total Distance	3588.28

Table A.80: EMIP-MDA+ERTR solution to MDA8 with $p = .1$.

No.	Route	Load	Distance
1	0 5(94) 1(6) 0	100	40.00
2	0 6(44) 2(56) 0	100	40.00
3	0 7(44) 3(56) 0	100	40.00
4	0 10(50) 6(50) 0	100	60.00
5	0 8(50) 4(50) 0	100	40.00
6	0 1(50) 9(50) 0	100	60.00
7	0 14(94) 10(6) 0	100	80.00
8	0 7(50) 11(50) 0	100	60.00
9	0 8(44) 12(56) 0	100	60.00
10	0 9(6) 13(94) 0	100	80.00
11	0 11(6) 15(94) 0	100	80.00
12	0 4(6) 16(94) 0	100	80.00
13	0 29(94) 17(6) 0	100	160.00
14	0 22(44) 18(56) 0	100	120.00
15	0 23(44) 19(56) 0	100	120.00
16	0 24(44) 20(56) 0	100	120.00
17	0 17(50) 21(50) 0	100	120.00
18	0 26(50) 22(50) 0	100	140.00
19	0 27(50) 23(50) 0	100	140.00
20	0 28(50) 24(50) 0	100	140.00
21	0 21(44) 25(56) 0	100	140.00
22	0 47(94) 27(6) 0	100	240.00
23	0 26(6) 30(94) 0	100	160.00
24	0 35(56) 31(44) 0	100	180.00
25	0 28(6) 32(94) 0	100	160.00
26	0 37(44) 33(56) 0	100	200.00
27	0 38(44) 34(56) 0	100	200.00
28	0 44(50) 36(50) 0	100	220.00
29	0 42(50) 38(50) 0	100	220.00
30	0 31(50) 39(50) 0	100	200.00
31	0 36(6) 40(94) 0	100	200.00
32	0 37(50) 41(50) 0	100	220.00
33	0 39(44) 43(56) 0	100	220.00
34	0 41(6) 45(94) 0	100	240.00
35	0 42(6) 46(94) 0	100	240.00
36	0 44(6) 48(94) 0	100	240.00
		Total Distance	5060.00

Table A.81: EMIP-MDA+ERTR solution to MDA9 with $p = .1$.

No.	Route	Load	Distance
1	0 12(44) 1(56) 0	100	25.18
2	0 3(50) 2(50) 0	100	25.18
3	0 5(50) 4(50) 0	100	25.18
4	0 17(94) 5(6) 0	100	40.00
5	0 42(94) 6(6) 0	100	80.00
6	0 8(50) 7(50) 0	100	25.18
7	0 10(50) 9(50) 0	100	25.18
8	0 47(94) 11(6) 0	100	79.99
9	0 48(94) 12(6) 0	100	80.01
10	0 2(6) 14(94) 0	100	40.00
11	0 3(6) 15(94) 0	100	40.00
12	0 4(6) 16(94) 0	100	40.00
13	0 6(50) 18(50) 0	100	40.00
14	0 7(6) 19(94) 0	100	40.00
15	0 8(6) 20(94) 0	100	40.00
16	0 9(6) 21(94) 0	100	40.00
17	0 10(6) 22(94) 0	100	40.00
18	0 11(50) 23(50) 0	100	40.00
19	0 12(6) 24(94) 0	100	40.00
20	0 13(50) 25(50) 0	100	60.00
21	0 26(50) 27(50) 0	100	75.53
22	0 29(50) 28(50) 0	100	75.53
23	0 18(44) 30(56) 0	100	60.00
24	0 32(50) 31(50) 0	100	75.53
25	0 34(50) 33(50) 0	100	75.53
26	0 23(44) 35(56) 0	100	60.00
27	0 13(44) 36(56) 0	100	66.15
28	0 25(6) 37(94) 0	100	80.00
29	0 26(6) 38(94) 0	100	80.00
30	0 27(6) 39(94) 0	100	80.00
31	0 28(6) 40(94) 0	100	80.00
32	0 29(6) 41(94) 0	100	80.00
33	0 31(6) 43(94) 0	100	80.00
34	0 32(6) 44(94) 0	100	80.00
35	0 33(6) 45(94) 0	100	80.00
36	0 34(6) 46(94) 0	100	80.00
		Total Distance	2074.12

Table A.82: EMIP-MDA+ERTR solution to MDA10 with $p = .1$.

No.	Route	Load	Distance
1	0 16(50) 15(50) 0	100	23.90
2	0 4(50) 3(50) 0	100	23.90
3	0 4(6) 20(94) 0	100	40.00
4	0 8(50) 7(50) 0	100	23.90
5	0 22(94) 6(6) 0	100	40.00
6	0 5(50) 6(50) 0	100	23.91
7	0 10(50) 9(50) 0	100	23.91
8	0 12(50) 11(50) 0	100	23.90
9	0 27(94) 11(6) 0	100	39.99
10	0 2(50) 1(50) 0	100	23.91
11	0 13(50) 14(50) 0	100	23.91
12	0 14(6) 30(94) 0	100	40.00
13	0 2(6) 18(94) 0	100	40.00
14	0 1(6) 17(94) 0	100	40.00
15	0 3(6) 19(94) 0	100	39.99
16	0 21(94) 5(6) 0	100	40.00
17	0 7(6) 23(94) 0	100	39.99
18	0 24(94) 8(6) 0	100	40.01
19	0 42(50) 41(50) 0	100	71.71
20	0 10(6) 26(94) 0	100	40.00
21	0 28(94) 12(6) 0	100	40.01
22	0 29(94) 13(6) 0	100	40.00
23	0 16(6) 32(94) 0	100	40.01
24	0 15(6) 31(94) 0	100	39.99
25	0 33(6) 49(94) 0	100	80.00
26	0 47(50) 48(50) 0	100	71.70
27	0 36(6) 52(94) 0	100	79.99
28	0 35(50) 36(50) 0	100	71.71
29	0 37(50) 38(50) 0	100	71.71
30	0 55(94) 39(6) 0	100	80.00
31	0 39(44) 40(56) 0	100	71.71
32	0 57(94) 41(6) 0	100	80.00
33	0 25(94) 9(6) 0	100	40.00

(cont.)

Table A.82 continued.

No.	Route	Load	Distance
34	0 44(50) 43(50) 0	100	71.71
35	0 44(6) 60(94) 0	100	79.99
36	0 45(50) 46(50) 0	100	71.71
37	0 34(50) 33(50) 0	100	71.71
38	0 64(94) 48(6) 0	100	79.99
39	0 34(6) 50(94) 0	100	80.01
40	0 35(6) 51(94) 0	100	79.99
41	0 53(94) 37(6) 0	100	80.00
42	0 54(94) 38(6) 0	100	80.01
43	0 39(6) 56(94) 0	100	86.80
44	0 42(6) 58(94) 0	100	80.00
45	0 43(6) 59(94) 0	100	80.00
46	0 45(6) 61(94) 0	100	80.00
47	0 62(94) 46(6) 0	100	80.00
48	0 63(94) 47(6) 0	100	80.00
		Total Distance	2691.69

Table A.83: EMIP-MDA+ERTR solution to MDA11 with $p = .1$.

No.	Route	Load	Distance
1	0 27(6) 31(94) 0	100	160.00
2	0 8(50) 4(50) 0	100	40.00
3	0 16(94) 4(6) 0	100	80.00
4	0 24(44) 20(56) 0	100	120.00
5	0 43(6) 47(94) 0	100	240.00
6	0 26(50) 22(50) 0	100	140.00
7	0 5(84) 1(16) 0	100	40.00
8	0 49(50) 53(50) 0	100	280.00
9	0 15(94) 3(6) 0	100	80.00
10	0 17(10) 21(40) 25(50) 0	100	140.00
11	0 10(50) 2(50) 0	100	60.00
12	0 34(6) 38(94) 0	100	200.00
13	0 21(54) 17(46) 0	100	120.00
14	0 3(50) 7(50) 0	100	40.00
15	0 43(50) 39(50) 0	100	220.00
16	0 42(6) 46(94) 0	100	240.00
17	0 73(50) 69(50) 0	100	380.00
18	0 34(50) 42(50) 0	100	220.00
19	0 22(44) 18(56) 0	100	120.00
20	0 76(50) 72(50) 0	100	380.00
21	0 30(94) 26(6) 0	100	160.00
22	0 28(6) 32(94) 0	100	160.00
23	0 37(44) 41(56) 0	100	220.00
24	0 51(56) 55(44) 0	100	280.00
25	0 36(50) 44(50) 0	100	220.00
26	0 33(6) 45(94) 0	100	240.00
27	0 14(94) 10(6) 0	100	80.00
28	0 59(50) 55(50) 0	100	300.00
29	0 36(6) 40(94) 0	100	200.00
30	0 71(44) 67(56) 0	100	360.00
31	0 35(56) 39(44) 0	100	200.00
32	0 33(50) 37(50) 0	100	200.00
33	0 60(6) 64(94) 0	100	320.00

(cont.)

Table A.83 continued.

No.	Route	Load	Distance
34	0 23(44) 19(56) 0	100	120.00
35	0 54(50) 62(50) 0	100	320.00
36	0 1(40) 5(10) 9(50) 0	100	60.00
37	0 11(56) 7(44) 0	100	60.00
38	0 8(44) 12(56) 0	100	60.00
39	0 75(50) 71(50) 0	100	380.00
40	0 72(44) 68(56) 0	100	360.00
41	0 57(6) 61(94) 0	100	320.00
42	0 50(56) 54(44) 0	100	280.00
43	0 69(44) 65(56) 0	100	360.00
44	0 62(44) 58(56) 0	100	320.00
45	0 2(6) 6(94) 0	100	40.00
46	0 44(6) 48(94) 0	100	240.00
47	0 13(94) 9(6) 0	100	80.00
48	0 74(50) 70(50) 0	100	380.00
49	0 24(50) 28(50) 0	100	140.00
50	0 57(50) 53(44) 49(6) 0	100	300.00
51	0 70(44) 66(56) 0	100	360.00
52	0 27(50) 23(50) 0	100	140.00
53	0 56(44) 52(56) 0	100	280.00
54	0 75(6) 79(94) 0	100	400.00
55	0 56(50) 60(50) 0	100	300.00
56	0 25(6) 29(94) 0	100	160.00
57	0 78(94) 74(6) 0	100	400.00
58	0 63(94) 59(6) 0	100	320.00
59	0 80(94) 76(6) 0	100	400.00
60	0 77(94) 73(6) 0	100	400.00
		Total Distance	13220.00

Table A.84: EMIP-MDA+ERTR solution to MDA12 with $p = .1$.

No.	Route	Load	Distance
1	0 26(94) 18(6) 0	100	79.99
2	0 7(50) 6(50) 0	100	27.65
3	0 4(56) 0	56	20.00
4	0 5(56) 0	56	20.00
5	0 27(50) 35(20) 43(30) 0	100	120.00
6	0 1(50) 8(50) 0	100	27.65
7	0 3(50) 2(50) 0	100	27.65
8	0 1(6) 9(94) 0	100	40.00
9	0 2(6) 10(94) 0	100	39.99
10	0 28(50) 36(50) 0	100	100.00
11	0 44(94) 36(6) 0	100	120.00
12	0 56(56) 64(44) 0	100	160.00
13	0 8(6) 16(94) 0	100	39.99
14	0 49(50) 57(50) 0	100	160.00
15	0 11(94) 3(6) 0	100	40.00
16	0 27(44) 19(56) 0	100	80.00
17	0 12(94) 0	94	39.99
18	0 39(50) 31(50) 0	100	100.00
19	0 29(50) 21(50) 0	100	80.00
20	0 63(44) 55(56) 0	100	160.00
21	0 66(50) 50(50) 0	100	180.00
22	0 59(50) 51(50) 0	100	160.00
23	0 20(56) 28(44) 0	100	80.00
24	0 7(6) 15(94) 0	100	40.00
25	0 30(44) 22(56) 0	100	80.00
26	0 62(44) 54(56) 0	100	160.00
27	0 18(50) 34(50) 0	100	100.00
28	0 33(6) 41(94) 0	100	120.00
29	0 43(64) 35(36) 0	100	120.00
30	0 68(6) 76(94) 0	100	200.01
31	0 6(6) 14(94) 0	100	39.99
32	0 46(94) 38(6) 0	100	120.00
33	0 38(50) 30(50) 0	100	100.00

(cont.)

Table A.84 continued.

No.	Route	Load	Distance
34	0 17(50) 33(50) 0	100	100.00
35	0 66(6) 74(94) 0	100	200.00
36	0 69(50) 61(50) 0	100	180.00
37	0 39(6) 47(94) 0	100	120.00
38	0 40(6) 48(94) 0	100	120.00
39	0 25(94) 17(6) 0	100	80.00
40	0 42(94) 34(6) 0	100	120.01
41	0 51(6) 59(44) 67(50) 0	100	180.00
42	0 60(44) 52(56) 0	100	159.99
43	0 13(94) 0	94	40.00
44	0 24(56) 32(44) 0	100	80.00
45	0 31(44) 23(56) 0	100	80.00
46	0 37(56) 29(44) 0	100	100.00
47	0 40(50) 32(50) 0	100	100.00
48	0 61(44) 53(56) 0	100	160.00
49	0 70(50) 62(50) 0	100	180.00
50	0 71(50) 63(50) 0	100	180.00
51	0 72(50) 64(50) 0	100	180.00
52	0 73(94) 65(6) 0	100	200.00
53	0 49(6) 65(50) 57(44) 0	100	180.00
54	0 75(94) 67(6) 0	100	200.00
55	0 60(50) 68(50) 0	100	180.00
56	0 21(6) 45(94) 0	100	120.00
57	0 79(94) 71(6) 0	100	200.00
58	0 80(94) 72(6) 0	100	200.00
59	0 50(6) 58(94) 0	100	160.00
60	0 77(94) 69(6) 0	100	200.00
61	0 70(6) 78(94) 0	100	200.00
		Total Distance	7182.93

Table A.85: EMIP-MDA+ERTR solution to MDA13 with $p = .1$.

No.	Route	Load	Distance
1	0 90(94) 82(6) 0	100	239.99
2	0 43(44) 35(56) 0	100	120.00
3	0 12(64) 4(36) 0	100	39.99
4	0 26(44) 34(56) 0	100	100.00
5	0 7(6) 15(94) 0	100	40.00
6	0 2(6) 10(94) 0	100	39.99
7	0 24(6) 32(94) 0	100	80.00
8	0 3(6) 11(44) 3(50) 0	100	40.00
9	0 18(50) 17(50) 0	100	82.95
10	0 7(50) 8(50) 0	100	27.65
11	0 22(50) 21(50) 0	100	82.96
12	0 72(6) 80(94) 0	100	200.00
13	0 74(94) 50(6) 0	100	200.00
14	0 14(94) 6(6) 0	100	39.99
15	0 21(6) 29(94) 0	100	80.00
16	0 19(6) 27(94) 0	100	80.00
17	0 22(6) 30(94) 0	100	80.00
18	0 92(94) 84(6) 0	100	240.01
19	0 43(50) 51(50) 0	100	140.00
20	0 58(50) 82(50) 0	100	220.00
21	0 23(50) 24(50) 0	100	82.96
22	0 5(6) 13(94) 0	100	40.00
23	0 6(50) 5(50) 0	100	27.65
24	0 64(94) 40(6) 0	100	160.00
25	0 20(50) 12(30) 4(20) 0	100	59.99
26	0 49(50) 41(50) 0	100	140.00
27	0 40(6) 48(94) 0	100	120.00
28	0 44(44) 36(56) 0	100	120.00
29	0 45(44) 37(56) 0	100	120.00
30	0 46(44) 38(56) 0	100	120.00
31	0 79(50) 71(50) 0	100	200.00
32	0 42(94) 18(6) 0	100	120.01
33	0 66(56) 58(44) 0	100	180.00

(cont.)

Table A.85 continued.

No.	Route	Load	Distance
34	0 44(50) 52(50) 0	100	139.99
35	0 54(50) 46(50) 0	100	139.99
36	0 87(56) 79(44) 0	100	220.00
37	0 50(50) 26(50) 0	100	140.01
38	0 1(50) 2(50) 0	100	27.65
39	0 83(50) 67(50) 0	100	220.00
40	0 60(94) 52(6) 0	100	159.99
41	0 45(50) 53(50) 0	100	140.00
42	0 47(44) 39(56) 0	100	120.00
43	0 72(44) 88(56) 0	100	220.00
44	0 1(6) 9(94) 0	100	40.00
45	0 41(44) 33(56) 0	100	120.00
46	0 83(6) 91(94) 0	100	240.00
47	0 53(6) 61(94) 0	100	160.00
48	0 54(6) 62(94) 0	100	160.00
49	0 47(50) 63(50) 0	100	160.00
50	0 11(50) 19(50) 0	100	60.00
51	0 23(6) 31(94) 0	100	80.00
52	0 49(6) 57(94) 0	100	160.00
53	0 20(6) 28(94) 0	100	80.00
54	0 68(56) 76(44) 0	100	200.01
55	0 77(44) 69(56) 0	100	200.00
56	0 78(50) 86(50) 0	100	220.00
57	0 56(56) 40(44) 0	100	140.01
58	0 65(56) 73(44) 0	100	200.00
59	0 81(6) 89(94) 0	100	240.00
60	0 67(6) 75(94) 0	100	200.00
61	0 85(50) 77(50) 0	100	220.00
62	0 70(56) 78(44) 0	100	200.00
63	0 73(50) 81(50) 0	100	220.00
64	0 16(94) 8(6) 0	100	39.99
65	0 59(94) 51(6) 0	100	160.00
66	0 25(94) 17(6) 0	100	80.00

(cont.)

Table A.85 continued.

No.	Route	Load	Distance
67	0 93(94) 85(6) 0	100	240.00
68	0 94(94) 86(6) 0	100	239.99
69	0 63(44) 55(56) 0	100	160.00
70	0 72(6) 96(94) 0	100	240.01
71	0 84(50) 76(50) 0	100	220.01
72	0 71(6) 95(94) 0	100	240.00
		Total Distance	10111.79

Table A.86: EMIP-MDA+ERTR solution to MDA14 with $p = .1$.

No.	Route	Load	Distance
1	0 76(6) 112(94) 0	100	200.00
2	0 41(50) 29(50) 0	100	80.00
3	0 86(50) 110(50) 0	100	200.00
4	0 28(6) 40(94) 0	100	80.00
5	0 75(50) 99(50) 0	100	180.00
6	0 80(56) 92(44) 0	100	160.00
7	0 69(94) 57(6) 0	100	120.01
8	0 34(6) 46(94) 0	100	80.00
9	0 26(6) 38(94) 0	100	80.00
10	0 52(6) 64(94) 0	100	120.00
11	0 18(94) 6(6) 0	100	40.00
12	0 95(44) 83(56) 0	100	160.00
13	0 12(44) 1(56) 0	100	25.18
14	0 110(44) 98(56) 0	100	200.00
15	0 22(94) 0	94	40.00
16	0 5(50) 4(50) 0	100	25.18
17	0 60(6) 72(94) 0	100	120.01
18	0 88(44) 100(56) 0	100	180.00
19	0 97(6) 109(94) 0	100	200.00
20	0 21(94) 0	94	40.00
21	0 37(94) 0	94	80.00
22	0 31(50) 43(50) 0	100	80.00
23	0 57(50) 33(50) 0	100	100.01
24	0 105(50) 93(50) 0	100	180.01
25	0 84(6) 96(94) 0	100	160.01
26	0 101(6) 113(94) 0	100	200.00
27	0 103(56) 91(44) 0	100	180.00
28	0 82(56) 94(44) 0	100	160.00
29	0 102(6) 114(94) 0	100	200.01
30	0 49(6) 61(94) 0	100	120.00
31	0 12(12) 11(56) 0	68	25.18
32	0 30(6) 89(94) 0	100	166.06
33	0 52(50) 28(50) 0	100	100.00

(cont.)

Table A.86 continued.

No.	Route	Load	Distance
34	0 29(6) 65(94) 0	100	120.00
35	0 7(50) 6(50) 0	100	25.18
36	0 51(6) 63(94) 0	100	120.00
37	0 108(56) 84(44) 0	100	179.99
38	0 116(50) 92(50) 0	100	200.00
39	0 56(50) 32(50) 0	100	100.00
40	0 60(50) 36(50) 0	100	100.01
41	0 104(56) 116(44) 0	100	200.00
42	0 3(6) 15(94) 0	100	40.00
43	0 88(50) 76(50) 0	100	160.00
44	0 101(50) 102(50) 0	100	226.59
45	0 58(6) 70(94) 0	100	120.00
46	0 32(6) 44(94) 0	100	80.00
47	0 26(50) 13(50) 0	100	66.15
48	0 5(6) 17(94) 0	100	40.00
49	0 8(50) 9(40) 0	90	25.18
50	0 34(50) 58(50) 0	100	100.00
51	0 53(56) 41(44) 0	100	100.00
52	0 51(50) 27(50) 0	100	100.00
53	0 93(44) 81(56) 0	100	160.01
54	0 59(6) 71(94) 0	100	120.00
55	0 86(44) 74(56) 0	100	160.00
56	0 23(94) 0	94	40.00
57	0 43(44) 55(56) 0	100	100.00
58	0 95(50) 107(50) 0	100	180.00
59	0 79(6) 115(94) 0	100	200.00
60	0 106(6) 118(94) 0	100	200.00
61	0 105(6) 117(94) 0	100	200.01
62	0 47(94) 35(6) 0	100	79.99
63	0 4(6) 16(94) 0	100	40.00
64	0 25(56) 13(44) 0	100	60.00
65	0 107(6) 119(94) 0	100	200.00
66	0 73(56) 85(44) 0	100	160.00

(cont.)

Table A.86 continued.

No.	Route	Load	Distance
67	0 30(50) 42(50) 0	100	80.00
68	0 120(94) 84(6) 0	100	199.99
69	0 33(6) 45(94) 0	100	80.00
70	0 2(6) 14(94) 0	100	40.00
71	0 7(6) 19(94) 0	100	40.00
72	0 8(6) 20(94) 0	100	40.00
73	0 31(6) 67(94) 0	100	120.00
74	0 24(94) 0	94	40.00
75	0 36(6) 48(94) 0	100	80.01
76	0 94(50) 106(50) 0	100	180.00
77	0 3(50) 2(50) 0	100	25.18
78	0 50(6) 62(94) 0	100	120.00
79	0 87(94) 75(6) 0	100	160.00
80	0 66(44) 77(56) 0	100	165.00
81	0 91(50) 79(50) 0	100	160.00
82	0 42(44) 54(56) 0	100	100.00
83	0 78(50) 66(50) 0	100	140.00
84	0 27(6) 39(94) 0	100	80.00
85	0 49(50) 50(50) 0	100	125.88
86	0 56(6) 68(94) 0	100	119.99
87	0 59(50) 35(50) 0	100	100.01
88	0 99(6) 111(94) 0	100	200.00
89	0 10(56) 9(16) 0	72	25.18
90	0 85(50) 97(50) 0	100	180.00
91	0 78(6) 90(94) 0	100	160.01
		Total Distance	10845.91

Table A.87: EMIP-MDA+ERTR solution to MDA15 with $p = .1$.

No.	Route	Load	Distance
1	0 80(50) 68(50) 0	100	140.00
2	0 10(38) 11(56) 0	94	25.18
3	0 87(94) 75(6) 0	100	160.00
4	0 69(44) 57(56) 0	100	120.01
5	0 114(94) 102(6) 0	100	200.01
6	0 35(6) 47(94) 0	100	79.99
7	0 136(94) 124(6) 0	100	240.00
8	0 88(94) 52(6) 0	100	160.00
9	0 73(6) 85(94) 0	100	160.00
10	0 67(44) 55(56) 0	100	120.00
11	0 131(50) 119(50) 0	100	220.00
12	0 82(50) 58(50) 0	100	140.00
13	0 25(50) 13(50) 0	100	60.00
14	0 14(50) 12(50) 0	100	47.32
15	0 67(50) 79(50) 0	100	140.00
16	0 50(44) 74(56) 0	100	140.00
17	0 99(6) 111(94) 0	100	200.00
18	0 4(6) 16(94) 0	100	40.00
19	0 72(44) 84(56) 0	100	140.01
20	0 60(50) 72(50) 0	100	120.01
21	0 89(44) 101(56) 0	100	180.01
22	0 77(56) 41(44) 0	100	140.00
23	0 31(50) 44(50) 0	100	90.53
24	0 61(50) 73(50) 0	100	140.00
25	0 105(56) 117(44) 0	100	200.01
26	0 26(56) 14(44) 0	100	60.00
27	0 52(44) 76(56) 0	100	140.00
28	0 132(56) 96(44) 0	100	220.00
29	0 58(6) 70(94) 0	100	120.00
30	0 97(6) 133(94) 0	100	240.00
31	0 21(94) 0	94	40.00
32	0 91(94) 79(6) 0	100	160.00
33	0 59(50) 95(50) 0	100	160.00

(cont.)

Table A.87 continued.

No.	Route	Load	Distance
34	0 64(94) 52(6) 0	100	120.00
35	0 23(94) 0	94	40.00
36	0 49(56) 61(44) 0	100	120.00
37	0 37(94) 25(6) 0	100	80.00
38	0 24(94) 12(6) 0	100	40.00
39	0 100(6) 112(94) 0	100	200.00
40	0 28(50) 27(50) 0	100	75.53
41	0 30(6) 42(94) 0	100	80.00
42	0 103(50) 115(50) 0	100	200.00
43	0 44(44) 32(56) 0	100	80.00
44	0 30(50) 29(50) 0	100	75.53
45	0 2(56) 3(44) 0	100	25.18
46	0 95(44) 83(56) 0	100	160.00
47	0 66(50) 78(50) 0	100	140.00
48	0 142(94) 106(6) 0	100	240.00
49	0 4(50) 5(50) 0	100	25.18
50	0 71(94) 59(6) 0	100	120.00
51	0 116(50) 128(50) 0	100	220.00
52	0 90(94) 78(6) 0	100	160.01
53	0 102(50) 126(50) 0	100	220.01
54	0 81(50) 69(50) 0	100	140.01
55	0 86(94) 50(6) 0	100	160.00
56	0 38(94) 0	94	80.00
57	0 120(94) 108(6) 0	100	199.99
58	0 41(50) 53(50) 0	100	100.00
59	0 10(18) 33(56) 0	74	61.92
60	0 18(94) 6(6) 0	100	40.00
61	0 36(56) 13(44) 0	100	66.15
62	0 7(50) 6(50) 0	100	25.18
63	0 1(56) 3(12) 0	68	30.00
64	0 39(94) 27(6) 0	100	80.00
65	0 110(44) 98(56) 0	100	200.00
66	0 29(6) 113(94) 0	100	200.00

(cont.)

Table A.87 continued.

No.	Route	Load	Distance
67	0 68(44) 56(56) 0	100	119.99
68	0 123(6) 135(94) 0	100	239.99
69	0 63(94) 51(6) 0	100	120.00
70	0 45(94) 8(6) 0	100	81.73
71	0 126(6) 138(94) 0	100	240.00
72	0 9(56) 8(44) 0	100	25.18
73	0 128(6) 140(94) 0	100	240.00
74	0 48(94) 0	94	80.01
75	0 81(6) 93(94) 0	100	160.01
76	0 15(94) 0	94	40.00
77	0 8(6) 20(94) 0	100	40.00
78	0 5(6) 17(94) 0	100	40.00
79	0 104(56) 116(44) 0	100	200.00
80	0 43(94) 31(6) 0	100	80.00
81	0 106(50) 118(50) 0	100	200.00
82	0 60(6) 144(94) 0	100	240.00
83	0 54(56) 66(44) 0	100	120.00
84	0 125(6) 137(94) 0	100	240.00
85	0 99(50) 123(50) 0	100	220.00
86	0 119(44) 107(56) 0	100	200.00
87	0 89(50) 125(50) 0	100	220.00
88	0 53(6) 65(94) 0	100	120.00
89	0 139(94) 103(6) 0	100	240.00
90	0 75(50) 51(50) 0	100	140.00
91	0 35(50) 22(50) 0	100	66.15
92	0 109(44) 121(56) 0	100	220.00
93	0 110(50) 122(50) 0	100	220.00
94	0 100(50) 124(50) 0	100	220.00
95	0 7(6) 19(94) 0	100	40.00
96	0 115(44) 127(56) 0	100	220.00
97	0 117(50) 129(50) 0	100	220.01
98	0 118(44) 130(56) 0	100	220.00
99	0 108(50) 96(50) 0	100	179.99

(cont.)

Table A.87 continued.

No.	Route	Load	Distance
100	0 97(50) 109(50) 0	100	200.00
101	0 122(6) 134(94) 0	100	239.99
102	0 82(6) 94(94) 0	100	160.00
103	0 46(94) 0	94	80.00
104	0 92(94) 80(6) 0	100	160.00
105	0 28(6) 40(94) 0	100	80.00
106	0 129(6) 141(94) 0	100	240.00
107	0 22(44) 34(56) 0	100	60.00
108	0 131(6) 143(94) 0	100	239.99
109	0 50(6) 62(94) 0	100	120.00
		Total Distance	15180.73

Table A.88: EMIP-MDA+ERTR solution to MDA16 with $p = .1$.

No.	Route	Load	Distance
1	0 71(44) 72(56) 0	100	20.88
2	0 2(42) 1(56) 0	98	20.87
3	0 4(26) 5(50) 6(24) 0	100	21.75
4	0 82(94) 0	94	39.99
5	0 11(12) 12(56) 13(32) 0	100	21.75
6	0 120(94) 0	94	39.99
7	0 8(12) 7(56) 6(32) 0	100	21.74
8	0 10(56) 11(44) 0	100	20.87
9	0 15(26) 14(50) 13(24) 0	100	21.75
10	0 73(94) 0	94	40.00
11	0 17(14) 16(56) 15(30) 0	100	21.75
12	0 20(44) 19(56) 0	100	20.87
13	0 17(42) 18(56) 0	98	20.88
14	0 123(94) 0	94	39.99
15	0 31(44) 32(56) 0	100	20.87
16	0 52(12) 51(56) 49(32) 0	100	22.62
17	0 38(30) 39(56) 40(12) 0	98	21.75
18	0 24(20) 23(56) 22(24) 0	100	21.75
19	0 107(94) 0	94	40.01
20	0 53(56) 52(44) 0	100	20.87
21	0 62(44) 63(56) 0	100	20.87
22	0 29(24) 28(12) 27(56) 0	92	21.74
23	0 46(12) 47(56) 48(32) 0	100	21.74
24	0 5(6) 77(94) 0	100	39.99
25	0 36(24) 37(50) 38(26) 0	100	21.74
26	0 69(32) 70(56) 71(12) 0	100	21.75
27	0 131(94) 0	94	39.99
28	0 62(12) 61(56) 60(32) 0	100	21.73
29	0 134(94) 0	94	39.99
30	0 75(94) 0	94	40.01
31	0 116(94) 0	94	39.99
32	0 142(94) 0	94	40.00
33	0 124(94) 0	94	40.00

(cont.)

Table A.88 continued.

No.	Route	Load	Distance
34	0 65(12) 66(56) 67(30) 0	98	21.75
35	0 135(94) 0	94	39.99
36	0 122(94) 0	94	40.00
37	0 55(44) 56(56) 0	100	20.87
38	0 130(94) 0	94	40.00
39	0 113(94) 0	94	39.99
40	0 86(94) 14(6) 0	100	40.00
41	0 115(94) 0	94	40.00
42	0 112(94) 0	94	40.00
43	0 80(94) 0	94	39.99
44	0 34(44) 33(56) 0	100	20.87
45	0 58(44) 57(56) 0	100	20.87
46	0 4(30) 3(56) 2(14) 0	100	21.75
47	0 37(6) 109(94) 0	100	40.00
48	0 111(94) 0	94	40.01
49	0 144(94) 0	94	39.99
50	0 40(44) 41(56) 0	100	20.87
51	0 76(94) 0	94	40.00
52	0 138(94) 0	94	39.99
53	0 129(94) 0	94	40.01
54	0 125(94) 0	94	40.01
55	0 8(44) 9(56) 0	100	20.87
56	0 67(6) 139(94) 0	100	40.00
57	0 83(94) 0	94	40.00
58	0 84(94) 0	94	39.99
59	0 85(94) 0	94	40.00
60	0 81(94) 0	94	40.00
61	0 88(94) 0	94	40.00
62	0 89(94) 0	94	40.01
63	0 90(94) 0	94	39.99
64	0 91(94) 0	94	40.00
65	0 92(94) 0	94	39.99
66	0 93(94) 0	94	40.01

(cont.)

Table A.88 continued.

No.	Route	Load	Distance
67	0 94(94) 0	94	40.00
68	0 95(94) 0	94	39.99
69	0 96(94) 0	94	40.00
70	0 97(94) 0	94	40.00
71	0 98(94) 0	94	39.99
72	0 99(94) 0	94	39.99
73	0 100(94) 0	94	39.99
74	0 101(94) 0	94	40.00
75	0 102(94) 0	94	39.99
76	0 103(94) 0	94	40.00
77	0 104(94) 0	94	40.00
78	0 36(32) 35(56) 34(12) 0	100	21.75
79	0 31(12) 30(56) 29(32) 0	100	21.75
80	0 24(36) 25(56) 0	92	20.87
81	0 78(94) 0	94	40.00
82	0 133(94) 0	94	40.00
83	0 79(94) 0	94	40.00
84	0 60(24) 59(56) 58(12) 0	92	21.73
85	0 141(94) 0	94	39.99
86	0 69(24) 68(56) 67(20) 0	100	21.75
87	0 127(94) 0	94	40.00
88	0 128(94) 0	94	39.99
89	0 49(6) 121(94) 0	100	40.00
90	0 119(94) 0	94	40.00
91	0 108(94) 0	94	39.99
92	0 20(12) 21(56) 22(32) 0	100	21.75
93	0 46(44) 45(56) 0	100	20.87
94	0 43(44) 42(56) 0	100	20.87
95	0 105(94) 0	94	39.99
96	0 110(94) 0	94	39.99
97	0 28(44) 26(56) 0	100	21.74
98	0 132(94) 0	94	40.00
99	0 114(94) 0	94	40.00

(cont.)

Table A.88 continued.

No.	Route	Load	Distance
100	0 43(12) 44(56) 0	68	20.86
101	0 55(12) 54(56) 0	68	20.87
102	0 140(94) 0	94	40.00
103	0 136(94) 0	94	39.99
104	0 118(94) 0	94	39.99
105	0 117(94) 0	94	39.99
106	0 48(24) 49(18) 50(56) 0	98	21.74
107	0 106(94) 0	94	40.00
108	0 65(44) 64(56) 0	100	20.87
109	0 87(94) 0	94	39.99
110	0 74(94) 0	94	39.99
111	0 126(94) 0	94	39.99
112	0 137(94) 0	94	40.00
113	0 143(94) 0	94	40.01
		Total Distance	3755.70

Table A.89: EMIP-MDA+ERTR solution to MDA17 with $p = .1$.

No.	Route	Load	Distance
1	0 107(44) 99(56) 0	100	280.00
2	0 12(44) 4(56) 0	100	39.99
3	0 14(94) 0	94	39.99
4	0 25(94) 17(6) 0	100	80.00
5	0 24(6) 32(94) 0	100	80.00
6	0 50(6) 58(94) 0	100	160.00
7	0 114(6) 122(94) 0	100	319.99
8	0 33(6) 41(94) 0	100	120.00
9	0 9(44) 18(56) 0	100	71.24
10	0 49(6) 57(94) 0	100	160.00
11	0 1(50) 8(50) 0	100	27.65
12	0 26(94) 1(6) 0	100	83.67
13	0 72(50) 80(50) 0	100	200.00
14	0 47(50) 39(50) 0	100	120.00
15	0 82(6) 90(94) 0	100	239.99
16	0 43(94) 35(6) 0	100	120.00
17	0 7(56) 6(16) 0	72	27.65
18	0 53(6) 61(94) 0	100	160.00
19	0 6(40) 21(56) 0	96	63.99
20	0 104(6) 128(94) 0	100	320.01
21	0 17(50) 9(50) 0	100	60.00
22	0 66(50) 82(50) 0	100	220.00
23	0 27(84) 35(6) 27(10) 0	100	100.00
24	0 15(50) 5(50) 0	100	52.36
25	0 46(50) 54(50) 0	100	139.99
26	0 91(94) 0	94	240.00
27	0 66(6) 74(94) 0	100	200.00
28	0 38(56) 46(44) 0	100	120.00
29	0 11(22) 19(56) 0	78	60.00
30	0 49(50) 33(50) 0	100	140.00
31	0 23(50) 24(50) 0	100	82.96
32	0 59(44) 67(56) 0	100	180.00
33	0 20(56) 28(44) 0	100	80.00

(cont.)

Table A.89 continued.

No.	Route	Load	Distance
34	0 13(94) 0	94	40.00
35	0 56(56) 48(44) 0	100	140.01
36	0 47(44) 55(56) 0	100	140.00
37	0 75(44) 83(56) 0	100	220.00
38	0 30(94) 0	94	80.00
39	0 77(50) 93(50) 0	100	240.00
40	0 63(94) 39(6) 0	100	160.00
41	0 44(56) 36(44) 0	100	120.00
42	0 36(6) 44(38) 52(56) 0	100	139.99
43	0 78(56) 70(44) 0	100	200.00
44	0 120(56) 88(44) 0	100	300.00
45	0 42(44) 34(56) 0	100	120.01
46	0 147(6) 155(94) 0	100	400.00
47	0 48(50) 40(50) 0	100	120.00
48	0 40(6) 64(94) 0	100	160.00
49	0 104(50) 88(6) 80(44) 0	100	260.00
50	0 76(44) 68(56) 0	100	200.01
51	0 69(56) 77(44) 0	100	200.00
52	0 70(12) 86(50) 78(38) 0	100	220.00
53	0 79(44) 71(56) 0	100	200.00
54	0 87(6) 95(94) 0	100	240.00
55	0 65(56) 73(44) 0	100	200.00
56	0 146(6) 154(94) 0	100	400.00
57	0 59(50) 75(50) 0	100	200.00
58	0 84(50) 76(50) 0	100	220.01
59	0 45(50) 53(50) 0	100	140.00
60	0 45(44) 37(56) 0	100	120.00
61	0 97(50) 105(50) 0	100	280.00
62	0 42(50) 50(50) 0	100	140.01
63	0 10(94) 0	94	39.99
64	0 92(94) 84(6) 0	100	240.01
65	0 85(56) 93(44) 0	100	240.00
66	0 79(50) 87(50) 0	100	220.00

(cont.)

Table A.89 continued.

No.	Route	Load	Distance
67	0 81(6) 89(94) 0	100	240.00
68	0 22(56) 15(44) 0	100	71.26
69	0 2(56) 3(28) 0	84	27.65
70	0 110(60) 102(40) 0	100	280.00
71	0 23(6) 31(94) 0	100	80.00
72	0 144(44) 136(56) 0	100	360.00
73	0 81(50) 73(50) 0	100	220.00
74	0 106(44) 98(56) 0	100	280.00
75	0 8(6) 16(94) 0	100	39.99
76	0 116(50) 108(50) 0	100	300.00
77	0 101(56) 109(44) 0	100	280.00
78	0 94(94) 86(6) 0	100	239.99
79	0 119(44) 103(56) 0	100	300.00
80	0 119(6) 111(94) 0	100	300.00
81	0 138(50) 146(50) 0	100	380.00
82	0 36(6) 60(94) 0	100	159.99
83	0 100(56) 108(44) 0	100	280.00
84	0 102(16) 118(50) 110(34) 0	100	300.00
85	0 35(44) 51(56) 0	100	140.00
86	0 72(6) 96(94) 0	100	240.01
87	0 105(44) 113(56) 0	100	300.00
88	0 54(6) 62(94) 0	100	160.00
89	0 147(50) 131(50) 0	100	380.00
90	0 156(94) 132(6) 0	100	400.00
91	0 109(50) 117(50) 0	100	300.00
92	0 127(94) 119(6) 0	100	320.00
93	0 115(6) 123(94) 0	100	320.00
94	0 121(94) 97(6) 0	100	320.00
95	0 12(50) 28(50) 0	100	80.00
96	0 148(56) 140(44) 0	100	380.00
97	0 117(6) 125(94) 0	100	320.00
98	0 150(6) 158(94) 0	100	400.00
99	0 11(72) 3(28) 0	100	40.00

(cont.)

Table A.89 continued.

No.	Route	Load	Distance
100	0 137(44) 129(56) 0	100	360.00
101	0 5(6) 29(94) 0	100	80.00
102	0 107(50) 115(50) 0	100	300.00
103	0 140(50) 132(50) 0	100	360.00
104	0 141(44) 133(56) 0	100	360.00
105	0 150(50) 134(50) 0	100	380.00
106	0 88(6) 112(94) 0	100	280.00
107	0 145(50) 137(50) 0	100	380.00
108	0 130(56) 138(44) 0	100	360.00
109	0 149(50) 141(50) 0	100	380.00
110	0 134(6) 142(94) 0	100	359.99
111	0 151(50) 159(50) 0	100	400.00
112	0 152(50) 144(50) 0	100	380.00
113	0 153(94) 145(6) 0	100	400.00
114	0 114(50) 106(50) 0	100	300.00
115	0 139(94) 131(6) 0	100	360.00
116	0 124(94) 116(6) 0	100	319.99
117	0 126(94) 118(6) 0	100	319.99
118	0 143(94) 151(6) 0	100	380.00
119	0 160(94) 152(6) 0	100	400.00
120	0 149(6) 157(94) 0	100	400.00
121	0 135(56) 159(44) 0	100	400.00
		Total Distance	26628.38

Table A.90: EMIP-MDA+ERTR solution to MDA18 with $p = .1$.

No.	Route	Load	Distance
1	0 102(34) 134(50) 118(16) 0	100	180.00
2	0 8(6) 24(94) 0	100	40.01
3	0 20(94) 0	94	40.00
4	0 138(6) 154(94) 0	100	200.00
5	0 143(50) 127(50) 0	100	180.00
6	0 106(6) 122(94) 0	100	160.00
7	0 26(94) 0	94	40.00
8	0 148(50) 83(50) 0	100	210.14
9	0 15(44) 14(56) 0	100	23.90
10	0 33(6) 49(94) 0	100	80.00
11	0 145(50) 146(50) 0	100	239.02
12	0 59(94) 0	94	80.00
13	0 141(50) 125(50) 0	100	180.00
14	0 98(6) 114(94) 0	100	160.00
15	0 9(50) 8(50) 0	100	23.91
16	0 142(6) 158(94) 0	100	199.99
17	0 83(44) 67(56) 0	100	120.01
18	0 43(56) 15(12) 16(12) 0	80	75.53
19	0 1(6) 17(94) 0	100	40.00
20	0 86(94) 70(6) 0	100	119.99
21	0 140(50) 108(50) 0	100	179.99
22	0 123(44) 107(56) 0	100	160.00
23	0 104(6) 120(94) 0	100	160.00
24	0 131(50) 99(50) 0	100	180.00
25	0 138(50) 106(50) 0	100	179.99
26	0 78(50) 77(50) 0	100	119.52
27	0 5(32) 4(56) 3(12) 0	100	27.80
28	0 30(94) 0	94	40.00
29	0 41(44) 40(56) 0	100	71.71
30	0 90(94) 0	94	120.01
31	0 100(56) 84(44) 0	100	140.00
32	0 9(6) 25(94) 0	100	40.00
33	0 45(6) 61(94) 0	100	80.00

(cont.)

Table A.90 continued.

No.	Route	Load	Distance
34	0 103(6) 119(94) 0	100	159.99
35	0 27(94) 0	94	39.99
36	0 75(50) 76(50) 0	100	119.51
37	0 118(78) 102(22) 0	100	160.00
38	0 66(6) 82(94) 0	100	119.99
39	0 45(50) 60(50) 0	100	86.81
40	0 74(56) 58(44) 0	100	100.01
41	0 78(6) 94(94) 0	100	120.00
42	0 34(50) 35(50) 0	100	71.71
43	0 117(44) 101(56) 0	100	160.00
44	0 75(6) 91(94) 0	100	120.00
45	0 12(6) 28(94) 0	100	40.01
46	0 64(94) 0	94	79.99
47	0 32(44) 48(56) 0	100	60.00
48	0 141(6) 157(94) 0	100	200.00
49	0 38(6) 54(94) 0	100	80.01
50	0 65(56) 81(44) 0	100	120.00
51	0 72(6) 88(94) 0	100	120.00
52	0 7(56) 0	56	20.00
53	0 84(50) 68(50) 0	100	119.99
54	0 2(56) 3(44) 0	100	23.90
55	0 98(50) 66(50) 0	100	140.00
56	0 97(6) 113(94) 0	100	160.00
57	0 36(56) 21(44) 0	100	63.84
58	0 39(50) 38(50) 0	100	71.71
59	0 32(50) 33(50) 0	100	63.84
60	0 121(50) 105(50) 0	100	160.00
61	0 77(6) 93(94) 0	100	120.00
62	0 110(56) 126(44) 0	100	159.99
63	0 144(6) 160(94) 0	100	199.99
64	0 121(44) 137(56) 0	100	180.00
65	0 135(6) 151(94) 0	100	200.01
66	0 72(50) 87(50) 0	100	133.59

(cont.)

Table A.90 continued.

No.	Route	Load	Distance
67	0 19(94) 0	94	39.99
68	0 37(50) 21(50) 0	100	60.00
69	0 139(6) 155(94) 0	100	200.00
70	0 71(56) 87(44) 0	100	120.00
71	0 140(6) 156(94) 0	100	199.99
72	0 47(6) 63(94) 0	100	80.00
73	0 57(94) 0	94	80.00
74	0 76(6) 92(94) 0	100	120.00
75	0 68(6) 116(94) 0	100	160.00
76	0 10(44) 11(56) 0	100	23.90
77	0 47(50) 46(50) 0	100	71.71
78	0 5(24) 6(56) 0	80	23.91
79	0 134(6) 150(94) 0	100	200.00
80	0 131(6) 147(94) 0	100	200.00
81	0 152(50) 104(50) 0	100	199.99
82	0 89(94) 0	94	120.00
83	0 34(6) 50(94) 0	100	80.01
84	0 56(94) 0	94	79.99
85	0 112(56) 128(44) 0	100	160.01
86	0 13(6) 29(94) 0	100	40.00
87	0 148(44) 132(56) 0	100	200.01
88	0 135(50) 103(50) 0	100	180.00
89	0 18(94) 0	94	40.00
90	0 52(94) 0	94	79.99
91	0 69(6) 85(94) 0	100	120.00
92	0 79(6) 95(94) 0	100	120.00
93	0 123(50) 139(50) 0	100	180.00
94	0 12(50) 13(50) 0	100	23.91
95	0 99(6) 115(94) 0	100	160.00
96	0 145(44) 129(56) 0	100	200.00
97	0 97(50) 81(50) 0	100	140.00
98	0 105(6) 153(94) 0	100	200.00
99	0 96(94) 80(6) 0	100	120.00

(cont.)

Table A.90 continued.

No.	Route	Load	Distance
100	0 142(50) 126(50) 0	100	179.99
101	0 80(50) 79(50) 0	100	119.51
102	0 108(6) 124(94) 0	100	160.00
103	0 70(50) 69(50) 0	100	119.51
104	0 46(6) 62(94) 0	100	80.00
105	0 37(6) 53(94) 0	100	80.00
106	0 16(44) 1(50) 0	94	23.91
107	0 127(44) 111(56) 0	100	160.00
108	0 10(12) 42(6) 73(56) 41(12) 0	86	105.07
109	0 22(94) 0	94	40.00
110	0 42(50) 58(50) 0	100	80.00
111	0 23(94) 0	94	39.99
112	0 144(50) 128(50) 0	100	180.00
113	0 143(6) 159(94) 0	100	200.00
114	0 35(6) 51(94) 0	100	79.99
115	0 133(50) 117(50) 0	100	180.00
116	0 31(94) 0	94	39.99
117	0 136(56) 152(44) 0	100	199.99
118	0 60(44) 44(56) 0	100	79.99
119	0 125(44) 109(56) 0	100	160.00
120	0 39(6) 55(94) 0	100	80.00
121	0 146(44) 130(56) 0	100	200.01
122	0 133(6) 149(94) 0	100	200.00
		Total Distance	14477.78

Table A.91: EMIP-MDA+ERTR solution to MDA19 with $p = .1$.

No.	Route	Load	Distance
1	0 184(94) 136(6) 0	100	240.00
2	0 79(50) 111(50) 0	100	140.01
3	0 130(6) 178(94) 0	100	240.01
4	0 101(50) 69(50) 0	100	140.00
5	0 177(94) 129(6) 0	100	240.00
6	0 1(50) 2(50) 0	100	23.91
7	0 76(38) 172(56) 0	94	220.00
8	0 41(6) 57(94) 0	100	80.00
9	0 165(50) 133(50) 0	100	220.00
10	0 109(56) 125(44) 0	100	160.00
11	0 171(50) 155(50) 0	100	220.00
12	0 176(50) 128(50) 0	100	220.00
13	0 61(94) 0	94	80.00
14	0 137(6) 153(94) 0	100	200.00
15	0 4(56) 0	56	20.00
16	0 151(94) 103(6) 0	100	200.01
17	0 56(94) 40(6) 0	100	79.99
18	0 94(44) 78(56) 0	100	120.00
19	0 89(44) 73(56) 0	100	120.00
20	0 106(6) 122(94) 0	100	160.00
21	0 152(94) 136(6) 0	100	199.99
22	0 59(94) 0	94	80.00
23	0 8(56) 10(36) 0	92	27.66
24	0 13(30) 14(56) 0	86	23.91
25	0 72(12) 88(38) 104(50) 0	100	140.00
26	0 102(56) 118(44) 0	100	160.00
27	0 94(50) 110(50) 0	100	140.01
28	0 70(56) 54(44) 0	100	100.01
29	0 142(44) 174(56) 0	100	219.99
30	0 110(6) 126(94) 0	100	159.99
31	0 95(94) 79(6) 0	100	120.00
32	0 43(38) 42(56) 0	94	71.71
33	0 123(94) 0	94	160.00

(cont.)

Table A.91 continued.

No.	Route	Load	Distance
34	0 26(94) 0	94	40.00
35	0 32(94) 16(6) 0	100	40.01
36	0 100(50) 68(50) 0	100	140.00
37	0 83(94) 0	94	120.01
38	0 180(94) 164(6) 0	100	240.00
39	0 173(50) 140(50) 0	100	243.66
40	0 124(94) 0	94	160.00
41	0 85(94) 69(6) 0	100	120.00
42	0 139(56) 155(44) 0	100	200.00
43	0 53(94) 36(6) 0	100	86.81
44	0 23(50) 39(50) 0	100	59.99
45	0 132(56) 116(44) 0	100	180.00
46	0 77(56) 45(12) 13(26) 0	94	100.00
47	0 136(44) 168(56) 0	100	219.99
48	0 147(44) 163(56) 0	100	220.00
49	0 154(44) 138(56) 0	100	200.00
50	0 29(94) 0	94	40.00
51	0 142(6) 190(94) 0	100	240.00
52	0 142(6) 158(94) 0	100	199.99
53	0 64(94) 48(6) 0	100	79.99
54	0 154(50) 170(50) 0	100	219.99
55	0 134(56) 150(44) 0	100	200.00
56	0 141(50) 125(50) 0	100	180.00
57	0 170(6) 186(94) 0	100	240.00
58	0 179(94) 131(6) 0	100	239.99
59	0 147(50) 131(50) 0	100	200.00
60	0 50(94) 2(6) 0	100	80.01
61	0 20(94) 0	94	40.00
62	0 146(94) 130(6) 0	100	200.01
63	0 72(44) 88(56) 0	100	120.00
64	0 92(94) 0	94	120.00
65	0 93(94) 0	94	120.00
66	0 49(94) 0	94	80.00

(cont.)

Table A.91 continued.

No.	Route	Load	Distance
67	0 35(50) 34(50) 0	100	71.71
68	0 62(44) 46(56) 0	100	80.00
69	0 34(6) 66(56) 65(34) 0	96	119.50
70	0 11(6) 107(24) 91(68) 0	98	139.99
71	0 60(94) 0	94	79.99
72	0 19(94) 3(6) 0	100	39.99
73	0 183(94) 167(6) 0	100	240.01
74	0 156(94) 140(6) 0	100	199.99
75	0 35(6) 51(94) 0	100	79.99
76	0 81(84) 0	84	120.00
77	0 27(94) 11(6) 0	100	39.99
78	0 103(6) 119(94) 0	100	159.99
79	0 105(6) 121(94) 0	100	160.00
80	0 30(94) 0	94	40.00
81	0 28(94) 0	94	40.01
82	0 58(94) 0	94	80.00
83	0 98(6) 114(94) 0	100	160.00
84	0 5(50) 3(50) 0	100	27.65
85	0 25(94) 0	94	40.00
86	0 96(50) 112(50) 0	100	140.01
87	0 15(50) 16(50) 0	100	23.90
88	0 63(94) 47(6) 0	100	80.00
89	0 101(6) 117(94) 0	100	160.00
90	0 17(94) 1(6) 0	100	40.00
91	0 47(50) 62(50) 0	100	86.82
92	0 144(56) 128(44) 0	100	180.00
93	0 176(6) 192(94) 0	100	240.00
94	0 100(6) 148(94) 0	100	200.01
95	0 145(94) 129(6) 0	100	200.00
96	0 40(50) 41(50) 0	100	71.71
97	0 159(50) 143(50) 0	100	200.00
98	0 22(94) 0	94	40.00
99	0 188(94) 108(6) 0	100	240.00

(cont.)

Table A.91 continued.

No.	Route	Load	Distance
100	0 38(6) 86(94) 0	100	119.99
101	0 191(94) 143(6) 0	100	240.01
102	0 38(50) 54(50) 0	100	80.01
103	0 135(56) 103(44) 0	100	180.00
104	0 90(50) 106(50) 0	100	139.99
105	0 82(94) 98(6) 0	100	140.00
106	0 105(50) 89(50) 0	100	140.00
107	0 21(94) 5(6) 0	100	40.00
108	0 175(56) 159(44) 0	100	220.00
109	0 67(56) 36(44) 0	100	105.07
110	0 137(44) 169(56) 0	100	220.00
111	0 39(6) 87(94) 0	100	120.00
112	0 150(50) 166(50) 0	100	220.00
113	0 141(6) 157(94) 0	100	200.00
114	0 98(44) 99(56) 0	100	167.31
115	0 81(10) 97(56) 65(22) 0	88	140.00
116	0 90(44) 74(56) 0	100	120.01
117	0 160(94) 112(6) 0	100	199.99
118	0 6(28) 7(56) 0	84	23.90
119	0 36(6) 52(94) 0	100	79.99
120	0 161(56) 129(44) 0	100	220.00
121	0 12(56) 11(44) 0	100	23.90
122	0 48(50) 33(50) 0	100	71.71
123	0 130(44) 162(56) 0	100	220.00
124	0 18(94) 0	94	40.00
125	0 45(44) 44(56) 0	100	71.70
126	0 167(50) 118(50) 0	100	237.33
127	0 84(94) 68(6) 0	100	119.99
128	0 182(94) 166(6) 0	100	240.01
129	0 133(6) 149(94) 0	100	200.00
130	0 71(56) 23(44) 0	100	100.00
131	0 91(26) 75(56) 43(18) 0	100	120.00
132	0 37(56) 6(28) 0	84	61.11

(cont.)

Table A.91 continued.

No.	Route	Load	Distance
133	0 137(6) 185(94) 0	100	240.00
134	0 80(56) 96(44) 0	100	120.00
135	0 15(6) 31(94) 0	100	39.99
136	0 9(56) 10(20) 0	76	23.91
137	0 127(94) 111(6) 0	100	160.00
138	0 55(94) 0	94	80.00
139	0 33(6) 113(94) 0	100	160.00
140	0 187(94) 171(6) 0	100	239.99
141	0 24(94) 0	94	40.01
142	0 165(6) 181(94) 0	100	240.00
143	0 189(94) 173(6) 0	100	240.00
144	0 115(94) 0	94	160.00
145	0 120(94) 104(6) 0	100	160.00
146	0 76(18) 108(50) 107(32) 0	100	167.31
147	0 116(50) 164(50) 0	100	220.01
		Total Distance	20432.18

Table A.92: EMIP-MDA+ERTR solution to MDA20 with $p = .1$.

No.	Route	Load	Distance
1	0 7(44) 19(44) 8(12) 0	100	42.39
2	0 38(94) 0	94	80.00
3	0 217(50) 205(50) 0	100	380.00
4	0 131(6) 143(94) 0	100	239.99
5	0 154(56) 190(10) 166(34) 0	100	320.00
6	0 70(44) 58(56) 0	100	120.00
7	0 69(44) 57(56) 0	100	120.01
8	0 110(38) 122(56) 98(6) 0	100	220.00
9	0 12(56) 0	56	20.00
10	0 152(6) 176(50) 164(44) 0	100	300.00
11	0 100(50) 124(50) 0	100	220.00
12	0 226(56) 214(44) 0	100	380.00
13	0 126(50) 114(50) 0	100	220.01
14	0 119(44) 107(56) 0	100	200.00
15	0 140(94) 128(6) 0	100	240.00
16	0 98(6) 134(94) 0	100	239.99
17	0 205(44) 193(56) 0	100	360.00
18	0 60(6) 96(94) 0	100	160.01
19	0 209(50) 173(28) 149(22) 0	100	360.00
20	0 33(6) 45(94) 0	100	80.00
21	0 222(6) 234(94) 0	100	400.00
22	0 64(40) 76(56) 0	96	140.00
23	0 101(40) 77(50) 0	90	180.01
24	0 188(94) 176(6) 0	100	320.00
25	0 124(6) 136(94) 0	100	240.00
26	0 128(50) 104(50) 0	100	220.00
27	0 108(6) 120(94) 0	100	199.99
28	0 44(44) 32(56) 0	100	80.00
29	0 67(44) 55(56) 0	100	120.00
30	0 100(6) 112(94) 0	100	200.00
31	0 113(94) 0	94	200.00
32	0 232(44) 220(56) 0	100	400.00
33	0 231(94) 147(6) 0	100	400.00

(cont.)

Table A.92 continued.

No.	Route	Load	Distance
34	0 44(50) 31(50) 0	100	90.53
35	0 161(84) 6(12) 0	96	281.44
36	0 67(50) 79(50) 0	100	140.00
37	0 13(94) 1(6) 0	100	40.00
38	0 203(6) 215(94) 0	100	360.01
39	0 51(6) 87(94) 0	100	160.00
40	0 41(94) 0	94	80.00
41	0 225(6) 237(94) 0	100	399.99
42	0 25(6) 50(56) 39(38) 0	100	123.53
43	0 78(50) 54(50) 0	100	140.00
44	0 119(50) 131(50) 0	100	220.00
45	0 130(56) 142(44) 0	100	240.00
46	0 216(50) 228(50) 0	100	380.00
47	0 81(50) 69(50) 0	100	140.01
48	0 95(94) 0	94	160.00
49	0 149(6) 233(94) 0	100	400.00
50	0 7(12) 197(56) 185(32) 0	100	345.23
51	0 4(56) 0	56	20.00
52	0 88(94) 0	94	160.00
53	0 146(6) 158(94) 0	100	279.99
54	0 80(6) 92(94) 0	100	160.00
55	0 172(50) 160(50) 0	100	300.00
56	0 151(6) 235(94) 0	100	400.00
57	0 24(44) 35(56) 0	100	66.15
58	0 79(6) 91(94) 0	100	160.00
59	0 225(50) 201(50) 0	100	379.99
60	0 62(44) 39(56) 0	100	132.29
61	0 105(56) 117(44) 0	100	200.01
62	0 56(6) 68(94) 0	100	119.99
63	0 137(94) 0	94	240.00
64	0 203(6) 239(94) 0	100	400.00
65	0 169(50) 157(50) 0	100	300.00
66	0 212(44) 224(56) 0	100	380.01

(cont.)

Table A.92 continued.

No.	Route	Load	Distance
67	0 22(94) 10(6) 0	100	40.00
68	0 212(50) 200(50) 0	100	359.99
69	0 33(50) 34(50) 0	100	75.53
70	0 85(94) 49(6) 0	100	160.00
71	0 25(44) 26(56) 0	100	75.53
72	0 75(56) 51(44) 0	100	140.00
73	0 74(50) 62(50) 0	100	140.00
74	0 98(44) 110(56) 0	100	200.00
75	0 34(6) 46(94) 0	100	80.00
76	0 3(44) 27(56) 0	100	60.00
77	0 18(94) 0	94	40.00
78	0 72(44) 84(56) 0	100	140.01
79	0 199(34) 187(66) 0	100	340.00
80	0 199(22) 211(50) 187(28) 0	100	360.00
81	0 185(62) 173(28) 161(10) 0	100	320.00
82	0 48(44) 36(56) 0	100	80.01
83	0 195(6) 207(94) 0	100	359.99
84	0 214(50) 202(50) 0	100	360.00
85	0 202(6) 238(94) 0	100	400.00
86	0 2(50) 1(50) 0	100	25.18
87	0 81(6) 93(94) 0	100	160.01
88	0 61(50) 49(50) 0	100	120.00
89	0 155(6) 191(94) 0	100	320.01
90	0 28(6) 40(94) 0	100	80.00
91	0 210(44) 198(56) 0	100	360.00
92	0 48(50) 24(50) 0	100	80.01
93	0 219(56) 183(44) 0	100	380.00
94	0 47(44) 59(56) 0	100	100.01
95	0 20(94) 0	94	40.00
96	0 78(6) 90(94) 0	100	160.01
97	0 195(50) 183(50) 0	100	339.99
98	0 126(6) 138(94) 0	100	240.00
99	0 94(50) 70(50) 0	100	160.00

(cont.)

Table A.92 continued.

No.	Route	Load	Distance
100	0 103(40) 115(60) 0	100	200.00
101	0 77(6) 89(94) 0	100	160.00
102	0 160(44) 148(56) 0	100	280.00
103	0 31(6) 43(94) 0	100	80.00
104	0 104(6) 116(94) 0	100	200.00
105	0 117(50) 129(50) 0	100	220.01
106	0 209(44) 221(56) 0	100	380.00
107	0 21(94) 0	94	40.00
108	0 194(56) 218(44) 0	100	380.01
109	0 54(6) 66(94) 0	100	120.00
110	0 115(34) 139(10) 127(56) 0	100	240.00
111	0 25(6) 37(94) 0	100	80.00
112	0 177(6) 189(94) 0	100	320.00
113	0 132(6) 168(94) 0	100	280.00
114	0 218(6) 230(94) 0	100	400.01
115	0 111(34) 123(56) 111(10) 0	100	220.00
116	0 30(50) 19(50) 0	100	66.15
117	0 146(6) 182(94) 0	100	320.01
118	0 114(44) 102(56) 0	100	200.01
119	0 42(94) 30(6) 0	100	80.00
120	0 141(44) 153(56) 0	100	260.00
121	0 8(44) 9(56) 0	100	25.18
122	0 132(50) 108(50) 0	100	220.00
123	0 156(56) 144(44) 0	100	260.00
124	0 121(50) 109(50) 0	100	220.00
125	0 72(50) 60(50) 0	100	120.01
126	0 29(6) 65(94) 0	100	120.00
127	0 232(50) 208(50) 0	100	400.00
128	0 10(50) 11(50) 0	100	25.18
129	0 172(6) 184(94) 0	100	320.00
130	0 139(50) 151(50) 0	100	260.00
131	0 17(94) 0	94	40.00
132	0 109(44) 97(56) 0	100	200.00

(cont.)

Table A.92 continued.

No.	Route	Load	Distance
133	0 178(40) 166(60) 0	100	300.00
134	0 147(50) 135(50) 0	100	259.99
135	0 155(6) 167(94) 0	100	279.99
136	0 6(44) 5(56) 0	100	25.18
137	0 74(6) 86(94) 0	100	160.00
138	0 106(56) 118(44) 0	100	200.00
139	0 162(44) 150(56) 0	100	280.00
140	0 103(16) 163(28) 175(56) 0	100	300.00
141	0 99(6) 159(94) 0	100	279.99
142	0 52(20) 64(54) 3(12) 0	86	121.58
143	0 190(84) 178(16) 0	100	320.00
144	0 94(44) 82(56) 0	100	160.00
145	0 180(56) 192(44) 0	100	320.00
146	0 169(6) 181(94) 0	100	320.00
147	0 135(44) 171(56) 0	100	299.99
148	0 174(56) 186(44) 0	100	320.00
149	0 80(50) 56(50) 0	100	140.00
150	0 155(44) 179(56) 0	100	300.01
151	0 133(94) 121(6) 0	100	240.00
152	0 218(6) 206(94) 0	100	380.01
153	0 196(56) 208(44) 0	100	360.00
154	0 14(94) 2(6) 0	100	40.00
155	0 200(6) 236(94) 0	100	400.01
156	0 99(50) 111(50) 0	100	200.00
157	0 16(94) 0	94	40.00
158	0 146(44) 170(56) 0	100	299.99
159	0 157(44) 145(56) 0	100	280.00
160	0 61(44) 73(56) 0	100	140.00
161	0 47(50) 71(50) 0	100	120.00
162	0 210(50) 222(50) 0	100	380.00
163	0 163(66) 139(34) 0	100	280.00
164	0 213(94) 201(6) 0	100	359.99
165	0 142(50) 118(50) 0	100	240.00

(cont.)

Table A.92 continued.

No.	Route	Load	Distance
166	0 204(56) 216(44) 0	100	360.00
167	0 71(44) 83(56) 0	100	140.00
168	0 129(6) 165(94) 0	100	279.99
169	0 51(6) 63(94) 0	100	120.00
170	0 186(50) 162(50) 0	100	320.00
171	0 211(44) 223(56) 0	100	380.00
172	0 164(50) 152(50) 0	100	280.00
173	0 177(50) 141(50) 0	100	300.00
174	0 29(50) 28(50) 0	100	75.53
175	0 203(44) 227(56) 0	100	380.00
176	0 192(50) 144(50) 0	100	320.00
177	0 217(6) 229(94) 0	100	400.00
178	0 11(6) 23(94) 0	100	40.00
179	0 52(36) 53(56) 0	92	125.88
180	0 15(94) 0	94	40.00
181	0 101(16) 149(28) 125(56) 0	100	260.00
182	0 240(94) 228(6) 0	100	400.00
		Total Distance	40202.48

Table A.93: EMIP-MDA+ERTR solution to MDA21 with $p = .1$.

No.	Route	Load	Distance
1	0 12(56) 11(38) 0	94	20.87
2	0 114(94) 0	94	40.00
3	0 70(56) 69(44) 0	100	20.87
4	0 112(10) 184(56) 183(34) 0	100	62.61
5	0 74(94) 0	94	39.99
6	0 85(94) 0	94	40.00
7	0 262(94) 190(6) 0	100	80.00
8	0 73(94) 0	94	40.00
9	0 29(50) 28(46) 0	96	20.87
10	0 222(94) 0	94	79.99
11	0 23(6) 95(94) 0	100	39.99
12	0 229(50) 230(50) 0	100	83.48
13	0 173(50) 174(50) 0	100	62.62
14	0 6(12) 151(56) 150(12) 5(12) 0	92	62.73
15	0 125(94) 0	94	40.01
16	0 177(6) 249(94) 0	100	80.00
17	0 263(94) 191(6) 0	100	80.01
18	0 68(6) 140(94) 0	100	40.00
19	0 22(56) 20(38) 0	94	21.75
20	0 87(94) 0	94	39.99
21	0 119(94) 0	94	40.00
22	0 32(56) 33(12) 34(12) 0	80	21.75
23	0 37(56) 38(12) 40(32) 0	100	22.62
24	0 155(56) 154(32) 0	88	62.61
25	0 127(94) 0	94	40.00
26	0 39(56) 38(44) 0	100	20.88
27	0 257(50) 258(50) 0	100	83.49
28	0 102(94) 0	94	39.99
29	0 116(94) 44(6) 0	100	39.99
30	0 44(50) 46(50) 0	100	21.74
31	0 166(50) 165(50) 0	100	62.61
32	0 106(94) 0	94	40.00
33	0 26(12) 27(56) 28(10) 31(22) 0	100	24.35

(cont.)

Table A.93 continued.

No.	Route	Load	Distance
34	0 82(94) 0	94	39.99
35	0 16(56) 18(12) 19(32) 0	100	22.62
36	0 54(48) 53(50) 0	98	20.88
37	0 15(56) 14(44) 0	100	20.88
38	0 212(6) 284(94) 0	100	80.00
39	0 105(94) 0	94	39.99
40	0 161(50) 162(50) 0	100	62.61
41	0 72(56) 0	56	20.00
42	0 219(94) 147(6) 0	100	80.00
43	0 226(94) 0	94	79.99
44	0 264(94) 192(6) 0	100	80.00
45	0 218(94) 146(6) 0	100	80.01
46	0 132(94) 0	94	40.00
47	0 156(56) 154(24) 0	80	65.22
48	0 287(94) 215(6) 0	100	80.00
49	0 126(94) 0	94	39.99
50	0 121(94) 0	94	40.00
51	0 104(94) 0	94	40.00
52	0 17(56) 18(44) 0	100	20.88
53	0 83(94) 0	94	40.00
54	0 63(44) 64(56) 0	100	20.87
55	0 193(50) 195(50) 0	100	65.23
56	0 214(50) 213(50) 0	100	62.63
57	0 267(56) 266(44) 0	100	83.49
58	0 113(94) 0	94	39.99
59	0 135(94) 0	94	39.99
60	0 115(94) 0	94	40.00
61	0 145(6) 217(94) 0	100	80.00
62	0 24(56) 23(44) 0	100	20.88
63	0 130(94) 0	94	40.00
64	0 123(94) 0	94	39.99
65	0 89(94) 0	94	40.01
66	0 216(50) 215(50) 0	100	62.61

(cont.)

Table A.93 continued.

No.	Route	Load	Distance
67	0 285(94) 213(6) 0	100	80.01
68	0 166(6) 238(94) 0	100	80.00
69	0 148(6) 220(94) 0	100	80.00
70	0 199(6) 271(94) 0	100	80.00
71	0 159(6) 231(94) 0	100	80.00
72	0 33(44) 36(56) 0	100	22.61
73	0 11(18) 10(56) 9(12) 0	86	21.74
74	0 138(94) 0	94	39.99
75	0 269(94) 197(6) 0	100	80.00
76	0 4(56) 5(44) 0	100	20.87
77	0 158(56) 230(44) 0	100	80.00
78	0 100(94) 0	94	39.99
79	0 98(94) 0	94	39.99
80	0 69(12) 141(38) 143(50) 0	100	43.48
81	0 191(50) 192(50) 0	100	62.62
82	0 169(6) 241(94) 0	100	80.00
83	0 136(94) 0	94	39.99
84	0 234(94) 162(6) 0	100	80.01
85	0 47(38) 46(6) 45(56) 0	100	21.74
86	0 49(26) 48(56) 47(18) 0	100	21.75
87	0 58(32) 60(12) 62(56) 0	100	23.48
88	0 201(50) 202(50) 0	100	62.61
89	0 232(94) 160(6) 0	100	80.00
90	0 153(56) 152(44) 0	100	62.60
91	0 52(56) 50(34) 0	90	21.75
92	0 75(94) 0	94	40.01
93	0 3(56) 2(44) 0	100	20.88
94	0 137(94) 0	94	40.00
95	0 84(94) 0	94	39.99
96	0 86(94) 0	94	40.00
97	0 93(94) 0	94	40.01
98	0 124(94) 0	94	40.00
99	0 42(18) 41(56) 40(24) 0	98	21.75

(cont.)

Table A.93 continued.

No.	Route	Load	Distance
100	0 88(94) 0	94	40.00
101	0 157(56) 229(44) 0	100	80.00
102	0 81(94) 0	94	40.00
103	0 59(56) 58(24) 56(20) 0	100	22.62
104	0 225(44) 224(44) 152(12) 0	100	83.49
105	0 19(24) 20(18) 21(56) 0	98	21.75
106	0 8(56) 9(44) 0	100	20.87
107	0 170(6) 242(94) 0	100	80.00
108	0 31(34) 30(56) 0	90	20.88
109	0 35(56) 34(44) 0	100	20.87
110	0 175(6) 247(94) 0	100	80.00
111	0 214(6) 286(94) 0	100	80.01
112	0 261(94) 189(6) 0	100	80.00
113	0 96(94) 0	94	40.00
114	0 51(56) 50(22) 0	78	20.88
115	0 139(94) 68(6) 0	100	40.07
116	0 14(12) 13(56) 0	68	20.87
117	0 146(50) 145(50) 0	100	62.62
118	0 103(94) 0	94	40.00
119	0 61(56) 60(44) 0	100	20.87
120	0 225(50) 224(50) 0	100	83.49
121	0 148(50) 147(50) 0	100	62.61
122	0 79(94) 0	94	40.00
123	0 282(94) 210(6) 0	100	80.00
124	0 92(94) 0	94	39.99
125	0 221(94) 0	94	80.00
126	0 120(94) 0	94	39.99
127	0 101(94) 29(6) 0	100	40.00
128	0 265(94) 193(6) 0	100	80.00
129	0 187(50) 186(50) 0	100	62.62
130	0 281(94) 209(6) 0	100	80.01
131	0 172(50) 171(50) 0	100	62.61
132	0 159(50) 160(50) 0	100	62.61

(cont.)

Table A.93 continued.

No.	Route	Load	Distance
133	0 236(44) 164(56) 0	100	80.00
134	0 99(94) 0	94	39.99
135	0 176(50) 175(50) 0	100	62.62
136	0 167(6) 239(94) 0	100	80.00
137	0 90(94) 0	94	39.99
138	0 200(6) 272(94) 0	100	80.00
139	0 110(94) 0	94	39.99
140	0 142(94) 0	94	40.00
141	0 200(50) 199(50) 0	100	62.62
142	0 178(50) 177(50) 0	100	62.61
143	0 250(94) 178(6) 0	100	80.01
144	0 203(50) 204(50) 0	100	62.61
145	0 49(30) 53(6) 54(8) 55(56) 0	100	25.22
146	0 122(94) 0	94	40.00
147	0 179(6) 251(94) 0	100	80.00
148	0 273(94) 201(6) 0	100	79.99
149	0 170(50) 169(50) 0	100	62.62
150	0 133(94) 0	94	40.00
151	0 128(94) 0	94	39.99
152	0 228(94) 0	94	80.00
153	0 267(38) 266(50) 194(12) 0	100	83.49
154	0 134(94) 0	94	39.99
155	0 260(94) 187(6) 0	100	80.45
156	0 194(44) 196(56) 0	100	65.23
157	0 109(94) 0	94	40.00
158	0 78(94) 0	94	40.00
159	0 76(94) 0	94	40.00
160	0 94(94) 23(6) 0	100	40.08
161	0 141(56) 143(44) 0	100	43.48
162	0 270(50) 197(50) 0	100	80.45
163	0 91(94) 0	94	40.00
164	0 131(94) 0	94	39.99
165	0 255(94) 0	94	79.99

(cont.)

Table A.93 continued.

No.	Route	Load	Distance
166	0 203(6) 275(94) 0	100	80.00
167	0 204(6) 276(94) 0	100	79.99
168	0 183(22) 111(78) 0	100	59.99
169	0 277(50) 278(50) 0	100	83.49
170	0 277(44) 205(56) 0	100	79.99
171	0 278(44) 206(56) 0	100	80.00
172	0 202(6) 274(94) 0	100	80.00
173	0 258(44) 188(56) 0	100	81.67
174	0 112(84) 111(16) 0	100	41.75
175	0 210(50) 209(50) 0	100	62.62
176	0 248(94) 176(6) 0	100	80.00
177	0 65(32) 66(56) 0	88	20.87
178	0 212(50) 211(50) 0	100	62.62
179	0 181(6) 253(94) 0	100	80.00
180	0 80(94) 0	94	39.99
181	0 227(94) 0	94	80.00
182	0 63(12) 65(24) 67(56) 0	92	23.49
183	0 181(6) 254(94) 0	100	80.45
184	0 77(94) 0	94	39.99
185	0 186(6) 259(94) 0	100	80.44
186	0 57(56) 56(36) 0	92	20.88
187	0 168(50) 167(50) 0	100	62.62
188	0 283(94) 211(6) 0	100	80.01
189	0 150(44) 149(56) 0	100	62.62
190	0 117(94) 0	94	39.99
191	0 288(94) 216(6) 0	100	80.01
192	0 172(6) 244(94) 0	100	80.00
193	0 25(56) 26(44) 0	100	20.88
194	0 174(6) 246(94) 0	100	80.00
195	0 7(56) 6(44) 0	100	20.87
196	0 180(6) 252(94) 0	100	80.01
197	0 279(94) 207(6) 0	100	80.01
198	0 235(94) 163(6) 0	100	80.00

(cont.)

Table A.93 continued.

No.	Route	Load	Distance
199	0 233(94) 161(6) 0	100	80.00
200	0 97(94) 0	94	40.00
201	0 118(94) 0	94	39.99
202	0 163(50) 236(50) 0	100	80.45
203	0 257(44) 185(56) 0	100	80.00
204	0 168(6) 240(94) 0	100	79.99
205	0 189(50) 190(50) 0	100	62.61
206	0 223(94) 0	94	80.00
207	0 195(6) 268(94) 0	100	80.45
208	0 179(50) 180(50) 0	100	62.61
209	0 181(44) 182(56) 0	100	62.62
210	0 270(44) 198(56) 0	100	80.01
211	0 173(6) 245(94) 0	100	80.00
212	0 42(38) 43(56) 0	94	20.87
213	0 129(94) 0	94	40.01
214	0 108(94) 0	94	39.99
215	0 256(94) 0	94	80.00
216	0 68(44) 71(56) 0	100	22.61
217	0 243(94) 171(6) 0	100	80.00
218	0 165(6) 237(94) 0	100	79.99
219	0 144(94) 0	94	39.99
220	0 107(94) 0	94	40.01
221	0 207(50) 208(50) 0	100	62.61
222	0 280(94) 208(6) 0	100	80.00
223	0 1(56) 2(12) 0	68	20.87
		Total Distance	12014.61

Table A.94: EMIP-MDA+ERTR solution to MDA1 with $p = .2$.

No.	Route	Load	Distance
1	0 2(50) 1(50) 0	100	34.14
2	0 6(87) 2(13) 0	100	40.00
3	0 7(87) 3(13) 0	100	40.00
4	0 3(50) 4(50) 0	100	34.14
5	0 1(13) 5(87) 0	100	40.00
6	0 4(13) 8(87) 0	100	40.00
		Total Distance	228.28

Table A.95: EMIP-MDA+ERTR solution to MDA2 with $p = .2$.

No.	Route	Load	Distance
1	0 5(37) 1(63) 0	100	40.00
2	0 6(37) 2(63) 0	100	40.00
3	0 7(37) 3(63) 0	100	40.00
4	0 8(50) 4(50) 0	100	40.00
5	0 10(50) 6(50) 0	100	60.00
6	0 11(50) 7(50) 0	100	60.00
7	0 12(63) 8(37) 0	100	60.00
8	0 5(50) 9(50) 0	100	60.00
9	0 14(87) 10(13) 0	100	80.00
10	0 9(13) 13(87) 0	100	80.00
11	0 11(13) 15(87) 0	100	80.00
12	0 4(13) 16(87) 0	100	80.00
		Total Distance	720.00

Table A.96: EMIP-MDA+ERTR solution to MDA3 with $p = .2$.

No.	Route	Load	Distance
1	0 8(50) 1(50) 0	100	27.65
2	0 10(87) 2(13) 0	100	39.99
3	0 2(50) 3(50) 0	100	27.65
4	0 12(87) 4(13) 0	100	39.99
5	0 4(50) 5(50) 0	100	27.65
6	0 7(50) 6(50) 0	100	27.65
7	0 15(87) 7(13) 0	100	40.00
8	0 16(87) 8(13) 0	100	39.99
9	0 1(13) 9(87) 0	100	40.00
10	0 3(13) 11(87) 0	100	40.00
11	0 5(13) 13(87) 0	100	40.00
12	0 6(13) 14(87) 0	100	39.99
		Total Distance	430.58

Table A.97: EMIP-MDA+ERTR solution to MDA4 with $p = .2$.

No.	Route	Load	Distance
1	0 14(87) 2(13) 0	100	40.00
2	0 13(87) 1(13) 0	100	40.00
3	0 2(50) 3(50) 0	100	25.18
4	0 4(50) 5(50) 0	100	25.18
5	0 7(50) 6(50) 0	100	25.18
6	0 18(87) 6(13) 0	100	40.00
7	0 20(87) 8(13) 0	100	40.00
8	0 8(50) 9(50) 0	100	25.18
9	0 11(50) 10(50) 0	100	25.18
10	0 1(50) 12(50) 0	100	25.18
11	0 4(13) 16(87) 0	100	40.00
12	0 3(13) 15(87) 0	100	40.00
13	0 5(13) 17(87) 0	100	40.00
14	0 7(13) 19(87) 0	100	40.00
15	0 10(13) 22(87) 0	100	40.00
16	0 9(13) 21(87) 0	100	40.00
17	0 11(13) 23(87) 0	100	40.00
18	0 12(13) 24(87) 0	100	40.00
		Total Distance	631.05

Table A.98: EMIP-MDA+ERTR solution to MDA5 with $p = .2$.

No.	Route	Load	Distance
1	0 2(50) 1(50) 0	100	27.65
2	0 10(87) 2(13) 0	100	39.99
3	0 11(87) 3(13) 0	100	40.00
4	0 3(50) 4(50) 0	100	27.65
5	0 13(87) 5(13) 0	100	40.00
6	0 5(50) 6(50) 0	100	27.65
7	0 8(50) 7(50) 0	100	27.65
8	0 16(87) 8(13) 0	100	39.99
9	0 1(13) 9(87) 0	100	40.00
10	0 4(13) 12(87) 0	100	39.99
11	0 6(13) 14(87) 0	100	39.99
12	0 7(13) 15(87) 0	100	40.00
13	0 17(50) 18(50) 0	100	82.95
14	0 27(87) 19(13) 0	100	80.00
15	0 19(50) 20(50) 0	100	82.95
16	0 22(50) 21(50) 0	100	82.96
17	0 30(87) 22(13) 0	100	80.00
18	0 24(50) 23(50) 0	100	82.96
19	0 17(13) 25(87) 0	100	80.00
20	0 18(13) 26(87) 0	100	79.99
21	0 20(13) 28(87) 0	100	80.00
22	0 21(13) 29(87) 0	100	80.00
23	0 23(13) 31(87) 0	100	80.00
24	0 24(13) 32(87) 0	100	80.00
		Total Distance	1402.40

Table A.99: EMIP-MDA+ERTR solution to MDA6 with $p = .2$.

No.	Route	Load	Distance
1	0 18(87) 2(13) 0	100	40.00
2	0 2(50) 3(50) 0	100	23.90
3	0 5(50) 4(50) 0	100	23.91
4	0 21(87) 5(13) 0	100	40.00
5	0 7(50) 6(50) 0	100	23.90
6	0 8(50) 9(50) 0	100	23.91
7	0 26(87) 10(13) 0	100	40.00
8	0 10(50) 11(50) 0	100	23.90
9	0 12(50) 13(50) 0	100	23.91
10	0 30(87) 14(13) 0	100	40.00
11	0 14(50) 15(50) 0	100	23.90
12	0 1(50) 16(50) 0	100	23.91
13	0 1(13) 17(87) 0	100	40.00
14	0 3(13) 19(87) 0	100	39.99
15	0 4(13) 20(87) 0	100	40.00
16	0 6(13) 22(87) 0	100	40.00
17	0 7(13) 23(87) 0	100	39.99
18	0 8(13) 24(87) 0	100	40.01
19	0 9(13) 25(87) 0	100	40.00
20	0 11(13) 27(87) 0	100	39.99
21	0 12(13) 28(87) 0	100	40.01
22	0 13(13) 29(87) 0	100	40.00
23	0 15(13) 31(87) 0	100	39.99
24	0 16(13) 32(87) 0	100	40.01
		Total Distance	831.24

Table A.100: EMIP-MDA+ERTR solution to MDA7 with $p = .2$.

No.	Route	Load	Distance
1	0 4(50) 1(50) 0	100	34.14
2	0 3(50) 2(50) 0	100	34.14
3	0 8(87) 4(13) 0	100	40.00
4	0 1(13) 5(87) 0	100	40.00
5	0 2(13) 6(87) 0	100	40.00
6	0 3(13) 7(87) 0	100	40.00
7	0 13(50) 9(50) 0	100	80.00
8	0 22(87) 10(13) 0	100	120.00
9	0 15(50) 11(50) 0	100	80.00
10	0 16(37) 12(63) 0	100	80.00
11	0 10(50) 14(50) 0	100	80.00
12	0 20(50) 16(50) 0	100	100.00
13	0 13(37) 17(63) 0	100	100.00
14	0 14(37) 18(63) 0	100	100.00
15	0 15(37) 19(63) 0	100	100.00
16	0 9(13) 21(87) 0	100	120.00
17	0 11(13) 23(87) 0	100	120.00
18	0 20(13) 24(87) 0	100	120.00
19	0 33(50) 25(50) 0	100	180.00
20	0 38(87) 26(13) 0	100	200.00
21	0 31(37) 27(63) 0	100	160.00
22	0 32(37) 28(63) 0	100	160.00
23	0 25(13) 29(87) 0	100	160.00
24	0 26(50) 30(50) 0	100	160.00
25	0 35(50) 31(50) 0	100	180.00
26	0 36(50) 32(50) 0	100	180.00
27	0 37(87) 33(13) 0	100	200.00
28	0 30(37) 34(63) 0	100	180.00
29	0 39(87) 35(13) 0	100	200.00
30	0 36(13) 40(87) 0	100	200.00
		Total Distance	3588.28

Table A.101: EMIP-MDA+ERTR solution to MDA8 with $p = .2$.

No.	Route	Load	Distance
1	0 29(87) 17(13) 0	100	160.00
2	0 5(37) 9(63) 0	100	60.00
3	0 8(50) 4(50) 0	100	40.00
4	0 10(50) 6(50) 0	100	60.00
5	0 1(50) 5(50) 0	100	40.00
6	0 19(63) 15(37) 0	100	100.00
7	0 3(63) 7(37) 0	100	40.00
8	0 6(37) 2(63) 0	100	40.00
9	0 14(87) 10(13) 0	100	80.00
10	0 7(50) 11(50) 0	100	60.00
11	0 12(63) 8(37) 0	100	60.00
12	0 4(13) 16(87) 0	100	80.00
13	0 37(87) 33(13) 0	100	200.00
14	0 22(37) 18(63) 0	100	120.00
15	0 40(87) 36(13) 0	100	200.00
16	0 17(50) 21(50) 0	100	120.00
17	0 26(50) 22(50) 0	100	140.00
18	0 11(13) 23(87) 0	100	120.00
19	0 20(50) 24(50) 0	100	120.00
20	0 21(37) 25(63) 0	100	140.00
21	0 30(87) 26(13) 0	100	160.00
22	0 35(50) 43(50) 0	100	220.00
23	0 24(37) 28(63) 0	100	140.00
24	0 27(13) 31(87) 0	100	160.00
25	0 45(87) 33(13) 0	100	240.00
26	0 42(50) 34(50) 0	100	220.00
27	0 39(87) 35(13) 0	100	200.00
28	0 44(50) 36(50) 0	100	220.00
29	0 1(13) 13(87) 0	100	80.00
30	0 42(13) 46(87) 0	100	240.00
31	0 44(13) 48(87) 0	100	240.00
32	0 33(37) 41(63) 0	100	220.00
33	0 15(50) 27(50) 0	100	140.00
34	0 32(87) 20(13) 0	100	160.00
35	0 34(13) 38(87) 0	100	200.00
36	0 43(13) 47(87) 0	100	240.00
		Total Distance	5060.00

Table A.102: EMIP-MDA+ERTR solution to MDA9 with $p = .2$.

No.	Route	Load	Distance
1	0 13(37) 1(63) 0	100	40.00
2	0 12(50) 11(50) 0	100	25.18
3	0 15(87) 3(13) 0	100	40.00
4	0 13(50) 25(50) 0	100	60.00
5	0 36(50) 35(50) 0	100	75.53
6	0 18(87) 6(13) 0	100	40.00
7	0 20(87) 8(13) 0	100	40.00
8	0 6(50) 7(50) 0	100	25.18
9	0 23(87) 11(13) 0	100	40.00
10	0 4(50) 5(50) 0	100	25.18
11	0 31(50) 30(50) 0	100	75.53
12	0 2(13) 14(87) 0	100	40.00
13	0 4(13) 16(87) 0	100	40.00
14	0 5(13) 17(87) 0	100	40.00
15	0 32(13) 44(87) 0	100	80.00
16	0 9(13) 21(87) 0	100	40.00
17	0 10(63) 22(37) 0	100	40.00
18	0 12(13) 24(87) 0	100	40.00
19	0 37(87) 25(13) 0	100	80.00
20	0 27(50) 26(50) 0	100	75.53
21	0 2(50) 3(50) 0	100	25.18
22	0 8(50) 9(50) 0	100	25.18
23	0 42(87) 30(13) 0	100	80.00
24	0 33(50) 32(50) 0	100	75.53
25	0 45(87) 33(13) 0	100	80.00
26	0 34(50) 22(50) 0	100	60.00
27	0 29(50) 28(50) 0	100	75.53
28	0 48(87) 36(13) 0	100	80.01
29	0 26(13) 38(87) 0	100	80.00
30	0 27(13) 39(87) 0	100	80.00
31	0 28(13) 40(87) 0	100	80.00
32	0 29(13) 41(87) 0	100	80.00
33	0 7(13) 19(87) 0	100	40.00
34	0 31(13) 43(87) 0	100	80.00
35	0 34(13) 46(87) 0	100	80.00
36	0 35(13) 47(87) 0	100	79.99
		Total Distance	2063.50

Table A.103: EMIP-MDA+ERTR solution to MDA10 with $p = .2$.

No.	Route	Load	Distance
1	0 21(87) 0	87	40.00
2	0 12(13) 28(87) 0	100	40.01
3	0 39(50) 38(50) 0	100	71.71
4	0 7(50) 6(50) 0	100	23.90
5	0 34(13) 50(87) 0	100	80.01
6	0 38(13) 54(87) 0	100	80.01
7	0 19(87) 0	87	39.99
8	0 10(63) 0	63	20.00
9	0 29(87) 13(13) 0	100	40.00
10	0 9(13) 25(87) 0	100	40.00
11	0 14(50) 13(50) 0	100	23.91
12	0 46(50) 47(50) 0	100	71.71
13	0 35(50) 34(50) 0	100	71.71
14	0 41(50) 40(50) 0	100	71.71
15	0 55(87) 39(13) 0	100	80.00
16	0 5(63) 4(37) 0	100	23.91
17	0 35(13) 51(87) 0	100	79.99
18	0 30(87) 14(13) 0	100	40.00
19	0 43(50) 42(50) 0	100	71.71
20	0 11(13) 27(87) 0	100	39.99
21	0 2(50) 1(50) 0	100	23.91
22	0 20(87) 0	87	40.00
23	0 56(87) 40(13) 0	100	79.99
24	0 31(87) 15(13) 0	100	39.99
25	0 1(13) 17(87) 0	100	40.00
26	0 26(87) 0	87	40.00
27	0 8(13) 24(87) 0	100	40.01
28	0 59(87) 43(13) 0	100	80.00
29	0 37(50) 36(50) 0	100	71.71
30	0 23(87) 7(13) 0	100	39.99
31	0 16(50) 15(50) 0	100	23.90
32	0 11(50) 12(50) 0	100	23.90
33	0 18(87) 2(13) 0	100	40.00

(cont.)

Table A.103 continued.

No.	Route	Load	Distance
34	0 53(87) 37(13) 0	100	80.00
35	0 9(50) 8(50) 0	100	23.91
36	0 60(87) 44(13) 0	100	79.99
37	0 33(13) 49(87) 0	100	80.00
38	0 42(13) 58(87) 0	100	80.00
39	0 16(13) 32(87) 0	100	40.01
40	0 52(87) 36(13) 0	100	79.99
41	0 62(87) 46(13) 0	100	80.00
42	0 44(50) 45(50) 0	100	71.70
43	0 22(87) 6(13) 0	100	40.00
44	0 41(13) 57(87) 0	100	80.00
45	0 48(50) 33(50) 0	100	71.71
46	0 61(87) 45(13) 0	100	80.00
47	0 63(87) 47(13) 0	100	80.00
48	0 64(87) 48(13) 0	100	79.99
49	0 3(63) 4(26) 0	89	23.90
		Total Distance	2704.89

Table A.104: EMIP-MDA+ERTR solution to MDA11 with $p = .2$.

No.	Route	Load	Distance
1	0 9(13) 13(87) 0	100	80.00
2	0 14(87) 2(13) 0	100	80.00
3	0 11(13) 15(87) 0	100	80.00
4	0 8(37) 4(63) 0	100	40.00
5	0 1(26) 9(50) 5(24) 0	100	60.00
6	0 2(50) 6(50) 0	100	40.00
7	0 3(26) 11(50) 7(24) 0	100	60.00
8	0 12(50) 8(50) 0	100	60.00
9	0 5(63) 1(37) 0	100	40.00
10	0 6(37) 10(63) 0	100	60.00
11	0 7(63) 3(37) 0	100	40.00
12	0 12(13) 16(87) 0	100	80.00
13	0 22(37) 18(63) 0	100	120.00
14	0 27(13) 31(87) 0	100	160.00
15	0 17(63) 21(37) 0	100	120.00
16	0 30(68) 22(32) 0	100	160.00
17	0 19(63) 23(37) 0	100	120.00
18	0 20(63) 24(37) 0	100	120.00
19	0 21(50) 25(50) 0	100	140.00
20	0 23(50) 27(50) 0	100	140.00
21	0 32(87) 28(13) 0	100	160.00
22	0 25(13) 29(87) 0	100	160.00
23	0 22(18) 26(63) 30(19) 0	100	160.00
24	0 28(50) 24(50) 0	100	140.00
25	0 37(37) 33(63) 0	100	200.00
26	0 38(87) 34(13) 0	100	200.00
27	0 59(50) 55(50) 0	100	300.00
28	0 44(63) 48(37) 0	100	240.00
29	0 37(32) 41(50) 37(18) 0	100	220.00
30	0 34(50) 42(50) 0	100	220.00
31	0 35(50) 39(50) 0	100	200.00
32	0 40(50) 48(50) 0	100	240.00
33	0 45(87) 41(13) 0	100	240.00

(cont.)

Table A.104 continued.

No.	Route	Load	Distance
34	0 46(87) 42(13) 0	100	240.00
35	0 35(13) 39(37) 43(50) 0	100	220.00
36	0 36(63) 40(37) 0	100	200.00
37	0 65(31) 69(69) 0	100	360.00
38	0 54(37) 50(63) 0	100	280.00
39	0 43(13) 47(37) 55(37) 51(13) 0	100	280.00
40	0 56(37) 52(63) 0	100	280.00
41	0 49(26) 57(50) 53(24) 0	100	300.00
42	0 60(50) 56(50) 0	100	300.00
43	0 53(63) 49(37) 0	100	280.00
44	0 62(87) 58(13) 0	100	320.00
45	0 51(50) 47(50) 0	100	260.00
46	0 69(18) 73(50) 61(32) 0	100	380.00
47	0 58(50) 54(50) 0	100	300.00
48	0 63(87) 59(13) 0	100	320.00
49	0 60(13) 64(87) 0	100	320.00
50	0 57(13) 61(55) 65(32) 0	100	340.00
51	0 70(37) 66(63) 0	100	360.00
52	0 71(37) 67(63) 0	100	360.00
53	0 74(50) 70(50) 0	100	380.00
54	0 68(63) 72(37) 0	100	360.00
55	0 78(87) 74(13) 0	100	400.00
56	0 71(50) 75(50) 0	100	380.00
57	0 72(50) 76(50) 0	100	380.00
58	0 73(13) 77(87) 0	100	400.00
59	0 75(13) 79(87) 0	100	400.00
60	0 76(13) 80(87) 0	100	400.00
		Total Distance	13280.00

Table A.105: EMIP-MDA+ERTR solution to MDA12 with $p = .2$.

No.	Route	Load	Distance
1	0 45(87) 21(13) 0	100	120.00
2	0 76(87) 20(13) 0	100	200.01
3	0 3(63) 0	63	20.00
4	0 46(87) 38(13) 0	100	120.00
5	0 16(87) 8(13) 0	100	39.99
6	0 17(31) 25(69) 0	100	80.00
7	0 18(13) 26(87) 0	100	79.99
8	0 7(13) 15(87) 0	100	40.00
9	0 44(37) 68(63) 0	100	180.00
10	0 14(87) 6(13) 0	100	39.99
11	0 12(87) 4(13) 0	100	39.99
12	0 10(87) 0	87	39.99
13	0 2(63) 0	63	20.00
14	0 18(50) 34(50) 0	100	100.00
15	0 13(87) 5(13) 0	100	40.00
16	0 43(87) 19(13) 0	100	120.00
17	0 7(50) 6(50) 0	100	27.65
18	0 25(18) 33(50) 17(32) 0	100	100.00
19	0 23(63) 31(37) 0	100	80.00
20	0 71(13) 79(87) 0	100	200.00
21	0 22(63) 30(37) 0	100	80.00
22	0 1(50) 8(50) 0	100	27.65
23	0 11(87) 0	87	40.00
24	0 44(50) 52(50) 0	100	139.99
25	0 38(50) 30(50) 0	100	100.00
26	0 29(50) 21(50) 0	100	80.00
27	0 32(37) 24(63) 0	100	80.00
28	0 31(50) 39(50) 0	100	100.00
29	0 5(50) 4(50) 0	100	27.65
30	0 27(24) 35(63) 19(13) 0	100	100.00
31	0 51(37) 67(63) 0	100	180.00
32	0 61(37) 53(63) 0	100	160.00
33	0 60(87) 52(13) 0	100	159.99

(cont.)

Table A.105 continued.

No.	Route	Load	Distance
34	0 40(50) 32(50) 0	100	100.00
35	0 49(13) 73(87) 0	100	200.00
36	0 34(13) 42(87) 0	100	120.01
37	0 40(13) 48(87) 0	100	120.00
38	0 57(50) 49(50) 0	100	160.00
39	0 66(13) 74(87) 0	100	200.00
40	0 75(87) 51(13) 0	100	200.00
41	0 28(50) 20(50) 0	100	80.00
42	0 29(37) 37(63) 0	100	100.00
43	0 62(37) 54(63) 0	100	160.00
44	0 63(37) 55(63) 0	100	160.00
45	0 64(37) 56(63) 0	100	160.00
46	0 65(63) 57(37) 0	100	180.00
47	0 58(87) 50(13) 0	100	160.00
48	0 59(87) 51(13) 0	100	160.00
49	0 1(13) 9(87) 0	100	40.00
50	0 70(50) 62(50) 0	100	180.00
51	0 71(50) 63(50) 0	100	180.00
52	0 50(50) 66(50) 0	100	180.00
53	0 27(63) 19(37) 0	100	80.00
54	0 36(63) 28(37) 0	100	100.00
55	0 69(50) 61(50) 0	100	180.00
56	0 78(87) 70(13) 0	100	200.00
57	0 39(13) 47(87) 0	100	120.00
58	0 64(50) 72(50) 0	100	180.00
59	0 41(87) 33(13) 0	100	120.00
60	0 69(13) 77(87) 0	100	200.00
61	0 72(13) 80(87) 0	100	200.00
		Total Distance	7182.93

Table A.106: EMIP-MDA+ERTR solution to MDA13 with $p = .2$.

No.	Route	Load	Distance
1	0 10(37) 2(63) 0	100	39.99
2	0 11(87) 3(13) 0	100	40.00
3	0 3(50) 4(50) 0	100	27.65
4	0 13(37) 5(63) 0	100	40.00
5	0 14(37) 6(63) 0	100	39.99
6	0 15(37) 7(63) 0	100	40.00
7	0 16(37) 8(63) 0	100	39.99
8	0 1(63) 9(37) 0	100	40.00
9	0 18(50) 10(50) 0	100	59.99
10	0 4(13) 12(87) 0	100	39.99
11	0 21(50) 13(50) 0	100	60.00
12	0 22(50) 14(50) 0	100	60.01
13	0 23(50) 15(50) 0	100	60.00
14	0 24(50) 16(50) 0	100	60.01
15	0 9(50) 17(50) 0	100	60.00
16	0 19(50) 20(50) 0	100	82.95
17	0 29(87) 21(13) 0	100	80.00
18	0 17(13) 25(87) 0	100	80.00
19	0 18(13) 26(87) 0	100	79.99
20	0 19(13) 27(87) 0	100	80.00
21	0 20(13) 28(87) 0	100	80.00
22	0 22(13) 30(87) 0	100	80.00
23	0 23(13) 31(87) 0	100	80.00
24	0 24(13) 32(87) 0	100	80.00
25	0 73(87) 33(13) 0	100	200.00
26	0 42(37) 34(63) 0	100	120.01
27	0 43(37) 35(63) 0	100	120.00
28	0 45(37) 37(63) 0	100	120.00
29	0 46(50) 38(50) 0	100	120.00
30	0 47(37) 39(63) 0	100	120.00
31	0 48(37) 40(63) 0	100	120.00
32	0 33(13) 41(87) 0	100	120.00
33	0 50(50) 42(50) 0	100	140.01

(cont.)

Table A.106 continued.

No.	Route	Load	Distance
34	0 51(50) 43(50) 0	100	140.00
35	0 36(63) 44(37) 0	100	120.00
36	0 53(50) 45(50) 0	100	140.00
37	0 54(63) 46(37) 0	100	139.99
38	0 55(50) 47(50) 0	100	140.00
39	0 64(50) 48(50) 0	100	160.00
40	0 33(37) 49(63) 0	100	140.00
41	0 59(87) 51(13) 0	100	160.00
42	0 44(50) 52(50) 0	100	139.99
43	0 93(87) 53(13) 0	100	240.00
44	0 65(50) 57(50) 0	100	180.00
45	0 50(13) 58(87) 0	100	160.00
46	0 52(13) 60(87) 0	100	159.99
47	0 77(50) 61(50) 0	100	200.00
48	0 38(13) 62(87) 0	100	160.00
49	0 55(13) 63(87) 0	100	160.00
50	0 56(63) 64(37) 0	100	160.00
51	0 89(87) 65(13) 0	100	240.00
52	0 90(87) 66(13) 0	100	239.99
53	0 83(50) 67(50) 0	100	220.00
54	0 61(37) 69(63) 0	100	180.00
55	0 78(37) 70(63) 0	100	200.00
56	0 79(87) 71(13) 0	100	200.00
57	0 80(50) 72(50) 0	100	200.00
58	0 66(50) 74(50) 0	100	200.00
59	0 67(13) 75(87) 0	100	200.00
60	0 68(63) 76(37) 0	100	200.01
61	0 85(63) 77(37) 0	100	220.00
62	0 88(63) 80(37) 0	100	220.00
63	0 57(37) 81(63) 0	100	220.00
64	0 74(37) 82(63) 0	100	220.00
65	0 76(50) 84(50) 0	100	220.01
66	0 78(50) 86(50) 0	100	220.00

(cont.)

Table A.106 continued.

No.	Route	Load	Distance
67	0 71(50) 87(50) 0	100	220.00
68	0 83(13) 91(87) 0	100	240.00
69	0 84(13) 92(87) 0	100	240.01
70	0 86(13) 94(87) 0	100	239.99
71	0 87(13) 95(87) 0	100	240.00
72	0 72(13) 96(87) 0	100	240.01
		Total Distance	10130.57

Table A.107: EMIP-MDA+ERTR solution to MDA14 with $p = .2$.

No.	Route	Load	Distance
1	0 56(13) 68(87) 0	100	119.99
2	0 113(87) 77(13) 0	100	200.00
3	0 36(63) 48(37) 0	100	80.01
4	0 16(87) 0	87	40.00
5	0 89(87) 77(13) 0	100	160.00
6	0 8(13) 20(87) 0	100	40.00
7	0 8(50) 7(50) 0	100	25.18
8	0 73(13) 109(87) 0	100	200.00
9	0 104(13) 116(87) 0	100	200.00
10	0 21(87) 9(13) 0	100	40.00
11	0 3(13) 15(87) 0	100	40.00
12	0 1(63) 0	63	20.00
13	0 79(50) 103(50) 0	100	180.00
14	0 59(50) 35(50) 0	100	100.01
15	0 6(50) 5(50) 0	100	25.18
16	0 100(50) 88(50) 0	100	180.00
17	0 66(87) 54(13) 0	100	120.00
18	0 93(50) 81(50) 0	100	160.01
19	0 32(50) 56(50) 0	100	100.00
20	0 30(13) 42(87) 0	100	80.00
21	0 38(50) 26(50) 0	100	80.00
22	0 46(50) 58(50) 0	100	100.00
23	0 104(50) 92(50) 0	100	180.00
24	0 96(87) 84(13) 0	100	160.01
25	0 37(87) 25(13) 0	100	80.00
26	0 57(50) 33(50) 0	100	100.01
27	0 11(63) 12(37) 0	100	25.18
28	0 45(87) 33(13) 0	100	80.00
29	0 10(63) 9(37) 0	100	25.18
30	0 2(63) 3(37) 0	100	25.18
31	0 47(87) 35(13) 0	100	79.99
32	0 49(13) 61(87) 0	100	120.00
33	0 40(87) 28(13) 0	100	80.00

(cont.)

Table A.107 continued.

No.	Route	Load	Distance
34	0 6(13) 18(87) 0	100	40.00
35	0 73(13) 85(87) 0	100	160.00
36	0 31(63) 43(37) 0	100	80.00
37	0 7(13) 19(87) 0	100	40.00
38	0 32(13) 44(87) 0	100	80.00
39	0 55(50) 43(50) 0	100	100.00
40	0 110(87) 74(13) 0	100	200.00
41	0 13(87) 0	87	40.00
42	0 90(50) 102(50) 0	100	180.01
43	0 14(87) 3(13) 0	100	42.39
44	0 102(13) 114(87) 0	100	200.01
45	0 4(63) 0	63	20.00
46	0 63(87) 51(13) 0	100	120.00
47	0 62(87) 26(13) 0	100	120.00
48	0 112(87) 100(13) 0	100	200.00
49	0 5(13) 17(87) 0	100	40.00
50	0 55(13) 67(87) 0	100	120.00
51	0 46(37) 34(63) 0	100	80.00
52	0 69(87) 57(13) 0	100	120.01
53	0 101(63) 77(37) 0	100	180.01
54	0 106(13) 118(87) 0	100	200.00
55	0 60(13) 72(87) 0	100	120.01
56	0 50(63) 38(37) 0	100	100.00
57	0 39(87) 27(13) 0	100	80.00
58	0 52(13) 64(87) 0	100	120.00
59	0 49(50) 25(50) 0	100	100.00
60	0 80(63) 92(37) 0	100	160.00
61	0 53(13) 65(87) 0	100	120.00
62	0 107(13) 119(87) 0	100	200.00
63	0 71(87) 59(13) 0	100	120.00
64	0 98(63) 86(37) 0	100	180.00
65	0 86(50) 74(50) 0	100	160.00
66	0 87(37) 75(63) 0	100	160.00

(cont.)

Table A.107 continued.

No.	Route	Load	Distance
67	0 97(63) 73(37) 0	100	180.00
68	0 41(87) 29(13) 0	100	80.00
69	0 79(13) 91(87) 0	100	160.00
70	0 107(50) 95(50) 0	100	180.00
71	0 105(63) 93(37) 0	100	180.01
72	0 82(63) 94(37) 0	100	160.00
73	0 95(37) 83(63) 0	100	160.00
74	0 106(50) 94(50) 0	100	180.00
75	0 23(87) 12(13) 0	100	42.39
76	0 51(50) 27(50) 0	100	100.00
77	0 28(50) 52(50) 0	100	100.00
78	0 48(50) 60(50) 0	100	100.01
79	0 30(50) 54(50) 0	100	100.00
80	0 22(87) 9(13) 0	100	42.39
81	0 87(50) 99(50) 0	100	180.00
82	0 108(50) 84(50) 0	100	179.99
83	0 70(87) 58(13) 0	100	120.00
84	0 111(87) 99(13) 0	100	200.00
85	0 78(63) 90(37) 0	100	160.01
86	0 76(63) 88(37) 0	100	160.00
87	0 53(50) 29(50) 0	100	100.00
88	0 103(13) 115(87) 0	100	200.00
89	0 117(87) 81(13) 0	100	200.01
90	0 108(13) 120(87) 0	100	199.99
91	0 24(87) 12(13) 0	100	40.00
		Total Distance	10733.07

Table A.108: EMIP-MDA+ERTR solution to MDA15 with $p = .2$.

No.	Route	Load	Distance
1	0 92(87) 56(13) 0	100	160.00
2	0 64(50) 76(50) 0	100	140.00
3	0 17(87) 5(13) 0	100	40.00
4	0 127(63) 115(37) 0	100	220.00
5	0 135(87) 123(13) 0	100	239.99
6	0 76(13) 88(87) 0	100	160.00
7	0 2(26) 1(63) 0	89	25.18
8	0 27(13) 39(87) 0	100	80.00
9	0 33(13) 45(87) 0	100	80.00
10	0 63(50) 75(50) 0	100	140.00
11	0 114(37) 102(63) 0	100	200.01
12	0 31(50) 19(50) 0	100	60.00
13	0 122(63) 98(37) 0	100	220.00
14	0 81(50) 69(50) 0	100	140.01
15	0 62(37) 74(50) 50(13) 0	100	140.00
16	0 9(50) 8(50) 0	100	25.18
17	0 24(87) 0	87	40.00
18	0 15(87) 0	87	40.00
19	0 31(13) 91(87) 0	100	160.00
20	0 137(87) 125(13) 0	100	240.00
21	0 50(50) 62(50) 0	100	120.00
22	0 29(50) 30(50) 0	100	75.53
23	0 109(50) 121(50) 0	100	220.00
24	0 12(63) 2(37) 0	100	30.00
25	0 111(87) 99(13) 0	100	200.00
26	0 42(87) 30(13) 0	100	80.00
27	0 98(13) 110(87) 0	100	200.00
28	0 11(13) 46(87) 0	100	81.74
29	0 130(13) 142(87) 0	100	240.00
30	0 94(87) 82(13) 0	100	160.00
31	0 123(50) 99(50) 0	100	220.00
32	0 98(13) 134(87) 0	100	239.99
33	0 35(13) 48(87) 0	100	90.53

(cont.)

Table A.108 continued.

No.	Route	Load	Distance
34	0 18(87) 6(13) 0	100	40.00
35	0 85(87) 73(13) 0	100	160.00
36	0 125(37) 101(63) 0	100	220.00
37	0 35(13) 47(87) 0	100	79.99
38	0 26(50) 27(50) 0	100	75.53
39	0 136(87) 124(13) 0	100	240.00
40	0 49(13) 73(50) 61(37) 0	100	140.00
41	0 117(50) 129(50) 0	100	220.01
42	0 114(50) 126(50) 0	100	220.01
43	0 132(13) 144(87) 0	100	240.00
44	0 25(13) 37(87) 0	100	80.00
45	0 13(50) 25(50) 0	100	60.00
46	0 78(50) 66(50) 0	100	140.00
47	0 38(87) 26(13) 0	100	80.00
48	0 87(87) 75(13) 0	100	160.00
49	0 103(13) 139(87) 0	100	240.00
50	0 52(26) 64(37) 52(37) 0	100	120.00
51	0 5(50) 6(50) 0	100	25.18
52	0 49(50) 61(50) 0	100	120.00
53	0 44(87) 32(13) 0	100	80.00
54	0 43(37) 55(63) 0	100	100.00
55	0 103(50) 115(50) 0	100	200.00
56	0 86(87) 74(13) 0	100	160.00
57	0 119(50) 107(50) 0	100	200.00
58	0 104(13) 116(87) 0	100	200.00
59	0 96(87) 84(13) 0	100	160.01
60	0 120(37) 108(63) 0	100	199.99
61	0 8(13) 20(87) 0	100	40.00
62	0 112(37) 100(63) 0	100	200.00
63	0 104(13) 140(87) 0	100	240.00
64	0 53(50) 65(50) 0	100	120.00
65	0 16(87) 0	87	40.00
66	0 130(50) 118(50) 0	100	220.00

(cont.)

Table A.108 continued.

No.	Route	Load	Distance
67	0 143(87) 107(13) 0	100	239.99
68	0 89(87) 53(13) 0	100	160.00
69	0 57(63) 69(37) 0	100	120.01
70	0 10(63) 11(37) 0	100	25.18
71	0 32(50) 33(50) 0	100	75.53
72	0 13(37) 36(63) 0	100	66.15
73	0 80(63) 68(37) 0	100	140.00
74	0 117(37) 105(63) 0	100	200.01
75	0 23(87) 11(13) 0	100	40.00
76	0 59(63) 71(37) 0	100	120.00
77	0 9(13) 21(87) 0	100	40.00
78	0 7(63) 19(37) 0	100	40.00
79	0 81(13) 93(87) 0	100	160.01
80	0 68(50) 56(50) 0	100	119.99
81	0 67(37) 79(63) 0	100	140.00
82	0 119(37) 131(63) 0	100	220.00
83	0 60(63) 72(37) 0	100	120.01
84	0 97(63) 109(37) 0	100	200.00
85	0 132(50) 120(50) 0	100	220.00
86	0 3(63) 4(26) 0	89	25.18
87	0 34(63) 35(37) 0	100	75.53
88	0 77(63) 65(37) 0	100	140.00
89	0 118(37) 106(63) 0	100	200.00
90	0 40(87) 0	87	80.00
91	0 22(87) 0	87	40.00
92	0 70(50) 82(50) 0	100	140.00
93	0 84(50) 72(50) 0	100	140.01
94	0 41(87) 29(13) 0	100	80.00
95	0 112(50) 124(50) 0	100	220.00
96	0 129(13) 141(87) 0	100	240.00
97	0 58(63) 70(37) 0	100	120.00
98	0 126(13) 138(87) 0	100	240.00
99	0 90(87) 78(13) 0	100	160.01

(cont.)

Table A.108 continued.

No.	Route	Load	Distance
100	0 104(37) 128(63) 0	100	220.00
101	0 71(50) 83(50) 0	100	140.00
102	0 95(87) 83(13) 0	100	160.00
103	0 121(13) 133(87) 0	100	240.00
104	0 28(63) 4(37) 0	100	60.00
105	0 113(87) 125(13) 0	100	220.00
106	0 43(50) 67(50) 0	100	120.00
107	0 51(63) 63(37) 0	100	120.00
108	0 14(87) 0	87	40.00
109	0 66(37) 54(63) 0	100	120.00
		Total Distance	15116.39

Table A.109: EMIP-MDA+ERTR solution to MDA16 with $p = .2$.

No.	Route	Load	Distance
1	0 1(26) 72(63) 0	89	20.87
2	0 2(63) 1(37) 0	100	20.87
3	0 3(63) 4(37) 0	100	20.87
4	0 5(63) 4(26) 0	89	20.87
5	0 6(63) 7(26) 0	89	20.87
6	0 7(37) 8(63) 0	100	20.88
7	0 9(63) 10(37) 0	100	20.87
8	0 10(26) 11(63) 0	89	20.87
9	0 13(26) 14(63) 0	89	20.87
10	0 13(37) 12(63) 0	100	20.88
11	0 16(26) 15(63) 0	89	20.87
12	0 16(37) 17(63) 0	100	20.87
13	0 18(63) 19(37) 0	100	20.87
14	0 19(26) 20(63) 0	89	20.87
15	0 21(63) 22(26) 0	89	20.87
16	0 23(63) 22(37) 0	100	20.87
17	0 25(37) 26(63) 0	100	20.88
18	0 25(26) 24(63) 0	89	20.87
19	0 28(37) 27(63) 0	100	20.87
20	0 28(26) 29(63) 0	89	20.87
21	0 30(63) 31(26) 0	89	20.88
22	0 32(63) 31(37) 0	100	20.87
23	0 34(37) 33(63) 0	100	20.87
24	0 34(26) 35(63) 0	89	20.87
25	0 36(63) 37(26) 0	89	20.87
26	0 38(63) 37(37) 0	100	20.87
27	0 44(63) 43(26) 0	89	20.86
28	0 41(37) 40(63) 0	100	20.87
29	0 41(26) 39(63) 0	89	21.74
30	0 43(37) 42(63) 0	100	20.87
31	0 45(63) 46(37) 0	100	20.87
32	0 46(26) 47(63) 0	89	20.87
33	0 49(26) 48(63) 0	89	20.88

(cont.)

Table A.109 continued.

No.	Route	Load	Distance
34	0 50(63) 49(37) 0	100	20.87
35	0 52(26) 51(63) 0	89	20.87
36	0 52(37) 53(63) 0	100	20.87
37	0 55(26) 54(63) 0	89	20.87
38	0 56(63) 55(37) 0	100	20.87
39	0 57(63) 58(37) 0	100	20.87
40	0 58(26) 59(63) 0	89	20.87
41	0 60(63) 61(26) 0	89	20.87
42	0 62(63) 61(37) 0	100	20.86
43	0 64(37) 63(63) 0	100	20.87
44	0 65(63) 64(26) 0	89	20.87
45	0 67(26) 66(63) 0	89	20.88
46	0 68(63) 67(37) 0	100	20.87
47	0 71(63) 70(26) 0	89	20.87
48	0 70(37) 69(63) 0	100	20.87
49	0 73(87) 0	87	40.00
50	0 74(87) 0	87	39.99
51	0 75(87) 0	87	40.01
52	0 76(87) 0	87	40.00
53	0 77(87) 0	87	39.99
54	0 78(87) 0	87	40.00
55	0 79(87) 0	87	40.00
56	0 80(87) 0	87	39.99
57	0 81(87) 0	87	40.00
58	0 82(87) 0	87	39.99
59	0 83(87) 0	87	40.00
60	0 84(87) 0	87	39.99
61	0 85(87) 0	87	40.00
62	0 86(87) 0	87	40.00
63	0 87(87) 0	87	39.99
64	0 88(87) 0	87	40.00
65	0 89(87) 0	87	40.01
66	0 90(87) 0	87	39.99

(cont.)

Table A.109 continued.

No.	Route	Load	Distance
67	0 91(87) 0	87	40.00
68	0 92(87) 0	87	39.99
69	0 93(87) 0	87	40.01
70	0 94(87) 0	87	40.00
71	0 95(87) 0	87	39.99
72	0 96(87) 0	87	40.00
73	0 97(87) 0	87	40.00
74	0 98(87) 0	87	39.99
75	0 99(87) 0	87	39.99
76	0 100(87) 0	87	39.99
77	0 101(87) 0	87	40.00
78	0 102(87) 0	87	39.99
79	0 103(87) 0	87	40.00
80	0 104(87) 0	87	40.00
81	0 105(87) 0	87	39.99
82	0 106(87) 0	87	40.00
83	0 107(87) 0	87	40.01
84	0 108(87) 0	87	39.99
85	0 109(87) 0	87	40.00
86	0 110(87) 0	87	39.99
87	0 111(87) 0	87	40.01
88	0 112(87) 0	87	40.00
89	0 113(87) 0	87	39.99
90	0 114(87) 0	87	40.00
91	0 115(87) 0	87	40.00
92	0 116(87) 0	87	39.99
93	0 117(87) 0	87	39.99
94	0 118(87) 0	87	39.99
95	0 119(87) 0	87	40.00
96	0 120(87) 0	87	39.99
97	0 121(61) 122(39) 0	100	41.75
98	0 122(48) 123(52) 0	100	41.74
99	0 121(26) 124(56) 125(18) 0	100	46.96

(cont.)

Table A.109 continued.

No.	Route	Load	Distance
100	0 125(69) 124(31) 0	100	41.75
101	0 123(35) 126(61) 0	96	45.21
102	0 128(69) 127(31) 0	100	41.74
103	0 126(26) 127(56) 128(18) 0	100	43.49
104	0 129(87) 0	87	40.01
105	0 130(87) 0	87	40.00
106	0 131(87) 0	87	39.99
107	0 132(87) 0	87	40.00
108	0 133(87) 0	87	40.00
109	0 134(87) 0	87	39.99
110	0 135(87) 0	87	39.99
111	0 136(87) 0	87	39.99
112	0 137(87) 0	87	40.00
113	0 138(87) 0	87	39.99
114	0 139(87) 0	87	40.00
115	0 140(87) 0	87	40.00
116	0 141(87) 0	87	39.99
117	0 142(87) 0	87	40.00
118	0 143(87) 0	87	40.01
119	0 144(87) 0	87	39.99
		Total Distance	3865.24

Table A.110: EMIP-MDA+ERTR solution to MDA17 with $p = .2$.

No.	Route	Load	Distance
1	0 1(13) 9(87) 0	100	40.00
2	0 47(50) 55(50) 0	100	140.00
3	0 75(37) 67(63) 0	100	200.00
4	0 85(63) 77(37) 0	100	220.00
5	0 3(13) 27(87) 0	100	80.00
6	0 72(50) 80(50) 0	100	200.00
7	0 95(87) 87(13) 0	100	240.00
8	0 37(13) 45(87) 0	100	120.00
9	0 48(50) 40(50) 0	100	120.00
10	0 47(37) 39(63) 0	100	120.00
11	0 96(87) 72(13) 0	100	240.01
12	0 18(13) 26(87) 0	100	79.99
13	0 12(37) 20(63) 0	100	59.99
14	0 33(50) 49(50) 0	100	140.00
15	0 68(50) 76(50) 0	100	200.01
16	0 32(50) 23(50) 0	100	98.33
17	0 93(37) 117(63) 0	100	300.00
18	0 28(87) 4(13) 0	100	80.00
19	0 84(63) 76(37) 0	100	220.01
20	0 37(50) 53(50) 0	100	140.00
21	0 30(87) 22(13) 0	100	80.00
22	0 7(50) 6(50) 0	100	27.65
23	0 23(13) 31(87) 0	100	80.00
24	0 22(50) 21(50) 0	100	82.96
25	0 11(37) 19(63) 0	100	60.00
26	0 133(63) 141(37) 0	100	360.00
27	0 33(13) 41(87) 0	100	120.00
28	0 43(37) 51(63) 0	100	140.00
29	0 144(87) 136(13) 0	100	360.00
30	0 73(37) 65(63) 0	100	200.00
31	0 15(87) 7(13) 0	100	40.00
32	0 13(87) 0	87	40.00
33	0 52(50) 44(50) 0	100	139.99

(cont.)

Table A.110 continued.

No.	Route	Load	Distance
34	0 2(63) 0	63	20.00
35	0 98(50) 106(50) 0	100	280.00
36	0 55(13) 63(87) 0	100	160.00
37	0 35(50) 43(50) 0	100	120.00
38	0 114(63) 106(37) 0	100	300.00
39	0 25(87) 17(13) 0	100	80.00
40	0 125(87) 53(13) 0	100	320.00
41	0 10(87) 0	87	39.99
42	0 66(13) 74(87) 0	100	200.00
43	0 44(37) 36(63) 0	100	120.00
44	0 78(37) 70(63) 0	100	200.00
45	0 38(13) 62(87) 0	100	160.00
46	0 81(50) 73(50) 0	100	220.00
47	0 58(18) 66(19) 82(63) 0	100	220.00
48	0 124(87) 100(13) 0	100	319.99
49	0 68(13) 92(87) 0	100	240.01
50	0 35(13) 59(87) 0	100	160.00
51	0 3(50) 11(50) 0	100	40.00
52	0 152(50) 136(50) 0	100	380.00
53	0 50(13) 90(87) 0	100	239.99
54	0 101(50) 93(50) 0	100	260.00
55	0 5(63) 0	63	20.00
56	0 46(37) 54(63) 0	100	139.99
57	0 52(13) 60(87) 0	100	159.99
58	0 149(13) 157(87) 0	100	400.00
59	0 38(50) 46(50) 0	100	120.00
60	0 8(13) 16(87) 0	100	39.99
61	0 75(50) 83(50) 0	100	220.00
62	0 71(50) 87(50) 0	100	220.00
63	0 104(13) 128(87) 0	100	320.01
64	0 101(13) 109(87) 0	100	280.00
65	0 81(13) 89(87) 0	100	240.00
66	0 146(13) 154(87) 0	100	400.00

(cont.)

Table A.110 continued.

No.	Route	Load	Distance
67	0 99(13) 107(87) 0	100	280.00
68	0 71(13) 79(87) 0	100	200.00
69	0 42(50) 50(50) 0	100	140.01
70	0 118(63) 110(37) 0	100	300.00
71	0 80(37) 88(63) 0	100	220.00
72	0 98(13) 122(87) 0	100	319.99
73	0 105(68) 97(32) 0	100	280.00
74	0 1(50) 8(50) 0	100	27.65
75	0 83(13) 91(87) 0	100	240.00
76	0 100(50) 108(50) 0	100	280.00
77	0 94(50) 78(50) 0	100	239.99
78	0 111(37) 103(63) 0	100	280.00
79	0 57(87) 49(13) 0	100	160.00
80	0 14(87) 6(13) 0	100	39.99
81	0 150(50) 134(50) 0	100	380.00
82	0 143(50) 151(50) 0	100	380.00
83	0 120(63) 112(37) 0	100	300.00
84	0 105(19) 113(63) 97(18) 0	100	300.00
85	0 32(37) 24(63) 0	100	80.00
86	0 115(13) 123(87) 0	100	320.00
87	0 140(37) 132(63) 0	100	360.00
88	0 141(50) 149(50) 0	100	380.00
89	0 42(37) 34(63) 0	100	120.01
90	0 159(87) 151(13) 0	100	400.00
91	0 18(50) 17(50) 0	100	82.95
92	0 121(87) 97(13) 0	100	320.00
93	0 58(69) 66(31) 0	100	180.00
94	0 139(50) 155(50) 0	100	400.00
95	0 94(37) 86(63) 0	100	239.99
96	0 12(50) 4(50) 0	100	39.99
97	0 126(87) 102(13) 0	100	319.99
98	0 137(50) 145(50) 0	100	380.00
99	0 130(32) 138(18) 146(50) 0	100	380.00

(cont.)

Table A.110 continued.

No.	Route	Load	Distance
100	0 99(50) 115(50) 0	100	300.00
101	0 108(37) 116(63) 0	100	300.00
102	0 61(37) 69(63) 0	100	180.00
103	0 142(87) 134(13) 0	100	359.99
104	0 143(37) 135(63) 0	100	360.00
105	0 152(13) 160(87) 0	100	400.00
106	0 129(63) 137(37) 0	100	360.00
107	0 130(31) 138(69) 0	100	360.00
108	0 131(63) 139(37) 0	100	360.00
109	0 140(50) 148(18) 156(32) 0	100	400.00
110	0 61(50) 77(50) 0	100	200.00
111	0 111(50) 119(50) 0	100	300.00
112	0 145(13) 153(87) 0	100	400.00
113	0 155(37) 147(63) 0	100	400.00
114	0 156(55) 148(45) 0	100	400.00
115	0 64(87) 40(13) 0	100	160.00
116	0 110(50) 102(50) 0	100	280.00
117	0 112(50) 104(50) 0	100	280.00
118	0 56(63) 48(37) 0	100	140.01
119	0 150(13) 158(87) 0	100	400.00
120	0 119(13) 127(87) 0	100	320.00
121	0 21(13) 29(87) 0	100	80.00
		Total Distance	26519.45

Table A.111: EMIP-MDA+ERTR solution to MDA18 with $p = .2$.

No.	Route	Load	Distance
1	0 59(87) 0	87	80.00
2	0 79(13) 95(87) 0	100	120.00
3	0 139(13) 155(87) 0	100	200.00
4	0 137(13) 153(87) 0	100	200.00
5	0 30(37) 46(63) 0	100	60.01
6	0 17(87) 0	87	40.00
7	0 80(13) 96(87) 0	100	120.00
8	0 27(50) 76(50) 0	100	102.43
9	0 5(13) 21(87) 0	100	40.00
10	0 65(50) 50(50) 0	100	110.12
11	0 144(63) 160(37) 0	100	199.99
12	0 27(37) 43(63) 0	100	60.01
13	0 12(13) 28(87) 0	100	40.01
14	0 97(50) 113(50) 0	100	160.00
15	0 137(50) 105(50) 0	100	180.00
16	0 140(50) 124(50) 0	100	179.99
17	0 4(37) 7(63) 0	100	31.11
18	0 16(13) 31(87) 0	100	41.41
19	0 58(50) 57(50) 0	100	95.60
20	0 2(26) 34(63) 0	89	60.01
21	0 16(13) 32(87) 0	100	40.01
22	0 135(50) 103(50) 0	100	180.00
23	0 107(50) 91(50) 0	100	139.99
24	0 72(13) 88(87) 0	100	120.00
25	0 141(50) 142(50) 0	100	215.11
26	0 12(37) 44(63) 0	100	59.99
27	0 30(50) 47(50) 0	100	63.84
28	0 72(50) 40(50) 0	100	100.00
29	0 84(87) 0	87	119.99
30	0 103(13) 119(87) 0	100	159.99
31	0 143(50) 111(50) 0	100	180.00
32	0 6(50) 5(50) 0	100	23.91
33	0 26(87) 0	87	40.00

(cont.)

Table A.111 continued.

No.	Route	Load	Distance
34	0 71(13) 87(87) 0	100	120.00
35	0 50(37) 66(63) 0	100	99.99
36	0 10(63) 0	63	20.00
37	0 16(37) 15(63) 0	100	23.90
38	0 48(13) 64(87) 0	100	79.99
39	0 94(50) 110(50) 0	100	140.01
40	0 62(87) 0	87	80.00
41	0 142(13) 158(87) 0	100	199.99
42	0 109(63) 77(37) 0	100	140.00
43	0 111(13) 127(87) 0	100	160.00
44	0 13(31) 14(63) 0	94	23.91
45	0 19(37) 35(63) 0	100	59.99
46	0 11(63) 0	63	20.00
47	0 19(50) 20(50) 0	100	47.81
48	0 146(87) 0	87	200.01
49	0 143(13) 159(87) 0	100	200.00
50	0 79(50) 80(50) 0	100	119.51
51	0 132(50) 100(50) 0	100	180.00
52	0 29(87) 0	87	40.00
53	0 97(13) 113(37) 129(50) 0	100	180.00
54	0 53(50) 69(50) 0	100	100.00
55	0 138(50) 139(50) 0	100	215.11
56	0 120(63) 104(37) 0	100	160.00
57	0 129(13) 145(87) 0	100	200.00
58	0 48(50) 33(50) 0	100	71.71
59	0 94(37) 78(63) 0	100	120.00
60	0 53(37) 37(63) 0	100	80.00
61	0 20(37) 36(63) 0	100	60.01
62	0 82(37) 98(63) 0	100	140.00
63	0 77(13) 125(87) 0	100	160.00
64	0 100(13) 116(87) 0	100	160.00
65	0 150(50) 118(50) 0	100	200.00
66	0 4(26) 3(63) 0	89	23.90

(cont.)

Table A.111 continued.

No.	Route	Load	Distance
67	0 136(13) 152(87) 0	100	199.99
68	0 65(13) 81(87) 0	100	120.00
69	0 51(37) 67(63) 0	100	100.00
70	0 135(13) 151(87) 0	100	200.01
71	0 131(50) 99(50) 0	100	180.00
72	0 57(37) 73(63) 0	100	100.00
73	0 18(87) 0	87	40.00
74	0 138(13) 154(87) 0	100	200.00
75	0 8(13) 89(87) 0	100	120.91
76	0 118(37) 102(63) 0	100	160.00
77	0 83(87) 0	87	120.01
78	0 8(13) 24(87) 0	100	40.01
79	0 22(87) 0	87	40.00
80	0 74(13) 122(87) 0	100	160.00
81	0 33(13) 49(87) 0	100	80.00
82	0 124(37) 108(63) 0	100	160.00
83	0 101(13) 149(87) 0	100	200.00
84	0 6(13) 54(87) 0	100	80.01
85	0 133(63) 117(37) 0	100	180.00
86	0 55(50) 71(50) 0	100	100.00
87	0 130(63) 114(37) 0	100	180.00
88	0 136(50) 120(24) 104(26) 0	100	180.01
89	0 131(13) 147(87) 0	100	200.00
90	0 25(87) 0	87	40.00
91	0 47(13) 63(87) 0	100	80.00
92	0 75(63) 91(37) 0	100	120.00
93	0 74(31) 90(69) 0	100	120.01
94	0 40(13) 56(87) 0	100	79.99
95	0 110(13) 126(87) 0	100	159.99
96	0 140(13) 156(87) 0	100	199.99
97	0 114(50) 82(50) 0	100	160.00
98	0 128(50) 160(50) 0	100	199.99
99	0 12(13) 60(87) 0	100	79.99

(cont.)

Table A.111 continued.

No.	Route	Load	Distance
100	0 61(87) 0	87	80.00
101	0 93(87) 77(13) 0	100	120.00
102	0 51(32) 52(68) 0	100	95.59
103	0 99(13) 115(87) 0	100	160.00
104	0 69(13) 85(87) 0	100	120.00
105	0 23(50) 39(50) 0	100	59.99
106	0 8(37) 41(63) 0	100	61.11
107	0 92(87) 76(13) 0	100	120.00
108	0 13(32) 45(63) 0	95	60.00
109	0 101(50) 117(50) 0	100	160.00
110	0 105(13) 121(87) 0	100	160.00
111	0 106(63) 90(18) 74(19) 0	100	139.99
112	0 39(13) 86(87) 0	100	124.26
113	0 2(37) 1(63) 0	100	23.91
114	0 150(37) 134(63) 0	100	200.00
115	0 107(13) 123(87) 0	100	160.00
116	0 132(13) 148(87) 0	100	200.01
117	0 23(37) 38(63) 0	100	63.84
118	0 42(63) 58(37) 0	100	80.00
119	0 9(63) 0	63	20.00
120	0 141(13) 157(87) 0	100	200.00
121	0 51(18) 68(63) 52(19) 0	100	110.10
122	0 55(37) 70(63) 0	100	110.12
123	0 112(63) 128(37) 0	100	160.01
		Total Distance	14559.20

Table A.112: EMIP-MDA+ERTR solution to MDA19 with $p = .2$.

No.	Route	Load	Distance
1	0 104(13) 120(87) 0	100	160.00
2	0 76(50) 92(50) 0	100	120.00
3	0 82(37) 66(63) 0	100	119.99
4	0 34(63) 17(37) 0	100	63.84
5	0 23(50) 9(50) 0	100	44.73
6	0 39(63) 23(37) 0	100	59.99
7	0 117(87) 69(13) 0	100	160.00
8	0 29(87) 13(13) 0	100	40.00
9	0 12(13) 28(87) 0	100	40.01
10	0 42(13) 58(87) 0	100	80.00
11	0 187(87) 171(13) 0	100	239.99
12	0 96(37) 112(63) 0	100	140.01
13	0 168(63) 136(37) 0	100	219.99
14	0 144(13) 192(87) 0	100	240.00
15	0 125(87) 0	87	160.00
16	0 151(37) 135(63) 0	100	200.01
17	0 88(37) 72(63) 0	100	120.00
18	0 4(50) 5(50) 0	100	23.91
19	0 84(87) 68(13) 0	100	119.99
20	0 55(87) 38(13) 0	100	86.81
21	0 98(13) 114(87) 0	100	160.00
22	0 81(50) 97(50) 0	100	140.00
23	0 52(37) 36(63) 0	100	79.99
24	0 49(87) 33(13) 0	100	80.00
25	0 61(69) 45(31) 0	100	80.00
26	0 77(43) 93(55) 0	98	120.00
27	0 136(13) 184(87) 0	100	240.00
28	0 18(87) 0	87	40.00
29	0 5(13) 21(87) 0	100	40.00
30	0 169(13) 185(87) 0	100	240.00
31	0 93(32) 109(63) 0	95	140.00
32	0 162(13) 178(87) 0	100	240.01
33	0 140(63) 156(37) 0	100	199.99

(cont.)

Table A.112 continued.

No.	Route	Load	Distance
34	0 83(87) 35(13) 0	100	120.01
35	0 87(37) 103(63) 0	100	139.99
36	0 27(87) 0	87	39.99
37	0 76(13) 124(87) 0	100	160.00
38	0 15(13) 31(87) 0	100	39.99
39	0 70(63) 54(37) 0	100	100.01
40	0 91(37) 107(63) 0	100	139.99
41	0 80(63) 64(37) 0	100	100.00
42	0 67(63) 35(37) 0	100	100.00
43	0 130(13) 146(87) 0	100	200.01
44	0 10(63) 11(37) 0	100	23.90
45	0 134(63) 150(37) 0	100	200.00
46	0 26(87) 0	87	40.00
47	0 30(87) 0	87	40.00
48	0 8(63) 6(37) 0	100	27.66
49	0 118(87) 0	87	160.00
50	0 149(87) 133(13) 0	100	200.00
51	0 47(63) 15(37) 0	100	60.01
52	0 137(26) 153(24) 169(50) 0	100	220.00
53	0 127(87) 15(13) 0	100	160.00
54	0 98(50) 82(50) 0	100	140.00
55	0 166(13) 182(87) 0	100	240.01
56	0 6(26) 7(63) 0	89	23.90
57	0 96(50) 95(50) 0	100	143.41
58	0 139(13) 155(87) 0	100	200.00
59	0 38(50) 53(50) 0	100	86.81
60	0 90(50) 74(50) 0	100	120.01
61	0 136(13) 152(87) 0	100	199.99
62	0 157(87) 141(13) 0	100	200.00
63	0 137(37) 153(63) 0	100	200.00
64	0 108(63) 92(37) 0	100	140.01
65	0 86(37) 102(63) 0	100	139.99
66	0 44(13) 60(87) 0	100	79.99

(cont.)

Table A.112 continued.

No.	Route	Load	Distance
67	0 53(37) 37(63) 0	100	80.00
68	0 100(13) 116(87) 0	100	160.00
69	0 25(87) 9(13) 0	100	40.00
70	0 160(87) 0	87	199.99
71	0 71(13) 119(87) 0	100	159.99
72	0 138(50) 154(50) 0	100	200.00
73	0 63(50) 64(50) 0	100	95.61
74	0 42(50) 43(50) 0	100	71.71
75	0 183(87) 167(13) 0	100	240.01
76	0 71(50) 87(50) 0	100	120.00
77	0 99(13) 115(87) 0	100	160.00
78	0 75(50) 91(50) 0	100	120.00
79	0 161(50) 129(50) 0	100	220.00
80	0 126(87) 46(13) 0	100	159.99
81	0 43(13) 59(87) 0	100	80.00
82	0 65(63) 81(37) 0	100	120.00
83	0 12(50) 13(50) 0	100	23.91
84	0 88(50) 104(50) 0	100	140.00
85	0 50(87) 2(13) 0	100	80.01
86	0 179(50) 147(50) 0	100	239.99
87	0 165(13) 181(87) 0	100	240.00
88	0 94(87) 0	87	120.00
89	0 46(50) 78(26) 77(20) 0	96	119.52
90	0 44(50) 61(18) 45(32) 0	100	86.80
91	0 159(37) 175(63) 0	100	220.00
92	0 142(63) 158(37) 0	100	199.99
93	0 75(13) 123(87) 0	100	160.00
94	0 186(87) 138(13) 0	100	240.00
95	0 41(50) 40(50) 0	100	71.71
96	0 141(50) 173(50) 0	100	220.00
97	0 69(50) 85(50) 0	100	120.00
98	0 1(63) 16(36) 0	99	23.91
99	0 128(37) 176(63) 0	100	220.00

(cont.)

Table A.112 continued.

No.	Route	Load	Distance
100	0 179(37) 163(63) 0	100	239.99
101	0 132(63) 148(37) 0	100	200.01
102	0 170(63) 154(37) 0	100	219.99
103	0 143(13) 191(87) 0	100	240.01
104	0 144(50) 128(50) 0	100	180.00
105	0 17(50) 33(50) 0	100	60.00
106	0 20(87) 4(13) 0	100	40.00
107	0 68(50) 52(50) 0	100	100.00
108	0 24(87) 0	87	40.01
109	0 14(63) 11(26) 0	89	31.11
110	0 143(50) 159(50) 0	100	200.00
111	0 99(50) 100(50) 0	100	167.31
112	0 79(63) 63(37) 0	100	100.00
113	0 54(50) 86(50) 0	100	119.99
114	0 3(50) 2(50) 0	100	23.90
115	0 151(50) 167(50) 0	100	220.01
116	0 95(37) 111(63) 0	100	140.01
117	0 89(50) 105(50) 0	100	140.00
118	0 73(63) 89(37) 0	100	120.00
119	0 78(37) 110(63) 0	100	140.01
120	0 121(87) 105(13) 0	100	160.00
121	0 173(13) 189(87) 0	100	240.00
122	0 74(13) 122(87) 0	100	160.00
123	0 40(13) 56(87) 0	100	79.99
124	0 48(63) 16(27) 0	90	60.00
125	0 147(37) 131(63) 0	100	200.00
126	0 106(63) 90(37) 0	100	139.99
127	0 129(13) 145(87) 0	100	200.00
128	0 164(13) 180(87) 0	100	240.00
129	0 19(87) 3(13) 0	100	39.99
130	0 101(63) 85(37) 0	100	140.00
131	0 139(50) 171(50) 0	100	220.00
132	0 164(50) 148(50) 0	100	220.01

(cont.)

Table A.112 continued.

No.	Route	Load	Distance
133	0 158(50) 174(50) 0	100	219.99
134	0 156(50) 172(50) 0	100	220.00
135	0 190(87) 174(13) 0	100	240.00
136	0 97(13) 113(87) 0	100	160.00
137	0 62(87) 0	87	80.00
138	0 130(50) 162(50) 0	100	220.00
139	0 32(87) 0	87	40.01
140	0 22(87) 0	87	40.00
141	0 41(13) 57(87) 0	100	80.00
142	0 133(50) 165(50) 0	100	220.00
143	0 172(13) 188(87) 0	100	240.00
144	0 166(50) 150(50) 0	100	220.00
145	0 161(13) 177(87) 0	100	240.00
146	0 35(13) 51(87) 0	100	79.99
		Total Distance	20300.41

Table A.113: EMIP-MDA+ERTR solution to MDA20 with $p = .2$.

No.	Route	Load	Distance
1	0 101(50) 113(50) 0	100	200.00
2	0 173(13) 209(87) 0	100	360.00
3	0 140(87) 128(13) 0	100	240.00
4	0 95(37) 83(63) 0	100	160.00
5	0 18(87) 0	87	40.00
6	0 198(63) 210(37) 0	100	360.00
7	0 115(87) 103(13) 0	100	200.00
8	0 97(13) 109(87) 0	100	200.00
9	0 88(87) 76(13) 0	100	160.00
10	0 157(37) 145(63) 0	100	280.00
11	0 186(87) 174(13) 0	100	320.00
12	0 207(87) 195(13) 0	100	359.99
13	0 197(63) 185(37) 0	100	340.00
14	0 72(37) 60(63) 0	100	120.01
15	0 135(37) 147(63) 0	100	259.99
16	0 76(50) 52(50) 0	100	140.00
17	0 204(50) 240(50) 0	100	400.00
18	0 132(50) 108(50) 0	100	220.00
19	0 185(50) 221(50) 0	100	380.00
20	0 112(87) 100(13) 0	100	200.00
21	0 42(87) 30(13) 0	100	80.00
22	0 135(50) 159(50) 0	100	279.99
23	0 81(50) 69(50) 0	100	140.01
24	0 74(63) 87(32) 0	95	190.00
25	0 70(37) 58(63) 0	100	120.00
26	0 43(37) 31(63) 0	100	80.00
27	0 32(63) 21(37) 0	100	66.15
28	0 7(50) 8(50) 0	100	25.18
29	0 33(13) 45(87) 0	100	80.00
30	0 122(13) 134(87) 0	100	239.99
31	0 13(18) 50(63) 27(18) 0	99	112.49
32	0 159(37) 171(63) 0	100	299.99
33	0 121(50) 97(50) 0	100	220.00

(cont.)

Table A.113 continued.

No.	Route	Load	Distance
34	0 55(37) 43(50) 0	87	100.00
35	0 24(56) 36(44) 0	100	60.00
36	0 63(87) 51(13) 0	100	120.00
37	0 148(50) 172(50) 0	100	300.00
38	0 15(37) 4(63) 0	100	42.39
39	0 80(13) 92(87) 0	100	160.00
40	0 191(50) 167(50) 0	100	320.01
41	0 53(32) 77(50) 65(18) 0	100	140.00
42	0 210(50) 222(50) 0	100	380.00
43	0 90(87) 54(13) 0	100	160.01
44	0 110(87) 98(13) 0	100	200.00
45	0 226(13) 238(87) 0	100	400.00
46	0 157(50) 169(50) 0	100	300.00
47	0 202(63) 214(37) 0	100	360.00
48	0 21(50) 33(50) 0	100	60.00
49	0 195(50) 219(50) 0	100	380.00
50	0 61(87) 0	87	120.00
51	0 24(31) 23(69) 0	100	50.35
52	0 68(50) 80(50) 0	100	140.00
53	0 87(55) 99(44) 0	99	180.00
54	0 213(37) 225(63) 0	100	379.99
55	0 222(13) 234(87) 0	100	400.00
56	0 162(50) 174(50) 0	100	300.00
57	0 16(87) 0	87	40.00
58	0 98(50) 122(50) 0	100	220.00
59	0 28(50) 15(50) 0	100	66.15
60	0 64(87) 52(13) 0	100	120.00
61	0 73(13) 85(87) 0	100	160.00
62	0 166(50) 178(50) 0	100	300.00
63	0 67(87) 0	87	120.00
64	0 38(87) 0	87	80.00
65	0 219(13) 231(87) 0	100	400.00
66	0 56(63) 68(37) 0	100	119.99

(cont.)

Table A.113 continued.

No.	Route	Load	Distance
67	0 114(50) 126(50) 0	100	220.01
68	0 200(50) 224(50) 0	100	380.01
69	0 12(26) 1(63) 0	89	25.18
70	0 168(50) 192(50) 0	100	320.00
71	0 71(37) 59(63) 0	100	120.00
72	0 72(50) 84(50) 0	100	140.01
73	0 169(13) 205(87) 0	100	360.00
74	0 96(87) 84(13) 0	100	160.01
75	0 34(50) 22(50) 0	100	60.00
76	0 221(13) 233(87) 0	100	400.00
77	0 119(50) 143(50) 0	100	239.99
78	0 228(63) 240(37) 0	100	400.00
79	0 173(50) 149(19) 137(31) 0	100	300.00
80	0 206(50) 218(50) 0	100	380.01
81	0 48(56) 49(44) 0	100	115.23
82	0 14(87) 0	87	40.00
83	0 176(13) 188(87) 0	100	320.00
84	0 220(50) 208(50) 0	100	380.00
85	0 103(13) 139(87) 0	100	240.00
86	0 150(63) 162(37) 0	100	280.00
87	0 9(63) 0	63	20.00
88	0 164(37) 152(63) 0	100	280.00
89	0 95(50) 71(50) 0	100	160.00
90	0 107(63) 119(37) 0	100	200.00
91	0 196(63) 208(37) 0	100	360.00
92	0 121(13) 133(87) 0	100	240.00
93	0 237(87) 201(13) 0	100	399.99
94	0 7(13) 19(87) 0	100	40.00
95	0 120(87) 108(13) 0	100	199.99
96	0 181(69) 193(31) 0	100	340.00
97	0 155(63) 167(37) 0	100	279.99
98	0 55(26) 79(63) 0	89	140.00
99	0 65(69) 53(31) 0	100	120.00

(cont.)

Table A.113 continued.

No.	Route	Load	Distance
100	0 89(87) 77(13) 0	100	160.00
101	0 111(69) 99(19) 0	88	200.00
102	0 138(87) 126(13) 0	100	240.00
103	0 11(63) 12(37) 0	100	25.18
104	0 37(87) 0	87	80.00
105	0 82(13) 94(87) 0	100	160.00
106	0 129(50) 105(50) 0	100	220.01
107	0 6(63) 0	63	20.00
108	0 182(19) 170(63) 158(18) 0	100	320.01
109	0 124(50) 100(50) 0	100	220.00
110	0 191(37) 179(63) 0	100	320.01
111	0 211(50) 223(50) 0	100	380.00
112	0 40(87) 28(13) 0	100	80.00
113	0 217(13) 229(87) 0	100	400.00
114	0 131(63) 143(37) 0	100	239.99
115	0 181(18) 217(50) 193(32) 0	100	380.00
116	0 226(50) 214(50) 0	100	380.00
117	0 44(87) 0	87	80.00
118	0 49(19) 73(50) 48(31) 0	100	150.63
119	0 144(87) 132(13) 0	100	240.00
120	0 30(50) 41(19) 29(31) 0	100	90.53
121	0 183(87) 75(13) 0	100	319.99
122	0 69(37) 57(63) 0	100	120.01
123	0 129(13) 141(87) 0	100	240.00
124	0 75(50) 51(50) 0	100	140.00
125	0 206(37) 194(63) 0	100	360.01
126	0 180(63) 192(37) 0	100	320.00
127	0 200(13) 212(87) 0	100	359.99
128	0 8(13) 20(87) 0	100	40.00
129	0 148(13) 160(87) 0	100	280.00
130	0 154(63) 166(37) 0	100	280.00
131	0 5(63) 3(37) 0	100	30.00
132	0 17(87) 0	87	40.00

(cont.)

Table A.113 continued.

No.	Route	Load	Distance
133	0 78(63) 66(37) 0	100	140.00
134	0 118(87) 106(13) 0	100	200.00
135	0 23(18) 35(63) 36(19) 0	100	75.53
136	0 137(56) 149(44) 0	100	260.00
137	0 161(87) 101(13) 0	100	280.00
138	0 211(37) 199(63) 0	100	360.00
139	0 124(13) 136(87) 0	100	240.00
140	0 177(50) 165(50) 0	100	300.00
141	0 176(50) 164(50) 0	100	300.00
142	0 41(68) 29(32) 0	100	80.00
143	0 184(87) 172(13) 0	100	320.00
144	0 215(50) 227(50) 0	100	380.00
145	0 163(37) 151(63) 0	100	280.00
146	0 114(37) 102(63) 0	100	200.01
147	0 117(87) 105(13) 0	100	200.01
148	0 39(87) 27(13) 0	100	80.00
149	0 216(87) 204(13) 0	100	360.00
150	0 13(37) 26(63) 0	100	66.15
151	0 25(63) 13(32) 0	95	60.00
152	0 93(87) 81(13) 0	100	160.01
153	0 62(87) 0	87	120.00
154	0 224(13) 236(87) 0	100	400.01
155	0 187(37) 175(63) 0	100	320.00
156	0 153(63) 165(37) 0	100	279.99
157	0 70(50) 82(50) 0	100	140.00
158	0 203(63) 215(37) 0	100	360.01
159	0 2(63) 3(26) 0	89	25.18
160	0 168(37) 156(63) 0	100	280.00
161	0 104(50) 128(50) 0	100	220.00
162	0 218(13) 230(87) 0	100	400.01
163	0 146(32) 182(68) 0	100	320.01
164	0 54(50) 66(50) 0	100	120.00
165	0 163(50) 187(50) 0	100	320.00

(cont.)

Table A.113 continued.

No.	Route	Load	Distance
166	0 189(87) 177(13) 0	100	320.00
167	0 106(50) 130(50) 0	100	220.00
168	0 146(31) 158(69) 0	100	279.99
169	0 127(63) 103(37) 0	100	220.00
170	0 220(13) 232(87) 0	100	400.00
171	0 125(63) 113(37) 0	100	220.00
172	0 235(87) 223(13) 0	100	400.00
173	0 213(50) 201(50) 0	100	359.99
174	0 178(13) 190(87) 0	100	320.00
175	0 22(37) 10(63) 0	100	40.00
176	0 142(87) 130(13) 0	100	240.00
177	0 86(87) 27(13) 0	100	166.06
178	0 123(63) 111(18) 27(19) 0	100	220.00
179	0 47(87) 0	87	79.99
180	0 91(87) 0	87	160.00
181	0 104(13) 116(87) 0	100	200.00
182	0 227(13) 239(87) 0	100	400.00
183	0 34(13) 46(87) 0	100	80.00
		Total Distance	40102.34

Table A.114: EMIP-MDA+ERTR solution to MDA21 with $p = .2$.

No.	Route	Load	Distance
1	0 89(87) 0	87	40.01
2	0 126(87) 0	87	39.99
3	0 264(50) 263(50) 0	100	83.49
4	0 183(37) 182(63) 0	100	62.62
5	0 271(50) 270(50) 0	100	83.49
6	0 35(37) 33(63) 0	100	21.74
7	0 193(13) 265(87) 0	100	80.00
8	0 222(37) 147(63) 0	100	83.47
9	0 175(50) 173(50) 0	100	65.24
10	0 184(37) 181(63) 0	100	67.83
11	0 274(37) 202(63) 0	100	80.00
12	0 74(87) 0	87	39.99
13	0 145(50) 146(50) 0	100	62.62
14	0 232(50) 229(50) 0	100	90.45
15	0 211(13) 283(87) 0	100	80.01
16	0 233(87) 0	87	80.00
17	0 80(50) 81(50) 0	100	41.75
18	0 109(87) 0	87	40.00
19	0 216(63) 0	63	60.01
20	0 180(32) 179(63) 0	95	62.61
21	0 164(13) 236(87) 0	100	80.00
22	0 206(50) 207(50) 0	100	62.62
23	0 194(13) 266(87) 0	100	80.00
24	0 14(13) 86(87) 0	100	40.00
25	0 45(37) 44(63) 0	100	20.87
26	0 271(37) 199(63) 0	100	80.00
27	0 120(87) 0	87	39.99
28	0 113(87) 0	87	39.99
29	0 127(87) 0	87	40.00
30	0 14(50) 10(50) 0	100	23.47
31	0 192(37) 190(63) 0	100	65.23
32	0 1(63) 0	63	20.00
33	0 166(37) 167(63) 0	100	62.62

(cont.)

Table A.114 continued.

No.	Route	Load	Distance
34	0 106(87) 0	87	40.00
35	0 103(87) 0	87	40.00
36	0 252(87) 0	87	80.01
37	0 246(87) 0	87	80.00
38	0 248(87) 0	87	80.00
39	0 23(63) 24(37) 0	100	20.88
40	0 238(87) 0	87	80.00
41	0 136(87) 64(13) 0	100	39.99
42	0 59(63) 58(26) 0	89	20.87
43	0 81(37) 154(63) 0	100	60.22
44	0 209(37) 208(63) 0	100	62.62
45	0 261(87) 0	87	80.00
46	0 254(50) 253(50) 0	100	83.48
47	0 19(63) 0	63	20.00
48	0 115(87) 0	87	40.00
49	0 276(37) 204(63) 0	100	79.99
50	0 10(13) 82(87) 0	100	39.99
51	0 97(37) 162(63) 0	100	67.82
52	0 263(37) 189(63) 0	100	81.69
53	0 15(31) 17(63) 0	94	21.74
54	0 251(87) 0	87	80.00
55	0 148(50) 149(50) 0	100	62.62
56	0 284(37) 212(63) 0	100	80.00
57	0 9(37) 8(63) 0	100	20.87
58	0 64(13) 137(87) 0	100	40.08
59	0 3(63) 0	63	20.01
60	0 133(37) 132(63) 0	100	41.75
61	0 210(50) 211(50) 0	100	62.62
62	0 146(13) 218(87) 0	100	80.01
63	0 219(87) 0	87	80.00
64	0 78(87) 0	87	40.00
65	0 264(37) 195(63) 0	100	83.49
66	0 156(50) 152(50) 0	100	70.40

(cont.)

Table A.114 continued.

No.	Route	Load	Distance
67	0 144(87) 0	87	39.99
68	0 29(26) 27(63) 0	89	21.74
69	0 119(87) 0	87	40.00
70	0 57(37) 55(63) 0	100	21.75
71	0 124(87) 0	87	40.00
72	0 257(87) 185(13) 0	100	80.00
73	0 209(13) 280(87) 0	100	80.45
74	0 187(13) 259(87) 0	100	80.00
75	0 241(37) 168(63) 0	100	80.44
76	0 13(26) 11(63) 0	89	21.75
77	0 93(87) 0	87	40.01
78	0 184(26) 254(37) 253(37) 0	100	85.17
79	0 196(50) 197(50) 0	100	62.62
80	0 230(87) 0	87	80.00
81	0 267(87) 0	87	80.01
82	0 112(87) 0	87	40.00
83	0 225(50) 227(50) 0	100	86.97
84	0 5(37) 4(63) 0	100	20.87
85	0 200(13) 273(87) 0	100	80.44
86	0 142(87) 0	87	40.00
87	0 210(13) 282(87) 0	100	80.00
88	0 94(87) 0	87	40.00
89	0 69(63) 0	63	20.01
90	0 87(87) 0	87	39.99
91	0 26(63) 0	63	20.00
92	0 231(87) 0	87	80.00
93	0 35(26) 34(63) 0	89	20.87
94	0 183(13) 256(87) 0	100	80.45
95	0 130(50) 133(50) 0	100	45.23
96	0 200(13) 272(87) 0	100	80.00
97	0 197(13) 269(87) 0	100	80.00
98	0 129(87) 0	87	40.01
99	0 143(87) 0	87	40.01

(cont.)

Table A.114 continued.

No.	Route	Load	Distance
100	0 61(50) 60(50) 0	100	20.87
101	0 100(87) 0	87	39.99
102	0 67(26) 66(63) 0	89	20.88
103	0 84(87) 0	87	39.99
104	0 223(50) 222(50) 0	100	83.49
105	0 122(87) 0	87	40.00
106	0 152(13) 224(87) 0	100	80.00
107	0 64(37) 63(63) 0	100	20.87
108	0 232(37) 158(63) 0	100	81.69
109	0 270(37) 198(63) 0	100	80.01
110	0 243(87) 0	87	80.00
111	0 5(13) 77(87) 0	100	39.99
112	0 83(87) 0	87	40.00
113	0 102(87) 0	87	39.99
114	0 277(87) 0	87	79.99
115	0 99(37) 172(63) 0	100	60.22
116	0 174(63) 0	63	60.00
117	0 40(37) 39(63) 0	100	20.87
118	0 207(13) 279(87) 0	100	80.01
119	0 123(87) 0	87	39.99
120	0 215(13) 287(87) 0	100	80.00
121	0 258(87) 186(13) 0	100	79.99
122	0 161(37) 160(63) 0	100	62.62
123	0 18(63) 0	63	20.00
124	0 116(87) 0	87	39.99
125	0 276(50) 274(50) 0	100	86.97
126	0 240(87) 169(13) 0	100	80.44
127	0 205(63) 132(24) 60(13) 0	100	60.23
128	0 111(87) 0	87	40.01
129	0 215(50) 214(50) 0	100	62.62
130	0 30(26) 32(63) 0	89	21.74
131	0 164(13) 235(87) 0	100	80.45
132	0 213(13) 285(87) 0	100	80.01

(cont.)

Table A.114 continued.

No.	Route	Load	Distance
133	0 114(87) 0	87	40.00
134	0 193(50) 194(50) 0	100	62.62
135	0 88(87) 0	87	40.00
136	0 227(37) 155(63) 0	100	80.00
137	0 229(37) 157(63) 0	100	80.00
138	0 169(50) 241(50) 0	100	80.00
139	0 135(87) 0	87	39.99
140	0 156(13) 228(87) 0	100	80.00
141	0 21(37) 22(63) 0	100	20.87
142	0 95(87) 0	87	39.99
143	0 244(87) 0	87	80.00
144	0 206(13) 278(87) 0	100	80.00
145	0 43(63) 45(26) 0	89	21.75
146	0 239(87) 0	87	80.00
147	0 76(87) 5(13) 0	100	40.08
148	0 188(50) 187(50) 0	100	62.61
149	0 164(37) 163(63) 0	100	62.62
150	0 65(63) 0	63	20.00
151	0 67(37) 68(63) 0	100	20.87
152	0 166(26) 165(63) 0	89	62.61
153	0 284(50) 213(50) 0	100	80.45
154	0 98(50) 99(50) 0	100	41.73
155	0 96(87) 0	87	40.00
156	0 2(63) 0	63	20.00
157	0 24(26) 25(63) 0	89	20.87
158	0 214(13) 286(87) 0	100	80.01
159	0 53(26) 54(63) 0	89	20.88
160	0 47(26) 46(63) 0	89	20.87
161	0 105(87) 0	87	39.99
162	0 262(87) 0	87	80.00
163	0 91(87) 0	87	40.00
164	0 92(87) 0	87	39.99
165	0 180(31) 176(63) 0	94	70.42

(cont.)

Table A.114 continued.

No.	Route	Load	Distance
166	0 140(87) 0	87	40.00
167	0 15(32) 16(63) 0	95	20.87
168	0 134(87) 61(13) 0	100	40.07
169	0 173(13) 245(87) 0	100	80.00
170	0 175(13) 247(87) 0	100	80.00
171	0 75(87) 0	87	40.01
172	0 90(87) 0	87	39.99
173	0 188(13) 260(87) 0	100	80.00
174	0 177(13) 249(87) 0	100	80.00
175	0 139(87) 0	87	40.00
176	0 28(63) 29(37) 0	100	20.87
177	0 40(26) 41(63) 0	89	20.87
178	0 85(87) 0	87	40.00
179	0 110(87) 0	87	39.99
180	0 117(87) 0	87	39.99
181	0 226(87) 0	87	79.99
182	0 225(37) 153(63) 0	100	80.00
183	0 288(87) 0	87	80.01
184	0 21(26) 20(63) 0	89	20.88
185	0 149(13) 221(87) 0	100	80.00
186	0 50(26) 51(63) 0	89	20.88
187	0 12(63) 13(37) 0	100	20.88
188	0 170(13) 242(87) 0	100	80.00
189	0 196(13) 268(87) 0	100	80.01
190	0 38(63) 37(37) 0	100	20.87
191	0 57(26) 56(63) 0	89	20.88
192	0 108(87) 0	87	39.99
193	0 118(87) 0	87	39.99
194	0 71(37) 72(63) 0	100	20.88
195	0 170(50) 97(50) 0	100	60.24
196	0 79(87) 0	87	40.00
197	0 71(26) 70(63) 0	89	20.87
198	0 178(13) 250(87) 0	100	80.01

(cont.)

Table A.114 continued.

No.	Route	Load	Distance
199	0 237(87) 0	87	79.99
200	0 50(37) 49(63) 0	100	20.87
201	0 200(37) 201(63) 0	100	62.62
202	0 209(13) 281(87) 0	100	80.01
203	0 141(87) 0	87	39.99
204	0 223(37) 150(63) 0	100	80.44
205	0 128(87) 0	87	39.99
206	0 234(87) 0	87	80.01
207	0 30(37) 31(63) 0	100	20.88
208	0 121(87) 0	87	40.00
209	0 125(87) 0	87	40.01
210	0 98(37) 171(63) 0	100	60.22
211	0 53(37) 52(63) 0	100	20.87
212	0 183(13) 255(87) 0	100	79.99
213	0 101(87) 0	87	40.00
214	0 161(26) 159(63) 0	89	65.22
215	0 138(87) 0	87	39.99
216	0 145(13) 217(87) 0	100	80.00
217	0 275(87) 0	87	80.00
218	0 192(26) 191(63) 0	89	62.62
219	0 104(87) 0	87	40.00
220	0 178(50) 177(50) 0	100	62.61
221	0 130(37) 203(63) 0	100	60.23
222	0 6(63) 0	63	20.00
223	0 37(26) 36(63) 0	89	20.87
224	0 148(13) 220(87) 0	100	80.00
225	0 185(50) 186(50) 0	100	62.62
226	0 9(26) 7(63) 0	89	21.75
227	0 62(63) 58(37) 0	100	23.46
228	0 131(87) 0	87	39.99
229	0 73(87) 0	87	40.00
230	0 42(63) 0	63	20.00
231	0 48(63) 47(37) 0	100	20.87
232	0 80(37) 151(63) 0	100	60.22
233	0 107(87) 0	87	40.01
		Total Distance	12438.63

Table A.115: EMIP-MDA+ERTR solution to MDA1 with $p = .3$.

No.	Route	Load	Distance
1	0 1(50) 2(50) 0	100	34.14
2	0 3(50) 4(50) 0	100	34.14
3	0 1(22) 5(78) 0	100	40.00
4	0 2(22) 6(78) 0	100	40.00
5	0 3(22) 7(78) 0	100	40.00
6	0 4(22) 8(78) 0	100	40.00
		Total Distance	228.28

Table A.116: EMIP-MDA+ERTR solution to MDA2 with $p = .3$.

No.	Route	Load	Distance
1	0 13(78) 1(22) 0	100	80.00
2	0 6(28) 2(72) 0	100	40.00
3	0 11(50) 3(50) 0	100	60.00
4	0 8(50) 4(50) 0	100	40.00
5	0 1(22) 5(78) 0	100	40.00
6	0 3(22) 7(78) 0	100	40.00
7	0 1(28) 9(72) 0	100	60.00
8	0 6(50) 10(50) 0	100	60.00
9	0 8(28) 12(72) 0	100	60.00
10	0 10(22) 14(78) 0	100	80.00
11	0 11(22) 15(78) 0	100	80.00
12	0 4(22) 16(78) 0	100	80.00
		Total Distance	720.00

Table A.117: EMIP-MDA+ERTR solution to MDA3 with $p = .3$.

No.	Route	Load	Distance
1	0 9(78) 1(22) 0	100	40.00
2	0 3(50) 2(50) 0	100	27.65
3	0 11(78) 3(22) 0	100	40.00
4	0 5(50) 4(50) 0	100	27.65
5	0 7(50) 6(50) 0	100	27.65
6	0 1(50) 8(50) 0	100	27.65
7	0 2(22) 10(78) 0	100	39.99
8	0 4(22) 12(78) 0	100	39.99
9	0 5(22) 13(78) 0	100	40.00
10	0 6(22) 14(78) 0	100	39.99
11	0 7(22) 15(78) 0	100	40.00
12	0 8(22) 16(78) 0	100	39.99
		Total Distance	430.58

Table A.118: EMIP-MDA+ERTR solution to MDA4 with $p = .3$.

No.	Route	Load	Distance
1	0 2(50) 1(50) 0	100	25.18
2	0 3(50) 4(50) 0	100	25.18
3	0 6(50) 5(50) 0	100	25.18
4	0 8(50) 7(50) 0	100	25.18
5	0 20(78) 8(22) 0	100	40.00
6	0 21(78) 9(22) 0	100	40.00
7	0 9(50) 10(50) 0	100	25.18
8	0 12(50) 11(50) 0	100	25.18
9	0 1(22) 13(78) 0	100	40.00
10	0 2(22) 14(78) 0	100	40.00
11	0 3(22) 15(78) 0	100	40.00
12	0 4(22) 16(78) 0	100	40.00
13	0 5(22) 17(78) 0	100	40.00
14	0 6(22) 18(78) 0	100	40.00
15	0 7(22) 19(78) 0	100	40.00
16	0 10(22) 22(78) 0	100	40.00
17	0 11(22) 23(78) 0	100	40.00
18	0 12(22) 24(78) 0	100	40.00
		Total Distance	631.05

Table A.119: EMIP-MDA+ERTR solution to MDA5 with $p = .3$.

No.	Route	Load	Distance
1	0 9(78) 1(22) 0	100	40.00
2	0 1(50) 2(50) 0	100	27.65
3	0 3(50) 4(50) 0	100	27.65
4	0 13(78) 5(22) 0	100	40.00
5	0 5(50) 6(50) 0	100	27.65
6	0 8(50) 7(50) 0	100	27.65
7	0 16(78) 8(22) 0	100	39.99
8	0 2(22) 10(78) 0	100	39.99
9	0 3(22) 11(78) 0	100	40.00
10	0 4(22) 12(78) 0	100	39.99
11	0 6(22) 14(78) 0	100	39.99
12	0 7(22) 15(78) 0	100	40.00
13	0 25(78) 17(22) 0	100	80.00
14	0 17(50) 18(50) 0	100	82.95
15	0 19(50) 20(50) 0	100	82.95
16	0 22(50) 21(50) 0	100	82.96
17	0 30(78) 22(22) 0	100	80.00
18	0 31(78) 23(22) 0	100	80.00
19	0 23(50) 24(50) 0	100	82.96
20	0 18(22) 26(78) 0	100	79.99
21	0 19(22) 27(78) 0	100	80.00
22	0 20(22) 28(78) 0	100	80.00
23	0 21(22) 29(78) 0	100	80.00
24	0 24(22) 32(78) 0	100	80.00
		Total Distance	1402.40

Table A.120: EMIP-MDA+ERTR solution to MDA6 with $p = .3$.

No.	Route	Load	Distance
1	0 1(50) 2(50) 0	100	23.91
2	0 3(50) 4(50) 0	100	23.90
3	0 5(50) 6(50) 0	100	23.91
4	0 23(78) 7(22) 0	100	39.99
5	0 7(50) 8(50) 0	100	23.90
6	0 25(78) 9(22) 0	100	40.00
7	0 9(50) 10(50) 0	100	23.91
8	0 12(50) 11(50) 0	100	23.90
9	0 29(78) 13(22) 0	100	40.00
10	0 13(50) 14(50) 0	100	23.91
11	0 31(78) 15(22) 0	100	39.99
12	0 15(50) 16(50) 0	100	23.90
13	0 1(22) 17(78) 0	100	40.00
14	0 2(22) 18(78) 0	100	40.00
15	0 3(22) 19(78) 0	100	39.99
16	0 4(22) 20(78) 0	100	40.00
17	0 5(22) 21(78) 0	100	40.00
18	0 6(22) 22(78) 0	100	40.00
19	0 8(22) 24(78) 0	100	40.01
20	0 10(22) 26(78) 0	100	40.00
21	0 11(22) 27(78) 0	100	39.99
22	0 12(22) 28(78) 0	100	40.01
23	0 14(22) 30(78) 0	100	40.00
24	0 16(22) 32(78) 0	100	40.01
		Total Distance	831.24

Table A.121: EMIP-MDA+ERTR solution to MDA7 with $p = .3$.

No.	Route	Load	Distance
1	0 5(78) 1(22) 0	100	40.00
2	0 3(50) 2(50) 0	100	34.14
3	0 1(50) 4(50) 0	100	34.14
4	0 2(22) 6(78) 0	100	40.00
5	0 3(22) 7(78) 0	100	40.00
6	0 4(22) 8(78) 0	100	40.00
7	0 13(28) 9(72) 0	100	80.00
8	0 16(28) 12(72) 0	100	80.00
9	0 17(50) 13(50) 0	100	100.00
10	0 10(72) 14(28) 0	100	80.00
11	0 11(50) 15(50) 0	100	80.00
12	0 20(50) 16(50) 0	100	100.00
13	0 21(78) 17(22) 0	100	120.00
14	0 14(50) 18(50) 0	100	100.00
15	0 15(28) 19(72) 0	100	100.00
16	0 18(22) 22(78) 0	100	120.00
17	0 11(22) 23(78) 0	100	120.00
18	0 20(22) 24(78) 0	100	120.00
19	0 33(50) 25(50) 0	100	180.00
20	0 30(28) 26(72) 0	100	160.00
21	0 32(28) 28(72) 0	100	160.00
22	0 25(22) 29(78) 0	100	160.00
23	0 27(72) 31(28) 0	100	160.00
24	0 36(50) 32(50) 0	100	180.00
25	0 30(50) 34(50) 0	100	180.00
26	0 31(50) 35(50) 0	100	180.00
27	0 40(78) 36(22) 0	100	200.00
28	0 33(22) 37(78) 0	100	200.00
29	0 34(22) 38(78) 0	100	200.00
30	0 35(22) 39(78) 0	100	200.00
		Total Distance	3588.28

Table A.122: EMIP-MDA+ERTR solution to MDA8 with $p = .3$.

No.	Route	Load	Distance
1	0 5(78) 1(22) 0	100	40.00
2	0 11(50) 3(50) 0	100	60.00
3	0 8(50) 4(50) 0	100	40.00
4	0 2(22) 6(78) 0	100	40.00
5	0 3(22) 7(78) 0	100	40.00
6	0 12(72) 8(28) 0	100	60.00
7	0 1(28) 9(72) 0	100	60.00
8	0 2(50) 10(50) 0	100	60.00
9	0 1(22) 13(78) 0	100	80.00
10	0 10(22) 14(78) 0	100	80.00
11	0 11(22) 15(78) 0	100	80.00
12	0 4(22) 16(78) 0	100	80.00
13	0 21(28) 17(72) 0	100	120.00
14	0 30(78) 18(22) 0	100	160.00
15	0 23(28) 19(72) 0	100	120.00
16	0 24(28) 20(72) 0	100	120.00
17	0 25(50) 21(50) 0	100	140.00
18	0 18(50) 22(50) 0	100	120.00
19	0 27(50) 23(50) 0	100	140.00
20	0 29(78) 25(22) 0	100	160.00
21	0 22(28) 26(72) 0	100	140.00
22	0 31(78) 27(22) 0	100	160.00
23	0 24(50) 28(50) 0	100	140.00
24	0 28(22) 32(78) 0	100	160.00
25	0 37(78) 33(22) 0	100	200.00
26	0 42(50) 34(50) 0	100	220.00
27	0 48(78) 36(22) 0	100	240.00
28	0 34(22) 38(78) 0	100	200.00
29	0 35(72) 39(28) 0	100	200.00
30	0 36(50) 40(50) 0	100	200.00
31	0 33(50) 41(50) 0	100	220.00
32	0 39(50) 43(50) 0	100	220.00
33	0 40(28) 44(72) 0	100	220.00
34	0 41(22) 45(78) 0	100	240.00
35	0 42(22) 46(78) 0	100	240.00
36	0 43(22) 47(78) 0	100	240.00
		Total Distance	5040.00

Table A.123: EMIP-MDA+ERTR solution to MDA9 with $p = .3$.

No.	Route	Load	Distance
1	0 1(22) 13(78) 0	100	40.00
2	0 1(50) 2(50) 0	100	25.18
3	0 3(50) 4(50) 0	100	25.18
4	0 17(78) 5(22) 0	100	40.00
5	0 18(78) 6(22) 0	100	40.00
6	0 5(50) 6(50) 0	100	25.18
7	0 9(50) 8(50) 0	100	25.18
8	0 9(22) 21(78) 0	100	40.00
9	0 11(50) 10(50) 0	100	25.18
10	0 23(78) 11(22) 0	100	40.00
11	0 12(22) 24(28) 12(50) 0	100	40.00
12	0 2(22) 14(78) 0	100	40.00
13	0 15(78) 3(22) 0	100	40.00
14	0 16(78) 4(22) 0	100	40.00
15	0 30(50) 29(50) 0	100	75.53
16	0 7(72) 19(28) 0	100	40.00
17	0 8(22) 20(78) 0	100	40.00
18	0 10(22) 22(78) 0	100	40.00
19	0 36(50) 24(50) 0	100	60.00
20	0 26(50) 25(50) 0	100	75.53
21	0 39(78) 27(22) 0	100	80.00
22	0 27(50) 28(50) 0	100	75.53
23	0 41(78) 29(22) 0	100	80.00
24	0 19(50) 31(50) 0	100	60.00
25	0 43(78) 31(22) 0	100	80.00
26	0 32(50) 33(50) 0	100	75.53
27	0 45(78) 33(22) 0	100	80.00
28	0 35(50) 34(50) 0	100	75.53
29	0 37(78) 25(22) 0	100	80.00
30	0 26(22) 38(78) 0	100	80.00
31	0 40(78) 28(22) 0	100	80.00
32	0 30(22) 42(78) 0	100	80.00
33	0 44(78) 32(22) 0	100	80.00
34	0 34(22) 46(78) 0	100	80.00
35	0 35(22) 47(78) 0	100	79.99
36	0 36(22) 48(78) 0	100	80.01
		Total Distance	2063.50

Table A.124: EMIP-MDA+ERTR solution to MDA10 with $p = .3$.

No.	Route	Load	Distance
1	0 20(78) 4(22) 0	100	40.00
2	0 36(50) 35(50) 0	100	71.71
3	0 19(78) 3(22) 0	100	39.99
4	0 40(50) 39(50) 0	100	71.71
5	0 38(50) 37(50) 0	100	71.71
6	0 22(78) 6(22) 0	100	40.00
7	0 8(72) 9(28) 0	100	23.91
8	0 10(72) 26(28) 0	100	40.00
9	0 34(50) 33(50) 0	100	71.71
10	0 27(78) 11(22) 0	100	39.99
11	0 42(50) 41(50) 0	100	71.71
12	0 31(78) 15(22) 0	100	39.99
13	0 11(50) 26(50) 0	100	41.42
14	0 18(78) 2(22) 0	100	40.00
15	0 16(22) 32(78) 0	100	40.01
16	0 7(22) 23(78) 0	100	39.99
17	0 5(22) 21(78) 0	100	40.00
18	0 24(78) 9(22) 0	100	41.43
19	0 9(22) 25(78) 0	100	40.00
20	0 12(22) 28(78) 0	100	40.01
21	0 48(22) 64(78) 0	100	79.99
22	0 30(78) 14(22) 0	100	40.00
23	0 48(50) 47(50) 0	100	71.70
24	0 6(50) 7(50) 0	100	23.90
25	0 5(50) 4(50) 0	100	23.91
26	0 12(50) 13(50) 0	100	23.91
27	0 56(78) 40(22) 0	100	79.99
28	0 3(50) 2(50) 0	100	23.90
29	0 37(22) 53(78) 0	100	80.00
30	0 15(50) 14(50) 0	100	23.90
31	0 16(50) 1(50) 0	100	23.91
32	0 43(50) 44(50) 0	100	71.71
33	0 46(72) 45(28) 0	100	71.71

(cont.)

Table A.124 continued.

No.	Route	Load	Distance
34	0 63(78) 47(22) 0	100	80.00
35	0 17(78) 1(22) 0	100	40.00
36	0 33(22) 49(78) 0	100	80.00
37	0 34(22) 50(78) 0	100	80.01
38	0 35(22) 51(78) 0	100	79.99
39	0 52(78) 36(22) 0	100	79.99
40	0 55(78) 39(22) 0	100	80.00
41	0 38(22) 54(78) 0	100	80.01
42	0 41(22) 57(78) 0	100	80.00
43	0 43(22) 59(78) 0	100	80.00
44	0 58(78) 42(22) 0	100	80.00
45	0 45(22) 61(78) 0	100	80.00
46	0 44(22) 60(78) 0	100	79.99
47	0 45(22) 62(78) 0	100	86.81
48	0 13(22) 29(78) 0	100	40.00
		Total Distance	2710.64

Table A.125: EMIP-MDA+ERTR solution to MDA11 with $p = .3$.

No.	Route	Load	Distance
1	0 9(50) 5(28) 1(22) 0	100	60.00
2	0 11(50) 3(50) 0	100	60.00
3	0 1(50) 4(50) 0	100	34.14
4	0 5(50) 0	50	40.00
5	0 2(48) 6(52) 0	100	40.00
6	0 3(22) 7(78) 0	100	40.00
7	0 4(22) 8(78) 0	100	40.00
8	0 21(50) 25(50) 0	100	140.00
9	0 2(24) 6(26) 10(50) 0	100	60.00
10	0 15(78) 11(22) 0	100	80.00
11	0 12(72) 0	72	60.00
12	0 9(22) 13(78) 0	100	80.00
13	0 10(22) 14(78) 0	100	80.00
14	0 22(28) 18(72) 0	100	120.00
15	0 31(78) 19(22) 0	100	160.00
16	0 24(50) 20(50) 0	100	120.00
17	0 17(72) 21(28) 0	100	120.00
18	0 26(50) 22(50) 0	100	140.00
19	0 19(50) 23(50) 0	100	120.00
20	0 16(78) 0	78	80.00
21	0 29(78) 25(22) 0	100	160.00
22	0 20(22) 24(28) 28(50) 0	100	140.00
23	0 26(22) 30(78) 0	100	160.00
24	0 23(28) 27(72) 0	100	140.00
25	0 37(24) 41(50) 33(26) 0	100	220.00
26	0 38(78) 34(22) 0	100	200.00
27	0 39(28) 35(72) 0	100	200.00
28	0 28(22) 32(78) 0	100	160.00
29	0 33(46) 37(54) 0	100	200.00
30	0 43(50) 39(50) 0	100	220.00
31	0 36(50) 40(50) 0	100	200.00
32	0 77(78) 41(22) 0	100	400.00
33	0 34(50) 42(50) 0	100	220.00

(cont.)

Table A.125 continued.

No.	Route	Load	Distance
34	0 36(22) 40(28) 44(50) 0	100	220.00
35	0 49(26) 53(50) 45(24) 0	100	280.00
36	0 46(78) 42(22) 0	100	240.00
37	0 43(22) 47(78) 0	100	240.00
38	0 44(22) 48(78) 0	100	240.00
39	0 45(54) 49(46) 0	100	260.00
40	0 58(72) 62(28) 0	100	320.00
41	0 55(50) 51(50) 0	100	280.00
42	0 72(78) 52(22) 0	100	360.00
43	0 57(72) 53(28) 0	100	300.00
44	0 62(50) 54(50) 0	100	320.00
45	0 52(50) 56(50) 0	100	280.00
46	0 50(72) 54(28) 0	100	280.00
47	0 55(28) 59(72) 0	100	300.00
48	0 64(28) 60(72) 0	100	320.00
49	0 65(72) 61(28) 0	100	340.00
50	0 51(22) 63(78) 0	100	320.00
51	0 68(50) 64(50) 0	100	340.00
52	0 70(28) 66(72) 0	100	360.00
53	0 71(50) 67(50) 0	100	360.00
54	0 80(78) 68(22) 0	100	400.00
55	0 61(50) 69(50) 0	100	360.00
56	0 56(28) 76(72) 0	100	380.00
57	0 69(28) 73(72) 0	100	380.00
58	0 70(50) 74(50) 0	100	380.00
59	0 71(28) 75(72) 0	100	380.00
60	0 78(78) 74(22) 0	100	400.00
61	0 67(22) 79(78) 0	100	400.00
		Total Distance	13334.14

Table A.126: EMIP-MDA+ERTR solution to MDA12 with $p = .3$.

No.	Route	Load	Distance
1	0 28(50) 36(50) 0	100	100.00
2	0 12(78) 4(22) 0	100	39.99
3	0 6(50) 5(50) 0	100	27.65
4	0 68(50) 52(50) 0	100	180.00
5	0 13(78) 5(22) 0	100	40.00
6	0 67(50) 51(50) 0	100	180.00
7	0 14(78) 6(22) 0	100	39.99
8	0 18(22) 42(78) 0	100	120.01
9	0 8(22) 16(78) 0	100	39.99
10	0 7(22) 15(78) 0	100	40.00
11	0 3(22) 11(78) 0	100	40.00
12	0 17(22) 41(78) 0	100	120.00
13	0 1(22) 9(78) 0	100	40.00
14	0 74(78) 66(22) 0	100	200.00
15	0 4(50) 3(50) 0	100	27.65
16	0 21(72) 29(28) 0	100	80.00
17	0 20(72) 28(28) 0	100	80.00
18	0 22(72) 30(28) 0	100	80.00
19	0 23(72) 31(28) 0	100	80.00
20	0 24(72) 32(28) 0	100	80.00
21	0 25(50) 17(50) 0	100	80.00
22	0 57(50) 49(50) 0	100	160.00
23	0 80(78) 72(22) 0	100	200.00
24	0 35(50) 19(50) 0	100	100.00
25	0 39(50) 31(50) 0	100	100.00
26	0 46(50) 62(50) 0	100	160.00
27	0 1(50) 2(50) 0	100	27.65
28	0 25(28) 33(72) 0	100	100.00
29	0 50(72) 58(28) 0	100	160.00
30	0 44(78) 36(22) 0	100	120.00
31	0 77(78) 53(22) 0	100	200.00
32	0 38(22) 78(78) 0	100	200.00
33	0 38(50) 30(50) 0	100	100.00

(cont.)

Table A.126 continued.

No.	Route	Load	Distance
34	0 57(28) 65(50) 49(22) 0	100	180.00
35	0 37(50) 29(50) 0	100	100.00
36	0 61(50) 53(50) 0	100	160.00
37	0 39(22) 47(78) 0	100	120.00
38	0 18(22) 26(78) 0	100	79.99
39	0 67(22) 75(78) 0	100	200.00
40	0 34(72) 18(28) 0	100	100.00
41	0 27(78) 19(22) 0	100	80.00
42	0 60(78) 52(22) 0	100	159.99
43	0 37(22) 45(78) 0	100	120.00
44	0 62(28) 70(72) 0	100	180.00
45	0 43(78) 35(22) 0	100	120.00
46	0 66(50) 58(50) 0	100	180.00
47	0 7(50) 8(50) 0	100	27.65
48	0 69(72) 61(28) 0	100	180.00
49	0 55(72) 63(28) 0	100	160.00
50	0 56(72) 64(28) 0	100	160.00
51	0 65(22) 73(78) 0	100	200.00
52	0 40(22) 48(78) 0	100	120.00
53	0 40(50) 32(50) 0	100	100.00
54	0 76(78) 68(22) 0	100	200.01
55	0 46(28) 54(72) 0	100	139.99
56	0 63(50) 71(50) 0	100	180.00
57	0 72(50) 64(50) 0	100	180.00
58	0 51(22) 59(78) 0	100	160.00
59	0 71(22) 79(78) 0	100	200.00
60	0 2(22) 10(78) 0	100	39.99
		Total Distance	7170.58

Table A.127: EMIP-MDA+ERTR solution to MDA13 with $p = .3$.

No.	Route	Load	Distance
1	0 13(28) 5(72) 0	100	40.00
2	0 2(22) 10(78) 0	100	39.99
3	0 18(22) 26(78) 0	100	79.99
4	0 4(72) 0	72	20.00
5	0 50(50) 42(50) 0	100	140.01
6	0 13(50) 21(50) 0	100	60.00
7	0 2(50) 3(50) 0	100	27.65
8	0 1(72) 0	72	20.00
9	0 17(22) 25(78) 0	100	80.00
10	0 8(72) 16(28) 0	100	39.99
11	0 16(50) 24(50) 0	100	60.01
12	0 62(78) 38(22) 0	100	160.00
13	0 23(22) 31(78) 0	100	80.00
14	0 18(50) 17(50) 0	100	82.95
15	0 23(50) 22(50) 0	100	82.97
16	0 19(22) 27(78) 0	100	80.00
17	0 12(28) 20(72) 0	100	59.99
18	0 15(78) 7(22) 0	100	40.00
19	0 7(50) 6(50) 0	100	27.65
20	0 30(78) 22(22) 0	100	80.00
21	0 32(78) 24(22) 0	100	80.00
22	0 3(22) 11(78) 0	100	40.00
23	0 28(78) 0	78	80.00
24	0 6(22) 14(78) 0	100	39.99
25	0 49(22) 57(78) 0	100	160.00
26	0 42(28) 34(72) 0	100	120.01
27	0 43(28) 35(72) 0	100	120.00
28	0 9(78) 0	78	40.00
29	0 45(28) 37(72) 0	100	120.00
30	0 78(28) 70(72) 0	100	200.00
31	0 47(50) 55(50) 0	100	140.00
32	0 40(22) 48(78) 0	100	120.00
33	0 65(50) 81(50) 0	100	220.00

(cont.)

Table A.127 continued.

No.	Route	Load	Distance
34	0 12(50) 19(50) 0	100	71.25
35	0 75(50) 43(50) 0	100	200.00
36	0 44(50) 52(50) 0	100	139.99
37	0 38(50) 46(50) 0	100	120.00
38	0 39(72) 47(28) 0	100	120.00
39	0 41(50) 49(50) 0	100	140.00
40	0 50(22) 58(78) 0	100	160.00
41	0 91(78) 51(22) 0	100	240.00
42	0 68(50) 76(50) 0	100	200.01
43	0 53(50) 45(50) 0	100	140.00
44	0 96(78) 72(22) 0	100	240.01
45	0 51(22) 59(78) 0	100	160.00
46	0 36(72) 44(28) 0	100	120.00
47	0 53(22) 61(78) 0	100	160.00
48	0 29(78) 21(22) 0	100	80.00
49	0 71(22) 95(78) 0	100	240.00
50	0 40(50) 56(50) 0	100	140.01
51	0 81(22) 89(78) 0	100	240.00
52	0 74(52) 66(48) 0	100	200.00
53	0 51(28) 67(72) 0	100	180.00
54	0 92(78) 68(22) 0	100	240.01
55	0 77(50) 69(50) 0	100	200.00
56	0 87(72) 71(28) 0	100	220.00
57	0 80(50) 72(50) 0	100	200.00
58	0 82(50) 74(26) 66(24) 0	100	220.00
59	0 83(72) 75(28) 0	100	220.00
60	0 52(22) 60(78) 0	100	159.99
61	0 54(72) 46(28) 0	100	139.99
62	0 71(22) 79(78) 0	100	200.00
63	0 41(28) 33(72) 0	100	120.00
64	0 76(28) 84(72) 0	100	220.01
65	0 77(28) 85(72) 0	100	220.00
66	0 78(50) 86(50) 0	100	220.00

(cont.)

Table A.127 continued.

No.	Route	Load	Distance
67	0 80(28) 88(72) 0	100	220.00
68	0 65(22) 73(78) 0	100	200.00
69	0 82(22) 90(78) 0	100	239.99
70	0 69(22) 93(78) 0	100	240.00
71	0 86(22) 94(78) 0	100	239.99
72	0 55(22) 63(78) 0	100	160.00
73	0 64(78) 56(22) 0	100	160.00
		Total Distance	10112.44

Table A.128: EMIP-MDA+ERTR solution to MDA14 with $p = .3$.

No.	Route	Load	Distance
1	0 10(22) 22(78) 0	100	40.00
2	0 27(22) 39(78) 0	100	80.00
3	0 62(78) 50(22) 0	100	120.00
4	0 21(78) 9(22) 0	100	40.00
5	0 25(72) 37(28) 0	100	80.00
6	0 4(28) 3(72) 0	100	25.18
7	0 58(72) 70(28) 0	100	120.00
8	0 94(50) 106(50) 0	100	180.00
9	0 109(78) 97(22) 0	100	200.00
10	0 23(50) 24(50) 0	100	50.35
11	0 47(28) 60(72) 0	100	115.22
12	0 2(22) 14(78) 0	100	40.00
13	0 8(22) 20(78) 0	100	40.00
14	0 77(22) 89(78) 0	100	160.00
15	0 11(72) 0	72	20.00
16	0 117(78) 105(22) 0	100	200.01
17	0 10(50) 9(50) 0	100	25.18
18	0 13(78) 2(22) 0	100	42.39
19	0 4(22) 15(78) 0	100	42.39
20	0 44(50) 56(50) 0	100	100.00
21	0 108(50) 84(50) 0	100	179.99
22	0 105(50) 81(50) 0	100	180.01
23	0 42(28) 30(72) 0	100	80.00
24	0 80(72) 92(28) 0	100	160.00
25	0 43(28) 31(72) 0	100	80.00
26	0 73(72) 61(28) 0	100	140.00
27	0 53(50) 29(50) 0	100	100.00
28	0 46(28) 34(72) 0	100	80.00
29	0 94(28) 82(72) 0	100	160.00
30	0 40(28) 28(72) 0	100	80.00
31	0 51(22) 63(78) 0	100	120.00
32	0 91(50) 79(50) 0	100	160.00
33	0 55(50) 43(50) 0	100	100.00

(cont.)

Table A.128 continued.

No.	Route	Load	Distance
34	0 70(50) 46(50) 0	100	120.00
35	0 98(22) 110(78) 0	100	200.00
36	0 1(72) 2(28) 0	100	25.18
37	0 48(78) 0	78	80.01
38	0 49(50) 37(50) 0	100	100.00
39	0 77(22) 113(78) 0	100	200.00
40	0 88(28) 76(72) 0	100	160.00
41	0 42(50) 54(50) 0	100	100.00
42	0 33(50) 57(50) 0	100	100.01
43	0 90(50) 102(50) 0	100	180.01
44	0 26(22) 38(78) 0	100	80.00
45	0 12(72) 0	72	20.00
46	0 86(78) 74(22) 0	100	160.00
47	0 6(22) 18(78) 0	100	40.00
48	0 100(50) 88(50) 0	100	180.00
49	0 45(78) 33(22) 0	100	80.00
50	0 29(22) 41(78) 0	100	80.00
51	0 54(22) 66(78) 0	100	120.00
52	0 79(22) 115(78) 0	100	200.00
53	0 81(22) 93(78) 0	100	160.01
54	0 40(50) 64(50) 0	100	120.00
55	0 23(28) 35(72) 0	100	60.00
56	0 8(50) 7(50) 0	100	25.18
57	0 74(50) 98(50) 0	100	180.00
58	0 75(22) 111(78) 0	100	200.00
59	0 64(28) 52(72) 0	100	120.00
60	0 67(78) 55(22) 0	100	120.00
61	0 101(72) 77(28) 0	100	180.01
62	0 69(78) 57(22) 0	100	120.01
63	0 44(28) 32(72) 0	100	80.00
64	0 84(22) 96(78) 0	100	160.01
65	0 83(28) 107(72) 0	100	180.00
66	0 108(22) 120(78) 0	100	199.99

(cont.)

Table A.128 continued.

No.	Route	Load	Distance
67	0 5(50) 6(50) 0	100	25.18
68	0 5(22) 17(78) 0	100	40.00
69	0 75(22) 87(78) 0	100	160.00
70	0 53(22) 65(78) 0	100	120.00
71	0 104(50) 92(50) 0	100	180.00
72	0 24(28) 36(72) 0	100	60.00
73	0 106(22) 118(78) 0	100	200.00
74	0 85(78) 49(22) 0	100	160.00
75	0 75(28) 99(72) 0	100	180.00
76	0 61(50) 97(50) 0	100	180.00
77	0 91(28) 103(72) 0	100	180.00
78	0 27(50) 51(50) 0	100	100.00
79	0 90(28) 78(72) 0	100	160.01
80	0 47(50) 71(50) 0	100	120.00
81	0 16(78) 4(22) 0	100	40.00
82	0 119(78) 83(22) 0	100	200.00
83	0 59(72) 71(28) 0	100	120.00
84	0 26(50) 50(50) 0	100	100.00
85	0 19(78) 7(22) 0	100	40.00
86	0 72(78) 0	78	120.01
87	0 100(22) 112(78) 0	100	200.00
88	0 102(22) 114(78) 0	100	200.01
89	0 104(22) 116(78) 0	100	200.00
90	0 56(22) 68(78) 0	100	119.99
91	0 95(78) 83(22) 0	100	160.00
		Total Distance	10836.25

Table A.129: EMIP-MDA+ERTR solution to MDA15 with $p = .3$.

No.	Route	Load	Distance
1	0 6(72) 0	72	20.00
2	0 43(78) 31(22) 0	100	80.00
3	0 37(78) 25(22) 0	100	80.00
4	0 61(50) 73(50) 0	100	140.00
5	0 21(28) 10(72) 0	100	42.39
6	0 8(22) 20(78) 0	100	40.00
7	0 74(50) 50(50) 0	100	140.00
8	0 18(28) 30(72) 0	100	60.00
9	0 36(22) 48(78) 0	100	80.01
10	0 27(50) 16(50) 0	100	66.15
11	0 21(50) 33(50) 0	100	60.00
12	0 29(50) 18(50) 0	100	66.15
13	0 55(72) 67(28) 0	100	120.00
14	0 11(50) 12(50) 0	100	25.18
15	0 35(50) 34(50) 0	100	75.53
16	0 5(22) 17(78) 0	100	40.00
17	0 1(72) 0	72	20.00
18	0 22(78) 9(22) 0	100	42.39
19	0 47(78) 35(22) 0	100	79.99
20	0 86(78) 74(22) 0	100	160.00
21	0 33(22) 45(78) 0	100	80.00
22	0 51(72) 63(28) 0	100	120.00
23	0 92(24) 104(72) 0	96	180.00
24	0 16(28) 28(72) 0	100	60.00
25	0 4(50) 5(50) 0	100	25.18
26	0 68(50) 44(50) 0	100	119.99
27	0 13(78) 0	78	40.00
28	0 40(24) 52(72) 0	96	100.00
29	0 26(22) 38(78) 0	100	80.00
30	0 14(28) 2(72) 0	100	40.00
31	0 23(78) 11(22) 0	100	40.00
32	0 126(72) 114(28) 0	100	220.01
33	0 8(50) 9(50) 0	100	25.18

(cont.)

Table A.129 continued.

No.	Route	Load	Distance
34	0 19(78) 0	78	40.00
35	0 34(22) 46(78) 0	100	80.00
36	0 12(22) 24(78) 0	100	40.00
37	0 65(28) 53(72) 0	100	120.00
38	0 61(28) 49(72) 0	100	120.00
39	0 134(78) 98(22) 0	100	239.99
40	0 76(50) 64(32) 0	82	140.00
41	0 114(50) 102(50) 0	100	200.01
42	0 54(28) 78(72) 0	100	140.00
43	0 80(72) 68(28) 0	100	140.00
44	0 7(72) 0	72	20.00
45	0 69(28) 57(72) 0	100	120.01
46	0 72(28) 60(72) 0	100	120.01
47	0 71(28) 59(72) 0	100	120.00
48	0 94(28) 82(72) 0	100	160.00
49	0 64(46) 40(54) 0	100	120.00
50	0 3(72) 0	72	20.00
51	0 79(50) 67(50) 0	100	140.00
52	0 81(50) 69(50) 0	100	140.01
53	0 106(50) 130(50) 0	100	220.00
54	0 84(50) 72(50) 0	100	140.01
55	0 36(50) 25(50) 0	100	75.53
56	0 14(50) 26(50) 0	100	60.00
57	0 63(50) 75(50) 0	100	140.00
58	0 27(22) 39(78) 0	100	80.00
59	0 65(50) 77(50) 0	100	140.00
60	0 101(22) 137(78) 0	100	240.00
61	0 89(78) 77(22) 0	100	160.00
62	0 56(72) 44(28) 0	100	100.00
63	0 70(28) 58(72) 0	100	120.00
64	0 119(50) 107(50) 0	100	200.00
65	0 73(22) 85(78) 0	100	160.00
66	0 4(22) 15(78) 0	100	42.39

(cont.)

Table A.129 continued.

No.	Route	Load	Distance
67	0 111(78) 99(22) 0	100	200.00
68	0 76(22) 88(78) 0	100	160.00
69	0 138(78) 102(22) 0	100	240.00
70	0 66(78) 54(22) 0	100	120.00
71	0 42(78) 31(22) 0	100	90.53
72	0 105(22) 117(78) 0	100	200.01
73	0 107(22) 143(78) 0	100	239.99
74	0 84(22) 96(78) 0	100	160.01
75	0 109(78) 97(22) 0	100	200.00
76	0 135(78) 99(22) 0	100	239.99
77	0 124(50) 100(50) 0	100	220.00
78	0 31(28) 32(72) 0	100	75.53
79	0 29(22) 41(78) 0	100	80.00
80	0 115(28) 103(72) 0	100	200.00
81	0 141(78) 129(22) 0	100	240.00
82	0 70(50) 94(50) 0	100	160.00
83	0 71(50) 83(50) 0	100	140.00
84	0 108(22) 120(78) 0	100	199.99
85	0 98(22) 110(78) 0	100	200.00
86	0 87(78) 75(22) 0	100	160.00
87	0 136(78) 124(22) 0	100	240.00
88	0 101(50) 113(50) 0	100	200.00
89	0 79(22) 91(78) 0	100	160.00
90	0 127(50) 115(50) 0	100	220.00
91	0 128(50) 116(46) 0	96	220.00
92	0 106(22) 118(78) 0	100	200.00
93	0 132(22) 144(78) 0	100	240.00
94	0 97(50) 121(50) 0	100	220.00
95	0 98(28) 122(72) 0	100	220.00
96	0 99(28) 123(72) 0	100	220.00
97	0 113(28) 125(72) 0	100	220.00
98	0 139(78) 127(22) 0	100	240.00
99	0 116(32) 92(54) 0	86	200.00

(cont.)

Table A.129 continued.

No.	Route	Load	Distance
100	0 129(50) 105(50) 0	100	220.01
101	0 142(78) 130(22) 0	100	240.00
102	0 119(28) 131(72) 0	100	220.00
103	0 108(50) 132(50) 0	100	220.00
104	0 133(78) 121(22) 0	100	240.00
105	0 62(78) 50(22) 0	100	120.00
106	0 100(22) 112(78) 0	100	200.00
107	0 90(78) 54(22) 0	100	160.01
108	0 128(22) 140(78) 0	100	240.00
109	0 93(78) 81(22) 0	100	160.01
110	0 95(78) 83(22) 0	100	160.00
		Total Distance	15172.11

Table A.130: EMIP-MDA+ERTR solution to MDA16 with $p = .3$.

No.	Route	Load	Distance
1	0 45(72) 0	72	20.00
2	0 26(22) 98(78) 0	100	39.99
3	0 19(28) 20(72) 0	100	20.87
4	0 51(22) 123(78) 0	100	39.99
5	0 117(78) 0	78	39.99
6	0 132(78) 0	78	40.00
7	0 1(28) 72(72) 0	100	20.87
8	0 2(22) 74(78) 0	100	39.99
9	0 97(78) 0	78	40.00
10	0 125(78) 0	78	40.01
11	0 46(22) 118(78) 0	100	39.99
12	0 34(28) 33(72) 0	100	20.87
13	0 32(72) 0	72	20.00
14	0 40(72) 0	72	20.00
15	0 124(78) 0	78	40.00
16	0 27(44) 26(50) 0	94	20.87
17	0 18(22) 90(78) 0	100	39.99
18	0 47(22) 119(78) 0	100	40.00
19	0 112(78) 0	78	40.00
20	0 12(72) 0	72	20.00
21	0 25(72) 0	72	20.00
22	0 34(22) 105(78) 0	100	40.07
23	0 38(28) 37(72) 0	100	20.87
24	0 3(72) 0	72	20.01
25	0 15(22) 88(78) 0	100	40.08
26	0 108(78) 0	78	39.99
27	0 16(72) 0	72	20.00
28	0 104(78) 0	78	40.00
29	0 134(78) 0	78	39.99
30	0 60(28) 56(72) 0	100	23.46
31	0 136(78) 0	78	39.99
32	0 73(78) 0	78	40.00
33	0 39(50) 38(44) 0	94	20.88

(cont.)

Table A.130 continued.

No.	Route	Load	Distance
34	0 10(28) 11(72) 0	100	20.87
35	0 54(50) 55(50) 0	100	20.87
36	0 43(44) 42(44) 0	88	20.87
37	0 94(78) 0	78	40.00
38	0 68(50) 66(44) 0	94	21.74
39	0 70(50) 69(50) 0	100	20.87
40	0 133(78) 61(22) 0	100	40.00
41	0 6(50) 5(44) 0	94	20.88
42	0 14(44) 15(50) 0	94	20.88
43	0 142(78) 70(22) 0	100	40.00
44	0 30(28) 29(72) 0	100	20.87
45	0 83(78) 0	78	40.00
46	0 100(78) 0	78	39.99
47	0 130(78) 0	78	40.00
48	0 131(78) 0	78	39.99
49	0 35(72) 0	72	20.01
50	0 91(78) 0	78	40.00
51	0 53(72) 0	72	20.01
52	0 76(30) 75(54) 0	84	41.76
53	0 107(78) 0	78	40.01
54	0 54(22) 126(78) 0	100	39.99
55	0 92(78) 0	78	39.99
56	0 8(72) 0	72	20.00
57	0 79(46) 77(54) 0	100	43.48
58	0 110(78) 0	78	39.99
59	0 18(50) 19(44) 0	94	20.87
60	0 22(44) 23(44) 0	88	20.87
61	0 14(28) 13(72) 0	100	20.87
62	0 138(78) 0	78	39.99
63	0 57(22) 129(78) 0	100	40.01
64	0 52(72) 0	72	20.00
65	0 75(24) 76(48) 77(24) 0	96	43.49
66	0 39(22) 111(78) 0	100	40.01

(cont.)

Table A.130 continued.

No.	Route	Load	Distance
67	0 57(50) 59(44) 0	94	21.74
68	0 128(78) 0	78	39.99
69	0 64(72) 0	72	20.00
70	0 17(72) 0	72	20.01
71	0 101(78) 0	78	40.00
72	0 1(44) 2(50) 0	94	20.87
73	0 144(78) 0	78	39.99
74	0 143(78) 0	78	40.01
75	0 36(72) 0	72	20.00
76	0 43(28) 44(72) 0	100	20.86
77	0 109(78) 0	78	40.00
78	0 89(78) 0	78	40.01
79	0 96(78) 0	78	40.00
80	0 86(54) 87(46) 0	100	41.74
81	0 42(28) 41(72) 0	100	20.88
82	0 31(50) 30(44) 0	94	20.88
83	0 5(28) 4(72) 0	100	20.87
84	0 122(78) 0	78	40.00
85	0 62(28) 63(72) 0	100	20.87
86	0 140(78) 68(22) 0	100	40.00
87	0 141(78) 69(22) 0	100	39.99
88	0 7(72) 0	72	20.00
89	0 51(50) 49(44) 0	94	21.75
90	0 34(22) 106(78) 0	100	40.00
91	0 135(78) 0	78	39.99
92	0 9(22) 81(78) 0	100	40.00
93	0 139(78) 0	78	40.00
94	0 120(78) 0	78	39.99
95	0 48(72) 0	72	20.00
96	0 102(78) 0	78	39.99
97	0 55(22) 127(78) 0	100	40.00
98	0 103(78) 31(22) 0	100	40.00
99	0 137(78) 65(22) 0	100	40.00

(cont.)

Table A.130 continued.

No.	Route	Load	Distance
100	0 22(28) 21(72) 0	100	20.87
101	0 66(28) 67(72) 0	100	20.88
102	0 47(50) 46(50) 0	100	20.87
103	0 27(28) 28(72) 0	100	20.87
104	0 116(78) 0	78	39.99
105	0 121(78) 0	78	40.00
106	0 99(78) 0	78	39.99
107	0 114(78) 0	78	40.00
108	0 113(78) 0	78	39.99
109	0 60(44) 61(50) 0	94	20.87
110	0 85(78) 0	78	40.00
111	0 59(28) 58(72) 0	100	20.87
112	0 6(22) 78(78) 0	100	40.00
113	0 49(28) 50(72) 0	100	20.87
114	0 115(78) 0	78	40.00
115	0 10(44) 9(50) 0	94	20.87
116	0 65(50) 62(44) 0	94	22.61
117	0 71(72) 0	72	20.01
118	0 84(78) 0	78	39.99
119	0 82(78) 0	78	39.99
120	0 23(28) 24(72) 0	100	20.88
121	0 93(78) 0	78	40.01
122	0 87(32) 86(24) 79(32) 0	88	53.77
123	0 80(78) 0	78	39.99
124	0 95(78) 0	78	39.99
		Total Distance	3962.67

Table A.131: EMIP-MDA+ERTR solution to MDA17 with $p = .3$.

No.	Route	Load	Distance
1	0 52(50) 36(50) 0	100	139.99
2	0 15(50) 23(50) 0	100	60.00
3	0 34(22) 58(78) 0	100	160.00
4	0 12(50) 11(50) 0	100	55.30
5	0 1(72) 9(28) 0	100	40.00
6	0 88(72) 96(28) 0	100	240.01
7	0 46(50) 38(50) 0	100	120.00
8	0 127(78) 119(22) 0	100	320.00
9	0 125(50) 109(50) 0	100	320.00
10	0 121(78) 113(22) 0	100	320.00
11	0 64(28) 72(72) 0	100	180.00
12	0 41(50) 49(50) 0	100	140.00
13	0 43(24) 51(72) 0	96	140.00
14	0 13(28) 21(72) 0	100	60.00
15	0 23(22) 31(78) 0	100	80.00
16	0 53(72) 45(28) 0	100	140.00
17	0 5(22) 29(78) 0	100	80.00
18	0 124(78) 116(22) 0	100	319.99
19	0 4(72) 0	72	20.00
20	0 120(22) 128(78) 0	100	320.01
21	0 68(50) 76(50) 0	100	200.01
22	0 54(72) 46(28) 0	100	139.99
23	0 27(32) 35(50) 0	82	100.00
24	0 135(50) 151(26) 143(24) 0	100	380.00
25	0 71(72) 79(28) 0	100	200.00
26	0 8(72) 0	72	20.00
27	0 79(50) 87(50) 0	100	220.00
28	0 16(78) 0	78	39.99
29	0 47(28) 39(72) 0	100	120.00
30	0 3(72) 0	72	20.00
31	0 120(50) 112(50) 0	100	300.00
32	0 17(50) 9(50) 0	100	60.00
33	0 59(52) 67(48) 0	100	180.00

(cont.)

Table A.131 continued.

No.	Route	Load	Distance
34	0 37(50) 45(50) 0	100	120.00
35	0 77(50) 69(50) 0	100	200.00
36	0 7(72) 0	72	20.00
37	0 2(26) 18(50) 10(24) 0	100	59.99
38	0 22(22) 30(78) 0	100	80.00
39	0 42(50) 34(50) 0	100	120.01
40	0 59(26) 75(50) 67(24) 0	100	200.00
41	0 52(22) 60(78) 0	100	159.99
42	0 13(50) 5(50) 0	100	40.00
43	0 38(22) 62(78) 0	100	160.00
44	0 40(50) 32(50) 0	100	100.00
45	0 6(72) 14(28) 0	100	39.99
46	0 106(28) 98(72) 0	100	280.00
47	0 78(28) 70(72) 0	100	200.00
48	0 48(78) 0	78	120.00
49	0 27(46) 43(54) 0	100	120.00
50	0 106(50) 114(50) 0	100	300.00
51	0 136(50) 152(50) 0	100	380.00
52	0 24(72) 15(28) 0	100	71.25
53	0 69(22) 93(78) 0	100	240.00
54	0 86(72) 94(28) 0	100	239.99
55	0 22(50) 14(50) 0	100	60.01
56	0 40(22) 80(78) 0	100	200.00
57	0 65(48) 73(52) 0	100	200.00
58	0 19(72) 11(28) 0	100	60.00
59	0 83(72) 75(28) 0	100	220.00
60	0 100(72) 108(28) 0	100	280.00
61	0 32(28) 56(72) 0	100	140.01
62	0 110(50) 126(50) 0	100	319.99
63	0 89(78) 81(22) 0	100	240.00
64	0 65(24) 73(26) 81(50) 0	100	220.00
65	0 126(28) 118(72) 0	100	319.99
66	0 63(78) 55(22) 0	100	160.00

(cont.)

Table A.131 continued.

No.	Route	Load	Distance
67	0 112(28) 104(72) 0	100	280.00
68	0 10(54) 2(46) 0	100	39.99
69	0 146(22) 154(78) 0	100	400.00
70	0 155(78) 115(22) 0	100	400.00
71	0 68(22) 92(78) 0	100	240.01
72	0 77(28) 85(72) 0	100	220.00
73	0 41(28) 33(72) 0	100	120.00
74	0 129(72) 137(28) 0	100	360.00
75	0 42(28) 50(72) 0	100	140.01
76	0 91(78) 35(22) 0	100	240.00
77	0 36(22) 44(78) 0	100	120.00
78	0 95(28) 103(72) 0	100	260.00
79	0 110(28) 102(72) 0	100	280.00
80	0 159(78) 135(22) 0	100	400.00
81	0 96(50) 64(50) 0	100	240.01
82	0 145(22) 153(78) 0	100	400.00
83	0 130(26) 138(24) 146(50) 0	100	380.00
84	0 123(50) 139(50) 0	100	360.00
85	0 156(78) 148(22) 0	100	400.00
86	0 157(78) 149(22) 0	100	400.00
87	0 78(50) 94(50) 0	100	239.99
88	0 74(28) 66(72) 0	100	200.00
89	0 57(78) 49(22) 0	100	160.00
90	0 17(22) 25(78) 0	100	80.00
91	0 107(78) 99(22) 0	100	280.00
92	0 125(28) 117(72) 0	100	320.00
93	0 134(28) 150(72) 0	100	380.00
94	0 119(50) 95(50) 0	100	300.00
95	0 82(50) 74(50) 0	100	220.00
96	0 115(50) 99(50) 0	100	300.00
97	0 116(50) 108(50) 0	100	300.00
98	0 141(28) 133(72) 0	100	360.00
99	0 20(72) 12(28) 0	100	59.99

(cont.)

Table A.131 continued.

No.	Route	Load	Distance
100	0 111(78) 87(22) 0	100	280.00
101	0 147(72) 139(28) 0	100	380.00
102	0 140(28) 132(72) 0	100	360.00
103	0 101(72) 109(28) 0	100	280.00
104	0 134(22) 158(78) 0	100	400.00
105	0 26(78) 18(22) 0	100	79.99
106	0 37(22) 61(78) 0	100	160.00
107	0 113(50) 105(50) 0	100	300.00
108	0 130(46) 138(54) 0	100	360.00
109	0 84(72) 76(28) 0	100	220.01
110	0 134(22) 142(78) 0	100	359.99
111	0 82(22) 90(78) 0	100	239.99
112	0 136(22) 144(78) 0	100	360.00
113	0 105(28) 97(72) 0	100	280.00
114	0 131(72) 123(28) 0	100	340.00
115	0 140(50) 148(50) 0	100	380.00
116	0 149(50) 141(50) 0	100	380.00
117	0 28(78) 0	78	80.00
118	0 143(54) 151(46) 0	100	380.00
119	0 160(78) 152(22) 0	100	400.00
120	0 145(50) 137(50) 0	100	380.00
121	0 114(22) 122(78) 0	100	319.99
122	0 47(50) 55(50) 0	100	140.00
		Total Distance	26646.46

Table A.132: EMIP-MDA+ERTR solution to MDA18 with $p = .3$.

No.	Route	Load	Distance
1	0 54(78) 0	78	80.01
2	0 56(28) 72(72) 0	100	100.00
3	0 42(22) 58(78) 0	100	80.00
4	0 4(22) 20(78) 0	100	40.00
5	0 70(22) 86(78) 0	100	119.99
6	0 1(50) 2(50) 0	100	23.91
7	0 24(28) 40(72) 0	100	60.01
8	0 4(50) 5(50) 0	100	23.91
9	0 74(50) 89(50) 0	100	133.60
10	0 79(22) 95(78) 0	100	120.00
11	0 16(22) 32(78) 0	100	40.01
12	0 77(22) 93(78) 0	100	120.00
13	0 115(78) 99(22) 0	100	160.00
14	0 68(22) 84(78) 0	100	119.99
15	0 69(22) 85(78) 0	100	120.00
16	0 70(50) 69(50) 0	100	119.51
17	0 36(50) 19(50) 0	100	63.84
18	0 98(22) 146(78) 0	100	200.01
19	0 39(50) 24(50) 0	100	63.82
20	0 12(22) 28(78) 0	100	40.01
21	0 66(22) 82(78) 0	100	119.99
22	0 7(28) 6(72) 0	100	23.90
23	0 39(22) 55(78) 0	100	80.00
24	0 74(22) 90(78) 0	100	120.01
25	0 10(50) 9(44) 0	94	23.91
26	0 76(72) 92(28) 0	100	120.00
27	0 36(22) 52(78) 0	100	79.99
28	0 62(28) 78(72) 0	100	100.01
29	0 41(22) 57(78) 0	100	80.00
30	0 22(50) 7(44) 0	94	41.42
31	0 126(78) 110(22) 0	100	159.99
32	0 10(22) 26(78) 0	100	40.00
33	0 83(78) 0	78	120.01

(cont.)

Table A.132 continued.

No.	Route	Load	Distance
34	0 65(22) 81(78) 0	100	120.00
35	0 15(22) 31(78) 0	100	39.99
36	0 44(22) 60(78) 0	100	79.99
37	0 22(28) 38(72) 0	100	60.01
38	0 30(78) 0	78	40.00
39	0 80(22) 96(78) 0	100	120.00
40	0 59(28) 43(72) 0	100	80.00
41	0 51(50) 66(50) 0	100	110.10
42	0 88(78) 0	78	120.00
43	0 75(22) 91(78) 0	100	120.00
44	0 80(50) 65(50) 0	100	119.51
45	0 2(22) 18(78) 0	100	40.00
46	0 29(28) 45(72) 0	100	60.00
47	0 23(78) 0	78	39.99
48	0 34(22) 50(78) 0	100	80.01
49	0 75(50) 59(50) 0	100	100.00
50	0 79(50) 48(50) 0	100	105.06
51	0 15(50) 16(50) 0	100	23.90
52	0 109(22) 125(78) 0	100	160.00
53	0 11(72) 0	72	20.00
54	0 19(28) 35(72) 0	100	59.99
55	0 33(50) 34(50) 0	100	71.71
56	0 1(22) 17(78) 0	100	40.00
57	0 100(50) 132(50) 0	100	180.00
58	0 9(28) 8(72) 0	100	23.91
59	0 42(50) 41(50) 0	100	71.71
60	0 63(78) 0	78	80.00
61	0 51(28) 67(72) 0	100	100.00
62	0 62(50) 46(50) 0	100	80.00
63	0 48(22) 64(78) 0	100	79.99
64	0 37(22) 53(78) 0	100	80.00
65	0 71(50) 56(50) 0	100	110.11
66	0 13(22) 61(78) 0	100	80.00

(cont.)

Table A.132 continued.

No.	Route	Load	Distance
67	0 27(78) 0	78	39.99
68	0 110(22) 158(78) 0	100	199.99
69	0 138(50) 106(50) 0	100	179.99
70	0 122(78) 106(22) 0	100	160.00
71	0 89(28) 73(72) 0	100	120.00
72	0 14(72) 0	72	20.00
73	0 5(22) 21(78) 0	100	40.00
74	0 47(72) 0	72	60.01
75	0 46(22) 94(78) 0	100	120.00
76	0 3(72) 0	72	20.00
77	0 113(52) 97(48) 0	100	160.00
78	0 13(50) 12(50) 0	100	23.91
79	0 25(78) 0	78	40.00
80	0 116(78) 100(22) 0	100	160.00
81	0 117(52) 101(48) 0	100	160.00
82	0 150(78) 102(22) 0	100	200.00
83	0 119(78) 103(22) 0	100	159.99
84	0 104(72) 120(28) 0	100	160.00
85	0 123(28) 107(72) 0	100	160.00
86	0 92(50) 77(50) 0	100	133.59
87	0 157(50) 109(50) 0	100	200.00
88	0 71(22) 87(78) 0	100	120.00
89	0 127(50) 143(50) 0	100	180.00
90	0 112(72) 128(28) 0	100	160.01
91	0 98(50) 114(50) 0	100	160.00
92	0 131(50) 99(50) 0	100	180.00
93	0 117(26) 133(50) 101(24) 0	100	180.00
94	0 102(50) 118(50) 0	100	160.00
95	0 103(50) 135(50) 0	100	180.00
96	0 105(22) 121(78) 0	100	160.00
97	0 44(50) 29(50) 0	100	63.82
98	0 140(22) 156(78) 0	100	199.99
99	0 33(22) 49(78) 0	100	80.00

(cont.)

Table A.132 continued.

No.	Route	Load	Distance
100	0 142(72) 110(28) 0	100	179.99
101	0 129(50) 113(26) 97(24) 0	100	180.00
102	0 114(28) 130(72) 0	100	180.00
103	0 68(50) 37(50) 0	100	105.07
104	0 149(78) 133(22) 0	100	200.00
105	0 118(28) 134(72) 0	100	180.00
106	0 151(78) 135(22) 0	100	200.01
107	0 120(50) 136(50) 0	100	180.01
108	0 105(50) 137(50) 0	100	180.00
109	0 154(78) 138(22) 0	100	200.00
110	0 123(50) 139(50) 0	100	180.00
111	0 140(50) 108(50) 0	100	179.99
112	0 157(28) 141(72) 0	100	200.00
113	0 127(28) 111(72) 0	100	160.00
114	0 128(50) 144(50) 0	100	180.00
115	0 129(22) 145(78) 0	100	200.00
116	0 131(22) 147(78) 0	100	200.00
117	0 132(22) 148(78) 0	100	200.01
118	0 152(78) 136(22) 0	100	199.99
119	0 137(22) 153(78) 0	100	200.00
120	0 155(78) 139(22) 0	100	200.00
121	0 108(22) 124(78) 0	100	160.00
122	0 143(22) 159(78) 0	100	200.00
123	0 160(78) 144(22) 0	100	199.99
		Total Distance	14420.21

Table A.133: EMIP-MDA+ERTR solution to MDA19 with $p = .3$.

No.	Route	Load	Distance
1	0 61(78) 45(22) 0	100	80.00
2	0 23(50) 39(50) 0	100	59.99
3	0 85(50) 101(50) 0	100	140.00
4	0 47(72) 31(28) 0	100	60.01
5	0 1(22) 18(78) 0	100	41.42
6	0 148(28) 132(72) 0	100	200.01
7	0 4(22) 20(78) 0	100	40.00
8	0 183(78) 167(22) 0	100	240.01
9	0 2(22) 19(78) 0	100	41.41
10	0 55(78) 39(22) 0	100	80.00
11	0 80(22) 64(78) 0	100	100.00
12	0 147(78) 131(22) 0	100	200.00
13	0 130(22) 178(78) 0	100	240.01
14	0 192(78) 176(22) 0	100	240.00
15	0 121(78) 73(22) 0	100	160.00
16	0 58(78) 42(22) 0	100	80.00
17	0 26(78) 0	78	40.00
18	0 22(78) 0	78	40.00
19	0 33(50) 17(50) 0	100	60.00
20	0 59(78) 43(22) 0	100	80.00
21	0 16(50) 1(50) 0	100	23.91
22	0 94(28) 78(72) 0	100	120.00
23	0 68(72) 84(28) 0	100	119.99
24	0 8(72) 0	72	20.00
25	0 88(78) 40(22) 0	100	120.00
26	0 43(50) 42(50) 0	100	71.71
27	0 6(50) 7(44) 0	94	23.90
28	0 175(22) 191(78) 0	100	240.01
29	0 101(22) 117(78) 0	100	160.00
30	0 30(78) 0	78	40.00
31	0 105(72) 89(28) 0	100	140.00
32	0 90(78) 74(22) 0	100	120.01
33	0 29(28) 44(72) 0	100	63.82

(cont.)

Table A.133 continued.

No.	Route	Load	Distance
34	0 7(28) 38(72) 0	100	61.12
35	0 13(72) 12(28) 0	100	23.91
36	0 32(78) 16(22) 0	100	40.01
37	0 122(78) 74(22) 0	100	160.00
38	0 73(50) 89(50) 0	100	120.00
39	0 4(22) 52(78) 0	100	79.99
40	0 62(78) 0	78	80.00
41	0 15(72) 0	72	20.00
42	0 25(78) 9(22) 0	100	40.00
43	0 33(22) 49(78) 0	100	80.00
44	0 92(28) 76(72) 0	100	120.00
45	0 70(72) 53(28) 0	100	110.11
46	0 86(78) 37(22) 0	100	124.26
47	0 187(78) 171(22) 0	100	239.99
48	0 54(78) 6(22) 0	100	80.01
49	0 129(22) 145(78) 0	100	200.00
50	0 10(44) 9(50) 0	94	23.91
51	0 48(72) 17(28) 0	100	63.83
52	0 40(50) 41(50) 0	100	71.71
53	0 175(50) 159(50) 0	100	220.00
54	0 177(78) 161(22) 0	100	240.00
55	0 12(22) 60(78) 0	100	79.99
56	0 100(22) 116(78) 0	100	160.00
57	0 14(50) 31(50) 0	100	41.41
58	0 171(50) 139(50) 0	100	220.00
59	0 142(72) 158(28) 0	100	199.99
60	0 129(50) 161(50) 0	100	220.00
61	0 140(72) 156(28) 0	100	199.99
62	0 35(50) 34(50) 0	100	71.71
63	0 174(72) 190(28) 0	100	240.00
64	0 71(72) 87(28) 0	100	120.00
65	0 146(78) 130(22) 0	100	200.01
66	0 67(50) 83(50) 0	100	120.01

(cont.)

Table A.133 continued.

No.	Route	Load	Distance
67	0 12(22) 28(78) 0	100	40.01
68	0 27(78) 0	78	39.99
69	0 56(78) 0	78	79.99
70	0 136(50) 168(50) 0	100	219.99
71	0 103(22) 151(78) 0	100	200.01
72	0 106(72) 74(28) 0	100	139.99
73	0 35(22) 51(78) 0	100	79.99
74	0 190(50) 158(50) 0	100	240.00
75	0 189(50) 157(50) 0	100	240.00
76	0 124(78) 108(22) 0	100	160.00
77	0 79(72) 95(28) 0	100	120.00
78	0 112(72) 96(28) 0	100	140.01
79	0 98(50) 82(50) 0	100	140.00
80	0 114(78) 98(22) 0	100	160.00
81	0 180(78) 164(22) 0	100	240.00
82	0 118(50) 102(50) 0	100	160.00
83	0 92(50) 108(50) 0	100	140.01
84	0 166(50) 167(50) 0	100	262.93
85	0 137(72) 153(28) 0	100	200.00
86	0 69(72) 85(28) 0	100	120.00
87	0 45(50) 29(50) 0	100	60.00
88	0 155(78) 139(22) 0	100	200.00
89	0 65(50) 97(50) 0	100	140.00
90	0 123(78) 107(22) 0	100	160.00
91	0 5(22) 21(78) 0	100	40.00
92	0 67(22) 115(78) 0	100	160.00
93	0 131(50) 179(26) 163(24) 0	100	239.99
94	0 24(78) 0	78	40.01
95	0 136(22) 152(78) 0	100	199.99
96	0 113(78) 97(22) 0	100	160.00
97	0 168(22) 184(78) 0	100	240.00
98	0 109(22) 125(78) 0	100	160.00
99	0 14(22) 46(72) 0	94	60.01

(cont.)

Table A.133 continued.

No.	Route	Load	Distance
100	0 91(50) 107(50) 0	100	139.99
101	0 144(72) 128(24) 0	96	180.00
102	0 96(50) 80(50) 0	100	120.00
103	0 162(72) 130(28) 0	100	220.00
104	0 100(50) 84(50) 0	100	140.00
105	0 102(22) 150(78) 0	100	200.00
106	0 153(50) 169(50) 0	100	220.00
107	0 4(28) 36(72) 0	100	60.01
108	0 119(28) 135(72) 0	100	180.00
109	0 170(72) 186(28) 0	100	240.00
110	0 157(28) 141(72) 0	100	200.00
111	0 110(72) 126(28) 0	100	159.99
112	0 143(72) 159(28) 0	100	200.00
113	0 93(28) 77(72) 0	100	120.00
114	0 57(78) 41(22) 0	100	80.00
115	0 91(28) 75(72) 0	100	120.00
116	0 164(50) 148(50) 0	100	220.01
117	0 133(72) 149(28) 0	100	200.00
118	0 93(50) 109(50) 0	100	140.00
119	0 185(78) 169(22) 0	100	240.00
120	0 104(50) 87(50) 0	100	157.19
121	0 126(50) 94(50) 0	100	159.99
122	0 53(50) 37(50) 0	100	80.00
123	0 95(50) 111(50) 0	100	140.01
124	0 188(26) 172(24) 156(50) 0	100	240.00
125	0 160(46) 128(54) 0	100	199.99
126	0 10(28) 11(72) 0	100	23.90
127	0 179(52) 163(48) 0	100	239.99
128	0 3(72) 0	72	20.00
129	0 149(50) 165(50) 0	100	220.00
130	0 182(78) 166(22) 0	100	240.01
131	0 154(50) 186(50) 0	100	240.00
132	0 134(72) 118(28) 0	100	180.00

(cont.)

Table A.133 continued.

No.	Route	Load	Distance
133	0 120(78) 104(22) 0	100	160.00
134	0 138(72) 154(28) 0	100	200.00
135	0 34(22) 50(78) 0	100	80.01
136	0 188(52) 172(48) 0	100	240.00
137	0 189(28) 173(72) 0	100	240.00
138	0 82(28) 66(72) 0	100	119.99
139	0 72(72) 23(28) 0	100	102.43
140	0 160(32) 176(50) 0	82	220.00
141	0 2(50) 5(50) 0	100	31.11
142	0 83(28) 99(72) 0	100	140.01
143	0 165(22) 181(78) 0	100	240.00
144	0 63(78) 0	78	80.00
145	0 119(50) 103(50) 0	100	159.99
146	0 81(78) 65(22) 0	100	120.00
147	0 127(78) 111(22) 0	100	160.00
		Total Distance	20355.71

Table A.134: EMIP-MDA+ERTR solution to MDA20 with $p = .3$.

No.	Route	Load	Distance
1	0 135(78) 99(22) 0	100	239.99
2	0 27(72) 0	72	60.00
3	0 171(50) 147(50) 0	100	299.99
4	0 155(50) 167(50) 0	100	279.99
5	0 109(28) 97(72) 0	100	200.00
6	0 175(22) 187(78) 0	100	320.00
7	0 34(50) 21(50) 0	100	66.15
8	0 182(78) 26(22) 0	100	320.01
9	0 15(78) 0	78	40.00
10	0 25(22) 37(78) 0	100	80.00
11	0 5(22) 41(78) 0	100	80.00
12	0 22(78) 0	78	40.00
13	0 104(72) 116(28) 0	100	200.00
14	0 128(22) 140(78) 0	100	240.00
15	0 2(22) 14(78) 0	100	40.00
16	0 92(78) 80(22) 0	100	160.00
17	0 21(28) 33(72) 0	100	60.00
18	0 161(78) 149(22) 0	100	280.00
19	0 63(78) 51(22) 0	100	120.00
20	0 83(72) 71(28) 0	100	140.00
21	0 99(50) 111(50) 0	100	200.00
22	0 122(72) 110(28) 0	100	220.00
23	0 67(50) 79(50) 0	100	140.00
24	0 152(50) 164(50) 0	100	280.00
25	0 75(72) 39(28) 0	100	140.00
26	0 93(28) 105(72) 0	100	180.01
27	0 232(78) 220(22) 0	100	400.00
28	0 61(50) 25(50) 0	100	120.00
29	0 112(78) 76(22) 0	100	200.00
30	0 197(22) 233(78) 0	100	400.00
31	0 62(78) 50(22) 0	100	120.00
32	0 49(72) 61(28) 0	100	120.00
33	0 38(28) 74(72) 0	100	140.00

(cont.)

Table A.134 continued.

No.	Route	Load	Distance
34	0 206(78) 194(22) 0	100	360.01
35	0 123(72) 111(28) 0	100	220.00
36	0 102(50) 114(50) 0	100	200.01
37	0 68(28) 56(72) 0	100	119.99
38	0 109(50) 121(50) 0	100	220.00
39	0 218(50) 194(50) 0	100	380.01
40	0 70(28) 58(72) 0	100	120.00
41	0 52(22) 64(78) 0	100	120.00
42	0 16(78) 4(22) 0	100	40.00
43	0 78(50) 54(50) 0	100	140.00
44	0 90(78) 78(22) 0	100	160.01
45	0 81(72) 69(28) 0	100	140.01
46	0 53(22) 89(78) 0	100	160.00
47	0 117(28) 129(72) 0	100	220.01
48	0 169(22) 181(78) 0	100	320.00
49	0 163(28) 151(72) 0	100	280.00
50	0 127(50) 115(50) 0	100	220.00
51	0 141(78) 0	78	240.00
52	0 131(22) 143(78) 0	100	239.99
53	0 226(72) 214(28) 0	100	380.00
54	0 145(50) 157(50) 0	100	280.00
55	0 77(72) 53(28) 0	100	140.00
56	0 47(78) 0	78	79.99
57	0 51(50) 39(50) 0	100	100.00
58	0 134(28) 146(72) 0	100	259.99
59	0 98(72) 50(28) 0	100	180.00
60	0 60(72) 72(28) 0	100	120.01
61	0 43(28) 31(72) 0	100	80.00
62	0 102(22) 138(78) 0	100	240.00
63	0 165(50) 153(50) 0	100	279.99
64	0 6(72) 0	72	20.00
65	0 115(28) 103(72) 0	100	200.00
66	0 82(50) 70(50) 0	100	140.00

(cont.)

Table A.134 continued.

No.	Route	Load	Distance
67	0 106(50) 130(50) 0	100	220.00
68	0 186(78) 150(22) 0	100	320.00
69	0 42(78) 0	78	80.00
70	0 137(28) 173(72) 0	100	300.00
71	0 88(28) 100(72) 0	100	180.00
72	0 68(50) 80(50) 0	100	140.00
73	0 36(50) 12(50) 0	100	60.00
74	0 219(26) 231(24) 207(50) 0	100	400.00
75	0 154(22) 166(78) 0	100	280.00
76	0 106(22) 118(78) 0	100	200.00
77	0 44(50) 43(50) 0	100	100.70
78	0 183(78) 171(22) 0	100	319.99
79	0 1(50) 2(50) 0	100	25.18
80	0 3(72) 0	72	20.00
81	0 40(28) 124(72) 0	100	220.00
82	0 213(50) 189(50) 0	100	359.99
83	0 32(72) 44(28) 0	100	80.00
84	0 107(72) 119(28) 0	100	200.00
85	0 145(22) 157(28) 169(50) 0	100	300.00
86	0 55(72) 67(28) 0	100	120.00
87	0 1(22) 13(78) 0	100	40.00
88	0 29(72) 17(28) 0	100	60.00
89	0 101(50) 113(50) 0	100	200.00
90	0 10(72) 9(28) 0	100	25.18
91	0 71(50) 59(50) 0	100	120.00
92	0 57(50) 69(50) 0	100	120.01
93	0 190(78) 178(22) 0	100	320.00
94	0 195(72) 207(28) 0	100	359.99
95	0 72(50) 84(50) 0	100	140.01
96	0 20(78) 8(22) 0	100	40.00
97	0 114(28) 126(72) 0	100	220.01
98	0 215(28) 203(72) 0	100	360.01
99	0 155(22) 191(78) 0	100	320.01

(cont.)

Table A.134 continued.

No.	Route	Load	Distance
100	0 18(50) 17(50) 0	100	50.35
101	0 8(50) 7(50) 0	100	25.18
102	0 133(78) 121(22) 0	100	240.00
103	0 57(22) 45(78) 0	100	100.01
104	0 148(48) 136(52) 0	100	260.00
105	0 137(50) 149(50) 0	100	260.00
106	0 222(22) 234(78) 0	100	400.00
107	0 211(28) 199(72) 0	100	360.00
108	0 214(50) 202(50) 0	100	360.00
109	0 227(22) 239(78) 0	100	400.00
110	0 228(50) 204(50) 0	100	380.00
111	0 85(50) 110(50) 0	100	230.43
112	0 36(22) 48(78) 0	100	80.01
113	0 66(78) 54(22) 0	100	120.00
114	0 19(78) 7(22) 0	100	40.00
115	0 152(22) 188(78) 0	100	320.00
116	0 170(72) 158(28) 0	100	299.99
117	0 238(78) 202(22) 0	100	400.00
118	0 144(78) 132(22) 0	100	240.00
119	0 230(78) 218(22) 0	100	400.01
120	0 87(78) 0	78	160.00
121	0 136(26) 148(24) 160(50) 0	100	280.00
122	0 208(78) 0	78	360.00
123	0 163(50) 175(50) 0	100	300.00
124	0 108(22) 120(78) 0	100	199.99
125	0 180(22) 192(78) 0	100	320.00
126	0 53(22) 65(78) 0	100	120.00
127	0 204(22) 216(78) 0	100	360.00
128	0 229(78) 217(22) 0	100	400.00
129	0 217(50) 205(50) 0	100	380.00
130	0 160(28) 172(72) 0	100	300.00
131	0 113(28) 125(72) 0	100	220.00
132	0 162(28) 174(72) 0	100	300.00

(cont.)

Table A.134 continued.

No.	Route	Load	Distance
133	0 153(22) 237(78) 0	100	399.99
134	0 200(28) 224(72) 0	100	380.01
135	0 201(72) 189(28) 0	100	340.00
136	0 240(78) 228(22) 0	100	400.00
137	0 227(50) 215(50) 0	100	380.00
138	0 84(22) 96(78) 0	100	160.01
139	0 219(46) 231(54) 0	100	400.00
140	0 197(50) 209(50) 0	100	360.00
141	0 162(50) 150(50) 0	100	280.00
142	0 164(28) 176(72) 0	100	300.00
143	0 117(50) 93(50) 0	100	200.01
144	0 134(50) 158(50) 0	100	279.99
145	0 131(50) 119(50) 0	100	220.00
146	0 168(78) 180(22) 0	100	300.00
147	0 193(72) 205(28) 0	100	360.00
148	0 28(72) 0	72	60.00
149	0 40(24) 52(50) 40(26) 0	100	100.00
150	0 184(28) 196(72) 0	100	340.00
151	0 11(50) 9(44) 0	94	30.00
152	0 198(72) 210(28) 0	100	360.00
153	0 79(22) 91(78) 0	100	160.00
154	0 236(78) 200(22) 0	100	400.01
155	0 177(72) 165(28) 0	100	300.00
156	0 142(78) 130(22) 0	100	240.00
157	0 108(50) 132(50) 0	100	220.00
158	0 46(78) 34(22) 0	100	80.00
159	0 5(50) 4(50) 0	100	25.18
160	0 159(78) 147(22) 0	100	279.99
161	0 86(78) 50(22) 0	100	160.00
162	0 221(72) 209(28) 0	100	380.00
163	0 222(50) 210(50) 0	100	380.00
164	0 223(50) 211(50) 0	100	380.00
165	0 94(78) 82(22) 0	100	160.00

(cont.)

Table A.134 continued.

No.	Route	Load	Distance
166	0 116(50) 128(50) 0	100	220.00
167	0 178(50) 154(50) 0	100	300.00
168	0 95(78) 59(22) 0	100	160.00
169	0 101(22) 185(78) 0	100	320.00
170	0 213(28) 225(72) 0	100	379.99
171	0 180(28) 156(72) 0	100	300.00
172	0 167(28) 179(72) 0	100	300.01
173	0 88(50) 76(50) 0	100	160.00
174	0 26(50) 38(50) 0	100	80.00
175	0 35(72) 11(22) 0	94	60.00
176	0 73(72) 85(28) 0	100	160.00
177	0 220(50) 184(50) 0	100	380.00
178	0 18(28) 30(72) 0	100	60.00
179	0 139(78) 127(22) 0	100	240.00
180	0 200(22) 212(78) 0	100	359.99
181	0 223(22) 235(78) 0	100	400.00
182	0 12(22) 24(78) 0	100	40.00
183	0 23(78) 0	78	40.00
		Total Distance	40018.33

Table A.135: EMIP-MDA+ERTR solution to MDA21 with $p = .3$.

No.	Route	Load	Distance
1	0 92(78) 0	78	39.99
2	0 235(78) 163(22) 0	100	80.00
3	0 35(22) 106(78) 0	100	40.08
4	0 19(44) 23(50) 0	94	23.48
5	0 44(28) 43(72) 0	100	20.86
6	0 154(22) 226(78) 0	100	79.99
7	0 116(78) 44(22) 0	100	39.99
8	0 93(54) 91(46) 0	100	43.49
9	0 179(72) 107(28) 0	100	59.99
10	0 211(50) 212(50) 0	100	62.62
11	0 37(22) 109(78) 0	100	40.00
12	0 198(72) 127(24) 0	96	60.24
13	0 79(78) 0	78	40.00
14	0 208(72) 0	72	60.01
15	0 9(72) 8(28) 0	100	20.87
16	0 22(72) 0	72	20.00
17	0 94(78) 0	78	40.00
18	0 251(78) 0	78	80.00
19	0 162(50) 161(50) 0	100	62.61
20	0 77(54) 76(32) 0	86	41.74
21	0 41(72) 0	72	20.01
22	0 99(78) 0	78	39.99
23	0 224(78) 0	78	80.00
24	0 169(72) 0	72	60.00
25	0 134(78) 0	78	39.99
26	0 78(54) 76(46) 0	100	43.48
27	0 271(78) 199(22) 0	100	80.00
28	0 66(50) 67(44) 0	94	20.88
29	0 177(44) 105(54) 0	98	60.00
30	0 121(32) 120(54) 0	86	41.74
31	0 229(28) 230(28) 231(28) 0	84	86.98
32	0 162(22) 234(78) 0	100	80.01
33	0 86(50) 85(50) 0	100	41.75

(cont.)

Table A.135 continued.

No.	Route	Load	Distance
34	0 57(72) 58(28) 0	100	20.87
35	0 177(28) 178(72) 0	100	62.61
36	0 62(72) 0	72	19.99
37	0 270(78) 0	78	80.01
38	0 258(78) 0	78	79.99
39	0 11(72) 0	72	20.00
40	0 124(78) 0	78	40.00
41	0 52(44) 54(50) 0	94	21.75
42	0 1(22) 73(78) 0	100	40.00
43	0 54(22) 126(78) 0	100	39.99
44	0 89(54) 91(32) 0	86	43.49
45	0 17(72) 0	72	20.01
46	0 24(72) 0	72	20.00
47	0 86(28) 158(72) 0	100	60.00
48	0 170(72) 26(22) 0	94	60.01
49	0 2(72) 0	72	20.00
50	0 245(78) 172(22) 0	100	80.44
51	0 244(50) 243(24) 242(24) 0	98	86.98
52	0 282(78) 66(22) 0	100	80.00
53	0 129(54) 128(32) 0	86	41.74
54	0 93(24) 168(72) 0	96	61.88
55	0 40(50) 39(50) 0	100	20.87
56	0 44(22) 115(78) 0	100	40.07
57	0 266(78) 194(22) 0	100	80.00
58	0 145(22) 218(78) 0	100	80.45
59	0 244(28) 243(54) 0	82	83.48
60	0 193(50) 194(50) 0	100	62.62
61	0 136(78) 64(22) 0	100	39.99
62	0 121(46) 118(54) 0	100	45.22
63	0 149(28) 150(72) 0	100	62.62
64	0 236(78) 164(22) 0	100	80.00
65	0 111(50) 184(50) 0	100	60.23
66	0 212(22) 284(78) 0	100	80.00

(cont.)

Table A.135 continued.

No.	Route	Load	Distance
67	0 53(72) 0	72	20.01
68	0 223(78) 0	78	80.00
69	0 6(72) 0	72	20.00
70	0 219(78) 0	78	80.00
71	0 183(72) 111(28) 0	100	59.99
72	0 10(72) 0	72	20.00
73	0 204(22) 277(78) 0	100	80.44
74	0 143(78) 0	78	40.01
75	0 182(72) 0	72	60.01
76	0 231(50) 230(50) 0	100	83.50
77	0 253(78) 181(22) 0	100	80.00
78	0 200(22) 272(78) 0	100	80.00
79	0 239(46) 240(54) 0	100	83.49
80	0 12(72) 0	72	20.00
81	0 159(72) 0	72	60.00
82	0 18(72) 0	72	20.00
83	0 21(72) 0	72	20.01
84	0 48(72) 0	72	20.00
85	0 241(50) 240(24) 238(24) 0	98	90.47
86	0 117(78) 0	78	39.99
87	0 164(50) 163(50) 0	100	62.62
88	0 249(78) 0	78	80.00
89	0 263(78) 0	78	80.01
90	0 203(28) 202(72) 0	100	62.62
91	0 147(72) 0	72	59.99
92	0 222(78) 149(22) 0	100	80.44
93	0 5(22) 220(78) 0	100	80.05
94	0 119(78) 0	78	40.00
95	0 110(78) 38(22) 0	100	39.99
96	0 63(22) 135(78) 0	100	39.99
97	0 88(78) 0	78	40.00
98	0 114(78) 0	78	40.00
99	0 61(22) 133(78) 0	100	40.00

(cont.)

Table A.135 continued.

No.	Route	Load	Distance
100	0 61(50) 59(50) 0	100	21.75
101	0 27(28) 171(72) 0	100	59.99
102	0 200(50) 199(50) 0	100	62.62
103	0 191(72) 47(22) 0	94	60.01
104	0 56(72) 0	72	20.00
105	0 173(72) 28(28) 0	100	60.06
106	0 197(72) 125(28) 0	100	59.99
107	0 70(72) 0	72	20.00
108	0 288(78) 216(22) 0	100	80.01
109	0 96(78) 0	78	40.00
110	0 36(72) 0	72	20.00
111	0 138(78) 0	78	39.99
112	0 74(78) 0	78	39.99
113	0 246(78) 0	78	80.00
114	0 232(78) 0	78	80.00
115	0 221(78) 149(22) 0	100	80.00
116	0 257(78) 185(22) 0	100	80.00
117	0 40(22) 112(78) 0	100	40.00
118	0 241(28) 242(54) 0	82	83.48
119	0 5(50) 8(44) 0	94	22.62
120	0 267(78) 195(22) 0	100	80.01
121	0 90(78) 0	78	39.99
122	0 83(78) 0	78	40.00
123	0 105(24) 176(72) 0	96	60.23
124	0 69(72) 0	72	20.01
125	0 15(72) 0	72	20.01
126	0 81(78) 0	78	40.00
127	0 42(72) 0	72	20.00
128	0 145(22) 217(78) 0	100	80.00
129	0 265(78) 193(22) 0	100	80.00
130	0 123(78) 0	78	39.99
131	0 274(78) 203(22) 0	100	80.45
132	0 125(50) 47(50) 0	100	42.40

(cont.)

Table A.135 continued.

No.	Route	Load	Distance
133	0 71(72) 0	72	20.01
134	0 102(78) 0	78	39.99
135	0 13(22) 84(78) 0	100	40.07
136	0 216(50) 215(50) 0	100	62.61
137	0 250(78) 0	78	80.01
138	0 210(72) 0	72	60.00
139	0 25(72) 0	72	20.00
140	0 225(78) 153(22) 0	100	80.00
141	0 259(78) 187(22) 0	100	80.00
142	0 254(78) 0	78	80.00
143	0 142(28) 213(72) 0	100	60.23
144	0 252(78) 180(22) 0	100	80.01
145	0 122(78) 0	78	40.00
146	0 152(72) 0	72	60.00
147	0 248(78) 32(22) 0	100	80.00
148	0 87(78) 0	78	39.99
149	0 26(50) 27(44) 0	94	20.87
150	0 207(22) 279(78) 0	100	80.01
151	0 175(50) 172(50) 0	100	67.83
152	0 229(50) 228(50) 0	100	83.48
153	0 285(78) 0	78	80.01
154	0 49(72) 0	72	20.00
155	0 38(50) 37(50) 0	100	20.87
156	0 276(78) 204(22) 0	100	79.99
157	0 34(72) 35(28) 0	100	20.87
158	0 46(72) 0	72	20.00
159	0 189(22) 261(78) 0	100	80.00
160	0 268(78) 195(22) 0	100	80.45
161	0 4(28) 3(72) 0	100	20.87
162	0 269(78) 0	78	80.00
163	0 89(24) 160(72) 0	96	60.23
164	0 211(22) 283(78) 0	100	80.01
165	0 39(22) 255(78) 0	100	79.99

(cont.)

Table A.135 continued.

No.	Route	Load	Distance
166	0 227(78) 13(22) 0	100	80.20
167	0 141(78) 0	78	39.99
168	0 55(72) 0	72	20.00
169	0 104(78) 32(22) 0	100	40.00
170	0 185(50) 187(50) 0	100	65.23
171	0 72(72) 0	72	20.00
172	0 281(78) 0	78	80.01
173	0 215(22) 287(78) 0	100	80.00
174	0 85(28) 157(72) 0	100	60.00
175	0 181(50) 180(50) 0	100	62.63
176	0 103(50) 107(50) 0	100	46.95
177	0 214(50) 142(50) 0	100	60.01
178	0 203(22) 275(78) 0	100	80.00
179	0 30(72) 0	72	20.00
180	0 95(78) 23(22) 0	100	39.99
181	0 190(72) 118(24) 0	96	60.01
182	0 80(78) 0	78	39.99
183	0 75(78) 0	78	40.01
184	0 78(24) 151(72) 0	96	60.23
185	0 50(72) 0	72	20.00
186	0 60(72) 0	72	19.99
187	0 145(28) 146(72) 0	100	62.62
188	0 7(72) 0	72	20.00
189	0 209(72) 137(28) 0	100	60.01
190	0 192(72) 120(24) 0	96	60.00
191	0 137(50) 0	50	40.00
192	0 31(72) 32(28) 0	100	20.87
193	0 97(78) 0	78	40.00
194	0 189(50) 188(50) 0	100	62.62
195	0 207(50) 206(50) 0	100	62.62
196	0 108(78) 35(22) 0	100	40.07
197	0 63(50) 64(50) 0	100	20.87
198	0 51(72) 52(28) 0	100	20.87

(cont.)

Table A.135 continued.

No.	Route	Load	Distance
199	0 101(78) 29(22) 0	100	40.00
200	0 273(78) 0	78	79.99
201	0 82(78) 0	78	39.99
202	0 65(72) 0	72	20.00
203	0 139(78) 0	78	40.00
204	0 33(72) 0	72	20.01
205	0 228(28) 156(72) 0	100	80.00
206	0 16(72) 0	72	20.00
207	0 29(50) 28(44) 0	94	20.87
208	0 175(22) 247(78) 0	100	80.00
209	0 154(50) 153(50) 0	100	62.61
210	0 166(22) 237(78) 0	100	80.44
211	0 165(72) 166(22) 0	94	62.61
212	0 206(22) 278(78) 0	100	80.00
213	0 45(72) 0	72	20.00
214	0 144(78) 0	78	39.99
215	0 131(78) 58(22) 0	100	40.07
216	0 233(78) 161(22) 0	100	80.00
217	0 174(72) 103(28) 0	100	60.22
218	0 127(54) 128(46) 0	100	41.74
219	0 196(72) 195(28) 0	100	62.61
220	0 264(78) 0	78	80.00
221	0 98(78) 0	78	39.99
222	0 201(72) 129(24) 0	96	59.99
223	0 130(78) 58(22) 0	100	40.00
224	0 256(78) 184(22) 0	100	80.00
225	0 239(32) 238(54) 0	86	83.50
226	0 205(72) 204(28) 0	100	62.62
227	0 286(78) 214(22) 0	100	80.01
228	0 19(28) 20(72) 0	100	20.87
229	0 280(78) 0	78	80.00
230	0 148(72) 77(24) 0	96	60.23
231	0 155(72) 0	72	59.99

(cont.)

Table A.135 continued.

No.	Route	Load	Distance
232	0 167(72) 166(28) 0	100	62.62
233	0 140(78) 0	78	40.00
234	0 262(78) 0	78	80.00
235	0 186(72) 0	72	60.00
236	0 100(78) 0	78	39.99
237	0 260(78) 188(22) 0	100	80.00
238	0 68(72) 67(28) 0	100	20.87
239	0 1(50) 4(44) 0	94	22.61
240	0 132(78) 59(22) 0	100	40.08
241	0 14(72) 13(28) 0	100	20.87
242	0 113(78) 0	78	39.99
		Total Distance	12652.93

Table A.136: EMIP-MDA+ERTR solution to MDA1 with $p = .4$.

No.	Route	Load	Distance
1	0 2(50) 3(50) 0	100	34.14
2	0 1(50) 4(50) 0	100	34.14
3	0 1(34) 5(66) 0	100	40.00
4	0 2(34) 6(66) 0	100	40.00
5	0 3(34) 7(66) 0	100	40.00
6	0 4(34) 8(66) 0	100	40.00
		Total Distance	228.28

Table A.137: EMIP-MDA+ERTR solution to MDA2 with $p = .4$.

No.	Route	Load	Distance
1	0 9(50) 1(50) 0	100	60.00
2	0 10(50) 2(50) 0	100	60.00
3	0 11(50) 3(50) 0	100	60.00
4	0 12(50) 4(50) 0	100	60.00
5	0 1(34) 5(66) 0	100	40.00
6	0 2(34) 6(66) 0	100	40.00
7	0 3(34) 7(66) 0	100	40.00
8	0 4(34) 8(66) 0	100	40.00
9	0 13(66) 9(34) 0	100	80.00
10	0 15(66) 11(34) 0	100	80.00
11	0 16(66) 12(34) 0	100	80.00
12	0 10(34) 14(66) 0	100	80.00
		Total Distance	720.00

Table A.138: EMIP-MDA+ERTR solution to MDA3 with $p = .4$.

No.	Route	Load	Distance
1	0 2(50) 3(50) 0	100	27.65
2	0 5(50) 4(50) 0	100	27.65
3	0 7(50) 6(50) 0	100	27.65
4	0 1(50) 8(50) 0	100	27.65
5	0 1(34) 9(66) 0	100	40.00
6	0 2(34) 10(66) 0	100	39.99
7	0 3(34) 11(66) 0	100	40.00
8	0 4(34) 12(66) 0	100	39.99
9	0 5(34) 13(66) 0	100	40.00
10	0 6(34) 14(66) 0	100	39.99
11	0 7(34) 15(66) 0	100	40.00
12	0 8(34) 16(66) 0	100	39.99
		Total Distance	430.58

Table A.139: EMIP-MDA+ERTR solution to MDA4 with $p = .4$.

No.	Route	Load	Distance
1	0 1(50) 2(50) 0	100	25.18
2	0 3(50) 4(50) 0	100	25.18
3	0 6(50) 5(50) 0	100	25.18
4	0 18(66) 6(34) 0	100	40.00
5	0 19(66) 7(34) 0	100	40.00
6	0 7(50) 8(50) 0	100	25.18
7	0 9(50) 10(50) 0	100	25.18
8	0 12(50) 11(50) 0	100	25.18
9	0 1(34) 13(66) 0	100	40.00
10	0 2(34) 14(66) 0	100	40.00
11	0 3(34) 15(66) 0	100	40.00
12	0 4(34) 16(66) 0	100	40.00
13	0 5(34) 17(66) 0	100	40.00
14	0 8(34) 20(66) 0	100	40.00
15	0 9(34) 21(66) 0	100	40.00
16	0 10(34) 22(66) 0	100	40.00
17	0 11(34) 23(66) 0	100	40.00
18	0 12(34) 24(66) 0	100	40.00
		Total Distance	631.05

Table A.140: EMIP-MDA+ERTR solution to MDA5 with $p = .4$.

No.	Route	Load	Distance
1	0 1(84) 0	84	20.00
2	0 3(50) 2(50) 0	100	27.65
3	0 11(66) 3(34) 0	100	40.00
4	0 4(84) 0	84	20.00
5	0 5(84) 0	84	20.00
6	0 7(50) 6(50) 0	100	27.65
7	0 15(66) 7(34) 0	100	40.00
8	0 8(84) 0	84	20.00
9	0 2(34) 10(66) 0	100	39.99
10	0 12(34) 13(66) 0	100	55.30
11	0 6(34) 14(66) 0	100	39.99
12	0 9(34) 16(66) 0	100	55.30
13	0 9(32) 17(50) 0	82	60.00
14	0 26(66) 18(34) 0	100	79.99
15	0 18(50) 19(50) 0	100	82.95
16	0 20(84) 0	84	59.99
17	0 22(50) 21(50) 0	100	82.96
18	0 31(66) 23(34) 0	100	80.00
19	0 23(50) 24(50) 0	100	82.96
20	0 17(34) 25(66) 0	100	80.00
21	0 19(34) 27(66) 0	100	80.00
22	0 12(32) 28(66) 0	98	80.00
23	0 21(34) 29(66) 0	100	80.00
24	0 22(34) 30(66) 0	100	80.00
25	0 24(34) 32(66) 0	100	80.00
		Total Distance	1414.75

Table A.141: EMIP-MDA+ERTR solution to MDA6 with $p = .4$.

No.	Route	Load	Distance
1	0 1(50) 16(50) 0	100	23.91
2	0 3(50) 2(50) 0	100	23.90
3	0 4(84) 0	84	20.00
4	0 5(84) 0	84	20.00
5	0 6(84) 0	84	20.00
6	0 7(84) 0	84	20.00
7	0 8(84) 0	84	20.00
8	0 9(84) 0	84	20.00
9	0 10(84) 0	84	20.00
10	0 11(84) 0	84	20.00
11	0 12(84) 0	84	20.00
12	0 13(84) 0	84	20.00
13	0 14(84) 0	84	20.00
14	0 15(84) 0	84	20.00
15	0 18(66) 2(34) 0	100	40.00
16	0 16(34) 32(66) 0	100	40.01
17	0 3(34) 19(66) 0	100	39.99
18	0 21(34) 20(66) 0	100	47.80
19	0 21(32) 22(66) 0	98	47.80
20	0 24(32) 23(66) 0	98	47.80
21	0 24(34) 25(66) 0	100	47.81
22	0 27(32) 26(66) 0	98	47.81
23	0 28(66) 27(34) 0	100	47.80
24	0 30(34) 29(66) 0	100	47.80
25	0 31(66) 30(32) 0	98	47.81
26	0 17(66) 1(34) 0	100	40.00
		Total Distance	830.26

Table A.142: EMIP-MDA+ERTR solution to MDA7 with $p = .4$.

No.	Route	Load	Distance
1	0 6(66) 2(34) 0	100	40.00
2	0 2(50) 3(50) 0	100	34.14
3	0 1(50) 4(50) 0	100	34.14
4	0 1(34) 5(66) 0	100	40.00
5	0 3(34) 7(66) 0	100	40.00
6	0 4(34) 8(66) 0	100	40.00
7	0 14(66) 10(34) 0	100	80.00
8	0 19(50) 11(50) 0	100	100.00
9	0 9(34) 13(66) 0	100	80.00
10	0 11(34) 15(66) 0	100	80.00
11	0 12(34) 16(66) 0	100	80.00
12	0 9(50) 17(50) 0	100	100.00
13	0 10(50) 18(50) 0	100	100.00
14	0 12(50) 20(50) 0	100	100.00
15	0 17(34) 21(66) 0	100	120.00
16	0 18(34) 22(66) 0	100	120.00
17	0 19(34) 23(66) 0	100	120.00
18	0 20(34) 24(66) 0	100	120.00
19	0 33(50) 25(50) 0	100	180.00
20	0 34(50) 26(50) 0	100	180.00
21	0 35(50) 27(50) 0	100	180.00
22	0 32(66) 28(34) 0	100	160.00
23	0 25(34) 29(66) 0	100	160.00
24	0 26(34) 30(66) 0	100	160.00
25	0 27(34) 31(66) 0	100	160.00
26	0 28(50) 36(50) 0	100	180.00
27	0 33(34) 37(66) 0	100	200.00
28	0 34(34) 38(66) 0	100	200.00
29	0 35(34) 39(66) 0	100	200.00
30	0 36(34) 40(66) 0	100	200.00
		Total Distance	3588.28

Table A.143: EMIP-MDA+ERTR solution to MDA8 with $p = .4$.

No.	Route	Load	Distance
1	0 5(66) 1(34) 0	100	40.00
2	0 33(50) 41(50) 0	100	220.00
3	0 43(50) 35(50) 0	100	220.00
4	0 11(50) 3(50) 0	100	60.00
5	0 2(34) 6(66) 0	100	40.00
6	0 3(34) 7(66) 0	100	40.00
7	0 4(34) 8(66) 0	100	40.00
8	0 4(50) 12(50) 0	100	60.00
9	0 9(34) 13(66) 0	100	80.00
10	0 10(34) 14(66) 0	100	80.00
11	0 11(34) 15(66) 0	100	80.00
12	0 12(34) 16(66) 0	100	80.00
13	0 21(66) 17(34) 0	100	120.00
14	0 42(50) 34(50) 0	100	220.00
15	0 1(50) 9(50) 0	100	60.00
16	0 28(50) 20(50) 0	100	140.00
17	0 34(34) 38(66) 0	100	200.00
18	0 43(34) 47(66) 0	100	240.00
19	0 20(34) 24(66) 0	100	120.00
20	0 10(50) 2(50) 0	100	60.00
21	0 30(66) 26(34) 0	100	160.00
22	0 19(50) 27(50) 0	100	140.00
23	0 32(66) 28(34) 0	100	160.00
24	0 41(34) 45(66) 0	100	240.00
25	0 27(34) 31(66) 0	100	160.00
26	0 39(66) 35(34) 0	100	200.00
27	0 44(50) 36(50) 0	100	220.00
28	0 33(34) 37(66) 0	100	200.00
29	0 18(34) 22(66) 0	100	120.00
30	0 44(34) 48(66) 0	100	240.00
31	0 17(50) 25(50) 0	100	140.00
32	0 18(50) 26(50) 0	100	140.00
33	0 23(66) 19(34) 0	100	120.00
34	0 40(66) 36(34) 0	100	200.00
35	0 25(34) 29(66) 0	100	160.00
36	0 42(34) 46(66) 0	100	240.00
		Total Distance	5040.00

Table A.144: EMIP-MDA+ERTR solution to MDA9 with $p = .4$.

No.	Route	Load	Distance
1	0 2(50) 1(50) 0	100	25.18
2	0 4(50) 3(50) 0	100	25.18
3	0 5(84) 0	84	20.00
4	0 6(84) 0	84	20.00
5	0 8(50) 7(50) 0	100	25.18
6	0 9(84) 0	84	20.00
7	0 10(84) 0	84	20.00
8	0 23(66) 11(34) 0	100	40.00
9	0 11(50) 12(50) 0	100	25.18
10	0 1(34) 13(66) 0	100	40.00
11	0 2(34) 14(66) 0	100	40.00
12	0 3(34) 15(66) 0	100	40.00
13	0 4(34) 16(66) 0	100	40.00
14	0 18(66) 17(27) 0	93	50.35
15	0 7(34) 19(66) 0	100	40.00
16	0 8(34) 20(66) 0	100	40.00
17	0 22(27) 21(66) 0	93	50.35
18	0 34(50) 22(39) 0	89	60.00
19	0 12(34) 24(66) 0	100	40.00
20	0 25(50) 26(50) 0	100	75.53
21	0 28(50) 27(50) 0	100	75.53
22	0 17(39) 29(50) 0	89	60.00
23	0 30(50) 31(50) 0	100	75.53
24	0 44(66) 32(34) 0	100	80.00
25	0 32(50) 33(50) 0	100	75.53
26	0 47(66) 35(34) 0	100	79.99
27	0 35(50) 36(50) 0	100	75.53
28	0 25(34) 37(66) 0	100	80.00
29	0 26(34) 38(66) 0	100	80.00
30	0 27(34) 39(66) 0	100	80.00
31	0 28(34) 40(66) 0	100	80.00
32	0 29(34) 41(66) 0	100	80.00
33	0 30(34) 42(66) 0	100	80.00

(cont.)

Table A.144 continued.

No.	Route	Load	Distance
34	0 31(34) 43(66) 0	100	80.00
35	0 33(34) 45(66) 0	100	80.00
36	0 34(34) 46(66) 0	100	80.00
37	0 36(34) 48(66) 0	100	80.01
		Total Distance	2059.03

Table A.145: EMIP-MDA+ERTR solution to MDA10 with $p = .4$.

No.	Route	Load	Distance
1	0 62(66) 46(34) 0	100	80.00
2	0 16(50) 1(50) 0	100	23.91
3	0 19(66) 3(34) 0	100	39.99
4	0 5(84) 0	84	20.00
5	0 6(84) 0	84	20.00
6	0 27(66) 0	66	39.99
7	0 8(34) 24(66) 0	100	40.01
8	0 10(84) 0	84	20.00
9	0 11(84) 0	84	20.00
10	0 9(84) 0	84	20.00
11	0 14(84) 0	84	20.00
12	0 15(84) 0	84	20.00
13	0 2(50) 3(50) 0	100	23.90
14	0 63(66) 31(34) 0	100	80.00
15	0 4(84) 0	84	20.00
16	0 20(66) 21(32) 0	98	47.80
17	0 22(66) 21(34) 0	100	47.80
18	0 23(66) 7(34) 0	100	39.99
19	0 25(66) 26(27) 0	93	47.80
20	0 13(50) 12(50) 0	100	23.91
21	0 8(50) 7(50) 0	100	23.90
22	0 12(34) 28(66) 0	100	40.01
23	0 13(34) 29(66) 0	100	40.00
24	0 1(34) 17(66) 0	100	40.00
25	0 30(66) 31(32) 0	98	47.81
26	0 32(66) 16(34) 0	100	40.01
27	0 49(66) 33(34) 0	100	80.00
28	0 35(50) 34(50) 0	100	71.71
29	0 36(50) 37(50) 0	100	71.71
30	0 38(50) 39(50) 0	100	71.71
31	0 26(39) 42(50) 0	89	60.01
32	0 41(50) 40(50) 0	100	71.71
33	0 43(50) 44(50) 0	100	71.71

(cont.)

Table A.145 continued.

No.	Route	Load	Distance
34	0 46(50) 45(50) 0	100	71.71
35	0 47(84) 0	84	60.01
36	0 33(50) 48(50) 0	100	71.71
37	0 50(66) 34(34) 0	100	80.01
38	0 35(34) 51(66) 0	100	79.99
39	0 52(66) 36(34) 0	100	79.99
40	0 38(34) 54(66) 0	100	80.01
41	0 53(66) 37(34) 0	100	80.00
42	0 56(66) 40(34) 0	100	79.99
43	0 55(66) 39(34) 0	100	80.00
44	0 41(34) 57(66) 0	100	80.00
45	0 59(66) 43(34) 0	100	80.00
46	0 58(66) 42(34) 0	100	80.00
47	0 44(34) 60(66) 0	100	79.99
48	0 61(66) 45(34) 0	100	80.00
49	0 64(66) 48(34) 0	100	79.99
50	0 18(66) 2(34) 0	100	40.00
		Total Distance	2708.80

Table A.146: EMIP-MDA+ERTR solution to MDA11 with $p = .4$.

No.	Route	Load	Distance
1	0 57(50) 49(50) 0	100	300.00
2	0 15(66) 11(34) 0	100	80.00
3	0 12(50) 4(50) 0	100	60.00
4	0 1(34) 5(66) 0	100	40.00
5	0 10(34) 14(66) 0	100	80.00
6	0 8(66) 4(34) 0	100	40.00
7	0 10(50) 2(50) 0	100	60.00
8	0 1(50) 9(50) 0	100	60.00
9	0 9(34) 13(66) 0	100	80.00
10	0 2(34) 6(66) 0	100	40.00
11	0 35(34) 39(66) 0	100	200.00
12	0 20(34) 24(66) 0	100	120.00
13	0 74(50) 66(50) 0	100	380.00
14	0 19(50) 27(50) 0	100	140.00
15	0 60(50) 52(50) 0	100	300.00
16	0 17(34) 21(66) 0	100	120.00
17	0 22(66) 18(34) 0	100	120.00
18	0 7(66) 3(34) 0	100	40.00
19	0 12(34) 16(66) 0	100	80.00
20	0 11(50) 3(50) 0	100	60.00
21	0 40(66) 36(34) 0	100	200.00
22	0 41(34) 45(66) 0	100	240.00
23	0 38(66) 34(34) 0	100	200.00
24	0 51(34) 55(66) 0	100	280.00
25	0 37(66) 33(34) 0	100	200.00
26	0 58(50) 50(50) 0	100	300.00
27	0 35(50) 51(50) 0	100	260.00
28	0 36(50) 44(50) 0	100	220.00
29	0 30(66) 26(34) 0	100	160.00
30	0 31(66) 27(34) 0	100	160.00
31	0 48(66) 44(34) 0	100	240.00
32	0 17(50) 25(50) 0	100	140.00
33	0 25(34) 29(66) 0	100	160.00

(cont.)

Table A.146 continued.

No.	Route	Load	Distance
34	0 58(34) 62(66) 0	100	320.00
35	0 43(34) 47(66) 0	100	240.00
36	0 32(66) 28(34) 0	100	160.00
37	0 43(50) 59(50) 0	100	300.00
38	0 76(50) 68(50) 0	100	380.00
39	0 65(34) 69(66) 0	100	360.00
40	0 54(66) 50(34) 0	100	280.00
41	0 75(34) 79(66) 0	100	400.00
42	0 68(34) 72(66) 0	100	360.00
43	0 33(50) 41(50) 0	100	220.00
44	0 26(50) 18(50) 0	100	140.00
45	0 23(66) 19(34) 0	100	120.00
46	0 28(50) 20(50) 0	100	140.00
47	0 49(34) 53(66) 0	100	280.00
48	0 46(66) 42(34) 0	100	240.00
49	0 63(66) 59(34) 0	100	320.00
50	0 56(66) 52(34) 0	100	280.00
51	0 42(50) 34(50) 0	100	220.00
52	0 75(50) 67(50) 0	100	380.00
53	0 57(34) 61(66) 0	100	320.00
54	0 66(34) 70(66) 0	100	360.00
55	0 80(66) 76(34) 0	100	400.00
56	0 65(50) 73(50) 0	100	380.00
57	0 71(66) 67(34) 0	100	360.00
58	0 73(34) 77(66) 0	100	400.00
59	0 74(34) 78(66) 0	100	400.00
60	0 64(66) 60(34) 0	100	320.00
		Total Distance	13240.00

Table A.147: EMIP-MDA+ERTR solution to MDA12 with $p = .4$.

No.	Route	Load	Distance
1	0 1(50) 8(50) 0	100	27.65
2	0 2(84) 0	84	20.00
3	0 43(66) 35(34) 0	100	120.00
4	0 4(84) 0	84	20.00
5	0 5(84) 0	84	20.00
6	0 65(50) 49(50) 0	100	180.00
7	0 62(66) 54(34) 0	100	160.00
8	0 67(34) 75(66) 0	100	200.00
9	0 38(50) 30(34) 0	84	100.00
10	0 64(66) 56(34) 0	100	160.00
11	0 78(66) 70(34) 0	100	200.00
12	0 18(34) 26(66) 0	100	79.99
13	0 1(34) 9(66) 0	100	40.00
14	0 80(66) 72(34) 0	100	200.00
15	0 53(34) 61(66) 0	100	160.00
16	0 10(66) 0	66	39.99
17	0 6(50) 7(50) 0	100	27.65
18	0 36(34) 28(66) 0	100	100.00
19	0 39(50) 23(50) 0	100	100.00
20	0 22(84) 0	84	60.01
21	0 50(34) 58(66) 0	100	160.00
22	0 42(66) 34(34) 0	100	120.01
23	0 77(66) 69(34) 0	100	200.00
24	0 60(39) 68(50) 0	89	180.00
25	0 71(50) 55(50) 0	100	180.00
26	0 51(34) 59(66) 0	100	160.00
27	0 32(66) 24(34) 0	100	80.00
28	0 33(34) 41(66) 0	100	120.00
29	0 7(34) 15(66) 0	100	40.00
30	0 68(34) 76(66) 0	100	200.01
31	0 17(34) 25(66) 0	100	80.00
32	0 13(66) 6(34) 0	100	44.74
33	0 23(34) 31(66) 0	100	80.00

(cont.)

Table A.147 continued.

No.	Route	Load	Distance
34	0 72(50) 56(50) 0	100	180.00
35	0 69(50) 53(50) 0	100	180.00
36	0 66(50) 50(50) 0	100	180.00
37	0 39(34) 47(66) 0	100	120.00
38	0 17(50) 33(50) 0	100	100.00
39	0 65(34) 73(66) 0	100	200.00
40	0 54(50) 70(50) 0	100	180.00
41	0 52(84) 0	84	139.99
42	0 30(32) 14(66) 0	98	80.00
43	0 66(34) 74(66) 0	100	200.00
44	0 67(50) 51(50) 0	100	180.00
45	0 11(66) 0	66	40.00
46	0 19(34) 27(66) 0	100	80.00
47	0 21(50) 37(50) 0	100	100.00
48	0 40(50) 24(50) 0	100	100.00
49	0 45(66) 37(34) 0	100	120.00
50	0 49(34) 57(66) 0	100	160.00
51	0 21(34) 29(66) 0	100	80.00
52	0 20(50) 36(50) 0	100	100.00
53	0 19(50) 35(50) 0	100	100.00
54	0 60(27) 44(66) 0	93	159.99
55	0 18(50) 34(50) 0	100	100.00
56	0 16(66) 8(34) 0	100	39.99
57	0 38(34) 46(66) 0	100	120.00
58	0 55(34) 63(66) 0	100	160.00
59	0 79(66) 71(34) 0	100	200.00
60	0 20(34) 12(66) 0	100	59.99
61	0 3(84) 0	84	20.00
62	0 48(66) 40(34) 0	100	120.00
		Total Distance	7260.01

Table A.148: EMIP-MDA+ERTR solution to MDA13 with $p = .4$.

No.	Route	Load	Distance
1	0 18(50) 17(50) 0	100	82.95
2	0 3(84) 0	84	20.00
3	0 4(84) 0	84	20.00
4	0 33(50) 65(50) 0	100	180.00
5	0 6(84) 0	84	20.00
6	0 14(66) 7(34) 0	100	44.73
7	0 56(50) 40(50) 0	100	140.01
8	0 65(34) 73(66) 0	100	200.00
9	0 31(66) 15(27) 0	93	80.00
10	0 2(34) 10(66) 0	100	39.99
11	0 52(34) 60(66) 0	100	159.99
12	0 22(50) 5(50) 0	100	64.00
13	0 18(34) 26(66) 0	100	79.99
14	0 54(50) 38(50) 0	100	139.99
15	0 8(34) 16(66) 0	100	39.99
16	0 19(84) 0	84	60.00
17	0 20(84) 0	84	59.99
18	0 21(84) 0	84	60.00
19	0 95(66) 87(34) 0	100	240.00
20	0 23(84) 0	84	60.00
21	0 24(34) 32(66) 0	100	80.00
22	0 49(34) 57(66) 0	100	160.00
23	0 43(66) 51(34) 0	100	140.00
24	0 12(34) 11(66) 0	100	55.30
25	0 29(34) 61(66) 0	100	160.00
26	0 45(66) 29(32) 0	98	120.00
27	0 1(50) 2(50) 0	100	27.65
28	0 67(84) 0	84	180.00
29	0 69(34) 77(66) 0	100	200.00
30	0 8(50) 7(50) 0	100	27.65
31	0 39(50) 55(50) 0	100	140.00
32	0 86(50) 70(50) 0	100	220.00
33	0 40(34) 48(66) 0	100	120.00

(cont.)

Table A.148 continued.

No.	Route	Load	Distance
34	0 34(34) 42(66) 0	100	120.01
35	0 35(50) 51(50) 0	100	140.00
36	0 22(34) 30(66) 0	100	80.00
37	0 70(34) 78(66) 0	100	200.00
38	0 38(34) 46(66) 0	100	120.00
39	0 33(34) 41(66) 0	100	120.00
40	0 39(34) 47(66) 0	100	120.00
41	0 82(50) 66(50) 0	100	220.00
42	0 52(50) 36(50) 0	100	139.99
43	0 53(84) 0	84	140.00
44	0 81(34) 89(66) 0	100	240.00
45	0 72(50) 88(50) 0	100	220.00
46	0 1(34) 9(66) 0	100	40.00
47	0 58(66) 50(34) 0	100	160.00
48	0 27(66) 35(34) 0	100	100.00
49	0 37(84) 0	84	100.00
50	0 86(34) 94(66) 0	100	239.99
51	0 72(34) 80(66) 0	100	200.00
52	0 49(50) 81(50) 0	100	220.00
53	0 50(50) 34(50) 0	100	140.01
54	0 59(32) 75(66) 0	98	200.00
55	0 84(34) 92(66) 0	100	240.01
56	0 85(34) 93(66) 0	100	240.00
57	0 24(50) 15(39) 0	89	71.25
58	0 87(50) 71(50) 0	100	220.00
59	0 17(34) 25(66) 0	100	80.00
60	0 66(34) 74(66) 0	100	200.00
61	0 5(34) 13(66) 0	100	40.00
62	0 54(34) 62(66) 0	100	160.00
63	0 55(34) 63(66) 0	100	160.00
64	0 88(34) 96(66) 0	100	240.01
65	0 83(84) 0	84	220.00
66	0 84(50) 68(50) 0	100	220.01

(cont.)

Table A.148 continued.

No.	Route	Load	Distance
67	0 71(34) 79(66) 0	100	200.00
68	0 36(34) 44(66) 0	100	120.00
69	0 82(34) 90(66) 0	100	239.99
70	0 91(66) 59(34) 0	100	240.00
71	0 68(34) 76(66) 0	100	200.01
72	0 28(66) 12(32) 0	98	80.00
73	0 85(50) 69(50) 0	100	220.00
74	0 56(34) 64(66) 0	100	160.00
		Total Distance	10233.50

Table A.149: EMIP-MDA+ERTR solution to MDA14 with $p = .4$.

No.	Route	Load	Distance
1	0 2(84) 0	84	20.00
2	0 113(66) 101(34) 0	100	200.00
3	0 94(66) 82(34) 0	100	160.00
4	0 5(84) 0	84	20.00
5	0 6(84) 0	84	20.00
6	0 8(84) 0	84	20.00
7	0 97(34) 109(66) 0	100	200.00
8	0 63(66) 51(34) 0	100	120.00
9	0 81(50) 105(50) 0	100	180.01
10	0 100(34) 112(66) 0	100	200.00
11	0 70(66) 58(34) 0	100	120.00
12	0 84(34) 96(66) 0	100	160.01
13	0 3(50) 4(50) 0	100	25.18
14	0 48(66) 47(32) 0	98	100.70
15	0 16(66) 4(34) 0	100	40.00
16	0 31(50) 55(50) 0	100	100.00
17	0 61(27) 85(66) 0	93	160.00
18	0 52(50) 53(50) 0	100	125.88
19	0 118(66) 106(34) 0	100	200.00
20	0 25(34) 13(66) 0	100	60.00
21	0 98(34) 110(66) 0	100	200.00
22	0 28(84) 0	84	60.00
23	0 29(84) 0	84	60.00
24	0 74(50) 98(50) 0	100	180.00
25	0 117(66) 105(34) 0	100	200.01
26	0 88(66) 76(34) 0	100	160.00
27	0 80(50) 104(50) 0	100	180.00
28	0 75(50) 99(50) 0	100	180.00
29	0 22(66) 11(34) 0	100	42.39
30	0 36(84) 0	84	60.00
31	0 9(50) 7(50) 0	100	30.00
32	0 75(34) 87(66) 0	100	160.00
33	0 11(50) 10(50) 0	100	25.18

(cont.)

Table A.149 continued.

No.	Route	Load	Distance
34	0 83(34) 95(66) 0	100	160.00
35	0 39(66) 27(34) 0	100	80.00
36	0 90(66) 78(34) 0	100	160.01
37	0 12(50) 1(50) 0	100	25.18
38	0 119(66) 107(34) 0	100	200.00
39	0 24(66) 12(34) 0	100	40.00
40	0 79(50) 103(50) 0	100	180.00
41	0 81(34) 93(66) 0	100	160.01
42	0 44(66) 32(34) 0	100	80.00
43	0 25(50) 49(50) 0	100	100.00
44	0 41(66) 18(34) 0	100	84.78
45	0 59(84) 0	84	100.01
46	0 92(66) 80(34) 0	100	160.00
47	0 20(66) 9(34) 0	100	42.39
48	0 42(66) 30(34) 0	100	80.00
49	0 43(66) 31(34) 0	100	80.00
50	0 74(34) 86(66) 0	100	160.00
51	0 15(66) 3(34) 0	100	40.00
52	0 58(50) 34(50) 0	100	100.00
53	0 54(34) 66(66) 0	100	120.00
54	0 10(34) 21(66) 0	100	42.39
55	0 116(66) 104(34) 0	100	200.00
56	0 23(66) 35(34) 0	100	60.00
57	0 73(84) 0	84	140.00
58	0 60(50) 35(50) 0	100	108.32
59	0 53(34) 65(66) 0	100	120.00
60	0 37(66) 49(34) 0	100	100.00
61	0 111(66) 99(34) 0	100	200.00
62	0 57(50) 33(50) 0	100	100.01
63	0 51(50) 27(50) 0	100	100.00
64	0 78(50) 102(50) 0	100	180.01
65	0 89(66) 77(34) 0	100	160.00
66	0 62(66) 50(34) 0	100	120.00

(cont.)

Table A.149 continued.

No.	Route	Load	Distance
67	0 108(34) 120(66) 0	100	199.99
68	0 97(50) 61(39) 0	89	180.00
69	0 67(66) 55(34) 0	100	120.00
70	0 103(34) 115(66) 0	100	200.00
71	0 79(34) 91(66) 0	100	160.00
72	0 30(50) 54(50) 0	100	100.00
73	0 17(66) 18(32) 0	98	50.35
74	0 56(50) 32(50) 0	100	100.00
75	0 56(34) 68(66) 0	100	119.99
76	0 84(50) 108(50) 0	100	179.99
77	0 69(66) 57(34) 0	100	120.01
78	0 83(50) 107(50) 0	100	180.00
79	0 40(66) 0	66	80.00
80	0 46(66) 34(34) 0	100	80.00
81	0 72(66) 60(34) 0	100	120.01
82	0 77(50) 101(50) 0	100	180.01
83	0 45(66) 33(34) 0	100	80.00
84	0 38(66) 26(34) 0	100	80.00
85	0 64(66) 52(34) 0	100	120.00
86	0 71(66) 47(34) 0	100	120.00
87	0 102(34) 114(66) 0	100	200.01
88	0 19(66) 7(34) 0	100	40.00
89	0 82(50) 106(50) 0	100	180.00
90	0 50(50) 26(50) 0	100	100.00
91	0 100(50) 76(50) 0	100	180.00
92	0 14(66) 1(34) 0	100	42.39
		Total Distance	10865.15

Table A.150: EMIP-MDA+ERTR solution to MDA15 with $p = .4$.

No.	Route	Load	Distance
1	0 2(84) 0	84	20.00
2	0 73(50) 49(50) 0	100	140.00
3	0 4(34) 16(66) 0	100	40.00
4	0 60(34) 72(66) 0	100	120.01
5	0 7(84) 0	84	20.00
6	0 8(84) 0	84	20.00
7	0 53(34) 65(66) 0	100	120.00
8	0 9(84) 0	84	20.00
9	0 11(84) 0	84	20.00
10	0 117(66) 105(34) 0	100	200.01
11	0 83(50) 59(50) 0	100	140.00
12	0 59(34) 71(66) 0	100	120.00
13	0 55(34) 67(66) 0	100	120.00
14	0 80(50) 56(50) 0	100	140.00
15	0 82(50) 58(50) 0	100	140.00
16	0 31(84) 0	84	60.00
17	0 32(84) 0	84	60.00
18	0 10(84) 0	84	20.00
19	0 84(50) 60(50) 0	100	140.01
20	0 129(34) 141(66) 0	100	240.00
21	0 77(34) 89(66) 0	100	160.00
22	0 68(66) 56(34) 0	100	119.99
23	0 33(84) 0	84	60.00
24	0 97(34) 109(66) 0	100	200.00
25	0 26(34) 38(66) 0	100	80.00
26	0 57(34) 69(66) 0	100	120.01
27	0 58(34) 70(66) 0	100	120.00
28	0 102(50) 126(50) 0	100	220.01
29	0 22(66) 0	66	40.00
30	0 73(34) 85(66) 0	100	160.00
31	0 135(66) 123(34) 0	100	239.99
32	0 50(34) 62(66) 0	100	120.00
33	0 53(50) 29(50) 0	100	100.00

(cont.)

Table A.150 continued.

No.	Route	Load	Distance
34	0 28(84) 0	84	60.00
35	0 12(34) 24(66) 0	100	40.00
36	0 5(34) 17(66) 0	100	40.00
37	0 128(34) 140(66) 0	100	240.00
38	0 104(34) 116(66) 0	100	200.00
39	0 74(50) 50(50) 0	100	140.00
40	0 49(34) 61(66) 0	100	120.00
41	0 121(34) 133(66) 0	100	240.00
42	0 98(50) 122(50) 0	100	220.00
43	0 75(50) 51(50) 0	100	140.00
44	0 6(34) 18(66) 0	100	40.00
45	0 36(34) 48(66) 0	100	80.01
46	0 105(50) 129(50) 0	100	220.01
47	0 19(66) 20(32) 0	98	50.35
48	0 134(66) 122(34) 0	100	239.99
49	0 128(50) 104(50) 0	100	220.00
50	0 1(34) 13(66) 0	100	40.00
51	0 30(34) 42(66) 0	100	80.00
52	0 81(34) 93(66) 0	100	160.01
53	0 83(34) 95(66) 0	100	160.00
54	0 5(50) 6(50) 0	100	25.18
55	0 118(66) 106(34) 0	100	200.00
56	0 107(34) 119(66) 0	100	200.00
57	0 75(34) 87(66) 0	100	160.00
58	0 97(50) 121(50) 0	100	220.00
59	0 76(84) 0	84	140.00
60	0 79(50) 55(50) 0	100	140.00
61	0 79(34) 91(66) 0	100	160.00
62	0 90(66) 78(34) 0	100	160.01
63	0 20(34) 21(66) 0	100	50.35
64	0 81(50) 57(50) 0	100	140.01
65	0 51(34) 63(66) 0	100	120.00
66	0 77(50) 78(50) 0	100	176.23

(cont.)

Table A.150 continued.

No.	Route	Load	Distance
67	0 35(34) 47(66) 0	100	79.99
68	0 52(50) 40(39) 0	89	100.00
69	0 26(50) 27(50) 0	100	75.53
70	0 44(32) 45(66) 0	98	100.70
71	0 80(34) 92(66) 0	100	160.00
72	0 29(34) 41(66) 0	100	80.00
73	0 82(34) 94(66) 0	100	160.00
74	0 108(34) 120(66) 0	100	199.99
75	0 36(50) 12(50) 0	100	60.00
76	0 100(84) 0	84	180.00
77	0 101(50) 125(50) 0	100	220.00
78	0 102(34) 114(66) 0	100	200.01
79	0 25(50) 1(50) 0	100	60.00
80	0 23(66) 0	66	40.00
81	0 110(66) 98(34) 0	100	200.00
82	0 137(66) 125(34) 0	100	240.00
83	0 34(34) 46(66) 0	100	80.00
84	0 40(27) 39(66) 0	93	100.70
85	0 139(66) 127(34) 0	100	240.00
86	0 99(50) 123(50) 0	100	220.00
87	0 3(50) 4(50) 0	100	25.18
88	0 64(66) 52(34) 0	100	120.00
89	0 3(34) 14(66) 0	100	42.39
90	0 84(34) 96(66) 0	100	160.01
91	0 27(34) 15(66) 0	100	60.00
92	0 44(34) 43(66) 0	100	100.70
93	0 25(34) 37(66) 0	100	80.00
94	0 112(66) 88(34) 0	100	200.00
95	0 136(66) 88(32) 0	98	240.00
96	0 54(50) 30(50) 0	100	100.00
97	0 115(66) 103(34) 0	100	200.00
98	0 101(34) 113(66) 0	100	200.00
99	0 106(50) 130(50) 0	100	220.00

(cont.)

Table A.150 continued.

No.	Route	Load	Distance
100	0 107(50) 131(50) 0	100	220.00
101	0 108(50) 132(50) 0	100	220.00
102	0 74(34) 86(66) 0	100	160.00
103	0 103(50) 127(50) 0	100	220.00
104	0 111(66) 99(34) 0	100	200.00
105	0 124(84) 0	84	220.00
106	0 126(34) 138(66) 0	100	240.00
107	0 34(50) 35(50) 0	100	75.53
108	0 54(34) 66(66) 0	100	120.00
109	0 130(34) 142(66) 0	100	240.00
110	0 131(34) 143(66) 0	100	239.99
111	0 132(34) 144(66) 0	100	240.00
		Total Distance	15202.85

Table A.151: EMIP-MDA+ERTR solution to MDA16 with $p = .4$.

No.	Route	Load	Distance
1	0 1(84) 0	84	20.00
2	0 2(84) 0	84	20.00
3	0 3(84) 0	84	20.01
4	0 4(84) 0	84	20.00
5	0 5(84) 0	84	20.01
6	0 6(84) 0	84	20.00
7	0 7(84) 0	84	20.00
8	0 8(84) 0	84	20.00
9	0 9(84) 0	84	20.00
10	0 10(84) 0	84	20.00
11	0 11(84) 0	84	20.00
12	0 12(84) 0	84	20.00
13	0 13(84) 0	84	20.00
14	0 14(84) 0	84	20.00
15	0 15(84) 0	84	20.01
16	0 16(84) 0	84	20.00
17	0 17(84) 0	84	20.01
18	0 18(84) 0	84	20.00
19	0 19(84) 0	84	20.00
20	0 20(84) 0	84	20.00
21	0 21(84) 0	84	20.01
22	0 22(84) 0	84	20.00
23	0 23(84) 0	84	20.01
24	0 24(84) 0	84	20.00
25	0 25(84) 0	84	20.00
26	0 26(84) 0	84	20.00
27	0 27(84) 0	84	20.00
28	0 28(84) 0	84	20.00
29	0 29(84) 0	84	20.00
30	0 30(84) 0	84	20.00
31	0 31(84) 0	84	20.00
32	0 32(84) 0	84	20.00
33	0 34(84) 0	84	20.00

(cont.)

Table A.151 continued.

No.	Route	Load	Distance
34	0 103(34) 104(66) 0	100	41.75
35	0 35(84) 0	84	20.01
36	0 36(84) 0	84	20.00
37	0 37(84) 0	84	20.00
38	0 38(84) 0	84	20.00
39	0 39(84) 0	84	20.01
40	0 41(84) 0	84	20.01
41	0 40(84) 0	84	20.00
42	0 43(84) 0	84	20.00
43	0 42(84) 0	84	20.00
44	0 44(84) 0	84	19.99
45	0 45(84) 0	84	20.00
46	0 47(84) 0	84	20.00
47	0 46(84) 0	84	20.00
48	0 48(84) 0	84	20.00
49	0 49(84) 0	84	20.00
50	0 50(84) 0	84	20.00
51	0 51(84) 0	84	20.01
52	0 52(84) 0	84	20.00
53	0 53(84) 0	84	20.01
54	0 54(84) 0	84	20.00
55	0 55(84) 0	84	20.00
56	0 56(84) 0	84	20.00
57	0 57(84) 0	84	20.01
58	0 58(84) 0	84	20.00
59	0 60(84) 0	84	19.99
60	0 59(84) 0	84	20.01
61	0 61(84) 0	84	20.00
62	0 62(84) 0	84	19.99
63	0 63(84) 0	84	20.00
64	0 64(84) 0	84	20.00
65	0 65(84) 0	84	20.00
66	0 66(84) 0	84	20.00

(cont.)

Table A.151 continued.

No.	Route	Load	Distance
67	0 68(84) 0	84	20.00
68	0 67(84) 0	84	20.00
69	0 70(84) 0	84	20.00
70	0 69(84) 0	84	20.01
71	0 71(84) 0	84	20.01
72	0 72(84) 0	84	20.00
73	0 81(66) 82(32) 0	98	41.74
74	0 79(34) 78(66) 0	100	41.75
75	0 73(34) 144(66) 0	100	41.75
76	0 83(66) 82(34) 0	100	41.74
77	0 142(34) 143(66) 0	100	41.75
78	0 80(66) 79(32) 0	98	41.74
79	0 76(32) 75(66) 0	98	41.76
80	0 84(66) 85(34) 0	100	41.74
81	0 85(32) 86(66) 0	98	41.75
82	0 88(34) 87(66) 0	100	41.74
83	0 89(66) 88(32) 0	98	41.76
84	0 90(66) 91(34) 0	100	41.74
85	0 91(32) 92(66) 0	98	41.74
86	0 95(32) 93(66) 0	98	43.49
87	0 94(66) 95(34) 0	100	41.74
88	0 96(66) 97(32) 0	98	41.75
89	0 97(34) 98(66) 0	100	41.74
90	0 101(66) 100(32) 0	98	41.74
91	0 102(66) 103(32) 0	98	41.74
92	0 100(34) 99(66) 0	100	41.74
93	0 33(84) 0	84	20.01
94	0 109(34) 108(66) 0	100	41.74
95	0 112(32) 111(66) 0	98	41.75
96	0 106(34) 105(66) 0	100	41.74
97	0 128(66) 127(32) 0	98	41.74
98	0 107(66) 106(32) 0	98	41.76
99	0 125(66) 124(34) 0	100	41.75

(cont.)

Table A.151 continued.

No.	Route	Load	Distance
100	0 115(32) 114(66) 0	98	41.75
101	0 109(32) 110(66) 0	98	41.74
102	0 118(34) 119(66) 0	100	41.74
103	0 121(32) 122(66) 0	98	41.75
104	0 133(32) 134(66) 0	98	41.74
105	0 112(34) 113(66) 0	100	41.75
106	0 121(34) 120(66) 0	100	41.74
107	0 115(34) 116(66) 0	100	41.74
108	0 118(32) 117(66) 0	98	41.74
109	0 129(66) 130(32) 0	98	41.75
110	0 127(34) 126(66) 0	100	41.75
111	0 124(32) 123(66) 0	98	41.74
112	0 131(66) 130(34) 0	100	41.75
113	0 136(34) 135(66) 0	100	41.74
114	0 133(34) 132(66) 0	100	41.75
115	0 76(34) 77(66) 0	100	41.74
116	0 136(32) 137(66) 0	98	41.74
117	0 141(66) 142(32) 0	98	41.74
118	0 139(32) 138(66) 0	98	41.74
119	0 140(66) 139(34) 0	100	41.73
120	0 73(32) 74(66) 0	98	41.74
		Total Distance	3445.50

Table A.152: EMIP-MDA+ERTR solution to MDA17 with $p = .4$.

No.	Route	Load	Distance
1	0 160(66) 152(34) 0	100	400.00
2	0 10(66) 2(34) 0	100	39.99
3	0 11(66) 0	66	40.00
4	0 4(84) 0	84	20.00
5	0 6(84) 0	84	20.00
6	0 5(84) 0	84	20.00
7	0 7(50) 16(50) 0	100	44.73
8	0 101(34) 109(66) 0	100	280.00
9	0 33(34) 41(66) 0	100	120.00
10	0 28(66) 20(34) 0	100	80.00
11	0 64(27) 80(66) 0	93	200.00
12	0 3(84) 0	84	20.00
13	0 142(66) 134(34) 0	100	359.99
14	0 39(34) 47(66) 0	100	120.00
15	0 24(84) 0	84	60.01
16	0 78(66) 86(34) 0	100	220.00
17	0 125(66) 117(34) 0	100	320.00
18	0 26(66) 18(34) 0	100	79.99
19	0 21(84) 0	84	60.00
20	0 17(34) 25(66) 0	100	80.00
21	0 149(50) 133(50) 0	100	380.00
22	0 68(34) 76(66) 0	100	200.01
23	0 97(50) 113(50) 0	100	300.00
24	0 65(50) 81(50) 0	100	220.00
25	0 77(66) 69(34) 0	100	200.00
26	0 104(34) 112(66) 0	100	280.00
27	0 67(50) 51(50) 0	100	180.00
28	0 65(34) 73(66) 0	100	200.00
29	0 20(50) 12(39) 0	89	59.99
30	0 12(27) 29(66) 0	93	89.47
31	0 1(50) 2(50) 0	100	27.65
32	0 107(27) 123(66) 0	93	320.00
33	0 93(66) 85(34) 0	100	240.00

(cont.)

Table A.152 continued.

No.	Route	Load	Distance
34	0 98(34) 106(66) 0	100	280.00
35	0 120(50) 104(50) 0	100	300.00
36	0 74(66) 66(34) 0	100	200.00
37	0 158(66) 150(34) 0	100	400.00
38	0 88(50) 64(39) 0	89	220.00
39	0 39(50) 23(50) 0	100	100.00
40	0 114(50) 98(50) 0	100	300.00
41	0 32(66) 40(34) 0	100	100.00
42	0 103(34) 111(66) 0	100	280.00
43	0 94(66) 110(34) 0	100	280.00
44	0 38(50) 22(50) 0	100	100.00
45	0 52(50) 36(50) 0	100	139.99
46	0 144(66) 136(34) 0	100	360.00
47	0 56(50) 40(50) 0	100	140.01
48	0 68(50) 84(50) 0	100	220.01
49	0 132(50) 148(50) 0	100	380.00
50	0 114(34) 122(66) 0	100	319.99
51	0 137(66) 129(34) 0	100	360.00
52	0 88(34) 96(66) 0	100	240.01
53	0 82(34) 90(66) 0	100	239.99
54	0 16(16) 72(84) 0	100	180.00
55	0 97(34) 105(66) 0	100	280.00
56	0 38(34) 46(66) 0	100	120.00
57	0 37(50) 53(50) 0	100	140.00
58	0 19(34) 27(66) 0	100	80.00
59	0 61(66) 53(34) 0	100	160.00
60	0 84(34) 92(66) 0	100	240.01
61	0 35(34) 43(66) 0	100	120.00
62	0 128(66) 120(34) 0	100	320.01
63	0 70(50) 86(50) 0	100	220.00
64	0 55(84) 0	84	140.00
65	0 7(34) 15(66) 0	100	40.00
66	0 151(34) 159(66) 0	100	400.00

(cont.)

Table A.152 continued.

No.	Route	Load	Distance
67	0 42(66) 34(34) 0	100	120.01
68	0 8(84) 0	84	20.00
69	0 118(84) 0	84	300.00
70	0 83(84) 0	84	220.00
71	0 87(50) 103(50) 0	100	260.00
72	0 17(50) 18(50) 0	100	82.95
73	0 35(50) 19(50) 0	100	100.00
74	0 58(66) 50(34) 0	100	160.00
75	0 100(34) 108(66) 0	100	280.00
76	0 34(50) 50(50) 0	100	140.01
77	0 126(66) 110(32) 0	98	319.99
78	0 113(34) 121(66) 0	100	320.00
79	0 152(50) 136(50) 0	100	380.00
80	0 145(50) 129(50) 0	100	380.00
81	0 30(66) 22(34) 0	100	80.00
82	0 115(84) 0	84	300.00
83	0 59(66) 51(34) 0	100	160.00
84	0 13(66) 0	66	40.00
85	0 62(66) 70(34) 0	100	180.00
86	0 95(27) 79(66) 0	93	240.00
87	0 14(66) 0	66	39.99
88	0 66(50) 82(50) 0	100	220.00
89	0 102(84) 0	84	259.99
90	0 99(50) 147(50) 0	100	380.00
91	0 133(34) 141(66) 0	100	360.00
92	0 95(39) 119(50) 0	89	300.00
93	0 89(66) 81(34) 0	100	240.00
94	0 150(50) 134(50) 0	100	380.00
95	0 99(34) 91(66) 0	100	260.00
96	0 156(66) 148(34) 0	100	400.00
97	0 117(50) 101(50) 0	100	300.00
98	0 138(66) 130(34) 0	100	360.00
99	0 31(66) 23(34) 0	100	80.00

(cont.)

Table A.152 continued.

No.	Route	Load	Distance
100	0 49(50) 33(50) 0	100	140.00
101	0 71(84) 0	84	180.00
102	0 107(39) 131(50) 0	89	340.00
103	0 85(50) 69(50) 0	100	220.00
104	0 44(66) 36(34) 0	100	120.00
105	0 146(50) 130(50) 0	100	380.00
106	0 54(84) 0	84	139.99
107	0 139(66) 131(34) 0	100	360.00
108	0 153(66) 145(34) 0	100	400.00
109	0 48(66) 56(34) 0	100	140.01
110	0 147(34) 155(66) 0	100	400.00
111	0 124(66) 116(34) 0	100	319.99
112	0 149(34) 157(66) 0	100	400.00
113	0 63(66) 87(34) 0	100	220.00
114	0 135(34) 143(66) 0	100	360.00
115	0 9(66) 1(34) 0	100	40.00
116	0 37(34) 45(66) 0	100	120.00
117	0 140(66) 132(34) 0	100	360.00
118	0 151(50) 135(50) 0	100	380.00
119	0 52(34) 60(66) 0	100	159.99
120	0 146(34) 154(66) 0	100	400.00
121	0 100(50) 116(50) 0	100	300.00
122	0 49(34) 57(66) 0	100	160.00
123	0 127(66) 119(34) 0	100	320.00
124	0 67(34) 75(66) 0	100	200.00
		Total Distance	26904.73

Table A.153: EMIP-MDA+ERTR solution to MDA18 with $p = .4$.

No.	Route	Load	Distance
1	0 2(84) 0	84	20.00
2	0 1(84) 0	84	20.00
3	0 4(84) 0	84	20.00
4	0 3(84) 0	84	20.00
5	0 5(84) 0	84	20.00
6	0 41(50) 40(50) 0	100	71.71
7	0 8(84) 0	84	20.00
8	0 100(50) 132(50) 0	100	180.00
9	0 127(66) 111(34) 0	100	160.00
10	0 140(34) 156(66) 0	100	199.99
11	0 56(66) 40(34) 0	100	79.99
12	0 13(84) 0	84	20.00
13	0 142(50) 110(50) 0	100	179.99
14	0 14(84) 0	84	20.00
15	0 18(39) 19(39) 0	78	47.81
16	0 73(34) 89(66) 0	100	120.00
17	0 146(66) 130(34) 0	100	200.01
18	0 112(50) 65(50) 0	100	150.56
19	0 157(66) 141(34) 0	100	200.00
20	0 39(84) 0	84	59.99
21	0 7(50) 6(50) 0	100	23.90
22	0 58(66) 42(34) 0	100	80.00
23	0 76(50) 75(50) 0	100	119.51
24	0 139(34) 155(66) 0	100	200.00
25	0 29(66) 0	66	40.00
26	0 61(66) 30(27) 0	93	82.84
27	0 53(66) 37(34) 0	100	80.00
28	0 42(50) 43(50) 0	100	71.71
29	0 125(66) 109(34) 0	100	160.00
30	0 48(84) 0	84	60.00
31	0 34(84) 0	84	60.01
32	0 150(66) 134(34) 0	100	200.00
33	0 76(34) 92(66) 0	100	120.00

(cont.)

Table A.153 continued.

No.	Route	Load	Distance
34	0 99(34) 115(66) 0	100	160.00
35	0 133(50) 101(50) 0	100	180.00
36	0 98(50) 130(50) 0	100	180.00
37	0 97(34) 81(66) 0	100	140.00
38	0 132(34) 148(66) 0	100	200.01
39	0 122(66) 106(34) 0	100	160.00
40	0 85(66) 69(34) 0	100	120.00
41	0 45(84) 0	84	60.00
42	0 109(50) 141(50) 0	100	180.00
43	0 142(34) 158(66) 0	100	199.99
44	0 80(84) 0	84	100.00
45	0 33(84) 0	84	60.00
46	0 71(34) 87(66) 0	100	120.00
47	0 147(66) 131(34) 0	100	200.00
48	0 65(34) 49(66) 0	100	100.00
49	0 72(34) 88(66) 0	100	120.00
50	0 78(50) 77(50) 0	100	119.52
51	0 78(34) 94(66) 0	100	120.00
52	0 90(66) 74(34) 0	100	120.01
53	0 99(50) 131(50) 0	100	180.00
54	0 44(84) 0	84	59.99
55	0 140(50) 108(50) 0	100	179.99
56	0 24(66) 7(34) 0	100	41.43
57	0 11(50) 12(50) 0	100	23.90
58	0 104(34) 120(66) 0	100	160.00
59	0 54(66) 38(34) 0	100	80.01
60	0 137(34) 153(66) 0	100	200.00
61	0 68(84) 0	84	100.00
62	0 67(50) 66(50) 0	100	119.50
63	0 117(66) 101(34) 0	100	160.00
64	0 154(66) 138(34) 0	100	200.00
65	0 12(34) 28(66) 0	100	40.01
66	0 151(66) 135(34) 0	100	200.01

(cont.)

Table A.153 continued.

No.	Route	Load	Distance
67	0 35(50) 36(50) 0	100	71.71
68	0 112(34) 96(66) 0	100	140.01
69	0 15(50) 16(50) 0	100	23.90
70	0 16(34) 32(66) 0	100	40.01
71	0 22(32) 21(66) 0	98	47.80
72	0 17(66) 0	66	40.00
73	0 26(66) 10(34) 0	100	40.00
74	0 128(32) 113(66) 0	98	191.24
75	0 100(34) 116(66) 0	100	160.00
76	0 25(66) 9(34) 0	100	40.00
77	0 119(66) 103(34) 0	100	159.99
78	0 23(66) 6(34) 0	100	41.41
79	0 129(34) 145(66) 0	100	200.00
80	0 20(66) 0	66	40.00
81	0 108(34) 124(66) 0	100	160.00
82	0 11(34) 27(66) 0	100	39.99
83	0 64(66) 0	66	79.99
84	0 136(34) 152(66) 0	100	199.99
85	0 82(66) 66(34) 0	100	119.99
86	0 97(50) 129(50) 0	100	180.00
87	0 35(34) 51(66) 0	100	79.99
88	0 114(66) 98(34) 0	100	160.00
89	0 63(66) 47(34) 0	100	80.00
90	0 110(34) 126(66) 0	100	159.99
91	0 36(34) 52(66) 0	100	79.99
92	0 138(50) 106(50) 0	100	179.99
93	0 37(50) 38(50) 0	100	71.71
94	0 83(66) 67(34) 0	100	120.01
95	0 137(50) 105(50) 0	100	180.00
96	0 15(34) 31(66) 0	100	39.99
97	0 59(66) 43(34) 0	100	80.00
98	0 93(66) 77(34) 0	100	120.00
99	0 103(50) 135(50) 0	100	180.00

(cont.)

Table A.153 continued.

No.	Route	Load	Distance
100	0 136(50) 104(50) 0	100	180.01
101	0 62(66) 46(34) 0	100	80.00
102	0 160(66) 128(34) 0	100	199.99
103	0 86(66) 70(34) 0	100	119.99
104	0 79(50) 47(50) 0	100	100.00
105	0 111(50) 143(50) 0	100	180.00
106	0 139(50) 107(50) 0	100	180.00
107	0 118(66) 102(34) 0	100	160.00
108	0 105(34) 121(66) 0	100	160.00
109	0 144(84) 0	84	180.00
110	0 102(50) 134(50) 0	100	180.00
111	0 60(66) 0	66	79.99
112	0 70(50) 69(50) 0	100	119.51
113	0 55(66) 22(34) 0	100	82.85
114	0 84(66) 19(27) 0	93	122.22
115	0 79(34) 95(66) 0	100	120.00
116	0 50(66) 18(27) 0	93	80.01
117	0 159(66) 143(34) 0	100	200.00
118	0 149(66) 133(34) 0	100	200.00
119	0 107(34) 123(66) 0	100	160.00
120	0 30(39) 46(50) 0	89	60.01
121	0 71(50) 72(50) 0	100	119.51
122	0 41(34) 57(66) 0	100	80.00
123	0 75(34) 91(66) 0	100	120.00
124	0 74(50) 73(50) 0	100	119.51
125	0 10(50) 9(50) 0	100	23.91
		Total Distance	14447.59

Table A.154: EMIP-MDA+ERTR solution to MDA19 with $p = .4$.

No.	Route	Load	Distance
1	0 16(84) 0	84	20.00
2	0 1(84) 0	84	20.00
3	0 2(84) 0	84	20.00
4	0 183(66) 167(34) 0	100	240.01
5	0 3(84) 0	84	20.00
6	0 181(66) 165(34) 0	100	240.00
7	0 6(84) 0	84	20.00
8	0 7(84) 0	84	20.00
9	0 9(84) 0	84	20.00
10	0 10(84) 0	84	20.00
11	0 121(66) 105(34) 0	100	160.00
12	0 167(50) 135(50) 0	100	220.01
13	0 45(34) 61(66) 0	100	80.00
14	0 91(66) 75(34) 0	100	120.00
15	0 14(84) 0	84	20.00
16	0 15(84) 0	84	20.00
17	0 179(66) 163(34) 0	100	239.99
18	0 78(34) 94(66) 0	100	120.00
19	0 35(84) 0	84	59.99
20	0 56(66) 40(34) 0	100	79.99
21	0 99(50) 100(50) 0	100	167.31
22	0 38(84) 0	84	60.01
23	0 161(50) 129(50) 0	100	220.00
24	0 8(84) 0	84	20.00
25	0 74(34) 90(66) 0	100	120.01
26	0 149(66) 133(34) 0	100	200.00
27	0 20(66) 4(34) 0	100	40.00
28	0 190(66) 174(34) 0	100	240.00
29	0 47(84) 0	84	60.01
30	0 191(66) 159(32) 0	98	240.01
31	0 115(66) 99(34) 0	100	160.00
32	0 104(50) 72(50) 0	100	140.00
33	0 22(66) 0	66	40.00

(cont.)

Table A.154 continued.

No.	Route	Load	Distance
34	0 68(84) 0	84	100.00
35	0 102(50) 70(50) 0	100	139.99
36	0 39(84) 0	84	59.99
37	0 92(32) 124(66) 0	98	160.00
38	0 41(50) 42(50) 0	100	71.71
39	0 62(66) 46(34) 0	100	80.00
40	0 43(84) 0	84	60.01
41	0 95(66) 111(34) 0	100	140.01
42	0 73(34) 89(66) 0	100	120.00
43	0 79(50) 80(50) 0	100	119.51
44	0 65(84) 0	84	100.00
45	0 55(66) 71(34) 0	100	100.00
46	0 88(66) 72(34) 0	100	120.00
47	0 100(34) 116(66) 0	100	160.00
48	0 157(66) 141(34) 0	100	200.00
49	0 155(66) 139(34) 0	100	200.00
50	0 84(66) 83(27) 0	93	143.41
51	0 174(50) 142(50) 0	100	219.99
52	0 156(66) 140(34) 0	100	199.99
53	0 66(34) 82(66) 0	100	119.99
54	0 105(50) 137(50) 0	100	180.00
55	0 143(50) 111(50) 0	100	180.00
56	0 23(66) 0	66	39.99
57	0 148(66) 132(34) 0	100	200.01
58	0 33(84) 0	84	60.00
59	0 37(50) 36(50) 0	100	71.71
60	0 67(84) 0	84	100.00
61	0 75(50) 107(50) 0	100	139.99
62	0 163(50) 131(50) 0	100	220.00
63	0 162(50) 130(50) 0	100	220.00
64	0 17(66) 0	66	40.00
65	0 134(34) 150(66) 0	100	200.00
66	0 80(34) 81(66) 0	100	133.60

(cont.)

Table A.154 continued.

No.	Route	Load	Distance
67	0 87(39) 71(50) 0	89	120.00
68	0 48(84) 0	84	60.00
69	0 63(66) 79(34) 0	100	100.00
70	0 110(34) 126(66) 0	100	159.99
71	0 93(66) 77(34) 0	100	120.00
72	0 4(50) 5(50) 0	100	23.91
73	0 57(66) 41(34) 0	100	80.00
74	0 66(50) 34(50) 0	100	99.99
75	0 120(66) 104(34) 0	100	160.00
76	0 54(66) 0	66	80.01
77	0 30(66) 0	66	40.00
78	0 64(66) 32(32) 0	98	79.99
79	0 164(34) 180(66) 0	100	240.00
80	0 182(66) 166(34) 0	100	240.01
81	0 11(50) 12(50) 0	100	23.90
82	0 18(32) 49(66) 0	98	82.84
83	0 171(34) 187(66) 0	100	239.99
84	0 60(66) 76(34) 0	100	100.00
85	0 24(66) 0	66	40.01
86	0 103(84) 0	84	139.99
87	0 139(50) 171(50) 0	100	220.00
88	0 106(84) 0	84	139.99
89	0 112(34) 96(66) 0	100	140.01
90	0 108(84) 0	84	140.01
91	0 86(66) 70(34) 0	100	119.99
92	0 76(50) 77(50) 0	100	119.50
93	0 101(50) 69(50) 0	100	140.00
94	0 92(34) 123(66) 0	100	173.63
95	0 114(66) 98(34) 0	100	160.00
96	0 192(66) 176(34) 0	100	240.00
97	0 31(66) 32(34) 0	100	47.80
98	0 69(34) 85(66) 0	100	120.00
99	0 160(66) 159(34) 0	100	239.01

(cont.)

Table A.154 continued.

No.	Route	Load	Distance
100	0 184(66) 168(34) 0	100	240.00
101	0 144(50) 176(50) 0	100	220.00
102	0 168(50) 136(50) 0	100	219.99
103	0 186(66) 154(27) 0	93	240.00
104	0 109(84) 0	84	140.00
105	0 128(66) 144(34) 0	100	180.00
106	0 152(66) 136(34) 0	100	199.99
107	0 118(66) 102(34) 0	100	160.00
108	0 97(34) 113(66) 0	100	160.00
109	0 18(34) 51(66) 0	100	82.83
110	0 29(66) 13(34) 0	100	40.00
111	0 97(50) 112(50) 0	100	167.33
112	0 138(84) 0	84	179.99
113	0 5(34) 21(66) 0	100	40.00
114	0 166(50) 134(50) 0	100	220.00
115	0 146(66) 130(34) 0	100	200.01
116	0 153(66) 137(34) 0	100	200.00
117	0 42(34) 58(66) 0	100	80.00
118	0 132(50) 164(50) 0	100	220.01
119	0 133(50) 165(50) 0	100	220.00
120	0 44(50) 13(50) 0	100	61.10
121	0 19(66) 0	66	39.99
122	0 59(66) 44(34) 0	100	86.81
123	0 161(34) 177(66) 0	100	240.00
124	0 169(34) 185(66) 0	100	240.00
125	0 147(66) 131(34) 0	100	200.00
126	0 87(27) 119(66) 0	93	159.99
127	0 73(50) 74(50) 0	100	119.51
128	0 46(50) 45(50) 0	100	71.71
129	0 162(34) 178(66) 0	100	240.01
130	0 25(39) 40(50) 0	89	63.84
131	0 129(34) 145(66) 0	100	200.00
132	0 37(34) 53(66) 0	100	80.00

(cont.)

Table A.154 continued.

No.	Route	Load	Distance
133	0 26(66) 25(27) 0	93	47.80
134	0 151(66) 135(34) 0	100	200.01
135	0 170(84) 0	84	219.99
136	0 107(34) 122(66) 0	100	180.85
137	0 173(84) 0	84	220.00
138	0 110(50) 78(50) 0	100	140.01
139	0 175(84) 0	84	220.00
140	0 28(66) 12(34) 0	100	40.01
141	0 101(34) 117(66) 0	100	160.00
142	0 172(34) 188(66) 0	100	240.00
143	0 11(34) 27(66) 0	100	39.99
144	0 83(39) 98(50) 0	89	157.19
145	0 50(66) 34(34) 0	100	80.01
146	0 141(50) 125(39) 0	89	180.00
147	0 169(50) 154(39) 0	89	252.13
148	0 158(66) 142(34) 0	100	199.99
149	0 143(34) 127(66) 0	100	180.00
150	0 52(66) 36(34) 0	100	79.99
151	0 172(50) 140(50) 0	100	220.00
152	0 189(66) 125(27) 0	93	240.00
		Total Distance	20608.91

Table A.155: EMIP-MDA+ERTR solution to MDA20 with $p = .4$.

No.	Route	Load	Distance
1	0 78(50) 54(50) 0	100	140.00
2	0 130(34) 118(66) 0	100	220.00
3	0 200(50) 224(50) 0	100	380.01
4	0 5(84) 0	84	20.00
5	0 179(34) 191(66) 0	100	320.01
6	0 125(50) 101(50) 0	100	220.00
7	0 142(34) 141(66) 0	100	302.11
8	0 10(84) 0	84	20.00
9	0 34(34) 46(66) 0	100	80.00
10	0 12(84) 0	84	20.00
11	0 50(34) 62(66) 0	100	120.00
12	0 2(84) 0	84	20.00
13	0 124(50) 100(50) 0	100	220.00
14	0 82(50) 58(50) 0	100	140.00
15	0 223(34) 235(66) 0	100	400.00
16	0 30(84) 0	84	60.00
17	0 6(84) 0	84	20.00
18	0 32(84) 0	84	60.00
19	0 9(84) 0	84	20.00
20	0 72(39) 60(50) 0	89	120.01
21	0 217(50) 193(50) 0	100	380.00
22	0 156(34) 192(66) 0	100	320.00
23	0 155(34) 167(66) 0	100	279.99
24	0 44(32) 93(66) 0	98	169.57
25	0 7(50) 8(50) 0	100	25.18
26	0 79(50) 55(50) 0	100	140.00
27	0 49(50) 25(50) 0	100	100.00
28	0 35(84) 0	84	60.00
29	0 36(84) 0	84	60.00
30	0 51(50) 3(50) 0	100	100.00
31	0 27(84) 0	84	60.00
32	0 121(34) 133(66) 0	100	240.00
33	0 142(32) 166(66) 0	98	280.00

(cont.)

Table A.155 continued.

No.	Route	Load	Distance
34	0 152(50) 164(39) 0	89	280.00
35	0 33(34) 45(66) 0	100	80.00
36	0 222(50) 174(50) 0	100	380.00
37	0 72(27) 120(66) 0	93	199.99
38	0 203(34) 215(66) 0	100	360.01
39	0 13(32) 14(66) 0	98	50.35
40	0 29(50) 41(39) 0	89	80.00
41	0 56(50) 33(50) 0	100	108.32
42	0 31(84) 0	84	60.00
43	0 164(27) 188(66) 0	93	320.00
44	0 199(50) 223(50) 0	100	380.00
45	0 21(66) 0	66	40.00
46	0 131(34) 143(66) 0	100	239.99
47	0 28(34) 16(66) 0	100	60.00
48	0 84(34) 96(66) 0	100	160.01
49	0 149(34) 161(66) 0	100	280.00
50	0 102(50) 126(50) 0	100	220.01
51	0 26(34) 38(66) 0	100	80.00
52	0 50(50) 26(50) 0	100	100.00
53	0 169(50) 145(50) 0	100	300.00
54	0 11(34) 23(66) 0	100	40.00
55	0 81(84) 0	84	140.01
56	0 97(34) 109(66) 0	100	200.00
57	0 177(50) 153(50) 0	100	300.00
58	0 171(50) 147(50) 0	100	299.99
59	0 225(50) 201(50) 0	100	379.99
60	0 74(84) 0	84	140.00
61	0 41(27) 40(66) 0	93	100.70
62	0 171(34) 183(66) 0	100	319.99
63	0 219(34) 231(66) 0	100	400.00
64	0 104(50) 128(50) 0	100	220.00
65	0 80(84) 0	84	140.00
66	0 147(34) 159(66) 0	100	279.99

(cont.)

Table A.155 continued.

No.	Route	Load	Distance
67	0 193(34) 205(66) 0	100	360.00
68	0 1(50) 11(50) 0	100	30.00
69	0 145(34) 157(66) 0	100	280.00
70	0 123(84) 0	84	220.00
71	0 100(34) 112(66) 0	100	200.00
72	0 99(34) 87(66) 0	100	180.00
73	0 173(34) 185(66) 0	100	320.00
74	0 79(34) 91(66) 0	100	160.00
75	0 172(50) 148(50) 0	100	300.00
76	0 146(34) 158(66) 0	100	279.99
77	0 102(34) 90(66) 0	100	180.01
78	0 114(66) 126(34) 0	100	220.01
79	0 177(34) 189(66) 0	100	320.00
80	0 105(50) 57(50) 0	100	180.01
81	0 132(34) 144(66) 0	100	240.00
82	0 175(50) 151(50) 0	100	300.00
83	0 28(50) 4(50) 0	100	60.00
84	0 73(34) 85(66) 0	100	160.00
85	0 200(34) 212(66) 0	100	359.99
86	0 129(84) 0	84	220.01
87	0 106(84) 0	84	180.00
88	0 224(34) 236(66) 0	100	400.01
89	0 108(84) 0	84	179.99
90	0 187(66) 175(34) 0	100	320.00
91	0 7(34) 19(66) 0	100	40.00
92	0 204(34) 216(66) 0	100	360.00
93	0 184(66) 172(34) 0	100	320.00
94	0 209(66) 197(34) 0	100	360.00
95	0 169(34) 181(66) 0	100	320.00
96	0 57(34) 69(66) 0	100	120.01
97	0 8(34) 20(66) 0	100	40.00
98	0 195(34) 207(66) 0	100	359.99
99	0 53(50) 77(50) 0	100	140.00

(cont.)

Table A.155 continued.

No.	Route	Load	Distance
100	0 54(34) 42(66) 0	100	100.00
101	0 55(34) 67(66) 0	100	120.00
102	0 115(66) 103(34) 0	100	200.00
103	0 122(50) 98(50) 0	100	220.00
104	0 132(50) 84(50) 0	100	220.00
105	0 210(66) 186(34) 0	100	360.00
106	0 104(34) 92(66) 0	100	180.00
107	0 214(66) 154(34) 0	100	360.00
108	0 197(50) 221(50) 0	100	380.00
109	0 135(32) 111(66) 0	98	239.99
110	0 25(34) 37(66) 0	100	80.00
111	0 196(34) 208(66) 0	100	360.00
112	0 239(66) 227(34) 0	100	400.00
113	0 83(50) 59(50) 0	100	140.00
114	0 127(34) 139(66) 0	100	240.00
115	0 162(66) 150(34) 0	100	280.00
116	0 4(34) 18(66) 0	100	47.32
117	0 226(50) 178(50) 0	100	380.00
118	0 203(50) 227(50) 0	100	380.00
119	0 101(34) 113(66) 0	100	200.00
120	0 131(50) 107(50) 0	100	220.00
121	0 138(34) 186(32) 174(34) 0	100	320.00
122	0 44(34) 43(66) 0	100	100.70
123	0 3(34) 15(66) 0	100	40.00
124	0 156(50) 121(50) 0	100	305.07
125	0 170(34) 182(66) 0	100	320.01
126	0 234(66) 222(34) 0	100	400.00
127	0 225(34) 237(66) 0	100	399.99
128	0 58(34) 70(66) 0	100	120.00
129	0 194(50) 218(50) 0	100	380.01
130	0 59(34) 71(66) 0	100	120.00
131	0 228(34) 240(66) 0	100	400.00
132	0 77(34) 89(66) 0	100	160.00

(cont.)

Table A.155 continued.

No.	Route	Load	Distance
133	0 103(50) 127(50) 0	100	220.00
134	0 218(34) 230(66) 0	100	400.01
135	0 198(84) 0	84	340.00
136	0 176(84) 0	84	300.00
137	0 56(34) 68(66) 0	100	119.99
138	0 233(66) 221(34) 0	100	400.00
139	0 180(84) 0	84	300.00
140	0 98(34) 86(66) 0	100	180.00
141	0 170(50) 146(50) 0	100	299.99
142	0 13(34) 48(66) 0	100	84.80
143	0 99(50) 75(50) 0	100	180.00
144	0 217(34) 229(66) 0	100	400.00
145	0 83(34) 95(66) 0	100	160.00
146	0 220(34) 232(66) 0	100	400.00
147	0 194(34) 206(66) 0	100	360.01
148	0 135(34) 110(66) 0	100	280.12
149	0 196(50) 220(50) 0	100	380.00
150	0 105(34) 117(66) 0	100	200.01
151	0 128(34) 116(66) 0	100	220.00
152	0 179(50) 155(50) 0	100	300.01
153	0 238(66) 226(34) 0	100	400.00
154	0 152(34) 140(66) 0	100	260.00
155	0 199(34) 211(66) 0	100	360.00
156	0 34(50) 22(39) 0	89	60.00
157	0 150(50) 138(32) 0	82	260.00
158	0 137(66) 125(34) 0	100	240.00
159	0 76(34) 88(66) 0	100	160.00
160	0 202(84) 0	84	340.00
161	0 213(66) 201(34) 0	100	359.99
162	0 153(34) 165(66) 0	100	279.99
163	0 66(66) 78(34) 0	100	140.00
164	0 148(34) 160(66) 0	100	280.00
165	0 97(50) 73(50) 0	100	180.00

(cont.)

Table A.155 continued.

No.	Route	Load	Distance
166	0 163(66) 151(34) 0	100	280.00
167	0 52(34) 64(66) 0	100	120.00
168	0 178(34) 190(66) 0	100	320.00
169	0 154(50) 130(50) 0	100	260.00
170	0 65(66) 53(34) 0	100	120.00
171	0 49(34) 61(66) 0	100	120.00
172	0 60(34) 168(66) 0	100	280.00
173	0 219(50) 195(50) 0	100	380.00
174	0 173(50) 149(50) 0	100	300.00
175	0 122(34) 134(66) 0	100	239.99
176	0 204(50) 228(50) 0	100	380.00
177	0 47(66) 22(27) 0	93	84.77
178	0 76(50) 52(50) 0	100	140.00
179	0 75(34) 63(66) 0	100	140.00
180	0 29(34) 17(66) 0	100	60.00
181	0 107(34) 119(66) 0	100	200.00
182	0 51(34) 39(66) 0	100	100.00
183	0 82(34) 94(66) 0	100	160.00
184	0 1(34) 24(66) 0	100	42.39
185	0 124(34) 136(66) 0	100	240.00
		Total Distance	40551.37

Table A.156: EMIP-MDA+ERTR solution to MDA21 with $p = .4$.

No.	Route	Load	Distance
1	0 151(34) 221(66) 0	100	81.69
2	0 2(84) 0	84	20.00
3	0 3(84) 0	84	20.01
4	0 4(84) 0	84	20.00
5	0 5(84) 0	84	20.01
6	0 6(84) 0	84	20.00
7	0 7(84) 0	84	20.00
8	0 8(84) 0	84	20.00
9	0 9(84) 0	84	20.00
10	0 10(84) 0	84	20.00
11	0 238(66) 165(34) 0	100	80.45
12	0 187(34) 115(66) 0	100	60.00
13	0 13(84) 0	84	20.00
14	0 264(66) 192(34) 0	100	80.00
15	0 122(66) 194(34) 0	100	60.00
16	0 16(84) 0	84	20.00
17	0 17(84) 0	84	20.01
18	0 18(84) 0	84	20.00
19	0 19(84) 0	84	20.00
20	0 20(84) 0	84	20.00
21	0 21(84) 0	84	20.01
22	0 22(84) 0	84	20.00
23	0 23(84) 0	84	20.01
24	0 24(84) 0	84	20.00
25	0 25(84) 0	84	20.00
26	0 26(84) 0	84	20.00
27	0 27(84) 0	84	20.00
28	0 28(84) 0	84	20.00
29	0 29(84) 0	84	20.00
30	0 30(84) 0	84	20.00
31	0 277(66) 206(34) 0	100	80.43
32	0 110(34) 111(66) 0	100	41.74
33	0 33(84) 0	84	20.01

(cont.)

Table A.156 continued.

No.	Route	Load	Distance
34	0 105(66) 104(32) 0	98	41.74
35	0 245(66) 173(34) 0	100	80.00
36	0 36(84) 0	84	20.00
37	0 37(84) 0	84	20.00
38	0 271(66) 199(34) 0	100	80.00
39	0 128(66) 0	66	39.99
40	0 251(34) 252(66) 0	100	83.49
41	0 170(84) 0	84	60.01
42	0 42(84) 0	84	20.00
43	0 43(84) 0	84	20.00
44	0 44(84) 0	84	19.99
45	0 45(84) 0	84	20.00
46	0 46(84) 0	84	20.00
47	0 47(84) 0	84	20.00
48	0 48(84) 0	84	20.00
49	0 49(84) 0	84	20.00
50	0 50(84) 0	84	20.00
51	0 51(84) 0	84	20.01
52	0 34(34) 35(50) 0	84	20.87
53	0 53(84) 0	84	20.01
54	0 256(66) 184(34) 0	100	80.00
55	0 55(84) 0	84	20.00
56	0 56(84) 0	84	20.00
57	0 201(50) 202(50) 0	100	62.61
58	0 58(84) 0	84	20.00
59	0 172(84) 0	84	59.99
60	0 108(66) 107(32) 0	98	41.74
61	0 61(84) 0	84	20.00
62	0 78(34) 76(66) 0	100	43.48
63	0 149(84) 0	84	60.00
64	0 242(66) 243(32) 0	98	83.49
65	0 157(84) 0	84	60.00
66	0 66(84) 0	84	20.00

(cont.)

Table A.156 continued.

No.	Route	Load	Distance
67	0 186(34) 258(66) 0	100	79.99
68	0 176(34) 247(66) 0	100	80.44
69	0 220(66) 150(34) 0	100	81.69
70	0 68(84) 0	84	20.00
71	0 283(66) 284(34) 0	100	83.50
72	0 73(66) 1(34) 0	100	40.00
73	0 32(84) 0	84	20.00
74	0 134(66) 135(32) 0	98	41.73
75	0 191(50) 192(50) 0	100	62.62
76	0 63(84) 0	84	20.00
77	0 62(50) 0	50	19.99
78	0 137(66) 65(34) 0	100	40.00
79	0 154(34) 226(66) 0	100	79.99
80	0 140(66) 213(34) 0	100	60.23
81	0 230(34) 229(66) 0	100	83.48
82	0 284(32) 285(66) 0	98	83.49
83	0 67(50) 0	50	20.00
84	0 85(66) 0	66	40.00
85	0 254(66) 180(34) 0	100	81.69
86	0 67(34) 139(66) 0	100	40.00
87	0 183(34) 112(66) 0	100	60.22
88	0 204(50) 205(50) 0	100	62.62
89	0 167(50) 168(50) 0	100	62.62
90	0 80(34) 81(66) 0	100	41.75
91	0 132(66) 133(32) 0	98	41.75
92	0 199(50) 200(50) 0	100	62.62
93	0 155(34) 227(66) 0	100	80.00
94	0 57(84) 0	84	20.01
95	0 232(66) 233(32) 0	98	83.48
96	0 214(84) 0	84	60.01
97	0 90(34) 89(66) 0	100	41.74
98	0 207(34) 281(66) 0	100	81.69
99	0 177(50) 176(50) 0	100	62.62

(cont.)

Table A.156 continued.

No.	Route	Load	Distance
100	0 34(50) 35(34) 0	84	20.87
101	0 237(66) 236(34) 0	100	83.49
102	0 243(34) 244(66) 0	100	83.48
103	0 39(84) 0	84	20.01
104	0 119(66) 120(34) 0	100	41.75
105	0 114(66) 0	66	40.00
106	0 14(84) 0	84	20.00
107	0 145(84) 0	84	60.00
108	0 117(34) 118(66) 0	100	41.74
109	0 272(66) 200(34) 0	100	80.00
110	0 144(66) 216(34) 0	100	60.01
111	0 166(84) 0	84	60.00
112	0 153(50) 154(50) 0	100	62.61
113	0 147(50) 146(50) 0	100	62.62
114	0 257(66) 185(34) 0	100	80.00
115	0 93(66) 0	66	40.01
116	0 260(32) 261(66) 0	98	83.49
117	0 282(66) 210(34) 0	100	80.00
118	0 113(66) 0	66	39.99
119	0 40(84) 0	84	20.00
120	0 84(66) 83(34) 0	100	41.75
121	0 288(34) 217(66) 0	100	83.50
122	0 52(84) 0	84	20.00
123	0 125(66) 196(34) 0	100	60.23
124	0 267(66) 266(34) 0	100	83.49
125	0 15(84) 0	84	20.01
126	0 124(66) 123(27) 0	93	41.74
127	0 210(50) 213(50) 0	100	67.83
128	0 180(50) 182(50) 0	100	65.24
129	0 69(84) 0	84	20.01
130	0 147(34) 219(66) 0	100	80.00
131	0 117(32) 116(66) 0	98	41.73
132	0 129(66) 0	66	40.01

(cont.)

Table A.156 continued.

No.	Route	Load	Distance
133	0 148(84) 0	84	60.00
134	0 138(66) 0	66	39.99
135	0 253(66) 179(34) 0	100	81.68
136	0 123(39) 194(50) 0	89	60.23
137	0 72(84) 0	84	20.00
138	0 150(50) 151(50) 0	100	62.62
139	0 38(84) 0	84	20.00
140	0 41(84) 0	84	20.01
141	0 269(66) 197(34) 0	100	80.00
142	0 169(50) 171(50) 0	100	65.22
143	0 158(84) 0	84	60.00
144	0 159(84) 0	84	60.00
145	0 160(84) 0	84	60.01
146	0 80(32) 79(66) 0	98	41.74
147	0 190(84) 0	84	60.01
148	0 163(84) 0	84	60.00
149	0 215(34) 286(66) 0	100	80.46
150	0 188(50) 187(50) 0	100	62.61
151	0 184(50) 183(50) 0	100	62.61
152	0 62(34) 0	34	19.99
153	0 65(50) 0	50	20.00
154	0 189(84) 0	84	59.99
155	0 178(50) 179(50) 0	100	62.62
156	0 152(84) 0	84	60.00
157	0 263(66) 191(34) 0	100	80.01
158	0 234(66) 233(34) 0	100	83.49
159	0 260(34) 259(66) 0	100	83.48
160	0 164(34) 92(66) 0	100	60.01
161	0 278(66) 279(32) 0	98	83.49
162	0 130(66) 0	66	40.00
163	0 248(66) 177(34) 0	100	80.45
164	0 235(66) 236(32) 0	98	83.48
165	0 90(32) 91(66) 0	98	41.74

(cont.)

Table A.156 continued.

No.	Route	Load	Distance
166	0 171(34) 99(66) 0	100	59.99
167	0 273(66) 201(34) 0	100	79.99
168	0 188(34) 262(66) 0	100	81.69
169	0 193(84) 0	84	60.00
170	0 195(34) 268(66) 0	100	80.45
171	0 175(84) 0	84	60.00
172	0 82(66) 83(32) 0	98	41.74
173	0 266(32) 265(66) 0	98	83.48
174	0 239(66) 167(34) 0	100	80.00
175	0 203(84) 0	84	60.00
176	0 59(84) 0	84	20.01
177	0 270(66) 198(34) 0	100	80.01
178	0 141(66) 142(32) 0	98	41.74
179	0 276(66) 205(34) 0	100	80.44
180	0 209(84) 0	84	60.01
181	0 78(32) 77(66) 0	98	41.74
182	0 211(84) 0	84	60.00
183	0 212(84) 0	84	60.00
184	0 133(34) 131(66) 0	100	43.48
185	0 54(84) 0	84	20.00
186	0 246(66) 174(34) 0	100	80.00
187	0 106(66) 107(34) 0	100	41.76
188	0 94(66) 0	66	40.00
189	0 100(66) 101(32) 0	98	41.74
190	0 222(66) 224(32) 0	98	86.97
191	0 275(66) 204(34) 0	100	80.45
192	0 251(32) 250(66) 0	98	83.49
193	0 255(66) 182(34) 0	100	80.44
194	0 206(50) 207(50) 0	100	62.62
195	0 136(66) 135(34) 0	100	41.74
196	0 161(84) 0	84	59.99
197	0 88(34) 86(66) 0	100	43.48
198	0 127(66) 0	66	40.00

(cont.)

Table A.156 continued.

No.	Route	Load	Distance
199	0 287(66) 288(32) 0	98	83.49
200	0 202(34) 274(66) 0	100	80.00
201	0 98(34) 96(66) 0	100	43.49
202	0 198(50) 197(50) 0	100	62.61
203	0 162(84) 0	84	60.01
204	0 11(84) 0	84	20.00
205	0 70(84) 0	84	20.00
206	0 102(66) 101(34) 0	100	41.75
207	0 208(84) 0	84	60.01
208	0 71(84) 0	84	20.01
209	0 173(50) 174(50) 0	100	62.62
210	0 1(50) 0	50	20.00
211	0 168(34) 240(66) 0	100	79.99
212	0 165(50) 164(50) 0	100	62.62
213	0 12(84) 0	84	20.00
214	0 98(32) 97(66) 0	98	41.74
215	0 185(50) 186(50) 0	100	62.62
216	0 126(66) 0	66	39.99
217	0 215(50) 216(50) 0	100	62.61
218	0 249(66) 178(34) 0	100	80.45
219	0 60(84) 0	84	19.99
220	0 230(32) 231(66) 0	98	83.50
221	0 95(66) 0	66	39.99
222	0 110(32) 109(66) 0	98	41.74
223	0 228(66) 156(34) 0	100	80.00
224	0 225(66) 153(34) 0	100	80.00
225	0 155(50) 156(50) 0	100	62.60
226	0 88(32) 87(66) 0	98	41.74
227	0 223(66) 224(34) 0	100	83.48
228	0 279(34) 280(66) 0	100	83.50
229	0 241(66) 169(34) 0	100	80.00
230	0 74(66) 0	66	39.99
231	0 143(66) 142(34) 0	100	41.75

(cont.)

Table A.156 continued.

No.	Route	Load	Distance
232	0 64(84) 0	84	20.00
233	0 103(66) 104(34) 0	100	41.75
234	0 196(50) 195(50) 0	100	62.61
235	0 121(66) 120(32) 0	98	41.74
236	0 31(84) 0	84	20.00
237	0 75(66) 0	66	40.01
238	0 181(84) 0	84	60.00
239	0 218(66) 146(34) 0	100	80.01
		Total Distance	11909.12

Table A.157: Estimated solution for MDA1.

No.	Route	Load	Distance
1	0 1(50)2(50) 0	100	34.14
2	0 5(q) 1($100-q$) 0	100	40.00
3	0 6(q) 2($100-q$) 0	100	40.00
4	0 3(50)4(50) 0	100	34.14
5	0 7(q) 3($100-q$) 0	100	40.00
6	0 8(q) 4($100-q$) 0	100	40.00
		Total Distance	228.28

Note: $q = 94, 87, 78, 66$ for $p = .1, .2, .3, .4$, respectively.

Table A.158: Estimated solutions for MDA2.

No.	Route	Load	Distance
1	0 13(q) 9($100-q$) 0	100	80.00
2	0 9(50)1(50) 0	100	60.00
3	0 5(q) 1($100-q$) 0	100	40.00
4	0 14(q) 10($100-q$) 0	100	80.00
5	0 10(50)2(50) 0	100	60.00
6	0 6(q) 2($100-q$) 0	100	40.00
7	0 15(q) 11($100-q$) 0	100	80.00
8	0 11(50)3(50) 0	100	60.00
9	0 7(q) 3($100-q$) 0	100	40.00
10	0 16(q) 12($100-q$) 0	100	80.00
11	0 12(50)4(50) 0	100	60.00
12	0 8(q) 4($100-q$) 0	100	40.00
		Total Distance	720.00

Note: $q = 94, 87, 78, 66$ for $p = .1, .2, .3, .4$, respectively.

Table A.159: Estimated solutions for MDA3.

No.	Route	Load	Distance
1	0 1(50)2(50) 0	100	27.65
2	0 9(q) 1($100 - q$) 0	100	40.00
3	0 10(q) 2($100 - q$) 0	100	39.99
4	0 3(50)4(50) 0	100	27.65
5	0 11(q) 3($100 - q$) 0	100	40.00
6	0 12(q) 4($100 - q$) 0	100	39.99
7	0 5(50)6(50) 0	100	27.65
8	0 13(q) 5($100 - q$) 0	100	40.00
9	0 14(q) 6($100 - q$) 0	100	39.99
10	0 7(50)8(50) 0	100	27.65
11	0 15(q) 7($100 - q$) 0	100	40.00
12	0 16(q) 8($100 - q$) 0	100	39.99
		Total Distance	430.58

Note: $q = 94, 87, 78, 66$ for $p = .1, .2, .3, .4$, respectively.

Table A.160: Estimated solutions for MDA4.

No.	Route	Load	Distance
1	0 1(50)2(50) 0	100	25.18
2	0 13(q) 1($100-q$) 0	100	40.00
3	0 14(q) 2($100-q$) 0	100	40.00
4	0 3(50)4(50) 0	100	25.18
5	0 15(q) 3($100-q$) 0	100	40.00
6	0 16(q) 4($100-q$) 0	100	40.00
7	0 5(50)6(50) 0	100	25.18
8	0 17(q) 5($100-q$) 0	100	40.00
9	0 18(q) 6($100-q$) 0	100	40.00
10	0 7(50)8(50) 0	100	25.18
11	0 19(q) 7($100-q$) 0	100	40.00
12	0 20(q) 8($100-q$) 0	100	40.00
13	0 9(50)10(50) 0	100	25.18
14	0 21(q) 9($100-q$) 0	100	40.00
15	0 22(q) 10($100-q$) 0	100	40.00
16	0 11(50)12(50) 0	100	25.18
17	0 23(q) 11($100-q$) 0	100	40.00
18	0 24(q) 12($100-q$) 0	100	40.00
		Total Distance	631.05

Note: $q = 94, 87, 78, 66$ for $p = .1, .2, .3, .4$, respectively.

Table A.161: Estimated solutions for MDA5.

No.	Route	Load	Distance
1	0 1(50)2(50) 0	100	27.65
2	0 17(50)18(50) 0	100	82.95
3	0 9(q) 1($100 - q$) 0	100	40.00
4	0 10(q) 2($100 - q$) 0	100	39.99
5	0 25(q) 17($100 - q$) 0	100	80.00
6	0 26(q) 18($100 - q$) 0	100	79.99
7	0 3(50)4(50) 0	100	27.65
8	0 19(50)20(50) 0	100	82.95
9	0 11(q) 3($100 - q$) 0	100	40.00
10	0 12(q) 4($100 - q$) 0	100	39.99
11	0 27(q) 19($100 - q$) 0	100	80.00
12	0 28(q) 20($100 - q$) 0	100	80.00
13	0 5(50)6(50) 0	100	27.65
14	0 21(50)22(50) 0	100	82.96
15	0 13(q) 5($100 - q$) 0	100	40.00
16	0 14(q) 6($100 - q$) 0	100	39.99
17	0 29(q) 21($100 - q$) 0	100	80.00
18	0 30(q) 22($100 - q$) 0	100	80.00
19	0 7(50)8(50) 0	100	27.65
20	0 23(50)24(50) 0	100	82.96
21	0 15(q) 7($100 - q$) 0	100	40.00
22	0 16(q) 8($100 - q$) 0	100	39.99
23	0 31(q) 23($100 - q$) 0	100	80.00
24	0 32(q) 24($100 - q$) 0	100	80.00
		Total Distance	1402.40

Note: $q = 94, 87, 78, 66$ for $p = .1, .2, .3, .4$, respectively.

Table A.162: Estimated solutions for MDA6.

No.	Route	Load	Distance
1	0 1(50)2(50) 0	100	23.91
2	0 17(q) 1($100-q$) 0	100	40.00
3	0 18(q) 2($100-q$) 0	100	40.00
4	0 3(50)4(50) 0	100	23.90
5	0 19(q) 3($100-q$) 0	100	39.99
6	0 20(q) 4($100-q$) 0	100	40.00
7	0 5(50)6(50) 0	100	23.91
8	0 21(q) 5($100-q$) 0	100	40.00
9	0 22(q) 6($100-q$) 0	100	40.00
10	0 7(50)8(50) 0	100	23.90
11	0 23(q) 7($100-q$) 0	100	39.99
12	0 24(q) 8($100-q$) 0	100	40.01
13	0 9(50)10(50) 0	100	23.91
14	0 25(q) 9($100-q$) 0	100	40.00
15	0 26(q) 10($100-q$) 0	100	40.00
16	0 11(50)12(50) 0	100	23.90
17	0 27(q) 11($100-q$) 0	100	39.99
18	0 28(q) 12($100-q$) 0	100	40.01
19	0 13(50)14(50) 0	100	23.91
20	0 29(q) 13($100-q$) 0	100	40.00
21	0 30(q) 14($100-q$) 0	100	40.00
22	0 15(50)16(50) 0	100	23.90
23	0 31(q) 15($100-q$) 0	100	39.99
24	0 32(q) 16($100-q$) 0	100	40.01
		Total Distance	831.24

Note: $q = 94, 87, 78, 66$ for $p = .1, .2, .3, .4$, respectively.

Table A.163: Estimated solutions for MDA7.

No.	Route	Load	Distance
1	0 1(50)2(50) 0	100	34.14
2	0 5(q) 1($100-q$) 0	100	40.00
3	0 6(q) 2($100-q$) 0	100	40.00
4	0 3(50)4(50) 0	100	34.14
5	0 7(q) 3($100-q$) 0	100	40.00
6	0 8(q) 4($100-q$) 0	100	40.00
7	0 21(q) 17($100-q$) 0	100	120.00
8	0 17(50)9(50) 0	100	100.00
9	0 13(q) 9($100-q$) 0	100	80.00
10	0 22(q) 18($100-q$) 0	100	120.00
11	0 18(50)10(50) 0	100	100.00
12	0 14(q) 10($100-q$) 0	100	80.00
13	0 23(q) 19($100-q$) 0	100	120.00
14	0 19(50)11(50) 0	100	100.00
15	0 15(q) 11($100-q$) 0	100	80.00
16	0 24(q) 20($100-q$) 0	100	120.00
17	0 20(50)12(50) 0	100	100.00
18	0 16(q) 12($100-q$) 0	100	80.00
19	0 37(q) 33($100-q$) 0	100	200.00
20	0 33(50)25(50) 0	100	180.00
21	0 29(q) 25($100-q$) 0	100	160.00
22	0 38(q) 34($100-q$) 0	100	200.00
23	0 34(50)26(50) 0	100	180.00
24	0 30(q) 26($100-q$) 0	100	160.00
25	0 39(q) 35($100-q$) 0	100	200.00
26	0 35(50)27(50) 0	100	180.00
27	0 31(q) 27($100-q$) 0	100	160.00
28	0 40(q) 36($100-q$) 0	100	200.00
29	0 36(50)28(50) 0	100	180.00
30	0 32(q) 28($100-q$) 0	100	160.00
		Total Distance	3588.28

Note: $q = 94, 87, 78, 66$ for $p = .1, .2, .3, .4$, respectively.

Table A.164: Estimated solutions for MDA8.

No.	Route	Load	Distance
1	0 13(q) 9($100-q$) 0	100	80.00
2	0 9(50)1(50) 0	100	60.00
3	0 5(q) 1($100-q$) 0	100	40.00
4	0 14(q) 10($100-q$) 0	100	80.00
5	0 10(50)2(50) 0	100	60.00
6	0 6(q) 2($100-q$) 0	100	40.00
7	0 15(q) 11($100-q$) 0	100	80.00
8	0 11(50)3(50) 0	100	60.00
9	0 7(q) 3($100-q$) 0	100	40.00
10	0 16(q) 12($100-q$) 0	100	80.00
11	0 12(50)4(50) 0	100	60.00
12	0 8(q) 4($100-q$) 0	100	40.00
13	0 29(q) 25($100-q$) 0	100	160.00
14	0 25(50)17(50) 0	100	140.00
15	0 21(q) 17($100-q$) 0	100	120.00
16	0 30(q) 26($100-q$) 0	100	160.00
17	0 26(50)18(50) 0	100	140.00
18	0 22(q) 18($100-q$) 0	100	120.00
19	0 31(q) 27($100-q$) 0	100	160.00
20	0 27(50)19(50) 0	100	140.00
21	0 23(q) 19($100-q$) 0	100	120.00
22	0 32(q) 28($100-q$) 0	100	160.00
23	0 28(50)20(50) 0	100	140.00
24	0 24(q) 20($100-q$) 0	100	120.00
25	0 45(q) 41($100-q$) 0	100	240.00
26	0 41(50)33(50) 0	100	220.00
27	0 37(q) 33($100-q$) 0	100	200.00
28	0 46(q) 42($100-q$) 0	100	240.00
29	0 42(50)34(50) 0	100	220.00
30	0 38(q) 34($100-q$) 0	100	200.00
31	0 47(q) 43($100-q$) 0	100	240.00
32	0 43(50)35(50) 0	100	220.00
33	0 39(q) 35($100-q$) 0	100	200.00
34	0 48(q) 44($100-q$) 0	100	240.00
35	0 44(50)36(50) 0	100	220.00
36	0 40(q) 36($100-q$) 0	100	200.00
		Total Distance	5040.00

Note: $q = 94, 87, 78, 66$ for $p = .1, .2, .3, .4$, respectively.

Table A.165: Estimated solutions for MDA9.

No.	Route	Load	Distance
1	0 1(50)2(50) 0	100	25.18
2	0 25(50)26(50) 0	100	75.53
3	0 13(q) 1($100-q$) 0	100	40.00
4	0 14(q) 2($100-q$) 0	100	40.00
5	0 37(q) 25($100-q$) 0	100	80.00
6	0 38(q) 26($100-q$) 0	100	80.00
7	0 3(50)4(50) 0	100	25.18
8	0 27(50)28(50) 0	100	75.53
9	0 15(q) 3($100-q$) 0	100	40.00
10	0 16(q) 4($100-q$) 0	100	40.00
11	0 39(q) 27($100-q$) 0	100	80.00
12	0 40(q) 28($100-q$) 0	100	80.00
13	0 5(50)6(50) 0	100	25.18
14	0 29(50)30(50) 0	100	75.53
15	0 17(q) 5($100-q$) 0	100	40.00
16	0 18(q) 6($100-q$) 0	100	40.00
17	0 41(q) 29($100-q$) 0	100	80.00
18	0 42(q) 30($100-q$) 0	100	80.00
19	0 7(50)8(50) 0	100	25.18
20	0 31(50)32(50) 0	100	75.53
21	0 19(q) 7($100-q$) 0	100	40.00
22	0 20(q) 8($100-q$) 0	100	40.00
23	0 43(q) 31($100-q$) 0	100	80.00
24	0 44(q) 32($100-q$) 0	100	80.00
25	0 9(50)10(50) 0	100	25.18
26	0 33(50)34(50) 0	100	75.53
27	0 21(q) 9($100-q$) 0	100	40.00
28	0 22(q) 10($100-q$) 0	100	40.00
29	0 45(q) 33($100-q$) 0	100	80.00
30	0 46(q) 34($100-q$) 0	100	80.00
31	0 11(50)12(50) 0	100	25.18
32	0 35(50)36(50) 0	100	75.53
33	0 23(q) 11($100-q$) 0	100	40.00
34	0 24(q) 12($100-q$) 0	100	40.00
35	0 47(q) 35($100-q$) 0	100	79.99
36	0 48(q) 36($100-q$) 0	100	80.01
		Total Distance	2044.20

Note: $q = 94, 87, 78, 66$ for $p = .1, .2, .3, .4$, respectively.

Table A.166: Estimated solutions for MDA10.

No.	Route	Load	Distance
1	0 1(50)2(50) 0	100	23.91
2	0 33(50)34(50) 0	100	71.71
3	0 17(q) 1($100-q$) 0	100	40.00
4	0 18(q) 2($100-q$) 0	100	40.00
5	0 49(q) 33($100-q$) 0	100	80.00
6	0 50(q) 34($100-q$) 0	100	80.01
7	0 3(50)4(50) 0	100	23.90
8	0 35(50)36(50) 0	100	71.71
9	0 19(q) 3($100-q$) 0	100	39.99
10	0 20(q) 4($100-q$) 0	100	40.00
11	0 51(q) 35($100-q$) 0	100	79.99
12	0 52(q) 36($100-q$) 0	100	79.99
13	0 5(50)6(50) 0	100	23.91
14	0 37(50)38(50) 0	100	71.71
15	0 21(q) 5($100-q$) 0	100	40.00
16	0 22(q) 6($100-q$) 0	100	40.00
17	0 53(q) 37($100-q$) 0	100	80.00
18	0 54(q) 38($100-q$) 0	100	80.01
19	0 7(50)8(50) 0	100	23.90
20	0 39(50)40(50) 0	100	71.71
21	0 23(q) 7($100-q$) 0	100	39.99
22	0 24(q) 8($100-q$) 0	100	40.01
23	0 55(q) 39($100-q$) 0	100	80.00
24	0 56(q) 40($100-q$) 0	100	79.99
25	0 9(50)10(50) 0	100	23.91
26	0 41(50)42(50) 0	100	71.71
27	0 25(q) 9($100-q$) 0	100	40.00
28	0 26(q) 10($100-q$) 0	100	40.00
29	0 57(q) 41($100-q$) 0	100	80.00
30	0 58(q) 42($100-q$) 0	100	80.00
31	0 11(50)12(50) 0	100	23.90
32	0 43(50)44(50) 0	100	71.71
33	0 27(q) 11($100-q$) 0	100	39.99

(cont.)

Table A.166 continued.

No.	Route	Load	Distance
34	0 28(q) 12($100 - q$) 0	100	40.01
35	0 59(q) 43($100 - q$) 0	100	80.00
36	0 60(q) 44($100 - q$) 0	100	79.99
37	0 13(50)14(50) 0	100	23.91
38	0 45(50)46(50) 0	100	71.71
39	0 29(q) 13($100 - q$) 0	100	40.00
40	0 30(q) 14($100 - q$) 0	100	40.00
41	0 61(q) 45($100 - q$) 0	100	80.00
42	0 62(q) 46($100 - q$) 0	100	80.00
43	0 15(50)16(50) 0	100	23.90
44	0 47(50)48(50) 0	100	71.70
45	0 31(q) 15($100 - q$) 0	100	39.99
46	0 32(q) 16($100 - q$) 0	100	40.01
47	0 63(q) 47($100 - q$) 0	100	80.00
48	0 64(q) 48($100 - q$) 0	100	79.99
		Total Distance	2684.88

Note: $q = 94, 87, 78, 66$ for $p = .1, .2, .3, .4$, respectively.

Table A.167: Estimated solutions for MDA11.

No.	Route	Load	Distance
1	0 13(q) 9($100-q$) 0	100	80.00
2	0 9(50)1(50) 0	100	60.00
3	0 5(q) 1($100-q$) 0	100	40.00
4	0 14(q) 10($100-q$) 0	100	80.00
5	0 10(50)2(50) 0	100	60.00
6	0 6(q) 2($100-q$) 0	100	40.00
7	0 15(q) 11($100-q$) 0	100	80.00
8	0 11(50)3(50) 0	100	60.00
9	0 7(q) 3($100-q$) 0	100	40.00
10	0 16(q) 12($100-q$) 0	100	80.00
11	0 12(50)4(50) 0	100	60.00
12	0 8(q) 4($100-q$) 0	100	40.00
13	0 29(q) 25($100-q$) 0	100	160.00
14	0 25(50)17(50) 0	100	140.00
15	0 21(q) 17($100-q$) 0	100	120.00
16	0 30(q) 26($100-q$) 0	100	160.00
17	0 26(50)18(50) 0	100	140.00
18	0 22(q) 18($100-q$) 0	100	120.00
19	0 31(q) 27($100-q$) 0	100	160.00
20	0 27(50)19(50) 0	100	140.00
21	0 23(q) 19($100-q$) 0	100	120.00
22	0 32(q) 28($100-q$) 0	100	160.00
23	0 28(50)20(50) 0	100	140.00
24	0 24(q) 20($100-q$) 0	100	120.00
25	0 45(q) 41($100-q$) 0	100	240.00
26	0 41(50)33(50) 0	100	220.00
27	0 37(q) 33($100-q$) 0	100	200.00
28	0 46(q) 42($100-q$) 0	100	240.00
29	0 42(50)34(50) 0	100	220.00
30	0 38(q) 34($100-q$) 0	100	200.00
31	0 47(q) 43($100-q$) 0	100	240.00
32	0 43(50)35(50) 0	100	220.00
33	0 39(q) 35($100-q$) 0	100	200.00

(cont.)

Table A.167 continued.

No.	Route	Load	Distance
34	0 48(q) 44($100-q$) 0	100	240.00
35	0 44(50)36(50) 0	100	220.00
36	0 40(q) 36($100-q$) 0	100	200.00
37	0 61(q) 57($100-q$) 0	100	320.00
38	0 57(50)49(50) 0	100	300.00
39	0 53(q) 49($100-q$) 0	100	280.00
40	0 62(q) 58($100-q$) 0	100	320.00
41	0 58(50)50(50) 0	100	300.00
42	0 54(q) 50($100-q$) 0	100	280.00
43	0 63(q) 59($100-q$) 0	100	320.00
44	0 59(50)51(50) 0	100	300.00
45	0 55(q) 51($100-q$) 0	100	280.00
46	0 64(q) 60($100-q$) 0	100	320.00
47	0 60(50)52(50) 0	100	300.00
48	0 56(q) 52($100-q$) 0	100	280.00
49	0 77(q) 73($100-q$) 0	100	400.00
50	0 73(50)65(50) 0	100	380.00
51	0 69(q) 65($100-q$) 0	100	360.00
52	0 78(q) 74($100-q$) 0	100	400.00
53	0 74(50)66(50) 0	100	380.00
54	0 70(q) 66($100-q$) 0	100	360.00
55	0 79(q) 75($100-q$) 0	100	400.00
56	0 75(50)67(50) 0	100	380.00
57	0 71(q) 67($100-q$) 0	100	360.00
58	0 80(q) 76($100-q$) 0	100	400.00
59	0 76(50)68(50) 0	100	380.00
60	0 72(q) 68($100-q$) 0	100	360.00
		Total Distance	13200.00

Note: $q = 94, 87, 78, 66$ for $p = .1, .2, .3, .4$, respectively.

Table A.168: Estimated solutions for MDA12.

No.	Route	Load	Distance
1	0 1(50)2(50) 0	100	27.65
2	0 9(q) 1(100 − q) 0	100	40.00
3	0 10(q) 2(100 − q) 0	100	39.99
4	0 3(50)4(50) 0	100	27.65
5	0 11(q) 3(100 − q) 0	100	40.00
6	0 12(q) 4(100 − q) 0	100	39.99
7	0 5(50)6(50) 0	100	27.65
8	0 13(q) 5(100 − q) 0	100	40.00
9	0 14(q) 6(100 − q) 0	100	39.99
10	0 7(50)8(50) 0	100	27.65
11	0 15(q) 7(100 − q) 0	100	40.00
12	0 16(q) 8(100 − q) 0	100	39.99
13	0 41(q) 33(100 − q) 0	100	120.00
14	0 33(50)17(50) 0	100	100.00
15	0 25(q) 17(100 − q) 0	100	80.00
16	0 42(q) 34(100 − q) 0	100	120.01
17	0 34(50)18(50) 0	100	100.00
18	0 26(q) 18(100 − q) 0	100	79.99
19	0 43(q) 35(100 − q) 0	100	120.00
20	0 35(50)19(50) 0	100	100.00
21	0 27(q) 19(100 − q) 0	100	80.00
22	0 44(q) 36(100 − q) 0	100	120.00
23	0 36(50)20(50) 0	100	100.00
24	0 28(q) 20(100 − q) 0	100	80.00
25	0 45(q) 37(100 − q) 0	100	120.00
26	0 37(50)21(50) 0	100	100.00
27	0 29(q) 21(100 − q) 0	100	80.00
28	0 46(q) 38(100 − q) 0	100	120.00
29	0 38(50)22(50) 0	100	100.00
30	0 30(q) 22(100 − q) 0	100	80.00
31	0 47(q) 39(100 − q) 0	100	120.00
32	0 39(50)23(50) 0	100	100.00
33	0 31(q) 23(100 − q) 0	100	80.00

(cont.)

Table A.168 continued.

No.	Route	Load	Distance
34	0 48(q) 40($100-q$) 0	100	120.00
35	0 40(50)24(50) 0	100	100.00
36	0 32(q) 24($100-q$) 0	100	80.00
37	0 73(q) 65($100-q$) 0	100	200.00
38	0 65(50)49(50) 0	100	180.00
39	0 57(q) 49($100-q$) 0	100	160.00
40	0 74(q) 66($100-q$) 0	100	200.00
41	0 66(50)50(50) 0	100	180.00
42	0 58(q) 50($100-q$) 0	100	160.00
43	0 75(q) 67($100-q$) 0	100	200.00
44	0 67(50)51(50) 0	100	180.00
45	0 59(q) 51($100-q$) 0	100	160.00
46	0 76(q) 68($100-q$) 0	100	200.01
47	0 68(50)52(50) 0	100	180.00
48	0 60(q) 52($100-q$) 0	100	159.99
49	0 77(q) 69($100-q$) 0	100	200.00
50	0 69(50)53(50) 0	100	180.00
51	0 61(q) 53($100-q$) 0	100	160.00
52	0 78(q) 70($100-q$) 0	100	200.00
53	0 70(50)54(50) 0	100	180.00
54	0 62(q) 54($100-q$) 0	100	160.00
55	0 79(q) 71($100-q$) 0	100	200.00
56	0 71(50)55(50) 0	100	180.00
57	0 63(q) 55($100-q$) 0	100	160.00
58	0 80(q) 72($100-q$) 0	100	200.00
59	0 72(50)56(50) 0	100	180.00
60	0 64(q) 56($100-q$) 0	100	160.00
		Total Distance	7150.58

Note: $q = 94, 87, 78, 66$ for $p = .1, .2, .3, .4$, respectively.

Table A.169: Estimated solutions for MDA13.

No.	Route	Load	Distance
1	0 1(50)2(50) 0	100	27.65
2	0 17(50)18(50) 0	100	82.95
3	0 9(q) 1($100-q$) 0	100	40.00
4	0 10(q) 2($100-q$) 0	100	39.99
5	0 25(q) 17($100-q$) 0	100	80.00
6	0 26(q) 18($100-q$) 0	100	79.99
7	0 3(50)4(50) 0	100	27.65
8	0 19(50)20(50) 0	100	82.95
9	0 11(q) 3($100-q$) 0	100	40.00
10	0 12(q) 4($100-q$) 0	100	39.99
11	0 27(q) 19($100-q$) 0	100	80.00
12	0 28(q) 20($100-q$) 0	100	80.00
13	0 5(50)6(50) 0	100	27.65
14	0 21(50)22(50) 0	100	82.96
15	0 13(q) 5($100-q$) 0	100	40.00
16	0 14(q) 6($100-q$) 0	100	39.99
17	0 29(q) 21($100-q$) 0	100	80.00
18	0 30(q) 22($100-q$) 0	100	80.00
19	0 7(50)8(50) 0	100	27.65
20	0 23(50)24(50) 0	100	82.96
21	0 15(q) 7($100-q$) 0	100	40.00
22	0 16(q) 8($100-q$) 0	100	39.99
23	0 31(q) 23($100-q$) 0	100	80.00
24	0 32(q) 24($100-q$) 0	100	80.00
25	0 57(q) 49($100-q$) 0	100	160.00
26	0 49(50)33(50) 0	100	140.00
27	0 41(q) 33($100-q$) 0	100	120.00
28	0 58(q) 50($100-q$) 0	100	160.00
29	0 50(50)34(50) 0	100	140.01
30	0 42(q) 34($100-q$) 0	100	120.01
31	0 59(q) 51($100-q$) 0	100	160.00
32	0 51(50)35(50) 0	100	140.00
33	0 43(q) 35($100-q$) 0	100	120.00

(cont.)

Table A.169 continued.

No.	Route	Load	Distance
34	0 60(q) 52($100-q$) 0	100	159.99
35	0 52(50)36(50) 0	100	139.99
36	0 44(q) 36($100-q$) 0	100	120.00
37	0 61(q) 53($100-q$) 0	100	160.00
38	0 53(50)37(50) 0	100	140.00
39	0 45(q) 37($100-q$) 0	100	120.00
40	0 62(q) 54($100-q$) 0	100	160.00
41	0 54(50)38(50) 0	100	139.99
42	0 46(q) 38($100-q$) 0	100	120.00
43	0 63(q) 55($100-q$) 0	100	160.00
44	0 55(50)39(50) 0	100	140.00
45	0 47(q) 39($100-q$) 0	100	120.00
46	0 64(q) 56($100-q$) 0	100	160.00
47	0 56(50)40(50) 0	100	140.01
48	0 48(q) 40($100-q$) 0	100	120.00
49	0 89(q) 81($100-q$) 0	100	240.00
50	0 81(50)65(50) 0	100	220.00
51	0 73(q) 65($100-q$) 0	100	200.00
52	0 90(q) 82($100-q$) 0	100	239.99
53	0 82(50)66(50) 0	100	220.00
54	0 74(q) 66($100-q$) 0	100	200.00
55	0 91(q) 83($100-q$) 0	100	240.00
56	0 83(50)67(50) 0	100	220.00
57	0 75(q) 67($100-q$) 0	100	200.00
58	0 92(q) 84($100-q$) 0	100	240.01
59	0 84(50)68(50) 0	100	220.01
60	0 76(q) 68($100-q$) 0	100	200.01
61	0 93(q) 85($100-q$) 0	100	240.00
62	0 85(50)69(50) 0	100	220.00
63	0 77(q) 69($100-q$) 0	100	200.00
64	0 94(q) 86($100-q$) 0	100	239.99
65	0 86(50)70(50) 0	100	220.00
66	0 78(q) 70($100-q$) 0	100	200.00

(cont.)

Table A.169 continued.

No.	Route	Load	Distance
67	0 95(q) 87($100-q$) 0	100	240.00
68	0 87(50)71(50) 0	100	220.00
69	0 79(q) 71($100-q$) 0	100	200.00
70	0 96(q) 88($100-q$) 0	100	240.01
71	0 88(50)72(50) 0	100	220.00
72	0 80(q) 72($100-q$) 0	100	200.00
		Total Distance	10042.40

Note: $q = 94, 87, 78, 66$ for $p = .1, .2, .3, .4$, respectively.

Table A.170: Estimated solutions for MDA14.

No.	Route	Load	Distance
1	0 1(50)2(50) 0	100	25.18
2	0 13(q) 1($100-q$) 0	100	40.00
3	0 14(q) 2($100-q$) 0	100	40.00
4	0 3(50)4(50) 0	100	25.18
5	0 15(q) 3($100-q$) 0	100	40.00
6	0 16(q) 4($100-q$) 0	100	40.00
7	0 5(50)6(50) 0	100	25.18
8	0 17(q) 5($100-q$) 0	100	40.00
9	0 18(q) 6($100-q$) 0	100	40.00
10	0 7(50)8(50) 0	100	25.18
11	0 19(q) 7($100-q$) 0	100	40.00
12	0 20(q) 8($100-q$) 0	100	40.00
13	0 9(50)10(50) 0	100	25.18
14	0 21(q) 9($100-q$) 0	100	40.00
15	0 22(q) 10($100-q$) 0	100	40.00
16	0 11(50)12(50) 0	100	25.18
17	0 23(q) 11($100-q$) 0	100	40.00
18	0 24(q) 12($100-q$) 0	100	40.00
19	0 61(q) 49($100-q$) 0	100	120.00
20	0 49(50)25(50) 0	100	100.00
21	0 37(q) 25($100-q$) 0	100	80.00
22	0 62(q) 50($100-q$) 0	100	120.00
23	0 50(50)26(50) 0	100	100.00
24	0 38(q) 26($100-q$) 0	100	80.00
25	0 63(q) 51($100-q$) 0	100	120.00
26	0 51(50)27(50) 0	100	100.00
27	0 39(q) 27($100-q$) 0	100	80.00
28	0 64(q) 52($100-q$) 0	100	120.00
29	0 52(50)28(50) 0	100	100.00
30	0 40(q) 28($100-q$) 0	100	80.00
31	0 65(q) 53($100-q$) 0	100	120.00
32	0 53(50)29(50) 0	100	100.00
33	0 41(q) 29($100-q$) 0	100	80.00

(cont.)

Table A.170 continued.

No.	Route	Load	Distance
34	0 66(q) 54($100 - q$) 0	100	120.00
35	0 54(50)30(50) 0	100	100.00
36	0 42(q) 30($100 - q$) 0	100	80.00
37	0 67(q) 55($100 - q$) 0	100	120.00
38	0 55(50)31(50) 0	100	100.00
39	0 43(q) 31($100 - q$) 0	100	80.00
40	0 68(q) 56($100 - q$) 0	100	119.99
41	0 56(50)32(50) 0	100	100.00
42	0 44(q) 32($100 - q$) 0	100	80.00
43	0 69(q) 57($100 - q$) 0	100	120.01
44	0 57(50)33(50) 0	100	100.01
45	0 45(q) 33($100 - q$) 0	100	80.00
46	0 70(q) 58($100 - q$) 0	100	120.00
47	0 58(50)34(50) 0	100	100.00
48	0 46(q) 34($100 - q$) 0	100	80.00
49	0 71(q) 59($100 - q$) 0	100	120.00
50	0 59(50)35(50) 0	100	100.01
51	0 47(q) 35($100 - q$) 0	100	79.99
52	0 72(q) 60($100 - q$) 0	100	120.01
53	0 60(50)36(50) 0	100	100.01
54	0 48(q) 36($100 - q$) 0	100	80.01
55	0 109(q) 97($100 - q$) 0	100	200.00
56	0 97(50)73(50) 0	100	180.00
57	0 85(q) 73($100 - q$) 0	100	160.00
58	0 110(q) 98($100 - q$) 0	100	200.00
59	0 98(50)74(50) 0	100	180.00
60	0 86(q) 74($100 - q$) 0	100	160.00
61	0 111(q) 99($100 - q$) 0	100	200.00
62	0 99(50)75(50) 0	100	180.00
63	0 87(q) 75($100 - q$) 0	100	160.00
64	0 112(q) 100($100 - q$) 0	100	200.00
65	0 100(50)76(50) 0	100	180.00
66	0 88(q) 76($100 - q$) 0	100	160.00

(cont.)

Table A.170 continued.

No.	Route	Load	Distance
67	0 113(q) 101($100-q$) 0	100	200.00
68	0 101(50)77(50) 0	100	180.01
69	0 89(q) 77($100-q$) 0	100	160.00
70	0 114(q) 102($100-q$) 0	100	200.01
71	0 102(50)78(50) 0	100	180.01
72	0 90(q) 78($100-q$) 0	100	160.01
73	0 115(q) 103($100-q$) 0	100	200.00
74	0 103(50)79(50) 0	100	180.00
75	0 91(q) 79($100-q$) 0	100	160.00
76	0 116(q) 104($100-q$) 0	100	200.00
77	0 104(50)80(50) 0	100	180.00
78	0 92(q) 80($100-q$) 0	100	160.00
79	0 117(q) 105($100-q$) 0	100	200.01
80	0 105(50)81(50) 0	100	180.01
81	0 93(q) 81($100-q$) 0	100	160.01
82	0 118(q) 106($100-q$) 0	100	200.00
83	0 106(50)82(50) 0	100	180.00
84	0 94(q) 82($100-q$) 0	100	160.00
85	0 119(q) 107($100-q$) 0	100	200.00
86	0 107(50)83(50) 0	100	180.00
87	0 95(q) 83($100-q$) 0	100	160.00
88	0 120(q) 108($100-q$) 0	100	199.99
89	0 108(50)84(50) 0	100	179.99
90	0 96(q) 84($100-q$) 0	100	160.01
		Total Distance	10711.07

Note: $q = 94, 87, 78, 66$ for $p = .1, .2, .3, .4$, respectively.

Table A.171: Estimated solutions for MDA15.

No.	Route	Load	Distance
1	0 1(50)2(50) 0	100	25.18
2	0 25(50)26(50) 0	100	75.53
3	0 13(q) 1($100-q$) 0	100	40.00
4	0 14(q) 2($100-q$) 0	100	40.00
5	0 37(q) 25($100-q$) 0	100	80.00
6	0 38(q) 26($100-q$) 0	100	80.00
7	0 3(50)4(50) 0	100	25.18
8	0 27(50)28(50) 0	100	75.53
9	0 15(q) 3($100-q$) 0	100	40.00
10	0 16(q) 4($100-q$) 0	100	40.00
11	0 39(q) 27($100-q$) 0	100	80.00
12	0 40(q) 28($100-q$) 0	100	80.00
13	0 5(50)6(50) 0	100	25.18
14	0 29(50)30(50) 0	100	75.53
15	0 17(q) 5($100-q$) 0	100	40.00
16	0 18(q) 6($100-q$) 0	100	40.00
17	0 41(q) 29($100-q$) 0	100	80.00
18	0 42(q) 30($100-q$) 0	100	80.00
19	0 7(50)8(50) 0	100	25.18
20	0 31(50)32(50) 0	100	75.53
21	0 19(q) 7($100-q$) 0	100	40.00
22	0 20(q) 8($100-q$) 0	100	40.00
23	0 43(q) 31($100-q$) 0	100	80.00
24	0 44(q) 32($100-q$) 0	100	80.00
25	0 9(50)10(50) 0	100	25.18
26	0 33(50)34(50) 0	100	75.53
27	0 21(q) 9($100-q$) 0	100	40.00
28	0 22(q) 10($100-q$) 0	100	40.00
29	0 45(q) 33($100-q$) 0	100	80.00
30	0 46(q) 34($100-q$) 0	100	80.00
31	0 11(50)12(50) 0	100	25.18
32	0 35(50)36(50) 0	100	75.53
33	0 23(q) 11($100-q$) 0	100	40.00

(cont.)

Table A.171 continued.

No.	Route	Load	Distance
34	0 24(q) 12($100-q$) 0	100	40.00
35	0 47(q) 35($100-q$) 0	100	79.99
36	0 48(q) 36($100-q$) 0	100	80.01
37	0 85(q) 73($100-q$) 0	100	160.00
38	0 73(50)49(50) 0	100	140.00
39	0 61(q) 49($100-q$) 0	100	120.00
40	0 86(q) 74($100-q$) 0	100	160.00
41	0 74(50)50(50) 0	100	140.00
42	0 62(q) 50($100-q$) 0	100	120.00
43	0 87(q) 75($100-q$) 0	100	160.00
44	0 75(50)51(50) 0	100	140.00
45	0 63(q) 51($100-q$) 0	100	120.00
46	0 88(q) 76($100-q$) 0	100	160.00
47	0 76(50)52(50) 0	100	140.00
48	0 64(q) 52($100-q$) 0	100	120.00
49	0 89(q) 77($100-q$) 0	100	160.00
50	0 77(50)53(50) 0	100	140.00
51	0 65(q) 53($100-q$) 0	100	120.00
52	0 90(q) 78($100-q$) 0	100	160.01
53	0 78(50)54(50) 0	100	140.00
54	0 66(q) 54($100-q$) 0	100	120.00
55	0 91(q) 79($100-q$) 0	100	160.00
56	0 79(50)55(50) 0	100	140.00
57	0 67(q) 55($100-q$) 0	100	120.00
58	0 92(q) 80($100-q$) 0	100	160.00
59	0 80(50)56(50) 0	100	140.00
60	0 68(q) 56($100-q$) 0	100	119.99
61	0 93(q) 81($100-q$) 0	100	160.01
62	0 81(50)57(50) 0	100	140.01
63	0 69(q) 57($100-q$) 0	100	120.01
64	0 94(q) 82($100-q$) 0	100	160.00
65	0 82(50)58(50) 0	100	140.00
66	0 70(q) 58($100-q$) 0	100	120.00

(cont.)

Table A.171 continued.

No.	Route	Load	Distance
67	0 95(q) 83($100-q$) 0	100	160.00
68	0 83(50)59(50) 0	100	140.00
69	0 71(q) 59($100-q$) 0	100	120.00
70	0 96(q) 84($100-q$) 0	100	160.01
71	0 84(50)60(50) 0	100	140.01
72	0 72(q) 60($100-q$) 0	100	120.01
73	0 133(q) 121($100-q$) 0	100	240.00
74	0 121(50)97(50) 0	100	220.00
75	0 109(q) 97($100-q$) 0	100	200.00
76	0 134(q) 122($100-q$) 0	100	239.99
77	0 122(50)98(50) 0	100	220.00
78	0 110(q) 98($100-q$) 0	100	200.00
79	0 135(q) 123($100-q$) 0	100	239.99
80	0 123(50)99(50) 0	100	220.00
81	0 111(q) 99($100-q$) 0	100	200.00
82	0 136(q) 124($100-q$) 0	100	240.00
83	0 124(50)100(50) 0	100	220.00
84	0 112(q) 100($100-q$) 0	100	200.00
85	0 137(q) 125($100-q$) 0	100	240.00
86	0 125(50)101(50) 0	100	220.00
87	0 113(q) 101($100-q$) 0	100	200.00
88	0 138(q) 126($100-q$) 0	100	240.00
89	0 126(50)102(50) 0	100	220.01
90	0 114(q) 102($100-q$) 0	100	200.01
91	0 139(q) 127($100-q$) 0	100	240.00
92	0 127(50)103(50) 0	100	220.00
93	0 115(q) 103($100-q$) 0	100	200.00
94	0 140(q) 128($100-q$) 0	100	240.00
95	0 128(50)104(50) 0	100	220.00
96	0 116(q) 104($100-q$) 0	100	200.00
97	0 141(q) 129($100-q$) 0	100	240.00
98	0 129(50)105(50) 0	100	220.01
99	0 117(q) 105($100-q$) 0	100	200.01

(cont.)

Table A.171 continued.

No.	Route	Load	Distance
100	0 142(q) 130($100-q$) 0	100	240.00
101	0 130(50)106(50) 0	100	220.00
102	0 118(q) 106($100-q$) 0	100	200.00
103	0 143(q) 131($100-q$) 0	100	239.99
104	0 131(50)107(50) 0	100	220.00
105	0 119(q) 107($100-q$) 0	100	200.00
106	0 144(q) 132($100-q$) 0	100	240.00
107	0 132(50)108(50) 0	100	220.00
108	0 120(q) 108($100-q$) 0	100	199.99
		Total Distance	15004.22

Note: $q = 94, 87, 78, 66$ for $p = .1, .2, .3, .4$, respectively.

Table A.172: Estimated solutions for MDA16.

No.	Route	Load	Distance
1	0 1(50)2(50) 0	100	20.87
2	0 73(q) 1($100-q$) 0	100	40.00
3	0 74(q) 2($100-q$) 0	100	39.99
4	0 3(50)4(50) 0	100	20.87
5	0 75(q) 3($100-q$) 0	100	40.01
6	0 76(q) 4($100-q$) 0	100	40.00
7	0 5(50)6(50) 0	100	20.88
8	0 77(q) 5($100-q$) 0	100	39.99
9	0 78(q) 6($100-q$) 0	100	40.00
10	0 7(50)8(50) 0	100	20.88
11	0 79(q) 7($100-q$) 0	100	40.00
12	0 80(q) 8($100-q$) 0	100	39.99
13	0 9(50)10(50) 0	100	20.87
14	0 81(q) 9($100-q$) 0	100	40.00
15	0 82(q) 10($100-q$) 0	100	39.99
16	0 11(50)12(50) 0	100	20.87
17	0 83(q) 11($100-q$) 0	100	40.00
18	0 84(q) 12($100-q$) 0	100	39.99
19	0 13(50)14(50) 0	100	20.87
20	0 85(q) 13($100-q$) 0	100	40.00
21	0 86(q) 14($100-q$) 0	100	40.00
22	0 15(50)16(50) 0	100	20.87
23	0 87(q) 15($100-q$) 0	100	39.99
24	0 88(q) 16($100-q$) 0	100	40.00
25	0 17(50)18(50) 0	100	20.88
26	0 89(q) 17($100-q$) 0	100	40.01
27	0 90(q) 18($100-q$) 0	100	39.99
28	0 19(50)20(50) 0	100	20.87
29	0 91(q) 19($100-q$) 0	100	40.00
30	0 92(q) 20($100-q$) 0	100	39.99
31	0 21(50)22(50) 0	100	20.87
32	0 93(q) 21($100-q$) 0	100	40.01
33	0 94(q) 22($100-q$) 0	100	40.00

(cont.)

Table A.172 continued.

No.	Route	Load	Distance
34	0 23(50)24(50) 0	100	20.88
35	0 95(q) 23(100 − q) 0	100	39.99
36	0 96(q) 24(100 − q) 0	100	40.00
37	0 25(50)26(50) 0	100	20.88
38	0 97(q) 25(100 − q) 0	100	40.00
39	0 98(q) 26(100 − q) 0	100	39.99
40	0 27(50)28(50) 0	100	20.87
41	0 99(q) 27(100 − q) 0	100	39.99
42	0 100(q) 28(100 − q) 0	100	39.99
43	0 29(50)30(50) 0	100	20.87
44	0 101(q) 29(100 − q) 0	100	40.00
45	0 102(q) 30(100 − q) 0	100	39.99
46	0 31(50)32(50) 0	100	20.87
47	0 103(q) 31(100 − q) 0	100	40.00
48	0 104(q) 32(100 − q) 0	100	40.00
49	0 33(50)34(50) 0	100	20.87
50	0 105(q) 33(100 − q) 0	100	39.99
51	0 106(q) 34(100 − q) 0	100	40.00
52	0 35(50)36(50) 0	100	20.88
53	0 107(q) 35(100 − q) 0	100	40.01
54	0 108(q) 36(100 − q) 0	100	39.99
55	0 37(50)38(50) 0	100	20.87
56	0 109(q) 37(100 − q) 0	100	40.00
57	0 110(q) 38(100 − q) 0	100	39.99
58	0 39(50)40(50) 0	100	20.87
59	0 111(q) 39(100 − q) 0	100	40.01
60	0 112(q) 40(100 − q) 0	100	40.00
61	0 41(50)42(50) 0	100	20.88
62	0 113(q) 41(100 − q) 0	100	39.99
63	0 114(q) 42(100 − q) 0	100	40.00
64	0 43(50)44(50) 0	100	20.86
65	0 115(q) 43(100 − q) 0	100	40.00
66	0 116(q) 44(100 − q) 0	100	39.99

(cont.)

Table A.172 continued.

No.	Route	Load	Distance
67	0 45(50)46(50) 0	100	20.87
68	0 117(q) 45(100 − q) 0	100	39.99
69	0 118(q) 46(100 − q) 0	100	39.99
70	0 47(50)48(50) 0	100	20.87
71	0 119(q) 47(100 − q) 0	100	40.00
72	0 120(q) 48(100 − q) 0	100	39.99
73	0 49(50)50(50) 0	100	20.87
74	0 121(q) 49(100 − q) 0	100	40.00
75	0 122(q) 50(100 − q) 0	100	40.00
76	0 51(50)52(50) 0	100	20.87
77	0 123(q) 51(100 − q) 0	100	39.99
78	0 124(q) 52(100 − q) 0	100	40.00
79	0 53(50)54(50) 0	100	20.88
80	0 125(q) 53(100 − q) 0	100	40.01
81	0 126(q) 54(100 − q) 0	100	39.99
82	0 55(50)56(50) 0	100	20.87
83	0 127(q) 55(100 − q) 0	100	40.00
84	0 128(q) 56(100 − q) 0	100	39.99
85	0 57(50)58(50) 0	100	20.87
86	0 129(q) 57(100 − q) 0	100	40.01
87	0 130(q) 58(100 − q) 0	100	40.00
88	0 59(50)60(50) 0	100	20.87
89	0 131(q) 59(100 − q) 0	100	39.99
90	0 132(q) 60(100 − q) 0	100	40.00
91	0 61(50)62(50) 0	100	20.86
92	0 133(q) 61(100 − q) 0	100	40.00
93	0 134(q) 62(100 − q) 0	100	39.99
94	0 63(50)64(50) 0	100	20.87
95	0 135(q) 63(100 − q) 0	100	39.99
96	0 136(q) 64(100 − q) 0	100	39.99
97	0 65(50)66(50) 0	100	20.87
98	0 137(q) 65(100 − q) 0	100	40.00
99	0 138(q) 66(100 − q) 0	100	39.99

(cont.)

Table A.172 continued.

No.	Route	Load	Distance
100	0 67(50)68(50) 0	100	20.87
101	0 139(q) 67($100-q$) 0	100	40.00
102	0 140(q) 68($100-q$) 0	100	40.00
103	0 69(50)70(50) 0	100	20.87
104	0 141(q) 69($100-q$) 0	100	39.99
105	0 142(q) 70($100-q$) 0	100	40.00
106	0 71(50)72(50) 0	100	20.88
107	0 143(q) 71($100-q$) 0	100	40.01
108	0 144(q) 72($100-q$) 0	100	39.99
		Total Distance	3631.30

Note: $q = 94, 87, 78, 66$ for $p = .1, .2, .3, .4$, respectively.

Table A.173: Estimated solutions for MDA17.

No.	Route	Load	Distance
1	0 1(50)2(50) 0	100	27.65
2	0 17(50)18(50) 0	100	82.95
3	0 9(q) 1($100-q$) 0	100	40.00
4	0 10(q) 2($100-q$) 0	100	39.99
5	0 25(q) 17($100-q$) 0	100	80.00
6	0 26(q) 18($100-q$) 0	100	79.99
7	0 3(50)4(50) 0	100	27.65
8	0 19(50)20(50) 0	100	82.95
9	0 11(q) 3($100-q$) 0	100	40.00
10	0 12(q) 4($100-q$) 0	100	39.99
11	0 27(q) 19($100-q$) 0	100	80.00
12	0 28(q) 20($100-q$) 0	100	80.00
13	0 5(50)6(50) 0	100	27.65
14	0 21(50)22(50) 0	100	82.96
15	0 13(q) 5($100-q$) 0	100	40.00
16	0 14(q) 6($100-q$) 0	100	39.99
17	0 29(q) 21($100-q$) 0	100	80.00
18	0 30(q) 22($100-q$) 0	100	80.00
19	0 7(50)8(50) 0	100	27.65
20	0 23(50)24(50) 0	100	82.96
21	0 15(q) 7($100-q$) 0	100	40.00
22	0 16(q) 8($100-q$) 0	100	39.99
23	0 31(q) 23($100-q$) 0	100	80.00
24	0 32(q) 24($100-q$) 0	100	80.00
25	0 57(q) 49($100-q$) 0	100	160.00
26	0 49(50)33(50) 0	100	140.00
27	0 41(q) 33($100-q$) 0	100	120.00
28	0 58(q) 50($100-q$) 0	100	160.00
29	0 50(50)34(50) 0	100	140.01
30	0 42(q) 34($100-q$) 0	100	120.01
31	0 59(q) 51($100-q$) 0	100	160.00
32	0 51(50)35(50) 0	100	140.00
33	0 43(q) 35($100-q$) 0	100	120.00

(cont.)

Table A.173 continued.

No.	Route	Load	Distance
34	0 60(q) 52($100-q$) 0	100	159.99
35	0 52(50)36(50) 0	100	139.99
36	0 44(q) 36($100-q$) 0	100	120.00
37	0 61(q) 53($100-q$) 0	100	160.00
38	0 53(50)37(50) 0	100	140.00
39	0 45(q) 37($100-q$) 0	100	120.00
40	0 62(q) 54($100-q$) 0	100	160.00
41	0 54(50)38(50) 0	100	139.99
42	0 46(q) 38($100-q$) 0	100	120.00
43	0 63(q) 55($100-q$) 0	100	160.00
44	0 55(50)39(50) 0	100	140.00
45	0 47(q) 39($100-q$) 0	100	120.00
46	0 64(q) 56($100-q$) 0	100	160.00
47	0 56(50)40(50) 0	100	140.01
48	0 48(q) 40($100-q$) 0	100	120.00
49	0 89(q) 81($100-q$) 0	100	240.00
50	0 81(50)65(50) 0	100	220.00
51	0 73(q) 65($100-q$) 0	100	200.00
52	0 90(q) 82($100-q$) 0	100	239.99
53	0 82(50)66(50) 0	100	220.00
54	0 74(q) 66($100-q$) 0	100	200.00
55	0 91(q) 83($100-q$) 0	100	240.00
56	0 83(50)67(50) 0	100	220.00
57	0 75(q) 67($100-q$) 0	100	200.00
58	0 92(q) 84($100-q$) 0	100	240.01
59	0 84(50)68(50) 0	100	220.01
60	0 76(q) 68($100-q$) 0	100	200.01
61	0 93(q) 85($100-q$) 0	100	240.00
62	0 85(50)69(50) 0	100	220.00
63	0 77(q) 69($100-q$) 0	100	200.00
64	0 94(q) 86($100-q$) 0	100	239.99
65	0 86(50)70(50) 0	100	220.00
66	0 78(q) 70($100-q$) 0	100	200.00

(cont.)

Table A.173 continued.

No.	Route	Load	Distance
67	0 95(q) 87($100-q$) 0	100	240.00
68	0 87(50)71(50) 0	100	220.00
69	0 79(q) 71($100-q$) 0	100	200.00
70	0 96(q) 88($100-q$) 0	100	240.01
71	0 88(50)72(50) 0	100	220.00
72	0 80(q) 72($100-q$) 0	100	200.00
73	0 121(q) 113($100-q$) 0	100	320.00
74	0 113(50)97(50) 0	100	300.00
75	0 105(q) 97($100-q$) 0	100	280.00
76	0 122(q) 114($100-q$) 0	100	319.99
77	0 114(50)98(50) 0	100	300.00
78	0 106(q) 98($100-q$) 0	100	280.00
79	0 123(q) 115($100-q$) 0	100	320.00
80	0 115(50)99(50) 0	100	300.00
81	0 107(q) 99($100-q$) 0	100	280.00
82	0 124(q) 116($100-q$) 0	100	319.99
83	0 116(50)100(50) 0	100	300.00
84	0 108(q) 100($100-q$) 0	100	280.00
85	0 125(q) 117($100-q$) 0	100	320.00
86	0 117(50)101(50) 0	100	300.00
87	0 109(q) 101($100-q$) 0	100	280.00
88	0 126(q) 118($100-q$) 0	100	319.99
89	0 118(50)102(50) 0	100	300.00
90	0 110(q) 102($100-q$) 0	100	280.00
91	0 127(q) 119($100-q$) 0	100	320.00
92	0 119(50)103(50) 0	100	300.00
93	0 111(q) 103($100-q$) 0	100	280.00
94	0 128(q) 120($100-q$) 0	100	320.01
95	0 120(50)104(50) 0	100	300.00
96	0 112(q) 104($100-q$) 0	100	280.00
97	0 153(q) 145($100-q$) 0	100	400.00
98	0 145(50)129(50) 0	100	380.00
99	0 137(q) 129($100-q$) 0	100	360.00

(cont.)

Table A.173 continued.

No.	Route	Load	Distance
100	0 154(q) 146($100-q$) 0	100	400.00
101	0 146(50)130(50) 0	100	380.00
102	0 138(q) 130($100-q$) 0	100	360.00
103	0 155(q) 147($100-q$) 0	100	400.00
104	0 147(50)131(50) 0	100	380.00
105	0 139(q) 131($100-q$) 0	100	360.00
106	0 156(q) 148($100-q$) 0	100	400.00
107	0 148(50)132(50) 0	100	380.00
108	0 140(q) 132($100-q$) 0	100	360.00
109	0 157(q) 149($100-q$) 0	100	400.00
110	0 149(50)133(50) 0	100	380.00
111	0 141(q) 133($100-q$) 0	100	360.00
112	0 158(q) 150($100-q$) 0	100	400.00
113	0 150(50)134(50) 0	100	380.00
114	0 142(q) 134($100-q$) 0	100	359.99
115	0 159(q) 151($100-q$) 0	100	400.00
116	0 151(50)135(50) 0	100	380.00
117	0 143(q) 135($100-q$) 0	100	360.00
118	0 160(q) 152($100-q$) 0	100	400.00
119	0 152(50)136(50) 0	100	380.00
120	0 144(q) 136($100-q$) 0	100	360.00
		Total Distance	26362.36

Note: $q = 94, 87, 78, 66$ for $p = .1, .2, .3, .4$, respectively.

Table A.174: Estimated solutions for MDA18.

No.	Route	Load	Distance
1	0 1(50)2(50) 0	100	23.91
2	0 17(q) 1($100 - q$) 0	100	40.00
3	0 18(q) 2($100 - q$) 0	100	40.00
4	0 3(50)4(50) 0	100	23.90
5	0 19(q) 3($100 - q$) 0	100	39.99
6	0 20(q) 4($100 - q$) 0	100	40.00
7	0 5(50)6(50) 0	100	23.91
8	0 21(q) 5($100 - q$) 0	100	40.00
9	0 22(q) 6($100 - q$) 0	100	40.00
10	0 7(50)8(50) 0	100	23.90
11	0 23(q) 7($100 - q$) 0	100	39.99
12	0 24(q) 8($100 - q$) 0	100	40.01
13	0 9(50)10(50) 0	100	23.91
14	0 25(q) 9($100 - q$) 0	100	40.00
15	0 26(q) 10($100 - q$) 0	100	40.00
16	0 11(50)12(50) 0	100	23.90
17	0 27(q) 11($100 - q$) 0	100	39.99
18	0 28(q) 12($100 - q$) 0	100	40.01
19	0 13(50)14(50) 0	100	23.91
20	0 29(q) 13($100 - q$) 0	100	40.00
21	0 30(q) 14($100 - q$) 0	100	40.00
22	0 15(50)16(50) 0	100	23.90
23	0 31(q) 15($100 - q$) 0	100	39.99
24	0 32(q) 16($100 - q$) 0	100	40.01
25	0 33(50)34(50) 0	100	71.71
26	0 65(50)66(50) 0	100	119.50
27	0 49(q) 33($100 - q$) 0	100	80.00
28	0 50(q) 34($100 - q$) 0	100	80.01
29	0 81(q) 65($100 - q$) 0	100	120.00
30	0 82(q) 66($100 - q$) 0	100	119.99
31	0 35(50)36(50) 0	100	71.71
32	0 67(50)68(50) 0	100	119.51
33	0 51(q) 35($100 - q$) 0	100	79.99

(cont.)

Table A.174 continued.

No.	Route	Load	Distance
34	0 52(q) 36($100-q$) 0	100	79.99
35	0 83(q) 67($100-q$) 0	100	120.01
36	0 84(q) 68($100-q$) 0	100	119.99
37	0 37(50)38(50) 0	100	71.71
38	0 69(50)70(50) 0	100	119.51
39	0 53(q) 37($100-q$) 0	100	80.00
40	0 54(q) 38($100-q$) 0	100	80.01
41	0 85(q) 69($100-q$) 0	100	120.00
42	0 86(q) 70($100-q$) 0	100	119.99
43	0 39(50)40(50) 0	100	71.71
44	0 71(50)72(50) 0	100	119.51
45	0 55(q) 39($100-q$) 0	100	80.00
46	0 56(q) 40($100-q$) 0	100	79.99
47	0 87(q) 71($100-q$) 0	100	120.00
48	0 88(q) 72($100-q$) 0	100	120.00
49	0 41(50)42(50) 0	100	71.71
50	0 73(50)74(50) 0	100	119.51
51	0 57(q) 41($100-q$) 0	100	80.00
52	0 58(q) 42($100-q$) 0	100	80.00
53	0 89(q) 73($100-q$) 0	100	120.00
54	0 90(q) 74($100-q$) 0	100	120.01
55	0 43(50)44(50) 0	100	71.71
56	0 75(50)76(50) 0	100	119.51
57	0 59(q) 43($100-q$) 0	100	80.00
58	0 60(q) 44($100-q$) 0	100	79.99
59	0 91(q) 75($100-q$) 0	100	120.00
60	0 92(q) 76($100-q$) 0	100	120.00
61	0 45(50)46(50) 0	100	71.71
62	0 77(50)78(50) 0	100	119.52
63	0 61(q) 45($100-q$) 0	100	80.00
64	0 62(q) 46($100-q$) 0	100	80.00
65	0 93(q) 77($100-q$) 0	100	120.00
66	0 94(q) 78($100-q$) 0	100	120.00

(cont.)

Table A.174 continued.

No.	Route	Load	Distance
67	0 47(50)48(50) 0	100	71.70
68	0 79(50)80(50) 0	100	119.51
69	0 63(q) 47($100-q$) 0	100	80.00
70	0 64(q) 48($100-q$) 0	100	79.99
71	0 95(q) 79($100-q$) 0	100	120.00
72	0 96(q) 80($100-q$) 0	100	120.00
73	0 145(q) 129($100-q$) 0	100	200.00
74	0 129(50)97(50) 0	100	180.00
75	0 113(q) 97($100-q$) 0	100	160.00
76	0 146(q) 130($100-q$) 0	100	200.01
77	0 130(50)98(50) 0	100	180.00
78	0 114(q) 98($100-q$) 0	100	160.00
79	0 147(q) 131($100-q$) 0	100	200.00
80	0 131(50)99(50) 0	100	180.00
81	0 115(q) 99($100-q$) 0	100	160.00
82	0 148(q) 132($100-q$) 0	100	200.01
83	0 132(50)100(50) 0	100	180.00
84	0 116(q) 100($100-q$) 0	100	160.00
85	0 149(q) 133($100-q$) 0	100	200.00
86	0 133(50)101(50) 0	100	180.00
87	0 117(q) 101($100-q$) 0	100	160.00
88	0 150(q) 134($100-q$) 0	100	200.00
89	0 134(50)102(50) 0	100	180.00
90	0 118(q) 102($100-q$) 0	100	160.00
91	0 151(q) 135($100-q$) 0	100	200.01
92	0 135(50)103(50) 0	100	180.00
93	0 119(q) 103($100-q$) 0	100	159.99
94	0 152(q) 136($100-q$) 0	100	199.99
95	0 136(50)104(50) 0	100	180.01
96	0 120(q) 104($100-q$) 0	100	160.00
97	0 153(q) 137($100-q$) 0	100	200.00
98	0 137(50)105(50) 0	100	180.00
99	0 121(q) 105($100-q$) 0	100	160.00

(cont.)

Table A.174 continued.

No.	Route	Load	Distance
100	0 154(q) 138($100-q$) 0	100	200.00
101	0 138(50)106(50) 0	100	179.99
102	0 122(q) 106($100-q$) 0	100	160.00
103	0 155(q) 139($100-q$) 0	100	200.00
104	0 139(50)107(50) 0	100	180.00
105	0 123(q) 107($100-q$) 0	100	160.00
106	0 156(q) 140($100-q$) 0	100	199.99
107	0 140(50)108(50) 0	100	179.99
108	0 124(q) 108($100-q$) 0	100	160.00
109	0 157(q) 141($100-q$) 0	100	200.00
110	0 141(50)109(50) 0	100	180.00
111	0 125(q) 109($100-q$) 0	100	160.00
112	0 158(q) 142($100-q$) 0	100	199.99
113	0 142(50)110(50) 0	100	179.99
114	0 126(q) 110($100-q$) 0	100	159.99
115	0 159(q) 143($100-q$) 0	100	200.00
116	0 143(50)111(50) 0	100	180.00
117	0 127(q) 111($100-q$) 0	100	160.00
118	0 160(q) 144($100-q$) 0	100	199.99
119	0 144(50)112(50) 0	100	180.00
120	0 128(q) 112($100-q$) 0	100	160.01
		Total Distance	14200.92

Note: $q = 94, 87, 78, 66$ for $p = .1, .2, .3, .4$, respectively.

Table A.175: Estimated solutions for MDA19.

No.	Route	Load	Distance
1	0 1(50)2(50) 0	100	23.91
2	0 33(50)34(50) 0	100	71.71
3	0 17(q) 1($100-q$) 0	100	40.00
4	0 18(q) 2($100-q$) 0	100	40.00
5	0 49(q) 33($100-q$) 0	100	80.00
6	0 50(q) 34($100-q$) 0	100	80.01
7	0 3(50)4(50) 0	100	23.90
8	0 35(50)36(50) 0	100	71.71
9	0 19(q) 3($100-q$) 0	100	39.99
10	0 20(q) 4($100-q$) 0	100	40.00
11	0 51(q) 35($100-q$) 0	100	79.99
12	0 52(q) 36($100-q$) 0	100	79.99
13	0 5(50)6(50) 0	100	23.91
14	0 37(50)38(50) 0	100	71.71
15	0 21(q) 5($100-q$) 0	100	40.00
16	0 22(q) 6($100-q$) 0	100	40.00
17	0 53(q) 37($100-q$) 0	100	80.00
18	0 54(q) 38($100-q$) 0	100	80.01
19	0 7(50)8(50) 0	100	23.90
20	0 39(50)40(50) 0	100	71.71
21	0 23(q) 7($100-q$) 0	100	39.99
22	0 24(q) 8($100-q$) 0	100	40.01
23	0 55(q) 39($100-q$) 0	100	80.00
24	0 56(q) 40($100-q$) 0	100	79.99
25	0 9(50)10(50) 0	100	23.91
26	0 41(50)42(50) 0	100	71.71
27	0 25(q) 9($100-q$) 0	100	40.00
28	0 26(q) 10($100-q$) 0	100	40.00
29	0 57(q) 41($100-q$) 0	100	80.00
30	0 58(q) 42($100-q$) 0	100	80.00
31	0 11(50)12(50) 0	100	23.90
32	0 43(50)44(50) 0	100	71.71
33	0 27(q) 11($100-q$) 0	100	39.99

(cont.)

Table A.175 continued.

No.	Route	Load	Distance
34	0 28(q) 12($100-q$) 0	100	40.01
35	0 59(q) 43($100-q$) 0	100	80.00
36	0 60(q) 44($100-q$) 0	100	79.99
37	0 13(50)14(50) 0	100	23.91
38	0 45(50)46(50) 0	100	71.71
39	0 29(q) 13($100-q$) 0	100	40.00
40	0 30(q) 14($100-q$) 0	100	40.00
41	0 61(q) 45($100-q$) 0	100	80.00
42	0 62(q) 46($100-q$) 0	100	80.00
43	0 15(50)16(50) 0	100	23.90
44	0 47(50)48(50) 0	100	71.70
45	0 31(q) 15($100-q$) 0	100	39.99
46	0 32(q) 16($100-q$) 0	100	40.01
47	0 63(q) 47($100-q$) 0	100	80.00
48	0 64(q) 48($100-q$) 0	100	79.99
49	0 113(q) 97($100-q$) 0	100	160.00
50	0 97(50)65(50) 0	100	140.00
51	0 81(q) 65($100-q$) 0	100	120.00
52	0 114(q) 98($100-q$) 0	100	160.00
53	0 98(50)66(50) 0	100	140.00
54	0 82(q) 66($100-q$) 0	100	119.99
55	0 115(q) 99($100-q$) 0	100	160.00
56	0 99(50)67(50) 0	100	140.01
57	0 83(q) 67($100-q$) 0	100	120.01
58	0 116(q) 100($100-q$) 0	100	160.00
59	0 100(50)68(50) 0	100	140.00
60	0 84(q) 68($100-q$) 0	100	119.99
61	0 117(q) 101($100-q$) 0	100	160.00
62	0 101(50)69(50) 0	100	140.00
63	0 85(q) 69($100-q$) 0	100	120.00
64	0 118(q) 102($100-q$) 0	100	160.00
65	0 102(50)70(50) 0	100	139.99
66	0 86(q) 70($100-q$) 0	100	119.99

(cont.)

Table A.175 continued.

No.	Route	Load	Distance
67	0 119(q) 103($100-q$) 0	100	159.99
68	0 103(50)71(50) 0	100	139.99
69	0 87(q) 71($100-q$) 0	100	120.00
70	0 120(q) 104($100-q$) 0	100	160.00
71	0 104(50)72(50) 0	100	140.00
72	0 88(q) 72($100-q$) 0	100	120.00
73	0 121(q) 105($100-q$) 0	100	160.00
74	0 105(50)73(50) 0	100	140.00
75	0 89(q) 73($100-q$) 0	100	120.00
76	0 122(q) 106($100-q$) 0	100	160.00
77	0 106(50)74(50) 0	100	139.99
78	0 90(q) 74($100-q$) 0	100	120.01
79	0 123(q) 107($100-q$) 0	100	160.00
80	0 107(50)75(50) 0	100	139.99
81	0 91(q) 75($100-q$) 0	100	120.00
82	0 124(q) 108($100-q$) 0	100	160.00
83	0 108(50)76(50) 0	100	140.01
84	0 92(q) 76($100-q$) 0	100	120.00
85	0 125(q) 109($100-q$) 0	100	160.00
86	0 109(50)77(50) 0	100	140.00
87	0 93(q) 77($100-q$) 0	100	120.00
88	0 126(q) 110($100-q$) 0	100	159.99
89	0 110(50)78(50) 0	100	140.01
90	0 94(q) 78($100-q$) 0	100	120.00
91	0 127(q) 111($100-q$) 0	100	160.00
92	0 111(50)79(50) 0	100	140.01
93	0 95(q) 79($100-q$) 0	100	120.00
94	0 128(q) 112($100-q$) 0	100	160.01
95	0 112(50)80(50) 0	100	140.01
96	0 96(q) 80($100-q$) 0	100	120.00
97	0 177(q) 161($100-q$) 0	100	240.00
98	0 161(50)129(50) 0	100	220.00
99	0 145(q) 129($100-q$) 0	100	200.00

(cont.)

Table A.175 continued.

No.	Route	Load	Distance
100	0 178(q) 162($100-q$) 0	100	240.01
101	0 162(50)130(50) 0	100	220.00
102	0 146(q) 130($100-q$) 0	100	200.01
103	0 179(q) 163($100-q$) 0	100	239.99
104	0 163(50)131(50) 0	100	220.00
105	0 147(q) 131($100-q$) 0	100	200.00
106	0 180(q) 164($100-q$) 0	100	240.00
107	0 164(50)132(50) 0	100	220.01
108	0 148(q) 132($100-q$) 0	100	200.01
109	0 181(q) 165($100-q$) 0	100	240.00
110	0 165(50)133(50) 0	100	220.00
111	0 149(q) 133($100-q$) 0	100	200.00
112	0 182(q) 166($100-q$) 0	100	240.01
113	0 166(50)134(50) 0	100	220.00
114	0 150(q) 134($100-q$) 0	100	200.00
115	0 183(q) 167($100-q$) 0	100	240.01
116	0 167(50)135(50) 0	100	220.01
117	0 151(q) 135($100-q$) 0	100	200.01
118	0 184(q) 168($100-q$) 0	100	240.00
119	0 168(50)136(50) 0	100	219.99
120	0 152(q) 136($100-q$) 0	100	199.99
121	0 185(q) 169($100-q$) 0	100	240.00
122	0 169(50)137(50) 0	100	220.00
123	0 153(q) 137($100-q$) 0	100	200.00
124	0 186(q) 170($100-q$) 0	100	240.00
125	0 170(50)138(50) 0	100	219.99
126	0 154(q) 138($100-q$) 0	100	200.00
127	0 187(q) 171($100-q$) 0	100	239.99
128	0 171(50)139(50) 0	100	220.00
129	0 155(q) 139($100-q$) 0	100	200.00
130	0 188(q) 172($100-q$) 0	100	240.00
131	0 172(50)140(50) 0	100	220.00
132	0 156(q) 140($100-q$) 0	100	199.99

(cont.)

Table A.175 continued.

No.	Route	Load	Distance
133	0 189(q) 173($100-q$) 0	100	240.00
134	0 173(50)141(50) 0	100	220.00
135	0 157(q) 141($100-q$) 0	100	200.00
136	0 190(q) 174($100-q$) 0	100	240.00
137	0 174(50)142(50) 0	100	219.99
138	0 158(q) 142($100-q$) 0	100	199.99
139	0 191(q) 175($100-q$) 0	100	240.01
140	0 175(50)143(50) 0	100	220.00
141	0 159(q) 143($100-q$) 0	100	200.00
142	0 192(q) 176($100-q$) 0	100	240.00
143	0 176(50)144(50) 0	100	220.00
144	0 160(q) 144($100-q$) 0	100	199.99
		Total Distance	19964.86

Note: $q = 94, 87, 78, 66$ for $p = .1, .2, .3, .4$, respectively.

Table A.176: Estimated solutions for MDA20.

No.	Route	Load	Distance
1	0 1(50)2(50) 0	100	25.18
2	0 25(50)26(50) 0	100	75.53
3	0 13(q) 1($100-q$) 0	100	40.00
4	0 14(q) 2($100-q$) 0	100	40.00
5	0 37(q) 25($100-q$) 0	100	80.00
6	0 38(q) 26($100-q$) 0	100	80.00
7	0 3(50)4(50) 0	100	25.18
8	0 27(50)28(50) 0	100	75.53
9	0 15(q) 3($100-q$) 0	100	40.00
10	0 16(q) 4($100-q$) 0	100	40.00
11	0 39(q) 27($100-q$) 0	100	80.00
12	0 40(q) 28($100-q$) 0	100	80.00
13	0 5(50)6(50) 0	100	25.18
14	0 29(50)30(50) 0	100	75.53
15	0 17(q) 5($100-q$) 0	100	40.00
16	0 18(q) 6($100-q$) 0	100	40.00
17	0 41(q) 29($100-q$) 0	100	80.00
18	0 42(q) 30($100-q$) 0	100	80.00
19	0 7(50)8(50) 0	100	25.18
20	0 31(50)32(50) 0	100	75.53
21	0 19(q) 7($100-q$) 0	100	40.00
22	0 20(q) 8($100-q$) 0	100	40.00
23	0 43(q) 31($100-q$) 0	100	80.00
24	0 44(q) 32($100-q$) 0	100	80.00
25	0 9(50)10(50) 0	100	25.18
26	0 33(50)34(50) 0	100	75.53
27	0 21(q) 9($100-q$) 0	100	40.00
28	0 22(q) 10($100-q$) 0	100	40.00
29	0 45(q) 33($100-q$) 0	100	80.00
30	0 46(q) 34($100-q$) 0	100	80.00
31	0 11(50)12(50) 0	100	25.18
32	0 35(50)36(50) 0	100	75.53
33	0 23(q) 11($100-q$) 0	100	40.00

(cont.)

Table A.176 continued.

No.	Route	Load	Distance
34	0 24(q) 12($100-q$) 0	100	40.00
35	0 47(q) 35($100-q$) 0	100	79.99
36	0 48(q) 36($100-q$) 0	100	80.01
37	0 85(q) 73($100-q$) 0	100	160.00
38	0 73(50)49(50) 0	100	140.00
39	0 61(q) 49($100-q$) 0	100	120.00
40	0 86(q) 74($100-q$) 0	100	160.00
41	0 74(50)50(50) 0	100	140.00
42	0 62(q) 50($100-q$) 0	100	120.00
43	0 87(q) 75($100-q$) 0	100	160.00
44	0 75(50)51(50) 0	100	140.00
45	0 63(q) 51($100-q$) 0	100	120.00
46	0 88(q) 76($100-q$) 0	100	160.00
47	0 76(50)52(50) 0	100	140.00
48	0 64(q) 52($100-q$) 0	100	120.00
49	0 89(q) 77($100-q$) 0	100	160.00
50	0 77(50)53(50) 0	100	140.00
51	0 65(q) 53($100-q$) 0	100	120.00
52	0 90(q) 78($100-q$) 0	100	160.01
53	0 78(50)54(50) 0	100	140.00
54	0 66(q) 54($100-q$) 0	100	120.00
55	0 91(q) 79($100-q$) 0	100	160.00
56	0 79(50)55(50) 0	100	140.00
57	0 67(q) 55($100-q$) 0	100	120.00
58	0 92(q) 80($100-q$) 0	100	160.00
59	0 80(50)56(50) 0	100	140.00
60	0 68(q) 56($100-q$) 0	100	119.99
61	0 93(q) 81($100-q$) 0	100	160.01
62	0 81(50)57(50) 0	100	140.01
63	0 69(q) 57($100-q$) 0	100	120.01
64	0 94(q) 82($100-q$) 0	100	160.00
65	0 82(50)58(50) 0	100	140.00
66	0 70(q) 58($100-q$) 0	100	120.00

(cont.)

Table A.176 continued.

No.	Route	Load	Distance
67	0 95(q) 83($100-q$) 0	100	160.00
68	0 83(50)59(50) 0	100	140.00
69	0 71(q) 59($100-q$) 0	100	120.00
70	0 96(q) 84($100-q$) 0	100	160.01
71	0 84(50)60(50) 0	100	140.01
72	0 72(q) 60($100-q$) 0	100	120.01
73	0 133(q) 121($100-q$) 0	100	240.00
74	0 121(50)97(50) 0	100	220.00
75	0 109(q) 97($100-q$) 0	100	200.00
76	0 134(q) 122($100-q$) 0	100	239.99
77	0 122(50)98(50) 0	100	220.00
78	0 110(q) 98($100-q$) 0	100	200.00
79	0 135(q) 123($100-q$) 0	100	239.99
80	0 123(50)99(50) 0	100	220.00
81	0 111(q) 99($100-q$) 0	100	200.00
82	0 136(q) 124($100-q$) 0	100	240.00
83	0 124(50)100(50) 0	100	220.00
84	0 112(q) 100($100-q$) 0	100	200.00
85	0 137(q) 125($100-q$) 0	100	240.00
86	0 125(50)101(50) 0	100	220.00
87	0 113(q) 101($100-q$) 0	100	200.00
88	0 138(q) 126($100-q$) 0	100	240.00
89	0 126(50)102(50) 0	100	220.01
90	0 114(q) 102($100-q$) 0	100	200.01
91	0 139(q) 127($100-q$) 0	100	240.00
92	0 127(50)103(50) 0	100	220.00
93	0 115(q) 103($100-q$) 0	100	200.00
94	0 140(q) 128($100-q$) 0	100	240.00
95	0 128(50)104(50) 0	100	220.00
96	0 116(q) 104($100-q$) 0	100	200.00
97	0 141(q) 129($100-q$) 0	100	240.00
98	0 129(50)105(50) 0	100	220.01
99	0 117(q) 105($100-q$) 0	100	200.01

(cont.)

Table A.176 continued.

No.	Route	Load	Distance
100	0 142(q) 130($100-q$) 0	100	240.00
101	0 130(50)106(50) 0	100	220.00
102	0 118(q) 106($100-q$) 0	100	200.00
103	0 143(q) 131($100-q$) 0	100	239.99
104	0 131(50)107(50) 0	100	220.00
105	0 119(q) 107($100-q$) 0	100	200.00
106	0 144(q) 132($100-q$) 0	100	240.00
107	0 132(50)108(50) 0	100	220.00
108	0 120(q) 108($100-q$) 0	100	199.99
109	0 181(q) 169($100-q$) 0	100	320.00
110	0 169(50)145(50) 0	100	300.00
111	0 157(q) 145($100-q$) 0	100	280.00
112	0 182(q) 170($100-q$) 0	100	320.01
113	0 170(50)146(50) 0	100	299.99
114	0 158(q) 146($100-q$) 0	100	279.99
115	0 183(q) 171($100-q$) 0	100	319.99
116	0 171(50)147(50) 0	100	299.99
117	0 159(q) 147($100-q$) 0	100	279.99
118	0 184(q) 172($100-q$) 0	100	320.00
119	0 172(50)148(50) 0	100	300.00
120	0 160(q) 148($100-q$) 0	100	280.00
121	0 185(q) 173($100-q$) 0	100	320.00
122	0 173(50)149(50) 0	100	300.00
123	0 161(q) 149($100-q$) 0	100	280.00
124	0 186(q) 174($100-q$) 0	100	320.00
125	0 174(50)150(50) 0	100	300.00
126	0 162(q) 150($100-q$) 0	100	280.00
127	0 187(q) 175($100-q$) 0	100	320.00
128	0 175(50)151(50) 0	100	300.00
129	0 163(q) 151($100-q$) 0	100	280.00
130	0 188(q) 176($100-q$) 0	100	320.00
131	0 176(50)152(50) 0	100	300.00
132	0 164(q) 152($100-q$) 0	100	280.00

(cont.)

Table A.176 continued.

No.	Route	Load	Distance
133	0 189(q) 177($100-q$) 0	100	320.00
134	0 177(50)153(50) 0	100	300.00
135	0 165(q) 153($100-q$) 0	100	279.99
136	0 190(q) 178($100-q$) 0	100	320.00
137	0 178(50)154(50) 0	100	300.00
138	0 166(q) 154($100-q$) 0	100	280.00
139	0 191(q) 179($100-q$) 0	100	320.01
140	0 179(50)155(50) 0	100	300.01
141	0 167(q) 155($100-q$) 0	100	279.99
142	0 192(q) 180($100-q$) 0	100	320.00
143	0 180(50)156(50) 0	100	300.00
144	0 168(q) 156($100-q$) 0	100	280.00
145	0 229(q) 217($100-q$) 0	100	400.00
146	0 217(50)193(50) 0	100	380.00
147	0 205(q) 193($100-q$) 0	100	360.00
148	0 230(q) 218($100-q$) 0	100	400.01
149	0 218(50)194(50) 0	100	380.01
150	0 206(q) 194($100-q$) 0	100	360.01
151	0 231(q) 219($100-q$) 0	100	400.00
152	0 219(50)195(50) 0	100	380.00
153	0 207(q) 195($100-q$) 0	100	359.99
154	0 232(q) 220($100-q$) 0	100	400.00
155	0 220(50)196(50) 0	100	380.00
156	0 208(q) 196($100-q$) 0	100	360.00
157	0 233(q) 221($100-q$) 0	100	400.00
158	0 221(50)197(50) 0	100	380.00
159	0 209(q) 197($100-q$) 0	100	360.00
160	0 234(q) 222($100-q$) 0	100	400.00
161	0 222(50)198(50) 0	100	380.00
162	0 210(q) 198($100-q$) 0	100	360.00
163	0 235(q) 223($100-q$) 0	100	400.00
164	0 223(50)199(50) 0	100	380.00
165	0 211(q) 199($100-q$) 0	100	360.00

(cont.)

Table A.176 continued.

No.	Route	Load	Distance
166	0 236(q) 224($100-q$) 0	100	400.01
167	0 224(50)200(50) 0	100	380.01
168	0 212(q) 200($100-q$) 0	100	359.99
169	0 237(q) 225($100-q$) 0	100	399.99
170	0 225(50)201(50) 0	100	379.99
171	0 213(q) 201($100-q$) 0	100	359.99
172	0 238(q) 226($100-q$) 0	100	400.00
173	0 226(50)202(50) 0	100	380.00
174	0 214(q) 202($100-q$) 0	100	360.00
175	0 239(q) 227($100-q$) 0	100	400.00
176	0 227(50)203(50) 0	100	380.00
177	0 215(q) 203($100-q$) 0	100	360.01
178	0 240(q) 228($100-q$) 0	100	400.00
179	0 228(50)204(50) 0	100	380.00
180	0 216(q) 204($100-q$) 0	100	360.00
		Total Distance	39484.21

Note: $q = 94, 87, 78, 66$ for $p = .1, .2, .3, .4$, respectively.

Table A.177: Estimated solutions for MDA21.

No.	Route	Load	Distance
1	0 1(50)2(50) 0	100	20.87
2	0 145(50)146(50) 0	100	62.62
3	0 73(q) 1($100 - q$) 0	100	40.00
4	0 74(q) 2($100 - q$) 0	100	39.99
5	0 217(q) 145($100 - q$) 0	100	80.00
6	0 218(q) 146($100 - q$) 0	100	80.01
7	0 3(50)4(50) 0	100	20.87
8	0 147(50)148(50) 0	100	62.61
9	0 75(q) 3($100 - q$) 0	100	40.01
10	0 76(q) 4($100 - q$) 0	100	40.00
11	0 219(q) 147($100 - q$) 0	100	80.00
12	0 220(q) 148($100 - q$) 0	100	80.00
13	0 5(50)6(50) 0	100	20.88
14	0 149(50)150(50) 0	100	62.62
15	0 77(q) 5($100 - q$) 0	100	39.99
16	0 78(q) 6($100 - q$) 0	100	40.00
17	0 221(q) 149($100 - q$) 0	100	80.00
18	0 222(q) 150($100 - q$) 0	100	79.99
19	0 7(50)8(50) 0	100	20.88
20	0 151(50)152(50) 0	100	62.62
21	0 79(q) 7($100 - q$) 0	100	40.00
22	0 80(q) 8($100 - q$) 0	100	39.99
23	0 223(q) 151($100 - q$) 0	100	80.00
24	0 224(q) 152($100 - q$) 0	100	80.00
25	0 9(50)10(50) 0	100	20.87
26	0 153(50)154(50) 0	100	62.61
27	0 81(q) 9($100 - q$) 0	100	40.00
28	0 82(q) 10($100 - q$) 0	100	39.99
29	0 225(q) 153($100 - q$) 0	100	80.00
30	0 226(q) 154($100 - q$) 0	100	79.99
31	0 11(50)12(50) 0	100	20.87
32	0 155(50)156(50) 0	100	62.60
33	0 83(q) 11($100 - q$) 0	100	40.00

(cont.)

Table A.177 continued.

No.	Route	Load	Distance
34	0 84(q) 12($100-q$) 0	100	39.99
35	0 227(q) 155($100-q$) 0	100	80.00
36	0 228(q) 156($100-q$) 0	100	80.00
37	0 13(50)14(50) 0	100	20.87
38	0 157(50)158(50) 0	100	62.62
39	0 85(q) 13($100-q$) 0	100	40.00
40	0 86(q) 14($100-q$) 0	100	40.00
41	0 229(q) 157($100-q$) 0	100	80.00
42	0 230(q) 158($100-q$) 0	100	80.00
43	0 15(50)16(50) 0	100	20.87
44	0 159(50)160(50) 0	100	62.61
45	0 87(q) 15($100-q$) 0	100	39.99
46	0 88(q) 16($100-q$) 0	100	40.00
47	0 231(q) 159($100-q$) 0	100	80.00
48	0 232(q) 160($100-q$) 0	100	80.00
49	0 17(50)18(50) 0	100	20.88
50	0 161(50)162(50) 0	100	62.61
51	0 89(q) 17($100-q$) 0	100	40.01
52	0 90(q) 18($100-q$) 0	100	39.99
53	0 233(q) 161($100-q$) 0	100	80.00
54	0 234(q) 162($100-q$) 0	100	80.01
55	0 19(50)20(50) 0	100	20.87
56	0 163(50)164(50) 0	100	62.62
57	0 91(q) 19($100-q$) 0	100	40.00
58	0 92(q) 20($100-q$) 0	100	39.99
59	0 235(q) 163($100-q$) 0	100	80.00
60	0 236(q) 164($100-q$) 0	100	80.00
61	0 21(50)22(50) 0	100	20.87
62	0 165(50)166(50) 0	100	62.61
63	0 93(q) 21($100-q$) 0	100	40.01
64	0 94(q) 22($100-q$) 0	100	40.00
65	0 237(q) 165($100-q$) 0	100	79.99
66	0 238(q) 166($100-q$) 0	100	80.00

(cont.)

Table A.177 continued.

No.	Route	Load	Distance
67	0 23(50)24(50) 0	100	20.88
68	0 167(50)168(50) 0	100	62.62
69	0 95(q) 23($100-q$) 0	100	39.99
70	0 96(q) 24($100-q$) 0	100	40.00
71	0 239(q) 167($100-q$) 0	100	80.00
72	0 240(q) 168($100-q$) 0	100	79.99
73	0 25(50)26(50) 0	100	20.88
74	0 169(50)170(50) 0	100	62.62
75	0 97(q) 25($100-q$) 0	100	40.00
76	0 98(q) 26($100-q$) 0	100	39.99
77	0 241(q) 169($100-q$) 0	100	80.00
78	0 242(q) 170($100-q$) 0	100	80.00
79	0 27(50)28(50) 0	100	20.87
80	0 171(50)172(50) 0	100	62.61
81	0 99(q) 27($100-q$) 0	100	39.99
82	0 100(q) 28($100-q$) 0	100	39.99
83	0 243(q) 171($100-q$) 0	100	80.00
84	0 244(q) 172($100-q$) 0	100	80.00
85	0 29(50)30(50) 0	100	20.87
86	0 173(50)174(50) 0	100	62.62
87	0 101(q) 29($100-q$) 0	100	40.00
88	0 102(q) 30($100-q$) 0	100	39.99
89	0 245(q) 173($100-q$) 0	100	80.00
90	0 246(q) 174($100-q$) 0	100	80.00
91	0 31(50)32(50) 0	100	20.87
92	0 175(50)176(50) 0	100	62.62
93	0 103(q) 31($100-q$) 0	100	40.00
94	0 104(q) 32($100-q$) 0	100	40.00
95	0 247(q) 175($100-q$) 0	100	80.00
96	0 248(q) 176($100-q$) 0	100	80.00
97	0 33(50)34(50) 0	100	20.87
98	0 177(50)178(50) 0	100	62.61
99	0 105(q) 33($100-q$) 0	100	39.99

(cont.)

Table A.177 continued.

No.	Route	Load	Distance
100	0 106(q) 34($100-q$) 0	100	40.00
101	0 249(q) 177($100-q$) 0	100	80.00
102	0 250(q) 178($100-q$) 0	100	80.01
103	0 35(50)36(50) 0	100	20.88
104	0 179(50)180(50) 0	100	62.61
105	0 107(q) 35($100-q$) 0	100	40.01
106	0 108(q) 36($100-q$) 0	100	39.99
107	0 251(q) 179($100-q$) 0	100	80.00
108	0 252(q) 180($100-q$) 0	100	80.01
109	0 37(50)38(50) 0	100	20.87
110	0 181(50)182(50) 0	100	62.62
111	0 109(q) 37($100-q$) 0	100	40.00
112	0 110(q) 38($100-q$) 0	100	39.99
113	0 253(q) 181($100-q$) 0	100	80.00
114	0 254(q) 182($100-q$) 0	100	80.00
115	0 39(50)40(50) 0	100	20.87
116	0 183(50)184(50) 0	100	62.61
117	0 111(q) 39($100-q$) 0	100	40.01
118	0 112(q) 40($100-q$) 0	100	40.00
119	0 255(q) 183($100-q$) 0	100	79.99
120	0 256(q) 184($100-q$) 0	100	80.00
121	0 41(50)42(50) 0	100	20.88
122	0 185(50)186(50) 0	100	62.62
123	0 113(q) 41($100-q$) 0	100	39.99
124	0 114(q) 42($100-q$) 0	100	40.00
125	0 257(q) 185($100-q$) 0	100	80.00
126	0 258(q) 186($100-q$) 0	100	79.99
127	0 43(50)44(50) 0	100	20.86
128	0 187(50)188(50) 0	100	62.61
129	0 115(q) 43($100-q$) 0	100	40.00
130	0 116(q) 44($100-q$) 0	100	39.99
131	0 259(q) 187($100-q$) 0	100	80.00
132	0 260(q) 188($100-q$) 0	100	80.00

(cont.)

Table A.177 continued.

No.	Route	Load	Distance
133	0 45(50)46(50) 0	100	20.87
134	0 189(50)190(50) 0	100	62.61
135	0 117(q) 45($100-q$) 0	100	39.99
136	0 118(q) 46($100-q$) 0	100	39.99
137	0 261(q) 189($100-q$) 0	100	80.00
138	0 262(q) 190($100-q$) 0	100	80.00
139	0 47(50)48(50) 0	100	20.87
140	0 191(50)192(50) 0	100	62.62
141	0 119(q) 47($100-q$) 0	100	40.00
142	0 120(q) 48($100-q$) 0	100	39.99
143	0 263(q) 191($100-q$) 0	100	80.01
144	0 264(q) 192($100-q$) 0	100	80.00
145	0 49(50)50(50) 0	100	20.87
146	0 193(50)194(50) 0	100	62.62
147	0 121(q) 49($100-q$) 0	100	40.00
148	0 122(q) 50($100-q$) 0	100	40.00
149	0 265(q) 193($100-q$) 0	100	80.00
150	0 266(q) 194($100-q$) 0	100	80.00
151	0 51(50)52(50) 0	100	20.87
152	0 195(50)196(50) 0	100	62.61
153	0 123(q) 51($100-q$) 0	100	39.99
154	0 124(q) 52($100-q$) 0	100	40.00
155	0 267(q) 195($100-q$) 0	100	80.01
156	0 268(q) 196($100-q$) 0	100	80.01
157	0 53(50)54(50) 0	100	20.88
158	0 197(50)198(50) 0	100	62.61
159	0 125(q) 53($100-q$) 0	100	40.01
160	0 126(q) 54($100-q$) 0	100	39.99
161	0 269(q) 197($100-q$) 0	100	80.00
162	0 270(q) 198($100-q$) 0	100	80.01
163	0 55(50)56(50) 0	100	20.87
164	0 199(50)200(50) 0	100	62.62
165	0 127(q) 55($100-q$) 0	100	40.00

(cont.)

Table A.177 continued.

No.	Route	Load	Distance
166	0 128(q) 56($100-q$) 0	100	39.99
167	0 271(q) 199($100-q$) 0	100	80.00
168	0 272(q) 200($100-q$) 0	100	80.00
169	0 57(50)58(50) 0	100	20.87
170	0 201(50)202(50) 0	100	62.61
171	0 129(q) 57($100-q$) 0	100	40.01
172	0 130(q) 58($100-q$) 0	100	40.00
173	0 273(q) 201($100-q$) 0	100	79.99
174	0 274(q) 202($100-q$) 0	100	80.00
175	0 59(50)60(50) 0	100	20.87
176	0 203(50)204(50) 0	100	62.61
177	0 131(q) 59($100-q$) 0	100	39.99
178	0 132(q) 60($100-q$) 0	100	40.00
179	0 275(q) 203($100-q$) 0	100	80.00
180	0 276(q) 204($100-q$) 0	100	79.99
181	0 61(50)62(50) 0	100	20.86
182	0 205(50)206(50) 0	100	62.61
183	0 133(q) 61($100-q$) 0	100	40.00
184	0 134(q) 62($100-q$) 0	100	39.99
185	0 277(q) 205($100-q$) 0	100	79.99
186	0 278(q) 206($100-q$) 0	100	80.00
187	0 63(50)64(50) 0	100	20.87
188	0 207(50)208(50) 0	100	62.61
189	0 135(q) 63($100-q$) 0	100	39.99
190	0 136(q) 64($100-q$) 0	100	39.99
191	0 279(q) 207($100-q$) 0	100	80.01
192	0 280(q) 208($100-q$) 0	100	80.00
193	0 65(50)66(50) 0	100	20.87
194	0 209(50)210(50) 0	100	62.62
195	0 137(q) 65($100-q$) 0	100	40.00
196	0 138(q) 66($100-q$) 0	100	39.99
197	0 281(q) 209($100-q$) 0	100	80.01
198	0 282(q) 210($100-q$) 0	100	80.00

(cont.)

Table A.177 continued.

No.	Route	Load	Distance
199	0 67(50)68(50) 0	100	20.87
200	0 211(50)212(50) 0	100	62.62
201	0 139(q) 67($100-q$) 0	100	40.00
202	0 140(q) 68($100-q$) 0	100	40.00
203	0 283(q) 211($100-q$) 0	100	80.01
204	0 284(q) 212($100-q$) 0	100	80.00
205	0 69(50)70(50) 0	100	20.87
206	0 213(50)214(50) 0	100	62.63
207	0 141(q) 69($100-q$) 0	100	39.99
208	0 142(q) 70($100-q$) 0	100	40.00
209	0 285(q) 213($100-q$) 0	100	80.01
210	0 286(q) 214($100-q$) 0	100	80.01
211	0 71(50)72(50) 0	100	20.88
212	0 215(50)216(50) 0	100	62.61
213	0 143(q) 71($100-q$) 0	100	40.01
214	0 144(q) 72($100-q$) 0	100	39.99
215	0 287(q) 215($100-q$) 0	100	80.00
216	0 288(q) 216($100-q$) 0	100	80.01
		Total Distance	11645.47

Note: $q = 94, 87, 78, 66$ for $p = .1, .2, .3, .4$, respectively.

Table A.178: EMIP-MDA+ERTR solution to S51D2 with $p = .1, .2, .3, .4$.

No.	Route	Load	Distance
1	0 8(22) 26(18) 31(37) 28(23) 22(18) 1(33) 0	151	76.62
2	0 32(23) 20(21) 35(45) 36(22) 3(46) 0	157	90.27
3	0 11(46) 16(18) 50(20) 9(24) 49(47) 0	155	61.39
4	0 46(19) 0	19	4.47
5	0 13(37) 41(36) 40(20) 19(32) 42(18) 12(17) 0	160	102.07
6	0 24(23) 43(43) 7(47) 23(20) 48(19) 0	152	80.58
7	0 27(24) 6(21) 14(19) 25(43) 18(18) 47(33) 0	158	62.43
8	0 38(18) 30(18) 34(18) 21(47) 29(33) 2(23) 0	157	84.13
9	0 45(43) 33(19) 39(47) 10(20) 5(21) 0	150	90.60
10	0 4(28) 17(45) 44(17) 15(41) 37(25) 0	156	64.77
		Total Distance	717.34

Note: the solution was the same for the four values of p.

Table A.179: EMIP-MDA+ERTR solution to S51D3 with $p = .1, .2, .3$.

No.	Route	Load	Distance
1	0 5(20) 49(51) 38(57) 0	128	45.82
2	0 46(79) 47(76) 0	155	21.57
3	0 6(31) 43(68) 7(31) 23(18) 0	148	74.89
4	0 48(53) 26(52) 8(51) 0	156	58.20
5	0 27(21) 31(32) 28(78) 1(20) 0	151	66.51
6	0 9(20) 30(26) 39(56) 10(56) 0	158	81.93
7	0 24(70) 25(14) 14(74) 0	158	63.61
8	0 25(9) 13(20) 41(37) 40(69) 19(25) 0	160	100.29
9	0 22(72) 32(79) 0	151	42.51
10	0 33(28) 45(43) 15(29) 37(32) 12(25) 0	157	73.03
11	0 18(79) 4(71) 0	150	39.59
12	0 11(31) 16(32) 50(78) 0	141	53.87
13	0 35(43) 36(76) 3(30) 0	149	90.13
14	0 34(33) 21(21) 29(25) 20(54) 2(27) 0	160	91.16
15	0 17(20) 42(72) 44(61) 0	153	66.88
		Total Distance	969.99

Note: the solution was the same for the three values of p.

Table A.180: EMIP-MDA+ERTR solution to S51D4 with $p = .1$.

No.	Route	Load	Distance
1	0 22(14) 36(141) 0	155	88.93
2	0 4(143) 47(17) 0	160	34.45
3	0 27(58) 1(43) 0	101	29.95
4	0 8(131) 48(29) 0	160	47.05
5	0 10(65) 49(35) 38(60) 0	160	59.36
6	0 10(57) 39(100) 0	157	76.61
7	0 9(23) 34(92) 50(43) 0	158	64.66
8	0 12(94) 46(52) 0	146	17.37
9	0 17(45) 42(63) 19(32) 47(20) 0	160	72.03
10	0 6(70) 14(90) 0	160	39.81
11	0 38(17) 30(108) 49(35) 0	160	62.76
12	0 29(118) 11(30) 0	148	58.63
13	0 13(25) 40(127) 19(8) 0	160	90.69
14	0 41(136) 47(23) 0	159	61.13
15	0 20(45) 35(84) 3(25) 0	154	82.13
16	0 2(43) 21(69) 16(42) 0	154	67.86
17	0 23(48) 24(93) 6(19) 0	160	56.79
18	0 14(49) 25(94) 0	143	47.60
19	0 26(124) 48(36) 0	160	57.12
20	0 28(127) 22(33) 0	160	60.83
21	0 43(117) 7(27) 48(16) 0	160	73.82
22	0 32(142) 0	142	20.00
23	0 15(24) 33(136) 0	160	70.40
24	0 22(90) 31(70) 0	160	63.64
25	0 47(71) 37(89) 0	160	39.75
26	0 5(35) 45(112) 15(10) 0	157	65.61
27	0 37(54) 44(106) 0	160	50.39
28	0 18(143) 0	143	29.53
		Total Distance	1588.91

Table A.181: EMIP-MDA+ERTR solution to S51D5 with $p = .1$.

No.	Route	Load	Distance
1	0 50(106) 9(53) 0	159	54.92
2	0 23(52) 24(93) 6(15) 0	160	56.79
3	0 17(40) 42(111) 47(9) 0	160	63.38
4	0 4(108) 47(52) 0	160	34.45
5	0 38(104) 11(53) 0	157	34.56
6	0 2(47) 29(60) 16(53) 0	160	61.32
7	0 40(79) 19(52) 17(22) 0	153	87.30
8	0 37(49) 44(51) 15(19) 5(41) 0	160	60.18
9	0 25(45) 13(59) 41(55) 0	159	76.15
10	0 12(78) 0	78	16.12
11	0 6(48) 43(58) 7(54) 0	160	73.21
12	0 21(64) 34(91) 0	155	72.90
13	0 3(56) 20(69) 2(22) 0	147	73.43
14	0 6(31) 14(111) 25(18) 0	160	51.19
15	0 15(33) 45(66) 33(56) 0	155	72.45
16	0 48(71) 1(59) 32(30) 0	160	44.26
17	0 10(35) 39(55) 30(70) 0	160	81.23
18	0 18(99) 27(52) 0	151	42.61
19	0 32(81) 22(78) 0	159	42.51
20	0 46(111) 0	111	4.47
21	0 28(108) 31(52) 0	160	66.12
22	0 35(54) 36(100) 0	154	89.42
23	0 5(8) 10(74) 49(78) 0	160	57.60
24	0 26(51) 8(96) 0	147	57.39
		Total Distance	1373.98

Table A.182: EMIP-MDA+ERTR solution to S51D6 with $p = .1$.

No.	Route	Load	Distance
1	0 11(50) 1(100) 0	150	38.02
2	0 11(65) 2(95) 0	160	43.70
3	0 20(102) 3(58) 0	160	72.82
4	0 47(30) 4(125) 0	155	34.45
5	0 5(116) 0	116	28.28
6	0 27(24) 6(130) 0	154	28.46
7	0 7(114) 48(46) 0	160	53.54
8	0 27(20) 8(140) 0	160	44.06
9	0 39(133) 9(27) 0	160	80.69
10	0 33(142) 0	142	68.00
11	0 47(110) 12(50) 0	160	23.50
12	0 25(85) 14(73) 0	158	47.60
13	0 42(60) 15(100) 0	160	72.22
14	0 38(70) 16(83) 0	153	47.05
15	0 12(41) 17(119) 0	160	35.17
16	0 18(143) 0	143	29.53
17	0 42(63) 19(97) 0	160	71.77
18	0 20(17) 35(129) 0	146	78.93
19	0 16(35) 21(125) 0	160	64.14
20	0 22(142) 1(18) 0	160	41.77
21	0 14(40) 23(120) 0	160	55.66
22	0 14(29) 24(131) 0	160	53.94
23	0 13(114) 25(46) 0	160	65.39
24	0 26(139) 0	139	56.32
25	0 3(56) 28(104) 0	160	72.01
26	0 2(23) 29(137) 0	160	59.20
27	0 9(15) 30(135) 0	150	62.44
28	0 28(35) 31(125) 0	160	66.12
29	0 32(143) 0	143	20.00
30	0 34(131) 9(29) 0	160	63.87
31	0 36(143) 0	143	87.86
32	0 12(40) 37(120) 0	160	36.22
33	0 49(103) 38(57) 0	160	45.06

(cont.)

Table A.182 continued.

No.	Route	Load	Distance
34	0 4(18) 41(142) 0	160	61.14
35	0 19(21) 40(139) 0	160	84.74
36	0 43(137) 0	137	69.31
37	0 15(16) 45(136) 0	152	62.77
38	0 46(121) 0	121	4.47
39	0 37(23) 44(134) 0	157	50.39
40	0 27(78) 48(82) 0	160	32.41
41	0 10(138) 49(22) 0	160	57.57
42	0 9(42) 50(118) 0	160	54.92
		Total Distance	2225.51

Table A.183: EMIP-MDA+ERTR solution to S76D2 with $p = .1$.

No.	Route	Load	Distance
1	0 17(22) 3(11) 44(41) 32(29) 40(37) 26(20) 0	160	54.53
2	0 54(16) 19(47) 59(20) 14(18) 53(23) 7(34) 0	158	93.88
3	0 34(46) 46(40) 8(18) 35(35) 67(18) 0	157	40.43
4	0 13(35) 57(20) 15(46) 5(16) 29(43) 0	160	68.56
5	0 6(20) 1(44) 43(27) 63(19) 16(20) 51(23) 0	153	69.58
6	0 68(28) 2(22) 62(40) 73(23) 33(47) 0	160	50.95
7	0 3(11) 24(24) 49(32) 56(47) 23(46) 0	160	92.39
8	0 12(6) 9(44) 25(35) 55(21) 18(23) 50(29) 0	158	93.36
9	0 52(47) 27(43) 45(38) 4(18) 75(14) 0	160	40.12
10	0 74(40) 28(26) 61(16) 21(23) 48(13) 30(41) 0	159	77.42
11	0 48(31) 47(25) 36(33) 37(47) 5(24) 0	160	73.22
12	0 26(15) 58(29) 10(17) 31(39) 39(31) 72(16) 12(13) 0	160	81.69
13	0 41(43) 42(46) 64(38) 22(29) 75(4) 0	160	93.86
14	0 69(22) 71(18) 60(45) 70(46) 20(22) 5(7) 0	160	99.52
15	0 53(3) 11(42) 66(47) 65(19) 38(47) 0	158	77.16
		Total Distance	1106.68

Table A.184: EMIP-MDA+ERTR solution to S76D3 with $p = .1$.

No.	Route	Load	Distance
1	0 49(46) 24(61) 44(19) 3(24) 0	150	72.66
2	0 28(76) 74(32) 30(38) 0	146	51.94
3	0 9(21) 39(23) 72(57) 58(59) 0	160	57.72
4	0 6(52) 33(8) 1(27) 63(52) 16(21) 0	160	59.63
5	0 51(33) 17(30) 40(47) 12(46) 0	156	41.34
6	0 8(64) 19(20) 53(59) 26(17) 0	160	58.72
7	0 2(37) 62(51) 73(58) 6(10) 0	156	48.93
8	0 27(20) 13(12) 54(67) 52(61) 0	160	58.52
9	0 13(15) 57(70) 15(20) 29(21) 45(34) 0	160	64.16
10	0 22(46) 61(78) 21(32) 0	156	80.55
11	0 75(75) 68(68) 0	143	14.75
12	0 4(76) 67(61) 0	137	19.46
13	0 35(22) 14(79) 59(45) 7(10) 0	156	77.11
14	0 46(79) 34(59) 0	138	23.42
15	0 23(20) 56(75) 41(23) 43(26) 33(16) 0	160	83.63
16	0 18(67) 55(38) 25(31) 31(20) 0	156	113.69
17	0 10(77) 38(72) 26(2) 0	151	59.96
18	0 64(77) 42(79) 0	156	88.08
19	0 29(7) 20(37) 70(37) 60(79) 0	160	90.62
20	0 32(79) 50(74) 0	153	59.50
21	0 48(39) 47(29) 36(68) 5(17) 0	153	68.39
22	0 65(79) 66(44) 11(21) 7(12) 0	156	76.14
23	0 37(17) 71(69) 69(73) 0	159	88.48
		Total Distance	1457.40

Table A.185: EMIP-MDA+ERTR solution to S76D4 with $p = .1$.

No.	Route	Load	Distance
1	0 17(135) 26(24) 0	159	22.39
2	0 3(139) 44(20) 0	159	43.26
3	0 37(21) 71(139) 0	160	81.89
4	0 74(35) 61(121) 0	156	68.79
5	0 2(46) 28(47) 62(60) 0	153	53.37
6	0 4(23) 29(19) 15(118) 0	160	55.87
7	0 39(143) 12(17) 0	160	44.74
8	0 10(33) 38(25) 66(72) 53(30) 0	160	82.47
9	0 65(105) 58(49) 0	154	65.76
10	0 47(29) 36(42) 69(89) 0	160	77.90
11	0 68(138) 0	138	14.56
12	0 49(141) 16(19) 0	160	56.71
13	0 35(30) 14(29) 59(101) 0	160	76.98
14	0 53(19) 11(138) 0	157	59.83
15	0 16(6) 23(35) 56(73) 24(44) 0	158	89.22
16	0 22(25) 64(121) 42(14) 0	160	89.08
17	0 42(13) 41(96) 63(42) 0	151	77.94
18	0 72(143) 12(5) 0	148	41.70
19	0 40(33) 25(124) 0	157	66.49
20	0 7(143) 0	143	28.28
21	0 6(39) 63(89) 51(32) 0	160	46.59
22	0 53(94) 35(66) 0	160	47.70
23	0 29(34) 45(126) 0	160	37.05
24	0 34(7) 46(31) 52(49) 27(31) 4(42) 0	160	38.48
25	0 9(42) 55(55) 18(26) 50(35) 0	158	92.73
26	0 43(126) 33(31) 0	157	63.84
27	0 74(68) 47(57) 48(28) 30(7) 0	160	58.89
28	0 34(17) 54(41) 13(102) 0	160	57.40
29	0 29(31) 5(31) 60(98) 0	160	86.77
30	0 75(124) 0	124	6.00
31	0 21(143) 30(17) 0	160	54.65
32	0 20(37) 70(87) 37(31) 5(5) 0	160	84.06
33	0 67(143) 0	143	10.77

(cont.)

Table A.185 continued.

No.	Route	Load	Distance
34	0 57(135) 27(19) 0	154	56.54
35	0 32(47) 9(9) 31(100) 0	156	84.24
36	0 73(74) 1(86) 0	160	51.46
37	0 35(37) 19(82) 8(41) 0	160	48.74
		Total Distance	2123.16

Table A.186: EMIP-MDA+ERTR solution to S101D2 with $p = .1$.

No.	Route	Load	Distance
1	0 89(18) 5(26) 84(32) 17(40) 61(21) 99(17) 0	154	66.25
2	0 87(23) 42(19) 43(47) 15(46) 57(23) 0	158	72.41
3	0 60(20) 83(23) 45(32) 46(35) 8(23) 18(19) 0	152	76.79
4	0 6(18) 94(47) 13(30) 58(46) 0	141	33.95
5	0 82(24) 48(47) 7(41) 52(42) 0	154	57.20
6	0 93(18) 85(18) 91(22) 100(43) 37(40) 97(18) 0	159	54.53
7	0 2(18) 41(36) 22(20) 74(32) 72(45) 0	151	63.25
8	0 47(45) 36(39) 49(28) 64(25) 63(22) 0	159	112.44
9	0 53(26) 40(44) 73(18) 21(45) 0	133	41.31
10	0 95(20) 92(25) 98(43) 59(28) 96(36) 0	152	43.67
11	0 27(18) 69(19) 1(38) 70(41) 31(31) 0	147	49.49
12	0 75(21) 56(33) 23(27) 67(17) 39(46) 4(16) 0	160	95.52
13	0 42(12) 14(18) 44(47) 38(28) 86(37) 16(18) 0	160	99.71
14	0 50(39) 33(44) 79(23) 3(31) 77(18) 0	155	56.57
15	0 76(47) 68(37) 80(43) 12(21) 0	148	46.59
16	0 19(39) 11(47) 62(47) 88(19) 0	152	72.71
17	0 28(27) 24(21) 29(47) 34(25) 78(20) 81(18) 0	158	89.43
18	0 10(18) 90(45) 32(33) 30(23) 51(40) 0	159	83.48
19	0 20(16) 66(46) 65(20) 71(18) 35(41) 9(18) 0	159	112.62
20	0 54(43) 55(34) 25(47) 4(8) 26(21) 0	153	70.22
		Total Distance	1398.13

Table A.187: EMIP-MDA+ERTR solution to S101D3 with $p = .1$.

No.	Route	Load	Distance
1	0 73(21) 74(66) 72(61) 0	148	50.23
2	0 6(27) 59(17) 97(74) 95(41) 0	159	41.26
3	0 54(75) 26(74) 0	149	46.03
4	0 4(29) 39(25) 67(20) 23(44) 56(22) 72(15) 0	155	93.30
5	0 32(75) 90(71) 10(13) 0	159	71.04
6	0 46(70) 8(33) 89(52) 0	155	71.79
7	0 18(77) 83(27) 60(48) 0	152	44.79
8	0 61(31) 86(77) 16(44) 0	152	70.97
9	0 6(18) 96(78) 94(64) 0	160	31.46
10	0 45(17) 17(79) 84(24) 5(37) 0	157	68.04
11	0 12(38) 80(35) 77(18) 28(68) 0	159	47.77
12	0 70(48) 30(59) 20(52) 0	159	64.79
13	0 27(38) 31(33) 88(50) 52(35) 0	156	43.02
14	0 55(20) 25(69) 24(60) 0	149	79.07
15	0 51(20) 66(24) 65(30) 71(21) 35(29) 34(36) 0	160	118.78
16	0 53(24) 58(59) 13(74) 0	157	26.83
17	0 85(40) 93(64) 99(48) 0	152	46.17
18	0 75(22) 22(79) 41(22) 2(33) 0	156	66.36
19	0 29(58) 78(76) 79(24) 0	158	71.48
20	0 76(60) 50(79) 1(21) 0	160	42.59
21	0 87(31) 42(11) 43(23) 15(60) 57(31) 0	156	72.41
22	0 48(57) 47(21) 36(79) 0	157	82.82
23	0 21(77) 40(78) 53(5) 0	160	36.28
24	0 19(52) 11(68) 62(34) 0	154	72.64
25	0 82(79) 7(75) 0	154	50.37
26	0 69(26) 9(60) 81(28) 33(45) 0	159	67.96
27	0 92(68) 37(33) 98(55) 0	156	43.89
28	0 91(29) 38(22) 14(69) 42(38) 0	158	88.71
29	0 3(79) 68(79) 0	158	49.82
30	0 59(3) 91(6) 44(71) 100(79) 0	159	64.12
31	0 49(24) 64(69) 63(20) 10(45) 0	158	106.06
		Total Distance	1930.86

Table A.188: EMIP-MDA+ERTR solution to S101D5 with $p = .1$.

No.	Route	Load	Distance
1	0 69(111) 27(45) 0	156	24.45
2	0 82(60) 48(85) 7(15) 0	160	57.20
3	0 97(99) 87(46) 13(15) 0	160	39.91
4	0 57(99) 15(61) 0	160	60.89
5	0 33(35) 79(71) 76(54) 0	160	56.07
6	0 52(8) 7(27) 19(57) 11(63) 0	155	73.01
7	0 6(55) 99(77) 96(26) 0	158	35.08
8	0 38(89) 86(63) 5(6) 0	158	92.36
9	0 50(96) 1(52) 0	148	38.53
10	0 28(110) 0	110	12.65
11	0 53(32) 58(91) 13(37) 0	160	26.83
12	0 73(91) 41(69) 0	160	59.18
13	0 77(91) 3(62) 0	153	44.89
14	0 25(55) 67(50) 23(50) 0	155	96.73
15	0 74(6) 75(99) 72(55) 0	160	56.06
16	0 21(53) 4(103) 0	156	53.03
17	0 22(104) 74(42) 73(14) 0	160	54.68
18	0 20(37) 66(67) 71(28) 51(28) 0	160	89.73
19	0 70(56) 31(35) 52(69) 0	160	49.47
20	0 2(59) 43(100) 0	159	70.62
21	0 29(57) 24(102) 0	159	66.90
22	0 47(11) 49(83) 64(61) 0	155	105.62
23	0 31(29) 10(65) 30(58) 27(8) 0	160	61.14
24	0 20(49) 32(111) 0	160	76.39
25	0 79(40) 34(65) 78(55) 0	160	72.25
26	0 65(111) 71(49) 0	160	99.89
27	0 47(52) 36(108) 0	160	82.82
28	0 42(104) 87(48) 0	152	51.09
29	0 84(52) 17(52) 60(51) 0	155	61.09
30	0 56(71) 39(88) 0	159	70.18
31	0 18(79) 89(77) 0	156	32.62
32	0 5(46) 61(106) 6(8) 0	160	52.82
33	0 12(57) 26(84) 0	141	33.25

(cont.)

Table A.188 continued.

No.	Route	Load	Distance
34	0 46(111) 47(45) 0	156	79.67
35	0 50(14) 81(63) 51(83) 0	160	61.74
36	0 54(53) 55(107) 0	160	61.75
37	0 98(30) 37(64) 92(52) 95(14) 0	160	43.97
38	0 54(49) 80(53) 68(58) 0	160	54.24
39	0 10(23) 63(72) 90(64) 0	159	71.70
40	0 98(29) 85(50) 91(70) 97(11) 0	160	54.99
41	0 9(52) 35(75) 81(8) 33(25) 0	160	82.64
42	0 8(83) 45(75) 0	158	61.81
43	0 16(64) 44(93) 0	157	67.13
44	0 100(53) 14(106) 0	159	64.60
45	0 40(101) 53(59) 0	160	22.36
46	0 59(34) 93(98) 96(26) 0	158	41.07
47	0 88(52) 62(79) 7(21) 0	152	55.72
48	0 18(32) 83(109) 60(14) 0	155	44.79
49	0 94(62) 59(60) 95(38) 0	160	36.74
		Total Distance	2862.34

Table A.189: EMIP-MDA+ERTR solution to S51D4 with $p = .2$.

No.	Route	Load	Distance
1	0 23(48) 24(93) 6(19) 0	160	56.79
2	0 2(20) 29(118) 11(22) 0	160	59.59
3	0 48(61) 8(29) 31(70) 0	160	64.08
4	0 14(66) 25(94) 0	160	47.60
5	0 33(136) 15(24) 0	160	70.40
6	0 47(131) 0	131	18.87
7	0 46(52) 0	52	4.47
8	0 37(38) 15(10) 45(112) 0	160	63.35
9	0 2(23) 20(45) 35(84) 3(8) 0	160	82.74
10	0 1(20) 28(127) 0	147	60.01
11	0 14(73) 6(70) 0	143	39.81
12	0 16(42) 21(69) 50(43) 0	154	66.06
13	0 10(122) 5(35) 0	157	56.67
14	0 43(117) 7(27) 0	144	73.12
15	0 13(25) 40(127) 0	152	90.36
16	0 12(54) 37(105) 0	159	36.22
17	0 1(23) 22(137) 0	160	41.77
18	0 4(143) 0	143	34.41
19	0 17(45) 42(63) 19(40) 0	148	72.03
20	0 26(124) 48(20) 0	144	57.12
21	0 18(143) 0	143	29.53
22	0 30(42) 39(100) 49(18) 0	160	81.57
23	0 34(92) 30(66) 0	158	69.36
24	0 36(141) 3(17) 0	158	88.57
25	0 12(40) 44(106) 0	146	50.09
26	0 41(136) 0	136	60.96
27	0 8(102) 27(58) 0	160	44.06
28	0 32(142) 0	142	20.00
29	0 49(52) 9(23) 38(77) 11(8) 0	160	54.07
		Total Distance	1593.69

Table A.190: EMIP-MDA+ERTR solution to S51D5 with $p = .2$.

No.	Route	Load	Distance
1	0 14(50) 24(93) 23(17) 0	160	60.34
2	0 1(47) 32(111) 0	158	29.98
3	0 21(19) 34(91) 30(50) 0	160	78.70
4	0 49(78) 5(35) 12(47) 0	160	47.16
5	0 3(56) 20(69) 0	125	72.82
6	0 48(71) 27(52) 0	123	32.41
7	0 38(104) 11(53) 0	157	34.56
8	0 9(53) 50(106) 0	159	54.92
9	0 36(100) 35(54) 0	154	89.42
10	0 42(111) 17(18) 12(31) 0	160	63.55
11	0 15(52) 44(51) 37(49) 0	152	56.21
12	0 16(53) 21(45) 29(60) 0	158	68.40
13	0 47(61) 18(99) 0	160	32.26
14	0 26(51) 8(96) 0	147	57.39
15	0 19(52) 40(79) 41(29) 0	160	85.10
16	0 7(54) 43(58) 23(35) 0	147	73.52
17	0 5(14) 10(71) 39(55) 30(20) 0	160	81.27
18	0 28(108) 31(52) 0	160	66.12
19	0 25(63) 13(59) 41(26) 0	148	76.15
20	0 2(69) 22(78) 1(12) 0	159	52.62
21	0 10(38) 33(56) 45(66) 0	160	78.72
22	0 14(61) 6(94) 0	155	39.81
23	0 4(108) 17(44) 0	152	42.08
24	0 46(111) 0	111	4.47
		Total Distance	1377.99

Table A.191: EMIP-MDA+ERTR solution to S51D6 with $p = .2$.

No.	Route	Load	Distance
1	0 35(129) 36(29) 0	158	89.42
2	0 49(75) 10(85) 0	160	57.57
3	0 50(118) 16(26) 0	144	53.85
4	0 44(134) 0	134	50.00
5	0 36(114) 3(46) 0	160	88.57
6	0 27(122) 0	122	16.00
7	0 42(123) 40(37) 0	160	90.02
8	0 38(127) 12(29) 0	156	38.19
9	0 24(131) 6(26) 0	157	50.39
10	0 2(83) 29(77) 0	160	59.20
11	0 1(118) 0	118	27.78
12	0 46(121) 0	121	4.47
13	0 47(140) 0	140	18.87
14	0 45(136) 0	136	62.64
15	0 14(142) 0	142	36.22
16	0 9(113) 11(47) 0	160	47.93
17	0 18(143) 0	143	29.53
18	0 39(133) 49(25) 0	158	76.95
19	0 21(100) 29(60) 0	160	68.39
20	0 22(142) 0	142	41.62
21	0 8(105) 28(55) 0	160	64.99
22	0 20(119) 2(35) 0	154	65.52
23	0 16(92) 11(68) 0	160	44.06
24	0 26(139) 0	139	56.32
25	0 25(131) 0	131	46.17
26	0 37(102) 12(58) 0	160	36.22
27	0 30(135) 49(25) 0	160	62.55
28	0 32(143) 0	143	20.00
29	0 23(120) 6(40) 0	160	44.60
30	0 19(58) 40(102) 0	160	84.74
31	0 34(131) 21(25) 0	156	72.90
32	0 48(82) 6(64) 0	146	36.16
33	0 7(114) 48(46) 0	160	53.54

(cont.)

Table A.191 continued.

No.	Route	Load	Distance
34	0 17(119) 37(41) 0	160	40.47
35	0 3(68) 28(84) 0	152	72.01
36	0 41(96) 19(60) 0	156	67.39
37	0 10(53) 33(101) 0	154	74.40
38	0 31(125) 8(35) 0	160	61.08
39	0 43(137) 0	137	69.31
40	0 13(114) 41(46) 0	160	69.07
41	0 5(116) 12(44) 0	160	31.42
42	0 4(143) 0	143	34.41
43	0 15(116) 33(41) 0	157	70.40
		Total Distance	2285.37

Table A.192: EMIP-MDA+ERTR solution to S76D2 with $p = .2$, .3, and .4.

No.	Route	Load	Distance
1	0 35(35) 14(18) 59(20) 53(26) 7(34) 26(18) 0	151	79.64
2	0 67(18) 46(40) 52(47) 34(46) 0	151	30.86
3	0 48(44) 29(43) 45(38) 4(18) 0	143	45.63
4	0 57(20) 15(46) 37(47) 5(47) 0	160	73.71
5	0 40(37) 32(29) 44(41) 3(22) 17(22) 0	151	50.89
6	0 11(42) 66(47) 65(19) 38(47) 0	155	75.64
7	0 12(8) 9(44) 25(35) 55(21) 18(23) 50(29) 0	160	93.36
8	0 1(44) 42(46) 64(38) 22(29) 0	157	89.10
9	0 75(18) 30(41) 0	59	28.72
10	0 20(22) 70(46) 60(45) 71(18) 47(25) 0	156	92.72
11	0 68(28) 2(22) 62(40) 73(23) 33(47) 0	160	50.95
12	0 6(20) 43(27) 41(43) 56(47) 63(19) 0	156	83.59
13	0 8(18) 19(47) 54(16) 13(35) 27(43) 0	159	63.07
14	0 26(17) 58(29) 10(17) 31(39) 39(31) 72(16) 12(11) 0	160	81.69
15	0 28(26) 61(16) 69(22) 36(33) 21(23) 74(40) 0	160	94.42
16	0 51(23) 16(20) 23(46) 49(32) 24(24) 0	145	82.65
		Total Distance	1116.64

Note: the solution was the same for the three values of p.

Table A.193: EMIP-MDA+ERTR solution to S76D3 with $p = .2$.

No.	Route	Load	Distance
1	0 26(19) 58(59) 72(57) 39(23) 0	158	52.48
2	0 8(64) 35(22) 53(59) 7(7) 0	152	50.56
3	0 38(72) 10(77) 0	149	59.93
4	0 12(46) 31(20) 55(38) 25(31) 9(21) 0	156	102.36
5	0 7(15) 14(79) 59(45) 19(20) 0	159	79.96
6	0 16(21) 49(46) 24(61) 3(24) 0	152	69.50
7	0 27(20) 13(12) 54(67) 52(61) 0	160	58.52
8	0 51(33) 6(49) 2(37) 30(38) 0	157	47.31
9	0 64(77) 42(79) 0	156	88.08
10	0 29(7) 20(37) 70(37) 60(79) 0	160	90.62
11	0 33(16) 43(26) 41(23) 56(75) 23(20) 0	160	83.63
12	0 40(47) 32(79) 17(30) 0	156	44.96
13	0 6(13) 33(8) 63(52) 1(27) 73(58) 0	158	58.15
14	0 65(79) 66(44) 11(21) 0	144	75.34
15	0 5(17) 36(68) 47(29) 48(39) 0	153	68.39
16	0 45(34) 29(21) 15(20) 57(70) 13(15) 0	160	64.16
17	0 44(19) 18(67) 50(74) 0	160	70.72
18	0 74(32) 28(76) 62(51) 0	159	55.17
19	0 68(68) 75(75) 0	143	14.75
20	0 34(59) 46(79) 0	138	23.42
21	0 21(32) 61(78) 22(46) 0	156	80.55
22	0 4(76) 67(61) 0	137	19.46
23	0 37(17) 71(69) 69(73) 0	159	88.48
		Total Distance	1446.48

Table A.194: EMIP-MDA+ERTR solution to S76D4 with $p = .2$.

No.	Route	Load	Distance
1	0 63(46) 41(96) 42(15) 0	157	77.94
2	0 3(139) 44(20) 0	159	43.26
3	0 6(39) 63(85) 51(32) 0	156	46.59
4	0 43(126) 33(31) 0	157	63.84
5	0 40(33) 25(53) 50(27) 32(47) 0	160	71.31
6	0 34(7) 46(31) 52(49) 27(50) 4(18) 0	155	38.48
7	0 35(37) 19(82) 8(41) 0	160	48.74
8	0 75(124) 0	124	6.00
9	0 65(105) 58(49) 0	154	65.76
10	0 12(17) 72(143) 0	160	41.70
11	0 45(126) 4(34) 0	160	28.28
12	0 29(63) 15(94) 0	157	55.84
13	0 49(141) 16(17) 0	158	56.71
14	0 29(21) 71(139) 0	160	80.40
15	0 39(143) 12(5) 0	148	44.74
16	0 20(37) 70(87) 5(36) 0	160	84.05
17	0 74(68) 21(92) 0	160	55.36
18	0 42(12) 64(121) 22(25) 0	158	89.08
19	0 24(44) 56(73) 23(35) 16(8) 0	160	89.22
20	0 7(143) 26(16) 0	159	30.07
21	0 62(60) 28(47) 2(46) 0	153	53.37
22	0 1(86) 73(74) 0	160	51.46
23	0 47(29) 36(42) 69(89) 0	160	77.90
24	0 13(102) 54(41) 34(17) 0	160	57.40
25	0 53(49) 11(108) 0	157	59.83
26	0 68(138) 4(13) 0	151	21.63
27	0 60(98) 37(52) 0	150	86.99
28	0 67(143) 0	143	10.77
29	0 48(28) 47(57) 21(51) 30(24) 0	160	60.62
30	0 35(66) 53(94) 0	160	47.70
31	0 15(24) 57(135) 0	159	59.62
32	0 50(8) 18(26) 55(55) 25(71) 0	160	92.18
33	0 9(51) 31(100) 26(8) 0	159	79.03

(cont.)

Table A.194 continued.

No.	Route	Load	Distance
34	0 17(135) 0	135	16.12
35	0 10(33) 38(25) 66(72) 11(30) 0	160	81.10
36	0 61(121) 74(35) 0	156	68.79
37	0 35(30) 14(29) 59(101) 0	160	76.98
		Total Distance	2118.86

Table A.195: EMIP-MDA+ERTR solution to S101D2 with $p = .2$.

No.	Route	Load	Distance
1	0 50(39) 33(44) 81(18) 9(18) 51(40) 0	159	66.86
2	0 66(46) 65(20) 71(18) 35(41) 34(25) 76(10) 0	160	117.57
3	0 27(18) 69(19) 70(41) 1(38) 0	116	44.57
4	0 31(7) 62(47) 11(47) 19(39) 88(19) 0	159	74.65
5	0 87(23) 42(19) 43(47) 15(46) 57(23) 0	158	72.41
6	0 2(18) 41(36) 22(20) 74(32) 72(45) 0	151	63.25
7	0 58(46) 13(30) 94(47) 6(18) 0	141	33.95
8	0 42(12) 14(18) 44(47) 38(28) 86(37) 16(18) 0	160	99.71
9	0 89(18) 5(26) 84(32) 17(40) 61(21) 99(17) 0	154	66.25
10	0 77(18) 3(31) 79(23) 78(20) 29(47) 24(21) 0	160	79.30
11	0 97(18) 100(43) 91(22) 85(18) 93(18) 96(36) 0	155	54.24
12	0 63(22) 64(25) 49(28) 36(39) 47(45) 0	159	112.44
13	0 28(21) 76(37) 68(37) 80(43) 12(21) 0	159	46.70
14	0 82(24) 48(47) 7(41) 52(42) 0	154	57.20
15	0 26(21) 4(8) 25(47) 55(34) 54(43) 28(6) 0	159	71.63
16	0 59(28) 98(43) 37(40) 92(25) 95(20) 0	156	44.12
17	0 60(20) 83(23) 45(32) 46(35) 8(23) 18(19) 0	152	76.79
18	0 75(21) 56(33) 23(27) 67(17) 39(46) 4(16) 0	160	95.52
19	0 31(24) 10(18) 90(45) 32(33) 20(16) 30(23) 0	159	80.41
20	0 53(26) 40(44) 73(18) 21(45) 0	133	41.31
		Total Distance	1398.87

Table A.196: EMIP-MDA+ERTR solution to S101D3 with $p = .2$.

No.	Route	Load	Distance
1	0 85(10) 16(44) 44(71) 91(35) 0	160	67.44
2	0 50(79) 76(60) 0	139	38.01
3	0 48(57) 47(21) 36(79) 0	157	82.82
4	0 100(79) 14(69) 87(11) 0	159	66.23
5	0 28(68) 0	68	12.65
6	0 10(12) 90(71) 32(75) 0	158	71.04
7	0 51(20) 9(60) 81(28) 33(45) 0	153	66.84
8	0 13(74) 58(39) 53(29) 0	142	26.83
9	0 78(76) 34(36) 79(24) 77(18) 0	154	72.80
10	0 56(22) 39(25) 67(20) 25(69) 55(20) 0	156	95.31
11	0 49(24) 64(69) 63(20) 10(46) 0	159	106.06
12	0 82(79) 7(75) 0	154	50.37
13	0 68(79) 3(79) 0	158	49.82
14	0 89(14) 84(24) 17(79) 5(37) 0	154	61.22
15	0 6(45) 93(64) 85(30) 59(20) 0	159	46.42
16	0 73(21) 74(66) 75(22) 23(44) 0	153	72.74
17	0 40(78) 26(74) 0	152	29.43
18	0 72(76) 21(77) 0	153	44.97
19	0 8(33) 46(70) 45(17) 89(38) 0	158	75.68
20	0 58(20) 2(33) 41(22) 22(79) 0	154	61.49
21	0 98(55) 37(33) 92(68) 0	156	43.89
22	0 60(48) 83(27) 18(77) 0	152	44.79
23	0 52(35) 88(50) 31(33) 27(38) 0	156	43.02
24	0 61(31) 86(77) 38(22) 43(23) 0	153	100.82
25	0 69(26) 70(48) 30(59) 1(21) 0	154	52.44
26	0 94(27) 99(48) 96(78) 0	153	35.62
27	0 20(52) 66(24) 65(30) 71(21) 35(29) 0	156	112.21
28	0 94(37) 95(41) 97(74) 0	152	35.41
29	0 62(34) 11(68) 19(52) 0	154	72.64
30	0 12(38) 54(75) 4(29) 0	142	58.44
31	0 80(35) 24(60) 29(58) 0	153	67.22
32	0 87(20) 42(49) 15(60) 57(31) 0	160	65.29
		Total Distance	1929.96

Table A.197: EMIP-MDA+ERTR solution to S101D5 with $p = .2$.

No.	Route	Load	Distance
1	0 18(111) 52(43) 0	154	34.74
2	0 24(102) 29(57) 0	159	66.90
3	0 53(23) 40(46) 58(91) 0	160	24.36
4	0 89(77) 6(63) 0	140	25.28
5	0 25(55) 67(50) 23(50) 0	155	96.73
6	0 95(52) 97(56) 13(52) 0	160	35.45
7	0 54(53) 55(107) 0	160	61.75
8	0 88(52) 31(51) 1(52) 0	155	49.91
9	0 53(19) 26(84) 12(57) 0	160	34.61
10	0 69(111) 27(42) 0	153	24.45
11	0 2(59) 57(99) 0	158	47.03
12	0 56(71) 39(88) 0	159	70.18
13	0 43(100) 42(60) 0	160	68.73
14	0 60(14) 46(111) 48(33) 0	158	78.05
15	0 5(52) 17(52) 84(52) 0	156	61.03
16	0 72(31) 74(11) 22(104) 41(14) 0	160	61.90
17	0 42(44) 15(61) 41(55) 0	160	75.74
18	0 50(110) 77(50) 0	160	43.88
19	0 71(77) 35(28) 9(52) 0	157	87.82
20	0 79(111) 33(42) 0	153	55.97
21	0 27(11) 32(111) 70(18) 0	140	68.25
22	0 83(109) 60(51) 0	160	43.37
23	0 53(49) 28(110) 0	159	18.01
24	0 19(41) 36(108) 0	149	86.42
25	0 65(111) 35(47) 0	158	103.01
26	0 78(55) 34(65) 81(22) 33(18) 0	160	73.70
27	0 72(24) 75(99) 74(37) 0	160	56.06
28	0 11(63) 63(72) 10(24) 0	159	76.59
29	0 96(52) 99(77) 94(30) 0	159	35.62
30	0 54(49) 80(53) 68(58) 0	160	54.24
31	0 86(63) 38(89) 0	152	90.82
32	0 59(94) 92(34) 94(32) 0	160	38.49
33	0 85(50) 61(106) 0	156	52.99

(cont.)

Table A.197 continued.

No.	Route	Load	Distance
34	0 92(18) 37(64) 91(70) 0	152	51.92
35	0 73(105) 40(55) 0	160	40.25
36	0 82(60) 7(63) 52(34) 0	157	50.37
37	0 21(53) 4(103) 0	156	53.03
38	0 98(59) 93(98) 0	157	44.67
39	0 51(111) 81(49) 0	160	61.72
40	0 77(41) 3(62) 76(54) 0	157	44.89
41	0 19(16) 49(83) 64(61) 0	160	103.30
42	0 48(52) 47(108) 0	160	68.41
43	0 14(106) 100(53) 0	159	64.60
44	0 16(64) 44(93) 0	157	67.13
45	0 90(64) 30(58) 70(38) 0	160	69.75
46	0 45(75) 8(83) 0	158	61.81
47	0 20(86) 66(67) 0	153	81.06
48	0 87(94) 97(54) 0	148	39.83
49	0 62(79) 10(64) 31(13) 0	156	57.35
		Total Distance	2862.14

Table A.198: EMIP-MDA+ERTR solution to S51D4 with $p = .3$.

No.	Route	Load	Distance
1	0 16(42) 21(69) 34(49) 0	160	72.91
2	0 13(25) 40(127) 0	152	90.36
3	0 45(112) 15(34) 0	146	62.77
4	0 3(12) 35(84) 20(45) 2(18) 0	159	82.74
5	0 23(32) 24(93) 6(35) 0	160	56.79
6	0 33(136) 0	136	68.00
7	0 47(131) 12(29) 0	160	23.50
8	0 18(143) 0	143	29.53
9	0 32(142) 0	142	20.00
10	0 49(70) 38(77) 11(13) 0	160	48.00
11	0 10(122) 5(35) 0	157	56.67
12	0 2(25) 29(118) 11(17) 0	160	59.59
13	0 14(139) 0	139	36.22
14	0 9(23) 30(34) 39(100) 0	157	81.90
15	0 23(16) 43(117) 7(27) 0	160	73.52
16	0 37(89) 12(65) 0	154	36.22
17	0 30(74) 34(43) 50(43) 0	160	70.15
18	0 41(136) 0	136	60.96
19	0 48(50) 8(40) 31(70) 0	160	64.08
20	0 1(30) 28(127) 0	157	60.01
21	0 36(141) 3(13) 0	154	88.57
22	0 4(143) 0	143	34.41
23	0 6(54) 25(94) 0	148	51.13
24	0 26(124) 48(31) 0	155	57.12
25	0 1(13) 22(137) 0	150	41.77
26	0 44(106) 37(54) 0	160	50.39
27	0 27(58) 8(91) 0	149	44.06
28	0 46(52) 0	52	4.47
29	0 17(45) 42(63) 19(40) 0	148	72.03
		Total Distance	1597.89

Table A.199: EMIP-MDA+ERTR solution to S51D5 with $p = .3$.

No.	Route	Load	Distance
1	0 26(51) 8(96) 0	147	57.39
2	0 48(71) 27(52) 0	123	32.41
3	0 14(50) 24(93) 23(16) 0	159	60.34
4	0 50(106) 16(53) 0	159	53.85
5	0 10(35) 39(55) 30(70) 0	160	81.23
6	0 17(19) 4(108) 0	127	42.08
7	0 23(36) 43(58) 7(54) 0	148	73.52
8	0 31(52) 28(108) 0	160	66.12
9	0 41(26) 40(79) 19(52) 0	157	85.10
10	0 22(24) 3(56) 20(69) 0	149	73.28
11	0 46(62) 12(78) 0	140	17.37
12	0 14(61) 6(94) 0	155	39.81
13	0 34(91) 9(53) 0	144	63.87
14	0 38(104) 11(53) 0	157	34.56
15	0 1(37) 22(54) 2(69) 0	160	52.62
16	0 17(43) 44(51) 15(16) 5(49) 0	159	60.59
17	0 41(29) 13(59) 25(63) 0	151	76.15
18	0 32(111) 46(49) 0	160	21.46
19	0 1(22) 29(60) 21(64) 0	146	74.54
20	0 42(111) 37(49) 0	160	65.71
21	0 47(61) 18(99) 0	160	32.26
22	0 10(74) 49(78) 0	152	57.57
23	0 15(36) 45(66) 33(56) 0	158	72.45
24	0 36(100) 35(54) 0	154	89.42
		Total Distance	1383.71

Table A.200: EMIP-MDA+ERTR solution to S51D6 with $p = .3$.

No.	Route	Load	Distance
1	0 1(118) 0	118	27.78
2	0 11(38) 2(118) 0	156	43.70
3	0 28(46) 3(114) 0	160	72.01
4	0 4(143) 0	143	34.41
5	0 14(70) 6(90) 0	160	39.81
6	0 26(46) 7(114) 0	160	65.76
7	0 8(140) 0	140	44.05
8	0 49(125) 9(34) 0	159	51.12
9	0 10(138) 0	138	56.64
10	0 38(83) 11(77) 0	160	34.56
11	0 12(131) 0	131	16.12
12	0 25(46) 13(114) 0	160	65.39
13	0 37(43) 15(116) 0	159	50.06
14	0 21(38) 16(118) 0	156	64.14
15	0 17(119) 0	119	34.53
16	0 18(143) 0	143	29.53
17	0 19(118) 42(42) 0	160	71.77
18	0 36(83) 35(41) 20(36) 0	160	89.54
19	0 22(142) 0	142	41.62
20	0 6(40) 23(120) 0	160	44.60
21	0 24(131) 0	131	50.12
22	0 14(72) 25(85) 0	157	47.60
23	0 31(67) 26(93) 0	160	68.04
24	0 27(122) 0	122	16.00
25	0 21(87) 29(65) 0	152	68.39
26	0 28(93) 31(58) 0	151	66.12
27	0 32(143) 0	143	20.00
28	0 33(142) 0	142	68.00
29	0 30(62) 34(89) 0	151	69.36
30	0 20(83) 29(72) 0	155	71.62
31	0 35(88) 36(60) 0	148	89.42
32	0 44(55) 37(100) 0	155	50.39
33	0 5(116) 38(44) 0	160	37.02

(cont.)

Table A.200 continued.

No.	Route	Load	Distance
34	0 39(133) 0	133	76.58
35	0 40(139) 0	139	84.40
36	0 41(142) 0	142	60.96
37	0 43(137) 0	137	69.31
38	0 42(81) 44(79) 0	160	66.62
39	0 45(136) 0	136	62.64
40	0 46(121) 0	121	4.47
41	0 47(140) 0	140	18.87
42	0 48(128) 0	128	31.62
43	0 9(79) 30(73) 0	152	62.44
44	0 34(42) 50(118) 0	160	64.36
		Total Distance	2301.51

Table A.201: EMIP-MDA+ERTR solution to S76D3 with $p = .3$.

No.	Route	Load	Distance
1	0 7(15) 14(79) 59(45) 19(20) 0	159	79.96
2	0 20(37) 70(37) 60(79) 5(6) 0	159	90.60
3	0 21(32) 61(78) 22(46) 0	156	80.55
4	0 10(77) 38(72) 0	149	59.93
5	0 34(59) 46(79) 0	138	23.42
6	0 33(16) 43(26) 41(23) 56(75) 23(20) 0	160	83.63
7	0 48(39) 47(29) 36(68) 5(11) 29(10) 0	157	68.54
8	0 52(61) 54(67) 13(9) 27(20) 0	157	58.52
9	0 12(46) 31(20) 55(38) 25(31) 9(21) 0	156	102.36
10	0 65(79) 66(44) 11(21) 0	144	75.34
11	0 73(58) 1(27) 63(52) 33(8) 0	145	58.13
12	0 4(76) 30(38) 2(37) 0	151	37.85
13	0 42(79) 64(77) 0	156	88.08
14	0 75(75) 67(61) 0	136	15.46
15	0 68(68) 6(62) 17(30) 0	160	30.44
16	0 3(24) 24(61) 49(46) 16(21) 0	152	69.50
17	0 50(74) 18(67) 44(19) 0	160	70.72
18	0 69(73) 71(69) 37(17) 0	159	88.48
19	0 13(18) 57(70) 15(20) 29(18) 45(34) 0	160	64.16
20	0 51(33) 32(79) 40(47) 0	159	49.38
21	0 8(64) 35(22) 53(59) 7(7) 0	152	50.56
22	0 39(23) 72(57) 58(59) 26(19) 0	158	52.48
23	0 74(32) 28(76) 62(51) 0	159	55.17
		Total Distance	1453.25

Table A.202: EMIP-MDA+ERTR solution to S76D4 with $p = .3$.

No.	Route	Load	Distance
1	0 21(143) 0	143	54.59
2	0 62(60) 28(47) 2(46) 0	153	53.37
3	0 71(60) 60(98) 0	158	88.19
4	0 47(29) 36(42) 69(89) 0	160	77.90
5	0 75(124) 0	124	6.00
6	0 3(139) 44(20) 0	159	43.26
7	0 17(135) 0	135	16.12
8	0 35(133) 0	133	36.06
9	0 40(33) 25(80) 32(47) 0	160	67.53
10	0 10(33) 38(25) 66(72) 14(29) 0	159	88.28
11	0 57(93) 27(50) 0	143	56.54
12	0 68(138) 0	138	14.56
13	0 5(36) 70(87) 20(37) 0	160	84.05
14	0 1(86) 73(74) 0	160	51.46
15	0 7(143) 0	143	28.28
16	0 61(121) 30(24) 0	145	69.74
17	0 59(101) 54(41) 34(16) 0	158	88.64
18	0 8(41) 19(82) 46(31) 0	154	47.14
19	0 72(93) 39(63) 0	156	47.98
20	0 74(103) 47(57) 0	160	58.11
21	0 63(42) 41(96) 42(13) 0	151	77.94
22	0 49(141) 16(17) 0	158	56.71
23	0 13(102) 52(49) 34(8) 0	159	45.58
24	0 26(16) 11(138) 0	154	58.84
25	0 51(32) 63(89) 6(39) 0	160	46.59
26	0 48(28) 71(79) 37(52) 0	159	82.10
27	0 67(143) 0	143	10.77
28	0 29(84) 4(31) 0	115	36.91
29	0 22(25) 64(121) 42(14) 0	160	89.08
30	0 4(34) 45(126) 0	160	28.28
31	0 25(44) 55(55) 18(26) 50(35) 0	160	92.18
32	0 53(143) 0	143	45.34
33	0 16(8) 23(35) 56(73) 24(44) 0	160	89.22

(cont.)

Table A.202 continued.

No.	Route	Load	Distance
34	0 58(49) 65(105) 0	154	65.76
35	0 57(42) 15(118) 0	160	59.62
36	0 26(8) 31(100) 72(50) 0	158	74.81
37	0 33(31) 43(126) 0	157	63.84
38	0 12(22) 39(80) 9(51) 0	153	50.10
		Total Distance	2151.49

Table A.203: EMIP-MDA+ERTR solution to S101D2 with $p = .3$.

No.	Route	Load	Distance
1	0 21(45) 73(18) 40(44) 53(26) 0	133	41.31
2	0 51(40) 9(18) 81(18) 33(44) 50(39) 0	159	66.86
3	0 75(21) 56(33) 23(27) 67(17) 39(46) 4(16) 0	160	95.52
4	0 82(24) 48(47) 7(41) 52(42) 0	154	57.20
5	0 54(43) 55(34) 25(47) 4(8) 26(21) 0	153	70.22
6	0 47(45) 36(39) 49(28) 64(25) 63(22) 0	159	112.44
7	0 72(45) 74(32) 22(20) 41(36) 2(18) 0	151	63.25
8	0 18(19) 8(23) 46(35) 45(32) 83(23) 60(20) 0	152	76.79
9	0 96(36) 93(18) 85(18) 91(22) 100(43) 97(18) 0	155	54.24
10	0 10(18) 90(45) 32(33) 20(16) 30(23) 69(19) 0	154	80.39
11	0 99(17) 61(21) 17(40) 84(32) 5(26) 89(18) 0	154	66.25
12	0 12(21) 80(43) 68(37) 76(47) 0	148	46.59
13	0 95(20) 92(25) 37(40) 98(43) 59(28) 0	156	44.12
14	0 58(46) 13(30) 94(47) 6(18) 0	141	33.95
15	0 88(19) 62(47) 11(47) 19(39) 0	152	72.71
16	0 16(18) 86(37) 38(28) 44(47) 14(18) 42(12) 0	160	99.71
17	0 28(27) 1(38) 70(41) 31(31) 27(18) 0	155	51.25
18	0 34(25) 35(41) 71(18) 65(20) 66(46) 0	150	117.36
19	0 87(23) 42(19) 43(47) 15(46) 57(23) 0	158	72.41
20	0 24(21) 29(47) 78(20) 79(23) 3(31) 77(18) 0	160	79.30
		Total Distance	1401.85

Table A.204: EMIP-MDA+ERTR solution to S101D3 with $p = .3$.

No.	Route	Load	Distance
1	0 95(41) 59(6) 93(64) 99(48) 0	159	42.19
2	0 43(23) 38(22) 86(77) 5(37) 0	159	102.22
3	0 85(40) 91(35) 100(79) 0	154	53.39
4	0 54(75) 26(74) 0	149	46.03
5	0 19(52) 49(24) 36(79) 0	155	94.40
6	0 35(29) 71(21) 65(30) 66(24) 20(52) 0	156	112.21
7	0 1(21) 30(59) 70(48) 69(26) 0	154	52.44
8	0 17(79) 16(44) 61(31) 0	154	71.56
9	0 82(79) 47(21) 48(57) 0	157	68.93
10	0 14(69) 44(71) 59(14) 0	154	69.62
11	0 32(75) 90(71) 31(14) 0	160	70.94
12	0 72(76) 21(77) 0	153	44.97
13	0 76(60) 50(79) 0	139	38.01
14	0 63(20) 64(69) 11(68) 0	157	95.89
15	0 41(22) 15(60) 57(31) 2(33) 0	146	72.14
16	0 89(16) 84(24) 45(17) 46(70) 8(33) 0	160	79.58
17	0 89(36) 96(78) 6(45) 0	159	33.37
18	0 18(77) 83(27) 60(48) 0	152	44.79
19	0 22(79) 74(66) 0	145	54.68
20	0 56(22) 39(25) 67(20) 23(44) 75(22) 73(21) 0	154	94.53
21	0 92(68) 37(33) 98(55) 0	156	43.89
22	0 68(79) 3(79) 0	158	49.82
23	0 94(64) 13(74) 0	138	27.69
24	0 88(50) 7(75) 52(35) 0	160	46.77
25	0 58(59) 40(78) 0	137	24.36
26	0 29(58) 24(60) 80(35) 0	153	67.22
27	0 53(29) 28(68) 0	97	18.01
28	0 51(20) 9(60) 81(28) 33(45) 0	153	66.84
29	0 97(74) 42(49) 87(31) 0	154	51.86
30	0 77(18) 79(24) 34(36) 78(76) 0	154	72.80
31	0 4(29) 25(69) 55(20) 12(38) 0	156	71.30
32	0 27(38) 31(19) 10(58) 62(34) 0	149	57.53
		Total Distance	1939.96

Table A.205: EMIP-MDA+ERTR solution to S101D5 with $p = .3$.

No.	Route	Load	Distance
1	0 20(86) 30(58) 27(16) 0	160	64.31
2	0 59(94) 94(62) 0	156	35.68
3	0 66(46) 65(111) 0	157	104.03
4	0 53(91) 0	91	8.94
5	0 13(32) 57(69) 2(59) 0	160	48.16
6	0 85(50) 91(70) 98(40) 0	160	51.92
7	0 35(75) 71(77) 0	152	87.41
8	0 10(27) 32(111) 66(21) 0	159	90.85
9	0 82(26) 46(111) 45(23) 0	160	76.29
10	0 44(93) 16(64) 0	157	67.13
11	0 52(47) 69(111) 0	158	34.25
12	0 87(94) 42(60) 0	154	51.09
13	0 73(105) 40(55) 0	160	40.25
14	0 61(106) 99(53) 0	159	51.23
15	0 57(30) 15(61) 41(69) 0	160	71.50
16	0 68(58) 80(53) 54(49) 0	160	54.24
17	0 75(99) 72(55) 0	154	55.64
18	0 70(56) 10(61) 31(41) 0	158	54.68
19	0 52(30) 82(34) 8(83) 0	147	56.61
20	0 9(52) 81(71) 33(33) 0	156	65.60
21	0 93(98) 99(24) 96(36) 0	158	40.58
22	0 51(111) 50(49) 0	160	55.08
23	0 48(36) 47(108) 0	144	68.41
24	0 50(61) 1(52) 27(37) 0	150	39.11
25	0 33(27) 79(71) 3(62) 0	160	56.38
26	0 76(54) 77(91) 0	145	39.47
27	0 40(46) 58(91) 13(20) 0	157	32.57
28	0 49(83) 64(61) 0	144	103.18
29	0 90(64) 63(72) 31(23) 0	159	71.65
30	0 4(103) 21(53) 0	156	53.03
31	0 95(16) 42(44) 43(100) 0	160	70.14
32	0 36(108) 48(49) 0	157	82.80
33	0 79(40) 34(65) 78(55) 0	160	72.25

(cont.)

Table A.205 continued.

No.	Route	Load	Distance
34	0 24(102) 29(57) 0	159	66.90
35	0 54(53) 55(107) 0	160	61.75
36	0 95(36) 97(110) 0	146	35.07
37	0 100(53) 14(106) 0	159	64.60
38	0 18(111) 89(49) 0	160	32.62
39	0 28(110) 0	110	12.65
40	0 84(52) 17(52) 45(52) 0	156	67.63
41	0 6(63) 5(52) 60(45) 0	160	43.68
42	0 25(55) 67(50) 23(50) 0	155	96.73
43	0 7(38) 19(57) 11(63) 0	158	73.01
44	0 7(25) 62(79) 88(52) 0	156	55.72
45	0 26(84) 12(57) 0	141	33.25
46	0 83(109) 60(20) 89(28) 0	157	43.39
47	0 22(104) 74(48) 0	152	54.68
48	0 38(89) 86(63) 0	152	90.82
49	0 39(88) 56(71) 0	159	70.18
50	0 96(16) 98(19) 37(64) 92(52) 0	151	44.60
		Total Distance	2901.76

Table A.206: EMIP-MDA+ERTR solution to S51D3 with $p = .4$.

No.	Route	Load	Distance
1	0 27(21) 31(32) 28(78) 1(20) 0	151	66.51
2	0 8(51) 26(52) 48(53) 0	156	58.20
3	0 7(31) 43(68) 23(18) 6(31) 0	148	74.08
4	0 46(47) 18(79) 25(23) 0	149	52.66
5	0 46(32) 38(57) 49(51) 5(20) 0	160	45.84
6	0 10(56) 39(56) 30(26) 9(20) 0	158	81.93
7	0 24(70) 14(74) 0	144	53.94
8	0 19(25) 40(69) 41(37) 13(20) 0	151	93.21
9	0 4(71) 47(76) 0	147	34.45
10	0 22(72) 32(79) 0	151	42.51
11	0 2(27) 20(54) 29(25) 21(21) 34(33) 0	160	91.16
12	0 44(61) 42(72) 17(20) 0	153	66.88
13	0 3(30) 36(76) 35(43) 0	149	90.13
14	0 50(78) 16(32) 11(31) 0	141	53.87
15	0 33(28) 45(43) 15(29) 37(32) 12(25) 0	157	73.03
		Total Distance	978.41

Table A.207: EMIP-MDA+ERTR solution to S51D4 with $p = .4$.

No.	Route	Load	Distance
1	0 26(124) 0	124	56.32
2	0 30(108) 38(46) 0	154	61.95
3	0 47(131) 0	131	18.87
4	0 18(143) 0	143	29.53
5	0 45(112) 15(34) 0	146	62.77
6	0 14(139) 0	139	36.22
7	0 44(106) 17(45) 0	151	50.81
8	0 43(117) 7(27) 0	144	73.12
9	0 40(127) 13(25) 0	152	90.36
10	0 8(131) 0	131	44.05
11	0 48(81) 31(70) 0	151	64.08
12	0 10(122) 49(38) 0	160	57.57
13	0 33(136) 5(17) 0	153	69.02
14	0 41(57) 19(40) 42(63) 0	160	75.34
15	0 22(137) 1(23) 0	160	41.77
16	0 46(52) 12(94) 0	146	17.37
17	0 36(141) 20(19) 0	160	88.91
18	0 37(143) 0	143	36.22
19	0 3(25) 35(84) 20(26) 2(25) 0	160	82.74
20	0 27(58) 6(89) 0	147	28.46
21	0 49(32) 39(100) 5(18) 0	150	77.01
22	0 32(142) 0	142	20.00
23	0 50(43) 34(92) 9(23) 0	158	64.66
24	0 2(18) 21(69) 16(42) 38(31) 0	160	70.87
25	0 29(118) 11(30) 0	148	58.63
26	0 28(127) 1(20) 0	147	60.01
27	0 4(81) 41(79) 0	160	61.14
28	0 24(93) 23(48) 0	141	56.52
29	0 4(62) 25(94) 0	156	57.98
		Total Distance	1612.30

Table A.208: EMIP-MDA+ERTR solution to S51D5 with $p = .4$.

No.	Route	Load	Distance
1	0 9(53) 50(106) 0	159	54.92
2	0 42(111) 19(31) 0	142	71.77
3	0 20(69) 3(56) 1(35) 0	160	73.36
4	0 28(108) 31(52) 0	160	66.12
5	0 6(45) 43(58) 7(54) 0	157	73.21
6	0 30(42) 34(91) 16(26) 0	159	71.64
7	0 47(36) 4(108) 0	144	34.45
8	0 29(60) 21(64) 16(27) 0	151	68.40
9	0 37(49) 44(51) 15(52) 0	152	56.21
10	0 10(109) 39(22) 30(28) 0	159	81.23
11	0 35(54) 36(100) 0	154	89.42
12	0 47(25) 17(62) 12(45) 0	132	36.56
13	0 27(21) 1(24) 32(111) 0	156	32.15
14	0 18(99) 13(59) 0	158	58.34
15	0 46(111) 0	111	4.47
16	0 49(78) 5(49) 12(33) 0	160	47.16
17	0 41(55) 40(79) 19(21) 0	155	85.10
18	0 25(63) 24(93) 0	156	62.18
19	0 38(104) 11(53) 0	157	34.56
20	0 22(78) 2(69) 0	147	52.46
21	0 8(96) 26(51) 0	147	57.39
22	0 14(111) 6(49) 0	160	39.81
23	0 39(33) 33(56) 45(66) 0	155	90.54
24	0 23(52) 48(71) 27(31) 0	154	47.84
		Total Distance	1389.32

Table A.209: EMIP-MDA+ERTR solution to S51D6 with $p = .4$.

No.	Route	Load	Distance
1	0 1(118) 0	118	27.78
2	0 2(118) 0	118	42.05
3	0 3(114) 0	114	65.12
4	0 4(143) 0	143	34.41
5	0 5(116) 0	116	28.28
6	0 6(130) 0	130	22.80
7	0 7(114) 0	114	52.84
8	0 8(140) 0	140	44.05
9	0 9(113) 0	113	46.17
10	0 10(138) 0	138	56.64
11	0 11(115) 0	115	24.08
12	0 12(131) 0	131	16.12
13	0 13(114) 0	114	58.31
14	0 14(142) 0	142	36.22
15	0 15(116) 0	116	49.48
16	0 16(118) 0	118	44.05
17	0 17(119) 0	119	34.53
18	0 18(143) 0	143	29.53
19	0 19(118) 0	118	63.81
20	0 20(119) 0	119	64.90
21	0 21(125) 0	125	64.12
22	0 22(142) 0	142	41.62
23	0 23(120) 0	120	44.05
24	0 24(131) 0	131	50.12
25	0 25(131) 0	131	46.17
26	0 26(139) 0	139	56.32
27	0 27(122) 0	122	16.00
28	0 28(139) 0	139	59.93
29	0 29(137) 0	137	58.24
30	0 30(135) 0	135	61.74
31	0 31(125) 0	125	59.67
32	0 32(143) 0	143	20.00
33	0 33(142) 0	142	68.00

(cont.)

Table A.209 continued.

No.	Route	Load	Distance
34	0 34(131) 0	131	63.56
35	0 35(129) 0	129	78.82
36	0 36(143) 0	143	87.86
37	0 37(143) 0	143	36.22
38	0 38(127) 0	127	31.62
39	0 39(133) 0	133	76.58
40	0 40(139) 0	139	84.40
41	0 41(142) 0	142	60.96
42	0 42(123) 0	123	62.64
43	0 43(137) 0	137	69.31
44	0 44(134) 0	134	50.00
45	0 45(136) 0	136	62.64
46	0 46(121) 0	121	4.47
47	0 47(140) 0	140	18.87
48	0 48(128) 0	128	31.62
49	0 49(125) 0	125	43.27
50	0 50(118) 0	118	52.35
		Total Distance	2402.35

Table A.210: EMIP-MDA+ERTR solution to S76D3 with $p = .4$.

No.	Route	Load	Distance
1	0 58(59) 72(57) 39(23) 9(21) 0	160	57.72
2	0 50(74) 32(79) 0	153	59.50
3	0 45(34) 29(14) 15(20) 57(70) 27(20) 0	158	61.42
4	0 33(14) 43(26) 41(23) 56(75) 23(20) 0	158	83.63
5	0 16(21) 63(52) 1(27) 73(58) 0	158	59.75
6	0 10(77) 38(72) 0	149	59.93
7	0 31(20) 25(31) 55(38) 18(67) 0	156	113.69
8	0 12(46) 40(47) 17(30) 51(33) 0	156	41.34
9	0 29(14) 5(10) 36(68) 47(29) 48(39) 0	160	68.54
10	0 22(46) 61(78) 21(32) 0	156	80.55
11	0 19(20) 59(45) 14(79) 7(9) 0	153	79.96
12	0 54(67) 13(27) 52(61) 0	155	57.51
13	0 30(38) 2(37) 6(62) 0	137	39.08
14	0 3(24) 44(19) 24(61) 49(46) 33(10) 0	160	79.03
15	0 7(13) 53(59) 35(22) 8(64) 0	158	50.56
16	0 34(59) 46(79) 26(19) 0	157	29.09
17	0 67(61) 4(76) 0	137	19.46
18	0 68(68) 75(75) 0	143	14.75
19	0 65(79) 66(44) 11(21) 0	144	75.34
20	0 42(79) 64(77) 0	156	88.08
21	0 5(7) 60(79) 70(37) 20(37) 0	160	90.60
22	0 74(32) 28(76) 62(51) 0	159	55.17
23	0 37(17) 71(69) 69(73) 0	159	88.48
		Total Distance	1453.17

Table A.211: EMIP-MDA+ERTR solution to S76D4 with $p = .4$.

No.	Route	Load	Distance
1	0 61(121) 0	121	68.47
2	0 53(143) 0	143	45.34
3	0 35(133) 0	133	36.06
4	0 49(141) 0	141	56.14
5	0 46(31) 19(82) 8(41) 0	154	47.14
6	0 13(102) 54(41) 0	143	57.39
7	0 21(143) 0	143	54.59
8	0 48(28) 47(86) 29(42) 0	156	56.56
9	0 3(139) 44(20) 0	159	43.26
10	0 73(74) 1(86) 0	160	51.46
11	0 11(138) 0	138	58.31
12	0 15(118) 29(42) 0	160	55.84
13	0 28(47) 62(60) 6(39) 0	146	54.46
14	0 5(36) 70(87) 20(37) 0	160	84.05
15	0 7(143) 0	143	28.28
16	0 67(143) 0	143	10.77
17	0 25(124) 50(35) 0	159	71.17
18	0 64(121) 22(25) 0	146	87.03
19	0 72(143) 12(13) 0	156	41.70
20	0 17(135) 0	135	16.12
21	0 74(103) 2(46) 0	149	41.77
22	0 36(42) 69(89) 30(24) 0	155	77.72
23	0 39(143) 12(9) 0	152	44.74
24	0 57(135) 0	135	56.36
25	0 24(44) 56(73) 23(35) 0	152	88.38
26	0 71(139) 0	139	79.65
27	0 66(72) 10(33) 58(49) 0	154	80.26
28	0 45(126) 4(31) 0	157	28.28
29	0 34(24) 52(49) 27(50) 4(34) 0	157	35.72
30	0 51(32) 41(96) 42(27) 0	155	79.16
31	0 26(24) 38(25) 65(105) 0	154	63.59
32	0 37(52) 60(98) 0	150	86.99
33	0 43(126) 33(31) 0	157	63.84

(cont.)

Table A.211 continued.

No.	Route	Load	Distance
34	0 75(124) 0	124	6.00
35	0 68(138) 0	138	14.56
36	0 16(25) 63(131) 0	156	47.86
37	0 59(101) 14(29) 0	130	76.85
38	0 9(24) 55(55) 18(26) 32(47) 0	152	92.60
39	0 31(100) 9(27) 40(33) 0	160	78.82
		Total Distance	2167.27

Table A.212: EMIP-MDA+ERTR solution to S101D2 with $p = .4$.

No.	Route	Load	Distance
1	0 60(20) 83(23) 45(32) 46(35) 8(23) 18(19) 0	152	76.79
2	0 97(18) 37(40) 100(43) 91(22) 85(18) 93(18) 0	159	54.53
3	0 76(47) 68(37) 80(43) 12(21) 0	148	46.59
4	0 2(18) 41(36) 22(20) 75(21) 72(45) 73(18) 0	158	67.24
5	0 20(16) 66(46) 65(20) 71(18) 35(41) 9(18) 0	159	112.62
6	0 16(18) 86(37) 38(28) 44(47) 14(18) 87(10) 0	158	98.64
7	0 58(46) 13(30) 94(47) 6(18) 0	141	33.95
8	0 52(42) 7(41) 48(47) 82(24) 0	154	57.20
9	0 89(18) 5(26) 84(32) 17(40) 61(21) 99(17) 0	154	66.25
10	0 19(39) 11(47) 62(47) 88(19) 0	152	72.71
11	0 4(24) 25(47) 55(34) 54(43) 0	148	69.89
12	0 31(31) 70(41) 1(38) 69(19) 27(18) 0	147	49.49
13	0 10(18) 90(45) 32(33) 30(23) 51(40) 0	159	83.48
14	0 56(33) 39(46) 67(17) 23(27) 74(32) 0	155	94.74
15	0 26(21) 21(45) 40(44) 53(26) 0	136	39.43
16	0 24(21) 29(47) 34(25) 78(20) 77(18) 28(27) 0	158	86.89
17	0 63(22) 64(25) 49(28) 36(39) 47(45) 0	159	112.44
18	0 3(31) 79(23) 81(18) 33(44) 50(39) 0	155	59.90
19	0 87(13) 42(31) 43(47) 15(46) 57(23) 0	160	72.41
20	0 95(20) 92(25) 98(43) 59(28) 96(36) 0	152	43.67
		Total Distance	1398.88

Table A.213: EMIP-MDA+ERTR solution to S101D3 with $p = .4$.

No.	Route	Load	Distance
1	0 54(75) 26(74) 0	149	46.03
2	0 76(60) 50(79) 0	139	38.01
3	0 10(58) 11(68) 62(34) 0	160	70.23
4	0 82(79) 18(77) 0	156	47.74
5	0 22(79) 74(66) 0	145	54.68
6	0 88(50) 7(75) 52(35) 0	160	46.77
7	0 94(64) 96(78) 0	142	31.31
8	0 97(74) 92(68) 0	142	38.75
9	0 12(38) 55(20) 25(69) 4(29) 0	156	71.30
10	0 3(79) 68(79) 0	158	49.82
11	0 77(18) 79(24) 34(36) 78(76) 0	154	72.80
12	0 80(35) 24(60) 29(58) 0	153	67.22
13	0 58(59) 13(74) 0	133	26.32
14	0 89(52) 60(48) 6(45) 0	145	38.18
15	0 5(37) 84(24) 17(79) 45(17) 0	157	68.04
16	0 40(78) 21(77) 0	155	36.28
17	0 31(14) 90(71) 32(75) 0	160	70.94
18	0 48(57) 46(70) 8(33) 0	160	75.19
19	0 43(23) 38(22) 86(77) 61(31) 0	153	100.82
20	0 19(52) 64(69) 63(20) 31(19) 0	160	98.37
21	0 49(24) 36(79) 47(21) 83(27) 0	151	101.11
22	0 35(29) 71(21) 65(30) 66(24) 20(52) 0	156	112.21
23	0 51(20) 9(60) 81(28) 33(45) 0	153	66.84
24	0 44(71) 14(69) 87(13) 0	153	71.20
25	0 28(68) 27(38) 0	106	18.03
26	0 57(31) 15(60) 42(49) 87(18) 0	158	65.29
27	0 2(33) 73(21) 72(76) 53(29) 0	159	52.66
28	0 99(48) 93(64) 95(41) 0	153	42.19
29	0 37(33) 91(35) 16(44) 85(40) 0	152	60.76
30	0 41(22) 23(44) 67(20) 39(25) 56(22) 75(22) 0	155	102.82
31	0 59(20) 98(55) 100(79) 0	154	48.61
32	0 1(21) 30(59) 70(48) 69(26) 0	154	52.44
		Total Distance	1942.94

Table A.214: EMIP-MDA+ERTR solution to S101D5 with $p = .4$.

No.	Route	Load	Distance
1	0 24(102) 29(57) 0	159	66.90
2	0 25(55) 67(50) 23(50) 0	155	96.73
3	0 58(91) 40(60) 0	151	24.36
4	0 96(52) 99(77) 95(30) 0	159	37.75
5	0 79(111) 3(37) 0	148	51.52
6	0 46(111) 47(49) 0	160	79.67
7	0 92(52) 37(64) 98(24) 0	140	43.89
8	0 98(35) 91(70) 100(53) 0	158	52.94
9	0 66(27) 65(111) 9(21) 0	159	104.50
10	0 28(110) 0	110	12.65
11	0 11(63) 64(61) 49(34) 0	158	103.20
12	0 56(71) 39(88) 0	159	70.18
13	0 5(52) 17(52) 84(52) 0	156	61.03
14	0 4(103) 12(57) 0	160	55.81
15	0 95(22) 97(110) 0	132	35.07
16	0 42(60) 43(100) 0	160	68.73
17	0 10(88) 31(64) 0	152	51.02
18	0 50(110) 1(31) 0	141	38.53
19	0 14(106) 42(44) 0	150	66.73
20	0 88(52) 62(79) 7(29) 0	160	55.72
21	0 52(77) 89(77) 0	154	28.38
22	0 87(94) 13(52) 0	146	36.85
23	0 94(62) 93(98) 0	160	40.83
24	0 75(99) 72(55) 0	154	55.64
25	0 83(109) 60(39) 0	148	43.37
26	0 53(91) 0	91	8.94
27	0 41(69) 15(61) 0	130	71.44
28	0 59(94) 6(63) 0	157	36.20
29	0 78(55) 34(65) 9(31) 0	151	79.26
30	0 45(75) 8(83) 0	158	61.81
31	0 61(106) 85(50) 0	156	52.99
32	0 22(104) 74(48) 0	152	54.68
33	0 54(49) 80(53) 68(58) 0	160	54.24

(cont.)

Table A.214 continued.

No.	Route	Load	Distance
34	0 30(34) 66(40) 20(86) 0	160	81.87
35	0 26(84) 40(41) 0	125	29.43
36	0 71(77) 35(75) 0	152	87.41
37	0 16(64) 44(93) 0	157	67.13
38	0 1(21) 51(111) 30(24) 0	156	61.99
39	0 38(89) 86(63) 0	152	90.82
40	0 33(60) 81(71) 3(25) 0	156	58.95
41	0 7(34) 19(57) 47(59) 0	150	74.66
42	0 77(91) 76(54) 0	145	39.47
43	0 32(111) 70(32) 0	143	68.25
44	0 36(108) 49(49) 0	157	94.28
45	0 48(85) 82(60) 0	145	56.51
46	0 69(111) 27(31) 0	142	24.45
47	0 73(105) 21(53) 0	158	41.31
48	0 70(24) 90(64) 63(72) 0	160	73.03
49	0 60(26) 18(111) 27(22) 0	159	44.74
50	0 55(107) 54(53) 0	160	61.75
51	0 57(99) 2(59) 0	158	47.03
		Total Distance	2904.61

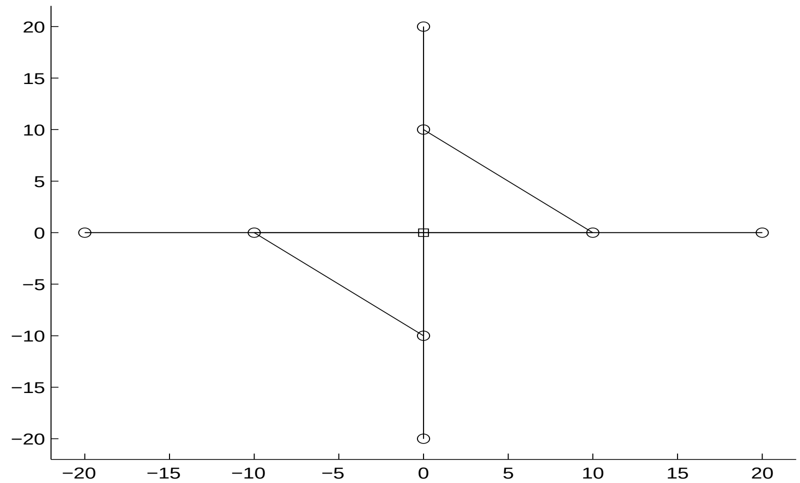


Figure A.1: Estimated and EMIP-MDA + ERTR solutions to MDA1 with $p = .1$, .2, .3, and .4.

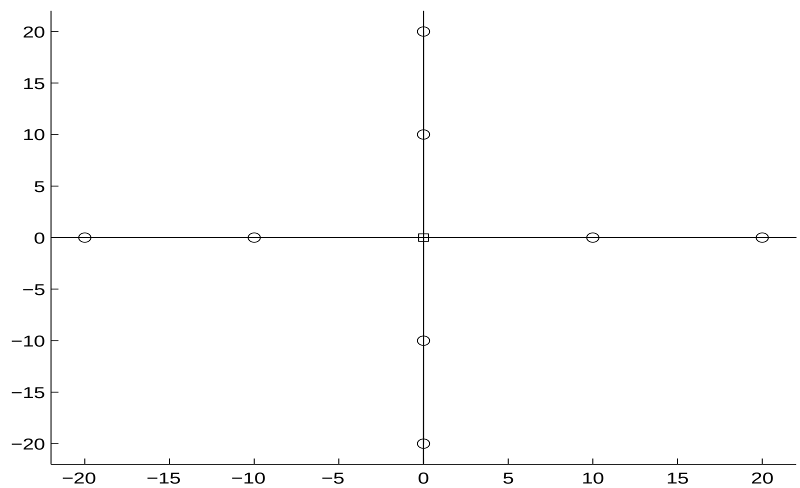


Figure A.2: Estimated and EMIP-MDA + ERTR solutions to MDA2 with $p = .1$, .2, .3, and .4.

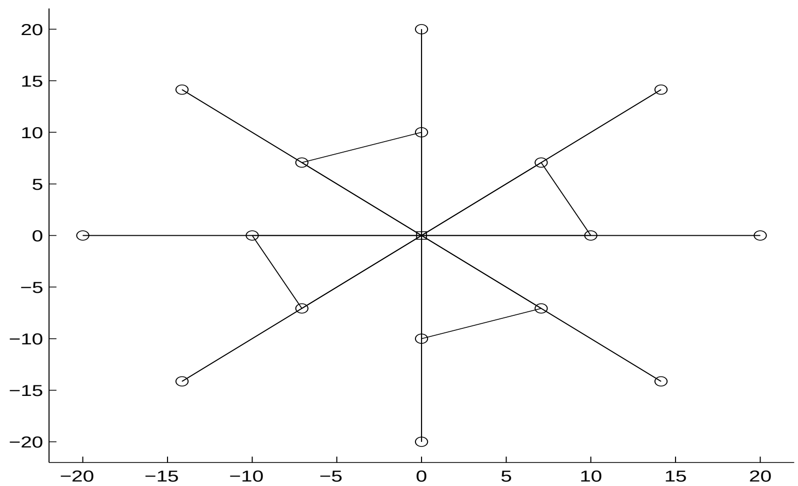


Figure A.3: Estimated and EMIP-MDA + ERTR solutions to MDA3 with $p = .1$, .2, .3, and .4.

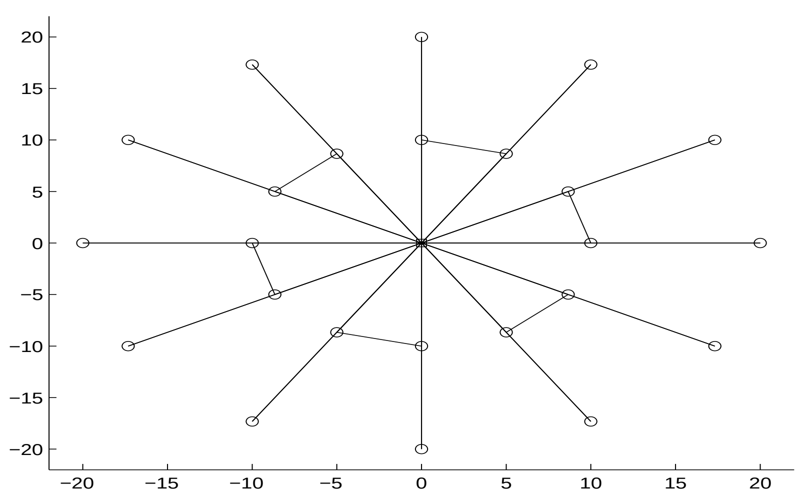


Figure A.4: Estimated and EMIP-MDA + ERTR solutions to MDA4 with $p = .1$, .2, .3, and .4.

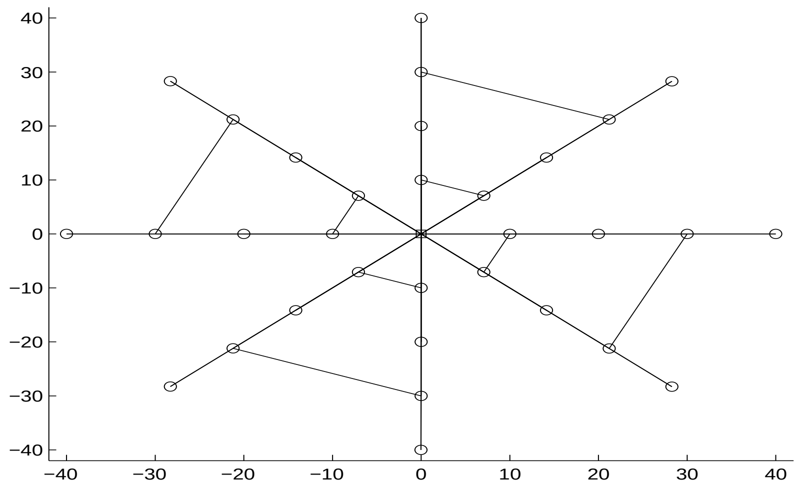


Figure A.5: EMIP-MDA + ERTR solution to MDA5 with $p = .1$.

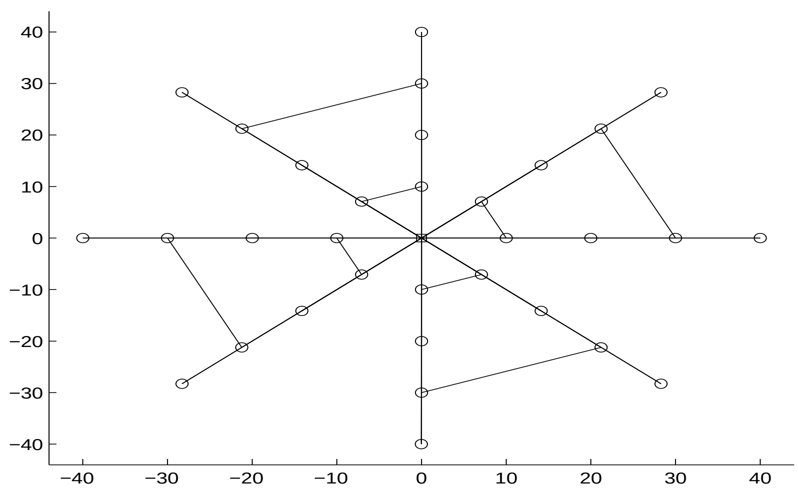


Figure A.6: Estimated and EMIP-MDA + ERTR solutions to MDA5 with $p = .2$ and .3.

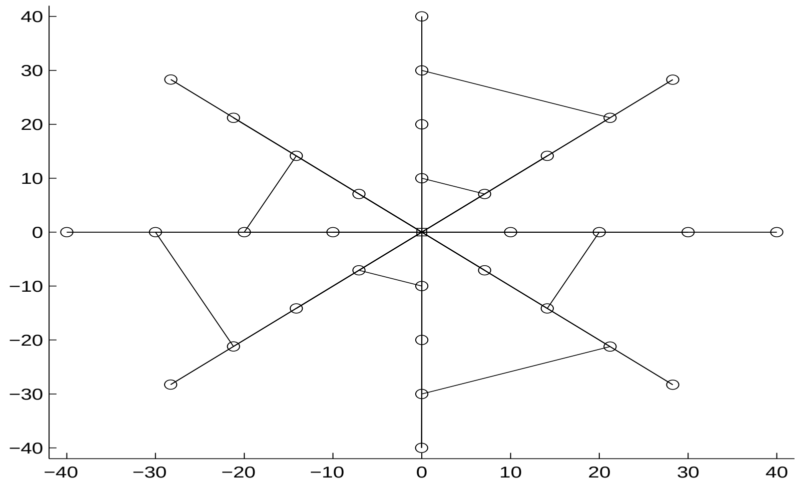


Figure A.7: EMIP-MDA + ERTR solution to MDA5 with $p = .4$.

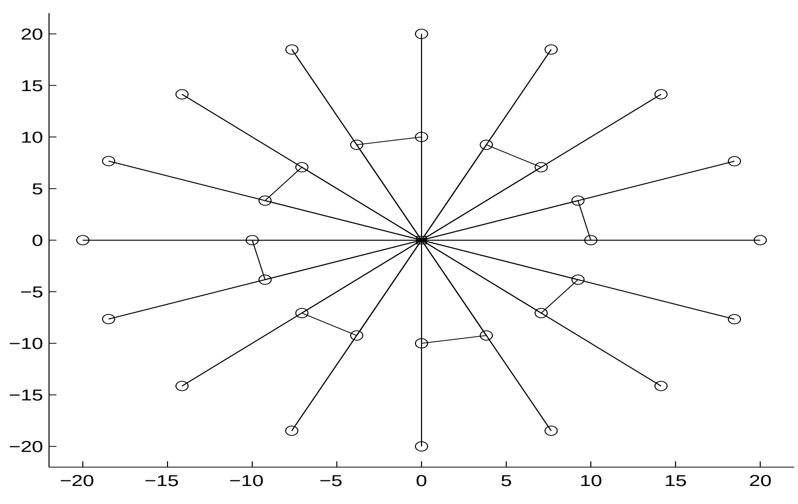


Figure A.8: Estimated and EMIP-MDA + ERTR solutions to MDA6 with $p = .1$, .2, and .3.

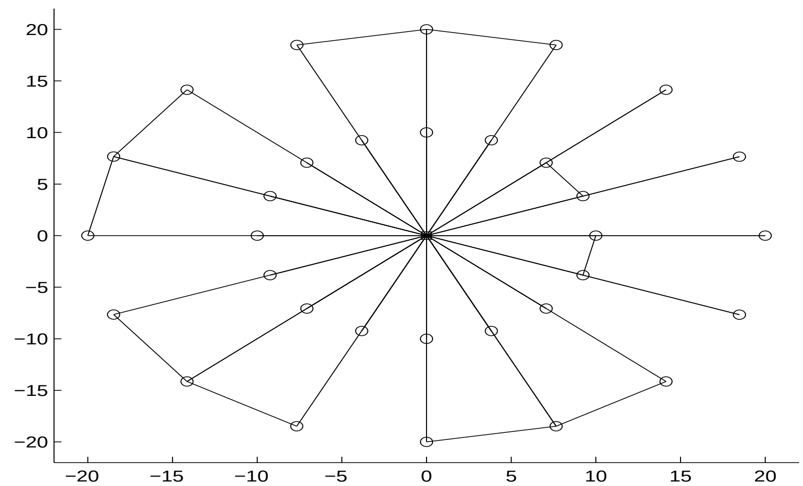


Figure A.9: EMIP-MDA + ERTR solution to MDA6 with $p = .4$.

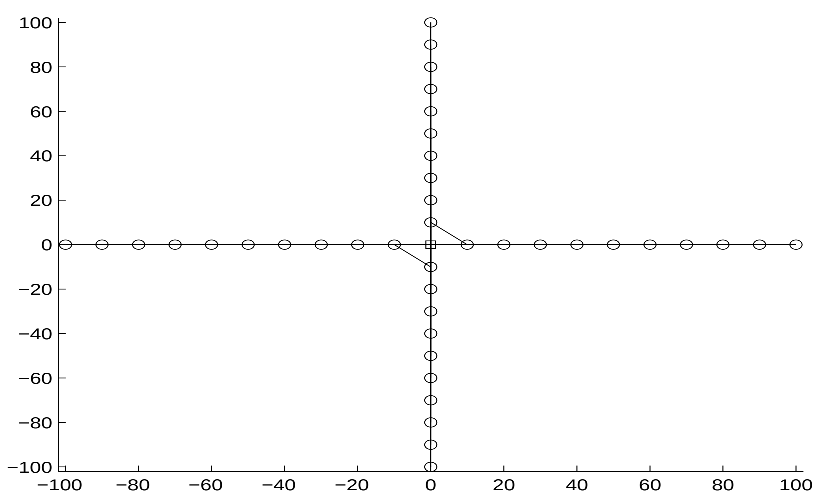


Figure A.10: Estimated and EMIP-MDA + ERTR solutions to MDA7 with $p = .1$, .2, .3, and .4.

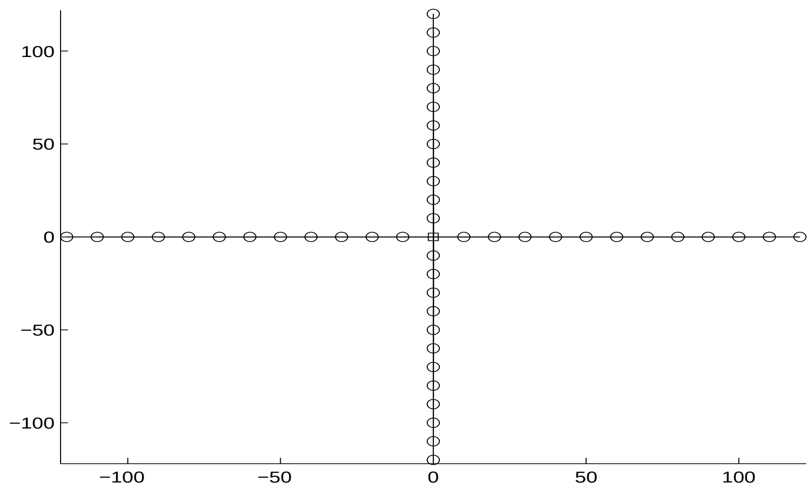


Figure A.11: EMIP-MDA + ERTR solution to MDA8 with $p = .1$ and $.2$.

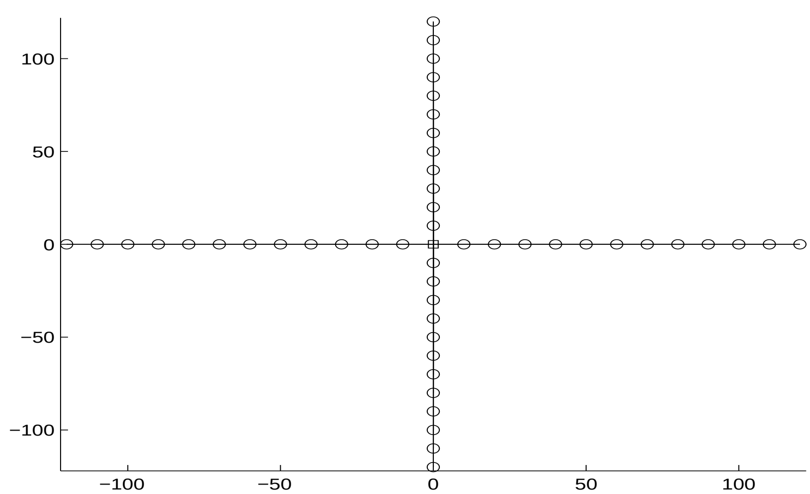


Figure A.12: Estimated and EMIP-MDA + ERTR solutions to MDA8 with $p = .3$ and $.4$.

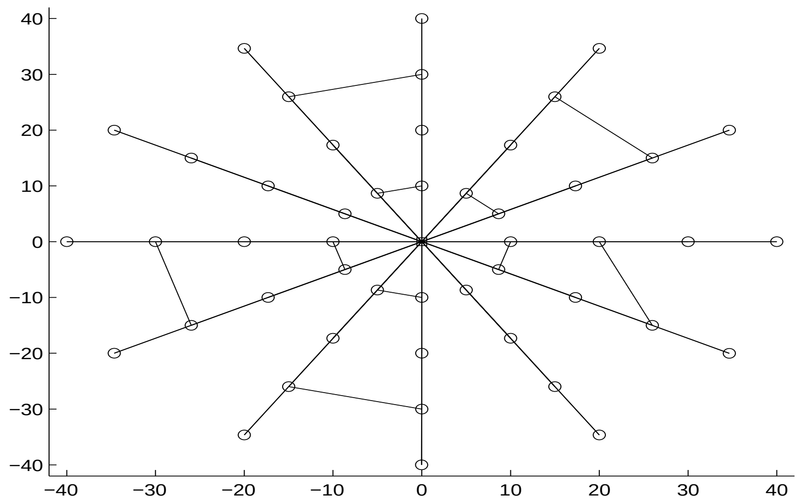


Figure A.13: EMIP-MDA + ERTR solution to MDA9 with $p = .1$.

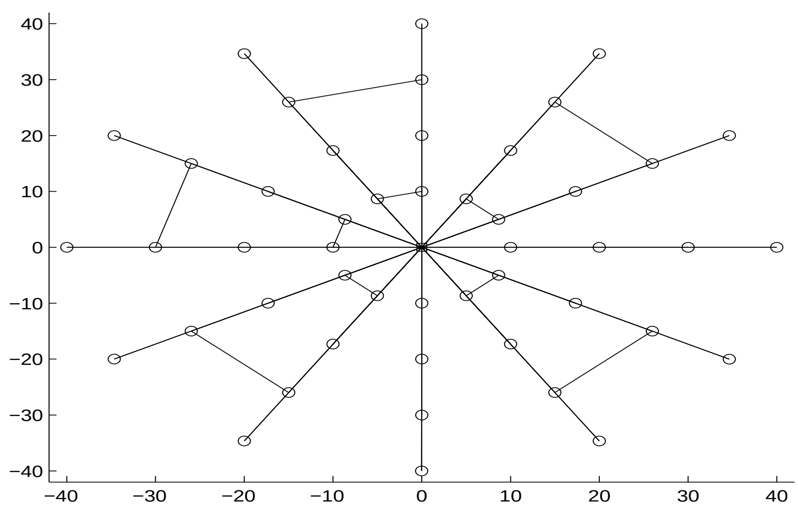


Figure A.14: EMIP-MDA + ERTR solution to MDA9 with $p = .2$ and $.3$.

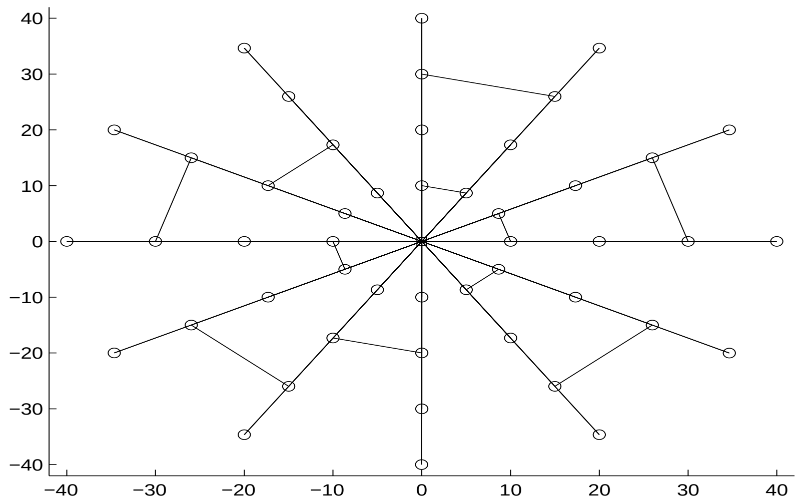


Figure A.15: EMIP-MDA + ERTR solution to MDA9 with $p = .4$.

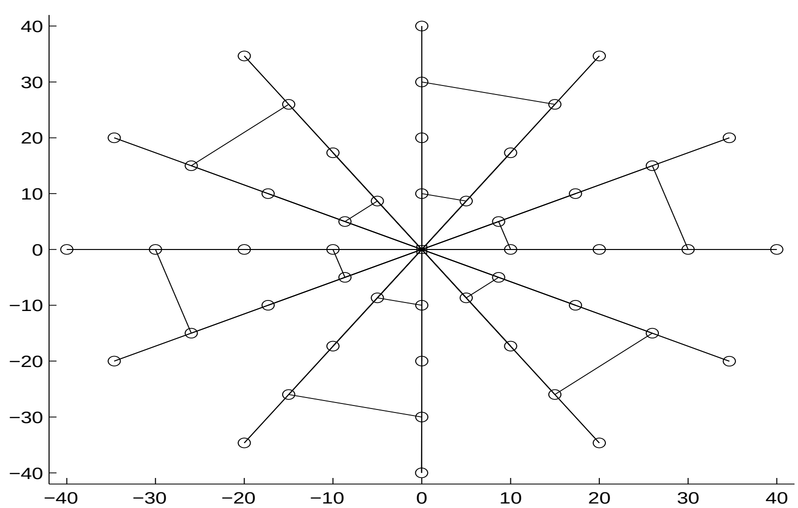


Figure A.16: Estimated solution to MDA9.

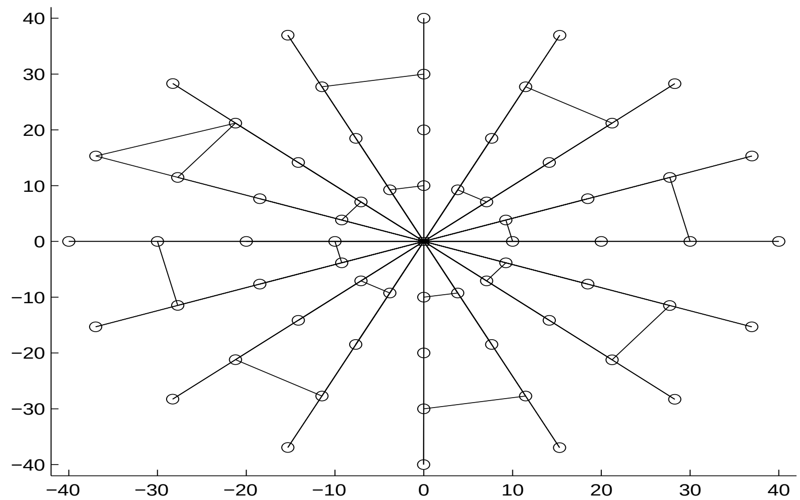


Figure A.17: EMIP-MDA + ERTR solution to MDA10 with $p = .1$.

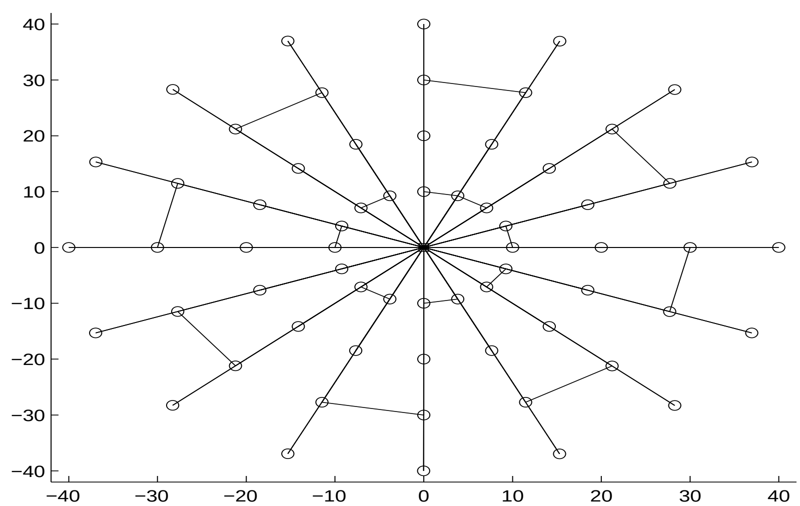


Figure A.18: EMIP-MDA + ERTR solution to MDA10 with $p = .2$.

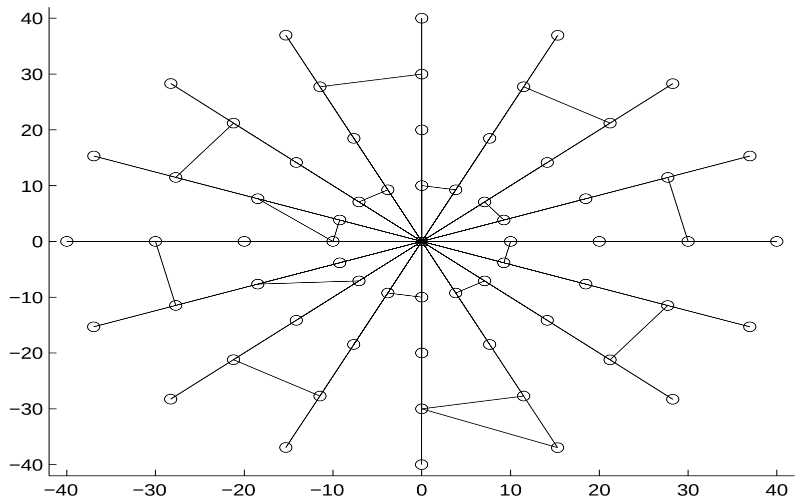


Figure A.19: EMIP-MDA + ERTR solution to MDA10 with $p = .3$.

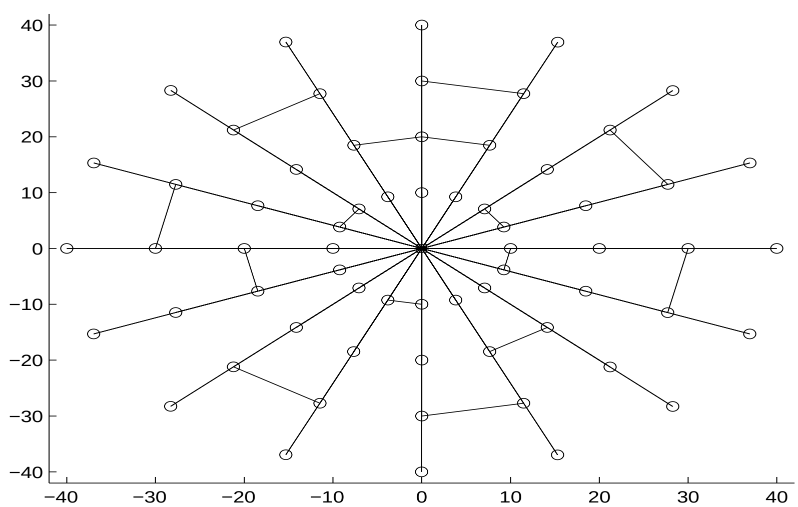


Figure A.20: EMIP-MDA + ERTR solution to MDA10 with $p = .4$.

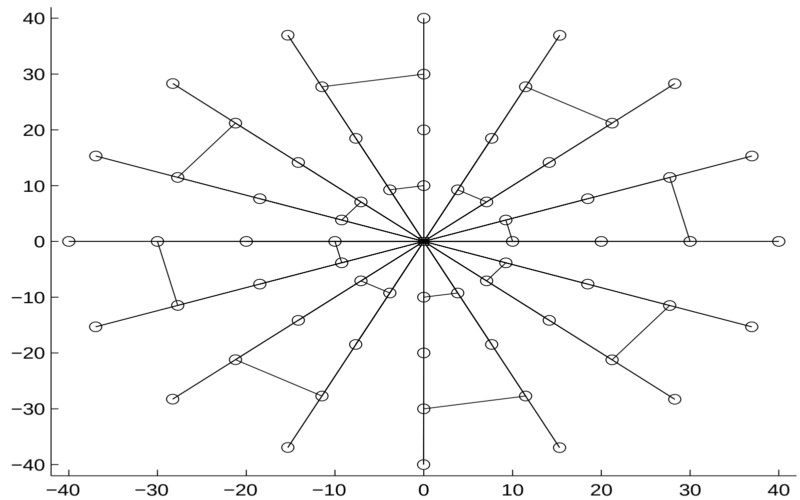


Figure A.21: Estimated solution to MDA10.

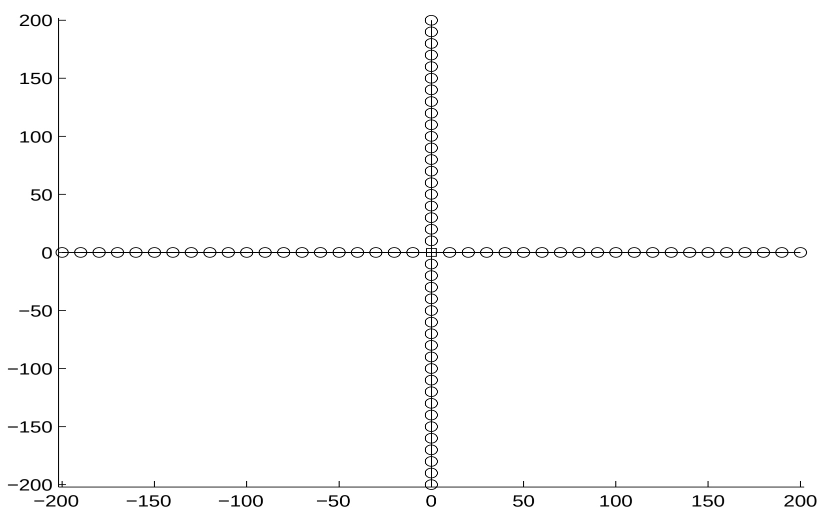


Figure A.22: EMIP-MDA + ERTR solution to MDA11 with $p = .1$.

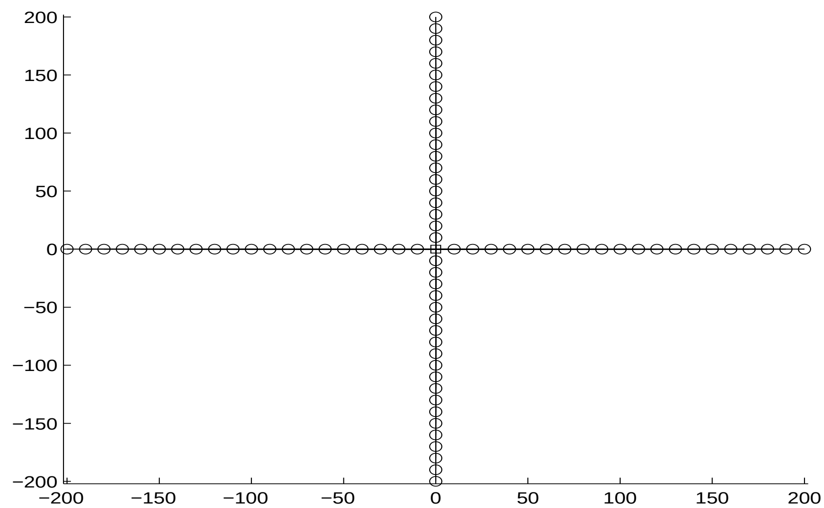


Figure A.23: EMIP-MDA + ERTR solution to MDA11 with $p = .2$.

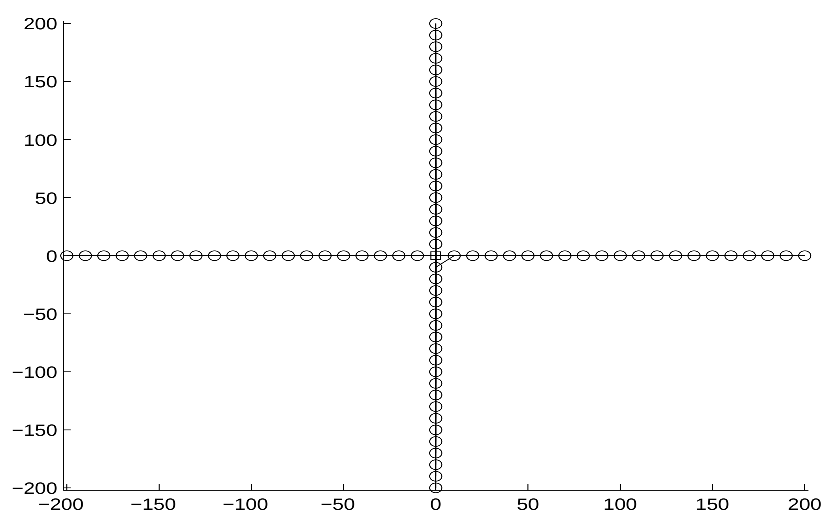


Figure A.24: EMIP-MDA + ERTR solution to MDA11 with $p = .3$.

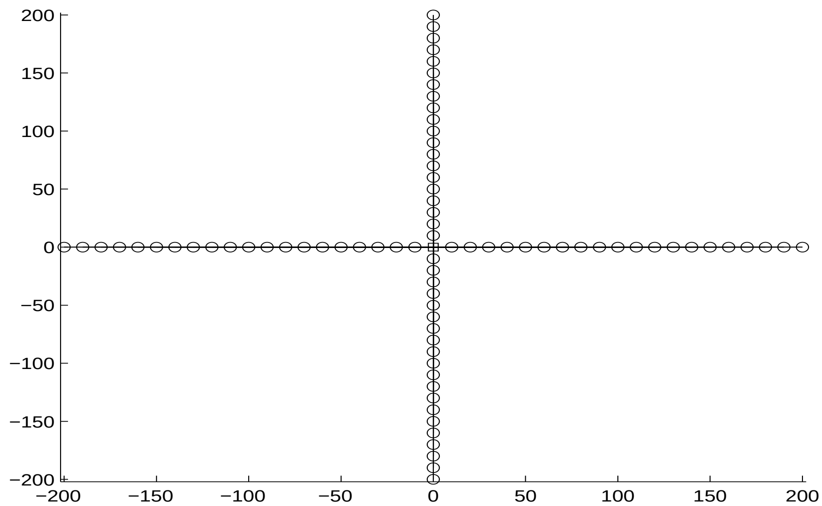


Figure A.25: EMIP-MDA + ERTR solution to MDA11 with $p = .4$.

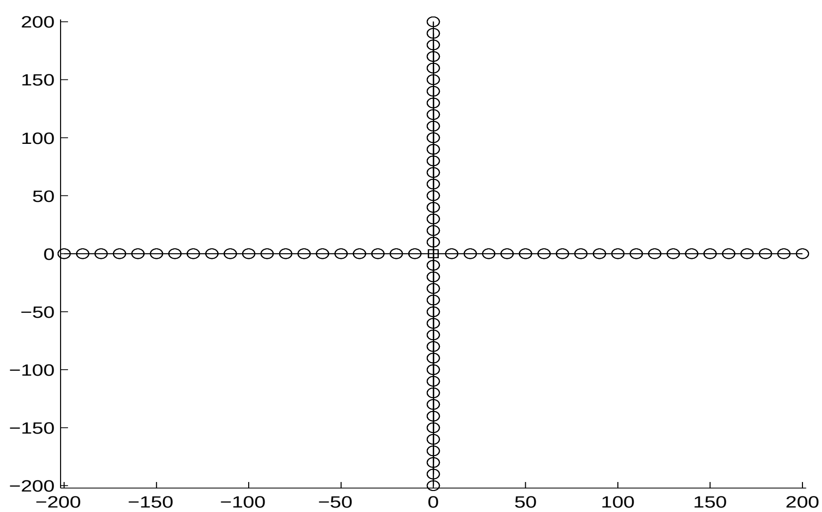


Figure A.26: Estimated solution to MDA11.

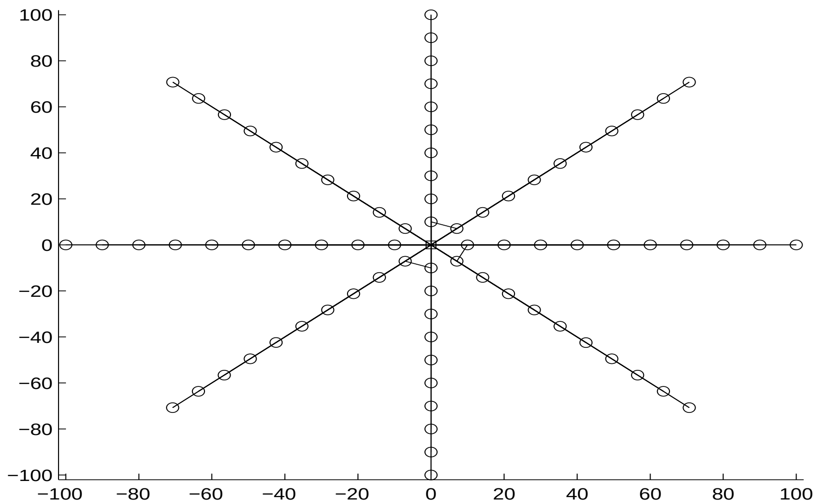


Figure A.27: EMIP-MDA + ERTR solution to MDA12 with $p = .1$ and $.2$.

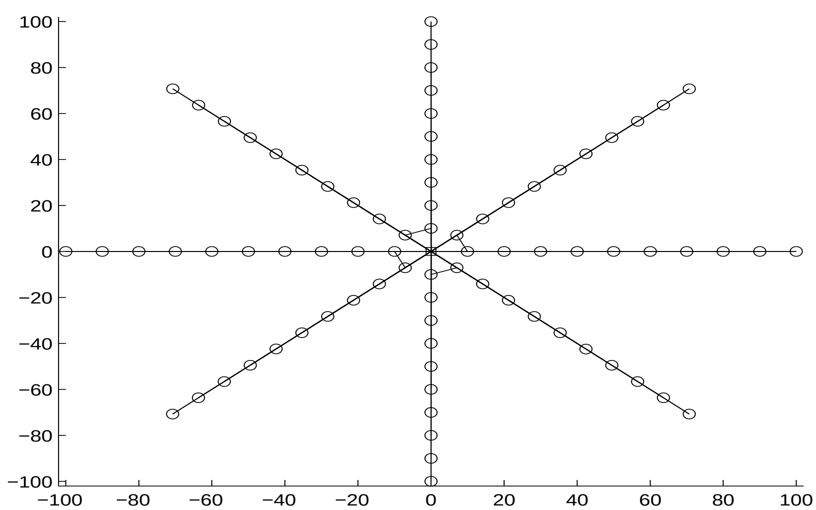


Figure A.28: EMIP-MDA + ERTR solution to MDA12 with $p = .3$.

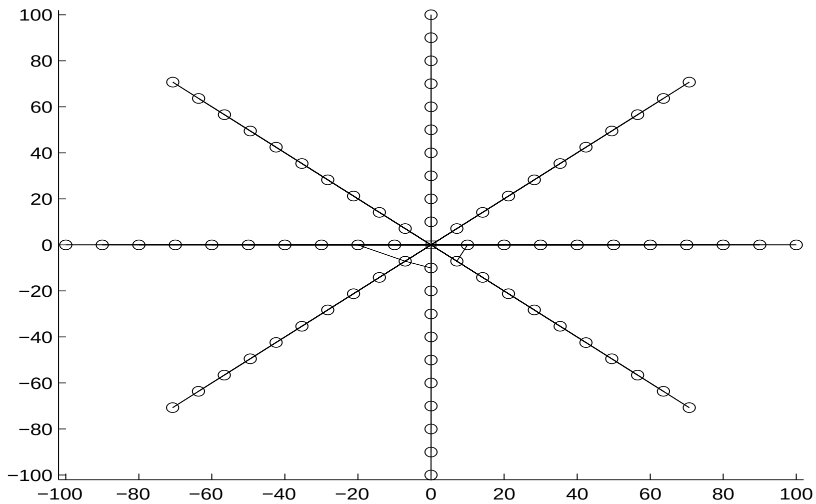


Figure A.29: EMIP-MDA + ERTR solution to MDA12 with $p = .4$.

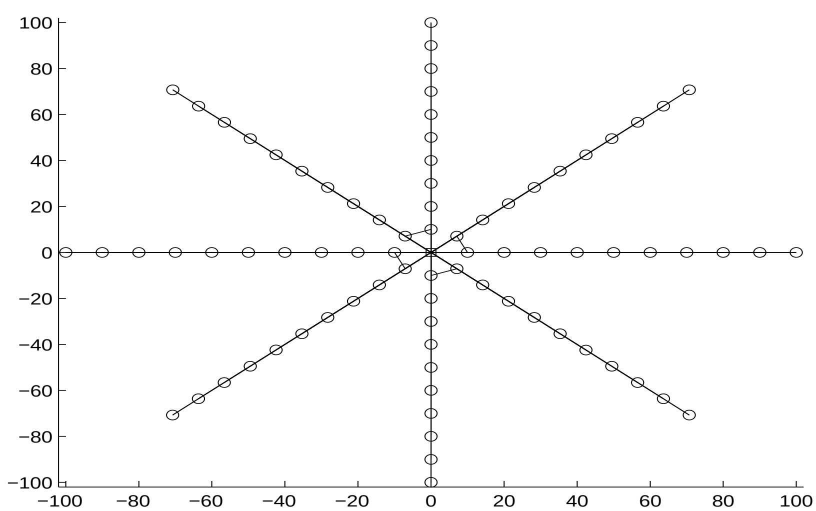


Figure A.30: Estimated solution to MDA12.

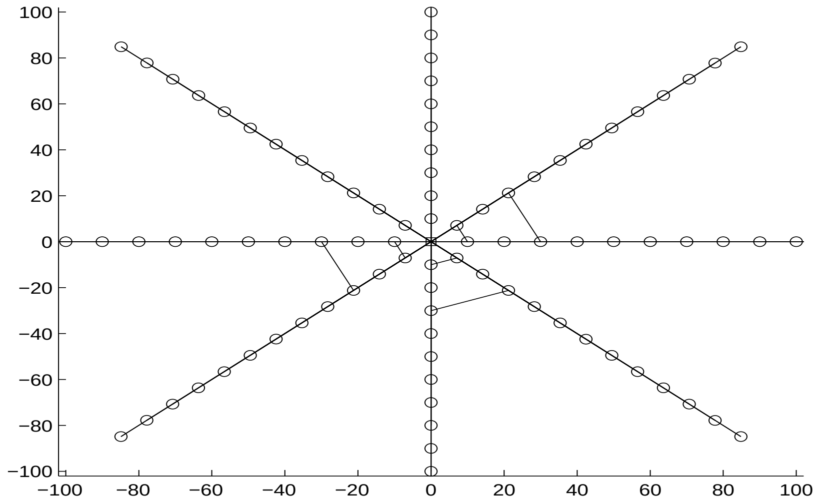


Figure A.31: EMIP-MDA + ERTR solution to MDA13 with $p = .1$.

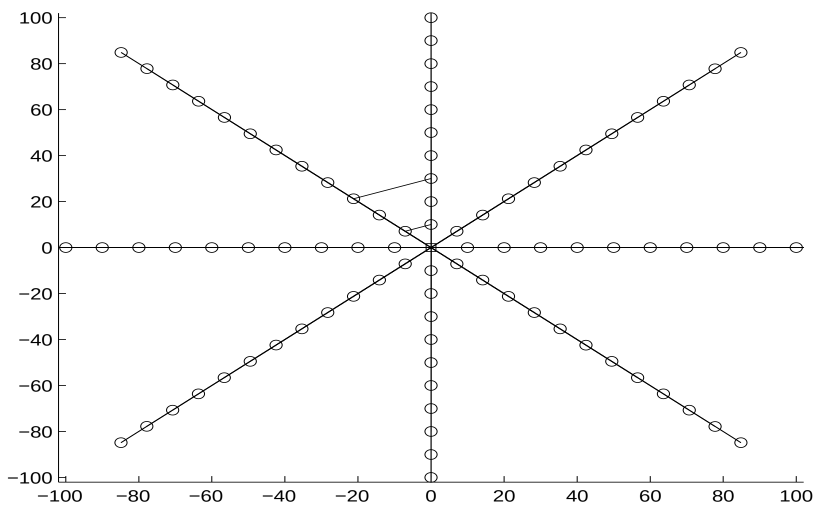


Figure A.32: EMIP-MDA + ERTR solution to MDA13 with $p = .2$.

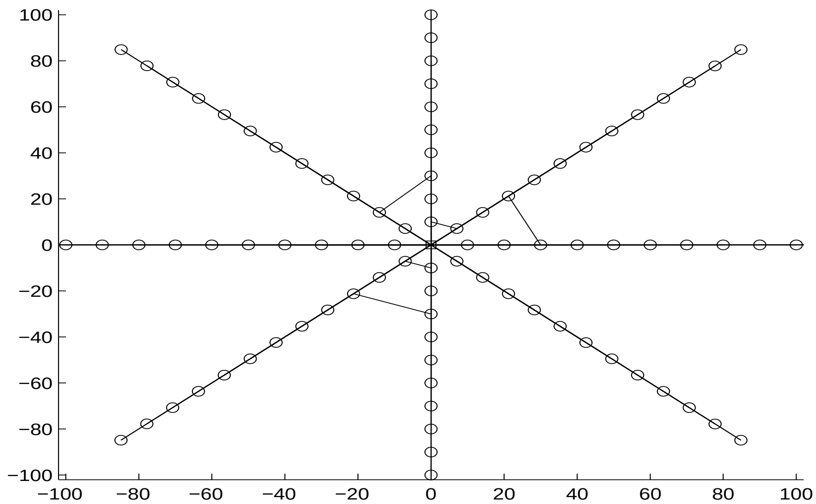


Figure A.33: EMIP-MDA + ERTR solution to MDA13 with $p = .3$.

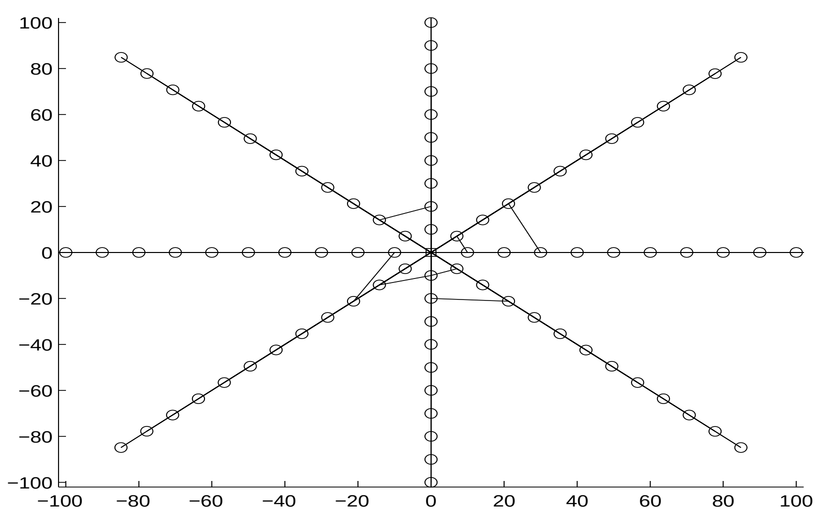


Figure A.34: EMIP-MDA + ERTR solution to MDA13 with $p = .4$.

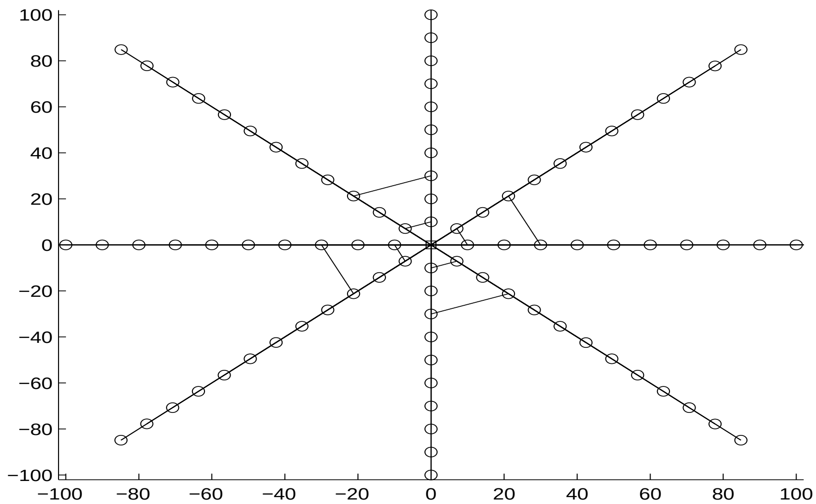


Figure A.35: Estimated solution to MDA13.

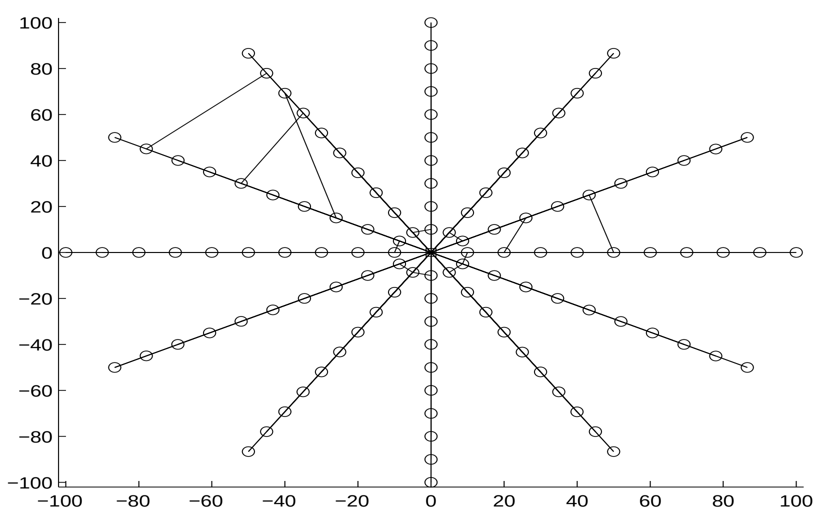


Figure A.36: EMIP-MDA + ERTR solution to MDA14 with $p = .1$.

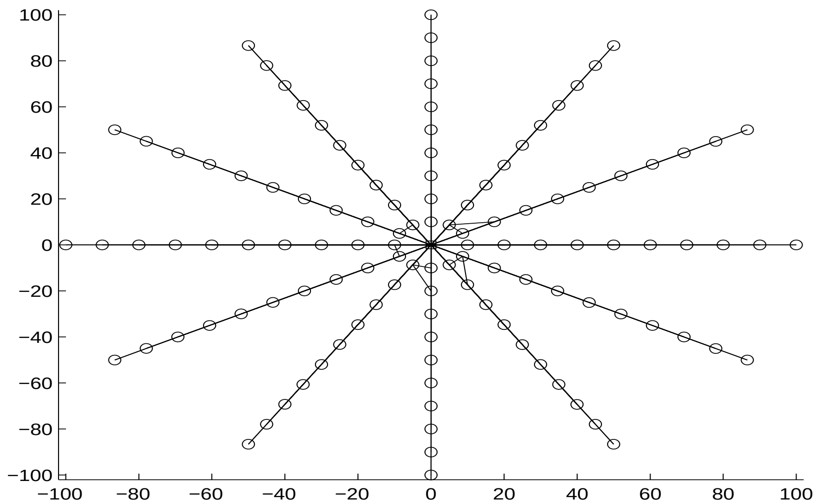


Figure A.37: EMIP-MDA + ERTR solution to MDA14 with $p = .2$.

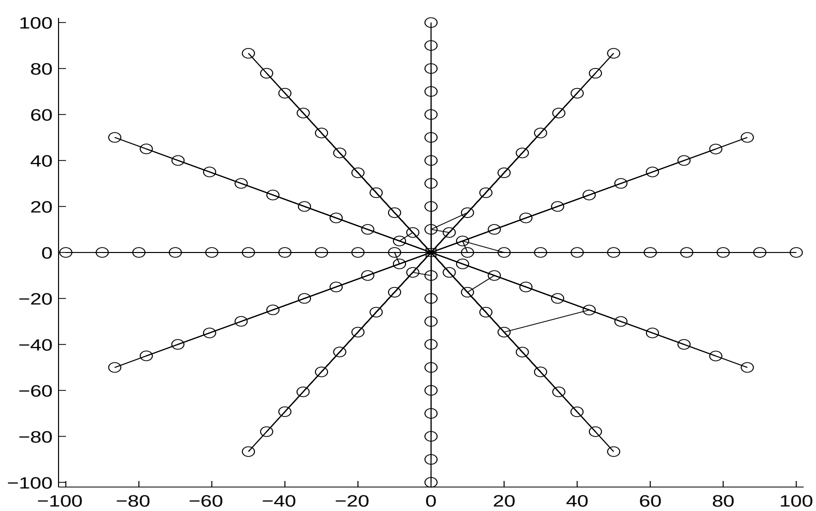


Figure A.38: EMIP-MDA + ERTR solution to MDA14 with $p = .3$.

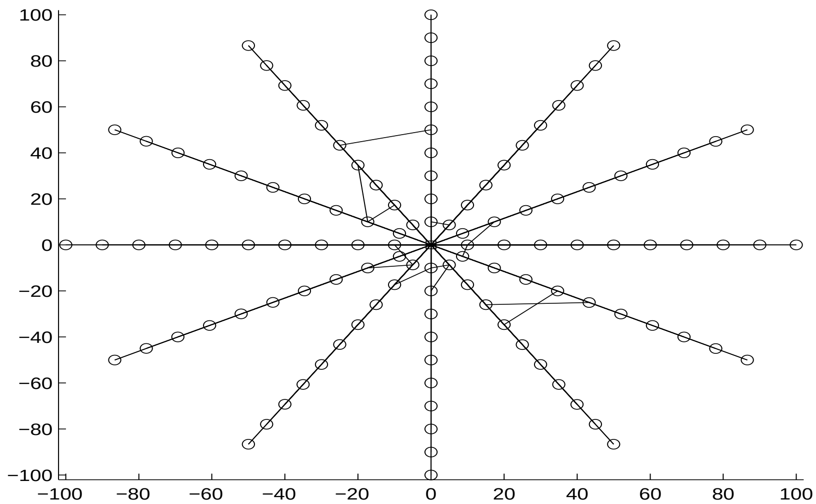


Figure A.39: EMIP-MDA + ERTR solution to MDA14 with $p = .4$.

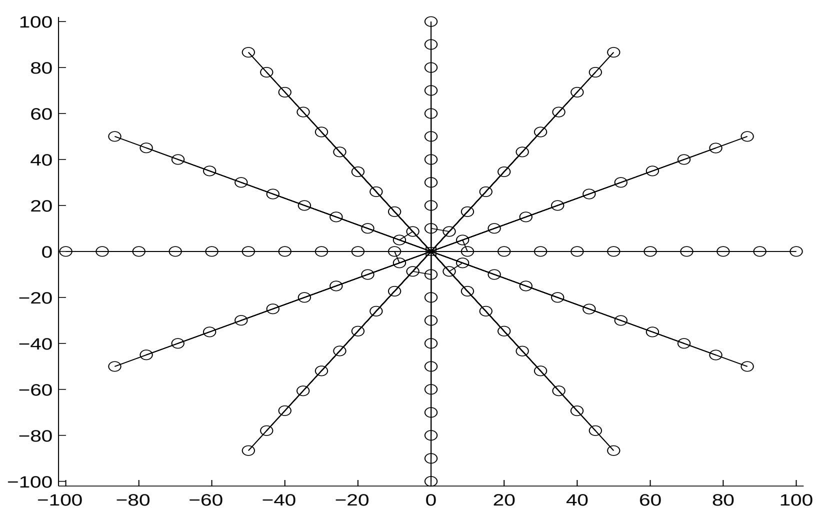


Figure A.40: Estimated solution to MDA14.

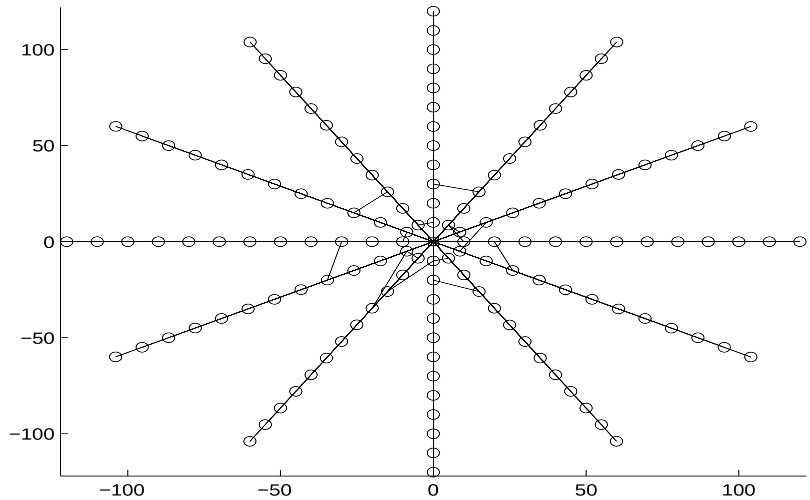


Figure A.41: EMIP-MDA + ERTR solution to MDA15 with $p = .1$.

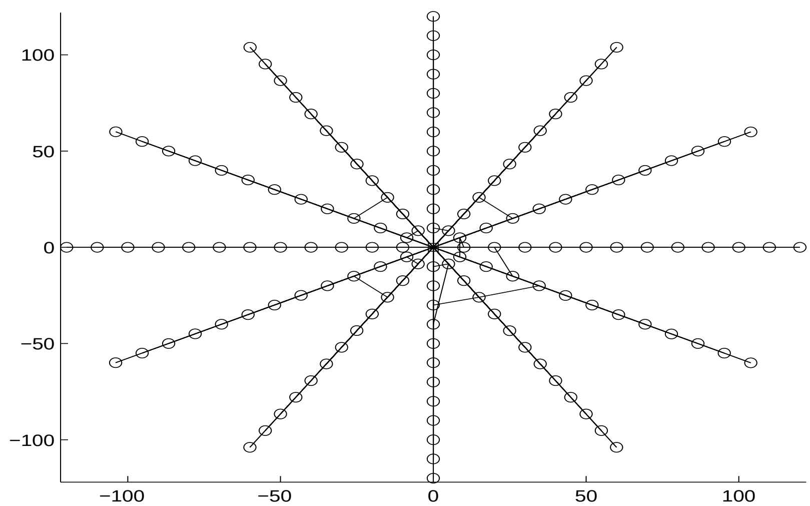


Figure A.42: EMIP-MDA + ERTR solution to MDA15 with $p = .2$.

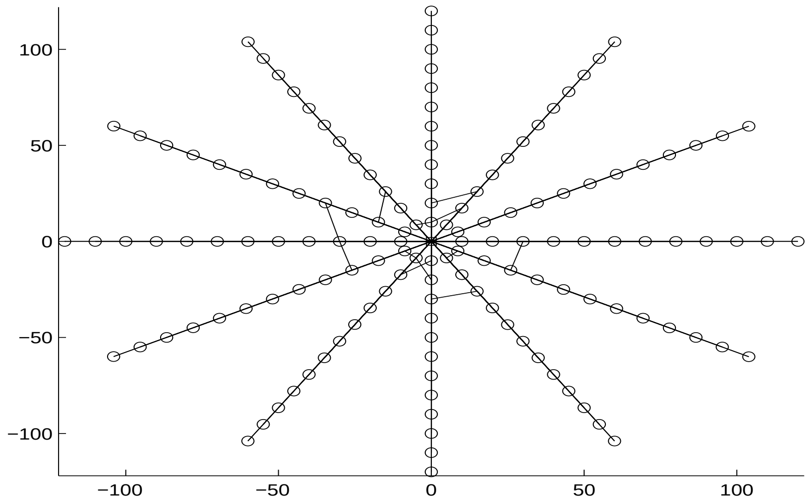


Figure A.43: EMIP-MDA + ERTR solution to MDA15 with $p = .3$.

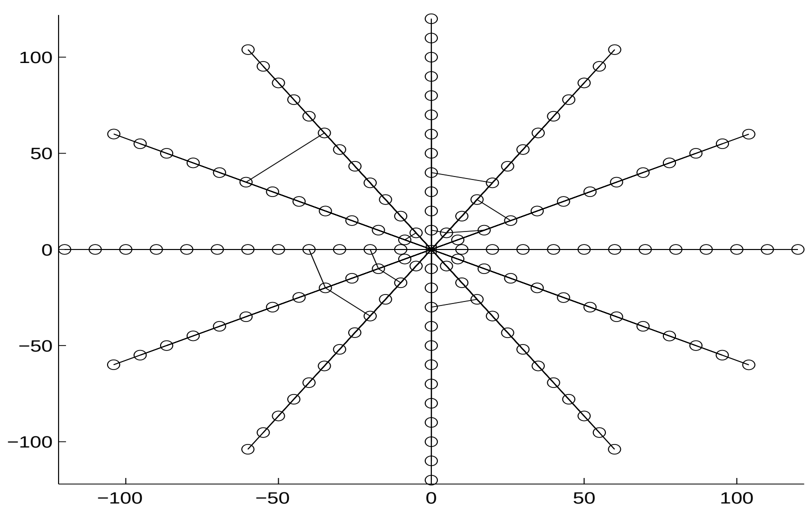


Figure A.44: EMIP-MDA + ERTR solution to MDA15 with $p = .4$.

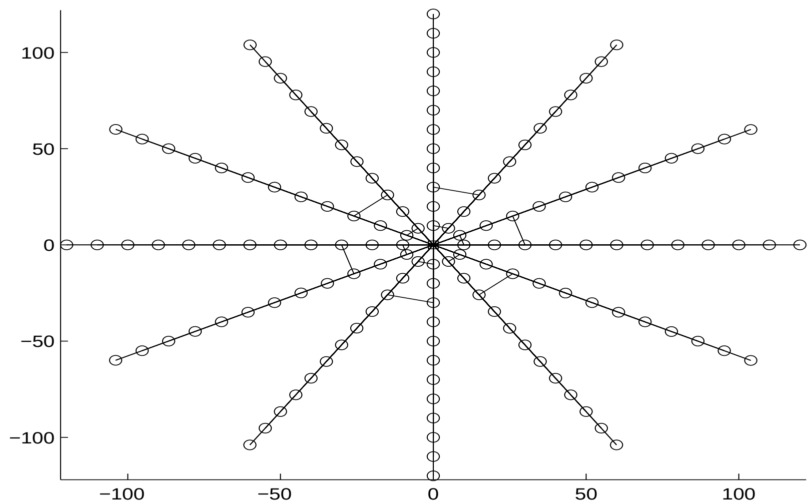


Figure A.45: Estimated solution to MDA15.

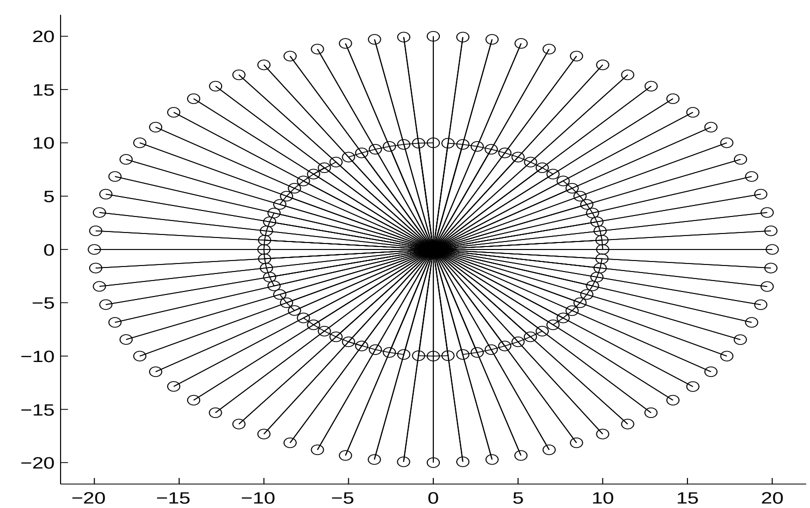


Figure A.46: EMIP-MDA + ERTR solution to MDA16 with $p = .1$.

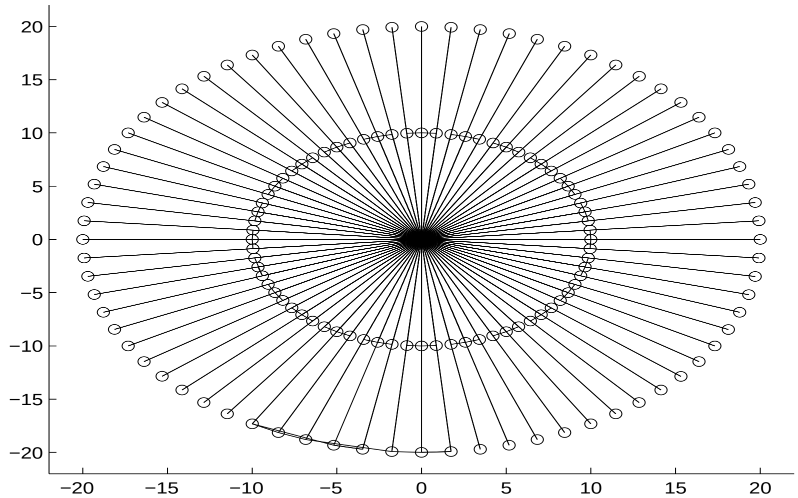


Figure A.47: EMIP-MDA + ERTR solution to MDA16 with $p = .2$.

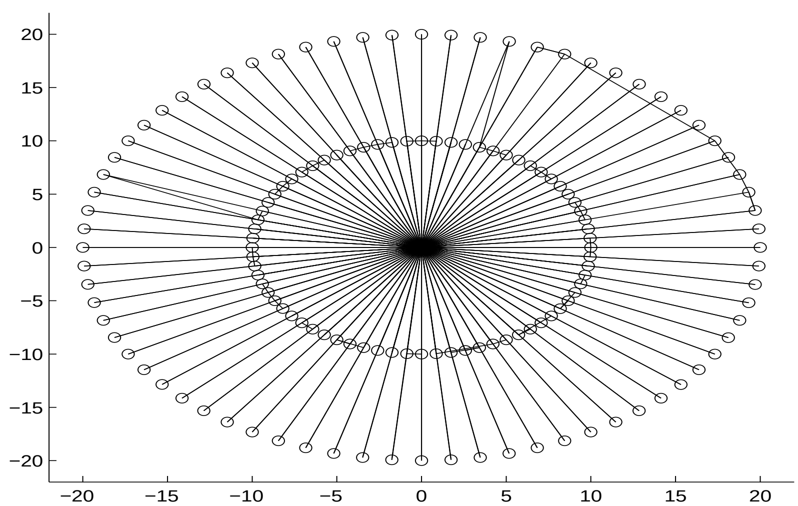


Figure A.48: EMIP-MDA + ERTR solution to MDA16 with $p = .3$.

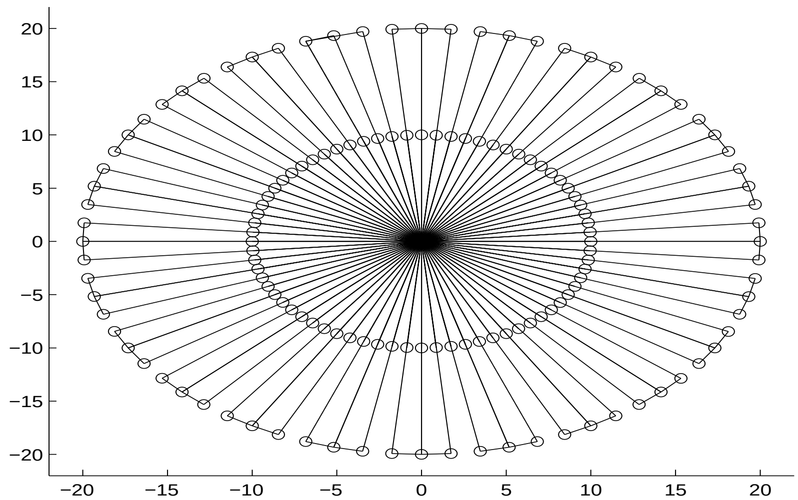


Figure A.49: EMIP-MDA + ERTR solution to MDA16 with $p = .4$.

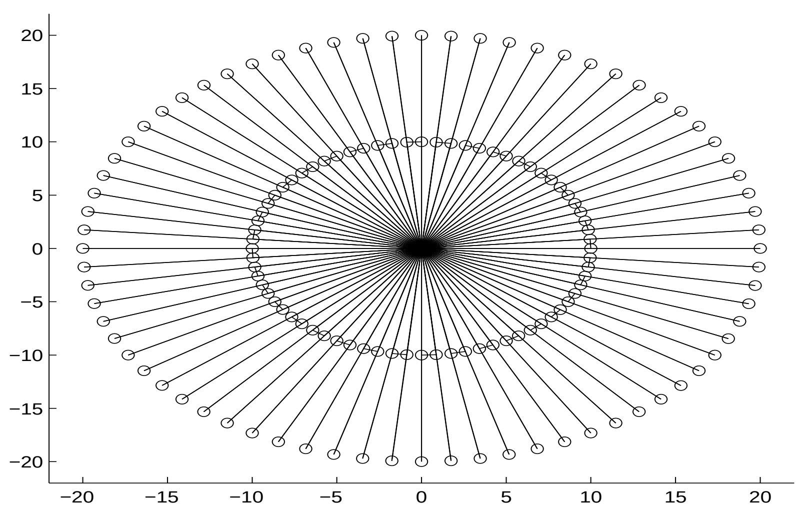


Figure A.50: Estimated solution to MDA16.

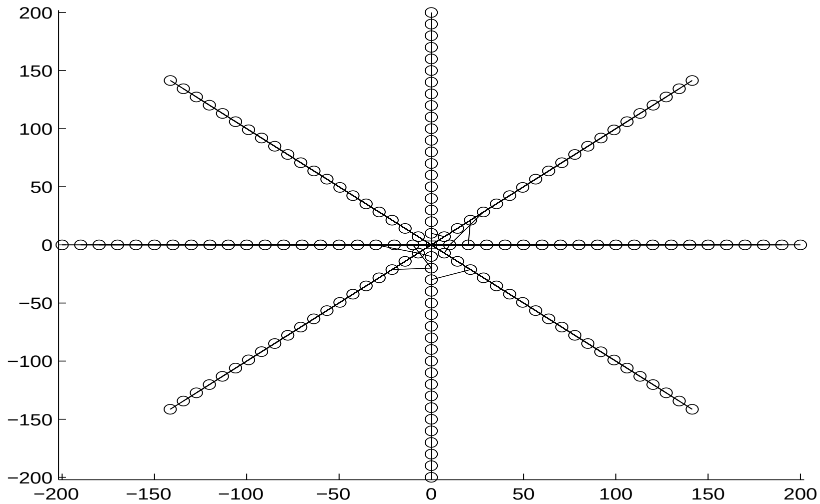


Figure A.51: EMIP-MDA + ERTR solution to MDA17 with $p = .1$.

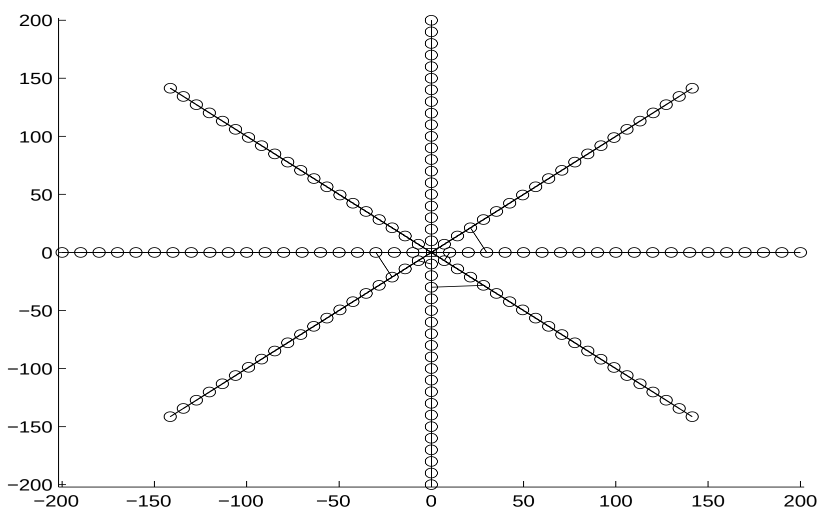


Figure A.52: EMIP-MDA + ERTR solution to MDA17 with $p = .2$.

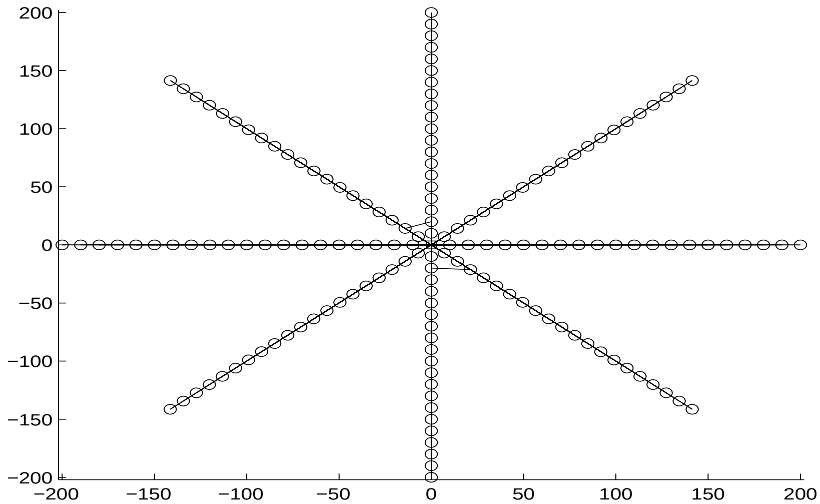


Figure A.53: EMIP-MDA + ERTR solution to MDA17 with $p = .3$.

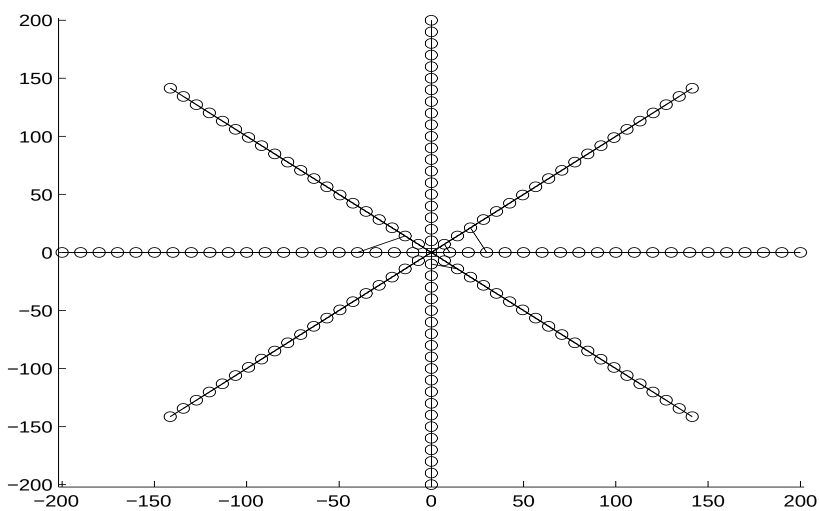


Figure A.54: EMIP-MDA + ERTR solution to MDA17 with $p = .4$.

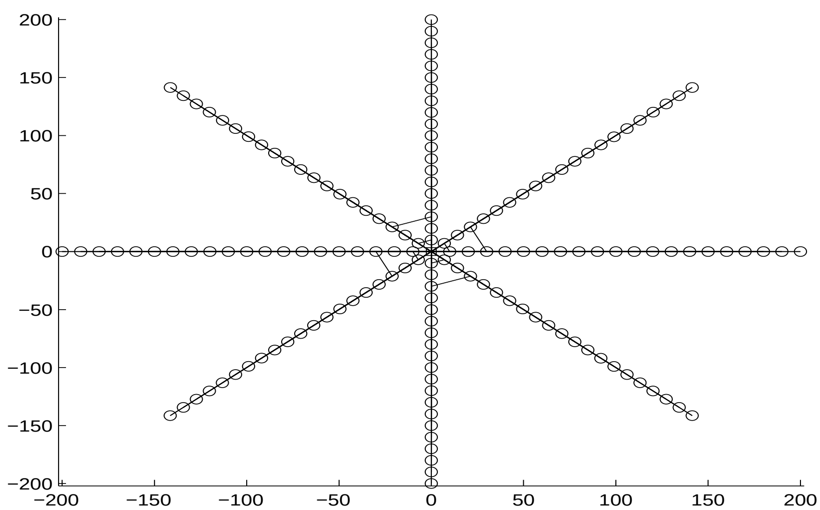


Figure A.55: Estimated solution to MDA17.

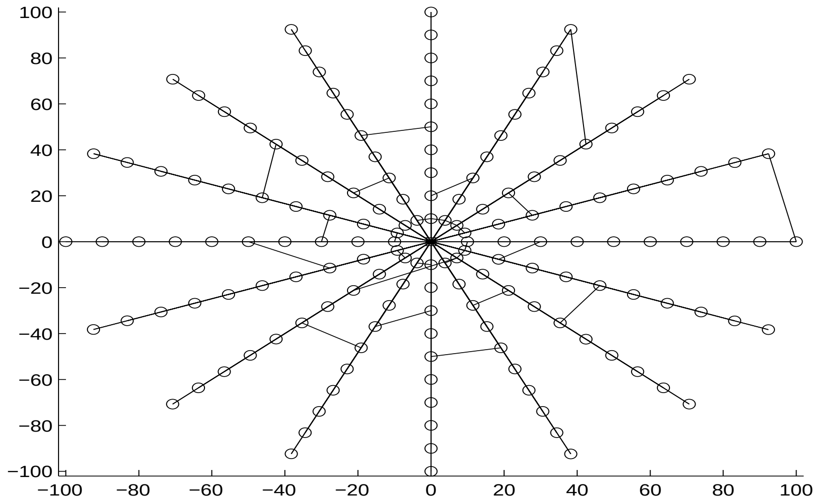


Figure A.56: EMIP-MDA + ERTR solution to MDA18 with $p = .1$.

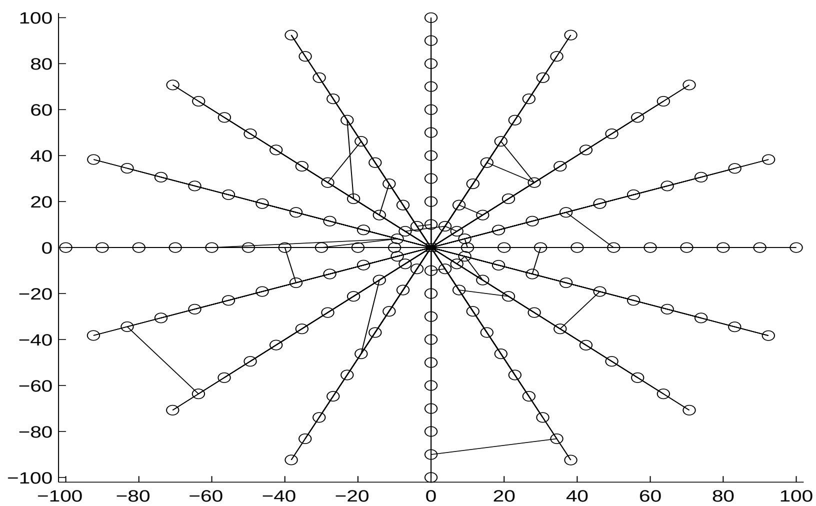


Figure A.57: EMIP-MDA + ERTR solution to MDA18 with $p = .2$.

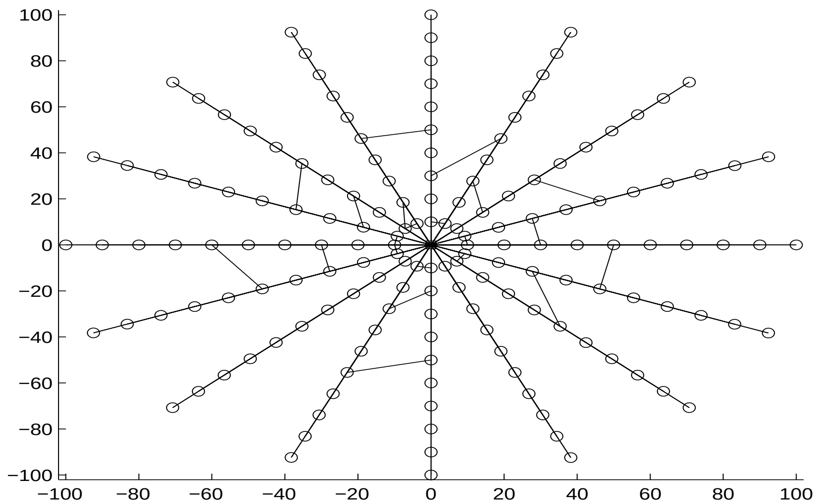


Figure A.58: EMIP-MDA + ERTR solution to MDA18 with $p = .3$.

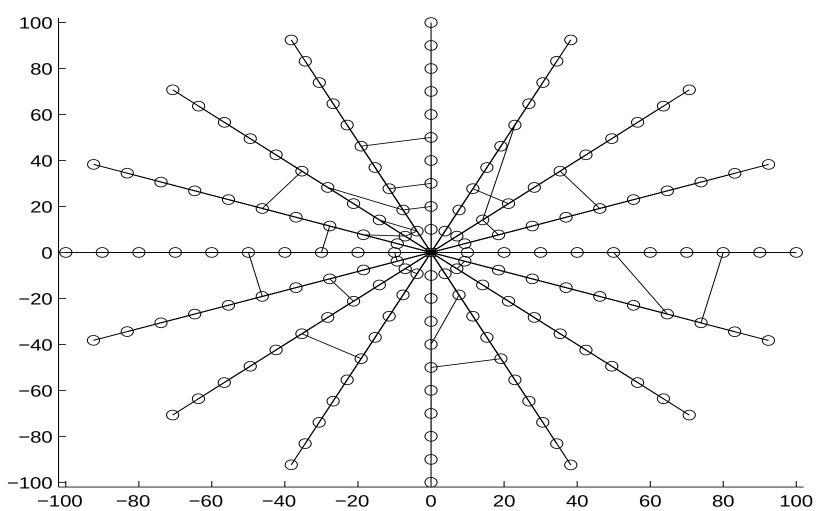


Figure A.59: EMIP-MDA + ERTR solution to MDA18 with $p = .4$.

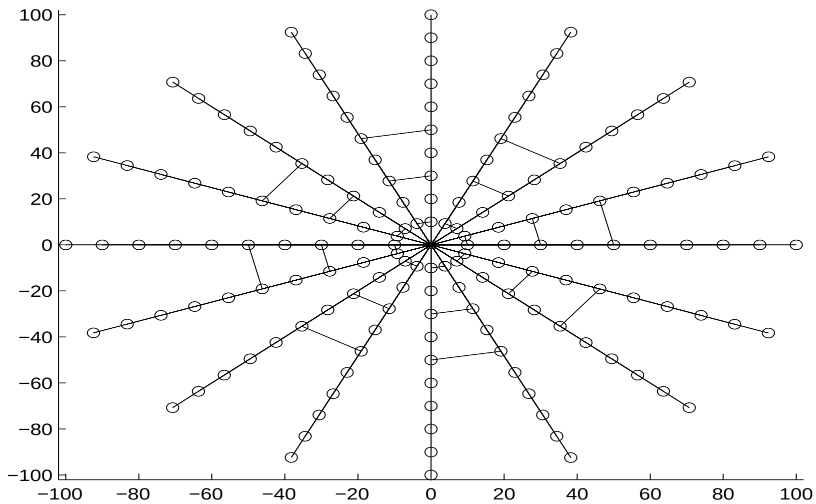


Figure A.60: Estimated solution to MDA18.

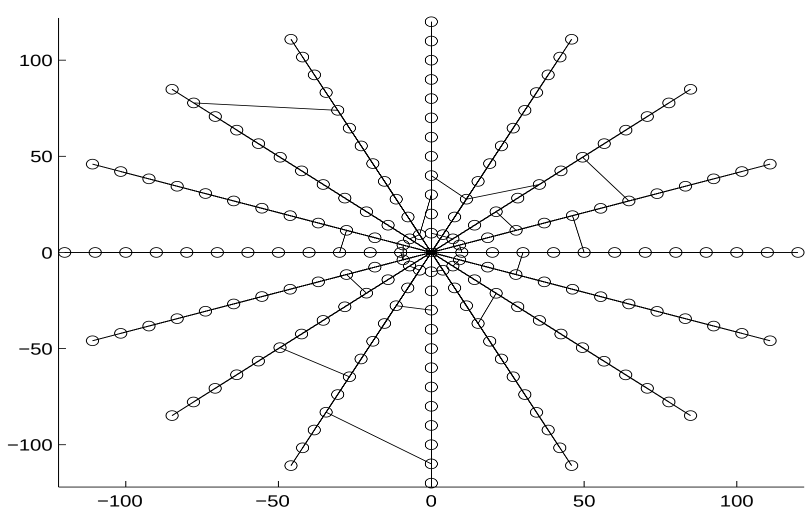


Figure A.61: EMIP-MDA + ERTR solution to MDA19 with $p = .1$.

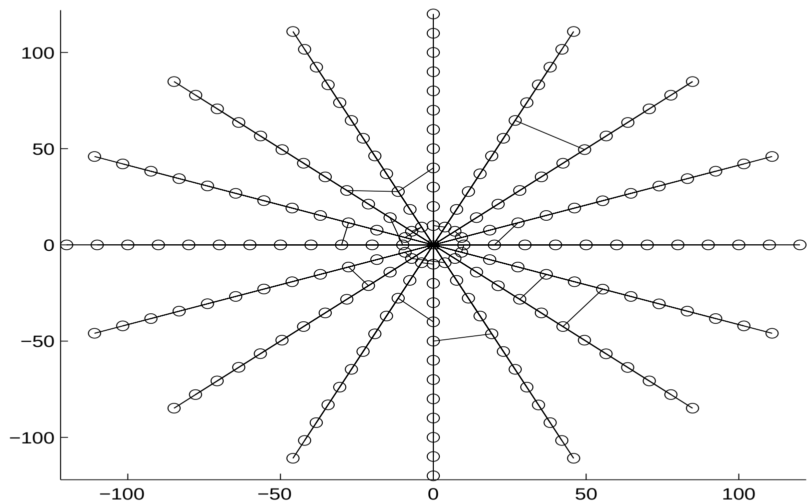


Figure A.62: EMIP-MDA + ERTR solution to MDA19 with $p = .2$.

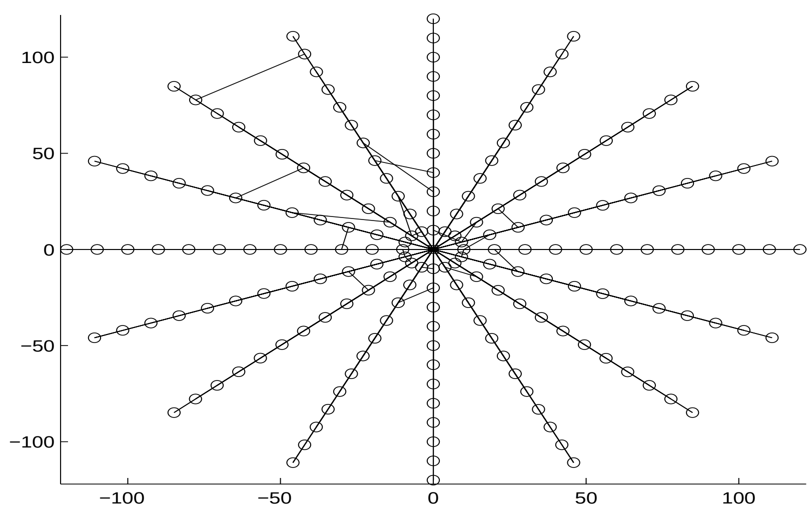


Figure A.63: EMIP-MDA + ERTR solution to MDA19 with $p = .3$.

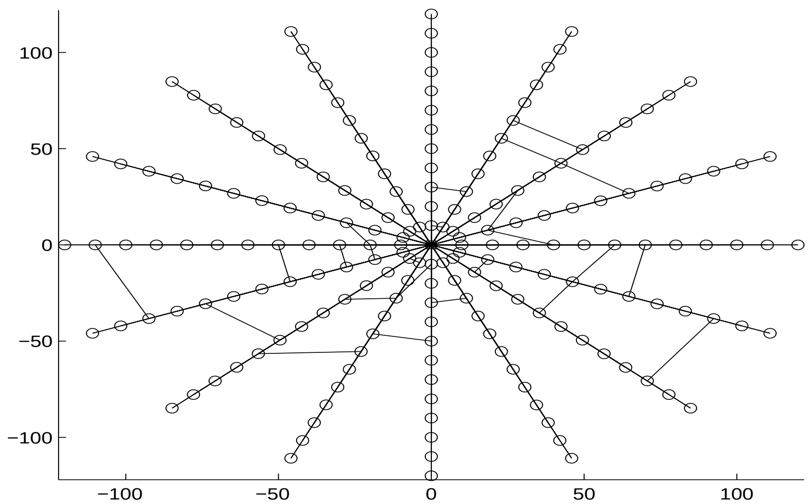


Figure A.64: EMIP-MDA + ERTR solution to MDA19 with $p = .4$.

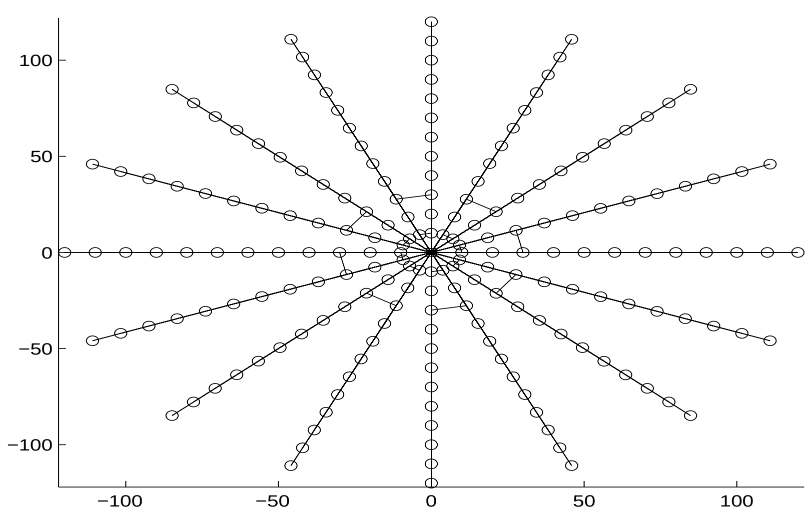


Figure A.65: Estimated solution to MDA19.

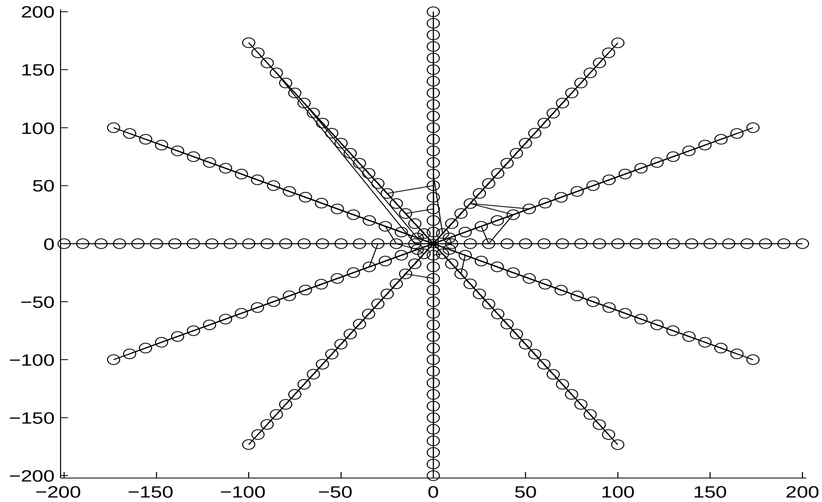


Figure A.66: EMIP-MDA + ERTR solution to MDA20 with $p = .1$.

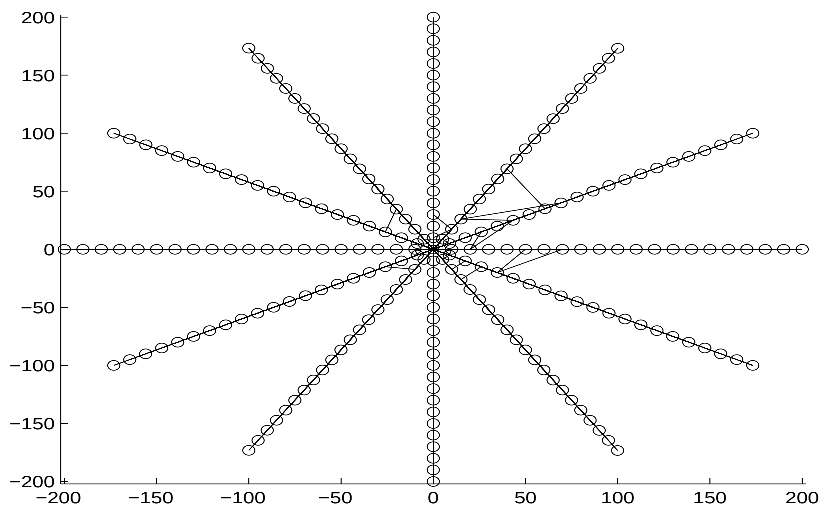


Figure A.67: EMIP-MDA + ERTR solution to MDA20 with $p = .2$.

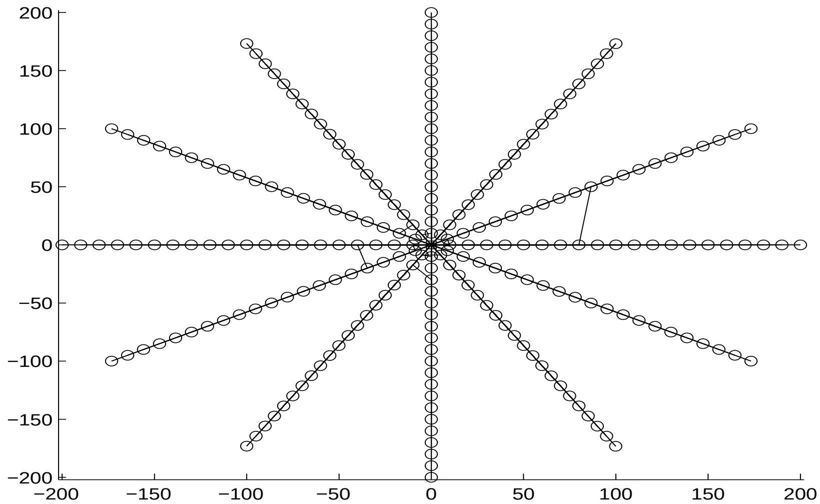


Figure A.68: EMIP-MDA + ERTR solution to MDA20 with $p = .3$.

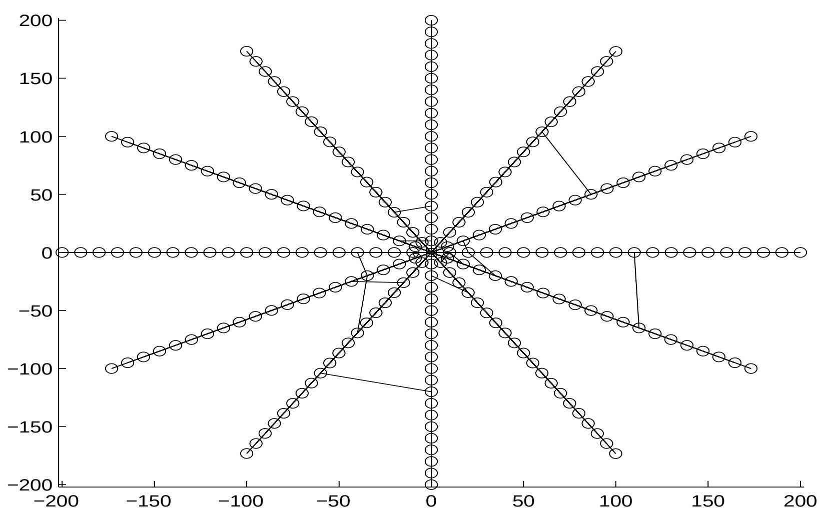


Figure A.69: EMIP-MDA + ERTR solution to MDA20 with $p = .4$.

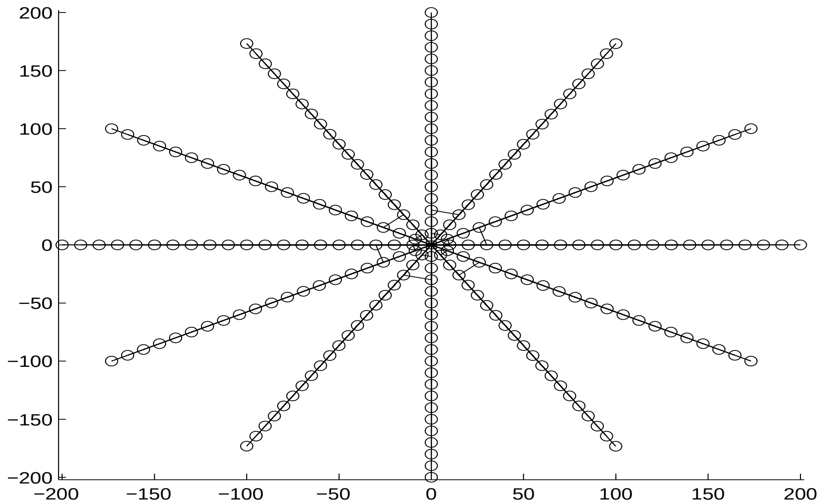


Figure A.70: Estimated solution to MDA20.

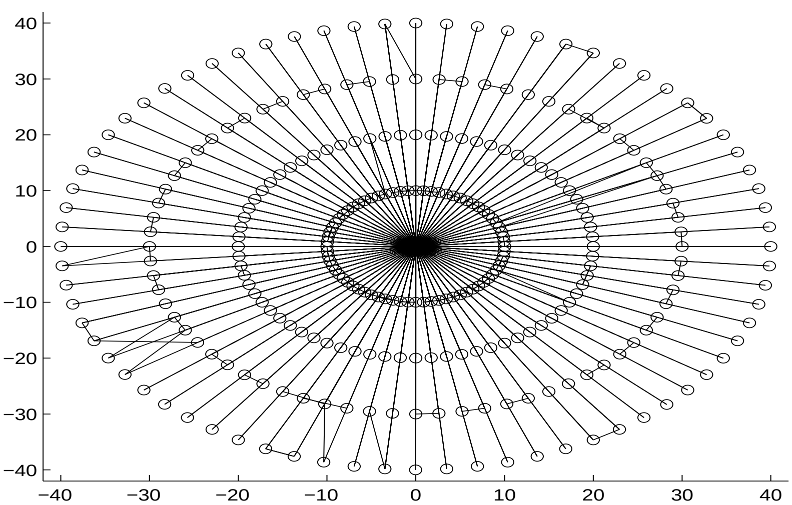


Figure A.71: EMIP-MDA + ERTR solution to MDA21 with $p = .1$.

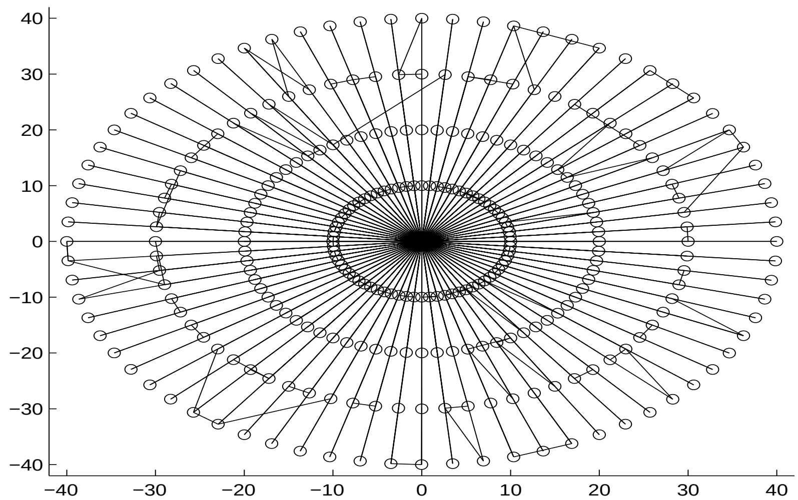


Figure A.72: EMIP-MDA + ERTR solution to MDA21 with $p = .2$.

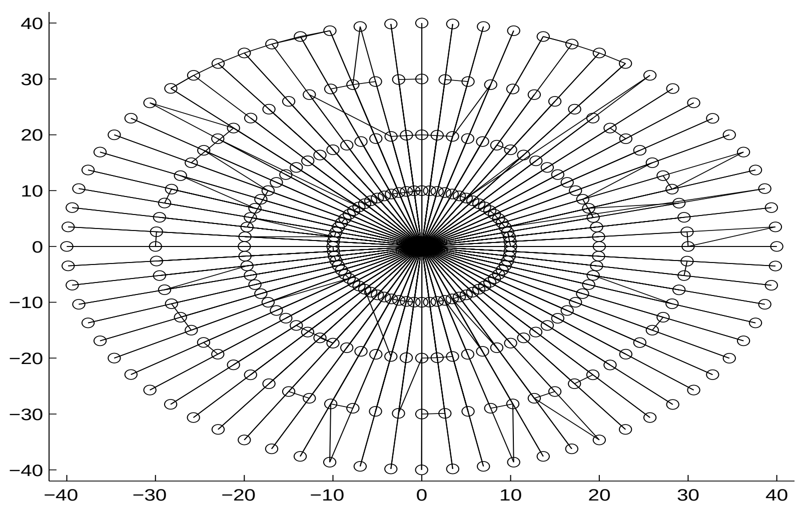


Figure A.73: EMIP-MDA + ERTR solution to MDA21 with $p = .3$.

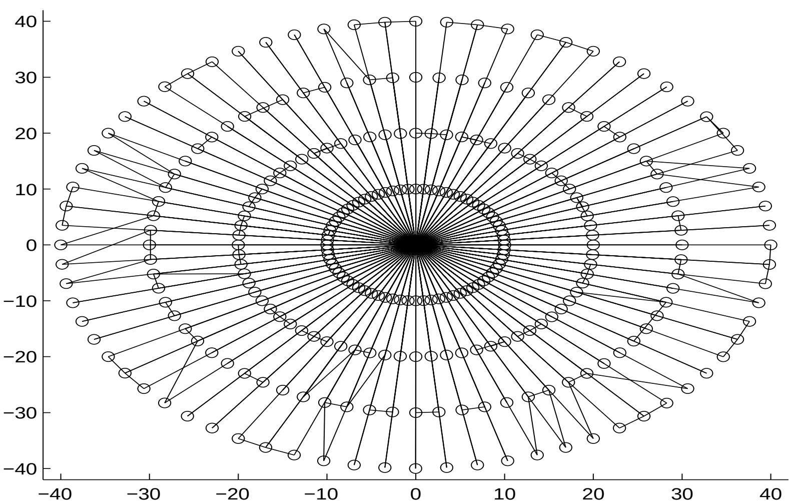


Figure A.74: EMIP-MDA + ERTR solution to MDA21 with $p = .4$.

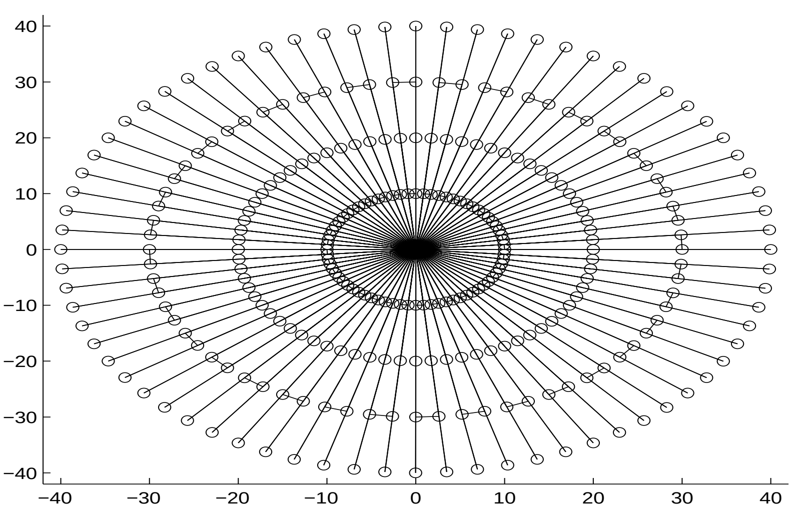


Figure A.75: Estimated solution to MDA21.

Appendix B

MDSDVRP: Problems and Solutions

Table B.1: Symbol key.

N	Number of customers in a problem
M	Number of depots
Q	Vehicle capacity
No.	Customer or route number
x	x-coordinate of a node's location
y	y-coordinate of a node's location
D	Customer demand

Note: nodes 0 and $N+1$, ..., $N+M-1$ are depots.

Table B.2: Dimensions for 10 MDSDVRPs.

Problem	N	M	Q
MDSD1	50	4	80
MDSD2	75	5	140
MDSD3	100	2	100
MDSD4	100	2	200
MDSD5	100	3	100
MDSD6	100	4	100
MDSD7	249	2	500
MDSD8	249	3	500
MDSD9	249	4	500
MDSD10	249	5	500

Table B.3: Dimensions for 12 MDSDVRPs.

Problem	N	N	Q
SQ1	32	2	100
SQ2	48	3	100
SQ3	64	4	100
SQ4	80	5	100
SQ5	64	2	100
SQ6	96	3	100
SQ7	128	4	100
SQ8	160	5	100
SQ9	96	2	100
SQ10	144	3	100
SQ11	192	4	100
SQ12	240	5	100

Table B.4: Node locations and demands for MDSD1 with three demand ranges.

No.	x	y	D_1	D_2	D_3	No.	x	y	D_1	D_2	D_3
0	20	20	0	0	0	27	30	48	54	50	70
1	37	52	56	42	65	28	43	67	42	26	66
2	49	49	49	51	62	29	58	48	66	32	63
3	52	64	55	31	63	30	58	27	25	33	69
4	20	26	70	36	69	31	37	69	43	47	60
5	40	30	66	27	63	32	38	46	62	48	67
6	21	47	20	24	56	33	46	10	41	42	68
7	17	63	33	42	59	34	61	33	26	50	58
8	31	62	34	48	59	35	62	63	43	35	64
9	52	33	56	34	70	36	63	69	57	53	59
10	51	21	66	50	66	37	32	22	34	25	57
11	42	41	13	53	69	38	45	35	18	37	64
12	31	32	54	49	69	39	59	15	59	42	71
13	5	25	57	41	56	40	5	6	66	40	59
14	12	42	64	29	68	41	10	17	71	42	58
15	36	16	60	55	63	42	21	10	34	49	65
16	52	41	62	28	57	43	5	64	9	25	66
17	27	23	45	32	58	44	30	15	43	43	57
18	17	33	23	47	60	45	39	10	43	35	58
19	13	13	28	37	61	46	32	39	34	39	59
20	57	58	49	46	70	47	25	32	62	26	65
21	62	42	16	55	70	48	25	55	13	36	59
22	42	57	15	45	67	49	48	28	31	26	69
23	16	57	9	38	59	50	56	37	23	36	57
24	8	52	65	48	62	51	30	40	0	0	0
25	7	38	29	31	68	52	50	30	0	0	0
26	27	68	45	49	64	53	60	50	0	0	0

Note: D_1, D_2, and D_3 are demands for ranges [.1, .9], [.3, .7], and [.7, .9], respectively.

Table B.5: Node locations and demands for MDSD2 with three demand ranges.

No.	x	y	D_1	D_2	D_3	No.	x	y	D_1	D_2	D_3
0	40	40	0	0	0	35	55	50	57	86	107
1	22	22	82	76	115	36	54	10	77	51	102
2	36	26	17	59	112	37	60	15	90	59	122
3	21	45	60	90	111	38	47	66	96	93	107
4	45	35	96	46	110	39	30	60	107	55	118
5	55	20	75	80	113	40	30	50	118	80	113
6	33	34	92	92	122	41	12	17	65	53	114
7	50	50	45	54	114	42	15	14	15	52	100
8	55	45	87	84	112	43	16	19	83	73	124
9	26	59	117	95	113	44	21	48	52	49	115
10	40	66	26	55	113	45	50	30	122	82	100
11	55	65	85	75	111	46	51	42	122	48	125
12	35	51	34	52	104	47	50	15	35	46	107
13	62	35	57	50	99	48	48	21	93	73	118
14	62	57	21	48	118	49	12	38	56	80	110
15	62	24	46	45	125	50	15	56	117	87	98
16	21	36	104	47	107	51	29	39	70	96	116
17	33	44	41	66	123	52	54	38	121	65	100
18	9	56	95	61	109	53	55	57	124	53	119
19	62	48	26	79	99	54	67	41	48	52	122
20	66	14	61	75	113	55	10	70	115	74	105
21	44	13	112	62	100	56	6	25	79	95	122
22	26	13	60	49	124	57	65	27	37	47	107
23	11	28	36	85	104	58	40	60	91	68	110
24	7	43	116	44	109	59	70	64	95	65	115
25	17	64	65	93	99	60	64	4	123	60	104
26	41	46	84	42	110	61	36	6	34	52	118
27	55	34	76	45	106	62	30	20	27	82	105
28	35	16	55	64	125	63	20	30	112	66	120
29	52	26	121	42	115	64	15	5	99	97	113
30	43	26	24	59	122	65	50	70	67	95	116
31	31	76	65	62	116	66	57	72	34	87	108
32	22	53	17	68	115	67	45	42	43	75	123
33	26	29	17	57	123	68	38	33	93	94	112
34	50	40	55	54	121	69	50	4	110	43	110

(cont.)

Table B.5 continued.

No.	x	y	D_1	D_2	D_3	No.	x	y	D_1	D_2	D_3
70	66	8	97	47	111	75	40	37	111	78	114
71	59	5	39	58	111	76	50	22	0	0	0
72	35	60	68	82	120	77	55	55	0	0	0
73	27	24	100	52	118	78	25	45	0	0	0
74	40	20	93	79	99	79	20	20	0	0	0

Note: D_1, D_2, and D_3 are demands for ranges [.1, .9], [.3, .7], and [.7, .9], respectively.

Table B.6: Node locations and demands for MDSD3 with three demand ranges.

No.	x	y	D_1	D_2	D_3	No.	x	y	D_1	D_2	D_3
0	35	20	0	0	0	35	63	65	31	45	78
1	41	49	59	54	82	36	2	60	69	34	80
2	35	17	89	31	78	37	20	20	15	50	86
3	55	45	56	56	83	38	5	5	87	38	82
4	55	20	21	51	79	39	60	12	59	44	86
5	15	30	56	59	75	40	40	25	27	59	84
6	25	30	16	30	83	41	42	7	65	66	73
7	20	50	84	33	70	42	24	12	24	51	87
8	10	43	42	38	73	43	23	3	29	45	77
9	55	60	25	56	72	44	11	14	84	50	76
10	30	60	88	56	84	45	6	38	27	31	84
11	20	65	36	44	78	46	2	48	87	43	83
12	50	35	31	40	74	47	8	56	46	55	83
13	30	25	64	54	73	48	13	52	67	35	70
14	15	10	43	64	76	49	6	68	53	64	88
15	30	5	66	54	73	50	47	47	21	67	77
16	10	20	77	33	75	51	49	58	72	64	86
17	5	30	53	36	73	52	27	43	25	57	75
18	20	40	17	31	86	53	37	31	52	67	71
19	15	60	11	50	88	54	57	29	44	35	83
20	45	65	64	38	76	55	63	23	58	62	75
21	45	20	31	35	76	56	53	12	23	63	78
22	45	10	48	39	70	57	32	12	50	49	84
23	55	5	31	36	72	58	36	26	23	48	82
24	65	35	81	68	82	59	21	24	54	55	73
25	65	20	62	55	84	60	17	34	49	52	85
26	45	30	30	38	80	61	12	24	29	67	74
27	35	40	16	39	71	62	24	58	42	48	73
28	41	37	55	31	80	63	27	69	70	32	83
29	64	42	34	52	74	64	15	77	37	35	87
30	40	60	61	31	74	65	62	77	76	58	87
31	31	52	79	31	70	66	49	73	53	53	75
32	35	69	24	45	75	67	67	5	56	61	88
33	53	52	73	68	75	68	56	39	34	50	87
34	65	55	34	39	82	69	37	47	14	41	84

(cont.)

Table B.6 continued.

No.	x	y	D_1	D_2	D_3	No.	x	y	D_1	D_2	D_3
70	37	56	26	61	80	86	4	18	58	50	88
71	57	68	69	32	81	87	28	18	43	63	72
72	47	16	18	38	82	88	26	52	53	48	84
73	44	17	67	55	87	89	26	35	46	48	86
74	46	13	42	35	79	90	31	67	49	34	85
75	49	11	36	63	85	91	15	19	60	54	86
76	49	42	52	57	87	92	22	22	23	35	78
77	53	43	62	41	73	93	18	24	31	66	70
78	61	52	66	57	78	94	26	27	85	30	71
79	57	48	87	37	84	95	25	24	32	65	85
80	56	37	31	39	71	96	22	27	65	54	71
81	55	54	61	63	86	97	25	21	12	61	81
82	15	47	57	69	86	98	19	21	18	48	72
83	14	37	37	69	87	99	20	26	53	62	77
84	11	31	34	41	79	100	18	18	17	33	86
85	16	22	12	67	84	101	35	35	0	0	0

Note: D_1, D_2, and D_3 are demands for ranges [.1, .9], [.3, .7], and [.7, .9], respectively.

Table B.7: Node locations and demands for MDSD4 with three demand ranges.

No.	x	y	D_1	D_2	D_3	No.	x	y	D_1	D_2	D_3
0	15	35	0	0	0	35	63	65	154	73	163
1	41	49	118	109	164	36	2	60	48	128	157
2	35	17	113	76	159	37	20	20	172	96	143
3	55	45	53	105	140	38	5	5	149	71	153
4	55	20	88	84	165	39	60	12	111	115	143
5	15	30	178	100	166	40	40	25	31	81	141
6	25	30	142	117	176	41	42	7	73	70	175
7	20	50	61	61	178	42	24	12	87	104	168
8	10	43	44	95	161	43	23	3	111	86	150
9	55	60	59	82	152	44	11	14	60	83	143
10	30	60	75	127	178	45	6	38	63	129	164
11	20	65	62	78	147	46	2	48	45	81	156
12	50	35	66	84	152	47	8	56	132	93	152
13	30	25	42	103	152	48	13	52	135	60	174
14	15	10	97	101	162	49	6	68	80	94	169
15	30	5	49	108	154	50	47	47	145	83	147
16	10	20	61	99	171	51	49	58	90	125	151
17	5	30	179	103	169	52	27	43	91	61	159
18	20	40	173	96	143	53	37	31	58	77	157
19	15	60	148	79	172	54	57	29	125	88	149
20	45	65	136	97	166	55	63	23	140	115	154
21	45	20	43	134	156	56	53	12	129	138	154
22	45	10	36	130	164	57	32	12	174	66	179
23	55	5	130	88	177	58	36	26	63	131	167
24	65	35	163	108	169	59	21	24	71	97	146
25	65	20	163	96	176	60	17	34	114	66	157
26	45	30	176	114	142	61	12	24	30	113	167
27	35	40	49	90	175	62	24	58	125	136	162
28	41	37	116	110	166	63	27	69	137	106	145
29	64	42	112	61	142	64	15	77	125	127	142
30	40	60	76	86	162	65	62	77	133	99	178
31	31	52	44	130	171	66	49	73	150	69	169
32	35	69	54	89	173	67	67	5	28	85	165
33	53	52	138	71	155	68	56	39	56	108	173
34	65	55	67	106	157	69	37	47	162	78	155

(cont.)

Table B.7 continued.

No.	x	y	D_1	D_2	D_3	No.	x	y	D_1	D_2	D_3
70	37	56	68	122	145	86	4	18	161	120	143
71	57	68	90	116	171	87	28	18	75	130	161
72	47	16	121	77	158	88	26	52	73	65	159
73	44	17	100	79	166	89	26	35	39	122	144
74	46	13	43	116	166	90	31	67	71	77	143
75	49	11	55	95	149	91	15	19	35	77	145
76	49	42	63	70	177	92	22	22	161	106	177
77	53	43	163	130	165	93	18	24	170	63	166
78	61	52	67	76	153	94	26	27	153	121	167
79	57	48	28	136	163	95	25	24	107	104	152
80	56	37	34	105	146	96	22	27	169	122	143
81	55	54	164	110	161	97	25	21	125	95	146
82	15	47	122	136	173	98	19	21	176	120	149
83	14	37	114	106	153	99	20	26	109	93	140
84	11	31	147	134	173	100	18	18	129	106	168
85	16	22	171	97	144	101	55	35	0	0	0

Note: D_1, D_2, and D_3 are demands for ranges [.1, .9], [.3, .7], and [.7, .9], respectively.

Table B.8: Node locations and demands for MDSD5 with three demand ranges.

No.	x	y	D_1	D_2	D_3	No.	x	y	D_1	D_2	D_3
0	15	20	0	0	0	35	63	65	68	42	89
1	41	49	59	54	82	36	2	60	35	58	70
2	35	17	63	45	85	37	20	20	77	38	84
3	55	45	32	63	79	38	5	5	11	63	80
4	55	20	26	64	89	39	60	12	10	54	79
5	15	30	47	42	86	40	40	25	69	69	85
6	25	30	32	33	72	41	42	7	23	46	82
7	20	50	60	57	88	42	24	12	25	30	87
8	10	43	13	67	83	43	23	3	83	69	74
9	55	60	44	45	77	44	11	14	67	67	87
10	30	60	67	53	71	45	6	38	68	69	77
11	20	65	14	34	72	46	2	48	75	56	81
12	50	35	38	43	76	47	8	56	75	66	74
13	30	25	27	48	71	48	13	52	80	30	84
14	15	10	66	56	82	49	6	68	42	33	70
15	30	5	36	52	72	50	47	47	47	53	71
16	10	20	57	42	71	51	49	58	57	35	85
17	5	30	61	48	88	52	27	43	88	50	88
18	20	40	76	38	84	53	37	31	78	55	83
19	15	60	39	62	77	54	57	29	64	62	72
20	45	65	70	53	86	55	63	23	61	68	70
21	45	20	23	57	88	56	53	12	40	30	84
22	45	10	76	34	76	57	32	12	82	30	87
23	55	5	71	37	80	58	36	26	79	33	79
24	65	35	69	54	87	59	21	24	65	30	87
25	65	20	41	67	77	60	17	34	61	41	85
26	45	30	50	35	78	61	12	24	34	41	83
27	35	40	17	53	77	62	24	58	16	48	73
28	41	37	68	58	83	63	27	69	16	51	83
29	64	42	58	52	72	64	15	77	65	48	75
30	40	60	87	60	85	65	62	77	67	39	79
31	31	52	39	47	84	66	49	73	32	56	77
32	35	69	80	47	75	67	67	5	56	39	89
33	53	52	33	31	82	68	56	39	63	47	71
34	65	55	42	52	75	69	37	47	16	66	81

(cont.)

Table B.8 continued.

No.	x	y	D_1	D_2	D_3	No.	x	y	D_1	D_2	D_3
70	37	56	35	68	79	87	28	18	40	58	73
71	57	68	24	34	86	88	26	52	15	55	88
72	47	16	50	40	83	89	26	35	44	34	78
73	44	17	28	62	71	90	31	67	69	64	89
74	46	13	21	37	82	91	15	19	14	36	70
75	49	11	11	39	70	92	22	22	41	30	76
76	49	42	45	54	85	93	18	24	11	45	75
77	53	43	18	44	77	94	26	27	48	52	82
78	61	52	52	45	79	95	25	24	77	33	71
79	57	48	71	35	74	96	22	27	55	40	78
80	56	37	74	38	84	97	25	21	42	57	87
81	55	54	14	36	78	98	19	21	88	50	84
82	15	47	84	31	84	99	20	26	13	48	81
83	14	37	74	32	71	100	18	18	81	60	87
84	11	31	74	65	85	101	50	20	0	0	0
85	16	22	85	41	85	102	35	55	0	0	0
86	4	18	60	41	78						

Note: D_1, D_2, and D_3 are demands for ranges [.1, .9], [.3, .7], and [.7, .9], respectively.

Table B.9: Node locations and demands for MDSD6 with three demand ranges.

No.	x	y	D_1	D_2	D_3	No.	x	y	D_1	D_2	D_3
0	15	35	0	0	0	35	63	65	14	45	85
1	41	49	59	54	82	36	2	60	89	56	75
2	35	17	33	66	74	37	20	20	37	63	79
3	55	45	61	30	79	38	5	5	38	57	87
4	55	20	16	68	75	39	60	12	19	39	82
5	15	30	88	50	83	40	40	25	85	35	88
6	25	30	28	37	77	41	42	7	87	60	80
7	20	50	41	35	71	42	24	12	35	48	82
8	10	43	36	54	84	43	23	3	64	47	77
9	55	60	46	49	80	44	11	14	71	62	81
10	30	60	27	58	86	45	6	38	36	67	83
11	20	65	11	69	88	46	2	48	84	31	73
12	50	35	39	45	77	47	8	56	52	39	72
13	30	25	60	31	85	48	13	52	23	47	76
14	15	10	70	61	86	49	6	68	45	49	86
15	30	5	70	36	88	50	47	47	88	49	77
16	10	20	76	32	77	51	49	58	87	43	86
17	5	30	25	59	88	52	27	43	53	34	81
18	20	40	35	62	78	53	37	31	76	62	70
19	15	60	75	40	86	54	57	29	40	33	89
20	45	65	49	39	78	55	63	23	56	50	73
21	45	20	86	59	74	56	53	12	64	68	76
22	45	10	59	45	72	57	32	12	11	35	70
23	55	5	44	33	83	58	36	26	49	34	88
24	65	35	46	36	76	59	21	24	77	69	83
25	65	20	86	51	89	60	17	34	20	54	89
26	45	30	26	66	75	61	12	24	83	50	80
27	35	40	33	50	70	62	24	58	39	56	75
28	41	37	70	61	86	63	27	69	84	60	76
29	64	42	13	49	80	64	15	77	80	32	75
30	40	60	85	67	72	65	62	77	50	41	85
31	31	52	17	63	84	66	49	73	56	65	79
32	35	69	13	38	83	67	67	5	77	34	78
33	53	52	65	33	77	68	56	39	14	47	83
34	65	55	64	68	86	69	37	47	42	59	88

(cont.)

Table B.9 continued.

No.	x	y	D_1	D_2	D_3	No.	x	y	D_1	D_2	D_3
70	37	56	74	41	82	87	28	18	82	47	71
71	57	68	45	58	85	88	26	52	74	51	89
72	47	16	17	57	88	89	26	35	17	60	71
73	44	17	87	58	72	90	31	67	61	51	78
74	46	13	66	40	74	91	15	19	24	42	74
75	49	11	29	48	74	92	22	22	16	61	73
76	49	42	33	36	89	93	18	24	19	39	87
77	53	43	17	33	86	94	26	27	43	44	75
78	61	52	45	43	79	95	25	24	78	64	82
79	57	48	64	53	74	96	22	27	43	40	81
80	56	37	31	59	76	97	25	21	25	68	84
81	55	54	72	49	77	98	19	21	71	51	70
82	15	47	29	52	79	99	20	26	82	61	77
83	14	37	74	61	80	100	18	18	73	58	86
84	11	31	85	33	89	101	55	35	0	0	0
85	16	22	46	69	82	102	35	20	0	0	0
86	4	18	49	44	84	103	35	50	0	0	0

Note: D_1, D_2, and D_3 are demands for ranges [.1, .9], [.3, .7], and [.7, .9], respectively.

Table B.10: Node locations and demands for MDSD7 with three demand ranges.

No.	x	y	D_1	D_2	D_3	No.	x	y	D_1	D_2	D_3
0	-33	33	0	0	0	35	37	-90	365	192	389
1	-99	-97	303	276	412	36	-83	49	381	229	370
2	-59	50	83	248	443	37	35	-1	370	334	416
3	0	14	370	183	376	38	7	59	193	252	366
4	-17	-66	337	237	425	39	12	48	254	261	426
5	-69	-19	213	150	420	40	57	95	178	242	445
6	31	12	281	330	400	41	92	28	194	293	372
7	5	-41	119	318	444	42	-3	97	269	213	448
8	-12	10	101	225	366	43	-7	52	219	169	370
9	-64	70	194	211	372	44	42	-15	404	263	447
10	-12	85	406	253	377	45	77	-43	274	251	350
11	-18	64	271	273	420	46	59	-49	403	287	390
12	-77	-16	251	247	395	47	25	91	346	247	420
13	-53	88	136	301	374	48	69	-19	293	271	438
14	83	-24	354	288	409	49	-82	-14	224	270	448
15	24	41	254	155	398	50	74	-70	418	205	400
16	17	21	181	334	383	51	69	59	166	277	419
17	42	96	245	156	416	52	29	33	56	303	434
18	-65	0	146	223	362	53	-97	9	411	188	425
19	-47	-26	279	308	417	54	-58	9	409	284	442
20	85	36	227	228	353	55	28	93	412	303	392
21	-35	-54	386	342	449	56	7	73	243	343	372
22	54	-21	159	282	371	57	-28	73	326	196	393
23	64	-17	301	192	355	58	-76	55	274	243	440
24	55	89	251	251	372	59	41	42	69	206	440
25	17	-25	395	274	421	60	92	40	56	333	369
26	-61	66	434	197	398	61	-84	-29	95	209	378
27	-61	26	160	184	366	62	-12	42	238	192	449
28	17	-72	267	250	394	63	51	-45	63	161	444
29	79	38	233	187	359	64	-37	46	131	327	393
30	-62	-2	59	213	437	65	-97	35	189	245	401
31	-90	-68	261	199	391	66	14	89	367	254	377
32	52	66	244	241	405	67	60	58	354	209	413
33	-54	-50	244	257	353	68	-63	-75	291	287	372
34	8	-84	260	257	434	69	-18	34	197	256	368

(cont.)

Table B.10 continued.

No.	x	y	D_1	D_2	D_3	No.	x	y	D_1	D_2	D_3
70	-46	-82	99	156	382	105	64	20	249	244	364
71	-86	-79	210	289	404	106	-96	85	323	236	357
72	-43	-30	203	321	389	107	93	-29	63	247	420
73	-44	7	130	232	407	108	-40	-84	70	241	439
74	-3	-20	191	273	420	109	86	35	446	316	410
75	36	41	400	346	392	110	91	36	93	205	401
76	-30	-94	225	288	355	111	62	-8	322	239	403
77	79	-62	302	228	441	112	-24	4	238	218	366
78	51	70	109	261	378	113	11	96	132	195	446
79	-61	-26	290	252	374	114	-53	62	177	336	416
80	6	94	382	151	433	115	-28	-71	306	152	375
81	-19	-62	77	310	350	116	7	-4	199	328	427
82	-20	51	57	344	369	117	95	-9	252	189	425
83	-81	37	191	172	412	118	-3	17	184	162	403
84	7	31	364	210	396	119	53	-90	53	311	416
85	52	12	315	300	395	120	58	-19	241	345	403
86	83	-91	272	207	411	121	-83	84	131	238	399
87	-7	-92	333	306	396	122	-1	49	166	178	371
88	82	-74	63	198	390	123	-4	17	335	195	432
89	-70	85	203	294	356	124	-82	-3	252	240	416
90	-83	-30	391	155	378	125	-43	47	92	296	441
91	71	-61	410	236	412	126	6	-6	202	211	355
92	85	11	372	167	384	127	70	99	364	152	426
93	66	-48	120	250	374	128	68	-29	57	168	370
94	78	-87	302	297	439	129	-94	-30	84	206	420
95	9	-79	283	213	429	130	-94	-20	378	321	426
96	-36	4	144	150	387	131	-21	77	299	334	385
97	66	39	407	204	431	132	64	37	140	188	378
98	92	-17	91	196	377	133	-70	-19	364	151	353
99	-46	-79	179	211	363	134	88	65	173	179	427
100	-30	-63	234	325	411	135	2	29	325	177	371
101	-42	63	92	223	366	136	33	57	259	340	421
102	20	42	103	163	404	137	-70	6	116	251	435
103	15	98	168	283	440	138	-38	-56	78	186	413
104	1	-17	125	273	444	139	-80	-95	267	271	419

(cont.)

Table B.10 continued.

No.	x	y	D_1	D_2	D_3	No.	x	y	D_1	D_2	D_3
140	-5	-39	61	177	435	175	31	85	59	312	443
141	8	-22	444	207	379	176	25	58	228	248	376
142	-61	-76	439	293	427	177	-16	36	322	294	443
143	76	-22	291	331	427	178	91	15	243	280	396
144	49	-71	415	348	403	179	60	-39	67	172	371
145	-30	-68	429	346	367	180	49	-47	259	172	416
146	1	34	359	162	382	181	42	33	409	178	399
147	77	79	273	329	416	182	16	-81	416	338	361
148	-58	64	373	168	428	183	-78	53	111	237	390
149	82	-97	291	173	435	184	53	-80	415	173	362
150	-80	55	445	247	384	185	-46	-26	329	271	397
151	81	-86	374	281	379	186	-25	-54	132	331	411
152	39	-49	73	340	358	187	69	-46	217	164	350
153	-67	72	330	203	415	188	0	-78	78	309	419
154	-25	-89	244	234	369	189	-84	74	167	194	418
155	-44	-95	411	160	376	190	-16	16	238	310	363
156	32	-68	100	171	358	191	-63	-14	343	160	371
157	-17	49	105	344	423	192	51	-77	77	189	359
158	93	49	155	200	387	193	-39	61	310	150	400
159	99	81	162	231	395	194	5	97	347	281	403
160	10	-49	402	274	389	195	-55	39	309	264	353
161	63	-41	115	227	449	196	70	-14	371	226	357
162	38	39	239	349	410	197	0	95	449	180	430
163	-28	39	181	269	448	198	-45	7	97	161	361
164	-2	-47	100	253	385	199	38	-24	81	294	357
165	38	8	438	161	424	200	50	-37	221	150	417
166	-42	-6	140	289	387	201	59	71	301	271	393
167	-67	88	89	165	411	202	-73	-96	421	188	449
168	19	93	78	198	398	203	-29	72	401	264	420
169	40	27	204	282	413	204	-47	12	174	260	383
170	-61	56	131	288	432	205	-88	-61	123	197	352
171	43	33	284	172	379	206	-88	36	264	308	365
172	-18	-39	81	278	394	207	-46	-3	299	217	427
173	-69	19	348	199	418	208	26	-37	155	254	382
174	75	-18	293	281	365	209	-39	-67	75	276	409

(cont.)

Table B.10 continued.

No.	x	y	D_1	D_2	D_3	No.	x	y	D_1	D_2	D_3
210	92	27	333	233	378	231	-72	-87	134	270	379
211	-80	-31	276	307	403	232	-57	-84	87	333	388
212	93	-50	193	312	425	233	23	52	306	259	377
213	-20	-5	100	334	441	234	-56	-62	150	213	390
214	-22	73	122	291	381	235	-19	59	313	213	389
215	-4	-7	91	254	432	236	63	-14	149	171	383
216	54	-48	84	265	392	237	-13	38	443	309	360
217	-70	39	173	229	445	238	-19	87	423	292	418
218	54	-82	200	153	428	239	44	-84	99	340	435
219	29	41	343	197	388	240	98	-17	238	337	381
220	-87	51	114	335	424	241	-16	62	66	234	404
221	-96	-36	197	253	380	242	3	66	397	243	439
222	49	8	390	171	354	243	26	22	102	316	405
223	-5	54	389	302	371	244	-38	-81	274	294	402
224	-26	43	342	266	358	245	70	-80	366	177	442
225	-11	60	191	164	360	246	17	-35	250	348	433
226	40	61	237	198	370	247	96	-83	354	265	367
227	82	35	176	323	429	248	-77	80	263	269	390
228	-92	12	168	347	433	249	-14	44	418	171	359
229	-93	-86	445	344	373	250	33	-33	0	0	0
230	-66	63	399	244	368						

Note: D_1, D_2, and D_3 are demands for ranges [.1, .9], [.3, .7], and [.7, .9], respectively.

Table B.11: Node locations and demands for MDSD8 with three demand ranges.

No.	x	y	D_1	D_2	D_3	No.	x	y	D_1	D_2	D_3
0	70	0	0	0	0	35	37	-90	365	192	389
1	-99	-97	303	276	412	36	-83	49	381	229	370
2	-59	50	83	248	443	37	35	-1	370	334	416
3	0	14	370	183	376	38	7	59	193	252	366
4	-17	-66	337	237	425	39	12	48	254	261	426
5	-69	-19	213	150	420	40	57	95	178	242	445
6	31	12	281	330	400	41	92	28	194	293	372
7	5	-41	119	318	444	42	-3	97	269	213	448
8	-12	10	101	225	366	43	-7	52	219	169	370
9	-64	70	194	211	372	44	42	-15	404	263	447
10	-12	85	406	253	377	45	77	-43	274	251	350
11	-18	64	271	273	420	46	59	-49	403	287	390
12	-77	-16	251	247	395	47	25	91	346	247	420
13	-53	88	136	301	374	48	69	-19	293	271	438
14	83	-24	354	288	409	49	-82	-14	224	270	448
15	24	41	254	155	398	50	74	-70	418	205	400
16	17	21	181	334	383	51	69	59	166	277	419
17	42	96	245	156	416	52	29	33	56	303	434
18	-65	0	146	223	362	53	-97	9	411	188	425
19	-47	-26	279	308	417	54	-58	9	409	284	442
20	85	36	227	228	353	55	28	93	412	303	392
21	-35	-54	386	342	449	56	7	73	243	343	372
22	54	-21	159	282	371	57	-28	73	326	196	393
23	64	-17	301	192	355	58	-76	55	274	243	440
24	55	89	251	251	372	59	41	42	69	206	440
25	17	-25	395	274	421	60	92	40	56	333	369
26	-61	66	434	197	398	61	-84	-29	95	209	378
27	-61	26	160	184	366	62	-12	42	238	192	449
28	17	-72	267	250	394	63	51	-45	63	161	444
29	79	38	233	187	359	64	-37	46	131	327	393
30	-62	-2	59	213	437	65	-97	35	189	245	401
31	-90	-68	261	199	391	66	14	89	367	254	377
32	52	66	244	241	405	67	60	58	354	209	413
33	-54	-50	244	257	353	68	-63	-75	291	287	372
34	8	-84	260	257	434	69	-18	34	197	256	368

(cont.)

Table B.11 continued.

No.	x	y	D_1	D_2	D_3	No.	x	y	D_1	D_2	D_3
70	-46	-82	99	156	382	105	64	20	249	244	364
71	-86	-79	210	289	404	106	-96	85	323	236	357
72	-43	-30	203	321	389	107	93	-29	63	247	420
73	-44	7	130	232	407	108	-40	-84	70	241	439
74	-3	-20	191	273	420	109	86	35	446	316	410
75	36	41	400	346	392	110	91	36	93	205	401
76	-30	-94	225	288	355	111	62	-8	322	239	403
77	79	-62	302	228	441	112	-24	4	238	218	366
78	51	70	109	261	378	113	11	96	132	195	446
79	-61	-26	290	252	374	114	-53	62	177	336	416
80	6	94	382	151	433	115	-28	-71	306	152	375
81	-19	-62	77	310	350	116	7	-4	199	328	427
82	-20	51	57	344	369	117	95	-9	252	189	425
83	-81	37	191	172	412	118	-3	17	184	162	403
84	7	31	364	210	396	119	53	-90	53	311	416
85	52	12	315	300	395	120	58	-19	241	345	403
86	83	-91	272	207	411	121	-83	84	131	238	399
87	-7	-92	333	306	396	122	-1	49	166	178	371
88	82	-74	63	198	390	123	-4	17	335	195	432
89	-70	85	203	294	356	124	-82	-3	252	240	416
90	-83	-30	391	155	378	125	-43	47	92	296	441
91	71	-61	410	236	412	126	6	-6	202	211	355
92	85	11	372	167	384	127	70	99	364	152	426
93	66	-48	120	250	374	128	68	-29	57	168	370
94	78	-87	302	297	439	129	-94	-30	84	206	420
95	9	-79	283	213	429	130	-94	-20	378	321	426
96	-36	4	144	150	387	131	-21	77	299	334	385
97	66	39	407	204	431	132	64	37	140	188	378
98	92	-17	91	196	377	133	-70	-19	364	151	353
99	-46	-79	179	211	363	134	88	65	173	179	427
100	-30	-63	234	325	411	135	2	29	325	177	371
101	-42	63	92	223	366	136	33	57	259	340	421
102	20	42	103	163	404	137	-70	6	116	251	435
103	15	98	168	283	440	138	-38	-56	78	186	413
104	1	-17	125	273	444	139	-80	-95	267	271	419

(cont.)

Table B.11 continued.

No.	x	y	D_1	D_2	D_3	No.	x	y	D_1	D_2	D_3
140	-5	-39	61	177	435	175	31	85	59	312	443
141	8	-22	444	207	379	176	25	58	228	248	376
142	-61	-76	439	293	427	177	-16	36	322	294	443
143	76	-22	291	331	427	178	91	15	243	280	396
144	49	-71	415	348	403	179	60	-39	67	172	371
145	-30	-68	429	346	367	180	49	-47	259	172	416
146	1	34	359	162	382	181	42	33	409	178	399
147	77	79	273	329	416	182	16	-81	416	338	361
148	-58	64	373	168	428	183	-78	53	111	237	390
149	82	-97	291	173	435	184	53	-80	415	173	362
150	-80	55	445	247	384	185	-46	-26	329	271	397
151	81	-86	374	281	379	186	-25	-54	132	331	411
152	39	-49	73	340	358	187	69	-46	217	164	350
153	-67	72	330	203	415	188	0	-78	78	309	419
154	-25	-89	244	234	369	189	-84	74	167	194	418
155	-44	-95	411	160	376	190	-16	16	238	310	363
156	32	-68	100	171	358	191	-63	-14	343	160	371
157	-17	49	105	344	423	192	51	-77	77	189	359
158	93	49	155	200	387	193	-39	61	310	150	400
159	99	81	162	231	395	194	5	97	347	281	403
160	10	-49	402	274	389	195	-55	39	309	264	353
161	63	-41	115	227	449	196	70	-14	371	226	357
162	38	39	239	349	410	197	0	95	449	180	430
163	-28	39	181	269	448	198	-45	7	97	161	361
164	-2	-47	100	253	385	199	38	-24	81	294	357
165	38	8	438	161	424	200	50	-37	221	150	417
166	-42	-6	140	289	387	201	59	71	301	271	393
167	-67	88	89	165	411	202	-73	-96	421	188	449
168	19	93	78	198	398	203	-29	72	401	264	420
169	40	27	204	282	413	204	-47	12	174	260	383
170	-61	56	131	288	432	205	-88	-61	123	197	352
171	43	33	284	172	379	206	-88	36	264	308	365
172	-18	-39	81	278	394	207	-46	-3	299	217	427
173	-69	19	348	199	418	208	26	-37	155	254	382
174	75	-18	293	281	365	209	-39	-67	75	276	409

(cont.)

Table B.11 continued.

No.	x	y	D_1	D_2	D_3	No.	x	y	D_1	D_2	D_3
210	92	27	333	233	378	231	-72	-87	134	270	379
211	-80	-31	276	307	403	232	-57	-84	87	333	388
212	93	-50	193	312	425	233	23	52	306	259	377
213	-20	-5	100	334	441	234	-56	-62	150	213	390
214	-22	73	122	291	381	235	-19	59	313	213	389
215	-4	-7	91	254	432	236	63	-14	149	171	383
216	54	-48	84	265	392	237	-13	38	443	309	360
217	-70	39	173	229	445	238	-19	87	423	292	418
218	54	-82	200	153	428	239	44	-84	99	340	435
219	29	41	343	197	388	240	98	-17	238	337	381
220	-87	51	114	335	424	241	-16	62	66	234	404
221	-96	-36	197	253	380	242	3	66	397	243	439
222	49	8	390	171	354	243	26	22	102	316	405
223	-5	54	389	302	371	244	-38	-81	274	294	402
224	-26	43	342	266	358	245	70	-80	366	177	442
225	-11	60	191	164	360	246	17	-35	250	348	433
226	40	61	237	198	370	247	96	-83	354	265	367
227	82	35	176	323	429	248	-77	80	263	269	390
228	-92	12	168	347	433	249	-14	44	418	171	359
229	-93	-86	445	344	373	250	-50	60	0	0	0
230	-66	63	399	244	368	251	-50	-60	0	0	0

Note: D_1, D_2, and D_3 are demands for ranges [.1, .9], [.3, .7], and [.7, .9], respectively.

Table B.12: Node locations and demands for MDSD9 with three demand ranges.

No.	x	y	D_1	D_2	D_3	No.	x	y	D_1	D_2	D_3
0	75	0	0	0	0	35	37	-90	365	192	389
1	-99	-97	303	276	412	36	-83	49	381	229	370
2	-59	50	83	248	443	37	35	-1	370	334	416
3	0	14	370	183	376	38	7	59	193	252	366
4	-17	-66	337	237	425	39	12	48	254	261	426
5	-69	-19	213	150	420	40	57	95	178	242	445
6	31	12	281	330	400	41	92	28	194	293	372
7	5	-41	119	318	444	42	-3	97	269	213	448
8	-12	10	101	225	366	43	-7	52	219	169	370
9	-64	70	194	211	372	44	42	-15	404	263	447
10	-12	85	406	253	377	45	77	-43	274	251	350
11	-18	64	271	273	420	46	59	-49	403	287	390
12	-77	-16	251	247	395	47	25	91	346	247	420
13	-53	88	136	301	374	48	69	-19	293	271	438
14	83	-24	354	288	409	49	-82	-14	224	270	448
15	24	41	254	155	398	50	74	-70	418	205	400
16	17	21	181	334	383	51	69	59	166	277	419
17	42	96	245	156	416	52	29	33	56	303	434
18	-65	0	146	223	362	53	-97	9	411	188	425
19	-47	-26	279	308	417	54	-58	9	409	284	442
20	85	36	227	228	353	55	28	93	412	303	392
21	-35	-54	386	342	449	56	7	73	243	343	372
22	54	-21	159	282	371	57	-28	73	326	196	393
23	64	-17	301	192	355	58	-76	55	274	243	440
24	55	89	251	251	372	59	41	42	69	206	440
25	17	-25	395	274	421	60	92	40	56	333	369
26	-61	66	434	197	398	61	-84	-29	95	209	378
27	-61	26	160	184	366	62	-12	42	238	192	449
28	17	-72	267	250	394	63	51	-45	63	161	444
29	79	38	233	187	359	64	-37	46	131	327	393
30	-62	-2	59	213	437	65	-97	35	189	245	401
31	-90	-68	261	199	391	66	14	89	367	254	377
32	52	66	244	241	405	67	60	58	354	209	413
33	-54	-50	244	257	353	68	-63	-75	291	287	372
34	8	-84	260	257	434	69	-18	34	197	256	368

(cont.)

Table B.12 continued.

No.	x	y	D_1	D_2	D_3	No.	x	y	D_1	D_2	D_3
70	-46	-82	99	156	382	105	64	20	249	244	364
71	-86	-79	210	289	404	106	-96	85	323	236	357
72	-43	-30	203	321	389	107	93	-29	63	247	420
73	-44	7	130	232	407	108	-40	-84	70	241	439
74	-3	-20	191	273	420	109	86	35	446	316	410
75	36	41	400	346	392	110	91	36	93	205	401
76	-30	-94	225	288	355	111	62	-8	322	239	403
77	79	-62	302	228	441	112	-24	4	238	218	366
78	51	70	109	261	378	113	11	96	132	195	446
79	-61	-26	290	252	374	114	-53	62	177	336	416
80	6	94	382	151	433	115	-28	-71	306	152	375
81	-19	-62	77	310	350	116	7	-4	199	328	427
82	-20	51	57	344	369	117	95	-9	252	189	425
83	-81	37	191	172	412	118	-3	17	184	162	403
84	7	31	364	210	396	119	53	-90	53	311	416
85	52	12	315	300	395	120	58	-19	241	345	403
86	83	-91	272	207	411	121	-83	84	131	238	399
87	-7	-92	333	306	396	122	-1	49	166	178	371
88	82	-74	63	198	390	123	-4	17	335	195	432
89	-70	85	203	294	356	124	-82	-3	252	240	416
90	-83	-30	391	155	378	125	-43	47	92	296	441
91	71	-61	410	236	412	126	6	-6	202	211	355
92	85	11	372	167	384	127	70	99	364	152	426
93	66	-48	120	250	374	128	68	-29	57	168	370
94	78	-87	302	297	439	129	-94	-30	84	206	420
95	9	-79	283	213	429	130	-94	-20	378	321	426
96	-36	4	144	150	387	131	-21	77	299	334	385
97	66	39	407	204	431	132	64	37	140	188	378
98	92	-17	91	196	377	133	-70	-19	364	151	353
99	-46	-79	179	211	363	134	88	65	173	179	427
100	-30	-63	234	325	411	135	2	29	325	177	371
101	-42	63	92	223	366	136	33	57	259	340	421
102	20	42	103	163	404	137	-70	6	116	251	435
103	15	98	168	283	440	138	-38	-56	78	186	413
104	1	-17	125	273	444	139	-80	-95	267	271	419

(cont.)

Table B.12 continued.

No.	x	y	D_1	D_2	D_3	No.	x	y	D_1	D_2	D_3
140	-5	-39	61	177	435	175	31	85	59	312	443
141	8	-22	444	207	379	176	25	58	228	248	376
142	-61	-76	439	293	427	177	-16	36	322	294	443
143	76	-22	291	331	427	178	91	15	243	280	396
144	49	-71	415	348	403	179	60	-39	67	172	371
145	-30	-68	429	346	367	180	49	-47	259	172	416
146	1	34	359	162	382	181	42	33	409	178	399
147	77	79	273	329	416	182	16	-81	416	338	361
148	-58	64	373	168	428	183	-78	53	111	237	390
149	82	-97	291	173	435	184	53	-80	415	173	362
150	-80	55	445	247	384	185	-46	-26	329	271	397
151	81	-86	374	281	379	186	-25	-54	132	331	411
152	39	-49	73	340	358	187	69	-46	217	164	350
153	-67	72	330	203	415	188	0	-78	78	309	419
154	-25	-89	244	234	369	189	-84	74	167	194	418
155	-44	-95	411	160	376	190	-16	16	238	310	363
156	32	-68	100	171	358	191	-63	-14	343	160	371
157	-17	49	105	344	423	192	51	-77	77	189	359
158	93	49	155	200	387	193	-39	61	310	150	400
159	99	81	162	231	395	194	5	97	347	281	403
160	10	-49	402	274	389	195	-55	39	309	264	353
161	63	-41	115	227	449	196	70	-14	371	226	357
162	38	39	239	349	410	197	0	95	449	180	430
163	-28	39	181	269	448	198	-45	7	97	161	361
164	-2	-47	100	253	385	199	38	-24	81	294	357
165	38	8	438	161	424	200	50	-37	221	150	417
166	-42	-6	140	289	387	201	59	71	301	271	393
167	-67	88	89	165	411	202	-73	-96	421	188	449
168	19	93	78	198	398	203	-29	72	401	264	420
169	40	27	204	282	413	204	-47	12	174	260	383
170	-61	56	131	288	432	205	-88	-61	123	197	352
171	43	33	284	172	379	206	-88	36	264	308	365
172	-18	-39	81	278	394	207	-46	-3	299	217	427
173	-69	19	348	199	418	208	26	-37	155	254	382
174	75	-18	293	281	365	209	-39	-67	75	276	409

(cont.)

Table B.12 continued.

No.	x	y	D_1	D_2	D_3	No.	x	y	D_1	D_2	D_3
210	92	27	333	233	378	232	-57	-84	87	333	388
211	-80	-31	276	307	403	233	23	52	306	259	377
212	93	-50	193	312	425	234	-56	-62	150	213	390
213	-20	-5	100	334	441	235	-19	59	313	213	389
214	-22	73	122	291	381	236	63	-14	149	171	383
215	-4	-7	91	254	432	237	-13	38	443	309	360
216	54	-48	84	265	392	238	-19	87	423	292	418
217	-70	39	173	229	445	239	44	-84	99	340	435
218	54	-82	200	153	428	240	98	-17	238	337	381
219	29	41	343	197	388	241	-16	62	66	234	404
220	-87	51	114	335	424	242	3	66	397	243	439
221	-96	-36	197	253	380	243	26	22	102	316	405
222	49	8	390	171	354	244	-38	-81	274	294	402
223	-5	54	389	302	371	245	70	-80	366	177	442
224	-26	43	342	266	358	246	17	-35	250	348	433
225	-11	60	191	164	360	247	96	-83	354	265	367
226	40	61	237	198	370	248	-77	80	263	269	390
227	82	35	176	323	429	249	-14	44	418	171	359
228	-92	12	168	347	433	250	0	75	0	0	0
229	-93	-86	445	344	373	251	-75	0	0	0	0
230	-66	63	399	244	368	252	0	-75	0	0	0
231	-72	-87	134	270	379						

Note: D_1, D_2, and D_3 are demands for ranges [.1, .9], [.3, .7], and [.7, .9], respectively.

Table B.13: Node locations and demands for MDSD10 with three demand ranges.

No.	x	y	D_1	D_2	D_3	No.	x	y	D_1	D_2	D_3
0	70	0	0	0	0	35	37	-90	365	192	389
1	-99	-97	303	276	412	36	-83	49	381	229	370
2	-59	50	83	248	443	37	35	-1	370	334	416
3	0	14	370	183	376	38	7	59	193	252	366
4	-17	-66	337	237	425	39	12	48	254	261	426
5	-69	-19	213	150	420	40	57	95	178	242	445
6	31	12	281	330	400	41	92	28	194	293	372
7	5	-41	119	318	444	42	-3	97	269	213	448
8	-12	10	101	225	366	43	-7	52	219	169	370
9	-64	70	194	211	372	44	42	-15	404	263	447
10	-12	85	406	253	377	45	77	-43	274	251	350
11	-18	64	271	273	420	46	59	-49	403	287	390
12	-77	-16	251	247	395	47	25	91	346	247	420
13	-53	88	136	301	374	48	69	-19	293	271	438
14	83	-24	354	288	409	49	-82	-14	224	270	448
15	24	41	254	155	398	50	74	-70	418	205	400
16	17	21	181	334	383	51	69	59	166	277	419
17	42	96	245	156	416	52	29	33	56	303	434
18	-65	0	146	223	362	53	-97	9	411	188	425
19	-47	-26	279	308	417	54	-58	9	409	284	442
20	85	36	227	228	353	55	28	93	412	303	392
21	-35	-54	386	342	449	56	7	73	243	343	372
22	54	-21	159	282	371	57	-28	73	326	196	393
23	64	-17	301	192	355	58	-76	55	274	243	440
24	55	89	251	251	372	59	41	42	69	206	440
25	17	-25	395	274	421	60	92	40	56	333	369
26	-61	66	434	197	398	61	-84	-29	95	209	378
27	-61	26	160	184	366	62	-12	42	238	192	449
28	17	-72	267	250	394	63	51	-45	63	161	444
29	79	38	233	187	359	64	-37	46	131	327	393
30	-62	-2	59	213	437	65	-97	35	189	245	401
31	-90	-68	261	199	391	66	14	89	367	254	377
32	52	66	244	241	405	67	60	58	354	209	413
33	-54	-50	244	257	353	68	-63	-75	291	287	372
34	8	-84	260	257	434	69	-18	34	197	256	368

(cont.)

Table B.13 continued.

No.	x	y	D_1	D_2	D_3	No.	x	y	D_1	D_2	D_3
70	-46	-82	99	156	382	105	64	20	249	244	364
71	-86	-79	210	289	404	106	-96	85	323	236	357
72	-43	-30	203	321	389	107	93	-29	63	247	420
73	-44	7	130	232	407	108	-40	-84	70	241	439
74	-3	-20	191	273	420	109	86	35	446	316	410
75	36	41	400	346	392	110	91	36	93	205	401
76	-30	-94	225	288	355	111	62	-8	322	239	403
77	79	-62	302	228	441	112	-24	4	238	218	366
78	51	70	109	261	378	113	11	96	132	195	446
79	-61	-26	290	252	374	114	-53	62	177	336	416
80	6	94	382	151	433	115	-28	-71	306	152	375
81	-19	-62	77	310	350	116	7	-4	199	328	427
82	-20	51	57	344	369	117	95	-9	252	189	425
83	-81	37	191	172	412	118	-3	17	184	162	403
84	7	31	364	210	396	119	53	-90	53	311	416
85	52	12	315	300	395	120	58	-19	241	345	403
86	83	-91	272	207	411	121	-83	84	131	238	399
87	-7	-92	333	306	396	122	-1	49	166	178	371
88	82	-74	63	198	390	123	-4	17	335	195	432
89	-70	85	203	294	356	124	-82	-3	252	240	416
90	-83	-30	391	155	378	125	-43	47	92	296	441
91	71	-61	410	236	412	126	6	-6	202	211	355
92	85	11	372	167	384	127	70	99	364	152	426
93	66	-48	120	250	374	128	68	-29	57	168	370
94	78	-87	302	297	439	129	-94	-30	84	206	420
95	9	-79	283	213	429	130	-94	-20	378	321	426
96	-36	4	144	150	387	131	-21	77	299	334	385
97	66	39	407	204	431	132	64	37	140	188	378
98	92	-17	91	196	377	133	-70	-19	364	151	353
99	-46	-79	179	211	363	134	88	65	173	179	427
100	-30	-63	234	325	411	135	2	29	325	177	371
101	-42	63	92	223	366	136	33	57	259	340	421
102	20	42	103	163	404	137	-70	6	116	251	435
103	15	98	168	283	440	138	-38	-56	78	186	413
104	1	-17	125	273	444	139	-80	-95	267	271	419

(cont.)

Table B.13 continued.

No.	x	y	D_1	D_2	D_3	No.	x	y	D_1	D_2	D_3
140	-5	-39	61	177	435	175	31	85	59	312	443
141	8	-22	444	207	379	176	25	58	228	248	376
142	-61	-76	439	293	427	177	-16	36	322	294	443
143	76	-22	291	331	427	178	91	15	243	280	396
144	49	-71	415	348	403	179	60	-39	67	172	371
145	-30	-68	429	346	367	180	49	-47	259	172	416
146	1	34	359	162	382	181	42	33	409	178	399
147	77	79	273	329	416	182	16	-81	416	338	361
148	-58	64	373	168	428	183	-78	53	111	237	390
149	82	-97	291	173	435	184	53	-80	415	173	362
150	-80	55	445	247	384	185	-46	-26	329	271	397
151	81	-86	374	281	379	186	-25	-54	132	331	411
152	39	-49	73	340	358	187	69	-46	217	164	350
153	-67	72	330	203	415	188	0	-78	78	309	419
154	-25	-89	244	234	369	189	-84	74	167	194	418
155	-44	-95	411	160	376	190	-16	16	238	310	363
156	32	-68	100	171	358	191	-63	-14	343	160	371
157	-17	49	105	344	423	192	51	-77	77	189	359
158	93	49	155	200	387	193	-39	61	310	150	400
159	99	81	162	231	395	194	5	97	347	281	403
160	10	-49	402	274	389	195	-55	39	309	264	353
161	63	-41	115	227	449	196	70	-14	371	226	357
162	38	39	239	349	410	197	0	95	449	180	430
163	-28	39	181	269	448	198	-45	7	97	161	361
164	-2	-47	100	253	385	199	38	-24	81	294	357
165	38	8	438	161	424	200	50	-37	221	150	417
166	-42	-6	140	289	387	201	59	71	301	271	393
167	-67	88	89	165	411	202	-73	-96	421	188	449
168	19	93	78	198	398	203	-29	72	401	264	420
169	40	27	204	282	413	204	-47	12	174	260	383
170	-61	56	131	288	432	205	-88	-61	123	197	352
171	43	33	284	172	379	206	-88	36	264	308	365
172	-18	-39	81	278	394	207	-46	-3	299	217	427
173	-69	19	348	199	418	208	26	-37	155	254	382
174	75	-18	293	281	365	209	-39	-67	75	276	409

(cont.)

Table B.13 continued.

No.	x	y	D_1	D_2	D_3	No.	x	y	D_1	D_2	D_3
210	92	27	333	233	378	232	-57	-84	87	333	388
211	-80	-31	276	307	403	233	23	52	306	259	377
212	93	-50	193	312	425	234	-56	-62	150	213	390
213	-20	-5	100	334	441	235	-19	59	313	213	389
214	-22	73	122	291	381	236	63	-14	149	171	383
215	-4	-7	91	254	432	237	-13	38	443	309	360
216	54	-48	84	265	392	238	-19	87	423	292	418
217	-70	39	173	229	445	239	44	-84	99	340	435
218	54	-82	200	153	428	240	98	-17	238	337	381
219	29	41	343	197	388	241	-16	62	66	234	404
220	-87	51	114	335	424	242	3	66	397	243	439
221	-96	-36	197	253	380	243	26	22	102	316	405
222	49	8	390	171	354	244	-38	-81	274	294	402
223	-5	54	389	302	371	245	70	-80	366	177	442
224	-26	43	342	266	358	246	17	-35	250	348	433
225	-11	60	191	164	360	247	96	-83	354	265	367
226	40	61	237	198	370	248	-77	80	263	269	390
227	82	35	176	323	429	249	-14	44	418	171	359
228	-92	12	168	347	433	250	40	80	0	0	0
229	-93	-86	445	344	373	251	40	-80	0	0	0
230	-66	63	399	244	368	252	-60	20	0	0	0
231	-72	-87	134	270	379	253	-60	-20	0	0	0

Note: D_1, D_2, and D_3 are demands for ranges [.1, .9], [.3, .7], and [.7, .9], respectively.

Table B.14: Node locations and demands for SQ1.

No.	x	y	D	No.	x	y	D	No.	x	y	D	No.	x	y	D
0	0	0	0	9	-20	-20	90	18	32	0	60	27	22	20	95
1	-10	-10	90	10	-20	0	60	19	32	10	90	28	42	-20	60
2	-10	0	60	11	-20	20	90	20	42	-10	60	29	42	20	60
3	-10	10	90	12	0	-20	60	21	42	10	60	30	62	-20	90
4	0	-10	60	13	0	20	60	22	52	-10	90	31	62	0	60
5	0	10	60	14	20	-20	85	23	52	0	60	32	62	20	90
6	10	-10	90	15	20	0	55	24	52	10	90	33	42	0	0
7	10	0	60	16	20	20	85	25	22	-20	95				
8	10	10	90	17	32	-10	90	26	22	0	65				

Table B.15: Node locations and demands for Problem SQ2.

No.	x	y	D	No.	x	y	D	No.	x	y	D	No.	x	y	D
0	0	0	0	13	0	20	60	26	22	0	65	39	52	42	60
1	-10	-10	90	14	20	-20	85	27	22	20	95	40	52	52	90
2	-10	0	60	15	20	0	55	28	42	-20	60	41	22	22	90
3	-10	10	90	16	20	20	85	29	42	20	65	42	22	42	60
4	0	-10	60	17	32	-10	90	30	62	-20	90	43	22	62	90
5	0	10	60	18	32	0	60	31	62	0	60	44	42	22	55
6	10	-10	90	19	32	10	90	32	62	20	95	45	42	62	60
7	10	0	60	20	42	-10	60	33	32	32	90	46	62	22	85
8	10	10	90	21	42	10	60	34	32	42	60	47	62	42	60
9	-20	-20	90	22	52	-10	90	35	32	52	90	48	62	62	90
10	-20	0	60	23	52	0	60	36	42	32	60	49	42	0	0
11	-20	20	90	24	52	10	90	37	42	52	60	50	42	42	0
12	0	-20	60	25	22	-20	95	38	52	32	90				

Table B.16: Node locations and demands for Problem SQ3.

No.	x	y	D	No.	x	y	D	No.	x	y	D	No.	x	y	D
0	0	0	0	17	32	-10	90	34	32	42	60	51	-10	52	90
1	-10	-10	90	18	32	0	60	35	32	52	90	52	0	32	60
2	-10	0	60	19	32	10	90	36	42	32	60	53	0	52	60
3	-10	10	90	20	42	-10	60	37	42	52	60	54	10	32	90
4	0	-10	60	21	42	10	60	38	52	32	90	55	10	42	60
5	0	10	60	22	52	-10	90	39	52	42	60	56	10	52	90
6	10	-10	90	23	52	0	60	40	52	52	90	57	-20	22	95
7	10	0	60	24	52	10	90	41	22	22	85	58	-20	42	60
8	10	10	90	25	22	-20	95	42	22	42	55	59	-20	62	90
9	-20	-20	90	26	22	0	65	43	22	62	85	60	0	22	65
10	-20	0	60	27	22	20	95	44	42	22	55	61	0	62	60
11	-20	20	85	28	42	-20	60	45	42	62	60	62	20	22	95
12	0	-20	60	29	42	20	65	46	62	22	85	63	20	42	65
13	0	20	55	30	62	-20	90	47	62	42	60	64	20	62	95
14	20	-20	85	31	62	0	60	48	62	62	90	65	42	0	0
15	20	0	55	32	62	20	95	49	-10	32	90	66	42	42	0
16	20	20	85	33	32	32	90	50	-10	42	60	67	0	42	0

Table B.17: Node locations and demands for Problem SQ4.

No.	x	y	D	No.	x	y	D	No.	x	y	D	No.	x	y	D
0	0	0	0	22	52	-10	90	44	42	22	55	66	74	0	60
1	-10	-10	90	23	52	0	60	45	42	62	60	67	74	10	90
2	-10	0	60	24	52	10	90	46	62	22	90	68	84	-10	60
3	-10	10	90	25	22	-20	95	47	62	42	60	69	84	10	60
4	0	-10	60	26	22	0	65	48	62	62	90	70	94	-10	90
5	0	10	60	27	22	20	95	49	-10	32	90	71	94	0	60
6	10	-10	90	28	42	-20	60	50	-10	42	60	72	94	10	90
7	10	0	60	29	42	20	65	51	-10	52	90	73	64	-20	85
8	10	10	90	30	62	-20	95	52	0	32	60	74	64	0	55
9	-20	-20	90	31	62	0	65	53	0	52	60	75	64	20	85
10	-20	0	60	32	62	20	95	54	10	32	90	76	84	-20	60
11	-20	20	85	33	32	32	90	55	10	42	60	77	84	20	60
12	0	-20	60	34	32	42	60	56	10	52	90	78	104	-20	90
13	0	20	55	35	32	52	90	57	-20	22	95	79	104	0	60
14	20	-20	85	36	42	32	60	58	-20	42	60	80	104	20	90
15	20	0	55	37	42	52	60	59	-20	62	90	81	42	0	0
16	20	20	85	38	52	32	90	60	0	22	65	82	42	42	0
17	32	-10	90	39	52	42	60	61	0	62	60	83	0	42	0
18	32	0	60	40	52	52	90	62	20	22	95	84	84	0	0
19	32	10	90	41	22	22	85	63	20	42	65				
20	42	-10	60	42	22	42	55	64	20	62	95				
21	42	10	60	43	22	62	85	65	74	-10	90				

Table B.18: Node locations and demands for Problem SQ5.

No.	x	y	D	No.	x	y	D	No.	x	y	D	No.	x	y	D
0	0	0	0	17	-30	-30	90	34	72	0	60	51	52	30	90
1	-10	-10	90	18	-30	0	60	35	72	10	90	52	82	-30	60
2	-10	0	60	19	-30	30	90	36	82	-10	60	53	82	30	60
3	-10	10	90	20	0	-30	60	37	82	10	60	54	112	-30	90
4	0	-10	60	21	0	30	60	38	92	-10	90	55	112	0	60
5	0	10	60	22	30	-30	90	39	92	0	60	56	112	30	90
6	10	-10	90	23	30	0	60	40	92	10	90	57	42	-40	95
7	10	0	60	24	30	30	90	41	62	-20	90	58	42	0	65
8	10	10	90	25	-40	-40	90	42	62	0	60	59	42	40	95
9	-20	-20	90	26	-40	0	60	43	62	20	90	60	82	-40	60
10	-20	0	60	27	-40	40	90	44	82	-20	60	61	82	40	60
11	-20	20	90	28	0	-40	60	45	82	20	60	62	122	-40	90
12	0	-20	60	29	0	40	60	46	102	-20	90	63	122	0	60
13	0	20	60	30	40	-40	85	47	102	0	60	64	122	40	90
14	20	-20	90	31	40	0	55	48	102	20	90	65	82	0	0
15	20	0	60	32	40	40	85	49	52	-30	90				
16	20	20	90	33	72	-10	90	50	52	0	60				

Table B.19: Node locations and demands for Problem SQ6.

No.	x	y	D	No.	x	y	D	No.	x	y	D	No.	x	y	D
0	0	0	0	25	-40	-40	90	50	52	0	60	75	62	102	90
1	-10	-10	90	26	-40	0	60	51	52	30	90	76	82	62	60
2	-10	0	60	27	-40	40	90	52	82	-30	60	77	82	102	60
3	-10	10	90	28	0	-40	60	53	82	30	60	78	102	62	90
4	0	-10	60	29	0	40	60	54	112	-30	90	79	102	82	60
5	0	10	60	30	40	-40	85	55	112	0	60	80	102	102	90
6	10	-10	90	31	40	0	55	56	112	30	90	81	52	52	90
7	10	0	60	32	40	40	85	57	42	-40	95	82	52	82	60
8	10	10	90	33	72	-10	90	58	42	0	65	83	52	112	90
9	-20	-20	90	34	72	0	60	59	42	40	95	84	82	52	60
10	-20	0	60	35	72	10	90	60	82	-40	60	85	82	112	60
11	-20	20	90	36	82	-10	60	61	82	40	65	86	112	52	90
12	0	-20	60	37	82	10	60	62	122	-40	90	87	112	82	60
13	0	20	60	38	92	-10	90	63	122	0	60	88	112	112	90
14	20	-20	90	39	92	0	60	64	122	40	95	89	42	42	90
15	20	0	60	40	92	10	90	65	72	72	90	90	42	82	60
16	20	20	90	41	62	-20	90	66	72	82	60	91	42	122	90
17	-30	-30	90	42	62	0	60	67	72	92	90	92	82	42	55
18	-30	0	60	43	62	20	90	68	82	72	60	93	82	122	60
19	-30	30	90	44	82	-20	60	69	82	92	60	94	122	42	85
20	0	-30	60	45	82	20	60	70	92	72	90	95	122	82	60
21	0	30	60	46	102	-20	90	71	92	82	60	96	122	122	90
22	30	-30	90	47	102	0	60	72	92	92	90	97	82	0	0
23	30	0	60	48	102	20	90	73	62	62	90	98	82	82	0
24	30	30	90	49	52	-30	90	74	62	82	60				

Table B.20: Node locations and demands for Problem SQ7.

No.	x	y	D	No.	x	y	D	No.	x	y	D	No.	x	y	D
0	0	0	0	33	72	-10	90	66	72	82	60	99	-10	92	90
1	-10	-10	90	34	72	0	60	67	72	92	90	100	0	72	60
2	-10	0	60	35	72	10	90	68	82	72	60	101	0	92	60
3	-10	10	90	36	82	-10	60	69	82	92	60	102	10	72	90
4	0	-10	60	37	82	10	60	70	92	72	90	103	10	82	60
5	0	10	60	38	92	-10	90	71	92	82	60	104	10	92	90
6	10	-10	90	39	92	0	60	72	92	92	90	105	-20	62	90
7	10	0	60	40	92	10	90	73	62	62	90	106	-20	82	60
8	10	10	90	41	62	-20	90	74	62	82	60	107	-20	102	90
9	-20	-20	90	42	62	0	60	75	62	102	90	108	0	62	60
10	-20	0	60	43	62	20	90	76	82	62	60	109	0	102	60
11	-20	20	90	44	82	-20	60	77	82	102	60	110	20	62	90
12	0	-20	60	45	82	20	60	78	102	62	90	111	20	82	60
13	0	20	60	46	102	-20	90	79	102	82	60	112	20	102	90
14	20	-20	90	47	102	0	60	80	102	102	90	113	-30	52	90
15	20	0	60	48	102	20	90	81	52	52	90	114	-30	82	60
16	20	20	90	49	52	-30	90	82	52	82	60	115	-30	112	90
17	-30	-30	90	50	52	0	60	83	52	112	90	116	0	52	60
18	-30	0	60	51	52	30	90	84	82	52	60	117	0	112	60
19	-30	30	90	52	82	-30	60	85	82	112	60	118	30	52	90
20	0	-30	60	53	82	30	60	86	112	52	90	119	30	82	60
21	0	30	60	54	112	-30	90	87	112	82	60	120	30	112	90
22	30	-30	90	55	112	0	60	88	112	112	90	121	-40	42	95
23	30	0	60	56	112	30	90	89	42	42	85	122	-40	82	60
24	30	30	90	57	42	-40	95	90	42	82	55	123	-40	122	90
25	-40	-40	90	58	42	0	65	91	42	122	85	124	0	42	65
26	-40	0	60	59	42	40	95	92	82	42	55	125	0	122	60
27	-40	40	85	60	82	-40	60	93	82	122	60	126	40	42	95
28	0	-40	60	61	82	40	65	94	122	42	85	127	40	82	65
29	0	40	55	62	122	-40	90	95	122	82	60	128	40	122	95
30	40	-40	85	63	122	0	60	96	122	122	90	129	82	0	0
31	40	0	55	64	122	40	95	97	-10	72	90	130	82	82	0
32	40	40	85	65	72	72	90	98	-10	82	60	131	0	82	0

Table B.21: Node locations and demands for Problem SQ8.

No.	x	y	D	No.	x	y	D	No.	x	y	D	No.	x	y	D
0	0	0	0	35	72	10	90	70	92	72	90	105	-20	62	90
1	-10	-10	90	36	82	-10	60	71	92	82	60	106	-20	82	60
2	-10	0	60	37	82	10	60	72	92	92	90	107	-20	102	90
3	-10	10	90	38	92	-10	90	73	62	62	90	108	0	62	60
4	0	-10	60	39	92	0	60	74	62	82	60	109	0	102	60
5	0	10	60	40	92	10	90	75	62	102	90	110	20	62	90
6	10	-10	90	41	62	-20	90	76	82	62	60	111	20	82	60
7	10	0	60	42	62	0	60	77	82	102	60	112	20	102	90
8	10	10	90	43	62	20	90	78	102	62	90	113	-30	52	90
9	-20	-20	90	44	82	-20	60	79	102	82	60	114	-30	82	60
10	-20	0	60	45	82	20	60	80	102	102	90	115	-30	112	90
11	-20	20	90	46	102	-20	90	81	52	52	90	116	0	52	60
12	0	-20	60	47	102	0	60	82	52	82	60	117	0	112	60
13	0	20	60	48	102	20	90	83	52	112	90	118	30	52	90
14	20	-20	90	49	52	-30	90	84	82	52	60	119	30	82	60
15	20	0	60	50	52	0	60	85	82	112	60	120	30	112	90
16	20	20	90	51	52	30	90	86	112	52	90	121	-40	42	95
17	-30	-30	90	52	82	-30	60	87	112	82	60	122	-40	82	60
18	-30	0	60	53	82	30	60	88	112	112	90	123	-40	122	90
19	-30	30	90	54	112	-30	90	89	42	42	85	124	0	42	65
20	0	-30	60	55	112	0	60	90	42	82	55	125	0	122	60
21	0	30	60	56	112	30	90	91	42	122	85	126	40	42	95
22	30	-30	90	57	42	-40	95	92	82	42	55	127	40	82	65
23	30	0	60	58	42	0	65	93	82	122	60	128	40	122	95
24	30	30	90	59	42	40	95	94	122	42	90	129	154	-10	90
25	-40	-40	90	60	82	-40	60	95	122	82	60	130	154	0	60
26	-40	0	60	61	82	40	65	96	122	122	90	131	154	10	90
27	-40	40	85	62	122	-40	95	97	-10	72	90	132	164	-10	60
28	0	-40	60	63	122	0	65	98	-10	82	60	133	164	10	60
29	0	40	55	64	122	40	95	99	-10	92	90	134	174	-10	90
30	40	-40	85	65	72	72	90	100	0	72	60	135	174	0	60
31	40	0	55	66	72	82	60	101	0	92	60	136	174	10	90
32	40	40	85	67	72	92	90	102	10	72	90	137	144	-20	90
33	72	-10	90	68	82	72	60	103	10	82	60	138	144	0	60
34	72	0	60	69	82	92	60	104	10	92	90	139	144	20	90

(cont.)

Table B.21 continued.

No.	x	y	D	No.	x	y	D	No.	x	y	D	No.	x	y	D
140	164	-20	60	147	134	30	90	154	124	0	55	161	82	0	0
141	164	20	60	148	164	-30	60	155	124	40	85	162	82	82	0
142	184	-20	90	149	164	30	60	156	164	-40	60	163	0	82	0
143	184	0	60	150	194	-30	90	157	164	40	60	164	164	0	0
144	184	20	90	151	194	0	60	158	204	-40	90				
145	134	-30	90	152	194	30	90	159	204	0	60				
146	134	0	60	153	124	-40	85	160	204	40	90				

Table B.22: Node locations and demands for Problem SQ9.

No.	x	y	D	No.	x	y	D	No.	x	y	D	No.	x	y	D
0	0	0	0	25	-40	-40	90	50	112	0	60	75	82	40	90
1	-10	-10	90	26	-40	0	60	51	112	10	90	76	122	-40	60
2	-10	0	60	27	-40	40	90	52	122	-10	60	77	122	40	60
3	-10	10	90	28	0	-40	60	53	122	10	60	78	162	-40	90
4	0	-10	60	29	0	40	60	54	132	-10	90	79	162	0	60
5	0	10	60	30	40	-40	90	55	132	0	60	80	162	40	90
6	10	-10	90	31	40	0	60	56	132	10	90	81	72	-50	90
7	10	0	60	32	40	40	90	57	102	-20	90	82	72	0	60
8	10	10	90	33	-50	-50	90	58	102	0	60	83	72	50	90
9	-20	-20	90	34	-50	0	60	59	102	20	90	84	122	-50	60
10	-20	0	60	35	-50	50	90	60	122	-20	60	85	122	50	60
11	-20	20	90	36	0	-50	60	61	122	20	60	86	172	-50	90
12	0	-20	60	37	0	50	60	62	142	-20	90	87	172	0	60
13	0	20	60	38	50	-50	90	63	142	0	60	88	172	50	90
14	20	-20	90	39	50	0	60	64	142	20	90	89	62	-60	95
15	20	0	60	40	50	50	90	65	92	-30	90	90	62	0	65
16	20	20	90	41	-60	-60	90	66	92	0	60	91	62	60	95
17	-30	-30	90	42	-60	0	60	67	92	30	90	92	122	-60	60
18	-30	0	60	43	-60	60	90	68	122	-30	60	93	122	60	60
19	-30	30	90	44	0	-60	60	69	122	30	60	94	182	-60	90
20	0	-30	60	45	0	60	60	70	152	-30	90	95	182	0	60
21	0	30	60	46	60	-60	85	71	152	0	60	96	182	60	90
22	30	-30	90	47	60	0	55	72	152	30	90	97	122	0	0
23	30	0	60	48	60	60	85	73	82	-40	90				
24	30	30	90	49	112	-10	90	74	82	0	60				

Table B.23: Node locations and demands for Problem SQ10.

No.	x	y	D	No.	x	y	D	No.	x	y	D	No.	x	y	D
0	0	0	0	37	0	50	60	74	82	0	60	111	142	122	60
1	-10	-10	90	38	50	-50	90	75	82	40	90	112	142	142	90
2	-10	0	60	39	50	0	60	76	122	-40	60	113	92	92	90
3	-10	10	90	40	50	50	90	77	122	40	60	114	92	122	60
4	0	-10	60	41	-60	-60	90	78	162	-40	90	115	92	152	90
5	0	10	60	42	-60	0	60	79	162	0	60	116	122	92	60
6	10	-10	90	43	-60	60	90	80	162	40	90	117	122	152	60
7	10	0	60	44	0	-60	60	81	72	-50	90	118	152	92	90
8	10	10	90	45	0	60	60	82	72	0	60	119	152	122	60
9	-20	-20	90	46	60	-60	85	83	72	50	90	120	152	152	90
10	-20	0	60	47	60	0	55	84	122	-50	60	121	82	82	90
11	-20	20	90	48	60	60	85	85	122	50	60	122	82	122	60
12	0	-20	60	49	112	-10	90	86	172	-50	90	123	82	162	90
13	0	20	60	50	112	0	60	87	172	0	60	124	122	82	60
14	20	-20	90	51	112	10	90	88	172	50	90	125	122	162	60
15	20	0	60	52	122	-10	60	89	62	-60	95	126	162	82	90
16	20	20	90	53	122	10	60	90	62	0	65	127	162	122	60
17	-30	-30	90	54	132	-10	90	91	62	60	95	128	162	162	90
18	-30	0	60	55	132	0	60	92	122	-60	60	129	72	72	90
19	-30	30	90	56	132	10	90	93	122	60	65	130	72	122	60
20	0	-30	60	57	102	-20	90	94	182	-60	90	131	72	172	90
21	0	30	60	58	102	0	60	95	182	0	60	132	122	72	60
22	30	-30	90	59	102	20	90	96	182	60	95	133	122	172	60
23	30	0	60	60	122	-20	60	97	112	112	90	134	172	72	90
24	30	30	90	61	122	20	60	98	112	122	60	135	172	122	60
25	-40	-40	90	62	142	-20	90	99	112	132	90	136	172	172	90
26	-40	0	60	63	142	0	60	100	122	112	60	137	62	62	90
27	-40	40	90	64	142	20	90	101	122	132	60	138	62	122	60
28	0	-40	60	65	92	-30	90	102	132	112	90	139	62	182	90
29	0	40	60	66	92	0	60	103	132	122	60	140	122	62	55
30	40	-40	90	67	92	30	90	104	132	132	90	141	122	182	60
31	40	0	60	68	122	-30	60	105	102	102	90	142	182	62	85
32	40	40	90	69	122	30	60	106	102	122	60	143	182	122	60
33	-50	-50	90	70	152	-30	90	107	102	142	90	144	182	182	90
34	-50	0	60	71	152	0	60	108	122	102	60	145	122	0	0
35	-50	50	90	72	152	30	90	109	122	142	60	146	122	122	0
36	0	-50	60	73	82	-40	90	110	142	102	90				

Table B.24: Node locations and demands for Problem SQ11.

No.	x	y	D	No.	x	y	D	No.	x	y	D	No.	x	y	D
0	0	0	0	35	-50	50	90	70	152	-30	90	105	102	102	90
1	-10	-10	90	36	0	-50	60	71	152	0	60	106	102	122	60
2	-10	0	60	37	0	50	60	72	152	30	90	107	102	142	90
3	-10	10	90	38	50	-50	90	73	82	-40	90	108	122	102	60
4	0	-10	60	39	50	0	60	74	82	0	60	109	122	142	60
5	0	10	60	40	50	50	90	75	82	40	90	110	142	102	90
6	10	-10	90	41	-60	-60	90	76	122	-40	60	111	142	122	60
7	10	0	60	42	-60	0	60	77	122	40	60	112	142	142	90
8	10	10	90	43	-60	60	85	78	162	-40	90	113	92	92	90
9	-20	-20	90	44	0	-60	60	79	162	0	60	114	92	122	60
10	-20	0	60	45	0	60	55	80	162	40	90	115	92	152	90
11	-20	20	90	46	60	-60	85	81	72	-50	90	116	122	92	60
12	0	-20	60	47	60	0	55	82	72	0	60	117	122	152	60
13	0	20	60	48	60	60	85	83	72	50	90	118	152	92	90
14	20	-20	90	49	112	-10	90	84	122	-50	60	119	152	122	60
15	20	0	60	50	112	0	60	85	122	50	60	120	152	152	90
16	20	20	90	51	112	10	90	86	172	-50	90	121	82	82	90
17	-30	-30	90	52	122	-10	60	87	172	0	60	122	82	122	60
18	-30	0	60	53	122	10	60	88	172	50	90	123	82	162	90
19	-30	30	90	54	132	-10	90	89	62	-60	95	124	122	82	60
20	0	-30	60	55	132	0	60	90	62	0	65	125	122	162	60
21	0	30	60	56	132	10	90	91	62	60	95	126	162	82	90
22	30	-30	90	57	102	-20	90	92	122	-60	60	127	162	122	60
23	30	0	60	58	102	0	60	93	122	60	65	128	162	162	90
24	30	30	90	59	102	20	90	94	182	-60	90	129	72	72	90
25	-40	-40	90	60	122	-20	60	95	182	0	60	130	72	122	60
26	-40	0	60	61	122	20	60	96	182	60	95	131	72	172	90
27	-40	40	90	62	142	-20	90	97	112	112	90	132	122	72	60
28	0	-40	60	63	142	0	60	98	112	122	60	133	122	172	60
29	0	40	60	64	142	20	90	99	112	132	90	134	172	72	90
30	40	-40	90	65	92	-30	90	100	122	112	60	135	172	122	60
31	40	0	60	66	92	0	60	101	122	132	60	136	172	172	90
32	40	40	90	67	92	30	90	102	132	112	90	137	62	62	85
33	-50	-50	90	68	122	-30	60	103	132	122	60	138	62	122	55
34	-50	0	60	69	122	30	60	104	132	132	90	139	62	182	85

(cont.)

Table B.24 continued.

No.	x	y	D	No.	x	y	D	No.	x	y	D	No.	x	y	D
140	122	62	55	154	-20	122	60	168	30	152	90	182	50	72	90
141	122	182	60	155	-20	142	90	169	-40	82	90	183	50	122	60
142	182	62	85	156	0	102	60	170	-40	122	60	184	50	172	90
143	182	122	60	157	0	142	60	171	-40	162	90	185	-60	62	95
144	182	182	90	158	20	102	90	172	0	82	60	186	-60	122	60
145	-10	112	90	159	20	122	60	173	0	162	60	187	-60	182	90
146	-10	122	60	160	20	142	90	174	40	82	90	188	0	62	65
147	-10	132	90	161	-30	92	90	175	40	122	60	189	0	182	60
148	0	112	60	162	-30	122	60	176	40	162	90	190	60	62	95
149	0	132	60	163	-30	152	90	177	-50	72	90	191	60	122	65
150	10	112	90	164	0	92	60	178	-50	122	60	192	60	182	95
151	10	122	60	165	0	152	60	179	-50	172	90	193	122	0	0
152	10	132	90	166	30	92	90	180	0	72	60	194	122	122	0
153	-20	102	90	167	30	122	60	181	0	172	60	195	0	122	0

Table B.25: Node locations and demands for Problem SQ12.

No.	x	y	D	No.	x	y	D	No.	x	y	D	No.	x	y	D
0	0	0	0	35	-50	50	90	70	152	-30	90	105	102	102	90
1	-10	-10	90	36	0	-50	60	71	152	0	60	106	102	122	60
2	-10	0	60	37	0	50	60	72	152	30	90	107	102	142	90
3	-10	10	90	38	50	-50	90	73	82	-40	90	108	122	102	60
4	0	-10	60	39	50	0	60	74	82	0	60	109	122	142	60
5	0	10	60	40	50	50	90	75	82	40	90	110	142	102	90
6	10	-10	90	41	-60	-60	90	76	122	-40	60	111	142	122	60
7	10	0	60	42	-60	0	60	77	122	40	60	112	142	142	90
8	10	10	90	43	-60	60	85	78	162	-40	90	113	92	92	90
9	-20	-20	90	44	0	-60	60	79	162	0	60	114	92	122	60
10	-20	0	60	45	0	60	55	80	162	40	90	115	92	152	90
11	-20	20	90	46	60	-60	85	81	72	-50	90	116	122	92	60
12	0	-20	60	47	60	0	55	82	72	0	60	117	122	152	60
13	0	20	60	48	60	60	85	83	72	50	90	118	152	92	90
14	20	-20	90	49	112	-10	90	84	122	-50	60	119	152	122	60
15	20	0	60	50	112	0	60	85	122	50	60	120	152	152	90
16	20	20	90	51	112	10	90	86	172	-50	90	121	82	82	90
17	-30	-30	90	52	122	-10	60	87	172	0	60	122	82	122	60
18	-30	0	60	53	122	10	60	88	172	50	90	123	82	162	90
19	-30	30	90	54	132	-10	90	89	62	-60	95	124	122	82	60
20	0	-30	60	55	132	0	60	90	62	0	65	125	122	162	60
21	0	30	60	56	132	10	90	91	62	60	95	126	162	82	90
22	30	-30	90	57	102	-20	90	92	122	-60	60	127	162	122	60
23	30	0	60	58	102	0	60	93	122	60	65	128	162	162	90
24	30	30	90	59	102	20	90	94	182	-60	95	129	72	72	90
25	-40	-40	90	60	122	-20	60	95	182	0	65	130	72	122	60
26	-40	0	60	61	122	20	60	96	182	60	95	131	72	172	90
27	-40	40	90	62	142	-20	90	97	112	112	90	132	122	72	60
28	0	-40	60	63	142	0	60	98	112	122	60	133	122	172	60
29	0	40	60	64	142	20	90	99	112	132	90	134	172	72	90
30	40	-40	90	65	92	-30	90	100	122	112	60	135	172	122	60
31	40	0	60	66	92	0	60	101	122	132	60	136	172	172	90
32	40	40	90	67	92	30	90	102	132	112	90	137	62	62	85
33	-50	-50	90	68	122	-30	60	103	132	122	60	138	62	122	55
34	-50	0	60	69	122	30	60	104	132	132	90	139	62	182	85

(cont.)

Table B.25 continued.

No.	x	y	D	No.	x	y	D	No.	x	y	D	No.	x	y	D
140	122	62	55	167	30	122	60	194	234	0	60	221	244	40	60
141	122	182	60	168	30	152	90	195	234	10	90	222	284	-40	90
142	182	62	90	169	-40	82	90	196	244	-10	60	223	284	0	60
143	182	122	60	170	-40	122	60	197	244	10	60	224	284	40	90
144	182	182	90	171	-40	162	90	198	254	-10	90	225	194	-50	90
145	-10	112	90	172	0	82	60	199	254	0	60	226	194	0	60
146	-10	122	60	173	0	162	60	200	254	10	90	227	194	50	90
147	-10	132	90	174	40	82	90	201	224	-20	90	228	244	-50	60
148	0	112	60	175	40	122	60	202	224	0	60	229	244	50	60
149	0	132	60	176	40	162	90	203	224	20	90	230	294	-50	90
150	10	112	90	177	-50	72	90	204	244	-20	60	231	294	0	60
151	10	122	60	178	-50	122	60	205	244	20	60	232	294	50	90
152	10	132	90	179	-50	172	90	206	264	-20	90	233	184	-60	85
153	-20	102	90	180	0	72	60	207	264	0	60	234	184	0	55
154	-20	122	60	181	0	172	60	208	264	20	90	235	184	60	85
155	-20	142	90	182	50	72	90	209	214	-30	90	236	244	-60	60
156	0	102	60	183	50	122	60	210	214	0	60	237	244	60	60
157	0	142	60	184	50	172	90	211	214	30	90	238	304	-60	90
158	20	102	90	185	-60	62	95	212	244	-30	60	239	304	0	60
159	20	122	60	186	-60	122	60	213	244	30	60	240	304	60	90
160	20	142	90	187	-60	182	90	214	274	-30	90	241	122	0	0
161	-30	92	90	188	0	62	65	215	274	0	60	242	122	122	0
162	-30	122	60	189	0	182	60	216	274	30	90	243	0	122	0
163	-30	152	90	190	60	62	95	217	204	-40	90	244	244	0	0
164	0	92	60	191	60	122	65	218	204	0	60				
165	0	152	60	192	60	182	95	219	204	40	90				
166	30	92	90	193	234	-10	90	220	244	-40	60				

Table B.26: IDH solution to MDSD1 with demand range [.1, .9].

	Route	Load	Distance
1	0 4(70) 0	70	12.00
2	0 19(23) 13(57) 0	80	40.13
3	0 37(34) 17(45) 0	79	24.88
4	0 40(66) 19(5) 0	71	41.05
5	0 42(34) 44(43) 0	77	31.53
6	0 41(71) 0	71	20.88
7	51(0) 27(33) 1(47) 51(0)	80	29.95
8	51(0) 14(7) 24(65) 51(0)	72	53.94
9	51(0) 23(9) 7(33) 43(9) 25(29) 51(0)	80	89.31
10	51(0) 14(57) 18(23) 51(0)	80	43.17
11	51(0) 31(43) 8(34) 27(3) 51(0)	80	61.09
12	51(0) 1(9) 28(42) 22(15) 11(13) 51(0)	79	68.14
13	51(0) 26(45) 48(13) 6(20) 51(0)	78	61.66
14	51(0) 27(18) 32(62) 51(0)	80	26.25
15	51(0) 12(54) 46(16) 51(0)	70	17.37
16	51(0) 47(62) 46(18) 51(0)	80	21.57
17	52(0) 5(66) 52(0)	66	20.00
18	52(0) 9(56) 52(0)	56	7.21
19	52(0) 10(66) 52(0)	66	18.11
20	52(0) 45(20) 15(60) 52(0)	80	49.33
21	52(0) 16(62) 38(18) 52(0)	80	27.47
22	52(0) 33(41) 45(23) 49(16) 52(0)	80	50.35
23	52(0) 30(25) 34(26) 50(23) 52(0)	74	30.87
24	52(0) 49(15) 39(59) 52(0)	74	37.35
25	53(0) 2(49) 21(16) 53(0)	65	34.06
26	53(0) 35(25) 3(55) 53(0)	80	39.33
27	53(0) 20(49) 53(0)	49	17.09
28	53(0) 29(66) 53(0)	66	5.66
29	53(0) 36(57) 35(18) 53(0)	75	38.47
		Total Distance	1018.22

Table B.27: IDH solution to MDSD2 with demand range [.1, .9].

	Route	Load	Distance
1	0 4(3) 52(57) 34(37) 67(43) 0	140	31.80
2	0 68(48) 6(92) 0	140	21.60
3	0 75(111) 0	111	6.00
4	0 46(122) 34(18) 0	140	23.42
5	0 26(84) 0	84	12.17
6	0 68(45) 4(93) 0	138	21.63
7	76(0) 36(77) 47(5) 48(47) 76(0)	129	27.61
8	76(0) 15(46) 57(37) 13(57) 76(0)	140	42.64
9	76(0) 20(61) 37(79) 76(0)	140	36.18
10	76(0) 30(24) 2(17) 28(55) 61(34) 76(0)	130	56.42
11	76(0) 60(123) 37(11) 76(0)	134	46.71
12	76(0) 29(121) 76(0)	121	8.94
13	76(0) 21(112) 76(0)	112	21.63
14	76(0) 45(122) 76(0)	122	16.00
15	76(0) 5(75) 76(0)	75	10.77
16	76(0) 27(76) 52(64) 76(0)	140	33.62
17	76(0) 47(30) 69(110) 76(0)	140	36.00
18	76(0) 70(97) 71(39) 76(0)	136	48.11
19	76(0) 48(46) 74(93) 76(0)	139	20.50
20	77(0) 8(87) 7(45) 77(0)	132	24.14
21	77(0) 38(23) 10(26) 58(91) 77(0)	140	42.41
22	77(0) 66(34) 11(85) 77(0)	119	34.40
23	77(0) 35(57) 54(48) 19(26) 77(0)	131	38.50
24	77(0) 65(67) 38(73) 77(0)	140	34.41
25	77(0) 53(124) 77(0)	124	4.00
26	77(0) 14(21) 59(95) 77(0)	116	35.40
27	78(0) 32(17) 50(117) 78(0)	134	31.03
28	78(0) 44(52) 3(60) 78(0)	112	12.00
29	78(0) 12(34) 72(68) 39(38) 78(0)	140	41.47
30	78(0) 49(36) 16(104) 78(0)	140	33.83
31	78(0) 51(70) 17(41) 78(0)	111	21.68
32	78(0) 25(45) 18(95) 78(0)	140	51.35
33	78(0) 49(20) 24(116) 78(0)	136	39.95

(cont.)

Table B.27 continued.

	Route	Load	Distance
34	78(0) 40(118) 78(0)	118	14.14
35	78(0) 55(115) 25(20) 78(0)	135	58.99
36	78(0) 31(65) 39(69) 78(0)	134	63.42
37	78(0) 9(117) 78(0)	117	28.07
38	79(0) 22(60) 1(80) 79(0)	140	21.90
39	79(0) 64(99) 42(15) 79(0)	114	32.62
40	79(0) 1(2) 33(17) 63(112) 79(0)	131	26.97
41	79(0) 23(36) 56(79) 41(8) 79(0)	123	36.42
42	79(0) 41(57) 43(83) 79(0)	140	17.14
43	79(0) 62(27) 73(100) 79(0)	127	23.06
		Total Distance	1289.06

Table B.28: IDH solution to MDSD3 with demand range [.1, .9].

	Route	Load	Distance
1	0 2(89) 0	89	6.00
2	0 22(48) 74(42) 0	90	30.34
3	0 57(34) 41(65) 0	99	34.49
4	0 100(17) 91(52) 85(12) 98(18) 0	99	42.64
5	0 37(15) 16(77) 91(8) 0	100	50.12
6	0 87(29) 44(71) 0	100	49.48
7	0 73(67) 21(31) 0	98	22.65
8	0 75(28) 55(58) 54(14) 0	100	67.34
9	0 40(13) 58(23) 13(64) 0	100	24.35
10	0 44(13) 38(87) 0	100	69.10
11	0 67(56) 23(31) 75(8) 0	95	72.47
12	0 56(23) 39(59) 72(18) 0	100	52.95
13	0 86(58) 61(29) 93(13) 0	100	64.53
14	0 87(14) 15(66) 57(16) 0	96	36.26
15	0 92(23) 93(18) 99(53) 0	94	36.61
16	0 97(12) 59(54) 95(32) 0	98	29.82
17	0 43(29) 14(43) 42(24) 0	96	54.26
18	0 40(14) 25(62) 4(21) 0	97	62.57
19	101(0) 88(53) 62(38) 52(9) 101(0)	100	52.17
20	101(0) 81(41) 9(6) 66(53) 101(0)	100	88.40
21	101(0) 62(4) 11(6) 64(37) 49(53) 101(0)	100	103.22
22	101(0) 82(57) 8(42) 101(0)	99	55.98
23	101(0) 47(46) 48(51) 101(0)	97	68.41
24	101(0) 90(49) 32(24) 70(26) 101(0)	99	70.97
25	101(0) 77(14) 50(8) 1(59) 69(14) 101(0)	95	49.87
26	101(0) 51(39) 30(61) 101(0)	100	61.64
27	101(0) 48(16) 36(69) 19(11) 101(0)	96	86.42
28	101(0) 31(79) 27(16) 101(0)	95	35.11
29	101(0) 9(19) 65(76) 101(0)	95	100.33
30	101(0) 10(88) 101(0)	88	50.99
31	101(0) 80(15) 29(34) 3(49) 101(0)	98	62.38
32	101(0) 83(37) 60(49) 89(14) 101(0)	100	43.39
33	101(0) 50(7) 81(20) 33(73) 101(0)	100	55.19

(cont.)

Table B.28 continued.

	Route	Load	Distance
34	101(0) 51(33) 20(64) 101(0)	97	66.61
35	101(0) 5(56) 84(34) 101(0)	90	49.07
36	101(0) 46(87) 18(13) 101(0)	100	70.98
37	101(0) 3(7) 79(87) 50(6) 101(0)	100	52.99
38	101(0) 54(30) 68(34) 12(31) 101(0)	95	55.06
39	101(0) 53(52) 101(0)	52	8.94
40	101(0) 96(65) 89(32) 101(0)	97	33.21
41	101(0) 63(70) 11(30) 101(0)	100	76.53
42	101(0) 34(34) 78(66) 101(0)	100	72.12
43	101(0) 94(85) 101(0)	85	24.08
44	101(0) 6(16) 17(53) 45(27) 18(4) 101(0)	100	69.20
45	101(0) 71(69) 35(31) 101(0)	100	87.41
46	101(0) 52(16) 7(84) 101(0)	100	42.43
47	101(0) 77(48) 76(52) 101(0)	100	39.47
48	101(0) 26(30) 28(55) 101(0)	85	25.57
49	101(0) 80(16) 24(81) 101(0)	97	60.31
		Total Distance	2624.41

Table B.29: IDH solution to MDSD4 with demand range [.1, .9].

	Route	Load	Distance
1	0 84(21) 17(179) 0	200	22.92
2	0 94(153) 6(33) 0	186	27.94
3	0 100(129) 44(60) 16(11) 0	200	47.22
4	0 61(30) 86(161) 0	191	41.65
5	0 83(114) 0	114	4.47
6	0 90(71) 64(125) 0	196	96.65
7	0 14(97) 42(87) 0	184	58.92
8	0 60(114) 0	114	4.47
9	0 93(128) 59(32) 99(40) 0	200	26.93
10	0 8(44) 19(148) 0	192	52.15
11	0 85(171) 0	171	26.08
12	0 99(69) 96(131) 0	200	23.16
13	0 57(174) 95(26) 0	200	57.36
14	0 11(62) 63(137) 0	199	74.53
15	0 45(63) 84(126) 0	189	23.75
16	0 52(91) 6(109) 0	200	38.76
17	0 16(50) 38(149) 0	199	63.25
18	0 31(44) 10(75) 88(73) 0	192	60.60
19	0 93(18) 37(172) 0	190	31.69
20	0 62(125) 7(61) 0	186	49.45
21	0 89(39) 13(42) 95(81) 96(38) 0	200	41.74
22	0 18(173) 0	173	14.14
23	0 93(24) 98(176) 0	200	29.12
24	0 48(135) 82(65) 0	200	34.50
25	0 49(80) 36(48) 46(45) 0	173	73.53
26	0 82(57) 47(132) 0	189	45.54
27	0 59(39) 92(161) 0	200	29.53
28	0 5(178) 0	178	10.00
29	0 97(125) 87(75) 0	200	42.85
30	0 91(35) 43(111) 15(49) 0	195	74.71
31	101(0) 55(28) 25(163) 101(0)	191	36.06
32	101(0) 21(43) 73(29) 2(113) 101(0)	185	57.10
33	101(0) 53(58) 58(63) 40(31) 101(0)	152	45.69

(cont.)

Table B.29 continued.

	Route	Load	Distance
34	101(0) 55(112) 4(88) 101(0)	200	37.97
35	101(0) 34(21) 65(133) 71(46) 101(0)	200	87.92
36	101(0) 26(176) 101(0)	176	22.36
37	101(0) 30(10) 32(54) 20(136) 101(0)	200	81.84
38	101(0) 66(150) 71(44) 9(6) 101(0)	200	81.15
39	101(0) 72(121) 74(7) 73(71) 101(0)	199	49.34
40	101(0) 67(28) 23(130) 56(40) 101(0)	198	74.68
41	101(0) 50(7) 51(90) 9(53) 78(50) 101(0)	200	59.95
42	101(0) 74(36) 22(36) 41(73) 75(55) 101(0)	200	63.98
43	101(0) 79(28) 81(164) 3(8) 101(0)	200	38.48
44	101(0) 30(66) 70(68) 1(66) 101(0)	200	62.02
45	101(0) 69(15) 27(49) 28(116) 101(0)	180	49.76
46	101(0) 80(34) 77(163) 101(0)	197	17.19
47	101(0) 24(163) 101(0)	163	20.00
48	101(0) 34(46) 35(154) 101(0)	200	63.61
49	101(0) 76(1) 1(52) 69(147) 101(0)	200	45.96
50	101(0) 54(125) 12(66) 101(0)	191	20.54
51	101(0) 29(112) 68(56) 101(0)	168	24.07
52	101(0) 39(111) 56(89) 101(0)	200	53.62
53	101(0) 76(62) 50(138) 101(0)	200	29.03
54	101(0) 78(17) 33(138) 3(45) 101(0)	200	43.31
		Total Distance	2393.23

Table B.30: IDH solution to MDSD5 with demand range [.1, .9].

	Route	Load	Distance
1	0 94(48) 13(27) 95(19) 92(6) 0	100	33.50
2	0 93(11) 83(74) 84(13) 0	98	37.01
3	0 92(35) 59(65) 0	100	16.73
4	0 37(77) 0	77	10.00
5	0 17(61) 84(39) 0	100	31.93
6	0 84(22) 45(68) 5(8) 0	98	42.35
7	0 14(66) 44(34) 0	100	22.87
8	0 44(33) 86(60) 0	93	26.45
9	0 97(42) 95(58) 0	100	23.82
10	0 100(81) 0	81	7.21
11	0 60(61) 5(39) 0	100	28.61
12	0 98(88) 0	88	8.25
13	0 16(57) 61(34) 0	91	14.47
14	0 57(57) 87(40) 0	97	39.15
15	0 96(55) 6(32) 99(13) 0	100	28.36
16	0 85(85) 0	85	4.47
17	0 57(25) 15(36) 42(25) 91(14) 0	100	47.69
18	0 38(11) 43(83) 0	94	54.93
19	101(0) 41(23) 22(76) 101(0)	99	30.69
20	101(0) 24(69) 55(31) 101(0)	100	46.72
21	101(0) 29(58) 68(37) 12(2) 101(0)	97	56.83
22	101(0) 56(29) 67(56) 39(10) 101(0)	95	46.90
23	101(0) 74(21) 72(50) 101(0)	71	16.22
24	101(0) 26(18) 53(78) 101(0)	96	36.27
25	101(0) 4(26) 25(41) 55(30) 101(0)	97	31.95
26	101(0) 56(11) 23(71) 75(11) 101(0)	93	33.36
27	101(0) 26(32) 28(68) 101(0)	100	38.48
28	101(0) 40(69) 101(0)	69	22.36
29	101(0) 12(36) 54(64) 101(0)	100	35.62
30	101(0) 21(9) 2(63) 73(28) 101(0)	100	31.15
31	101(0) 21(14) 58(79) 101(0)	93	31.05
32	101(0) 68(26) 80(74) 101(0)	100	39.95
33	102(0) 52(88) 102(0)	88	28.84

(cont.)

Table B.30 continued.

	Route	Load	Distance
34	102(0) 48(12) 46(75) 8(13) 102(0)	100	71.07
35	102(0) 70(35) 30(57) 102(0)	92	14.31
36	102(0) 31(39) 7(60) 102(0)	99	31.99
37	102(0) 90(52) 10(48) 102(0)	100	26.79
38	102(0) 62(16) 19(39) 48(43) 102(0)	98	51.07
39	102(0) 66(32) 65(67) 102(0)	99	71.23
40	102(0) 10(19) 64(65) 63(16) 102(0)	100	60.29
41	102(0) 51(57) 9(38) 102(0)	95	41.26
42	102(0) 11(14) 49(42) 36(35) 102(0)	91	74.67
43	102(0) 50(47) 76(45) 102(0)	92	38.91
44	102(0) 18(76) 102(0)	76	42.43
45	102(0) 32(80) 90(17) 102(0)	97	31.12
46	102(0) 71(24) 35(68) 9(6) 102(0)	98	62.31
47	102(0) 1(23) 69(16) 27(17) 89(44) 102(0)	100	52.46
48	102(0) 20(70) 30(30) 102(0)	100	28.28
49	102(0) 88(15) 82(84) 102(0)	99	43.11
50	102(0) 48(25) 47(75) 102(0)	100	55.63
51	102(0) 33(4) 78(52) 34(42) 102(0)	98	61.25
52	102(0) 81(14) 3(32) 77(18) 1(36) 102(0)	100	53.76
53	102(0) 79(71) 33(29) 102(0)	100	46.99
		Total Distance	1963.13

Table B.31: IDH solution to MDSD6 with demand range [.1, .9].

	Route	Load	Distance
1	0 5(88) 0	88	10.00
2	0 83(74) 0	74	4.47
3	0 84(85) 0	85	11.31
4	0 18(35) 89(17) 60(20) 0	72	26.17
5	0 91(24) 16(76) 0	100	36.91
6	0 99(23) 59(77) 0	100	25.06
7	0 61(83) 0	83	22.80
8	0 19(5) 49(45) 47(41) 0	91	71.34
9	0 45(26) 17(25) 86(49) 0	100	49.84
10	0 85(46) 93(19) 99(30) 0	95	28.99
11	0 47(11) 36(89) 0	100	57.53
12	0 8(36) 48(23) 82(29) 0	88	36.31
13	0 45(10) 46(84) 0	94	38.64
14	0 99(29) 96(43) 6(28) 0	100	27.95
15	101(0) 77(14) 79(64) 78(22) 101(0)	100	38.33
16	101(0) 29(13) 34(64) 78(23) 101(0)	100	47.47
17	101(0) 81(72) 33(28) 101(0)	100	38.95
18	101(0) 3(61) 12(39) 101(0)	100	26.18
19	101(0) 4(16) 55(42) 54(40) 101(0)	98	38.35
20	101(0) 26(26) 28(70) 101(0)	96	33.38
21	101(0) 55(14) 25(86) 101(0)	100	36.06
22	101(0) 24(46) 68(14) 80(31) 101(0)	91	24.08
23	101(0) 76(33) 50(22) 33(37) 77(3) 101(0)	95	39.66
24	102(0) 23(44) 22(52) 102(0)	96	50.32
25	102(0) 13(3) 98(60) 37(37) 102(0)	100	35.19
26	102(0) 41(87) 102(0)	87	29.53
27	102(0) 94(43) 13(57) 102(0)	100	22.94
28	102(0) 97(3) 38(38) 14(41) 102(0)	82	69.20
29	102(0) 2(17) 74(66) 72(17) 102(0)	100	30.52
30	102(0) 40(71) 58(29) 102(0)	100	17.28
31	102(0) 58(20) 53(76) 102(0)	96	22.36
32	102(0) 42(35) 43(64) 102(0)	99	43.47
33	102(0) 14(29) 44(71) 102(0)	100	52.76

(cont.)

Table B.31 continued.

	Route	Load	Distance
34	102(0) 73(87) 102(0)	87	18.97
35	102(0) 2(16) 15(70) 57(11) 102(0)	97	31.82
36	102(0) 97(22) 95(78) 102(0)	100	23.82
37	102(0) 92(16) 98(11) 100(73) 102(0)	100	36.59
38	102(0) 21(86) 40(14) 102(0)	100	24.14
39	102(0) 39(19) 67(77) 102(0)	96	71.49
40	102(0) 87(82) 102(0)	82	14.56
41	102(0) 56(64) 75(29) 22(7) 102(0)	100	42.09
42	103(0) 30(34) 70(62) 103(0)	96	22.50
43	103(0) 19(70) 62(30) 103(0)	100	45.18
44	103(0) 66(56) 71(22) 9(20) 103(0)	98	66.97
45	103(0) 10(27) 90(61) 70(12) 103(0)	100	37.11
46	103(0) 64(80) 11(11) 62(9) 103(0)	100	68.26
47	103(0) 31(17) 88(74) 103(0)	91	18.69
48	103(0) 7(41) 52(53) 103(0)	94	35.53
49	103(0) 20(49) 30(51) 103(0)	100	36.28
50	103(0) 71(23) 65(50) 35(14) 9(13) 103(0)	100	82.56
51	103(0) 32(13) 63(84) 103(0)	97	47.62
52	103(0) 50(66) 27(33) 69(1) 103(0)	100	37.15
53	103(0) 69(41) 1(59) 103(0)	100	14.16
54	103(0) 51(87) 9(13) 103(0)	100	44.81
		Total Distance	1963.68

Table B.32: IDH solution to MDSD7 with demand range [.1, .9].

	Route	Load	Distance
1	0 65(189) 206(264) 83(47) 0	500	128.32
2	0 47(10) 55(412) 168(78) 0	500	174.03
3	0 118(184) 123(306) 0	490	68.12
4	0 211(276) 90(224) 0	500	163.00
5	0 66(164) 47(336) 0	500	166.31
6	0 194(347) 10(123) 214(30) 0	500	152.35
7	0 163(82) 157(105) 235(313) 0	500	62.40
8	0 214(92) 131(125) 10(283) 0	500	113.73
9	0 224(342) 163(99) 0	441	24.49
10	0 225(160) 241(66) 11(271) 0	497	77.48
11	0 170(114) 189(121) 248(263) 0	498	139.04
12	0 195(309) 217(31) 27(160) 0	500	82.48
13	0 30(59) 12(251) 5(77) 191(105) 0	492	138.08
14	0 147(273) 40(178) 24(49) 0	500	255.48
15	0 146(359) 135(141) 0	500	74.34
16	0 8(101) 3(370) 123(29) 0	500	81.91
17	0 121(131) 106(323) 189(46) 0	500	166.18
18	0 79(290) 19(208) 0	498	139.95
19	0 78(109) 127(364) 223(7) 0	480	248.92
20	0 213(100) 185(329) 19(71) 0	500	135.22
21	0 228(79) 130(378) 61(43) 0	500	188.42
22	0 249(418) 0	418	43.91
23	0 122(166) 62(238) 0	404	71.66
24	0 66(10) 103(168) 113(132) 80(182) 0	492	164.42
25	0 203(77) 238(423) 0	500	113.02
26	0 69(20) 75(400) 219(80) 0	500	139.00
27	0 58(219) 183(111) 83(144) 0	474	115.57
28	0 43(103) 242(397) 0	500	98.24
29	0 64(131) 193(135) 101(92) 114(142) 0	500	78.61
30	0 217(142) 173(348) 0	490	96.13
31	0 207(299) 166(140) 0	439	83.30
32	0 82(57) 56(243) 38(193) 0	493	118.74
33	0 220(114) 36(381) 0	495	113.89

(cont.)

Table B.32 continued.

	Route	Load	Distance
34	0 43(116) 223(382) 0	498	70.03
35	0 150(445) 58(55) 0	500	104.20
36	0 175(53) 17(245) 24(202) 0	500	217.09
37	0 9(72) 89(203) 167(89) 13(136) 0	500	141.19
38	0 201(301) 175(6) 66(193) 0	500	221.42
39	0 26(434) 0	434	86.56
40	0 176(228) 136(259) 0	487	141.45
41	0 225(31) 80(200) 42(269) 0	500	153.01
42	0 133(364) 5(136) 0	500	128.07
43	0 69(177) 177(322) 0	499	35.12
44	0 193(175) 203(324) 0	499	82.71
45	0 131(174) 57(326) 0	500	93.98
46	0 96(144) 73(130) 198(97) 204(83) 0	454	69.32
47	0 135(48) 15(254) 102(103) 39(87) 0	492	121.85
48	0 129(84) 221(197) 61(52) 90(167) 0	500	189.75
49	0 135(136) 84(364) 0	500	80.66
50	0 114(35) 9(122) 153(330) 0	487	104.17
51	0 237(443) 0	443	41.23
52	0 16(181) 52(56) 219(263) 0	500	138.90
53	0 53(411) 228(89) 0	500	136.81
54	0 125(92) 148(373) 0	465	79.70
55	0 32(244) 226(237) 0	481	182.37
56	0 197(449) 0	449	140.47
57	0 2(83) 170(17) 230(399) 0	499	90.59
58	0 204(91) 54(409) 0	500	71.30
59	0 124(252) 49(224) 0	476	139.70
60	0 233(306) 39(167) 0	473	118.27
61	0 137(116) 18(146) 191(238) 0	500	123.51
62	0 190(238) 112(238) 0	476	68.83
63	250(0) 67(354) 132(140) 250(0)	494	192.86
64	250(0) 246(250) 25(250) 250(0)	500	44.01
65	250(0) 46(403) 216(84) 250(0)	487	61.43
66	250(0) 179(67) 107(63) 240(238) 98(91) 250(0)	459	142.27

(cont.)

Table B.32 continued.

	Route	Load	Distance
67	250(0) 99(179) 70(99) 244(222) 250(0)	500	188.18
68	250(0) 140(61) 142(439) 250(0)	500	208.96
69	250(0) 212(193) 77(302) 250(0)	495	135.18
70	250(0) 97(407) 250(0)	407	158.40
71	250(0) 172(81) 81(77) 4(337) 250(0)	495	138.75
72	250(0) 186(30) 71(155) 1(303) 250(0)	488	296.51
73	250(0) 196(371) 23(94) 250(0)	465	83.19
74	250(0) 76(225) 154(244) 250(0)	469	175.39
75	250(0) 100(62) 145(429) 250(0)	491	146.85
76	250(0) 208(98) 160(402) 250(0)	500	56.08
77	250(0) 20(227) 29(233) 250(0)	460	177.32
78	250(0) 164(22) 100(172) 115(306) 250(0)	500	150.06
79	250(0) 171(284) 181(113) 243(102) 250(0)	499	142.61
80	250(0) 25(145) 104(125) 74(191) 250(0)	461	79.05
81	250(0) 218(115) 245(366) 250(0)	481	129.25
82	250(0) 151(83) 86(272) 119(53) 218(85) 250(0)	493	168.28
83	250(0) 141(444) 250(0)	444	54.63
84	250(0) 232(87) 139(267) 231(134) 250(0)	488	258.33
85	250(0) 222(205) 6(281) 250(0)	486	107.49
86	250(0) 169(204) 181(296) 250(0)	500	133.34
87	250(0) 23(207) 48(293) 250(0)	500	78.90
88	250(0) 34(260) 28(183) 250(0)	443	113.95
89	250(0) 134(173) 159(162) 158(155) 250(0)	490	265.96
90	250(0) 117(252) 178(243) 250(0)	495	166.10
91	250(0) 71(55) 229(445) 250(0)	500	274.17
92	250(0) 94(94) 149(291) 239(99) 250(0)	484	173.40
93	250(0) 165(438) 250(0)	438	82.61
94	250(0) 28(84) 182(416) 250(0)	500	102.13
95	250(0) 187(217) 45(274) 250(0)	491	91.94
96	250(0) 41(194) 110(93) 60(56) 109(130) 250(0)	473	191.08
97	250(0) 186(102) 21(386) 250(0)	488	142.85
98	250(0) 35(365) 156(100) 250(0)	465	114.72
99	250(0) 199(81) 44(404) 250(0)	485	40.27

(cont.)

Table B.32 continued.

	Route	Load	Distance
100	250(0) 88(63) 247(354) 91(83) 250(0)	500	161.04
101	250(0) 105(249) 92(215) 250(0)	464	152.37
102	250(0) 128(57) 14(354) 143(84) 250(0)	495	102.70
103	250(0) 92(157) 210(333) 250(0)	490	169.73
104	250(0) 227(176) 109(316) 250(0)	492	174.03
105	250(0) 91(82) 50(418) 250(0)	500	111.92
106	250(0) 144(415) 152(73) 250(0)	488	82.49
107	250(0) 184(415) 192(77) 250(0)	492	102.22
108	250(0) 155(411) 108(70) 250(0)	481	199.61
109	250(0) 234(105) 31(261) 205(123) 250(0)	489	259.61
110	250(0) 143(207) 174(293) 250(0)	500	93.11
111	250(0) 215(91) 126(202) 116(199) 250(0)	492	96.46
112	250(0) 37(370) 250(0)	370	64.12
113	250(0) 22(159) 120(241) 63(63) 250(0)	463	77.22
114	250(0) 209(75) 68(291) 234(45) 138(78) 250(0)	489	213.29
115	250(0) 222(185) 85(315) 250(0)	500	97.86
116	250(0) 151(291) 94(208) 250(0)	499	144.96
117	250(0) 162(239) 59(69) 51(166) 250(0)	474	207.97
118	250(0) 208(57) 188(78) 87(333) 250(0)	468	143.54
119	250(0) 95(283) 164(78) 7(119) 250(0)	480	124.06
120	250(0) 91(245) 93(120) 161(115) 250(0)	480	99.79
121	250(0) 180(259) 200(221) 250(0)	480	48.77
122	250(0) 236(149) 111(322) 250(0)	471	79.88
123	250(0) 72(203) 33(244) 250(0)	447	187.53
124	250(0) 202(421) 244(52) 250(0)	473	247.09
		Total Distance	16096.91

Table B.33: IDH solution to MDSD8 with demand range [.1, .9].

	Route	Load	Distance
1	0 179(67) 46(403) 0	470	100.53
2	0 201(6) 40(178) 17(245) 175(59) 0	488	220.04
3	0 174(55) 14(354) 98(91) 0	500	67.89
4	0 144(415) 216(84) 0	499	148.17
5	0 171(91) 181(409) 0	500	86.92
6	0 184(134) 245(366) 0	500	178.79
7	0 78(90) 24(251) 201(159) 0	500	182.24
8	0 32(244) 78(19) 226(237) 0	500	154.72
9	0 109(446) 0	446	76.97
10	0 165(219) 37(281) 0	500	77.49
11	0 25(68) 104(125) 74(191) 215(91) 0	475	168.86
12	0 236(100) 120(241) 22(159) 0	500	53.60
13	0 187(217) 45(274) 0	491	98.12
14	0 151(374) 94(126) 0	500	177.23
15	0 48(47) 128(57) 91(30) 50(366) 0	500	140.82
16	0 107(63) 247(354) 88(63) 0	480	182.71
17	0 117(252) 240(238) 0	490	67.87
18	0 111(322) 0	322	22.63
19	0 23(184) 196(316) 0	500	38.74
20	0 210(76) 41(194) 110(93) 227(137) 0	500	89.95
21	0 92(372) 0	372	37.20
22	0 25(46) 141(444) 0	490	133.87
23	0 212(193) 77(302) 0	495	136.13
24	0 67(354) 132(140) 0	494	117.72
25	0 44(404) 0	404	63.53
26	0 91(380) 93(120) 0	500	123.10
27	0 15(2) 176(228) 136(259) 0	489	154.67
28	0 236(49) 23(117) 48(246) 174(84) 0	496	48.96
29	0 199(17) 246(250) 152(73) 63(63) 200(97) 0	500	152.55
30	0 178(243) 210(257) 0	500	72.68
31	0 52(56) 233(306) 102(103) 243(35) 0	500	153.07
32	0 85(315) 105(156) 0	471	56.94
33	0 156(100) 35(365) 192(22) 0	487	198.87

(cont.)

Table B.33 continued.

	Route	Load	Distance
34	0 20(227) 227(39) 29(233) 0	499	85.46
35	0 222(390) 0	390	44.94
36	0 184(281) 218(200) 0	481	167.57
37	0 127(364) 201(136) 0	500	200.93
38	0 169(47) 162(239) 171(193) 0	479	102.97
39	0 59(69) 75(400) 0	469	109.40
40	0 15(252) 16(181) 243(67) 0	500	141.06
41	0 192(55) 239(99) 119(53) 149(291) 0	498	227.60
42	0 200(124) 180(259) 161(115) 0	498	108.93
43	0 196(55) 143(291) 174(154) 0	500	46.80
44	0 6(281) 165(219) 0	500	81.85
45	0 126(202) 116(199) 37(89) 0	490	129.69
46	0 60(56) 147(273) 51(166) 0	495	167.99
47	0 158(155) 159(162) 134(173) 0	490	173.55
48	0 105(93) 97(407) 0	500	79.19
49	0 50(52) 94(176) 86(272) 0	500	185.91
50	0 169(157) 219(343) 0	500	116.15
51	0 199(64) 208(155) 25(281) 0	500	131.29
52	250(0) 146(328) 122(166) 250(0)	494	122.60
53	250(0) 190(190) 8(101) 213(100) 112(109) 250(0)	500	151.41
54	250(0) 114(66) 26(434) 250(0)	500	25.08
55	250(0) 9(70) 248(263) 189(167) 250(0)	500	79.59
56	250(0) 224(342) 64(131) 250(0)	473	59.92
57	250(0) 27(91) 54(409) 250(0)	500	104.62
58	250(0) 101(92) 10(406) 250(0)	498	91.23
59	250(0) 183(111) 36(381) 250(0)	492	70.05
60	250(0) 206(175) 65(189) 220(114) 250(0)	478	110.95
61	250(0) 38(193) 39(254) 250(0)	447	132.24
62	250(0) 170(101) 230(399) 250(0)	500	36.59
63	250(0) 146(31) 84(364) 157(105) 250(0)	500	128.74
64	250(0) 249(213) 43(219) 241(66) 250(0)	498	97.54
65	250(0) 11(94) 242(397) 250(0)	491	106.68
66	250(0) 193(310) 250(0)	310	22.09

(cont.)

Table B.33 continued.

	Route	Load	Distance
67	250(0) 53(411) 206(89) 250(0)	500	142.76
68	250(0) 42(266) 197(234) 250(0)	500	124.45
69	250(0) 57(201) 131(299) 250(0)	500	67.23
70	250(0) 69(178) 177(322) 250(0)	500	85.68
71	250(0) 80(97) 194(347) 42(3) 250(0)	447	136.49
72	250(0) 83(191) 58(274) 170(30) 250(0)	495	84.02
73	250(0) 2(83) 195(309) 125(92) 250(0)	484	54.35
74	250(0) 114(111) 148(373) 250(0)	484	17.93
75	250(0) 69(19) 118(102) 123(335) 250(0)	456	127.87
76	250(0) 11(177) 235(313) 250(0)	490	68.36
77	250(0) 89(203) 167(89) 13(136) 250(0)	428	78.42
78	250(0) 150(445) 250(0)	445	60.83
79	250(0) 47(258) 168(78) 113(132) 57(26) 250(0)	494	166.85
80	250(0) 225(103) 223(389) 250(0)	492	92.88
81	250(0) 118(82) 3(370) 190(48) 250(0)	500	139.68
82	250(0) 103(168) 56(243) 225(88) 250(0)	499	162.75
83	250(0) 9(124) 153(330) 250(0)	454	41.62
84	250(0) 57(99) 203(401) 250(0)	500	51.15
85	250(0) 214(122) 66(367) 250(0)	489	140.53
86	250(0) 124(252) 228(168) 217(75) 250(0)	495	152.52
87	250(0) 238(423) 250(0)	423	82.22
88	250(0) 112(129) 96(144) 73(130) 198(97) 250(0)	500	136.52
89	250(0) 106(323) 121(131) 250(0)	454	106.20
90	250(0) 27(47) 173(348) 217(98) 250(0)	493	95.39
91	250(0) 249(34) 62(238) 163(181) 250(0)	453	88.92
92	250(0) 204(157) 30(59) 18(146) 137(116) 27(22) 250(0)	500	137.69
93	250(0) 249(171) 135(325) 250(0)	496	121.87
94	250(0) 237(443) 82(57) 250(0)	500	89.13
95	250(0) 197(215) 80(285) 250(0)	500	132.63
96	250(0) 204(17) 207(299) 166(140) 250(0)	456	134.61
97	250(0) 55(412) 47(88) 250(0)	500	169.45
98	251(0) 71(210) 31(261) 251(0)	471	93.20
99	251(0) 68(74) 202(421) 251(0)	495	85.83

(cont.)

Table B.33 continued.

	Route	Load	Distance
100	251(0) 79(101) 191(343) 5(56) 251(0)	500	100.90
101	251(0) 28(267) 34(233) 251(0)	500	145.84
102	251(0) 221(197) 129(84) 211(219) 251(0)	500	113.97
103	251(0) 142(439) 251(0)	439	38.83
104	251(0) 70(99) 108(70) 76(225) 154(97) 251(0)	491	88.19
105	251(0) 145(429) 251(0)	429	43.08
106	251(0) 211(57) 90(391) 251(0)	448	89.49
107	251(0) 100(163) 4(337) 251(0)	500	67.11
108	251(0) 231(129) 229(371) 251(0)	500	106.10
109	251(0) 155(411) 232(87) 251(0)	498	77.54
110	251(0) 133(343) 5(157) 251(0)	500	91.81
111	251(0) 188(54) 95(283) 81(77) 100(71) 251(0)	485	126.22
112	251(0) 234(150) 33(244) 251(0)	394	29.26
113	251(0) 188(24) 182(416) 34(27) 251(0)	467	140.73
114	251(0) 231(5) 139(267) 68(217) 251(0)	489	92.24
115	251(0) 79(189) 19(108) 72(203) 251(0)	500	86.20
116	251(0) 133(21) 12(251) 49(224) 251(0)	496	114.65
117	251(0) 1(303) 229(74) 205(123) 251(0)	500	137.44
118	251(0) 172(81) 140(61) 7(119) 164(100) 186(132) 251(0)	493	120.44
119	251(0) 99(179) 244(274) 251(0)	453	51.85
120	251(0) 87(333) 154(147) 251(0)	480	110.14
121	251(0) 209(75) 115(306) 251(0)	381	49.34
122	251(0) 160(402) 251(0)	402	122.00
123	251(0) 19(171) 185(329) 251(0)	500	69.37
124	251(0) 138(78) 21(386) 251(0)	464	32.41
125	251(0) 130(378) 61(95) 251(0)	473	118.93
		Total Distance	13258.26

Table B.34: IDH solution to MDSD9 with demand range [.1, .9].

	Route	Load	Distance
1	0 169(204) 171(284) 0	488	96.88
2	0 161(97) 93(30) 245(366) 0	493	162.74
3	0 110(93) 60(56) 20(227) 109(88) 0	464	89.68
4	0 236(89) 120(241) 22(159) 0	489	59.68
5	0 227(75) 97(407) 0	482	92.21
6	0 51(166) 29(233) 227(101) 0	500	122.50
7	0 222(62) 165(438) 0	500	76.06
8	0 45(274) 187(217) 0	491	97.98
9	0 77(302) 212(193) 0	495	133.71
10	0 105(64) 181(409) 0	473	95.05
11	0 132(140) 67(354) 0	494	119.89
12	0 111(322) 0	322	30.53
13	0 151(198) 94(302) 0	500	176.42
14	0 178(128) 92(372) 0	500	44.01
15	0 48(25) 128(57) 50(418) 0	500	141.42
16	0 93(90) 91(410) 0	500	123.90
17	0 151(176) 86(272) 0	448	182.95
18	0 85(315) 105(185) 0	500	63.19
19	0 98(8) 240(238) 117(252) 0	498	60.52
20	0 109(358) 210(142) 0	500	78.59
21	0 200(221) 180(259) 63(1) 0	481	108.53
22	0 63(62) 216(84) 149(291) 88(63) 0	500	209.01
23	0 134(173) 159(162) 158(155) 0	490	170.46
24	0 44(404) 199(81) 0	485	90.20
25	0 179(67) 46(403) 161(18) 0	488	103.50
26	0 196(232) 48(268) 0	500	39.89
27	0 143(291) 174(147) 0	438	44.15
28	0 14(354) 174(146) 0	500	53.30
29	0 98(83) 107(63) 247(354) 0	500	175.78
30	0 222(198) 6(281) 0	479	91.25
31	0 236(60) 23(301) 196(139) 0	500	43.18
32	0 41(194) 210(191) 178(115) 0	500	67.73
33	0 37(370) 222(130) 0	500	83.86

(cont.)

Table B.34 continued.

	Route	Load	Distance
34	250(0) 131(70) 89(203) 167(89) 13(136) 250(0)	498	143.56
35	250(0) 56(243) 38(193) 250(0)	436	38.74
36	250(0) 47(285) 66(215) 250(0)	500	60.66
37	250(0) 52(56) 75(400) 250(0)	456	111.19
38	250(0) 26(337) 114(163) 250(0)	500	125.18
39	250(0) 39(254) 102(103) 15(104) 250(0)	461	85.29
40	250(0) 153(330) 26(97) 148(73) 250(0)	500	138.19
41	250(0) 249(175) 177(322) 250(0)	497	84.42
42	250(0) 157(105) 249(214) 62(181) 250(0)	500	74.84
43	250(0) 11(271) 57(171) 131(58) 250(0)	500	63.71
44	250(0) 242(397) 250(0)	397	18.97
45	250(0) 42(269) 80(229) 250(0)	498	51.62
46	250(0) 176(194) 233(306) 250(0)	500	69.08
47	250(0) 225(64) 82(57) 235(313) 241(66) 250(0)	500	64.25
48	250(0) 43(111) 223(389) 250(0)	500	48.46
49	250(0) 69(82) 163(181) 64(131) 125(92) 250(0)	486	124.75
50	250(0) 32(154) 226(237) 136(109) 250(0)	500	111.43
51	250(0) 131(171) 10(329) 250(0)	500	48.76
52	250(0) 118(54) 123(335) 43(108) 250(0)	497	118.25
53	250(0) 193(310) 203(178) 250(0)	488	85.46
54	250(0) 225(127) 224(342) 250(0)	469	82.50
55	250(0) 47(61) 17(245) 40(178) 250(0)	484	122.84
56	250(0) 249(29) 69(115) 190(238) 8(101) 250(0)	483	136.21
57	250(0) 215(91) 126(202) 116(199) 250(0)	492	173.69
58	250(0) 84(214) 16(181) 243(102) 250(0)	497	126.78
59	250(0) 122(141) 146(359) 250(0)	500	82.16
60	250(0) 9(194) 148(300) 250(0)	494	131.71
61	250(0) 162(239) 59(69) 136(150) 176(34) 250(0)	492	111.88
62	250(0) 118(130) 3(370) 250(0)	500	123.32
63	250(0) 197(449) 250(0)	449	40.00
64	250(0) 237(443) 62(57) 250(0)	500	78.45
65	250(0) 168(78) 55(412) 250(0)	490	68.46
66	250(0) 66(152) 103(168) 113(132) 250(0)	452	57.03

(cont.)

Table B.34 continued.

	Route	Load	Distance
67	250(0) 57(155) 203(223) 214(122) 250(0)	500	58.65
68	250(0) 189(167) 106(323) 250(0)	490	196.80
69	250(0) 230(399) 170(99) 250(0)	498	139.57
70	250(0) 219(343) 15(150) 250(0)	493	91.31
71	250(0) 175(59) 24(168) 147(273) 250(0)	500	158.17
72	250(0) 127(364) 24(83) 250(0)	447	148.78
73	250(0) 84(150) 135(325) 122(25) 250(0)	500	96.18
74	250(0) 101(92) 114(14) 248(263) 121(131) 250(0)	500	175.42
75	250(0) 194(347) 80(153) 250(0)	500	45.65
76	250(0) 32(90) 201(301) 78(109) 250(0)	500	120.68
77	250(0) 10(77) 238(423) 250(0)	500	45.37
78	251(0) 36(326) 220(114) 206(32) 251(0)	472	107.43
79	251(0) 211(276) 221(197) 251(0)	473	89.84
80	251(0) 191(160) 79(290) 5(50) 251(0)	500	61.16
81	251(0) 185(18) 72(203) 19(279) 251(0)	500	87.82
82	251(0) 133(337) 5(163) 251(0)	500	40.57
83	251(0) 133(27) 205(123) 31(261) 129(84) 251(0)	495	146.34
84	251(0) 36(55) 150(445) 251(0)	500	111.58
85	251(0) 124(252) 251(0)	252	15.23
86	251(0) 49(224) 12(251) 251(0)	475	37.16
87	251(0) 207(299) 166(140) 30(59) 251(0)	498	67.70
88	251(0) 61(95) 90(391) 251(0)	486	62.83
89	251(0) 2(83) 170(32) 58(274) 183(111) 251(0)	500	129.77
90	251(0) 206(232) 65(189) 228(79) 251(0)	500	91.68
91	251(0) 191(183) 185(311) 251(0)	494	78.20
92	251(0) 213(100) 112(238) 96(144) 251(0)	482	116.28
93	251(0) 18(99) 198(97) 73(130) 204(174) 251(0)	500	68.48
94	251(0) 130(378) 251(0)	378	55.17
95	251(0) 173(348) 137(116) 251(0)	464	40.77
96	251(0) 83(191) 217(173) 251(0)	364	87.98
97	251(0) 18(47) 54(409) 251(0)	456	40.64
98	251(0) 53(411) 228(89) 251(0)	500	50.41
99	251(0) 27(160) 195(309) 251(0)	469	87.68

(cont.)

Table B.34 continued.

	Route	Load	Distance
100	252(0) 70(99) 142(401) 252(0)	500	123.69
101	252(0) 4(337) 252(0)	337	38.47
102	252(0) 68(291) 142(38) 99(124) 252(0)	453	126.71
103	252(0) 209(75) 234(150) 33(244) 252(0)	469	129.20
104	252(0) 138(78) 21(386) 252(0)	464	86.91
105	252(0) 34(260) 95(199) 252(0)	459	26.99
106	252(0) 229(445) 99(55) 252(0)	500	187.34
107	252(0) 100(234) 186(132) 81(77) 252(0)	443	75.63
108	252(0) 232(72) 202(421) 252(0)	493	153.67
109	252(0) 28(135) 35(365) 252(0)	500	84.09
110	252(0) 76(225) 154(244) 252(0)	469	71.23
111	252(0) 192(77) 184(415) 252(0)	492	107.88
112	252(0) 164(100) 25(395) 252(0)	495	109.95
113	252(0) 115(48) 145(429) 252(0)	477	62.70
114	252(0) 239(99) 119(53) 218(200) 156(100) 28(34) 252(0)	486	122.65
115	252(0) 7(56) 141(444) 252(0)	500	107.20
116	252(0) 140(61) 104(125) 74(191) 172(81) 252(0)	458	128.61
117	252(0) 139(267) 71(210) 252(0)	477	185.64
118	252(0) 1(303) 231(134) 232(15) 244(32) 252(0)	484	203.21
119	252(0) 152(73) 144(415) 252(0)	488	120.20
120	252(0) 108(70) 155(411) 252(0)	481	101.04
121	252(0) 160(402) 28(98) 252(0)	500	69.16
122	252(0) 7(63) 246(250) 208(155) 252(0)	468	103.05
123	252(0) 244(242) 115(258) 252(0)	500	80.90
124	252(0) 95(84) 182(416) 252(0)	500	34.22
125	252(0) 188(78) 87(333) 252(0)	411	37.04
		Total Distance	11959.27

Table B.35: IDH solution to MDSD10 with demand range [.1, .9].

	Route	Load	Distance
1	0 222(219) 6(281) 0	500	81.72
2	0 236(15) 199(81) 44(404) 0	500	84.19
3	0 174(293) 143(207) 0	500	45.61
4	0 132(90) 181(409) 0	499	103.12
5	0 222(130) 37(370) 0	500	74.13
6	0 22(159) 120(241) 236(100) 0	500	53.60
7	0 111(322) 0	322	22.63
8	0 20(227) 227(40) 29(233) 0	500	85.46
9	0 97(407) 132(50) 105(43) 0	500	79.91
10	0 109(446) 0	446	76.97
11	0 222(41) 165(438) 85(21) 0	500	69.67
12	0 171(284) 162(167) 169(43) 0	494	102.97
13	0 210(27) 110(93) 60(56) 158(155) 227(136) 0	467	111.87
14	0 41(194) 210(306) 0	500	71.44
15	0 169(161) 52(56) 16(181) 243(102) 0	500	128.11
16	0 98(91) 240(238) 107(63) 0	392	83.82
17	0 48(293) 196(206) 0	499	38.13
18	0 196(165) 23(301) 236(34) 0	500	39.52
19	0 105(206) 85(294) 0	500	56.94
20	0 117(252) 178(243) 0	495	76.71
21	0 14(354) 143(84) 128(57) 0	495	74.27
22	0 92(372) 0	372	37.20
23	250(0) 238(423) 10(77) 250(0)	500	118.93
24	250(0) 242(140) 241(66) 11(271) 250(0)	477	121.97
25	250(0) 136(143) 15(254) 102(103) 250(0)	500	89.46
26	250(0) 226(237) 32(244) 250(0)	481	50.44
27	250(0) 17(71) 40(178) 24(251) 250(0)	500	54.98
28	250(0) 78(109) 67(354) 250(0)	463	59.60
29	250(0) 56(243) 242(257) 250(0)	500	81.36
30	250(0) 223(299) 225(191) 250(0)	490	115.24
31	250(0) 113(118) 80(382) 250(0)	500	75.28
32	250(0) 223(90) 43(219) 122(166) 250(0)	475	112.91
33	250(0) 55(86) 47(346) 175(59) 250(0)	491	40.08

(cont.)

Table B.35 continued.

	Route	Load	Distance
34	250(0) 127(364) 147(136) 250(0)	500	93.71
35	250(0) 17(174) 55(326) 250(0)	500	48.13
36	250(0) 59(69) 162(72) 75(359) 250(0)	500	84.29
37	250(0) 10(250) 197(247) 250(0)	497	110.58
38	250(0) 103(29) 42(269) 197(202) 250(0)	500	95.16
39	250(0) 66(367) 168(78) 250(0)	445	58.61
40	250(0) 214(122) 131(299) 10(79) 250(0)	500	130.80
41	250(0) 147(137) 159(162) 134(173) 250(0)	472	128.81
42	250(0) 75(41) 219(343) 136(116) 250(0)	500	86.74
43	250(0) 103(139) 194(347) 113(14) 250(0)	500	80.06
44	250(0) 51(166) 201(301) 250(0)	467	72.45
45	250(0) 176(187) 233(306) 250(0)	493	65.71
46	250(0) 38(193) 39(254) 176(41) 250(0)	488	94.23
47	251(0) 91(410) 192(77) 251(0)	487	73.37
48	251(0) 50(198) 77(302) 251(0)	500	87.83
49	251(0) 179(67) 161(115) 187(184) 93(120) 251(0)	486	101.87
50	251(0) 144(415) 251(0)	415	25.46
51	251(0) 28(137) 4(337) 251(0)	474	117.57
52	251(0) 119(53) 149(291) 218(151) 251(0)	495	92.14
53	251(0) 245(280) 50(220) 251(0)	500	76.21
54	251(0) 160(400) 156(100) 251(0)	500	86.63
55	251(0) 141(444) 208(52) 251(0)	496	134.89
56	251(0) 215(91) 116(199) 126(202) 251(0)	492	180.31
57	251(0) 25(395) 208(103) 251(0)	498	119.84
58	251(0) 160(2) 7(119) 246(250) 152(73) 180(53) 251(0)	497	136.47
59	251(0) 245(77) 151(374) 218(49) 251(0)	500	83.97
60	251(0) 34(260) 95(240) 251(0)	500	68.36
61	251(0) 94(228) 86(272) 251(0)	500	89.43
62	251(0) 184(415) 251(0)	415	26.00
63	251(0) 187(33) 45(274) 212(193) 251(0)	500	131.60
64	251(0) 216(84) 46(403) 251(0)	487	76.39
65	251(0) 245(9) 88(63) 247(354) 94(74) 251(0)	500	117.14
66	251(0) 104(125) 74(191) 140(61) 164(100) 251(0)	477	160.16

(cont.)

Table B.35 continued.

	Route	Load	Distance
67	251(0) 180(206) 200(221) 63(63) 251(0)	490	89.01
68	251(0) 182(370) 28(130) 251(0)	500	57.43
69	251(0) 35(365) 239(99) 251(0)	464	25.32
70	251(0) 87(333) 188(78) 95(43) 182(46) 251(0)	500	104.52
71	252(0) 228(132) 124(252) 137(116) 252(0)	500	83.22
72	252(0) 69(178) 177(322) 252(0)	500	93.92
73	252(0) 207(299) 73(130) 252(0)	429	57.74
74	252(0) 157(105) 82(57) 57(326) 252(0)	488	140.79
75	252(0) 54(409) 252(0)	409	22.36
76	252(0) 53(411) 228(36) 252(0)	447	77.42
77	252(0) 224(342) 64(131) 252(0)	473	87.16
78	252(0) 13(136) 167(89) 89(203) 153(72) 252(0)	500	152.41
79	252(0) 114(98) 101(92) 193(310) 252(0)	500	103.30
80	252(0) 195(268) 217(72) 27(160) 252(0)	500	56.54
81	252(0) 135(325) 62(156) 252(0)	481	134.56
82	252(0) 96(144) 213(100) 112(238) 252(0)	482	96.45
83	252(0) 36(381) 217(101) 252(0)	482	74.89
84	252(0) 69(19) 237(443) 252(0)	462	101.00
85	252(0) 18(146) 30(59) 198(97) 204(174) 252(0)	476	64.11
86	252(0) 146(136) 84(364) 252(0)	500	137.19
87	252(0) 170(48) 9(194) 153(258) 252(0)	500	106.41
88	252(0) 83(144) 183(82) 58(274) 252(0)	500	84.61
89	252(0) 123(92) 118(184) 146(223) 252(0)	499	137.13
90	252(0) 65(189) 206(264) 83(47) 252(0)	500	83.07
91	252(0) 249(418) 62(82) 252(0)	500	107.51
92	252(0) 121(131) 106(323) 189(44) 252(0)	498	156.42
93	252(0) 195(41) 170(60) 230(399) 252(0)	500	89.69
94	252(0) 173(348) 252(0)	348	18.11
95	252(0) 170(23) 26(212) 148(182) 2(83) 252(0)	500	93.67
96	252(0) 220(114) 189(123) 248(263) 252(0)	500	135.89
97	252(0) 3(370) 8(101) 252(0)	471	121.98
98	252(0) 123(243) 190(238) 252(0)	481	112.30
99	252(0) 114(79) 148(191) 26(222) 252(0)	492	97.58

(cont.)

Table B.35 continued.

	Route	Load	Distance
100	252(0) 125(92) 203(401) 252(0)	493	121.10
101	252(0) 163(181) 235(313) 252(0)	494	115.73
102	252(0) 150(445) 183(29) 252(0)	474	80.73
103	253(0) 1(303) 31(74) 205(123) 253(0)	500	173.61
104	253(0) 5(25) 130(378) 61(95) 253(0)	498	73.16
105	253(0) 191(343) 253(0)	343	13.42
106	253(0) 166(140) 72(203) 19(157) 253(0)	500	66.80
107	253(0) 138(42) 100(234) 186(132) 172(81) 253(0)	489	125.77
108	253(0) 71(32) 229(445) 31(8) 253(0)	485	149.23
109	253(0) 33(41) 234(150) 21(309) 253(0)	500	107.43
110	253(0) 12(251) 49(224) 253(0)	475	45.65
111	253(0) 31(179) 68(230) 99(91) 253(0)	500	162.60
112	253(0) 244(31) 76(225) 154(244) 253(0)	500	164.55
113	253(0) 19(122) 185(329) 253(0)	451	30.55
114	253(0) 21(35) 145(429) 138(36) 253(0)	500	113.68
115	253(0) 21(42) 81(77) 115(306) 209(75) 253(0)	500	136.00
116	253(0) 244(243) 108(70) 70(99) 99(88) 253(0)	500	138.41
117	253(0) 90(219) 221(197) 129(84) 253(0)	500	81.16
118	253(0) 5(136) 133(364) 253(0)	500	20.11
119	253(0) 71(178) 139(267) 231(55) 253(0)	500	160.94
120	253(0) 68(61) 142(439) 253(0)	500	113.33
121	253(0) 232(87) 155(411) 253(0)	498	157.79
122	253(0) 33(203) 79(290) 253(0)	493	61.68
123	253(0) 5(52) 90(172) 211(276) 253(0)	500	52.85
124	253(0) 231(79) 202(421) 253(0)	500	154.23
		Total Distance	11377.30

Table B.36: IDH solution to MDSD1 with demand range [.3, .7].

	Route	Load	Distance
1	0 41(39) 13(41) 0	80	35.69
2	0 4(36) 17(32) 37(12) 0	80	30.88
3	0 41(3) 40(40) 19(37) 0	80	43.05
4	0 44(12) 15(55) 37(13) 0	80	36.64
5	0 44(31) 42(49) 0	80	31.53
6	51(0) 22(45) 1(35) 51(0)	80	41.77
7	51(0) 27(50) 6(24) 51(0)	74	28.46
8	51(0) 23(13) 43(25) 7(42) 51(0)	80	73.52
9	51(0) 46(27) 11(53) 51(0)	80	24.48
10	51(0) 12(49) 47(26) 51(0)	75	23.50
11	51(0) 8(29) 26(49) 51(0)	78	57.39
12	51(0) 25(31) 18(47) 51(0)	78	49.03
13	51(0) 8(19) 48(36) 23(25) 51(0)	80	62.48
14	51(0) 14(29) 24(48) 51(0)	77	53.94
15	51(0) 31(47) 28(26) 1(7) 51(0)	80	66.21
16	51(0) 32(48) 46(12) 51(0)	60	21.46
17	52(0) 9(18) 34(50) 52(0)	68	24.01
18	52(0) 49(26) 10(50) 52(0)	76	19.50
19	52(0) 39(42) 30(33) 52(0)	75	38.08
20	52(0) 16(28) 50(36) 9(16) 52(0)	80	26.10
21	52(0) 45(35) 33(42) 52(0)	77	50.22
22	52(0) 5(27) 38(37) 52(0)	64	24.14
23	53(0) 20(24) 3(31) 35(25) 53(0)	80	39.56
24	53(0) 20(22) 2(51) 29(7) 53(0)	80	32.47
25	53(0) 29(25) 21(55) 53(0)	80	18.29
26	53(0) 35(10) 36(53) 53(0)	63	38.47
		Total Distance	990.85

Table B.37: IDH solution to MDSD2 with demand range [.3, .7].

	Route	Load	Distance
1	0 68(94) 4(46) 0	140	21.63
2	0 26(42) 67(75) 0	117	17.12
3	0 75(38) 34(54) 46(48) 0	140	26.86
4	0 6(92) 75(40) 0	132	19.84
5	76(0) 48(73) 30(59) 76(0)	132	17.37
6	76(0) 13(50) 52(65) 76(0)	115	42.73
7	76(0) 15(45) 57(47) 27(45) 76(0)	137	41.61
8	76(0) 5(6) 20(75) 37(59) 76(0)	140	36.20
9	76(0) 2(59) 74(79) 76(0)	138	31.97
10	76(0) 21(24) 61(52) 28(64) 76(0)	140	47.65
11	76(0) 45(82) 29(42) 76(0)	124	16.94
12	76(0) 21(38) 47(28) 5(74) 76(0)	140	29.60
13	76(0) 36(30) 60(60) 70(47) 76(0)	137	50.04
14	76(0) 47(18) 69(43) 71(58) 36(21) 76(0)	140	46.78
15	77(0) 35(86) 77(0)	86	10.00
16	77(0) 53(6) 11(22) 65(95) 77(0)	123	32.88
17	77(0) 53(47) 38(93) 77(0)	140	27.64
18	77(0) 7(54) 8(84) 77(0)	138	24.14
19	77(0) 54(52) 19(79) 77(0)	131	36.94
20	77(0) 58(68) 10(55) 77(0)	123	40.41
21	77(0) 11(53) 66(87) 77(0)	140	34.40
22	77(0) 59(65) 14(48) 77(0)	113	35.40
23	78(0) 16(47) 17(66) 78(0)	113	32.33
24	78(0) 44(49) 3(90) 78(0)	139	12.00
25	78(0) 24(44) 49(80) 78(0)	124	39.95
26	78(0) 12(52) 40(80) 78(0)	132	23.83
27	78(0) 32(39) 50(40) 18(61) 78(0)	140	41.58
28	78(0) 9(95) 32(29) 78(0)	124	29.79
29	78(0) 50(47) 25(93) 78(0)	140	43.73
30	78(0) 31(62) 55(74) 78(0)	136	82.57
31	78(0) 39(55) 72(82) 78(0)	137	38.84
32	78(0) 51(96) 78(0)	96	14.42
33	79(0) 43(28) 41(53) 42(52) 79(0)	133	20.65

(cont.)

Table B.37 continued.

	Route	Load	Distance
34	79(0) 22(49) 62(82) 79(0)	131	27.28
35	79(0) 63(55) 23(85) 79(0)	140	31.26
36	79(0) 73(52) 33(57) 63(11) 79(0)	120	29.24
37	79(0) 64(97) 79(0)	97	31.62
38	79(0) 43(45) 56(95) 79(0)	140	30.65
39	79(0) 1(76) 79(0)	76	5.66
		Total Distance	1223.57

Table B.38: IDH solution to MDSD3 with demand range [.3, .7].

	Route	Load	Distance
1	0 43(45) 15(54) 0	99	43.90
2	0 93(30) 61(56) 98(14) 0	100	47.11
3	0 13(54) 0	54	14.14
4	0 56(63) 74(35) 0	98	39.81
5	0 73(4) 72(38) 4(51) 40(7) 0	100	44.48
6	0 14(52) 91(48) 0	100	51.39
7	0 87(63) 0	63	14.56
8	0 55(62) 54(35) 0	97	60.42
9	0 59(55) 92(35) 97(10) 0	100	30.01
10	0 39(44) 25(55) 0	99	65.68
11	0 57(49) 42(51) 0	100	30.15
12	0 96(2) 99(62) 93(36) 0	100	37.29
13	0 97(16) 98(34) 37(50) 0	100	32.46
14	0 21(35) 73(51) 0	86	22.65
15	0 44(50) 38(38) 14(12) 0	100	69.10
16	0 100(33) 85(67) 0	100	40.69
17	0 22(39) 75(60) 0	99	34.91
18	0 2(31) 41(66) 0	97	29.97
19	0 58(48) 40(52) 0	100	17.28
20	0 97(35) 95(65) 0	100	23.82
21	0 67(61) 23(36) 75(3) 0	100	72.47
22	0 61(11) 86(50) 16(33) 91(6) 0	100	64.79
23	101(0) 70(61) 31(31) 101(0)	92	45.77
24	101(0) 33(28) 81(59) 3(13) 101(0)	100	58.95
25	101(0) 5(23) 17(36) 84(41) 101(0)	100	61.03
26	101(0) 96(12) 5(36) 60(52) 101(0)	100	45.38
27	101(0) 88(40) 10(56) 101(0)	96	53.67
28	101(0) 78(57) 34(39) 81(4) 101(0)	100	73.70
29	101(0) 76(57) 77(41) 101(0)	98	39.47
30	101(0) 52(5) 7(33) 19(50) 48(12) 101(0)	100	68.44
31	101(0) 49(64) 64(35) 101(0)	99	103.18
32	101(0) 33(7) 9(56) 51(37) 101(0)	100	66.26
33	101(0) 53(67) 101(0)	67	8.94

(cont.)

Table B.38 continued.

	Route	Load	Distance
34	101(0) 45(31) 83(69) 101(0)	100	58.31
35	101(0) 33(33) 50(67) 101(0)	100	49.54
36	101(0) 6(30) 96(40) 94(30) 101(0)	100	31.46
37	101(0) 3(43) 79(37) 29(20) 101(0)	100	65.02
38	101(0) 24(68) 29(32) 101(0)	100	66.90
39	101(0) 36(34) 47(55) 48(4) 101(0)	93	82.82
40	101(0) 8(38) 46(43) 48(19) 101(0)	100	75.19
41	101(0) 66(53) 35(45) 101(0)	98	97.66
42	101(0) 30(31) 90(34) 63(32) 101(0)	97	76.30
43	101(0) 82(69) 18(31) 101(0)	100	47.74
44	101(0) 27(39) 101(0)	39	10.00
45	101(0) 1(54) 69(41) 101(0)	95	31.87
46	101(0) 52(52) 89(48) 101(0)	100	28.38
47	101(0) 71(32) 65(58) 51(10) 101(0)	100	99.90
48	101(0) 51(17) 20(38) 32(45) 101(0)	100	79.76
49	101(0) 88(8) 11(44) 62(48) 101(0)	100	67.11
50	101(0) 68(50) 80(39) 12(9) 101(0)	98	44.70
51	101(0) 28(31) 12(31) 26(38) 101(0)	100	33.80
		Total Distance	2558.33

Table B.39: IDH solution to MDSD4 with demand range [.3, .7].

	Route	Load	Distance
1	0 7(61) 82(136) 0	197	33.64
2	0 43(86) 15(108) 0	194	73.81
3	0 16(87) 61(113) 0	200	31.69
4	0 11(78) 62(122) 0	200	63.17
5	0 99(78) 96(122) 0	200	23.16
6	0 52(61) 31(130) 18(9) 0	200	47.62
7	0 91(77) 100(106) 0	183	36.42
8	0 60(66) 5(100) 0	166	11.71
9	0 18(87) 83(106) 0	193	16.02
10	0 42(104) 57(66) 87(26) 0	196	61.31
11	0 90(77) 63(106) 62(14) 0	197	76.35
12	0 98(120) 93(63) 0	183	29.12
13	0 10(127) 88(65) 0	192	58.35
14	0 6(78) 89(122) 0	200	27.28
15	0 17(103) 45(97) 0	200	28.73
16	0 6(39) 94(24) 95(104) 59(17) 99(15) 0	199	34.04
17	0 97(95) 87(104) 0	199	42.85
18	0 92(106) 59(80) 0	186	29.53
19	0 64(127) 49(73) 0	200	88.93
20	0 16(12) 44(83) 14(101) 0	196	52.55
21	0 84(134) 0	134	11.31
22	0 8(19) 36(128) 49(21) 48(32) 0	200	71.75
23	0 38(71) 86(120) 0	191	64.91
24	0 37(96) 85(97) 0	193	33.32
25	0 48(28) 19(79) 47(93) 0	200	55.56
26	0 94(97) 13(103) 0	200	36.10
27	0 8(76) 46(81) 45(32) 0	189	39.13
28	101(0) 79(136) 29(61) 101(0)	197	33.77
29	101(0) 74(22) 73(13) 2(76) 58(89) 101(0)	200	67.32
30	101(0) 55(11) 67(85) 23(88) 56(15) 101(0)	199	75.23
31	101(0) 9(32) 65(99) 66(69) 101(0)	200	95.46
32	101(0) 3(105) 77(95) 101(0)	200	21.07
33	101(0) 20(97) 32(89) 30(8) 101(0)	194	81.84

(cont.)

Table B.39 continued.

	Route	Load	Distance
34	101(0) 73(66) 21(134) 101(0)	200	42.29
35	101(0) 41(70) 22(130) 101(0)	200	62.04
36	101(0) 75(95) 74(94) 101(0)	189	52.11
37	101(0) 27(90) 28(110) 101(0)	200	41.47
38	101(0) 55(104) 25(96) 101(0)	200	36.06
39	101(0) 54(88) 24(108) 101(0)	196	26.32
40	101(0) 78(76) 34(106) 80(13) 101(0)	195	45.39
41	101(0) 68(108) 80(92) 101(0)	200	8.36
42	101(0) 71(116) 35(73) 101(0)	189	70.82
43	101(0) 77(35) 33(71) 81(85) 101(0)	191	39.07
44	101(0) 53(77) 58(42) 40(81) 101(0)	200	45.69
45	101(0) 1(109) 69(78) 101(0)	187	45.90
46	101(0) 72(77) 56(123) 101(0)	200	50.91
47	101(0) 26(114) 12(84) 101(0)	198	23.25
48	101(0) 51(125) 9(50) 81(25) 101(0)	200	55.09
49	101(0) 50(83) 76(70) 101(0)	153	29.03
50	101(0) 39(115) 4(84) 101(0)	199	47.97
51	101(0) 30(78) 70(122) 101(0)	200	61.81
		Total Distance	2336.65

Table B.40: IDH solution to MDSD5 with demand range [.3, .7].

	Route	Load	Distance
1	0 97(19) 13(48) 95(33) 0	100	32.32
2	0 86(41) 16(42) 0	83	22.50
3	0 44(67) 0	67	14.42
4	0 100(60) 91(36) 0	96	7.77
5	0 42(18) 15(52) 57(30) 0	100	47.33
6	0 38(63) 14(37) 0	100	39.21
7	0 93(45) 99(48) 0	93	15.64
8	0 85(41) 61(41) 0	82	11.71
9	0 6(33) 94(52) 0	85	30.34
10	0 98(50) 37(38) 0	88	10.54
11	0 97(38) 87(58) 0	96	27.45
12	0 5(27) 83(32) 60(41) 0	100	35.46
13	0 45(69) 84(31) 0	100	40.43
14	0 42(12) 43(69) 14(19) 0	100	41.73
15	0 92(30) 59(30) 96(40) 0	100	22.58
16	0 17(48) 84(34) 5(15) 0	97	34.35
17	101(0) 53(55) 58(33) 40(12) 101(0)	100	37.43
18	101(0) 72(2) 41(46) 22(34) 74(17) 101(0)	99	30.76
19	101(0) 4(64) 101(0)	64	10.00
20	101(0) 56(30) 75(39) 74(20) 101(0)	89	24.33
21	101(0) 39(24) 67(39) 23(37) 101(0)	100	50.52
22	101(0) 54(46) 24(54) 101(0)	100	42.61
23	101(0) 72(38) 73(62) 101(0)	100	14.87
24	101(0) 29(52) 68(47) 101(0)	99	54.55
25	101(0) 40(2) 28(58) 26(35) 101(0)	95	42.46
26	101(0) 39(30) 25(67) 101(0)	97	37.24
27	101(0) 55(68) 101(0)	68	26.68
28	101(0) 54(16) 80(38) 12(43) 101(0)	97	40.79
29	101(0) 2(45) 40(55) 101(0)	100	35.91
30	101(0) 21(57) 101(0)	57	10.00
31	102(0) 69(46) 1(54) 102(0)	100	21.20
32	102(0) 47(66) 48(30) 102(0)	96	55.63
33	102(0) 79(35) 3(63) 102(0)	98	49.05

(cont.)

Table B.40 continued.

	Route	Load	Distance
34	102(0) 52(50) 89(34) 102(0)	84	44.42
35	102(0) 90(49) 63(51) 102(0)	100	33.25
36	102(0) 90(15) 32(47) 20(38) 102(0)	100	42.03
37	102(0) 20(15) 71(34) 35(42) 9(9) 102(0)	100	63.27
38	102(0) 50(2) 77(44) 76(54) 102(0)	100	44.86
39	102(0) 82(31) 8(67) 102(0)	98	55.67
40	102(0) 66(56) 65(39) 102(0)	95	71.23
41	102(0) 64(48) 49(33) 36(14) 102(0)	95	84.78
42	102(0) 9(36) 81(36) 33(28) 102(0)	100	47.69
43	102(0) 30(60) 102(0)	60	14.14
44	102(0) 51(35) 50(51) 102(0)	86	39.92
45	102(0) 31(47) 88(50) 102(0)	97	19.49
46	102(0) 33(3) 78(45) 34(52) 102(0)	100	61.25
47	102(0) 69(20) 27(53) 102(0)	73	30.53
48	102(0) 70(68) 102(0)	68	4.47
49	102(0) 62(47) 10(53) 102(0)	100	24.80
50	102(0) 88(5) 7(57) 18(38) 102(0)	100	47.02
51	102(0) 11(34) 19(62) 62(1) 102(0)	97	45.72
52	102(0) 36(44) 46(56) 102(0)	100	79.11
		Total Distance	1871.47

Table B.41: IDH solution to MDSD6 with demand range [.3, .7].

	Route	Load	Distance
1	0 99(50) 5(50) 0	100	21.70
2	0 89(60) 6(37) 0	97	27.28
3	0 61(20) 16(32) 86(44) 0	96	42.45
4	0 17(59) 84(33) 0	92	22.92
5	0 18(62) 0	62	14.14
6	0 8(13) 36(56) 46(31) 0	100	58.61
7	0 8(29) 45(67) 0	96	25.32
8	0 8(12) 47(39) 49(49) 0	100	68.96
9	0 82(52) 48(47) 0	99	34.50
10	0 96(40) 59(60) 0	100	26.32
11	0 60(54) 0	54	4.47
12	0 61(30) 91(42) 85(28) 0	100	33.43
13	0 83(61) 0	61	4.47
14	0 99(11) 59(9) 93(39) 85(41) 0	100	31.40
15	101(0) 78(43) 79(53) 101(0)	96	36.84
16	101(0) 24(36) 29(49) 101(0)	85	28.47
17	101(0) 55(16) 25(51) 54(33) 101(0)	100	36.39
18	101(0) 34(68) 3(30) 101(0)	98	46.50
19	101(0) 77(18) 33(33) 50(49) 101(0)	100	39.48
20	101(0) 26(66) 12(6) 101(0)	72	23.25
21	101(0) 80(59) 101(0)	59	4.47
22	101(0) 68(47) 77(15) 76(36) 101(0)	98	22.47
23	101(0) 4(66) 55(34) 101(0)	100	37.97
24	101(0) 28(61) 12(39) 101(0)	100	28.36
25	102(0) 13(31) 94(44) 102(0)	75	22.94
26	102(0) 23(33) 56(67) 102(0)	100	51.98
27	102(0) 40(35) 21(59) 102(0)	94	24.14
28	102(0) 37(14) 100(24) 44(62) 102(0)	100	50.63
29	102(0) 43(47) 14(52) 102(0)	99	53.80
30	102(0) 2(66) 102(0)	66	6.00
31	102(0) 22(33) 41(60) 102(0)	93	33.15
32	102(0) 72(57) 73(43) 102(0)	100	25.30
33	102(0) 57(35) 15(36) 102(0)	71	31.64

(cont.)

Table B.41 continued.

	Route	Load	Distance
34	102(0) 58(34) 53(62) 102(0)	96	22.36
35	102(0) 98(51) 37(49) 102(0)	100	32.45
36	102(0) 42(48) 87(47) 102(0)	95	28.09
37	102(0) 100(34) 38(57) 14(9) 102(0)	100	69.04
38	102(0) 95(64) 97(36) 102(0)	100	23.82
39	102(0) 22(12) 75(48) 74(40) 102(0)	100	34.91
40	102(0) 4(2) 39(39) 67(34) 56(1) 73(15) 102(0)	91	74.77
41	102(0) 92(61) 97(32) 102(0)	93	26.37
42	103(0) 69(46) 1(54) 103(0)	100	14.16
43	103(0) 31(63) 103(0)	63	8.94
44	103(0) 9(49) 81(49) 103(0)	98	48.76
45	103(0) 11(69) 10(25) 103(0)	94	43.57
46	103(0) 88(7) 7(35) 19(40) 10(14) 103(0)	96	52.90
47	103(0) 51(14) 35(45) 65(41) 103(0)	100	82.00
48	103(0) 69(13) 27(50) 52(34) 103(0)	97	30.06
49	103(0) 70(41) 30(59) 103(0)	100	22.50
50	103(0) 62(56) 88(44) 103(0)	100	29.15
51	103(0) 32(38) 90(51) 10(11) 103(0)	100	41.72
52	103(0) 51(29) 71(58) 20(4) 30(8) 103(0)	99	59.55
53	103(0) 10(8) 63(60) 64(32) 103(0)	100	68.69
54	103(0) 20(35) 66(65) 103(0)	100	53.90
		Total Distance	1887.48

Table B.42: IDH solution to MDSD7 with demand range [.3, .7].

	Route	Load	Distance
1	0 207(168) 166(289) 96(43) 0	500	84.09
2	0 30(213) 18(223) 54(44) 0	480	95.12
3	0 228(98) 53(188) 173(199) 0	485	136.82
4	0 24(251) 40(242) 0	493	219.92
5	0 190(188) 8(225) 112(87) 0	500	75.03
6	0 112(131) 213(334) 0	465	80.38
7	0 177(191) 69(256) 0	447	35.12
8	0 123(195) 3(183) 190(122) 0	500	78.29
9	0 39(261) 84(210) 0	471	105.20
10	0 16(334) 118(162) 0	496	105.82
11	0 175(312) 17(156) 0	468	195.97
12	0 15(147) 75(346) 0	493	139.02
13	0 157(344) 224(156) 0	500	45.65
14	0 73(232) 198(161) 0	393	57.87
15	0 219(197) 52(303) 0	500	132.51
16	0 176(248) 233(252) 0	500	128.62
17	0 177(103) 146(162) 135(177) 0	442	74.71
18	0 230(127) 153(203) 9(166) 0	496	105.53
19	0 54(240) 204(260) 0	500	71.30
20	0 61(168) 130(321) 0	489	174.54
21	0 131(306) 214(194) 0	500	91.22
22	0 206(308) 83(172) 0	480	110.32
23	0 58(243) 183(237) 0	480	100.37
24	0 237(1) 233(7) 136(11) 32(210) 201(271) 0	500	199.59
25	0 129(206) 221(253) 61(41) 0	500	188.19
26	0 193(150) 101(223) 64(127) 0	500	63.56
27	0 55(303) 47(197) 0	500	171.19
28	0 13(301) 26(197) 0	498	125.21
29	0 43(34) 223(302) 225(164) 0	500	78.34
30	0 27(184) 125(296) 0	480	73.73
31	0 47(50) 168(198) 66(252) 0	500	167.86
32	0 185(271) 19(180) 207(49) 0	500	122.71
33	0 127(152) 147(329) 0	481	262.75

(cont.)

Table B.42 continued.

	Route	Load	Distance
34	0 214(97) 10(60) 56(343) 0	500	136.15
35	0 241(220) 57(16) 203(264) 0	500	90.51
36	0 114(332) 148(168) 0	500	80.44
37	0 80(20) 113(195) 103(283) 66(2) 0	500	164.42
38	0 38(252) 242(243) 0	495	104.61
39	0 195(264) 217(229) 0	493	75.29
40	0 49(239) 12(247) 0	486	139.14
41	0 2(248) 170(252) 0	500	73.62
42	0 9(45) 248(261) 189(194) 0	500	139.33
43	0 124(240) 137(251) 0	491	121.61
44	0 220(335) 230(117) 170(36) 0	488	125.95
45	0 191(160) 5(150) 133(151) 0	461	128.39
46	0 96(107) 19(128) 79(252) 0	487	140.41
47	0 167(165) 89(294) 114(4) 0	463	132.73
48	0 102(163) 15(8) 136(329) 0	500	146.47
49	0 235(213) 241(14) 11(273) 0	500	71.04
50	0 197(92) 42(213) 10(193) 0	498	144.92
51	0 57(180) 238(292) 131(28) 0	500	112.76
52	0 163(269) 64(200) 0	469	32.81
53	0 249(171) 122(178) 43(135) 0	484	74.79
54	0 65(245) 228(249) 0	494	150.19
55	0 36(229) 150(247) 0	476	111.10
56	0 49(31) 90(155) 211(307) 0	493	166.49
57	0 80(131) 194(281) 197(88) 0	500	151.18
58	0 237(308) 62(192) 0	500	47.59
59	0 78(261) 32(31) 226(198) 0	490	187.10
60	0 106(236) 121(238) 248(8) 0	482	166.32
61	0 224(110) 82(344) 0	454	44.41
62	250(0) 212(312) 77(184) 250(0)	496	135.18
63	250(0) 50(205) 77(44) 91(236) 250(0)	485	119.92
64	250(0) 126(44) 215(254) 104(23) 141(179) 250(0)	500	95.33
65	250(0) 164(38) 209(276) 138(186) 250(0)	500	165.43
66	250(0) 181(178) 59(206) 171(116) 250(0)	500	151.64

(cont.)

Table B.42 continued.

	Route	Load	Distance
67	250(0) 25(23) 104(250) 74(227) 250(0)	500	79.05
68	250(0) 110(184) 109(316) 250(0)	500	181.45
69	250(0) 169(184) 243(316) 250(0)	500	130.72
70	250(0) 239(11) 35(192) 34(257) 95(40) 250(0)	500	147.99
71	250(0) 111(239) 236(171) 22(90) 250(0)	500	79.96
72	250(0) 182(338) 28(162) 250(0)	500	102.13
73	250(0) 162(349) 169(63) 165(88) 250(0)	500	144.75
74	250(0) 37(97) 165(73) 6(330) 250(0)	500	94.66
75	250(0) 94(92) 86(207) 149(173) 245(14) 250(0)	486	163.40
76	250(0) 22(192) 120(308) 250(0)	500	57.31
77	250(0) 68(80) 71(24) 31(199) 205(197) 250(0)	500	271.31
78	250(0) 178(280) 92(167) 250(0)	447	150.61
79	250(0) 4(237) 81(263) 250(0)	500	123.92
80	250(0) 88(198) 247(265) 250(0)	463	160.96
81	250(0) 208(160) 152(340) 250(0)	500	42.84
82	250(0) 94(205) 151(281) 250(0)	486	144.96
83	250(0) 199(294) 250(0)	294	20.59
84	250(0) 186(175) 100(325) 250(0)	500	141.76
85	250(0) 246(249) 25(251) 250(0)	500	44.01
86	250(0) 144(348) 250(0)	348	82.46
87	250(0) 244(122) 232(333) 115(45) 250(0)	500	208.59
88	250(0) 105(177) 227(323) 250(0)	500	168.65
89	250(0) 244(70) 155(160) 231(270) 250(0)	500	248.13
90	250(0) 200(150) 63(161) 180(172) 250(0)	483	49.62
91	250(0) 117(189) 240(311) 250(0)	500	141.97
92	250(0) 99(211) 70(48) 108(241) 250(0)	500	189.79
93	250(0) 51(277) 67(209) 250(0)	486	202.77
94	250(0) 202(188) 139(271) 250(0)	459	259.27
95	250(0) 210(233) 41(267) 250(0)	500	170.01
96	250(0) 71(265) 229(127) 70(108) 250(0)	500	277.61
97	250(0) 132(188) 97(204) 171(56) 169(35) 250(0)	483	170.27
98	250(0) 1(276) 229(217) 250(0)	493	295.92
99	250(0) 244(102) 76(288) 154(110) 250(0)	500	188.66

(cont.)

Table B.42 continued.

	Route	Load	Distance
100	250(0) 222(171) 85(300) 250(0)	471	97.86
101	250(0) 33(257) 234(213) 250(0)	470	194.42
102	250(0) 208(94) 7(318) 250(0)	412	58.56
103	250(0) 216(265) 46(235) 250(0)	500	61.43
104	250(0) 160(274) 164(215) 250(0)	489	77.88
105	250(0) 179(23) 45(251) 187(164) 46(52) 250(0)	490	94.64
106	250(0) 179(149) 14(288) 174(63) 250(0)	500	109.72
107	250(0) 161(227) 93(250) 250(0)	477	74.91
108	250(0) 245(163) 218(153) 184(173) 250(0)	489	129.26
109	250(0) 246(99) 72(321) 74(46) 141(28) 250(0)	494	156.06
110	250(0) 115(107) 145(346) 81(47) 250(0)	500	147.54
111	250(0) 172(278) 140(177) 250(0)	455	102.82
112	250(0) 120(37) 196(226) 174(218) 250(0)	481	92.65
113	250(0) 37(237) 44(263) 250(0)	500	67.84
114	250(0) 158(80) 159(231) 134(179) 250(0)	490	265.96
115	250(0) 186(156) 21(342) 250(0)	498	142.85
116	250(0) 107(247) 240(26) 98(196) 250(0)	469	140.26
117	250(0) 95(70) 87(306) 154(124) 250(0)	500	171.37
118	250(0) 105(67) 29(187) 20(228) 250(0)	482	177.56
119	250(0) 48(271) 23(192) 250(0)	463	78.90
120	250(0) 128(168) 143(331) 250(0)	499	90.24
121	250(0) 28(88) 95(103) 188(309) 250(0)	500	117.64
122	250(0) 156(171) 239(329) 250(0)	500	107.19
123	250(0) 41(26) 110(21) 60(333) 158(120) 250(0)	500	207.71
124	250(0) 142(293) 68(207) 250(0)	500	210.39
125	250(0) 126(167) 116(328) 250(0)	495	79.37
126	250(0) 192(189) 119(311) 250(0)	500	121.10
		Total Distance	16136.07

Table B.43: IDH solution to MDSD8 with demand range [.3, .7].

	Route	Load	Distance
1	0 176(170) 136(132) 226(198) 0	500	157.51
2	0 144(19) 239(188) 35(192) 152(94) 0	493	196.22
3	0 169(282) 181(178) 171(40) 0	500	90.32
4	0 29(177) 227(323) 0	500	80.29
5	0 218(153) 184(136) 192(189) 0	478	168.70
6	0 179(172) 46(287) 0	459	100.53
7	0 240(253) 107(247) 0	500	82.77
8	0 59(206) 162(162) 171(132) 0	500	105.73
9	0 147(329) 127(152) 0	481	199.50
10	0 60(333) 158(123) 109(44) 0	500	108.84
11	0 110(205) 41(293) 0	498	85.35
12	0 98(196) 240(84) 117(189) 0	469	68.92
13	0 14(288) 174(169) 0	457	55.98
14	0 20(228) 109(272) 0	500	78.90
15	0 215(254) 126(211) 0	465	148.66
16	0 37(162) 116(328) 0	490	126.30
17	0 196(226) 48(271) 0	497	38.13
18	0 144(329) 156(171) 0	500	169.20
19	0 78(2) 17(156) 175(312) 0	470	209.12
20	0 45(148) 88(124) 50(205) 0	477	154.03
21	0 132(188) 210(233) 0	421	102.04
22	0 51(277) 97(204) 0	481	118.44
23	0 111(239) 236(171) 0	410	33.05
24	0 243(166) 16(334) 0	500	115.26
25	0 151(281) 86(145) 88(74) 0	500	184.08
26	0 247(265) 149(173) 86(62) 0	500	204.78
27	0 219(164) 15(155) 102(163) 0	482	132.41
28	0 239(152) 119(311) 184(37) 0	500	190.53
29	0 23(192) 120(301) 0	493	46.82
30	0 67(209) 201(271) 0	480	143.74
31	0 165(161) 6(330) 0	491	81.85
32	0 105(244) 0	244	41.76
33	0 32(241) 78(259) 0	500	145.07

(cont.)

Table B.43 continued.

	Route	Load	Distance
34	0 77(228) 91(236) 0	464	131.72
35	0 158(77) 159(231) 134(179) 29(10) 0	497	173.62
36	0 22(282) 44(218) 0	500	71.58
37	0 128(85) 93(250) 187(164) 0	499	97.79
38	0 174(112) 143(331) 0	443	45.61
39	0 200(150) 180(172) 63(161) 0	483	103.78
40	0 25(227) 104(273) 0	500	147.55
41	0 208(52) 246(348) 25(47) 44(45) 0	492	135.40
42	0 136(208) 233(259) 219(33) 0	500	149.65
43	0 85(300) 222(171) 0	471	49.11
44	0 94(297) 245(177) 0	474	178.00
45	0 92(167) 178(280) 0	447	51.62
46	0 243(150) 52(303) 162(33) 0	486	121.86
47	0 120(44) 152(246) 208(202) 0	492	133.16
48	0 74(273) 141(207) 0	480	152.66
49	0 212(312) 45(103) 128(83) 0	498	118.21
50	0 161(227) 216(265) 0	492	103.59
51	0 162(154) 75(346) 0	500	106.54
52	0 37(172) 199(294) 0	466	98.21
53	0 24(251) 40(242) 0	493	192.47
54	250(0) 224(231) 163(269) 250(0)	500	64.30
55	250(0) 82(121) 157(344) 224(35) 250(0)	500	75.15
56	250(0) 113(195) 103(283) 66(2) 250(0)	480	154.62
57	250(0) 203(264) 57(196) 250(0)	460	51.15
58	250(0) 43(169) 223(302) 250(0)	471	91.96
59	250(0) 131(208) 214(291) 250(0)	499	68.61
60	250(0) 42(213) 197(180) 10(101) 250(0)	494	124.53
61	250(0) 249(171) 237(309) 250(0)	480	88.52
62	250(0) 248(269) 189(194) 250(0)	463	79.59
63	250(0) 150(165) 220(335) 250(0)	500	76.55
64	250(0) 38(252) 176(78) 242(170) 250(0)	500	151.78
65	250(0) 206(225) 228(275) 250(0)	500	133.06
66	250(0) 27(32) 137(251) 173(199) 250(0)	482	115.89

(cont.)

Table B.43 continued.

	Route	Load	Distance
67	250(0) 69(256) 177(217) 250(0)	473	85.68
68	250(0) 47(197) 55(303) 250(0)	500	169.45
69	250(0) 106(236) 121(238) 250(0)	474	106.20
70	250(0) 84(210) 39(261) 250(0)	471	144.82
71	250(0) 195(29) 18(223) 30(213) 54(35) 250(0)	500	128.78
72	250(0) 146(162) 135(177) 118(155) 250(0)	494	139.05
73	250(0) 235(124) 122(178) 62(192) 250(0)	494	106.69
74	250(0) 148(168) 170(288) 250(0)	456	29.19
75	250(0) 230(55) 153(203) 9(211) 250(0)	469	46.14
76	250(0) 230(189) 150(82) 36(229) 250(0)	500	73.90
77	250(0) 89(294) 167(165) 250(0)	459	69.01
78	250(0) 242(73) 56(343) 10(84) 250(0)	500	129.36
79	250(0) 235(89) 241(234) 11(160) 250(0)	483	70.34
80	250(0) 183(237) 58(243) 250(0)	480	58.17
81	250(0) 54(130) 207(217) 73(153) 250(0)	500	132.13
82	250(0) 112(16) 213(334) 96(150) 250(0)	500	147.67
83	250(0) 195(235) 2(248) 250(0)	483	46.75
84	250(0) 101(27) 131(126) 238(292) 250(0)	445	85.09
85	250(0) 11(113) 225(164) 82(223) 250(0)	500	84.36
86	250(0) 54(119) 27(152) 217(229) 250(0)	500	113.70
87	250(0) 64(327) 193(150) 250(0)	477	45.28
88	250(0) 118(7) 3(183) 190(310) 250(0)	500	139.68
89	250(0) 228(72) 53(188) 124(240) 250(0)	500	159.48
90	250(0) 66(252) 168(198) 47(50) 250(0)	500	164.15
91	250(0) 83(172) 206(83) 65(245) 250(0)	500	107.96
92	250(0) 101(196) 125(296) 250(0)	492	39.34
93	250(0) 177(77) 123(195) 8(225) 250(0)	497	137.52
94	250(0) 73(79) 198(161) 204(260) 250(0)	500	107.82
95	250(0) 10(68) 194(281) 80(151) 250(0)	500	134.97
96	250(0) 114(336) 250(0)	336	7.21
97	250(0) 166(289) 112(202) 250(0)	491	148.82
98	250(0) 26(197) 13(301) 250(0)	498	64.10
99	251(0) 160(274) 164(226) 251(0)	500	122.89

(cont.)

Table B.43 continued.

	Route	Load	Distance
100	251(0) 79(159) 5(150) 133(151) 251(0)	460	92.98
101	251(0) 129(206) 49(270) 251(0)	476	129.29
102	251(0) 95(213) 28(250) 164(27) 251(0)	490	153.74
103	251(0) 12(247) 191(160) 79(93) 251(0)	500	113.67
104	251(0) 61(16) 130(321) 90(155) 251(0)	492	118.93
105	251(0) 34(191) 188(309) 251(0)	500	125.91
106	251(0) 231(270) 202(188) 251(0)	458	86.60
107	251(0) 234(213) 33(257) 251(0)	470	29.26
108	251(0) 186(198) 172(278) 251(0)	476	80.54
109	251(0) 209(101) 154(76) 76(288) 244(35) 251(0)	500	85.64
110	251(0) 154(158) 87(306) 251(0)	464	110.14
111	251(0) 185(179) 19(308) 251(0)	487	69.37
112	251(0) 205(197) 221(253) 251(0)	450	116.15
113	251(0) 140(177) 7(318) 251(0)	495	118.05
114	251(0) 4(47) 182(338) 34(66) 209(42) 251(0)	493	141.35
115	251(0) 232(333) 155(160) 251(0)	493	77.54
116	251(0) 1(276) 229(224) 251(0)	500	124.18
117	251(0) 185(92) 72(321) 251(0)	413	70.04
118	251(0) 100(325) 186(133) 138(28) 251(0)	486	56.32
119	251(0) 142(293) 68(178) 251(0)	471	41.50
120	251(0) 81(310) 4(190) 251(0)	500	69.08
121	251(0) 209(133) 70(156) 99(211) 251(0)	500	52.01
122	251(0) 108(241) 244(259) 251(0)	500	53.79
123	251(0) 61(193) 211(307) 251(0)	500	92.21
124	251(0) 145(346) 115(152) 251(0)	498	49.74
125	251(0) 138(158) 21(342) 251(0)	500	32.41
126	251(0) 31(199) 71(289) 251(0)	488	93.20
127	251(0) 229(120) 139(271) 68(109) 251(0)	500	112.16
		Total Distance	13444.18

Table B.44: IDH solution to MDSD9 with demand range [.3, .7].

	Route	Load	Distance
1	0 178(280) 92(167) 0	447	44.01
2	0 44(97) 199(294) 22(74) 0	465	92.08
3	0 109(316) 110(184) 0	500	81.18
4	0 105(244) 85(253) 0	497	63.19
5	0 20(228) 227(85) 29(187) 0	500	82.98
6	0 6(330) 165(161) 0	491	91.52
7	0 91(236) 77(228) 45(35) 0	499	131.34
8	0 212(312) 45(180) 0	492	113.65
9	0 158(200) 60(243) 110(21) 41(36) 0	500	106.20
10	0 98(196) 14(288) 0	484	60.74
11	0 51(277) 67(209) 0	486	128.27
12	0 88(198) 247(265) 240(26) 0	489	185.60
13	0 120(53) 22(208) 111(239) 0	500	60.50
14	0 44(166) 37(334) 0	500	91.91
15	0 86(207) 149(173) 151(120) 0	500	194.69
16	0 216(213) 46(287) 0	500	109.04
17	0 151(161) 94(297) 45(36) 0	494	176.43
18	0 132(58) 97(204) 227(238) 0	500	93.61
19	0 200(115) 245(177) 50(205) 0	497	172.86
20	0 210(233) 41(257) 0	490	65.66
21	0 117(189) 240(311) 0	500	59.08
22	0 174(281) 196(219) 0	500	39.27
23	0 143(331) 128(168) 0	499	62.49
24	0 60(90) 159(231) 134(179) 0	500	170.76
25	0 236(171) 120(292) 0	463	51.01
26	0 222(171) 169(282) 85(47) 0	500	93.38
27	0 132(130) 171(172) 181(178) 0	480	107.65
28	0 196(7) 179(172) 161(148) 187(164) 0	491	99.60
29	0 48(271) 23(192) 0	463	45.56
30	0 161(79) 216(52) 180(172) 63(161) 200(35) 0	499	114.77
31	0 107(247) 93(250) 0	497	115.98
32	250(0) 3(13) 215(254) 126(211) 250(0)	478	173.65
33	250(0) 121(238) 106(236) 248(26) 250(0)	500	193.33

(cont.)

Table B.44 continued.

	Route	Load	Distance
34	250(0) 43(169) 223(302) 250(0)	471	48.46
35	250(0) 24(251) 40(242) 250(0)	493	123.49
36	250(0) 78(32) 32(241) 226(198) 250(0)	471	110.75
37	250(0) 102(163) 16(334) 250(0)	497	116.41
38	250(0) 47(1) 55(303) 168(176) 250(0)	480	68.46
39	250(0) 80(151) 194(281) 197(68) 250(0)	500	48.47
40	250(0) 9(116) 230(244) 26(134) 250(0)	494	138.97
41	250(0) 168(22) 17(156) 175(312) 250(0)	490	97.50
42	250(0) 103(283) 113(195) 250(0)	478	55.64
43	250(0) 248(243) 189(194) 153(63) 250(0)	500	170.57
44	250(0) 235(154) 82(344) 250(0)	498	64.14
45	250(0) 11(273) 241(227) 250(0)	500	44.54
46	250(0) 56(343) 250(0)	343	14.56
47	250(0) 62(68) 177(66) 190(310) 118(37) 250(0)	481	133.44
48	250(0) 47(246) 66(254) 250(0)	500	60.66
49	250(0) 241(7) 235(59) 224(142) 163(269) 225(16) 250(0)	493	92.41
50	250(0) 147(329) 127(152) 250(0)	481	172.29
51	250(0) 249(171) 237(309) 250(0)	480	79.31
52	250(0) 122(178) 39(261) 250(0)	439	68.60
53	250(0) 136(340) 176(7) 250(0)	347	75.88
54	250(0) 59(206) 75(294) 250(0)	500	107.25
55	250(0) 131(125) 238(292) 10(78) 250(0)	495	54.19
56	250(0) 233(259) 176(241) 250(0)	500	69.08
57	250(0) 57(196) 203(264) 250(0)	460	58.64
58	250(0) 193(24) 114(241) 148(168) 26(63) 250(0)	496	126.12
59	250(0) 3(170) 116(328) 250(0)	498	159.62
60	250(0) 13(41) 167(165) 89(294) 250(0)	500	143.52
61	250(0) 38(252) 242(243) 250(0)	495	35.01
62	250(0) 193(32) 64(327) 224(124) 250(0)	483	109.20
63	250(0) 157(344) 225(148) 250(0)	492	62.20
64	250(0) 69(256) 177(228) 250(0)	484	89.76
65	250(0) 75(52) 162(349) 250(0)	401	104.69
66	250(0) 243(316) 15(155) 250(0)	471	119.76

(cont.)

Table B.44 continued.

	Route	Load	Distance
67	250(0) 84(210) 146(162) 62(124) 250(0)	496	101.64
68	250(0) 9(95) 153(140) 13(260) 250(0)	495	143.63
69	250(0) 123(195) 118(125) 135(177) 250(0)	497	118.18
70	250(0) 131(209) 214(291) 250(0)	500	47.31
71	250(0) 197(112) 42(213) 10(175) 250(0)	500	54.23
72	250(0) 114(95) 170(288) 101(113) 250(0)	496	128.50
73	250(0) 52(303) 219(197) 250(0)	500	103.73
74	250(0) 193(94) 101(110) 125(296) 250(0)	500	112.39
75	250(0) 78(229) 201(271) 250(0)	500	118.44
76	251(0) 183(237) 150(247) 251(0)	484	111.14
77	251(0) 204(57) 8(225) 112(218) 251(0)	500	130.09
78	251(0) 173(199) 27(184) 137(98) 251(0)	481	60.30
79	251(0) 49(260) 124(240) 251(0)	500	34.27
80	251(0) 228(347) 137(153) 251(0)	500	51.42
81	251(0) 18(223) 30(213) 251(0)	436	26.76
82	251(0) 96(150) 213(334) 207(16) 251(0)	500	112.79
83	251(0) 205(197) 31(199) 71(92) 251(0)	488	161.12
84	251(0) 207(201) 166(289) 251(0)	490	67.70
85	251(0) 12(247) 133(151) 251(0)	398	43.39
86	251(0) 204(203) 54(284) 251(0)	487	61.10
87	251(0) 83(172) 36(64) 65(245) 251(0)	481	110.79
88	251(0) 191(100) 72(321) 19(79) 251(0)	500	87.92
89	251(0) 49(10) 221(253) 129(206) 130(31) 251(0)	500	85.64
90	251(0) 220(335) 36(165) 251(0)	500	106.51
91	251(0) 191(60) 79(252) 5(150) 251(0)	462	61.16
92	251(0) 130(290) 61(209) 251(0)	499	71.40
93	251(0) 217(229) 195(264) 251(0)	493	98.15
94	251(0) 58(243) 2(248) 251(0)	491	125.23
95	251(0) 19(229) 185(271) 251(0)	500	78.16
96	251(0) 53(188) 206(308) 251(0)	496	90.51
97	251(0) 73(232) 198(161) 251(0)	393	63.59
98	251(0) 211(307) 90(155) 251(0)	462	65.61
99	252(0) 232(150) 231(270) 142(80) 252(0)	500	149.57

(cont.)

Table B.44 continued.

	Route	Load	Distance
100	252(0) 218(153) 119(311) 239(32) 252(0)	496	118.24
101	252(0) 144(348) 156(64) 28(88) 252(0)	500	99.21
102	252(0) 7(20) 141(207) 104(273) 252(0)	500	120.21
103	252(0) 186(203) 172(278) 252(0)	481	89.45
104	252(0) 188(309) 252(0)	309	6.00
105	252(0) 244(70) 70(156) 99(211) 252(0)	437	95.71
106	252(0) 34(257) 95(213) 252(0)	470	26.99
107	252(0) 184(173) 192(189) 156(107) 252(0)	469	110.62
108	252(0) 154(205) 76(288) 252(0)	493	71.23
109	252(0) 208(254) 246(123) 160(114) 252(0)	491	98.77
110	252(0) 209(276) 244(224) 252(0)	500	92.32
111	252(0) 81(175) 100(325) 252(0)	500	66.38
112	252(0) 140(177) 74(273) 164(50) 252(0)	500	110.54
113	252(0) 182(338) 28(162) 252(0)	500	43.41
114	252(0) 164(203) 7(297) 252(0)	500	71.66
115	252(0) 139(271) 202(188) 252(0)	459	165.49
116	252(0) 1(276) 229(41) 232(183) 252(0)	500	207.71
117	252(0) 68(287) 142(213) 252(0)	500	126.24
118	252(0) 108(241) 155(160) 154(29) 252(0)	430	101.28
119	252(0) 186(128) 81(135) 4(237) 252(0)	500	66.36
120	252(0) 152(340) 160(160) 252(0)	500	103.73
121	252(0) 87(306) 252(0)	306	36.77
122	252(0) 239(308) 35(192) 252(0)	500	94.06
123	252(0) 138(30) 33(257) 234(213) 252(0)	500	129.23
124	252(0) 71(197) 229(303) 252(0)	500	189.64
125	252(0) 7(1) 25(274) 246(225) 252(0)	500	107.83
126	252(0) 115(152) 145(346) 252(0)	498	62.70
127	252(0) 138(156) 21(342) 252(0)	498	86.91
		Total Distance	12176.61

Table B.45: IDH solution to MDSD10 with demand range [.3, .7].

	Route	Load	Distance
1	0 109(95) 158(200) 110(205) 0	500	108.97
2	0 171(21) 181(178) 169(282) 0	481	90.32
3	0 105(103) 132(188) 97(204) 0	495	79.91
4	0 236(171) 111(239) 0	410	33.05
5	0 227(238) 109(221) 0	459	79.48
6	0 240(337) 98(163) 0	500	66.56
7	0 105(141) 60(333) 210(26) 0	500	103.12
8	0 117(189) 98(33) 107(247) 0	469	84.17
9	0 222(171) 85(300) 0	471	49.11
10	0 52(303) 243(176) 0	479	113.23
11	0 20(228) 227(85) 29(187) 0	500	85.46
12	0 174(212) 14(288) 0	500	55.98
13	0 128(168) 120(319) 0	487	65.68
14	0 23(192) 120(26) 22(282) 0	500	55.23
15	0 165(161) 6(330) 0	491	81.85
16	0 92(167) 178(280) 0	447	51.62
17	0 174(69) 143(331) 0	400	45.61
18	0 44(57) 37(334) 0	391	82.43
19	0 196(226) 48(271) 0	497	38.13
20	0 44(206) 199(294) 0	500	81.61
21	0 16(334) 243(140) 0	474	115.26
22	0 210(207) 41(293) 0	500	71.44
23	0 171(151) 162(349) 0	500	100.90
24	250(0) 226(198) 136(298) 250(0)	496	51.10
25	250(0) 51(277) 67(209) 250(0)	486	74.59
26	250(0) 24(251) 40(242) 250(0)	493	46.49
27	250(0) 42(213) 10(253) 250(0)	466	113.48
28	250(0) 75(164) 15(155) 102(163) 233(7) 250(0)	489	98.52
29	250(0) 201(259) 32(241) 250(0)	500	48.07
30	250(0) 75(182) 59(206) 250(0)	388	82.32
31	250(0) 242(243) 38(252) 250(0)	495	86.74
32	250(0) 197(180) 238(292) 250(0)	472	122.75
33	250(0) 233(252) 176(248) 250(0)	500	65.71

(cont.)

Table B.45 continued.

	Route	Load	Distance
34	250(0) 55(50) 194(281) 80(151) 250(0)	482	80.97
35	250(0) 113(195) 103(283) 250(0)	478	68.40
36	250(0) 201(12) 134(179) 159(231) 250(0)	422	129.06
37	250(0) 168(198) 66(254) 250(0)	452	58.61
38	250(0) 11(273) 241(58) 225(164) 250(0)	495	123.16
39	250(0) 47(247) 55(253) 250(0)	500	39.90
40	250(0) 78(261) 250(0)	261	29.73
41	250(0) 17(156) 175(312) 250(0)	468	41.98
42	250(0) 43(169) 241(176) 214(131) 250(0)	476	143.09
43	250(0) 147(329) 127(152) 250(0)	481	93.71
44	250(0) 122(178) 223(302) 250(0)	480	109.77
45	250(0) 131(334) 214(160) 250(0)	494	127.59
46	250(0) 56(343) 250(0)	343	67.47
47	250(0) 136(42) 219(197) 39(261) 250(0)	500	101.44
48	251(0) 4(237) 164(253) 251(0)	490	136.32
49	251(0) 180(172) 200(150) 63(161) 251(0)	483	89.01
50	251(0) 156(11) 104(273) 141(207) 251(0)	491	148.95
51	251(0) 34(66) 87(306) 95(71) 28(57) 251(0)	500	104.85
52	251(0) 239(304) 35(192) 251(0)	496	25.32
53	251(0) 25(151) 116(328) 251(0)	479	165.73
54	251(0) 187(164) 212(312) 77(11) 251(0)	487	130.41
55	251(0) 95(142) 182(338) 251(0)	480	62.32
56	251(0) 161(227) 216(265) 251(0)	492	91.61
57	251(0) 179(172) 45(251) 93(37) 251(0)	460	116.40
58	251(0) 126(211) 215(254) 251(0)	465	176.72
59	251(0) 94(235) 245(92) 184(173) 251(0)	500	79.27
60	251(0) 93(213) 46(287) 251(0)	500	84.66
61	251(0) 7(50) 74(273) 140(177) 251(0)	500	154.86
62	251(0) 218(153) 119(311) 239(36) 251(0)	500	38.68
63	251(0) 28(193) 7(268) 160(28) 251(0)	489	110.17
64	251(0) 192(152) 144(348) 251(0)	500	30.45
65	251(0) 149(173) 247(265) 94(62) 251(0)	500	122.19
66	251(0) 91(236) 77(217) 192(37) 251(0)	490	87.59

(cont.)

Table B.45 continued.

	Route	Load	Distance
67	251(0) 156(160) 152(340) 251(0)	500	65.69
68	251(0) 246(348) 25(123) 251(0)	471	120.15
69	251(0) 50(205) 88(198) 245(85) 251(0)	488	87.80
70	251(0) 160(246) 208(254) 251(0)	500	108.36
71	251(0) 34(191) 188(309) 251(0)	500	82.30
72	251(0) 151(281) 86(207) 251(0)	488	91.21
73	252(0) 36(64) 150(199) 183(237) 252(0)	500	84.14
74	252(0) 73(232) 204(260) 252(0)	492	41.71
75	252(0) 96(57) 112(218) 8(225) 252(0)	500	103.29
76	252(0) 83(172) 206(308) 252(0)	480	66.34
77	252(0) 13(301) 26(197) 252(0)	498	137.78
78	252(0) 65(245) 53(188) 228(67) 252(0)	500	104.74
79	252(0) 228(280) 173(199) 252(0)	479	66.08
80	252(0) 124(240) 137(251) 252(0)	491	64.03
81	252(0) 248(269) 189(183) 150(48) 252(0)	500	131.31
82	252(0) 54(284) 27(184) 252(0)	468	34.53
83	252(0) 69(256) 135(49) 123(195) 252(0)	500	134.38
84	252(0) 237(309) 177(191) 252(0)	500	100.75
85	252(0) 121(238) 106(236) 189(11) 252(0)	485	156.42
86	252(0) 153(203) 9(170) 170(124) 252(0)	497	106.41
87	252(0) 177(103) 62(192) 249(171) 252(0)	466	108.74
88	252(0) 18(223) 30(213) 252(0)	436	46.31
89	252(0) 125(132) 64(327) 252(0)	459	72.70
90	252(0) 135(128) 84(210) 146(162) 252(0)	500	137.33
91	252(0) 235(213) 82(188) 224(35) 252(0)	436	115.70
92	252(0) 114(336) 170(164) 252(0)	500	88.59
93	252(0) 195(264) 2(160) 252(0)	424	61.37
94	252(0) 58(243) 217(229) 252(0)	472	77.04
95	252(0) 220(335) 36(165) 252(0)	500	82.60
96	252(0) 163(269) 224(231) 252(0)	500	82.74
97	252(0) 193(40) 203(264) 57(196) 252(0)	500	124.26
98	252(0) 157(344) 82(156) 252(0)	500	106.08
99	252(0) 101(223) 193(110) 125(164) 252(0)	497	96.69

(cont.)

Table B.45 continued.

	Route	Load	Distance
100	252(0) 89(294) 167(165) 9(41) 252(0)	500	138.42
101	252(0) 3(183) 190(310) 252(0)	493	120.61
102	252(0) 213(334) 118(162) 252(0)	496	132.05
103	252(0) 230(244) 148(168) 2(88) 252(0)	500	95.53
104	252(0) 207(217) 96(93) 198(161) 252(0)	471	68.47
105	253(0) 244(52) 76(288) 155(160) 253(0)	500	170.83
106	253(0) 191(160) 133(151) 5(150) 253(0)	461	25.37
107	253(0) 139(271) 202(188) 231(41) 253(0)	500	161.81
108	253(0) 33(9) 232(333) 142(158) 253(0)	500	129.68
109	253(0) 211(307) 61(179) 253(0)	486	52.93
110	253(0) 19(229) 185(271) 253(0)	500	30.55
111	253(0) 12(17) 130(321) 90(155) 253(0)	493	74.87
112	253(0) 129(206) 221(253) 61(30) 253(0)	489	81.29
113	253(0) 19(79) 72(321) 253(0)	400	39.70
114	253(0) 115(152) 145(346) 253(0)	498	120.42
115	253(0) 209(276) 100(224) 253(0)	500	113.76
116	253(0) 138(158) 21(342) 253(0)	500	88.00
117	253(0) 142(135) 231(229) 99(136) 253(0)	500	159.41
118	253(0) 172(278) 186(222) 253(0)	500	111.45
119	253(0) 49(270) 12(230) 253(0)	500	45.65
120	253(0) 71(163) 1(276) 253(0)	439	172.99
121	253(0) 229(344) 71(126) 253(0)	470	148.16
122	253(0) 186(109) 81(310) 100(53) 138(28) 253(0)	500	122.66
123	253(0) 33(248) 79(252) 253(0)	500	61.68
124	253(0) 68(287) 234(213) 253(0)	500	112.04
125	253(0) 99(75) 70(156) 108(220) 100(48) 253(0)	499	145.65
126	253(0) 166(289) 253(0)	289	45.61
127	253(0) 244(242) 108(21) 154(234) 253(0)	497	161.63
128	253(0) 31(199) 205(197) 253(0)	396	113.53
		Total Distance	11831.52

Table B.46: IDH solution to MDSD1 with demand range [.7, .9].

	Route	Load	Distance
1	0 4(69) 0	69	12.00
2	0 41(24) 13(56) 0	80	35.69
3	0 44(17) 15(63) 0	80	33.76
4	0 37(57) 17(18) 0	75	24.88
5	0 41(34) 19(46) 0	80	25.34
6	0 19(15) 40(59) 0	74	41.05
7	0 42(65) 0	65	20.10
8	0 17(40) 44(40) 0	80	27.34
9	51(0) 11(69) 51(0)	69	24.08
10	51(0) 7(45) 8(35) 51(0)	80	62.48
11	51(0) 6(21) 23(59) 51(0)	80	44.60
12	51(0) 32(67) 51(0)	67	20.00
13	51(0) 8(20) 31(60) 51(0)	80	61.08
14	51(0) 18(60) 51(0)	60	29.53
15	51(0) 12(69) 51(0)	69	16.12
16	51(0) 7(14) 43(66) 51(0)	80	73.12
17	51(0) 6(18) 48(59) 51(0)	77	36.16
18	51(0) 46(59) 51(0)	59	4.47
19	51(0) 1(65) 51(0)	65	27.78
20	51(0) 8(4) 26(64) 51(0)	68	57.39
21	51(0) 6(17) 24(62) 51(0)	79	50.39
22	51(0) 25(68) 51(0)	68	46.17
23	51(0) 14(68) 51(0)	68	36.22
24	51(0) 27(70) 51(0)	70	16.00
25	51(0) 47(65) 51(0)	65	18.87
26	52(0) 49(12) 5(63) 52(0)	75	21.07
27	52(0) 16(57) 9(23) 52(0)	80	22.79
28	52(0) 49(23) 10(57) 52(0)	80	19.50
29	52(0) 9(11) 30(69) 52(0)	80	20.63
30	52(0) 49(12) 33(68) 52(0)	80	41.34
31	52(0) 9(13) 34(58) 52(0)	71	24.01
32	52(0) 38(64) 52(0)	64	14.14
33	52(0) 10(9) 39(71) 52(0)	80	36.55

(cont.)

Table B.46 continued.

	Route	Load	Distance
34	52(0) 45(58) 49(22) 52(0)	80	45.78
35	52(0) 9(23) 50(57) 52(0)	80	18.48
36	53(0) 2(62) 53(0)	62	22.09
37	53(0) 3(63) 20(17) 53(0)	80	32.48
38	53(0) 21(70) 53(0)	70	16.49
39	53(0) 20(13) 22(67) 53(0)	80	42.89
40	53(0) 20(14) 28(66) 53(0)	80	49.23
41	53(0) 29(63) 53(0)	63	5.66
42	53(0) 20(26) 35(54) 53(0)	80	28.77
43	53(0) 35(10) 36(59) 53(0)	69	38.47
		Total Distance	1344.99

Table B.47: IDH solution to MDSD2 with demand range [.7, .9].

	Route	Load	Distance
1	0 75(30) 4(110) 0	140	15.46
2	0 6(122) 0	122	18.44
3	0 26(110) 0	110	12.17
4	0 75(59) 34(81) 0	140	23.44
5	0 46(125) 0	125	22.36
6	0 34(40) 52(100) 0	140	28.61
7	0 67(123) 0	123	10.77
8	0 75(25) 68(112) 0	137	14.75
9	76(0) 48(118) 76(0)	118	4.47
10	76(0) 29(41) 13(99) 76(0)	140	35.62
11	76(0) 5(48) 15(92) 76(0)	140	25.61
12	76(0) 36(29) 71(111) 76(0)	140	38.96
13	76(0) 74(62) 21(78) 76(0)	140	29.08
14	76(0) 27(106) 29(34) 76(0)	140	26.02
15	76(0) 36(7) 70(111) 37(20) 76(0)	138	46.24
16	76(0) 47(107) 76(0)	107	14.00
17	76(0) 5(38) 37(102) 76(0)	140	24.66
18	76(0) 29(40) 45(100) 76(0)	140	16.94
19	76(0) 21(22) 61(118) 76(0)	140	42.71
20	76(0) 74(9) 28(125) 76(0)	134	32.76
21	76(0) 15(33) 57(107) 76(0)	140	32.22
22	76(0) 36(36) 60(104) 76(0)	140	47.11
23	76(0) 30(122) 76(0)	122	16.12
24	76(0) 36(30) 69(110) 76(0)	140	37.86
25	76(0) 5(27) 20(113) 76(0)	140	35.80
26	76(0) 74(28) 2(112) 76(0)	140	31.97
27	77(0) 35(28) 8(112) 77(0)	140	20.00
28	77(0) 38(27) 10(113) 77(0)	140	39.20
29	77(0) 65(116) 11(24) 77(0)	140	32.88
30	77(0) 14(118) 77(0)	118	14.56
31	77(0) 35(53) 19(87) 77(0)	140	22.18
32	77(0) 7(114) 35(26) 77(0)	140	17.07
33	77(0) 11(60) 38(80) 77(0)	140	31.66

(cont.)

Table B.47 continued.

	Route	Load	Distance
34	77(0) 53(119) 77(0)	119	4.00
35	77(0) 19(12) 54(122) 77(0)	134	36.94
36	77(0) 58(110) 77(0)	110	31.62
37	77(0) 59(115) 77(0)	115	34.99
38	77(0) 11(27) 66(108) 77(0)	135	34.40
39	78(0) 44(90) 3(50) 78(0)	140	12.00
40	78(0) 40(35) 9(105) 78(0)	140	30.96
41	78(0) 16(107) 78(0)	107	19.70
42	78(0) 17(123) 78(0)	123	16.12
43	78(0) 50(31) 18(109) 78(0)	140	40.28
44	78(0) 3(31) 24(109) 78(0)	140	36.25
45	78(0) 9(8) 31(116) 78(0)	124	63.33
46	78(0) 40(22) 39(118) 78(0)	140	32.88
47	78(0) 12(104) 40(36) 78(0)	140	23.83
48	78(0) 32(115) 44(25) 78(0)	140	18.64
49	78(0) 3(30) 49(110) 78(0)	140	30.17
50	78(0) 25(99) 50(32) 78(0)	131	43.73
51	78(0) 51(116) 78(0)	116	14.42
52	78(0) 50(35) 55(105) 78(0)	140	58.89
53	78(0) 40(20) 72(120) 78(0)	140	36.28
54	79(0) 1(115) 79(0)	115	5.66
55	79(0) 22(124) 79(0)	124	18.44
56	79(0) 33(123) 79(0)	123	21.63
57	79(0) 43(26) 41(114) 79(0)	140	17.14
58	79(0) 43(67) 42(73) 79(0)	140	17.03
59	79(0) 23(104) 43(31) 79(0)	135	26.46
60	79(0) 56(122) 79(0)	122	29.73
61	79(0) 62(105) 79(0)	105	20.00
62	79(0) 63(120) 79(0)	120	20.00
63	79(0) 42(27) 64(113) 79(0)	140	32.62
64	79(0) 73(118) 79(0)	118	16.12
		Total Distance	1705.98

Table B.48: IDH solution to MDSD3 with demand range [.7, .9].

	Route	Load	Distance
1	0 87(72) 0	72	14.56
2	0 56(52) 4(48) 0	100	47.94
3	0 61(74) 91(26) 0	100	49.20
4	0 55(75) 4(15) 21(10) 0	100	56.70
5	0 16(75) 91(25) 0	100	50.12
6	0 85(84) 92(16) 0	100	38.26
7	0 75(57) 22(43) 0	100	34.91
8	0 13(73) 0	73	14.14
9	0 2(78) 0	78	6.00
10	0 99(77) 59(20) 0	97	32.95
11	0 56(12) 67(88) 0	100	70.69
12	0 22(27) 41(73) 0	100	33.15
13	0 73(21) 74(79) 0	100	27.00
14	0 21(18) 72(82) 0	100	27.12
15	0 14(63) 42(37) 0	100	45.18
16	0 75(28) 23(72) 0	100	50.13
17	0 97(15) 95(85) 0	100	23.82
18	0 4(16) 25(84) 0	100	60.00
19	0 21(14) 40(84) 0	98	24.14
20	0 57(84) 0	84	17.09
21	0 58(82) 0	82	12.17
22	0 59(23) 98(72) 0	95	34.20
23	0 21(34) 73(66) 0	100	22.65
24	0 42(27) 15(73) 0	100	38.63
25	0 44(76) 91(24) 0	100	51.17
26	0 86(88) 91(11) 0	99	62.13
27	0 97(38) 92(62) 0	100	26.37
28	0 59(30) 93(70) 0	100	35.02
29	0 42(23) 43(77) 0	100	43.47
30	0 56(14) 39(86) 0	100	52.95
31	0 97(14) 100(86) 0	100	34.78
32	0 97(14) 37(86) 0	100	30.15
33	0 38(82) 14(13) 0	95	67.08

(cont.)

Table B.48 continued.

	Route	Load	Distance
34	101(0) 70(61) 30(39) 101(0)	100	51.59
35	101(0) 26(80) 101(0)	80	22.36
36	101(0) 84(26) 17(73) 101(0)	99	60.83
37	101(0) 19(53) 7(47) 101(0)	100	64.41
38	101(0) 82(60) 8(40) 101(0)	100	55.98
39	101(0) 51(28) 9(72) 101(0)	100	65.27
40	101(0) 19(35) 11(65) 101(0)	100	72.63
41	101(0) 89(14) 18(86) 101(0)	100	32.62
42	101(0) 51(39) 20(61) 101(0)	100	66.61
43	101(0) 24(82) 80(18) 101(0)	100	60.31
44	101(0) 60(13) 83(87) 101(0)	100	43.37
45	101(0) 27(71) 101(0)	71	10.00
46	101(0) 12(17) 54(83) 101(0)	100	47.02
47	101(0) 78(60) 79(40) 101(0)	100	62.28
48	101(0) 32(75) 30(25) 101(0)	100	69.79
49	101(0) 10(71) 31(29) 101(0)	100	51.02
50	101(0) 76(87) 101(0)	87	31.30
51	101(0) 78(18) 34(82) 101(0)	100	72.12
52	101(0) 47(20) 36(80) 101(0)	100	82.82
53	101(0) 8(16) 45(84) 101(0)	100	61.81
54	101(0) 8(17) 46(83) 101(0)	100	71.15
55	101(0) 48(59) 7(23) 52(18) 101(0)	100	56.30
56	101(0) 49(88) 101(0)	88	87.86
57	101(0) 1(23) 50(77) 101(0)	100	38.53
58	101(0) 31(41) 88(57) 101(0)	98	41.70
59	101(0) 12(13) 68(87) 101(0)	100	43.59
60	101(0) 33(13) 65(87) 101(0)	100	101.26
61	101(0) 5(75) 60(25) 101(0)	100	43.12
62	101(0) 88(27) 62(73) 101(0)	100	51.06
63	101(0) 11(13) 64(87) 101(0)	100	93.06
64	101(0) 30(10) 66(75) 20(15) 101(0)	100	81.87
65	101(0) 6(29) 94(71) 101(0)	100	26.38
66	101(0) 1(59) 69(41) 101(0)	100	31.87

(cont.)

Table B.48 continued.

	Route	Load	Distance
67	101(0) 90(81) 70(19) 101(0)	100	65.87
68	101(0) 51(19) 71(81) 101(0)	100	79.39
69	101(0) 77(17) 3(83) 101(0)	100	44.89
70	101(0) 33(36) 81(64) 101(0)	100	55.17
71	101(0) 33(26) 29(74) 101(0)	100	69.46
72	101(0) 77(56) 79(44) 101(0)	100	51.65
73	101(0) 12(44) 80(53) 101(0)	97	42.42
74	101(0) 35(78) 81(22) 101(0)	100	82.22
75	101(0) 82(26) 47(63) 48(11) 101(0)	100	68.93
76	101(0) 6(26) 96(71) 101(0)	97	30.69
77	101(0) 60(47) 84(53) 101(0)	100	49.07
78	101(0) 69(43) 52(57) 101(0)	100	34.25
79	101(0) 53(71) 101(0)	71	8.94
80	101(0) 10(13) 63(83) 90(4) 101(0)	100	71.70
81	101(0) 6(28) 89(72) 101(0)	100	25.28
82	101(0) 28(80) 101(0)	80	12.65
		Total Distance	3878.34

Table B.49: IDH solution to MDSD4 with demand range [.7, .9].

	Route	Load	Distance
1	0 97(50) 42(150) 0	200	50.96
2	0 44(50) 43(150) 0	200	70.64
3	0 52(159) 0	159	28.84
4	0 47(31) 49(169) 0	200	68.51
5	0 63(111) 11(89) 0	200	74.53
6	0 6(56) 89(144) 0	200	27.28
7	0 44(36) 38(153) 0	189	63.82
8	0 91(19) 14(162) 0	181	50.00
9	0 5(166) 0	166	10.00
10	0 60(157) 0	157	4.47
11	0 84(173) 0	173	11.31
12	0 57(179) 0	179	57.20
13	0 88(29) 31(171) 0	200	48.59
14	0 97(39) 87(161) 0	200	42.85
15	0 45(164) 0	164	18.97
16	0 92(21) 15(154) 42(18) 0	193	67.47
17	0 48(174) 0	174	34.23
18	0 47(80) 46(120) 0	200	50.52
19	0 82(21) 19(172) 0	193	50.00
20	0 7(48) 82(152) 0	200	33.64
21	0 99(96) 59(104) 0	200	25.06
22	0 90(143) 63(34) 0	177	76.30
23	0 17(169) 0	169	22.36
24	0 44(57) 86(143) 0	200	49.69
25	0 92(156) 59(42) 0	198	29.53
26	0 11(58) 64(142) 0	200	85.41
27	0 61(167) 0	167	22.80
28	0 93(166) 0	166	22.80
29	0 83(153) 0	153	4.47
30	0 16(171) 0	171	31.62
31	0 85(32) 100(168) 0	200	34.77
32	0 88(22) 10(178) 0	200	58.35
33	0 7(92) 88(108) 0	200	42.38

(cont.)

Table B.49 continued.

	Route	Load	Distance
34	0 97(57) 37(143) 0	200	38.12
35	0 85(74) 91(126) 0	200	32.20
36	0 18(143) 0	143	14.14
37	0 99(44) 96(143) 0	187	23.16
38	0 6(120) 94(71) 0	191	27.94
39	0 47(41) 36(157) 0	198	57.53
40	0 94(48) 13(152) 0	200	36.10
41	0 7(38) 62(162) 0	200	49.45
42	0 46(36) 8(161) 0	197	37.25
43	0 94(48) 95(152) 0	200	31.63
44	0 98(149) 85(38) 0	187	30.76
45	101(0) 70(145) 1(55) 101(0)	200	55.52
46	101(0) 40(41) 2(159) 101(0)	200	54.37
47	101(0) 77(89) 3(111) 101(0)	200	21.07
48	101(0) 12(34) 28(166) 101(0)	200	28.36
49	101(0) 66(169) 9(31) 101(0)	200	77.79
50	101(0) 54(82) 12(118) 101(0)	200	20.54
51	101(0) 72(78) 21(122) 101(0)	200	43.12
52	101(0) 21(34) 73(166) 101(0)	200	42.29
53	101(0) 24(169) 101(0)	169	20.00
54	101(0) 80(146) 101(0)	146	4.47
55	101(0) 53(157) 26(43) 101(0)	200	37.68
56	101(0) 27(175) 101(0)	175	41.23
57	101(0) 55(21) 25(176) 101(0)	197	36.06
58	101(0) 78(37) 35(163) 101(0)	200	62.23
59	101(0) 1(64) 30(135) 101(0)	199	60.00
60	101(0) 30(27) 32(173) 101(0)	200	78.90
61	101(0) 78(116) 33(83) 101(0)	199	43.14
62	101(0) 81(43) 34(157) 101(0)	200	51.41
63	101(0) 3(29) 79(163) 101(0)	192	26.76
64	101(0) 56(92) 39(108) 101(0)	200	53.62
65	101(0) 26(99) 40(100) 101(0)	199	36.28
66	101(0) 4(165) 101(0)	165	30.00

(cont.)

Table B.49 continued.

	Route	Load	Distance
67	101(0) 20(166) 51(34) 101(0)	200	63.45
68	101(0) 54(67) 55(133) 101(0)	200	29.23
69	101(0) 75(126) 56(62) 101(0)	188	51.95
70	101(0) 58(167) 101(0)	167	42.05
71	101(0) 71(22) 65(178) 101(0)	200	85.94
72	101(0) 39(35) 67(165) 101(0)	200	65.75
73	101(0) 68(173) 101(0)	173	8.25
74	101(0) 1(45) 69(155) 101(0)	200	45.90
75	101(0) 9(51) 71(149) 101(0)	200	66.31
76	101(0) 23(177) 75(23) 101(0)	200	63.22
77	101(0) 74(21) 22(164) 101(0)	185	53.86
78	101(0) 72(55) 74(145) 101(0)	200	47.55
79	101(0) 41(175) 72(25) 101(0)	200	61.78
80	101(0) 76(124) 77(76) 101(0)	200	21.59
81	101(0) 9(70) 51(117) 101(0)	187	55.09
82	101(0) 76(53) 50(147) 101(0)	200	29.03
83	101(0) 29(142) 101(0)	142	22.80
84	101(0) 33(72) 81(118) 101(0)	190	38.95
		Total Distance	3525.24

Table B.50: IDH solution to MDSD5 with demand range [.7, .9].

	Route	Load	Distance
1	0 84(50) 5(42) 0	92	25.83
2	0 94(28) 6(72) 0	100	30.34
3	0 14(82) 0	82	20.00
4	0 42(28) 15(72) 0	100	42.47
5	0 44(68) 16(32) 0	100	18.29
6	0 37(84) 0	84	10.00
7	0 44(19) 38(80) 0	99	36.06
8	0 57(87) 42(13) 0	100	38.83
9	0 42(19) 43(74) 0	93	39.89
10	0 84(23) 45(77) 0	100	40.43
11	0 92(76) 59(21) 0	97	16.73
12	0 5(15) 60(85) 0	100	28.61
13	0 16(17) 61(83) 0	100	14.47
14	0 5(29) 83(71) 0	100	34.10
15	0 17(88) 84(12) 0	100	31.93
16	0 85(85) 0	85	4.47
17	0 16(22) 86(78) 0	100	22.50
18	0 42(27) 87(73) 0	100	32.41
19	0 91(70) 0	70	2.00
20	0 59(66) 93(34) 0	100	15.21
21	0 95(46) 94(54) 0	100	26.97
22	0 13(71) 95(25) 0	96	31.68
23	0 93(22) 96(78) 0	100	19.90
24	0 97(87) 0	87	20.10
25	0 98(84) 0	84	8.25
26	0 93(19) 99(81) 0	100	15.64
27	0 100(87) 0	87	7.21
28	101(0) 74(18) 41(82) 101(0)	100	30.54
29	101(0) 80(28) 68(71) 101(0)	99	39.95
30	101(0) 26(24) 12(76) 101(0)	100	33.25
31	101(0) 67(89) 39(6) 101(0)	95	45.38
32	101(0) 73(15) 2(85) 101(0)	100	31.01
33	101(0) 54(28) 29(72) 101(0)	100	52.24

(cont.)

Table B.50 continued.

	Route	Load	Distance
34	101(0) 26(17) 28(83) 101(0)	100	38.48
35	101(0) 4(89) 101(0)	89	10.00
36	101(0) 40(17) 53(83) 101(0)	100	34.92
37	101(0) 21(88) 101(0)	88	10.00
38	101(0) 26(37) 40(63) 101(0)	100	29.43
39	101(0) 39(20) 23(80) 101(0)	100	37.22
40	101(0) 56(84) 101(0)	84	17.09
41	101(0) 80(56) 54(44) 101(0)	100	37.49
42	101(0) 39(53) 55(47) 101(0)	100	37.55
43	101(0) 25(77) 55(23) 101(0)	100	31.95
44	101(0) 75(70) 101(0)	70	18.11
45	101(0) 58(79) 40(5) 101(0)	84	30.53
46	101(0) 74(24) 22(76) 101(0)	100	22.40
47	101(0) 74(40) 73(56) 101(0)	96	19.24
48	101(0) 24(87) 101(0)	87	42.43
49	101(0) 72(83) 101(0)	83	10.00
50	102(0) 1(82) 102(0)	82	16.97
51	102(0) 50(21) 3(79) 102(0)	100	45.03
52	102(0) 88(12) 7(88) 102(0)	100	31.62
53	102(0) 48(17) 8(83) 102(0)	100	59.42
54	102(0) 51(23) 9(77) 102(0)	100	41.26
55	102(0) 62(73) 10(27) 102(0)	100	24.80
56	102(0) 49(70) 11(24) 102(0)	94	64.13
57	102(0) 18(84) 102(0)	84	42.43
58	102(0) 11(23) 19(77) 102(0)	100	45.71
59	102(0) 71(65) 20(25) 102(0)	90	52.07
60	102(0) 69(23) 27(77) 102(0)	100	30.53
61	102(0) 30(85) 102(0)	85	14.14
62	102(0) 69(36) 31(64) 102(0)	100	21.06
63	102(0) 90(16) 32(75) 102(0)	91	31.12
64	102(0) 35(89) 33(11) 102(0)	100	64.38
65	102(0) 78(24) 34(75) 102(0)	99	61.17
66	102(0) 47(22) 36(70) 102(0)	92	67.61

(cont.)

Table B.50 continued.

	Route	Load	Distance
67	102(0) 48(19) 46(81) 102(0)	100	67.64
68	102(0) 47(52) 48(48) 102(0)	100	55.63
69	102(0) 81(78) 50(12) 102(0)	90	45.08
70	102(0) 20(38) 51(62) 102(0)	100	36.52
71	102(0) 52(88) 102(0)	88	28.84
72	102(0) 10(17) 63(83) 102(0)	100	32.68
73	102(0) 11(25) 64(75) 102(0)	100	60.76
74	102(0) 71(21) 65(79) 102(0)	100	70.68
75	102(0) 20(23) 66(77) 102(0)	100	45.89
76	102(0) 89(78) 69(22) 102(0)	100	46.46
77	102(0) 70(79) 102(0)	79	4.47
78	102(0) 50(15) 76(85) 102(0)	100	38.91
79	102(0) 50(23) 77(77) 102(0)	100	43.27
80	102(0) 33(45) 78(55) 102(0)	100	52.42
81	102(0) 33(26) 79(74) 102(0)	100	46.99
82	102(0) 82(84) 102(0)	84	43.08
83	102(0) 31(20) 88(76) 102(0)	96	19.49
84	102(0) 10(27) 90(73) 102(0)	100	26.79
		Total Distance	2772.58

Table B.51: IDH solution to MDSD6 with demand range [.7, .9].

	Route	Load	Distance
1	0 61(23) 16(77) 0	100	31.69
2	0 61(44) 85(56) 0	100	28.91
3	0 96(41) 6(48) 0	89	26.05
4	0 47(13) 36(75) 0	88	57.53
5	0 17(88) 0	88	22.36
6	0 83(20) 18(78) 0	98	16.02
7	0 82(24) 48(76) 0	100	34.50
8	0 46(73) 8(27) 0	100	37.25
9	0 47(14) 49(86) 0	100	68.51
10	0 93(87) 0	87	22.80
11	0 99(17) 59(83) 0	100	25.06
12	0 60(89) 0	89	4.47
13	0 47(45) 82(55) 0	100	45.54
14	0 61(13) 86(84) 0	97	41.65
15	0 84(89) 0	89	11.31
16	0 83(43) 8(57) 0	100	18.88
17	0 83(17) 45(83) 0	100	19.79
18	0 6(29) 89(71) 0	100	27.28
19	0 85(26) 91(74) 0	100	32.20
20	0 5(83) 0	83	10.00
21	0 99(60) 96(40) 0	100	23.16
22	101(0) 68(5) 79(39) 3(56) 101(0)	100	26.78
23	101(0) 54(37) 12(63) 101(0)	100	20.54
24	101(0) 54(25) 4(75) 101(0)	100	30.54
25	101(0) 25(89) 101(0)	89	36.06
26	101(0) 78(14) 34(86) 101(0)	100	45.39
27	101(0) 76(89) 101(0)	89	18.44
28	101(0) 80(24) 24(76) 101(0)	100	21.46
29	101(0) 12(14) 28(86) 101(0)	100	28.36
30	101(0) 3(23) 33(77) 101(0)	100	34.40
31	101(0) 80(22) 68(78) 101(0)	100	8.36
32	101(0) 80(10) 77(86) 101(0)	96	17.19
33	101(0) 80(20) 29(80) 101(0)	100	23.07

(cont.)

Table B.51 continued.

	Route	Load	Distance
34	101(0) 55(73) 54(27) 101(0)	100	29.23
35	101(0) 79(35) 78(65) 101(0)	100	36.84
36	101(0) 26(75) 101(0)	75	22.36
37	102(0) 14(13) 38(87) 102(0)	100	67.08
38	102(0) 57(58) 2(40) 102(0)	98	17.37
39	102(0) 97(5) 98(70) 37(25) 102(0)	100	32.46
40	102(0) 42(82) 102(0)	82	27.20
41	102(0) 74(26) 21(74) 102(0)	100	30.11
42	102(0) 74(48) 22(52) 102(0)	100	30.34
43	102(0) 75(10) 23(83) 102(0)	93	50.13
44	102(0) 40(88) 102(0)	88	14.14
45	102(0) 73(12) 72(88) 102(0)	100	25.30
46	102(0) 94(75) 13(25) 102(0)	100	22.94
47	102(0) 41(80) 22(20) 102(0)	100	33.15
48	102(0) 73(60) 2(34) 102(0)	94	21.49
49	102(0) 58(30) 53(70) 102(0)	100	22.36
50	102(0) 44(81) 100(19) 102(0)	100	49.92
51	102(0) 58(58) 13(42) 102(0)	100	19.24
52	102(0) 92(73) 97(27) 102(0)	100	26.37
53	102(0) 56(22) 67(78) 102(0)	100	70.69
54	102(0) 57(12) 15(88) 102(0)	100	31.64
55	102(0) 56(36) 75(64) 102(0)	100	40.46
56	102(0) 14(73) 100(21) 102(0)	94	48.02
57	102(0) 97(52) 87(48) 102(0)	100	21.57
58	102(0) 56(18) 39(82) 102(0)	100	52.95
59	102(0) 43(77) 87(23) 102(0)	100	43.90
60	102(0) 13(18) 95(82) 102(0)	100	22.94
61	102(0) 37(54) 100(46) 102(0)	100	34.95
62	103(0) 71(15) 65(85) 103(0)	100	76.90
63	103(0) 20(21) 66(79) 103(0)	100	53.90
64	103(0) 30(17) 32(83) 103(0)	100	40.48
65	103(0) 7(71) 103(0)	71	30.00
66	103(0) 62(37) 11(63) 103(0)	100	42.88

(cont.)

Table B.51 continued.

	Route	Load	Distance
67	103(0) 51(23) 81(77) 103(0)	100	43.73
68	103(0) 69(39) 1(59) 103(0)	98	14.16
69	103(0) 69(30) 27(70) 103(0)	100	20.89
70	103(0) 62(24) 63(76) 103(0)	100	45.62
71	103(0) 1(23) 50(77) 103(0)	100	24.78
72	103(0) 11(25) 64(75) 103(0)	100	67.81
73	103(0) 30(22) 90(78) 103(0)	100	40.05
74	103(0) 71(70) 51(30) 103(0)	100	57.36
75	103(0) 62(14) 19(86) 103(0)	100	45.18
76	103(0) 31(84) 103(0)	84	8.94
77	103(0) 51(13) 35(85) 103(0)	98	63.54
78	103(0) 69(19) 52(81) 103(0)	100	25.01
79	103(0) 51(20) 9(80) 103(0)	100	44.81
80	103(0) 20(57) 30(33) 103(0)	90	36.28
81	103(0) 70(82) 103(0)	82	12.65
82	103(0) 10(86) 103(0)	86	22.36
83	103(0) 88(89) 103(0)	89	18.44
		Total Distance	2696.47

Table B.52: IDH solution to MDSD7 with demand range [.7, .9].

	Route	Load	Distance
1	0 213(441) 112(59) 0	500	80.38
2	0 64(393) 0	393	27.20
3	0 62(449) 0	449	45.69
4	0 2(443) 0	443	62.13
5	0 170(215) 9(285) 0	500	98.82
6	0 207(427) 0	427	76.55
7	0 176(112) 233(377) 0	489	128.62
8	0 101(156) 114(344) 0	500	77.59
9	0 73(407) 0	407	56.46
10	0 136(55) 32(405) 0	460	182.43
11	0 30(437) 0	437	90.91
12	0 54(138) 18(362) 0	500	92.02
13	0 58(440) 0	440	96.60
14	0 40(445) 0	445	218.58
15	0 206(88) 83(412) 0	500	110.32
16	0 204(244) 54(155) 0	399	71.30
17	0 130(80) 129(420) 0	500	178.50
18	0 217(205) 27(295) 0	500	82.16
19	0 190(363) 0	363	48.08
20	0 80(114) 113(386) 0	500	154.63
21	0 175(108) 55(392) 0	500	176.57
22	0 163(448) 0	448	15.62
23	0 194(181) 80(319) 0	500	150.00
24	0 49(105) 12(395) 0	500	139.14
25	0 189(418) 0	418	130.87
26	0 137(351) 54(149) 0	500	92.83
27	0 27(71) 53(425) 0	496	137.03
28	0 52(84) 75(392) 0	476	142.09
29	0 170(85) 153(415) 0	500	105.06
30	0 197(52) 42(448) 0	500	144.52
31	0 49(219) 61(281) 0	500	163.31
32	0 177(140) 224(358) 0	498	41.68
33	0 221(380) 90(120) 0	500	188.18

(cont.)

Table B.52 continued.

	Route	Load	Distance
34	0 175(280) 66(220) 0	500	173.04
35	0 11(420) 0	420	68.88
36	0 220(116) 150(384) 0	500	116.88
37	0 24(301) 78(199) 0	500	215.51
38	0 15(398) 0	398	115.12
39	0 47(102) 168(398) 0	500	167.75
40	0 123(134) 8(366) 0	500	74.90
41	0 203(104) 57(393) 0	497	80.93
42	0 52(350) 84(150) 0	500	124.14
43	0 78(95) 201(393) 0	488	199.39
44	0 242(439) 0	439	97.67
45	0 9(87) 121(56) 106(357) 0	500	166.60
46	0 170(132) 230(368) 0	500	89.44
47	0 102(102) 219(388) 0	490	125.33
48	0 185(397) 166(103) 0	500	120.84
49	0 235(389) 0	389	59.06
50	0 123(221) 118(279) 0	500	68.12
51	0 248(157) 121(343) 0	500	143.01
52	0 39(259) 122(241) 0	500	96.25
53	0 49(124) 130(346) 0	470	162.12
54	0 249(51) 43(370) 0	421	64.79
55	0 175(55) 17(416) 0	471	195.97
56	0 69(368) 0	368	30.07
57	0 90(258) 133(242) 0	500	161.28
58	0 84(246) 135(254) 0	500	80.66
59	0 223(371) 0	371	70.00
60	0 166(284) 96(216) 0	500	80.84
61	0 61(97) 211(403) 0	500	164.16
62	0 177(132) 237(360) 0	492	41.48
63	0 137(84) 124(416) 0	500	121.61
64	0 183(130) 36(370) 0	500	108.15
65	0 133(111) 79(374) 0	485	140.53
66	0 176(134) 136(366) 0	500	141.45

(cont.)

Table B.52 continued.

	Route	Load	Distance
67	0 82(22) 66(157) 47(318) 0	497	166.40
68	0 19(417) 0	417	121.28
69	0 78(84) 147(416) 0	500	238.53
70	0 26(398) 0	398	86.56
71	0 82(111) 56(372) 0	483	113.60
72	0 135(117) 146(382) 0	499	74.34
73	0 113(60) 103(440) 0	500	162.12
74	0 191(371) 0	371	111.52
75	0 118(124) 3(376) 0	500	76.32
76	0 114(72) 148(428) 0	500	80.44
77	0 5(420) 0	420	126.49
78	0 197(123) 10(377) 0	500	141.94
79	0 131(82) 238(418) 0	500	111.59
80	0 39(167) 102(302) 0	469	111.19
81	0 194(222) 197(255) 0	477	150.05
82	0 89(89) 167(411) 0	500	132.72
83	0 125(441) 0	441	34.41
84	0 177(171) 249(308) 0	479	47.46
85	0 157(423) 0	423	45.25
86	0 24(71) 127(426) 0	497	244.67
87	0 101(100) 193(400) 0	500	63.56
88	0 203(316) 214(184) 0	500	87.76
89	0 183(260) 217(240) 0	500	102.85
90	0 96(171) 112(307) 0	478	71.52
91	0 206(178) 220(308) 0	486	127.04
92	0 195(353) 0	353	45.61
93	0 204(139) 198(361) 0	500	59.26
94	0 123(77) 16(383) 0	460	105.92
95	0 173(418) 0	418	77.25
96	0 228(433) 0	433	125.25
97	0 214(197) 131(303) 0	500	91.22
98	0 176(130) 226(370) 0	500	156.64
99	0 206(99) 65(401) 0	500	128.17

(cont.)

Table B.52 continued.

	Route	Load	Distance
100	0 122(130) 38(366) 0	496	96.29
101	0 82(96) 241(404) 0	500	67.52
102	0 101(110) 13(374) 0	484	117.16
103	0 89(267) 248(233) 0	500	136.80
104	0 225(360) 82(140) 0	500	69.76
105	250(0) 229(88) 1(412) 250(0)	500	295.92
106	250(0) 105(22) 29(181) 109(263) 250(0)	466	178.66
107	250(0) 160(389) 250(0)	389	56.04
108	250(0) 143(427) 250(0)	427	88.77
109	250(0) 180(142) 152(358) 250(0)	500	48.55
110	250(0) 109(147) 20(353) 250(0)	500	174.03
111	250(0) 138(413) 100(87) 250(0)	500	155.04
112	250(0) 164(89) 186(411) 250(0)	500	123.42
113	250(0) 236(280) 23(220) 250(0)	500	73.56
114	250(0) 28(111) 70(382) 250(0)	493	198.91
115	250(0) 105(220) 92(280) 250(0)	500	152.37
116	250(0) 234(147) 33(353) 250(0)	500	194.42
117	250(0) 87(265) 34(235) 250(0)	500	145.08
118	250(0) 149(302) 94(198) 250(0)	500	161.67
119	250(0) 165(227) 37(273) 250(0)	500	82.85
120	250(0) 227(429) 250(0)	429	167.63
121	250(0) 244(277) 108(170) 250(0)	447	178.36
122	250(0) 245(442) 250(0)	442	119.63
123	250(0) 171(101) 181(399) 250(0)	500	134.36
124	250(0) 99(112) 232(388) 250(0)	500	206.95
125	250(0) 86(411) 94(10) 250(0)	421	153.27
126	250(0) 104(68) 215(432) 250(0)	500	92.18
127	250(0) 120(403) 250(0)	403	57.31
128	250(0) 187(141) 93(359) 250(0)	500	78.13
129	250(0) 236(103) 128(370) 250(0)	473	86.55
130	250(0) 141(80) 74(420) 250(0)	500	76.77
131	250(0) 165(51) 169(413) 250(0)	464	120.82
132	250(0) 246(433) 250(0)	433	32.25

(cont.)

Table B.52 continued.

	Route	Load	Distance
133	250(0) 108(145) 76(355) 250(0)	500	190.89
134	250(0) 100(233) 81(267) 250(0)	500	140.36
135	250(0) 218(428) 184(72) 250(0)	500	106.62
136	250(0) 134(322) 29(178) 250(0)	500	225.44
137	250(0) 48(438) 250(0)	438	77.25
138	250(0) 94(110) 88(390) 250(0)	500	147.78
139	250(0) 7(444) 250(0)	444	58.24
140	250(0) 184(290) 144(210) 250(0)	500	102.16
141	250(0) 117(425) 250(0)	425	132.97
142	250(0) 81(83) 145(367) 250(0)	450	144.14
143	250(0) 34(199) 95(290) 250(0)	489	113.78
144	250(0) 91(412) 250(0)	412	94.40
145	250(0) 110(244) 60(256) 250(0)	500	188.12
146	250(0) 14(130) 174(365) 250(0)	495	105.40
147	250(0) 132(378) 105(122) 250(0)	500	154.96
148	250(0) 243(60) 59(440) 250(0)	500	155.87
149	250(0) 22(371) 250(0)	371	48.37
150	250(0) 41(250) 110(157) 250(0)	407	183.07
151	250(0) 188(419) 250(0)	419	111.61
152	250(0) 196(357) 23(135) 250(0)	492	83.19
153	250(0) 85(395) 250(0)	395	97.69
154	250(0) 142(128) 68(372) 250(0)	500	210.39
155	250(0) 141(175) 126(325) 250(0)	500	81.62
156	250(0) 108(124) 155(376) 250(0)	500	199.61
157	250(0) 140(435) 250(0)	435	76.94
158	250(0) 37(143) 222(354) 250(0)	497	92.72
159	250(0) 231(17) 139(419) 71(51) 250(0)	487	274.06
160	250(0) 111(403) 250(0)	403	76.58
161	250(0) 165(146) 243(345) 250(0)	491	115.19
162	250(0) 164(75) 4(425) 250(0)	500	121.81
163	250(0) 63(444) 250(0)	444	43.27
164	250(0) 94(121) 151(379) 250(0)	500	144.96
165	250(0) 44(447) 250(0)	447	40.25

(cont.)

Table B.52 continued.

	Route	Load	Distance
166	250(0) 28(283) 156(217) 250(0)	500	92.69
167	250(0) 60(113) 158(387) 250(0)	500	204.52
168	250(0) 134(105) 159(395) 250(0)	500	263.52
169	250(0) 202(449) 99(50) 250(0)	499	246.63
170	250(0) 172(51) 21(449) 250(0)	500	145.19
171	250(0) 67(312) 162(188) 250(0)	500	196.16
172	250(0) 172(279) 164(221) 250(0)	500	106.94
173	250(0) 46(390) 216(110) 250(0)	500	61.43
174	250(0) 179(371) 250(0)	371	55.32
175	250(0) 162(222) 171(278) 250(0)	500	146.74
176	250(0) 67(101) 97(399) 250(0)	500	194.05
177	250(0) 142(299) 99(201) 250(0)	500	210.08
178	250(0) 92(104) 178(396) 250(0)	500	150.61
179	250(0) 87(131) 154(369) 250(0)	500	170.15
180	250(0) 25(421) 250(0)	421	35.78
181	250(0) 141(124) 104(376) 250(0)	500	71.69
182	250(0) 95(139) 182(361) 250(0)	500	110.09
183	250(0) 180(218) 216(282) 250(0)	500	52.17
184	250(0) 208(382) 250(0)	382	16.12
185	250(0) 6(400) 250(0)	400	90.09
186	250(0) 14(123) 98(377) 250(0)	500	123.34
187	250(0) 200(417) 250(0)	417	34.93
188	250(0) 14(37) 107(420) 250(0)	457	122.12
189	250(0) 180(56) 50(400) 250(0)	456	110.46
190	250(0) 77(441) 250(0)	441	108.76
191	250(0) 31(391) 205(109) 250(0)	500	259.36
192	250(0) 72(389) 172(64) 250(0)	453	153.98
193	250(0) 41(122) 210(378) 250(0)	500	170.01
194	250(0) 156(30) 239(435) 250(0)	465	107.19
195	250(0) 199(357) 250(0)	357	20.59
196	250(0) 93(15) 212(425) 187(59) 250(0)	499	125.93
197	250(0) 244(125) 115(375) 250(0)	500	171.71
198	250(0) 192(84) 119(416) 250(0)	500	121.10

(cont.)

Table B.52 continued.

	Route	Load	Distance
199	250(0) 71(215) 229(285) 250(0)	500	274.17
200	250(0) 71(138) 231(362) 250(0)	500	261.78
201	250(0) 156(111) 35(389) 250(0)	500	114.72
202	250(0) 205(243) 234(243) 250(0)	486	249.82
203	250(0) 51(419) 97(32) 250(0)	451	198.22
204	250(0) 192(275) 144(193) 250(0)	468	95.10
205	250(0) 14(119) 240(381) 250(0)	500	134.30
206	250(0) 100(91) 209(409) 250(0)	500	159.25
207	250(0) 187(150) 45(350) 250(0)	500	91.94
208	250(0) 126(30) 116(427) 250(0)	457	79.37
209	250(0) 161(449) 250(0)	449	62.10
210	250(0) 149(133) 247(367) 250(0)	500	180.83
		Total Distance	25502.49

Table B.53: IDH solution to MDSD8 with demand range [.7, .9].

	Route	Load	Distance
1	0 222(354) 0	354	44.94
2	0 107(345) 14(155) 0	500	75.49
3	0 233(377) 15(123) 0	500	142.76
4	0 208(382) 199(118) 0	500	115.18
5	0 24(84) 17(416) 0	500	205.02
6	0 134(351) 147(149) 0	500	164.56
7	0 98(119) 240(381) 0	500	66.56
8	0 147(267) 24(233) 0	500	193.73
9	0 174(130) 128(370) 0	500	60.79
10	0 78(181) 201(319) 0	500	152.44
11	0 44(213) 37(287) 0	500	82.43
12	0 24(55) 40(445) 0	500	192.47
13	0 243(117) 16(383) 0	500	115.26
14	0 199(239) 44(234) 0	473	81.61
15	0 94(121) 151(379) 0	500	177.23
16	0 165(424) 0	424	65.97
17	0 116(56) 215(432) 126(8) 0	496	148.86
18	0 97(81) 51(419) 0	500	118.44
19	0 105(105) 85(395) 0	500	56.94
20	0 110(131) 60(369) 0	500	91.45
21	0 32(87) 67(413) 0	500	138.58
22	0 92(104) 178(396) 0	500	51.62
23	0 88(89) 86(411) 0	500	183.92
24	0 50(400) 196(62) 0	462	140.26
25	0 161(449) 0	449	83.19
26	0 48(438) 0	438	38.05
27	0 218(428) 179(51) 0	479	167.22
28	0 94(318) 88(182) 0	500	175.94
29	0 93(88) 91(412) 0	500	123.10
30	0 210(220) 110(270) 0	490	85.56
31	0 245(442) 0	442	160.00
32	0 25(121) 141(379) 0	500	133.87
33	0 14(254) 98(246) 0	500	66.50

(cont.)

Table B.53 continued.

	Route	Load	Distance
34	0 117(425) 0	425	53.14
35	0 104(444) 0	444	142.13
36	0 132(241) 105(259) 0	500	75.36
37	0 20(212) 227(288) 0	500	79.16
38	0 236(226) 111(274) 0	500	33.05
39	0 134(76) 159(395) 0	471	172.90
40	0 236(60) 23(355) 0	415	36.84
41	0 25(80) 74(420) 0	500	154.91
42	0 37(129) 116(371) 0	500	126.30
43	0 25(153) 126(347) 0	500	144.84
44	0 111(129) 22(371) 0	500	52.98
45	0 29(359) 227(141) 0	500	80.29
46	0 32(318) 78(140) 0	458	145.07
47	0 181(13) 162(302) 136(167) 0	482	137.13
48	0 59(440) 0	440	102.08
49	0 149(435) 0	435	195.48
50	0 169(66) 52(434) 0	500	105.52
51	0 180(284) 152(216) 0	500	119.66
52	0 152(142) 156(358) 0	500	156.13
53	0 45(200) 93(286) 0	486	103.82
54	0 109(297) 20(141) 0	438	78.90
55	0 25(67) 246(433) 0	500	132.11
56	0 169(112) 219(388) 0	500	116.15
57	0 88(119) 247(367) 98(12) 0	498	185.53
58	0 77(441) 0	441	125.30
59	0 184(278) 192(183) 144(35) 0	496	165.76
60	0 78(57) 175(443) 0	500	191.05
61	0 136(124) 176(376) 0	500	149.43
62	0 174(30) 143(427) 0	457	45.61
63	0 63(361) 179(139) 0	500	99.92
64	0 144(368) 180(132) 0	500	149.52
65	0 169(235) 181(265) 0	500	89.96
66	0 179(110) 46(390) 0	500	100.53

(cont.)

Table B.53 continued.

	Route	Load	Distance
67	0 45(150) 187(350) 0	500	98.12
68	0 239(324) 192(176) 0	500	177.14
69	0 174(205) 196(295) 0	500	39.08
70	0 243(288) 15(179) 0	467	129.92
71	0 162(108) 75(392) 0	500	106.54
72	0 127(426) 201(74) 0	500	200.93
73	0 63(83) 216(392) 0	475	103.69
74	0 181(121) 171(379) 0	500	86.92
75	0 15(96) 102(404) 0	500	131.04
76	0 179(71) 200(417) 0	488	92.52
77	0 107(75) 212(425) 0	500	113.05
78	0 184(84) 119(416) 0	500	183.38
79	0 136(130) 226(370) 0	500	144.00
80	0 97(350) 132(137) 0	487	79.52
81	0 41(372) 0	372	71.22
82	0 35(389) 239(111) 0	500	193.01
83	0 236(97) 120(403) 0	500	45.20
84	0 109(113) 158(387) 0	500	108.27
85	0 92(280) 210(158) 0	438	70.89
86	0 6(400) 0	400	81.61
87	250(0) 2(443) 250(0)	443	26.91
88	250(0) 190(134) 8(366) 250(0)	500	125.62
89	250(0) 153(326) 9(174) 250(0)	500	41.62
90	250(0) 197(430) 10(70) 250(0)	500	122.14
91	250(0) 10(307) 11(169) 250(0)	476	99.58
92	250(0) 13(374) 250(0)	374	56.32
93	250(0) 54(222) 18(278) 250(0)	500	124.87
94	250(0) 26(398) 250(0)	398	25.06
95	250(0) 195(134) 27(366) 250(0)	500	71.64
96	250(0) 65(401) 36(49) 250(0)	450	107.82
97	250(0) 56(134) 38(366) 250(0)	500	129.47
98	250(0) 42(448) 250(0)	448	119.63
99	250(0) 228(75) 53(425) 250(0)	500	138.97

(cont.)

Table B.53 continued.

	Route	Load	Distance
100	250(0) 73(280) 54(220) 250(0)	500	119.10
101	250(0) 47(108) 55(392) 250(0)	500	169.45
102	250(0) 47(312) 56(188) 250(0)	500	165.07
103	250(0) 203(338) 57(159) 250(0)	497	51.15
104	250(0) 58(440) 250(0)	440	52.95
105	250(0) 249(167) 62(309) 250(0)	476	84.27
106	250(0) 193(293) 64(207) 250(0)	500	45.28
107	250(0) 80(225) 66(275) 250(0)	500	145.21
108	250(0) 204(373) 73(127) 250(0)	500	107.26
109	250(0) 194(403) 80(97) 250(0)	500	134.96
110	250(0) 43(131) 82(369) 250(0)	500	88.10
111	250(0) 83(412) 250(0)	412	77.20
112	250(0) 135(104) 84(396) 250(0)	500	129.88
113	250(0) 9(144) 89(356) 250(0)	500	65.38
114	250(0) 198(175) 96(325) 250(0)	500	120.45
115	250(0) 193(107) 101(366) 250(0)	473	23.19
116	250(0) 113(60) 103(440) 250(0)	500	150.60
117	250(0) 121(143) 106(357) 250(0)	500	106.20
118	250(0) 96(62) 112(366) 250(0)	428	131.46
119	250(0) 80(111) 113(386) 250(0)	497	141.73
120	250(0) 114(416) 250(0)	416	7.21
121	250(0) 123(97) 118(403) 250(0)	500	127.67
122	250(0) 189(170) 121(256) 250(0)	426	87.62
123	250(0) 223(129) 122(371) 250(0)	500	102.02
124	250(0) 3(376) 123(102) 250(0)	478	135.91
125	250(0) 18(84) 124(416) 250(0)	500	149.77
126	250(0) 125(441) 250(0)	441	29.53
127	250(0) 57(115) 131(385) 250(0)	500	67.23
128	250(0) 123(233) 135(267) 250(0)	500	136.92
129	250(0) 137(435) 250(0)	435	115.17
130	250(0) 39(426) 146(74) 250(0)	500	138.20
131	250(0) 148(428) 250(0)	428	17.89
132	250(0) 230(116) 150(384) 250(0)	500	62.82

(cont.)

Table B.53 continued.

	Route	Load	Distance
133	250(0) 167(411) 153(89) 250(0)	500	69.57
134	250(0) 64(77) 157(423) 250(0)	500	74.11
135	250(0) 64(109) 163(391) 250(0)	500	60.92
136	250(0) 66(102) 168(398) 250(0)	500	153.15
137	250(0) 170(432) 250(0)	432	23.41
138	250(0) 163(57) 177(443) 250(0)	500	84.40
139	250(0) 36(321) 183(179) 250(0)	500	70.05
140	250(0) 69(226) 190(229) 250(0)	455	114.95
141	250(0) 173(281) 195(219) 250(0)	500	91.19
142	250(0) 207(314) 198(186) 250(0)	500	126.41
143	250(0) 238(418) 203(82) 250(0)	500	83.32
144	250(0) 30(437) 204(10) 250(0)	447	131.76
145	250(0) 183(135) 206(365) 250(0)	500	93.53
146	250(0) 166(387) 207(113) 250(0)	500	134.61
147	250(0) 213(441) 250(0)	441	143.18
148	250(0) 57(119) 214(381) 250(0)	500	62.42
149	250(0) 217(445) 250(0)	445	58.00
150	250(0) 183(76) 220(424) 250(0)	500	76.16
151	250(0) 43(239) 223(242) 250(0)	481	91.96
152	250(0) 69(142) 224(358) 250(0)	500	82.68
153	250(0) 235(140) 225(360) 250(0)	500	78.08
154	250(0) 173(137) 228(358) 250(0)	495	133.01
155	250(0) 189(248) 230(252) 250(0)	500	74.14
156	250(0) 11(251) 235(249) 250(0)	500	68.36
157	250(0) 62(140) 237(360) 250(0)	500	89.22
158	250(0) 241(404) 250(0)	404	68.12
159	250(0) 56(50) 242(439) 250(0)	489	119.86
160	250(0) 9(54) 248(390) 250(0)	444	67.21
161	250(0) 146(308) 249(192) 250(0)	500	114.67
162	251(0) 229(88) 1(412) 251(0)	500	124.18
163	251(0) 7(444) 4(56) 251(0)	500	125.03
164	251(0) 12(356) 5(144) 251(0)	500	105.36
165	251(0) 49(448) 12(39) 251(0)	487	113.04

(cont.)

Table B.53 continued.

	Route	Load	Distance
166	251(0) 21(449) 251(0)	449	32.31
167	251(0) 205(352) 31(148) 251(0)	500	86.09
168	251(0) 33(353) 251(0)	353	21.54
169	251(0) 90(104) 61(378) 251(0)	482	92.02
170	251(0) 139(419) 68(81) 251(0)	500	92.20
171	251(0) 99(204) 70(296) 251(0)	500	44.78
172	251(0) 31(243) 71(189) 251(0)	432	93.20
173	251(0) 185(91) 72(389) 251(0)	480	70.04
174	251(0) 154(145) 76(355) 251(0)	500	84.81
175	251(0) 19(223) 79(277) 251(0)	500	83.87
176	251(0) 34(434) 81(66) 251(0)	500	128.66
177	251(0) 188(104) 87(396) 251(0)	500	122.39
178	251(0) 188(209) 95(290) 251(0)	499	124.18
179	251(0) 108(439) 99(61) 251(0)	500	53.23
180	251(0) 4(369) 115(131) 251(0)	500	70.22
181	251(0) 90(80) 129(420) 251(0)	500	108.85
182	251(0) 90(74) 130(426) 251(0)	500	118.93
183	251(0) 5(276) 133(224) 251(0)	500	91.81
184	251(0) 138(413) 251(0)	413	25.30
185	251(0) 164(58) 140(435) 251(0)	493	107.93
186	251(0) 68(170) 142(315) 251(0)	485	41.50
187	251(0) 100(133) 145(367) 251(0)	500	46.76
188	251(0) 115(244) 154(224) 251(0)	468	81.13
189	251(0) 70(86) 155(376) 251(0)	462	71.02
190	251(0) 164(111) 160(389) 251(0)	500	122.89
191	251(0) 81(284) 164(216) 251(0)	500	103.47
192	251(0) 186(98) 172(394) 251(0)	492	80.54
193	251(0) 95(139) 182(361) 251(0)	500	138.52
194	251(0) 19(194) 185(306) 251(0)	500	69.37
195	251(0) 100(187) 186(313) 251(0)	500	56.23
196	251(0) 28(394) 188(106) 251(0)	500	139.24
197	251(0) 133(129) 191(371) 251(0)	500	102.02
198	251(0) 202(449) 251(0)	449	85.44

(cont.)

Table B.53 continued.

	Route	Load	Distance
199	251(0) 100(91) 209(409) 251(0)	500	43.11
200	251(0) 79(97) 211(403) 251(0)	500	97.11
201	251(0) 90(120) 221(380) 251(0)	500	110.80
202	251(0) 71(215) 229(285) 251(0)	500	100.86
203	251(0) 68(121) 231(379) 251(0)	500	69.68
204	251(0) 142(112) 232(388) 251(0)	500	53.36
205	251(0) 234(390) 251(0)	390	12.65
206	251(0) 99(98) 244(402) 251(0)	500	51.85
		Total Distance	20915.02

Table B.54: IDH solution to MDSD9 with demand range [.7, .9].

	Route	Load	Distance
1	0 222(89) 6(400) 0	489	91.25
2	0 227(147) 20(353) 0	500	76.22
3	0 200(253) 22(247) 0	500	90.85
4	0 236(145) 23(355) 0	500	41.85
5	0 227(141) 29(359) 0	500	78.15
6	0 222(84) 37(416) 0	500	83.86
7	0 60(128) 41(372) 0	500	88.22
8	0 111(53) 44(447) 0	500	72.70
9	0 161(150) 45(350) 0	500	99.91
10	0 179(110) 46(390) 0	500	103.38
11	0 48(438) 0	438	39.85
12	0 91(100) 50(400) 0	500	140.62
13	0 158(128) 134(359) 0	487	135.25
14	0 200(56) 63(444) 0	500	103.72
15	0 51(87) 67(413) 0	500	128.27
16	0 77(441) 0	441	124.26
17	0 94(75) 86(411) 0	486	184.81
18	0 94(364) 88(136) 0	500	174.98
19	0 187(224) 91(254) 0	478	122.65
20	0 178(116) 92(384) 0	500	44.01
21	0 132(69) 97(431) 0	500	81.45
22	0 98(377) 0	377	48.08
23	0 105(364) 0	364	45.65
24	0 14(80) 107(420) 0	500	70.61
25	0 210(90) 109(410) 0	500	78.59
26	0 117(425) 0	425	43.86
27	0 236(88) 120(403) 0	491	51.01
28	0 174(130) 128(370) 0	500	60.87
29	0 171(191) 132(309) 0	500	105.95
30	0 159(395) 134(68) 0	463	170.18
31	0 143(427) 0	427	44.05
32	0 174(64) 149(435) 0	499	194.56
33	0 88(121) 151(379) 0	500	172.58

(cont.)

Table B.54 continued.

	Route	Load	Distance
34	0 60(241) 158(259) 0	500	104.72
35	0 179(177) 161(299) 0	476	88.11
36	0 222(76) 165(424) 0	500	76.06
37	0 171(87) 169(413) 0	500	96.88
38	0 14(329) 174(171) 0	500	53.30
39	0 210(189) 178(280) 0	469	65.88
40	0 179(84) 180(416) 0	500	109.10
41	0 171(101) 181(399) 0	500	93.64
42	0 93(374) 187(126) 0	500	98.83
43	0 196(357) 0	357	29.73
44	0 22(124) 199(357) 0	481	90.08
45	0 216(392) 200(108) 0	500	108.75
46	0 110(401) 210(99) 0	500	80.36
47	0 212(425) 0	425	106.28
48	0 85(395) 222(105) 0	500	58.15
49	0 51(332) 227(141) 0	473	122.29
50	0 111(350) 236(150) 0	500	39.79
51	0 240(381) 0	381	57.20
52	0 91(58) 245(442) 0	500	160.31
53	0 88(133) 247(367) 0	500	176.59
54	250(0) 89(126) 13(374) 250(0)	500	142.54
55	250(0) 10(82) 238(418) 250(0)	500	45.37
56	250(0) 3(145) 126(355) 250(0)	500	163.10
57	250(0) 131(205) 10(295) 250(0)	500	48.76
58	250(0) 43(141) 249(359) 250(0)	500	68.69
59	250(0) 66(102) 168(398) 250(0)	500	52.37
60	250(0) 43(100) 237(360) 250(0)	460	78.49
61	250(0) 39(426) 250(0)	426	59.09
62	250(0) 203(420) 250(0)	420	58.31
63	250(0) 153(75) 189(418) 250(0)	493	168.19
64	250(0) 136(297) 233(179) 250(0)	476	81.30
65	250(0) 42(448) 250(0)	448	44.41
66	250(0) 3(68) 215(432) 250(0)	500	164.48

(cont.)

Table B.54 continued.

	Route	Load	Distance
67	250(0) 64(393) 250(0)	393	94.02
68	250(0) 17(100) 40(400) 250(0)	500	122.40
69	250(0) 146(76) 16(383) 250(0)	459	118.24
70	250(0) 80(114) 113(386) 250(0)	500	49.02
71	250(0) 17(188) 55(312) 250(0)	500	94.56
72	250(0) 80(94) 194(403) 250(0)	497	45.65
73	250(0) 11(420) 250(0)	420	42.19
74	250(0) 125(441) 250(0)	441	102.63
75	250(0) 177(174) 224(326) 250(0)	500	95.59
76	250(0) 153(102) 26(398) 250(0)	500	137.21
77	250(0) 80(225) 66(275) 250(0)	500	49.16
78	250(0) 177(269) 69(231) 250(0)	500	89.76
79	250(0) 3(29) 116(427) 250(0)	456	159.62
80	250(0) 201(347) 78(153) 250(0)	500	118.44
81	250(0) 62(449) 250(0)	449	70.23
82	250(0) 175(443) 250(0)	443	65.15
83	250(0) 201(46) 147(416) 250(0)	462	155.94
84	250(0) 121(270) 89(230) 250(0)	500	167.24
85	250(0) 170(300) 101(200) 250(0)	500	127.82
86	250(0) 113(60) 103(440) 250(0)	500	55.64
87	250(0) 43(129) 122(371) 250(0)	500	56.77
88	250(0) 214(381) 250(0)	381	44.18
89	250(0) 101(84) 193(400) 250(0)	484	88.72
90	250(0) 162(60) 59(440) 250(0)	500	109.22
91	250(0) 55(80) 47(420) 250(0)	500	66.57
92	250(0) 52(95) 243(405) 250(0)	500	121.47
93	250(0) 131(100) 57(393) 250(0)	493	57.23
94	250(0) 3(134) 8(366) 250(0)	500	139.75
95	250(0) 146(104) 84(396) 250(0)	500	92.27
96	250(0) 101(82) 114(416) 250(0)	498	109.30
97	250(0) 123(432) 250(0)	432	116.28
98	250(0) 135(298) 146(202) 250(0)	500	92.15
99	250(0) 135(73) 118(403) 250(0)	476	117.12

(cont.)

Table B.54 continued.

	Route	Load	Distance
100	250(0) 121(129) 106(357) 250(0)	486	193.04
101	250(0) 9(262) 153(238) 250(0)	500	134.87
102	250(0) 242(439) 250(0)	439	18.97
103	250(0) 38(366) 250(0)	366	34.93
104	250(0) 219(108) 75(392) 250(0)	500	101.21
105	250(0) 69(137) 190(363) 250(0)	500	124.02
106	250(0) 224(32) 163(448) 250(0)	480	91.31
107	250(0) 148(428) 250(0)	428	118.07
108	250(0) 102(102) 15(398) 250(0)	500	84.33
109	250(0) 219(119) 162(350) 250(0)	469	106.25
110	250(0) 40(45) 127(426) 250(0)	471	148.01
111	250(0) 226(95) 32(405) 250(0)	500	108.15
112	250(0) 131(80) 167(411) 250(0)	491	136.64
113	250(0) 223(371) 250(0)	371	43.17
114	250(0) 9(110) 248(390) 250(0)	500	157.76
115	250(0) 52(339) 219(161) 250(0)	500	103.73
116	250(0) 241(111) 235(389) 250(0)	500	49.70
117	250(0) 225(131) 82(369) 250(0)	500	62.57
118	250(0) 241(293) 225(207) 250(0)	500	44.60
119	250(0) 78(225) 226(275) 250(0)	500	107.84
120	250(0) 170(132) 230(368) 250(0)	500	139.57
121	250(0) 102(302) 233(198) 250(0)	500	81.55
122	250(0) 136(124) 176(376) 250(0)	500	75.88
123	250(0) 197(430) 250(0)	430	40.00
124	250(0) 56(372) 250(0)	372	14.56
125	250(0) 225(22) 157(423) 250(0)	445	62.20
126	250(0) 17(128) 24(372) 250(0)	500	118.48
127	251(0) 217(57) 2(443) 251(0)	500	107.37
128	251(0) 5(420) 251(0)	420	39.85
129	251(0) 49(174) 12(326) 251(0)	500	37.16
130	251(0) 166(194) 19(306) 251(0)	500	92.37
131	251(0) 137(94) 27(366) 251(0)	460	59.27
132	251(0) 18(63) 30(437) 251(0)	500	26.76

(cont.)

Table B.54 continued.

	Route	Load	Distance
133	251(0) 130(226) 49(274) 251(0)	500	56.66
134	251(0) 53(425) 251(0)	425	47.54
135	251(0) 137(58) 54(442) 251(0)	500	39.41
136	251(0) 183(60) 58(440) 251(0)	500	110.92
137	251(0) 90(122) 61(378) 251(0)	500	62.83
138	251(0) 206(99) 65(401) 251(0)	500	88.67
139	251(0) 19(111) 72(389) 251(0)	500	87.73
140	251(0) 198(93) 73(407) 251(0)	500	63.59
141	251(0) 206(136) 83(364) 251(0)	500	82.83
142	251(0) 205(244) 90(256) 251(0)	500	124.82
143	251(0) 198(151) 96(349) 251(0)	500	79.50
144	251(0) 124(416) 251(0)	416	15.23
145	251(0) 130(200) 129(300) 251(0)	500	73.10
146	251(0) 191(147) 133(353) 251(0)	500	46.69
147	251(0) 18(299) 137(201) 251(0)	500	25.62
148	251(0) 207(293) 166(193) 251(0)	486	67.70
149	251(0) 137(82) 173(418) 251(0)	500	40.77
150	251(0) 150(384) 183(116) 251(0)	500	111.14
151	251(0) 191(98) 185(397) 251(0)	495	78.20
152	251(0) 79(374) 191(126) 251(0)	500	60.13
153	251(0) 217(147) 195(353) 251(0)	500	98.15
154	251(0) 204(383) 198(117) 251(0)	500	66.65
155	251(0) 31(391) 205(108) 251(0)	499	139.28
156	251(0) 36(370) 206(130) 251(0)	500	101.85
157	251(0) 112(366) 207(134) 251(0)	500	103.40
158	251(0) 12(69) 211(403) 251(0)	472	62.82
159	251(0) 96(38) 213(441) 251(0)	479	112.79
160	251(0) 183(214) 217(241) 251(0)	455	108.53
161	251(0) 83(48) 220(424) 251(0)	472	105.11
162	251(0) 129(120) 221(380) 251(0)	500	83.51
163	251(0) 228(433) 251(0)	433	41.62
164	252(0) 99(73) 142(427) 252(0)	500	122.48
165	252(0) 81(289) 4(211) 252(0)	500	46.73

(cont.)

Table B.54 continued.

	Route	Load	Distance
166	252(0) 145(82) 234(390) 252(0)	472	114.98
167	252(0) 152(358) 28(142) 252(0)	500	95.96
168	252(0) 138(147) 33(353) 252(0)	500	119.08
169	252(0) 34(434) 252(0)	434	24.08
170	252(0) 7(79) 25(421) 252(0)	500	107.18
171	252(0) 231(171) 68(329) 252(0)	500	150.99
172	252(0) 108(118) 70(382) 252(0)	500	93.85
173	252(0) 7(56) 104(444) 252(0)	500	116.71
174	252(0) 182(361) 252(0)	361	34.18
175	252(0) 154(145) 76(355) 252(0)	500	71.23
176	252(0) 140(435) 252(0)	435	72.69
177	252(0) 172(394) 252(0)	394	80.50
178	252(0) 95(429) 252(0)	429	19.70
179	252(0) 208(382) 252(0)	382	92.09
180	252(0) 28(110) 35(389) 252(0)	499	84.09
181	252(0) 68(43) 71(404) 252(0)	447	172.44
182	252(0) 99(290) 108(197) 252(0)	487	94.98
183	252(0) 87(396) 252(0)	396	36.77
184	252(0) 239(84) 119(416) 252(0)	500	110.81
185	252(0) 21(234) 138(266) 252(0)	500	86.91
186	252(0) 4(125) 115(375) 252(0)	500	59.60
187	252(0) 160(389) 252(0)	389	55.71
188	252(0) 7(121) 141(379) 252(0)	500	107.20
189	252(0) 144(403) 252(0)	403	98.33
190	252(0) 21(215) 145(285) 252(0)	500	86.49
191	252(0) 244(239) 154(224) 252(0)	463	82.39
192	252(0) 108(124) 155(376) 252(0)	500	101.04
193	252(0) 28(142) 156(358) 252(0)	500	65.54
194	252(0) 4(89) 100(411) 252(0)	500	64.89
195	252(0) 7(188) 164(312) 252(0)	500	71.66
196	252(0) 164(73) 74(420) 252(0)	493	110.17
197	252(0) 246(433) 252(0)	433	86.93
198	252(0) 188(419) 252(0)	419	6.00

(cont.)

Table B.54 continued.

	Route	Load	Distance
199	252(0) 239(141) 192(359) 252(0)	500	105.85
200	252(0) 81(61) 186(411) 252(0)	472	65.67
201	252(0) 232(51) 139(419) 252(0)	470	165.66
202	252(0) 184(362) 218(138) 252(0)	500	109.92
203	252(0) 229(373) 231(127) 252(0)	500	187.67
204	252(0) 202(449) 252(0)	449	151.92
205	252(0) 231(81) 1(412) 252(0)	493	203.20
206	252(0) 218(290) 239(210) 252(0)	500	109.56
207	252(0) 232(337) 244(163) 252(0)	500	115.41
208	252(0) 209(409) 252(0)	409	79.62
		Total Distance	18844.77

Table B.55: IDH solution to MDSD10 with demand range [.7, .9].

	Route	Load	Distance
1	0 222(100) 6(400) 0	500	81.72
2	0 107(420) 14(80) 0	500	75.49
3	0 210(147) 20(353) 0	500	85.23
4	0 120(258) 22(242) 0	500	53.35
5	0 37(416) 0	416	70.03
6	0 60(369) 41(131) 0	500	93.26
7	0 44(447) 0	447	63.53
8	0 52(434) 0	434	105.26
9	0 222(178) 85(308) 0	486	49.11
10	0 178(396) 92(57) 0	453	51.62
11	0 105(69) 97(431) 0	500	79.19
12	0 14(242) 98(258) 0	500	66.50
13	0 92(327) 105(173) 0	500	62.33
14	0 227(288) 109(212) 0	500	79.48
15	0 109(99) 110(401) 0	500	85.26
16	0 111(403) 0	403	22.63
17	0 117(425) 0	425	53.14
18	0 23(355) 120(145) 0	500	46.82
19	0 14(87) 128(370) 0	457	72.17
20	0 105(122) 132(378) 0	500	75.36
21	0 174(43) 143(427) 0	470	45.61
22	0 109(99) 158(387) 0	486	108.27
23	0 171(90) 162(410) 0	500	100.90
24	0 85(87) 169(413) 0	500	81.20
25	0 181(187) 171(289) 0	476	86.92
26	0 196(178) 174(322) 0	500	39.08
27	0 243(288) 181(212) 0	500	111.89
28	0 48(438) 196(62) 0	500	38.13
29	0 22(129) 199(357) 0	486	82.68
30	0 41(241) 210(231) 0	472	71.44
31	0 165(424) 222(76) 0	500	66.46
32	0 29(359) 227(141) 0	500	80.29
33	0 196(117) 236(383) 0	500	36.65

(cont.)

Table B.55 continued.

	Route	Load	Distance
34	0 98(119) 240(381) 0	500	66.56
35	0 16(383) 243(117) 0	500	115.26
36	250(0) 131(205) 10(295) 250(0)	500	125.36
37	250(0) 214(80) 11(420) 250(0)	500	132.41
38	250(0) 242(96) 241(404) 250(0)	500	117.80
39	250(0) 55(312) 17(188) 250(0)	500	48.13
40	250(0) 17(228) 24(272) 250(0)	500	48.38
41	250(0) 24(26) 40(445) 250(0)	471	46.49
42	250(0) 122(371) 38(97) 250(0)	468	103.32
43	250(0) 176(74) 39(426) 250(0)	500	85.55
44	250(0) 175(443) 250(0)	443	20.59
45	250(0) 80(52) 42(448) 250(0)	500	92.49
46	250(0) 136(127) 226(370) 250(0)	497	51.10
47	250(0) 159(395) 147(68) 250(0)	463	118.11
48	250(0) 201(73) 134(427) 250(0)	500	100.93
49	250(0) 201(81) 51(419) 250(0)	500	72.45
50	250(0) 168(187) 66(313) 250(0)	500	58.61
51	250(0) 219(163) 75(337) 250(0)	500	86.73
52	250(0) 176(96) 102(404) 250(0)	500	86.33
53	250(0) 56(119) 80(381) 250(0)	500	91.53
54	250(0) 168(151) 113(349) 250(0)	500	66.36
55	250(0) 113(97) 194(403) 250(0)	500	78.11
56	250(0) 75(55) 59(440) 250(0)	495	82.32
57	250(0) 176(206) 136(294) 250(0)	500	58.73
58	250(0) 201(152) 147(348) 250(0)	500	77.74
59	250(0) 168(60) 103(440) 250(0)	500	61.91
60	250(0) 55(80) 47(420) 250(0)	500	39.90
61	250(0) 201(87) 67(413) 250(0)	500	63.79
62	250(0) 223(371) 242(96) 250(0)	467	105.95
63	250(0) 233(102) 15(398) 250(0)	500	85.96
64	250(0) 66(64) 197(430) 250(0)	494	85.47
65	250(0) 24(74) 127(426) 250(0)	500	71.03
66	250(0) 131(180) 214(301) 250(0)	481	127.59

(cont.)

Table B.55 continued.

	Route	Load	Distance
67	250(0) 38(129) 43(370) 250(0)	499	109.48
68	250(0) 38(140) 225(360) 250(0)	500	111.92
69	250(0) 78(378) 250(0)	378	29.73
70	250(0) 219(225) 233(275) 250(0)	500	85.81
71	250(0) 10(82) 238(418) 250(0)	500	118.93
72	250(0) 32(405) 250(0)	405	36.88
73	250(0) 56(253) 242(247) 250(0)	500	81.36
74	251(0) 180(83) 200(417) 251(0)	500	88.40
75	251(0) 151(110) 88(390) 251(0)	500	95.90
76	251(0) 95(170) 34(330) 251(0)	500	68.36
77	251(0) 95(45) 4(425) 251(0)	470	118.78
78	251(0) 91(412) 251(0)	412	72.72
79	251(0) 28(394) 251(0)	394	48.70
80	251(0) 239(435) 251(0)	435	11.31
81	251(0) 161(449) 251(0)	449	90.55
82	251(0) 7(444) 251(0)	444	104.80
83	251(0) 45(75) 212(425) 251(0)	500	130.69
84	251(0) 141(68) 116(427) 251(0)	495	167.13
85	251(0) 104(30) 215(432) 251(0)	462	170.51
86	251(0) 245(442) 251(0)	442	60.00
87	251(0) 45(275) 93(224) 251(0)	499	105.64
88	251(0) 34(104) 87(396) 251(0)	500	97.76
89	251(0) 184(133) 218(367) 251(0)	500	29.38
90	251(0) 119(416) 251(0)	416	32.80
91	251(0) 192(100) 50(400) 251(0)	500	70.88
92	251(0) 104(145) 126(355) 251(0)	500	167.61
93	251(0) 77(441) 251(0)	441	85.91
94	251(0) 104(189) 141(311) 251(0)	500	148.94
95	251(0) 86(47) 149(435) 251(0)	482	95.78
96	251(0) 151(136) 86(364) 251(0)	500	91.21
97	251(0) 218(61) 94(439) 251(0)	500	77.30
98	251(0) 246(79) 208(382) 251(0)	461	104.98
99	251(0) 246(291) 160(209) 251(0)	500	109.33

(cont.)

Table B.55 continued.

	Route	Load	Distance
100	251(0) 35(389) 251(0)	389	20.88
101	251(0) 104(80) 74(420) 251(0)	500	152.91
102	251(0) 216(129) 179(371) 251(0)	500	91.36
103	251(0) 180(107) 46(390) 251(0)	497	80.76
104	251(0) 93(150) 187(350) 251(0)	500	89.52
105	251(0) 182(361) 95(139) 251(0)	500	62.32
106	251(0) 156(358) 251(0)	358	28.84
107	251(0) 246(63) 25(421) 251(0)	484	120.15
108	251(0) 152(358) 251(0)	358	62.03
109	251(0) 95(75) 188(419) 251(0)	494	80.12
110	251(0) 160(115) 164(385) 251(0)	500	108.72
111	251(0) 180(226) 216(263) 251(0)	489	74.23
112	251(0) 140(435) 160(65) 251(0)	500	122.04
113	251(0) 63(444) 251(0)	444	73.38
114	251(0) 192(259) 184(229) 251(0)	488	28.01
115	251(0) 151(133) 247(367) 251(0)	500	112.81
116	251(0) 144(403) 251(0)	403	25.46
117	252(0) 230(102) 26(398) 252(0)	500	95.26
118	252(0) 190(134) 112(366) 252(0)	500	98.00
119	252(0) 173(84) 124(416) 252(0)	500	66.44
120	252(0) 27(366) 252(0)	366	12.17
121	252(0) 248(101) 121(399) 252(0)	500	137.58
122	252(0) 198(117) 204(383) 252(0)	500	40.50
123	252(0) 30(437) 252(0)	437	44.18
124	252(0) 230(109) 9(372) 252(0)	481	100.86
125	252(0) 54(442) 252(0)	442	22.36
126	252(0) 135(102) 146(382) 252(0)	484	130.33
127	252(0) 2(443) 252(0)	443	60.03
128	252(0) 249(51) 62(449) 252(0)	500	107.51
129	252(0) 167(126) 13(374) 252(0)	500	150.72
130	252(0) 198(78) 96(387) 252(0)	465	58.18
131	252(0) 237(172) 69(328) 252(0)	500	101.00
132	252(0) 217(130) 36(370) 252(0)	500	74.89

(cont.)

Table B.55 continued.

	Route	Load	Distance
133	252(0) 173(192) 83(308) 252(0)	500	57.71
134	252(0) 123(97) 118(403) 252(0)	500	114.16
135	252(0) 101(84) 114(416) 252(0)	500	100.24
136	252(0) 189(143) 106(357) 252(0)	500	149.68
137	252(0) 228(75) 53(425) 252(0)	500	77.42
138	252(0) 135(104) 84(396) 252(0)	500	135.93
139	252(0) 65(401) 220(99) 252(0)	500	99.90
140	252(0) 135(165) 123(335) 252(0)	500	132.15
141	252(0) 125(441) 252(0)	441	63.81
142	252(0) 69(40) 177(443) 252(0)	483	93.92
143	252(0) 137(435) 252(0)	435	34.41
144	252(0) 190(124) 3(376) 252(0)	500	120.61
145	252(0) 83(104) 206(365) 252(0)	469	66.34
146	252(0) 213(441) 252(0)	441	94.34
147	252(0) 89(145) 167(285) 252(0)	430	138.37
148	252(0) 82(369) 163(114) 252(0)	483	102.24
149	252(0) 195(68) 170(432) 252(0)	500	73.69
150	252(0) 18(362) 252(0)	362	41.23
151	252(0) 157(111) 235(389) 252(0)	500	118.65
152	252(0) 189(275) 183(225) 252(0)	500	118.52
153	252(0) 217(116) 150(384) 252(0)	500	80.65
154	252(0) 101(282) 193(218) 252(0)	500	96.29
155	252(0) 217(199) 195(285) 252(0)	484	56.12
156	252(0) 230(72) 148(428) 252(0)	500	95.52
157	252(0) 193(182) 203(313) 252(0)	495	121.47
158	252(0) 8(366) 190(105) 252(0)	471	100.42
159	252(0) 203(107) 57(393) 252(0)	500	123.86
160	252(0) 64(393) 252(0)	393	69.43
161	252(0) 198(93) 73(407) 252(0)	500	41.46
162	252(0) 58(440) 252(0)	440	76.97
163	252(0) 183(165) 220(325) 252(0)	490	87.92
164	252(0) 163(142) 224(358) 252(0)	500	82.74
165	252(0) 173(142) 228(358) 252(0)	500	66.08

(cont.)

Table B.55 continued.

	Route	Load	Distance
166	252(0) 198(73) 207(427) 252(0)	500	56.83
167	252(0) 153(415) 230(85) 252(0)	500	104.94
168	252(0) 157(312) 237(188) 252(0)	500	113.90
169	252(0) 89(211) 248(289) 252(0)	500	136.73
170	252(0) 163(192) 249(308) 252(0)	500	103.97
171	253(0) 5(144) 12(356) 253(0)	500	35.06
172	253(0) 33(243) 19(257) 253(0)	500	69.91
173	253(0) 100(411) 21(89) 253(0)	500	104.93
174	253(0) 205(109) 31(391) 253(0)	500	113.53
175	253(0) 12(39) 49(448) 253(0)	487	45.65
176	253(0) 232(388) 68(112) 253(0)	500	129.97
177	253(0) 229(353) 71(147) 253(0)	500	148.16
178	253(0) 72(389) 253(0)	389	39.45
179	253(0) 79(374) 253(0)	374	12.17
180	253(0) 186(150) 81(350) 253(0)	500	117.49
181	253(0) 61(224) 90(258) 253(0)	482	52.13
182	253(0) 70(258) 99(242) 253(0)	500	127.20
183	253(0) 99(23) 108(439) 253(0)	462	135.50
184	253(0) 145(222) 115(278) 253(0)	500	120.42
185	253(0) 61(80) 129(420) 253(0)	500	71.12
186	253(0) 61(74) 130(426) 253(0)	500	73.09
187	253(0) 5(147) 133(353) 253(0)	500	20.11
188	253(0) 21(121) 138(379) 253(0)	500	88.00
189	253(0) 231(81) 139(419) 253(0)	500	157.00
190	253(0) 68(58) 142(427) 253(0)	485	113.33
191	253(0) 76(355) 145(145) 253(0)	500	162.45
192	253(0) 138(34) 115(97) 154(369) 253(0)	500	155.84
193	253(0) 70(124) 155(376) 253(0)	500	153.40
194	253(0) 166(387) 253(0)	387	45.61
195	253(0) 185(106) 172(394) 253(0)	500	92.20
196	253(0) 19(160) 185(291) 253(0)	451	30.55
197	253(0) 21(239) 186(261) 253(0)	500	101.00
198	253(0) 5(129) 191(371) 253(0)	500	23.57

(cont.)

Table B.55 continued.

	Route	Load	Distance
199	253(0) 202(449) 253(0)	449	154.21
200	253(0) 71(257) 205(243) 253(0)	500	132.23
201	253(0) 209(409) 253(0)	409	102.96
202	253(0) 211(403) 253(0)	403	45.65
203	253(0) 90(120) 221(380) 253(0)	500	78.79
204	253(0) 1(412) 229(20) 253(0)	432	172.63
205	253(0) 68(202) 231(298) 253(0)	500	138.15
206	253(0) 33(110) 234(390) 253(0)	500	84.95
207	253(0) 99(98) 244(402) 253(0)	500	133.73
		Total Distance	17777.76

Table B.56: IDH solution to SQ1.

	Route	Load	Distance
1	0 1(80) 2(20) 0	100	34.14
2	0 5(20) 3(80) 0	100	34.14
3	0 14(80) 4(20) 0	100	60.64
4	0 13(60) 5(40) 0	100	40.00
5	0 6(90) 0	90	28.28
6	0 7(60) 0	60	20.00
7	0 8(90) 0	90	28.28
8	0 1(10) 9(90) 0	100	56.57
9	0 2(40) 10(60) 0	100	40.00
10	0 3(10) 11(90) 0	100	56.57
11	0 4(40) 12(60) 0	100	40.00
12	0 15(20) 16(80) 0	100	68.28
13	0 14(5) 25(95) 0	100	60.02
14	0 15(35) 26(65) 0	100	44.00
15	0 16(5) 27(95) 0	100	60.02
16	33(0) 17(90) 33(0)	90	28.28
17	33(0) 21(20) 18(60) 33(0)	80	34.14
18	33(0) 19(90) 33(0)	90	28.28
19	33(0) 28(60) 20(40) 33(0)	100	40.00
20	33(0) 20(20) 22(80) 33(0)	100	34.14
21	33(0) 24(80) 23(20) 33(0)	100	34.14
22	33(0) 32(90) 24(10) 33(0)	100	56.57
23	33(0) 21(40) 29(60) 33(0)	100	40.00
24	33(0) 22(10) 30(90) 33(0)	100	56.57
25	33(0) 23(40) 31(60) 33(0)	100	40.00
		Total Distance	1063.08

Table B.57: IDH solution to SQ2.

	Route	Load	Distance
1	0 1(80) 2(20) 0	100	34.14
2	0 5(20) 3(80) 0	100	34.14
3	0 14(80) 4(20) 0	100	60.64
4	0 6(90) 0	90	28.28
5	0 7(60) 0	60	20.00
6	0 8(90) 0	90	28.28
7	0 1(10) 9(90) 0	100	56.57
8	0 2(40) 10(60) 0	100	40.00
9	0 3(10) 11(90) 0	100	56.57
10	0 12(60) 4(40) 0	100	40.00
11	0 5(40) 13(60) 0	100	40.00
12	0 14(5) 25(95) 0	100	60.02
13	0 15(20) 16(80) 0	100	68.28
14	0 15(35) 26(65) 0	100	44.00
15	0 27(95) 16(5) 0	100	60.02
16	49(0) 17(90) 49(0)	90	28.28
17	49(0) 19(40) 18(60) 49(0)	100	34.14
18	49(0) 41(90) 19(10) 49(0)	100	59.49
19	49(0) 22(80) 20(20) 49(0)	100	34.14
20	49(0) 30(90) 22(10) 49(0)	100	56.57
21	49(0) 24(90) 49(0)	90	28.28
22	49(0) 20(40) 28(60) 49(0)	100	40.00
23	49(0) 19(40) 21(60) 49(0)	100	34.14
24	49(0) 31(60) 23(40) 49(0)	100	40.00
25	49(0) 23(20) 32(80) 49(0)	100	60.64
26	49(0) 29(65) 44(35) 49(0)	100	44.00
27	49(0) 32(15) 46(85) 49(0)	100	60.02
28	50(0) 38(90) 50(0)	90	28.28
29	50(0) 36(60) 44(20) 34(20) 50(0)	100	52.36
30	50(0) 37(20) 35(80) 50(0)	100	34.14
31	50(0) 33(90) 50(0)	90	28.28
32	50(0) 39(20) 40(80) 50(0)	100	34.14
33	50(0) 34(40) 42(60) 50(0)	100	40.00

(cont.)

Table B.57 continued.

	Route	Load	Distance
34	50(0) 40(10) 48(90) 50(0)	100	56.57
35	50(0) 39(40) 47(60) 50(0)	100	40.00
36	50(0) 37(40) 45(60) 50(0)	100	40.00
37	50(0) 35(10) 43(90) 50(0)	100	56.57
		Total Distance	1601.02

Table B.58: IDH solution to SQ3.

	Route	Load	Distance
1	0 1(80) 2(20) 0	100	34.14
2	0 3(90) 0	90	28.28
3	0 14(80) 4(20) 0	100	60.64
4	0 5(60) 0	60	20.00
5	0 6(90) 0	90	28.28
6	0 7(60) 0	60	20.00
7	0 8(90) 0	90	28.28
8	0 1(10) 9(90) 0	100	56.57
9	0 2(40) 10(60) 0	100	40.00
10	0 57(95) 11(5) 0	100	60.02
11	0 4(40) 12(60) 0	100	40.00
12	0 11(80) 13(20) 0	100	68.28
13	0 25(95) 14(5) 0	100	60.02
14	0 16(80) 15(20) 0	100	68.28
15	0 15(35) 26(65) 0	100	44.00
16	0 41(85) 27(15) 0	100	62.84
17	0 13(35) 60(65) 0	100	44.00
18	0 16(5) 62(95) 0	100	60.02
19	65(0) 24(90) 65(0)	90	28.28
20	65(0) 22(10) 30(90) 65(0)	100	56.57
21	65(0) 18(60) 65(0)	60	20.00
22	65(0) 21(30) 44(5) 29(65) 65(0)	100	44.00
23	65(0) 20(20) 22(80) 65(0)	100	34.14
24	65(0) 23(40) 31(60) 65(0)	100	40.00
25	65(0) 21(30) 19(70) 65(0)	100	34.14
26	65(0) 17(90) 65(0)	90	28.28
27	65(0) 19(20) 27(80) 65(0)	100	56.57
28	65(0) 23(20) 32(80) 65(0)	100	60.64
29	65(0) 32(15) 46(85) 65(0)	100	60.02
30	65(0) 28(60) 20(40) 65(0)	100	40.00
31	66(0) 33(90) 66(0)	90	28.28
32	66(0) 42(20) 34(60) 66(0)	80	40.00
33	66(0) 35(90) 66(0)	90	28.28

(cont.)

Table B.58 continued.

	Route	Load	Distance
34	66(0) 44(50) 36(50) 66(0)	100	40.00
35	66(0) 45(60) 37(40) 66(0)	100	40.00
36	66(0) 36(10) 38(90) 66(0)	100	34.14
37	66(0) 40(80) 39(20) 66(0)	100	34.14
38	66(0) 37(20) 43(80) 66(0)	100	60.64
39	66(0) 39(40) 47(60) 66(0)	100	40.00
40	66(0) 40(10) 48(90) 66(0)	100	56.57
41	66(0) 42(35) 63(65) 66(0)	100	44.00
42	66(0) 43(5) 64(95) 66(0)	100	60.02
43	67(0) 49(90) 67(0)	90	28.28
44	67(0) 50(20) 52(60) 67(0)	80	34.14
45	67(0) 51(80) 53(20) 67(0)	100	34.14
46	67(0) 54(90) 67(0)	90	28.28
47	67(0) 55(60) 67(0)	60	20.00
48	67(0) 56(90) 67(0)	90	28.28
49	67(0) 50(40) 58(60) 67(0)	100	40.00
50	67(0) 51(10) 59(90) 67(0)	100	56.57
51	67(0) 61(60) 53(40) 67(0)	100	40.00
		Total Distance	2142.11

Table B.59: IDH solution to SQ4.

	Route	Load	Distance
1	0 1(90) 0	90	28.28
2	0 11(80) 2(20) 0	100	60.64
3	0 3(90) 0	90	28.28
4	0 14(80) 4(20) 0	100	60.64
5	0 5(60) 0	60	20.00
6	0 6(90) 0	90	28.28
7	0 7(60) 0	60	20.00
8	0 8(90) 0	90	28.28
9	0 9(90) 0	90	56.57
10	0 2(40) 10(60) 0	100	40.00
11	0 12(60) 4(40) 0	100	40.00
12	0 16(80) 13(20) 0	100	68.28
13	0 25(95) 14(5) 0	100	60.02
14	0 27(80) 15(20) 0	100	69.83
15	0 62(95) 16(5) 0	100	60.02
16	0 15(35) 26(65) 0	100	44.00
17	0 41(85) 27(15) 0	100	62.84
18	0 11(5) 57(95) 0	100	60.02
19	0 13(35) 60(65) 0	100	44.00
20	81(0) 17(90) 81(0)	90	28.28
21	81(0) 18(60) 81(0)	60	20.00
22	81(0) 19(90) 81(0)	90	28.28
23	81(0) 30(80) 20(20) 81(0)	100	60.64
24	81(0) 22(90) 81(0)	90	28.28
25	81(0) 23(60) 81(0)	60	20.00
26	81(0) 46(90) 24(10) 81(0)	100	59.49
27	81(0) 20(40) 28(60) 81(0)	100	40.00
28	81(0) 24(60) 21(40) 81(0)	100	34.14
29	81(0) 73(85) 30(15) 81(0)	100	60.02
30	81(0) 24(20) 32(80) 81(0)	100	56.57
31	81(0) 21(20) 29(65) 44(15) 81(0)	100	44.00
32	81(0) 31(65) 74(35) 81(0)	100	44.00
33	81(0) 32(15) 75(85) 81(0)	100	60.02

(cont.)

Table B.59 continued.

	Route	Load	Distance
34	82(0) 33(90) 82(0)	90	28.28
35	82(0) 42(20) 34(60) 82(0)	80	40.00
36	82(0) 35(90) 82(0)	90	28.28
37	82(0) 44(40) 36(60) 82(0)	100	40.00
38	82(0) 45(60) 37(40) 82(0)	100	40.00
39	82(0) 38(90) 82(0)	90	28.28
40	82(0) 40(80) 39(20) 82(0)	100	34.14
41	82(0) 37(20) 43(80) 82(0)	100	60.64
42	82(0) 39(40) 47(60) 82(0)	100	40.00
43	82(0) 40(10) 48(90) 82(0)	100	56.57
44	82(0) 63(65) 42(35) 82(0)	100	44.00
45	82(0) 43(5) 64(95) 82(0)	100	60.02
46	83(0) 49(90) 83(0)	90	28.28
47	83(0) 52(60) 50(20) 83(0)	80	34.14
48	83(0) 51(80) 53(20) 83(0)	100	34.14
49	83(0) 54(90) 83(0)	90	28.28
50	83(0) 55(60) 83(0)	60	20.00
51	83(0) 56(90) 83(0)	90	28.28
52	83(0) 50(40) 58(60) 83(0)	100	40.00
53	83(0) 51(10) 59(90) 83(0)	100	56.57
54	83(0) 53(40) 61(60) 83(0)	100	40.00
55	84(0) 65(90) 84(0)	90	28.28
56	84(0) 69(20) 74(20) 66(60) 84(0)	100	52.36
57	84(0) 67(90) 84(0)	90	28.28
58	84(0) 76(60) 68(40) 84(0)	100	40.00
59	84(0) 68(20) 70(80) 84(0)	100	34.14
60	84(0) 72(80) 71(20) 84(0)	100	34.14
61	84(0) 80(90) 72(10) 84(0)	100	56.57
62	84(0) 69(40) 77(60) 84(0)	100	40.00
63	84(0) 70(10) 78(90) 84(0)	100	56.57
64	84(0) 71(40) 79(60) 84(0)	100	40.00
		Total Distance	2684.02

Table B.60: IDH solution to SQ5.

	Route	Load	Distance
1	0 4(20) 1(80) 0	100	34.14
2	0 2(60) 0	60	20.00
3	0 5(20) 3(80) 0	100	34.14
4	0 12(60) 4(40) 0	100	40.00
5	0 6(70) 7(30) 0	100	34.14
6	0 7(30) 8(70) 0	100	34.14
7	0 1(10) 9(90) 0	100	56.57
8	0 3(10) 11(90) 0	100	56.57
9	0 5(40) 13(60) 0	100	40.00
10	0 6(20) 14(80) 0	100	56.57
11	0 30(80) 15(20) 0	100	121.29
12	0 8(20) 16(80) 0	100	56.57
13	0 10(40) 18(60) 0	100	60.00
14	0 21(20) 19(80) 0	100	102.43
15	0 17(80) 20(20) 0	100	102.43
16	0 14(10) 22(90) 0	100	84.85
17	0 15(40) 23(60) 0	100	60.00
18	0 16(10) 24(90) 0	100	84.85
19	0 17(10) 25(90) 0	100	113.14
20	0 10(20) 26(60) 0	80	80.00
21	0 19(10) 27(90) 0	100	113.14
22	0 20(40) 28(60) 0	100	80.00
23	0 21(40) 29(60) 0	100	80.00
24	0 32(80) 31(20) 0	100	136.57
25	0 59(95) 32(5) 0	100	116.57
26	0 30(5) 57(95) 0	100	116.57
27	0 31(35) 58(65) 0	100	84.00
28	65(0) 37(20) 43(80) 65(0)	100	60.64
29	65(0) 36(20) 60(60) 52(20) 65(0)	100	80.00
30	65(0) 55(20) 54(80) 65(0)	100	102.43
31	65(0) 33(90) 65(0)	90	28.28
32	65(0) 39(20) 40(80) 65(0)	100	34.14
33	65(0) 53(20) 56(80) 65(0)	100	102.43

(cont.)

Table B.60 continued.

	Route	Load	Distance
34	65(0) 38(90) 65(0)	90	28.28
35	65(0) 39(40) 47(60) 65(0)	100	40.00
36	65(0) 36(40) 34(60) 65(0)	100	34.14
37	65(0) 42(40) 50(60) 65(0)	100	60.00
38	65(0) 42(20) 41(80) 65(0)	100	68.28
39	65(0) 35(90) 65(0)	90	28.28
40	65(0) 41(10) 49(90) 65(0)	100	84.85
41	65(0) 40(10) 48(90) 65(0)	100	56.57
42	65(0) 43(10) 51(90) 65(0)	100	84.85
43	65(0) 56(10) 64(90) 65(0)	100	113.14
44	65(0) 46(90) 65(0)	90	56.57
45	65(0) 53(40) 61(60) 65(0)	100	80.00
46	65(0) 52(40) 44(60) 65(0)	100	60.00
47	65(0) 63(60) 55(40) 65(0)	100	80.00
48	65(0) 37(40) 45(60) 65(0)	100	40.00
49	65(0) 54(10) 62(90) 65(0)	100	113.14
		Total Distance	3434.71

Table B.61: IDH solution to SQ6.

	Route	Load	Distance
1	0 22(80) 20(20) 0	100	102.43
2	0 3(90) 0	90	28.28
3	0 4(20) 14(80) 0	100	60.64
4	0 5(20) 16(80) 0	100	60.64
5	0 6(90) 0	90	28.28
6	0 2(20) 11(80) 0	100	60.64
7	0 16(10) 24(90) 0	100	84.85
8	0 9(90) 0	90	56.57
9	0 18(40) 26(60) 0	100	80.00
10	0 19(90) 11(10) 0	100	84.85
11	0 20(40) 28(60) 0	100	80.00
12	0 29(60) 21(40) 0	100	80.00
13	0 22(5) 30(85) 14(10) 0	100	113.14
14	0 7(60) 15(40) 0	100	40.00
15	0 17(80) 18(20) 0	100	102.43
16	0 1(90) 0	90	28.28
17	0 32(75) 21(20) 0	95	127.80
18	0 8(90) 0	90	28.28
19	0 17(10) 25(90) 0	100	113.14
20	0 2(40) 10(60) 0	100	40.00
21	0 27(90) 0	90	113.14
22	0 12(60) 4(40) 0	100	40.00
23	0 5(40) 13(60) 0	100	40.00
24	0 22(5) 57(95) 0	100	116.05
25	0 23(60) 31(40) 0	100	80.00
26	0 89(90) 32(10) 0	100	118.79
27	0 15(20) 31(15) 58(65) 0	100	84.00
28	0 59(95) 0	95	116.00
29	97(0) 36(40) 44(60) 97(0)	100	40.00
30	97(0) 39(40) 47(60) 97(0)	100	40.00
31	97(0) 45(20) 53(5) 61(20) 92(55) 97(0)	100	84.00
32	97(0) 52(40) 60(60) 97(0)	100	80.00
33	97(0) 55(40) 63(60) 97(0)	100	80.00

(cont.)

Table B.61 continued.

	Route	Load	Distance
34	97(0) 56(90) 48(10) 97(0)	100	84.85
35	97(0) 54(10) 62(90) 97(0)	100	113.14
36	97(0) 38(90) 97(0)	90	28.28
37	97(0) 36(20) 41(80) 97(0)	100	60.64
38	97(0) 35(90) 97(0)	90	28.28
39	97(0) 52(20) 54(80) 97(0)	100	102.43
40	97(0) 41(10) 49(90) 97(0)	100	84.85
41	97(0) 46(90) 97(0)	90	56.57
42	97(0) 55(20) 64(80) 97(0)	100	127.80
43	97(0) 40(90) 97(0)	90	28.28
44	97(0) 45(40) 37(60) 97(0)	100	40.00
45	97(0) 33(90) 97(0)	90	28.28
46	97(0) 34(60) 97(0)	60	20.00
47	97(0) 42(40) 50(60) 97(0)	100	60.00
48	97(0) 39(20) 48(80) 97(0)	100	60.64
49	97(0) 42(20) 43(80) 97(0)	100	68.28
50	97(0) 64(15) 94(85) 97(0)	100	116.57
51	97(0) 43(10) 51(90) 97(0)	100	84.85
52	97(0) 53(55) 61(45) 97(0)	100	80.00
53	98(0) 65(90) 98(0)	90	28.28
54	98(0) 68(60) 66(40) 98(0)	100	34.14
55	98(0) 66(20) 82(20) 74(60) 98(0)	100	60.00
56	98(0) 76(20) 73(80) 98(0)	100	68.28
57	98(0) 70(90) 98(0)	90	28.28
58	98(0) 71(20) 78(80) 98(0)	100	60.64
59	98(0) 72(90) 98(0)	90	28.28
60	98(0) 67(10) 75(90) 98(0)	100	56.57
61	98(0) 69(20) 77(60) 69(20) 98(0)	100	40.00
62	98(0) 86(90) 78(10) 98(0)	100	84.85
63	98(0) 71(40) 79(60) 98(0)	100	40.00
64	98(0) 80(90) 98(0)	90	56.57
65	98(0) 73(10) 81(90) 98(0)	100	84.85
66	98(0) 69(20) 67(80) 98(0)	100	34.14

(cont.)

Table B.61 continued.

	Route	Load	Distance
67	98(0) 85(20) 83(80) 98(0)	100	102.43
68	98(0) 76(40) 84(60) 98(0)	100	60.00
69	98(0) 93(60) 85(40) 98(0)	100	80.00
70	98(0) 87(20) 88(80) 98(0)	100	102.43
71	98(0) 82(40) 90(60) 98(0)	100	80.00
72	98(0) 83(10) 91(90) 98(0)	100	113.14
73	98(0) 87(40) 95(60) 98(0)	100	80.00
74	98(0) 88(10) 96(90) 98(0)	100	113.14
		Total Distance	5142.06

Table B.62: IDH solution to SQ7.

	Route	Load	Distance
1	0 8(90) 0	90	28.28
2	0 16(40) 15(60) 0	100	68.28
3	0 7(60) 0	60	20.00
4	0 6(90) 0	90	28.28
5	0 5(40) 13(60) 0	100	40.00
6	0 3(90) 0	90	28.28
7	0 25(90) 0	90	113.14
8	0 2(40) 10(60) 0	100	40.00
9	0 58(65) 23(15) 0	80	84.00
10	0 14(80) 4(20) 0	100	60.64
11	0 4(40) 12(60) 0	100	40.00
12	0 5(20) 124(20) 21(60) 0	100	84.00
13	0 16(5) 126(95) 0	100	116.02
14	0 2(20) 9(80) 0	100	60.64
15	0 11(80) 0	80	56.57
16	0 1(90) 0	90	28.28
17	0 30(5) 57(95) 0	100	116.57
18	0 14(10) 22(90) 0	100	84.85
19	0 31(55) 23(45) 0	100	80.00
20	0 16(45) 24(55) 0	100	84.85
21	0 9(10) 17(90) 0	100	84.85
22	0 18(40) 26(60) 0	100	80.00
23	0 20(40) 28(60) 0	100	80.00
24	0 124(45) 29(55) 0	100	84.00
25	0 20(20) 30(80) 0	100	127.80
26	0 24(15) 32(85) 0	100	113.14
27	0 11(10) 19(90) 0	100	84.85
28	0 24(5) 59(95) 0	100	116.05
29	0 89(85) 24(15) 0	100	118.79
30	0 27(5) 121(95) 0	100	116.57
31	0 18(20) 27(80) 0	100	127.80
32	129(0) 52(20) 54(80) 129(0)	100	102.43
33	129(0) 45(40) 37(60) 129(0)	100	40.00

(cont.)

Table B.62 continued.

	Route	Load	Distance
34	129(0) 38(80) 129(0)	80	28.28
35	129(0) 43(10) 51(90) 129(0)	100	84.85
36	129(0) 39(40) 47(60) 129(0)	100	40.00
37	129(0) 42(40) 50(60) 129(0)	100	60.00
38	129(0) 38(10) 46(90) 129(0)	100	56.57
39	129(0) 34(60) 129(0)	60	20.00
40	129(0) 39(20) 48(80) 129(0)	100	60.64
41	129(0) 36(40) 44(60) 129(0)	100	40.00
42	129(0) 41(10) 49(90) 129(0)	100	84.85
43	129(0) 64(15) 94(85) 129(0)	100	116.57
44	129(0) 36(20) 41(80) 129(0)	100	60.64
45	129(0) 45(20) 61(20) 53(60) 129(0)	100	80.00
46	129(0) 52(40) 60(60) 129(0)	100	80.00
47	129(0) 40(90) 129(0)	90	28.28
48	129(0) 33(90) 129(0)	90	28.28
49	129(0) 55(20) 64(80) 129(0)	100	127.80
50	129(0) 54(10) 62(90) 129(0)	100	113.14
51	129(0) 35(90) 129(0)	90	28.28
52	129(0) 42(20) 43(80) 129(0)	100	68.28
53	129(0) 55(40) 63(60) 129(0)	100	80.00
54	129(0) 48(10) 56(90) 129(0)	100	84.85
55	129(0) 61(45) 92(55) 129(0)	100	84.00
56	130(0) 65(90) 130(0)	90	28.28
57	130(0) 85(20) 91(80) 130(0)	100	127.80
58	130(0) 67(90) 130(0)	90	28.28
59	130(0) 66(40) 74(60) 130(0)	100	40.00
60	130(0) 76(20) 73(80) 130(0)	100	68.28
61	130(0) 80(90) 130(0)	90	56.57
62	130(0) 72(90) 130(0)	90	28.28
63	130(0) 76(40) 84(60) 130(0)	100	60.00
64	130(0) 75(10) 83(90) 130(0)	100	84.85
65	130(0) 69(20) 75(80) 130(0)	100	60.64
66	130(0) 69(40) 77(60) 130(0)	100	40.00

(cont.)

Table B.62 continued.

	Route	Load	Distance
67	130(0) 71(40) 79(60) 130(0)	100	40.00
68	130(0) 70(90) 130(0)	90	28.28
69	130(0) 73(10) 81(90) 130(0)	100	84.85
70	130(0) 78(80) 71(20) 130(0)	100	60.64
71	130(0) 87(20) 88(80) 130(0)	100	102.43
72	130(0) 66(20) 90(55) 82(25) 130(0)	100	80.00
73	130(0) 78(10) 86(90) 130(0)	100	84.85
74	130(0) 68(60) 130(0)	60	20.00
75	130(0) 85(40) 93(60) 130(0)	100	80.00
76	130(0) 87(40) 95(60) 130(0)	100	80.00
77	130(0) 88(10) 96(90) 130(0)	100	113.14
78	130(0) 82(35) 127(65) 130(0)	100	84.00
79	130(0) 91(5) 128(95) 130(0)	100	116.57
80	131(0) 97(90) 131(0)	90	28.28
81	131(0) 98(20) 99(80) 131(0)	100	34.14
82	131(0) 105(80) 100(20) 131(0)	100	60.64
83	131(0) 101(60) 131(0)	60	20.00
84	131(0) 102(90) 131(0)	90	28.28
85	131(0) 100(40) 103(60) 131(0)	100	34.14
86	131(0) 104(90) 131(0)	90	28.28
87	131(0) 98(40) 106(60) 131(0)	100	40.00
88	131(0) 99(10) 107(90) 131(0)	100	56.57
89	131(0) 110(80) 108(20) 131(0)	100	68.28
90	131(0) 117(20) 109(60) 131(0)	80	60.00
91	131(0) 118(90) 110(10) 131(0)	100	84.85
92	131(0) 112(80) 111(20) 131(0)	100	68.28
93	131(0) 112(10) 120(90) 131(0)	100	84.85
94	131(0) 105(10) 113(90) 131(0)	100	84.85
95	131(0) 122(60) 114(40) 131(0)	100	80.00
96	131(0) 114(20) 115(80) 131(0)	100	102.43
97	131(0) 108(40) 116(60) 131(0)	100	60.00
98	131(0) 111(40) 119(60) 131(0)	100	60.00
99	131(0) 115(10) 123(90) 131(0)	100	113.14
100	131(0) 117(40) 125(60) 131(0)	100	80.00
		Total Distance	6869.14

Table B.63: IDH solution to SQ8.

	Route	Load	Distance
1	0 2(20) 11(80) 0	100	60.64
2	0 58(65) 23(35) 0	100	84.00
3	0 14(10) 22(90) 0	100	84.85
4	0 16(40) 15(60) 0	100	68.28
5	0 6(20) 14(80) 0	100	56.57
6	0 11(10) 19(90) 0	100	84.85
7	0 30(5) 57(95) 0	100	116.57
8	0 17(10) 25(90) 0	100	113.14
9	0 24(5) 59(95) 0	100	116.05
10	0 27(5) 121(95) 0	100	116.57
11	0 4(40) 12(60) 0	100	40.00
12	0 24(5) 126(95) 0	100	116.05
13	0 24(50) 16(50) 0	100	84.85
14	0 20(40) 28(60) 0	100	80.00
15	0 17(80) 4(20) 0	100	88.48
16	0 3(90) 0	90	28.28
17	0 7(60) 0	60	20.00
18	0 20(20) 30(80) 0	100	127.80
19	0 18(20) 27(80) 0	100	127.80
20	0 6(70) 0	70	28.28
21	0 9(90) 0	90	56.57
22	0 5(40) 13(60) 0	100	40.00
23	0 124(45) 29(55) 0	100	84.00
24	0 31(55) 23(25) 0	80	80.00
25	0 21(60) 124(20) 5(20) 0	100	84.00
26	0 18(40) 26(60) 0	100	80.00
27	0 24(15) 89(85) 0	100	118.79
28	0 8(90) 0	90	28.28
29	0 24(15) 32(85) 0	100	113.14
30	0 2(40) 10(60) 0	100	40.00
31	0 1(90) 0	90	28.28
32	161(0) 33(90) 161(0)	90	28.28
33	161(0) 64(15) 155(85) 161(0)	100	116.57

(cont.)

Table B.63 continued.

	Route	Load	Distance
34	161(0) 35(90) 161(0)	90	28.28
35	161(0) 47(20) 56(80) 161(0)	100	94.05
36	161(0) 46(90) 161(0)	90	56.57
37	161(0) 36(20) 41(80) 161(0)	100	60.64
38	161(0) 40(90) 161(0)	90	28.28
39	161(0) 49(90) 41(10) 161(0)	100	84.85
40	161(0) 39(60) 161(0)	60	20.00
41	161(0) 36(40) 44(60) 161(0)	100	40.00
42	161(0) 37(40) 45(60) 161(0)	100	40.00
43	161(0) 34(60) 161(0)	60	20.00
44	161(0) 63(20) 64(80) 161(0)	100	136.57
45	161(0) 56(10) 94(90) 161(0)	100	116.05
46	161(0) 42(40) 50(60) 161(0)	100	60.00
47	161(0) 43(10) 51(90) 161(0)	100	84.85
48	161(0) 61(40) 53(60) 161(0)	100	80.00
49	161(0) 52(20) 54(80) 161(0)	100	102.43
50	161(0) 47(40) 55(60) 161(0)	100	60.00
51	161(0) 52(40) 60(60) 161(0)	100	80.00
52	161(0) 42(20) 43(80) 161(0)	100	68.28
53	161(0) 37(20) 61(25) 92(55) 161(0)	100	84.00
54	161(0) 62(95) 161(0)	95	113.14
55	161(0) 48(90) 161(0)	90	56.57
56	161(0) 38(90) 161(0)	90	28.28
57	161(0) 63(45) 154(55) 161(0)	100	84.00
58	161(0) 54(10) 153(85) 161(0)	95	116.05
59	162(0) 65(90) 162(0)	90	28.28
60	162(0) 76(20) 73(80) 162(0)	100	68.28
61	162(0) 67(90) 162(0)	90	28.28
62	162(0) 68(60) 162(0)	60	20.00
63	162(0) 71(20) 78(80) 162(0)	100	60.64
64	162(0) 70(90) 162(0)	90	28.28
65	162(0) 87(20) 88(80) 162(0)	100	102.43
66	162(0) 66(40) 74(60) 162(0)	100	40.00

(cont.)

Table B.63 continued.

	Route	Load	Distance
67	162(0) 83(90) 75(10) 162(0)	100	84.85
68	162(0) 85(20) 91(80) 162(0)	100	127.80
69	162(0) 69(40) 77(60) 162(0)	100	40.00
70	162(0) 69(20) 75(80) 162(0)	100	60.64
71	162(0) 72(10) 80(90) 162(0)	100	56.57
72	162(0) 73(10) 81(90) 162(0)	100	84.85
73	162(0) 76(40) 84(60) 162(0)	100	60.00
74	162(0) 72(80) 162(0)	80	28.28
75	162(0) 78(10) 86(90) 162(0)	100	84.85
76	162(0) 71(40) 79(60) 162(0)	100	40.00
77	162(0) 96(90) 88(10) 162(0)	100	113.14
78	162(0) 66(20) 90(20) 82(60) 162(0)	100	80.00
79	162(0) 85(40) 93(60) 162(0)	100	80.00
80	162(0) 87(40) 95(60) 162(0)	100	80.00
81	162(0) 90(35) 127(65) 162(0)	100	84.00
82	162(0) 91(5) 128(95) 162(0)	100	116.57
83	163(0) 97(90) 163(0)	90	28.28
84	163(0) 98(20) 99(80) 163(0)	100	34.14
85	163(0) 105(80) 100(20) 163(0)	100	60.64
86	163(0) 101(60) 163(0)	60	20.00
87	163(0) 102(90) 163(0)	90	28.28
88	163(0) 100(40) 103(60) 163(0)	100	34.14
89	163(0) 104(90) 163(0)	90	28.28
90	163(0) 98(40) 106(60) 163(0)	100	40.00
91	163(0) 99(10) 107(90) 163(0)	100	56.57
92	163(0) 110(80) 108(20) 163(0)	100	68.28
93	163(0) 117(20) 109(60) 163(0)	80	60.00
94	163(0) 118(90) 110(10) 163(0)	100	84.85
95	163(0) 112(80) 111(20) 163(0)	100	68.28
96	163(0) 120(90) 112(10) 163(0)	100	84.85
97	163(0) 105(10) 113(90) 163(0)	100	84.85
98	163(0) 122(60) 114(40) 163(0)	100	80.00
99	163(0) 114(20) 115(80) 163(0)	100	102.43

(cont.)

Table B.63 continued.

	Route	Load	Distance
100	163(0) 108(40) 116(60) 163(0)	100	60.00
101	163(0) 111(40) 119(60) 163(0)	100	60.00
102	163(0) 115(10) 123(90) 163(0)	100	113.14
103	163(0) 117(40) 125(60) 163(0)	100	80.00
104	164(0) 129(90) 164(0)	90	28.28
105	164(0) 130(60) 164(0)	60	20.00
106	164(0) 131(90) 164(0)	90	28.28
107	164(0) 132(60) 164(0)	60	20.00
108	164(0) 139(80) 133(20) 164(0)	100	60.64
109	164(0) 134(80) 164(0)	80	28.28
110	164(0) 135(20) 136(80) 164(0)	100	34.14
111	164(0) 137(80) 138(20) 164(0)	100	68.28
112	164(0) 148(40) 140(60) 164(0)	100	60.00
113	164(0) 133(40) 141(60) 164(0)	100	40.00
114	164(0) 134(10) 142(90) 164(0)	100	56.57
115	164(0) 135(40) 143(60) 164(0)	100	40.00
116	164(0) 136(10) 144(90) 164(0)	100	56.57
117	164(0) 137(10) 145(90) 164(0)	100	84.85
118	164(0) 138(40) 146(60) 164(0)	100	60.00
119	164(0) 139(10) 147(90) 164(0)	100	84.85
120	164(0) 151(20) 150(80) 164(0)	100	102.43
121	164(0) 149(20) 152(80) 164(0)	100	102.43
122	164(0) 148(20) 156(60) 164(0)	80	80.00
123	164(0) 149(40) 157(60) 164(0)	100	80.00
124	164(0) 150(10) 158(90) 164(0)	100	113.14
125	164(0) 151(40) 159(60) 164(0)	100	80.00
126	164(0) 152(10) 160(90) 164(0)	100	113.14
		Total Distance	8600.60

Table B.64: IDH solution to SQ9.

	Route	Load	Distance
1	0 9(50) 1(50) 0	100	56.57
2	0 36(20) 28(60) 20(20) 0	100	100.00
3	0 2(60) 1(40) 0	100	34.14
4	0 22(30) 30(70) 0	100	113.14
5	0 9(40) 17(60) 0	100	84.85
6	0 41(90) 33(10) 0	100	169.71
7	0 12(60) 20(40) 0	100	60.00
8	0 16(60) 21(40) 0	100	80.64
9	0 47(20) 39(60) 31(20) 0	100	120.00
10	0 21(20) 37(20) 29(60) 0	100	100.00
11	0 17(30) 25(70) 0	100	113.14
12	0 24(70) 16(30) 0	100	84.85
13	0 11(40) 19(60) 0	100	84.85
14	0 27(20) 35(80) 0	100	141.42
15	0 8(90) 0	90	28.28
16	0 40(90) 24(10) 0	100	141.42
17	0 24(10) 32(90) 0	100	113.14
18	0 3(50) 11(50) 0	100	56.57
19	0 4(60) 6(40) 0	100	34.14
20	0 91(95) 48(5) 0	100	173.13
21	0 36(40) 44(60) 0	100	120.00
22	0 5(60) 0	60	20.00
23	0 25(20) 33(80) 0	100	141.42
24	0 15(20) 46(80) 0	100	176.96
25	0 83(20) 48(80) 0	100	188.13
26	0 35(10) 43(90) 0	100	169.71
27	0 10(20) 42(60) 34(20) 0	100	120.00
28	0 30(10) 81(90) 0	100	177.75
29	0 34(40) 26(60) 0	100	100.00
30	0 15(40) 7(60) 0	100	40.00
31	0 45(60) 37(40) 0	100	120.00
32	0 14(40) 22(60) 0	100	84.85
33	0 47(35) 90(65) 0	100	124.00

(cont.)

Table B.64 continued.

	Route	Load	Distance
34	0 30(10) 38(90) 0	100	141.42
35	0 19(30) 27(70) 0	100	113.14
36	0 31(40) 23(60) 0	100	80.00
37	0 46(5) 89(95) 0	100	173.13
38	0 10(40) 18(60) 0	100	60.00
39	0 6(50) 14(50) 0	100	56.57
40	0 13(60) 3(40) 0	100	48.28
41	97(0) 92(60) 84(40) 97(0)	100	120.00
42	97(0) 50(40) 49(60) 97(0)	100	34.14
43	97(0) 74(40) 66(60) 97(0)	100	80.00
44	97(0) 51(90) 97(0)	90	28.28
45	97(0) 67(50) 59(50) 97(0)	100	84.85
46	97(0) 79(40) 87(60) 97(0)	100	100.00
47	97(0) 59(40) 58(40) 50(20) 97(0)	100	68.28
48	97(0) 60(60) 68(40) 97(0)	100	60.00
49	97(0) 52(60) 97(0)	60	20.00
50	97(0) 72(60) 64(40) 97(0)	100	84.85
51	97(0) 93(60) 85(40) 97(0)	100	120.00
52	97(0) 74(20) 82(60) 58(20) 97(0)	100	100.00
53	97(0) 54(50) 62(50) 97(0)	100	56.57
54	97(0) 56(40) 53(60) 97(0)	100	34.14
55	97(0) 63(60) 71(40) 97(0)	100	60.00
56	97(0) 72(20) 88(80) 97(0)	100	141.42
57	97(0) 49(30) 57(70) 97(0)	100	56.57
58	97(0) 86(10) 94(90) 97(0)	100	169.71
59	97(0) 62(10) 70(90) 97(0)	100	84.85
60	97(0) 88(10) 96(90) 97(0)	100	169.71
61	97(0) 62(30) 78(70) 97(0)	100	113.14
62	97(0) 54(40) 55(60) 97(0)	100	34.14
63	97(0) 69(20) 85(20) 77(60) 97(0)	100	100.00
64	97(0) 86(80) 78(20) 97(0)	100	141.42
65	97(0) 64(50) 56(50) 97(0)	100	56.57
66	97(0) 83(70) 67(30) 97(0)	100	141.42

(cont.)

Table B.64 continued.

	Route	Load	Distance
67	97(0) 57(20) 65(80) 97(0)	100	84.85
68	97(0) 71(20) 79(20) 95(60) 97(0)	100	120.00
69	97(0) 65(10) 73(90) 97(0)	100	113.14
70	97(0) 67(10) 75(90) 97(0)	100	113.14
71	97(0) 68(20) 76(60) 84(20) 97(0)	100	100.00
72	97(0) 61(60) 69(40) 97(0)	100	60.00
73	97(0) 80(90) 72(10) 97(0)	100	113.14
		Total Distance	7109.71

Table B.65: IDH solution to SQ10.

	Route	Load	Distance
1	0 27(70) 19(30) 0	100	113.14
2	0 22(10) 38(90) 0	100	141.42
3	0 31(40) 23(60) 0	100	80.00
4	0 29(40) 37(60) 0	100	100.00
5	0 8(80) 0	80	28.28
6	0 7(20) 6(80) 0	100	34.14
7	0 21(60) 24(40) 0	100	102.43
8	0 48(5) 91(95) 0	100	173.13
9	0 47(40) 39(60) 0	100	120.00
10	0 24(10) 40(90) 0	100	141.42
11	0 44(60) 36(40) 0	100	120.00
12	0 17(60) 20(40) 0	100	102.43
13	0 6(10) 30(90) 0	100	113.14
14	0 32(30) 48(70) 0	100	169.71
15	0 43(90) 27(10) 0	100	169.71
16	0 13(60) 5(40) 0	100	40.00
17	0 10(60) 2(40) 0	100	40.00
18	0 24(40) 32(60) 0	100	113.14
19	0 14(90) 0	90	56.57
20	0 34(60) 26(40) 0	100	100.00
21	0 8(10) 16(90) 0	100	56.57
22	0 42(60) 26(20) 18(20) 0	100	120.00
23	0 12(60) 4(40) 0	100	40.00
24	0 9(90) 0	90	56.57
25	0 3(10) 11(90) 0	100	56.57
26	0 25(70) 17(30) 0	100	113.14
27	0 25(10) 41(90) 0	100	169.71
28	0 20(20) 36(20) 28(60) 0	100	100.00
29	0 25(10) 33(90) 0	100	141.42
30	0 19(60) 18(40) 0	100	102.43
31	0 5(20) 45(60) 29(20) 0	100	120.00
32	0 27(10) 35(90) 0	100	141.42
33	0 15(60) 7(40) 0	100	40.00

(cont.)

Table B.65 continued.

	Route	Load	Distance
34	0 48(10) 137(90) 0	100	175.36
35	0 1(90) 0	90	28.28
36	0 46(85) 89(15) 0	100	173.13
37	0 4(20) 22(80) 0	100	88.48
38	0 31(20) 47(15) 90(65) 0	100	124.00
39	0 2(20) 3(80) 0	100	34.14
40	145(0) 88(5) 96(95) 145(0)	100	169.71
41	145(0) 92(60) 84(40) 145(0)	100	120.00
42	145(0) 72(80) 56(20) 145(0)	100	84.85
43	145(0) 54(40) 55(60) 145(0)	100	34.14
44	145(0) 62(50) 54(50) 145(0)	100	56.57
45	145(0) 59(30) 67(70) 145(0)	100	84.85
46	145(0) 71(40) 63(60) 145(0)	100	60.00
47	145(0) 65(50) 57(40) 145(0)	90	84.85
48	145(0) 58(20) 66(60) 74(20) 145(0)	100	80.00
49	145(0) 72(10) 80(90) 145(0)	100	113.14
50	145(0) 57(50) 49(50) 145(0)	100	56.57
51	145(0) 78(10) 94(90) 145(0)	100	169.71
52	145(0) 78(80) 70(20) 145(0)	100	113.14
53	145(0) 75(10) 83(90) 145(0)	100	141.42
54	145(0) 65(20) 89(80) 145(0)	100	169.71
55	145(0) 65(10) 81(90) 145(0)	100	141.42
56	145(0) 93(10) 140(55) 85(35) 145(0)	100	124.00
57	145(0) 62(40) 70(60) 145(0)	100	84.85
58	145(0) 68(40) 60(60) 145(0)	100	60.00
59	145(0) 53(30) 61(60) 145(0)	90	40.00
60	145(0) 77(40) 69(60) 145(0)	100	80.00
61	145(0) 52(60) 145(0)	60	20.00
62	145(0) 51(90) 145(0)	90	28.28
63	145(0) 64(90) 145(0)	90	56.57
64	145(0) 67(20) 75(80) 145(0)	100	113.14
65	145(0) 74(40) 82(60) 145(0)	100	100.00
66	145(0) 56(70) 53(30) 145(0)	100	34.14

(cont.)

Table B.65 continued.

	Route	Load	Distance
67	145(0) 71(20) 87(20) 95(60) 145(0)	100	120.00
68	145(0) 68(20) 76(60) 84(20) 145(0)	100	100.00
69	145(0) 85(25) 93(55) 77(20) 145(0)	100	120.00
70	145(0) 58(40) 59(60) 145(0)	100	68.28
71	145(0) 49(40) 50(60) 145(0)	100	34.14
72	145(0) 65(10) 73(90) 145(0)	100	113.14
73	145(0) 87(40) 79(60) 145(0)	100	100.00
74	145(0) 86(90) 70(10) 145(0)	100	141.42
75	145(0) 88(85) 145(0)	85	141.42
76	146(0) 101(20) 99(80) 146(0)	100	34.14
77	146(0) 117(60) 109(40) 146(0)	100	60.00
78	146(0) 112(10) 128(90) 146(0)	100	113.14
79	146(0) 110(90) 146(0)	90	56.57
80	146(0) 99(10) 107(90) 146(0)	100	56.57
81	146(0) 114(40) 115(60) 146(0)	100	102.43
82	146(0) 108(40) 100(60) 146(0)	100	40.00
83	146(0) 98(40) 106(60) 146(0)	100	40.00
84	146(0) 114(20) 130(20) 122(60) 146(0)	100	100.00
85	146(0) 119(25) 134(75) 146(0)	100	154.56
86	146(0) 127(60) 119(35) 146(0)	95	80.00
87	146(0) 101(40) 104(60) 146(0)	100	34.14
88	146(0) 98(20) 121(80) 146(0)	100	116.57
89	146(0) 102(80) 103(20) 146(0)	100	34.14
90	146(0) 131(80) 123(10) 115(10) 146(0)	100	141.42
91	146(0) 104(20) 112(80) 146(0)	100	56.57
92	146(0) 97(90) 146(0)	90	28.28
93	146(0) 133(20) 125(60) 109(20) 146(0)	100	100.00
94	146(0) 135(20) 136(80) 146(0)	100	170.71
95	146(0) 102(10) 118(90) 146(0)	100	84.85
96	146(0) 130(40) 138(60) 146(0)	100	120.00
97	146(0) 133(40) 141(60) 146(0)	100	120.00
98	146(0) 104(10) 120(90) 146(0)	100	84.85
99	146(0) 135(40) 143(60) 146(0)	100	120.00

(cont.)

Table B.65 continued.

	Route	Load	Distance
100	146(0) 136(10) 144(90) 146(0)	100	169.71
101	146(0) 105(90) 146(0)	90	56.57
102	146(0) 121(10) 129(90) 146(0)	100	141.42
103	146(0) 113(90) 146(0)	90	84.85
104	146(0) 115(20) 123(80) 146(0)	100	113.14
105	146(0) 134(15) 142(85) 146(0)	100	169.71
106	146(0) 131(10) 139(90) 146(0)	100	169.71
107	146(0) 103(40) 111(60) 146(0)	100	40.00
108	146(0) 124(40) 116(60) 146(0)	100	80.00
109	146(0) 108(20) 132(60) 124(20) 146(0)	100	100.00
110	146(0) 126(90) 146(0)	90	113.14
		Total Distance	10586.51

Table B.66: IDH solution to SQ11.

	Route	Load	Distance
1	0 42(60) 34(20) 18(20) 0	100	120.00
2	0 17(60) 18(40) 0	100	102.43
3	0 27(60) 19(40) 0	100	113.14
4	0 22(15) 30(85) 0	100	113.14
5	0 26(60) 34(40) 0	100	100.00
6	0 22(15) 46(85) 0	100	169.71
7	0 5(10) 137(85) 40(5) 0	100	178.60
8	0 17(10) 25(90) 0	100	113.14
9	0 14(90) 6(10) 0	100	56.57
10	0 91(95) 0	95	172.56
11	0 16(40) 13(60) 0	100	68.28
12	0 15(10) 31(30) 23(60) 0	100	80.00
13	0 6(40) 4(60) 0	100	34.14
14	0 7(10) 39(60) 31(30) 0	100	100.00
15	0 27(5) 185(95) 0	100	172.58
16	0 22(60) 6(40) 0	100	84.85
17	0 24(50) 16(50) 0	100	84.85
18	0 28(60) 36(40) 0	100	100.00
19	0 19(50) 5(50) 0	100	88.48
20	0 7(50) 15(50) 0	100	40.00
21	0 2(10) 9(90) 0	100	60.64
22	0 45(20) 37(60) 21(20) 0	100	120.00
23	0 3(90) 0	90	28.28
24	0 43(85) 35(15) 0	100	169.71
25	0 89(95) 0	95	172.56
26	0 33(80) 17(20) 0	100	141.42
27	0 24(25) 32(75) 0	100	113.14
28	0 24(15) 48(85) 0	100	169.71
29	0 36(20) 44(60) 20(20) 0	100	120.00
30	0 190(95) 0	95	172.56
31	0 2(40) 10(60) 0	100	40.00
32	0 2(10) 11(90) 0	100	60.64
33	0 32(15) 40(85) 0	100	141.42

(cont.)

Table B.66 continued.

	Route	Load	Distance
34	0 45(35) 188(65) 0	100	124.00
35	0 8(90) 0	90	28.28
36	0 90(45) 47(55) 0	100	124.00
37	0 33(10) 41(90) 0	100	169.71
38	0 1(90) 0	90	28.28
39	0 29(60) 21(40) 0	100	80.00
40	0 30(5) 38(90) 0	95	141.42
41	0 12(60) 20(40) 0	100	60.00
42	0 27(25) 35(75) 0	100	141.42
43	193(0) 88(10) 96(5) 142(85) 193(0)	100	173.13
44	193(0) 49(90) 193(0)	90	28.28
45	193(0) 59(80) 53(20) 193(0)	100	60.64
46	193(0) 84(20) 92(60) 68(20) 193(0)	100	120.00
47	193(0) 62(50) 54(50) 193(0)	100	56.57
48	193(0) 51(90) 193(0)	90	28.28
49	193(0) 54(40) 52(60) 193(0)	100	34.14
50	193(0) 57(80) 193(0)	80	56.57
51	193(0) 66(60) 74(40) 193(0)	100	80.00
52	193(0) 80(70) 64(30) 193(0)	100	113.14
53	193(0) 53(40) 61(60) 193(0)	100	40.00
54	193(0) 86(90) 78(10) 193(0)	100	141.42
55	193(0) 70(10) 78(80) 70(10) 193(0)	100	113.14
56	193(0) 75(90) 193(0)	90	113.14
57	193(0) 73(10) 81(90) 193(0)	100	141.42
58	193(0) 55(60) 56(40) 193(0)	100	34.14
59	193(0) 93(65) 85(35) 193(0)	100	120.00
60	193(0) 80(20) 88(80) 193(0)	100	141.42
61	193(0) 62(30) 70(70) 193(0)	100	84.85
62	193(0) 71(40) 63(60) 193(0)	100	60.00
63	193(0) 50(20) 58(60) 50(20) 193(0)	100	40.00
64	193(0) 77(40) 69(60) 193(0)	100	80.00
65	193(0) 73(80) 50(20) 193(0)	100	116.57
66	193(0) 56(50) 64(50) 193(0)	100	56.57

(cont.)

Table B.66 continued.

	Route	Load	Distance
67	193(0) 65(90) 57(10) 193(0)	100	84.85
68	193(0) 68(40) 60(60) 193(0)	100	60.00
69	193(0) 79(60) 87(40) 193(0)	100	100.00
70	193(0) 76(60) 84(40) 193(0)	100	100.00
71	193(0) 140(55) 85(25) 77(20) 193(0)	100	124.00
72	193(0) 67(90) 59(10) 193(0)	100	84.85
73	193(0) 90(20) 82(60) 74(20) 193(0)	100	120.00
74	193(0) 83(90) 193(0)	90	141.42
75	193(0) 71(20) 87(20) 95(60) 193(0)	100	120.00
76	193(0) 62(10) 94(90) 193(0)	100	169.71
77	193(0) 64(10) 72(90) 193(0)	100	84.85
78	194(0) 118(60) 110(40) 194(0)	100	84.85
79	194(0) 97(10) 105(90) 194(0)	100	56.57
80	194(0) 118(10) 96(90) 194(0)	100	172.57
81	194(0) 109(20) 133(60) 125(20) 194(0)	100	100.00
82	194(0) 111(20) 127(20) 143(60) 194(0)	100	120.00
83	194(0) 192(15) 139(85) 194(0)	100	173.13
84	194(0) 121(10) 129(90) 194(0)	100	141.42
85	194(0) 144(90) 136(10) 194(0)	100	169.71
86	194(0) 101(60) 194(0)	60	20.00
87	194(0) 104(90) 194(0)	90	28.28
88	194(0) 112(50) 103(50) 194(0)	100	60.64
89	194(0) 113(20) 121(80) 194(0)	100	113.14
90	194(0) 97(50) 100(50) 194(0)	100	34.14
91	194(0) 123(10) 131(90) 194(0)	100	141.42
92	194(0) 108(10) 132(60) 124(30) 194(0)	100	100.00
93	194(0) 120(20) 136(80) 194(0)	100	141.42
94	194(0) 97(30) 113(70) 194(0)	100	84.85
95	194(0) 135(60) 127(40) 194(0)	100	100.00
96	194(0) 99(10) 107(90) 194(0)	100	56.57
97	194(0) 109(40) 117(60) 194(0)	100	60.00
98	194(0) 98(20) 123(80) 194(0)	100	116.57
99	194(0) 120(10) 128(90) 194(0)	100	113.14

(cont.)

Table B.66 continued.

	Route	Load	Distance
100	194(0) 110(50) 108(50) 194(0)	100	68.28
101	194(0) 98(40) 106(60) 194(0)	100	40.00
102	194(0) 103(10) 102(90) 194(0)	100	34.14
103	194(0) 116(60) 124(30) 100(10) 194(0)	100	80.00
104	194(0) 99(80) 194(0)	80	28.28
105	194(0) 112(40) 120(60) 194(0)	100	84.85
106	194(0) 115(90) 194(0)	90	84.85
107	194(0) 125(40) 141(60) 194(0)	100	120.00
108	194(0) 118(20) 126(80) 194(0)	100	113.14
109	194(0) 122(40) 114(60) 194(0)	100	80.00
110	194(0) 122(20) 138(20) 130(60) 194(0)	100	120.00
111	194(0) 138(35) 191(65) 194(0)	100	124.00
112	194(0) 126(10) 134(90) 194(0)	100	141.42
113	194(0) 111(40) 119(60) 194(0)	100	60.00
114	195(0) 169(10) 177(90) 195(0)	100	141.42
115	195(0) 146(60) 195(0)	60	20.00
116	195(0) 192(80) 184(20) 195(0)	100	169.71
117	195(0) 162(20) 178(60) 170(20) 195(0)	100	100.00
118	195(0) 159(40) 158(60) 195(0)	100	68.28
119	195(0) 160(40) 168(50) 160(10) 195(0)	100	84.85
120	195(0) 172(40) 180(60) 195(0)	100	100.00
121	195(0) 161(90) 195(0)	90	84.85
122	195(0) 145(10) 153(90) 195(0)	100	56.57
123	195(0) 158(20) 174(80) 195(0)	100	113.14
124	195(0) 159(20) 167(60) 175(20) 195(0)	100	80.00
125	195(0) 156(20) 145(80) 195(0)	100	48.28
126	195(0) 176(70) 168(30) 195(0)	100	113.14
127	195(0) 171(70) 155(30) 195(0)	100	113.14
128	195(0) 168(10) 184(70) 176(20) 195(0)	100	141.42
129	195(0) 157(60) 165(40) 195(0)	100	60.00
130	195(0) 156(40) 164(60) 195(0)	100	60.00
131	195(0) 172(20) 169(80) 195(0)	100	136.57
132	195(0) 150(90) 195(0)	90	28.28

(cont.)

Table B.66 continued.

	Route	Load	Distance
133	195(0) 149(10) 152(90) 195(0)	100	34.14
134	195(0) 170(40) 186(60) 195(0)	100	120.00
135	195(0) 158(10) 166(90) 195(0)	100	84.85
136	195(0) 147(90) 195(0)	90	28.28
137	195(0) 155(50) 149(50) 195(0)	100	60.64
138	195(0) 148(60) 195(0)	60	20.00
139	195(0) 174(10) 182(90) 195(0)	100	141.42
140	195(0) 171(10) 179(90) 195(0)	100	141.42
141	195(0) 173(40) 189(60) 195(0)	100	120.00
142	195(0) 162(40) 154(60) 195(0)	100	60.00
143	195(0) 165(20) 181(60) 173(20) 195(0)	100	100.00
144	195(0) 175(40) 183(60) 195(0)	100	100.00
145	195(0) 171(10) 187(90) 195(0)	100	169.71
146	195(0) 155(10) 163(90) 195(0)	100	84.85
147	195(0) 151(60) 160(40) 195(0)	100	60.64
		Total Distance	14135.80

Table B.67: IDH solution to SQ12.

	Route	Load	Distance
1	0 19(10) 27(90) 0	100	113.14
2	0 44(60) 36(40) 0	100	120.00
3	0 31(40) 23(60) 0	100	80.00
4	0 25(20) 33(80) 0	100	141.42
5	0 20(40) 12(60) 0	100	60.00
6	0 45(20) 37(60) 29(20) 0	100	120.00
7	0 91(95) 0	95	172.56
8	0 30(25) 38(75) 0	100	141.42
9	0 26(40) 34(60) 0	100	100.00
10	0 9(50) 1(50) 0	100	56.57
11	0 6(40) 7(60) 0	100	34.14
12	0 89(95) 0	95	172.56
13	0 8(90) 0	90	28.28
14	0 40(75) 24(25) 0	100	141.42
15	0 38(15) 46(85) 0	100	169.71
16	0 29(40) 21(60) 0	100	80.00
17	0 14(35) 30(65) 0	100	113.14
18	0 11(20) 19(80) 0	100	84.85
19	0 4(60) 1(40) 0	100	34.14
20	0 3(90) 0	90	28.28
21	0 17(60) 9(40) 0	100	84.85
22	0 35(90) 0	90	141.42
23	0 31(20) 39(60) 90(20) 0	100	124.00
24	0 43(5) 185(95) 0	100	173.13
25	0 16(45) 24(55) 0	100	84.85
26	0 24(10) 137(85) 0	95	175.36
27	0 33(10) 41(90) 0	100	169.71
28	0 5(20) 43(80) 0	100	172.96
29	0 20(20) 36(20) 28(60) 0	100	100.00
30	0 6(50) 14(50) 0	100	56.57
31	0 16(5) 32(90) 0	95	113.14
32	0 190(95) 0	95	172.56
33	0 2(20) 18(60) 0	80	60.00

(cont.)

Table B.67 continued.

	Route	Load	Distance
34	0 15(60) 16(40) 0	100	68.28
35	0 13(60) 5(40) 0	100	40.00
36	0 188(65) 45(35) 0	100	124.00
37	0 90(45) 47(55) 0	100	124.00
38	0 42(60) 26(20) 0	80	120.00
39	0 14(5) 22(90) 0	95	84.85
40	0 2(40) 10(60) 0	100	40.00
41	0 40(15) 48(85) 0	100	169.71
42	0 17(30) 25(70) 0	100	113.14
43	0 11(70) 0	70	56.57
44	241(0) 50(60) 51(40) 241(0)	100	34.14
45	241(0) 58(20) 59(80) 241(0)	100	68.28
46	241(0) 62(60) 55(40) 241(0)	100	60.64
47	241(0) 57(20) 65(70) 241(0)	90	84.85
48	241(0) 68(40) 60(60) 241(0)	100	60.00
49	241(0) 69(20) 93(65) 85(15) 241(0)	100	120.00
50	241(0) 70(10) 86(90) 241(0)	100	141.42
51	241(0) 49(60) 52(40) 241(0)	100	34.14
52	241(0) 74(40) 82(60) 241(0)	100	100.00
53	241(0) 78(15) 233(85) 241(0)	100	172.58
54	241(0) 65(20) 73(80) 241(0)	100	113.14
55	241(0) 72(40) 79(60) 241(0)	100	114.05
56	241(0) 94(95) 78(5) 241(0)	100	169.71
57	241(0) 72(5) 96(95) 241(0)	100	169.71
58	241(0) 52(20) 70(80) 241(0)	100	88.48
59	241(0) 53(10) 61(60) 241(0)	70	40.00
60	241(0) 59(10) 67(90) 241(0)	100	84.85
61	241(0) 74(20) 75(80) 241(0)	100	136.57
62	241(0) 54(90) 241(0)	90	28.28
63	241(0) 63(40) 71(60) 241(0)	100	60.00
64	241(0) 73(10) 81(90) 241(0)	100	141.42
65	241(0) 57(70) 49(30) 241(0)	100	56.57
66	241(0) 84(40) 92(60) 241(0)	100	120.00

(cont.)

Table B.67 continued.

	Route	Load	Distance
67	241(0) 69(40) 77(60) 241(0)	100	80.00
68	241(0) 58(40) 66(60) 241(0)	100	60.00
69	241(0) 72(45) 80(55) 241(0)	100	113.14
70	241(0) 84(20) 76(60) 68(20) 241(0)	100	100.00
71	241(0) 78(70) 62(30) 241(0)	100	113.14
72	241(0) 51(50) 53(50) 241(0)	100	34.14
73	241(0) 75(10) 83(90) 241(0)	100	141.42
74	241(0) 234(55) 87(45) 241(0)	100	124.00
75	241(0) 80(10) 88(90) 241(0)	100	141.42
76	241(0) 56(10) 64(90) 241(0)	100	56.57
77	241(0) 63(20) 95(65) 87(15) 241(0)	100	120.00
78	241(0) 85(45) 140(55) 241(0)	100	124.00
79	241(0) 80(10) 142(90) 241(0)	100	172.58
80	241(0) 55(20) 56(80) 241(0)	100	34.14
81	241(0) 80(15) 235(85) 241(0)	100	172.58
82	242(0) 115(90) 242(0)	90	84.85
83	242(0) 139(5) 192(95) 242(0)	100	173.13
84	242(0) 113(90) 242(0)	90	84.85
85	242(0) 102(20) 118(80) 242(0)	100	84.85
86	242(0) 138(35) 191(65) 242(0)	100	124.00
87	242(0) 97(90) 242(0)	90	28.28
88	242(0) 99(90) 242(0)	90	28.28
89	242(0) 122(20) 130(60) 138(20) 242(0)	100	120.00
90	242(0) 109(40) 117(60) 242(0)	100	60.00
91	242(0) 123(10) 131(90) 242(0)	100	141.42
92	242(0) 135(40) 127(60) 242(0)	100	100.00
93	242(0) 129(90) 242(0)	90	141.42
94	242(0) 109(20) 141(60) 133(20) 242(0)	100	120.00
95	242(0) 126(90) 242(0)	90	113.14
96	242(0) 120(10) 128(90) 242(0)	100	113.14
97	242(0) 101(60) 242(0)	60	20.00
98	242(0) 100(20) 124(20) 132(60) 242(0)	100	100.00
99	242(0) 100(40) 108(60) 242(0)	100	40.00

(cont.)

Table B.67 continued.

	Route	Load	Distance
100	242(0) 135(20) 143(60) 111(20) 242(0)	100	120.00
101	242(0) 111(40) 119(60) 242(0)	100	60.00
102	242(0) 124(40) 116(60) 242(0)	100	80.00
103	242(0) 120(10) 136(90) 242(0)	100	141.42
104	242(0) 121(90) 242(0)	90	113.14
105	242(0) 104(90) 242(0)	90	28.28
106	242(0) 98(20) 123(80) 242(0)	100	116.57
107	242(0) 103(30) 102(70) 242(0)	100	34.14
108	242(0) 98(40) 106(60) 242(0)	100	40.00
109	242(0) 133(40) 125(60) 242(0)	100	100.00
110	242(0) 110(90) 242(0)	90	56.57
111	242(0) 105(90) 242(0)	90	56.57
112	242(0) 118(10) 134(90) 242(0)	100	141.42
113	242(0) 107(90) 242(0)	90	56.57
114	242(0) 103(30) 120(70) 242(0)	100	88.48
115	242(0) 122(40) 114(60) 242(0)	100	80.00
116	242(0) 112(90) 242(0)	90	56.57
117	242(0) 144(90) 242(0)	90	169.71
118	243(0) 171(10) 179(90) 243(0)	100	141.42
119	243(0) 172(40) 180(60) 243(0)	100	100.00
120	243(0) 151(20) 183(60) 175(20) 243(0)	100	100.00
121	243(0) 178(20) 171(80) 243(0)	100	147.80
122	243(0) 158(30) 166(70) 243(0)	100	84.85
123	243(0) 168(50) 160(50) 243(0)	100	84.85
124	243(0) 174(10) 182(90) 243(0)	100	141.42
125	243(0) 147(80) 243(0)	80	28.28
126	243(0) 153(10) 161(90) 243(0)	100	84.85
127	243(0) 155(90) 243(0)	90	56.57
128	243(0) 162(40) 170(60) 243(0)	100	80.00
129	243(0) 156(40) 158(60) 243(0)	100	68.28
130	243(0) 156(20) 172(20) 164(60) 243(0)	100	80.00
131	243(0) 166(20) 174(80) 243(0)	100	113.14
132	243(0) 163(90) 243(0)	90	84.85

(cont.)

Table B.67 continued.

	Route	Load	Distance
133	243(0) 146(20) 153(80) 243(0)	100	60.64
134	243(0) 173(20) 189(60) 157(20) 243(0)	100	120.00
135	243(0) 151(40) 159(60) 243(0)	100	40.00
136	243(0) 160(40) 149(60) 243(0)	100	60.64
137	243(0) 168(20) 139(80) 243(0)	100	172.57
138	243(0) 168(10) 176(90) 243(0)	100	113.14
139	243(0) 175(40) 167(60) 243(0)	100	80.00
140	243(0) 147(10) 187(90) 243(0)	100	169.71
141	243(0) 162(20) 169(80) 243(0)	100	127.80
142	243(0) 150(90) 243(0)	90	28.28
143	243(0) 146(40) 154(60) 243(0)	100	40.00
144	243(0) 157(40) 165(60) 243(0)	100	60.00
145	243(0) 148(60) 243(0)	60	20.00
146	243(0) 173(40) 181(60) 243(0)	100	100.00
147	243(0) 168(10) 184(90) 243(0)	100	141.42
148	243(0) 169(10) 177(90) 243(0)	100	141.42
149	243(0) 186(60) 178(40) 243(0)	100	120.00
150	243(0) 152(90) 243(0)	90	28.28
151	243(0) 145(90) 243(0)	90	28.28
152	244(0) 218(40) 226(60) 244(0)	100	100.00
153	244(0) 195(40) 210(60) 244(0)	100	66.50
154	244(0) 207(60) 215(40) 244(0)	100	60.00
155	244(0) 216(60) 200(40) 244(0)	100	84.85
156	244(0) 199(60) 200(40) 244(0)	100	34.14
157	244(0) 194(40) 202(60) 244(0)	100	40.00
158	244(0) 201(90) 244(0)	90	56.57
159	244(0) 198(40) 196(60) 244(0)	100	34.14
160	244(0) 218(20) 219(80) 244(0)	100	136.57
161	244(0) 193(90) 244(0)	90	28.28
162	244(0) 230(10) 238(90) 244(0)	100	169.71
163	244(0) 215(20) 239(60) 231(20) 244(0)	100	120.00
164	244(0) 209(10) 217(90) 244(0)	100	113.14
165	244(0) 213(60) 205(40) 244(0)	100	60.00

(cont.)

Table B.67 continued.

	Route	Load	Distance
166	244(0) 206(30) 222(70) 244(0)	100	113.14
167	244(0) 194(20) 209(80) 244(0)	100	88.48
168	244(0) 225(90) 244(0)	90	141.42
169	244(0) 219(10) 227(90) 244(0)	100	141.42
170	244(0) 195(40) 197(60) 244(0)	100	34.14
171	244(0) 230(80) 222(20) 244(0)	100	141.42
172	244(0) 195(10) 211(90) 244(0)	100	84.85
173	244(0) 216(10) 232(90) 244(0)	100	141.42
174	244(0) 228(60) 220(40) 244(0)	100	100.00
175	244(0) 220(20) 236(60) 204(20) 244(0)	100	120.00
176	244(0) 198(50) 206(50) 244(0)	100	56.57
177	244(0) 203(90) 244(0)	90	56.57
178	244(0) 221(40) 237(60) 244(0)	100	120.00
179	244(0) 221(20) 229(60) 205(20) 244(0)	100	100.00
180	244(0) 216(10) 240(90) 244(0)	100	169.71
181	244(0) 206(10) 214(90) 244(0)	100	84.85
182	244(0) 231(40) 223(60) 244(0)	100	100.00
183	244(0) 200(10) 208(90) 244(0)	100	56.57
184	244(0) 216(10) 224(90) 244(0)	100	113.14
185	244(0) 204(40) 212(60) 244(0)	100	60.00
		Total Distance	17739.64

Table B.68: Estimated solution to SQ1.

	Route	Load	Distance
1	0 1(10) 9(90) 0	100	56.57
2	0 1(80) 2(20) 0	100	34.14
3	0 2(40) 10(60) 0	100	40.00
4	0 3(10) 11(90) 0	100	56.57
5	0 3(80) 5(20) 0	100	34.14
6	0 5(40) 13(60) 0	100	40.00
7	0 6(10) 14(85) 25(5) 14(0) 0	100	60.57
8	0 6(80) 4(20) 0	100	34.14
9	0 4(40) 12(60) 0	100	40.00
10	0 8(10) 16(85) 27(5) 16(0) 0	100	60.57
11	0 8(80) 7(20) 0	100	34.14
12	0 7(40) 15(55) 26(5) 0	100	44.00
13	33(0) 17(10) 25(90) 33(0)	100	56.57
14	33(0) 17(80) 18(20) 33(0)	100	34.14
15	33(0) 18(40) 26(60) 33(0)	100	40.00
16	33(0) 19(10) 27(90) 33(0)	100	56.57
17	33(0) 19(80) 21(20) 33(0)	100	34.14
18	33(0) 21(40) 29(60) 33(0)	100	40.00
19	33(0) 22(10) 30(90) 33(0)	100	56.57
20	33(0) 22(80) 20(20) 33(0)	100	34.14
21	33(0) 20(40) 28(60) 33(0)	100	40.00
22	33(0) 24(10) 32(90) 33(0)	100	56.57
23	33(0) 24(80) 23(20) 33(0)	100	34.14
24	33(0) 23(40) 31(60) 33(0)	100	40.00
		Total Distance	1057.69

Table B.69: Estimated solution to SQ2.

	Route	Load	Distance
1	0 1(10) 9(90) 0	100	56.57
2	0 1(80) 2(20) 0	100	34.14
3	0 2(40) 10(60) 0	100	40.00
4	0 3(10) 11(90) 0	100	56.57
5	0 3(80) 5(20) 0	100	34.14
6	0 5(40) 13(60) 0	100	40.00
7	0 6(10) 14(85) 25(5) 14(0) 0	100	60.57
8	0 6(80) 4(20) 0	100	34.14
9	0 4(40) 12(60) 0	100	40.00
10	0 8(10) 16(85) 27(5) 16(0) 0	100	60.57
11	0 8(80) 7(20) 0	100	34.14
12	0 7(40) 15(55) 26(5) 0	100	44.00
13	49(0) 17(10) 25(90) 49(0)	100	56.57
14	49(0) 17(80) 18(20) 49(0)	100	34.14
15	49(0) 18(40) 26(60) 49(0)	100	40.00
16	49(0) 19(10) 27(90) 49(0)	100	56.57
17	49(0) 19(80) 21(20) 49(0)	100	34.14
18	49(0) 21(40) 29(60) 49(0)	100	40.00
19	49(0) 22(10) 30(90) 49(0)	100	56.57
20	49(0) 22(80) 20(20) 49(0)	100	34.14
21	49(0) 20(40) 28(60) 49(0)	100	40.00
22	49(0) 24(10) 32(90) 49(0)	100	56.57
23	49(0) 24(80) 23(20) 49(0)	100	34.14
24	49(0) 23(40) 31(60) 49(0)	100	40.00
25	50(0) 33(10) 41(90) 50(0)	100	56.57
26	50(0) 33(80) 34(20) 50(0)	100	34.14
27	50(0) 34(40) 42(60) 50(0)	100	40.00
28	50(0) 35(10) 43(90) 50(0)	100	56.57
29	50(0) 35(80) 37(20) 50(0)	100	34.14
30	50(0) 37(40) 45(60) 50(0)	100	40.00
31	50(0) 38(10) 46(85) 32(5) 46(0) 50(0)	100	60.57
32	50(0) 38(80) 36(20) 50(0)	100	34.14
33	50(0) 36(40) 44(55) 29(5) 50(0)	100	44.00
34	50(0) 40(10) 48(90) 50(0)	100	56.57
35	50(0) 40(80) 39(20) 50(0)	100	34.14
36	50(0) 39(40) 47(60) 50(0)	100	40.00
		Total Distance	1588.53

Table B.70: Estimated solution to SQ3.

	Route	Load	Distance
1	0 1(10) 9(90) 0	100	56.57
2	0 1(80) 2(20) 0	100	34.14
3	0 2(40) 10(60) 0	100	40.00
4	0 3(10) 11(85) 57(5) 11(0) 0	100	60.57
5	0 3(80) 5(20) 0	100	34.14
6	0 5(40) 13(55) 60(5) 0	100	44.00
7	0 6(10) 14(85) 25(5) 14(0) 0	100	60.57
8	0 6(80) 4(20) 0	100	34.14
9	0 4(40) 12(60) 0	100	40.00
10	0 8(10) 16(85) 27(5) 16(0) 0	100	60.57
11	0 8(80) 7(20) 0	100	34.14
12	0 7(40) 15(55) 26(5) 0	100	44.00
13	65(0) 17(10) 25(90) 65(0)	100	56.57
14	65(0) 17(80) 18(20) 65(0)	100	34.14
15	65(0) 18(40) 26(60) 65(0)	100	40.00
16	65(0) 19(10) 27(90) 65(0)	100	56.57
17	65(0) 19(80) 21(20) 65(0)	100	34.14
18	65(0) 21(40) 29(60) 65(0)	100	40.00
19	65(0) 22(10) 30(90) 65(0)	100	56.57
20	65(0) 22(80) 20(20) 65(0)	100	34.14
21	65(0) 20(40) 28(60) 65(0)	100	40.00
22	65(0) 24(10) 32(90) 65(0)	100	56.57
23	65(0) 24(80) 23(20) 65(0)	100	34.14
24	65(0) 23(40) 31(60) 65(0)	100	40.00
25	66(0) 33(10) 41(85) 62(5) 41(0) 66(0)	100	60.57
26	66(0) 33(80) 34(20) 66(0)	100	34.14
27	66(0) 34(40) 42(55) 63(5) 66(0)	100	44.00
28	66(0) 35(10) 43(85) 64(5) 43(0) 66(0)	100	60.57
29	66(0) 35(80) 37(20) 66(0)	100	34.14
30	66(0) 37(40) 45(60) 66(0)	100	40.00
31	66(0) 38(10) 46(85) 32(5) 46(0) 66(0)	100	60.57
32	66(0) 38(80) 36(20) 66(0)	100	34.14
33	66(0) 36(40) 44(55) 29(5) 66(0)	100	44.00

(cont.)

Table B.70 continued.

	Route	Load	Distance
34	66(0) 40(10) 48(90) 66(0)	100	56.57
35	66(0) 40(80) 39(20) 66(0)	100	34.14
36	66(0) 39(40) 47(60) 66(0)	100	40.00
37	67(0) 49(10) 57(90) 67(0)	100	56.57
38	67(0) 49(80) 50(20) 67(0)	100	34.14
39	67(0) 50(40) 58(60) 67(0)	100	40.00
40	67(0) 51(10) 59(90) 67(0)	100	56.57
41	67(0) 51(80) 53(20) 67(0)	100	34.14
42	67(0) 53(40) 61(60) 67(0)	100	40.00
43	67(0) 54(10) 62(90) 67(0)	100	56.57
44	67(0) 54(80) 52(20) 67(0)	100	34.14
45	67(0) 52(40) 60(60) 67(0)	100	40.00
46	67(0) 56(10) 64(90) 67(0)	100	56.57
47	67(0) 56(80) 55(20) 67(0)	100	34.14
48	67(0) 55(40) 63(60) 67(0)	100	40.00
		Total Distance	2131.37

Table B.71: Estimated solution to SQ4.

	Route	Load	Distance
1	0 1(10) 9(90) 0	100	56.57
2	0 1(80) 2(20) 0	100	34.14
3	0 2(40) 10(60) 0	100	40.00
4	0 3(10) 11(85) 57(5) 11(0) 0	100	60.57
5	0 3(80) 5(20) 0	100	34.14
6	0 5(40) 13(55) 60(5) 0	100	44.00
7	0 6(10) 14(85) 25(5) 14(0) 0	100	60.57
8	0 6(80) 4(20) 0	100	34.14
9	0 4(40) 12(60) 0	100	40.00
10	0 8(10) 16(85) 27(5) 16(0) 0	100	60.57
11	0 8(80) 7(20) 0	100	34.14
12	0 7(40) 15(55) 26(5) 0	100	44.00
13	81(0) 17(10) 25(90) 81(0)	100	56.57
14	81(0) 17(80) 18(20) 81(0)	100	34.14
15	81(0) 18(40) 26(60) 81(0)	100	40.00
16	81(0) 19(10) 27(90) 81(0)	100	56.57
17	81(0) 19(80) 21(20) 81(0)	100	34.14
18	81(0) 21(40) 29(60) 81(0)	100	40.00
19	81(0) 22(10) 30(90) 81(0)	100	56.57
20	81(0) 22(80) 20(20) 81(0)	100	34.14
21	81(0) 20(40) 28(60) 81(0)	100	40.00
22	81(0) 24(10) 32(90) 81(0)	100	56.57
23	81(0) 24(80) 23(20) 81(0)	100	34.14
24	81(0) 23(40) 31(60) 81(0)	100	40.00
25	82(0) 33(10) 41(85) 62(5) 41(0) 82(0)	100	60.57
26	82(0) 33(80) 34(20) 82(0)	100	34.14
27	82(0) 34(40) 42(55) 63(5) 82(0)	100	44.00
28	82(0) 35(10) 43(85) 64(5) 43(0) 82(0)	100	60.57
29	82(0) 35(80) 37(20) 82(0)	100	34.14
30	82(0) 37(40) 45(60) 82(0)	100	40.00
31	82(0) 38(10) 46(90) 82(0)	100	56.57
32	82(0) 38(80) 36(20) 82(0)	100	34.14
33	82(0) 36(40) 44(55) 29(5) 82(0)	100	44.00

(cont.)

Table B.71 continued.

	Route	Load	Distance
34	82(0) 40(10) 48(90) 82(0)	100	56.57
35	82(0) 40(80) 39(20) 82(0)	100	34.14
36	82(0) 39(40) 47(60) 82(0)	100	40.00
37	83(0) 49(10) 57(90) 83(0)	100	56.57
38	83(0) 49(80) 50(20) 83(0)	100	34.14
39	83(0) 50(40) 58(60) 83(0)	100	40.00
40	83(0) 51(10) 59(90) 83(0)	100	56.57
41	83(0) 51(80) 53(20) 83(0)	100	34.14
42	83(0) 53(40) 61(60) 83(0)	100	40.00
43	83(0) 54(10) 62(90) 83(0)	100	56.57
44	83(0) 54(80) 52(20) 83(0)	100	34.14
45	83(0) 52(40) 60(60) 83(0)	100	40.00
46	83(0) 56(10) 64(90) 83(0)	100	56.57
47	83(0) 56(80) 55(20) 83(0)	100	34.14
48	83(0) 55(40) 63(60) 83(0)	100	40.00
49	84(0) 65(10) 73(85) 30(5) 73(0) 84(0)	100	60.57
50	84(0) 65(80) 66(20) 84(0)	100	34.14
51	84(0) 66(40) 74(55) 31(5) 84(0)	100	44.00
52	84(0) 67(10) 75(85) 32(5) 75(0) 84(0)	100	60.57
53	84(0) 67(80) 69(20) 84(0)	100	34.14
54	84(0) 69(40) 77(60) 84(0)	100	40.00
55	84(0) 70(10) 78(90) 84(0)	100	56.57
56	84(0) 70(80) 68(20) 84(0)	100	34.14
57	84(0) 68(40) 76(60) 84(0)	100	40.00
58	84(0) 72(10) 80(90) 84(0)	100	56.57
59	84(0) 72(80) 71(20) 84(0)	100	34.14
60	84(0) 71(40) 79(60) 84(0)	100	40.00
		Total Distance	2662.21

Table B.72: Estimated solution to SQ5.

	Route	Load	Distance
1	0 1(10) 9(90) 0	100	56.57
2	0 1(80) 2(20) 0	100	34.14
3	0 2(40) 10(60) 0	100	40.00
4	0 3(10) 11(90) 0	100	56.57
5	0 3(80) 5(20) 0	100	34.14
6	0 5(40) 13(60) 0	100	40.00
7	0 6(10) 14(90) 0	100	56.57
8	0 6(80) 4(20) 0	100	34.14
9	0 4(40) 12(60) 0	100	40.00
10	0 8(10) 16(90) 0	100	56.57
11	0 8(80) 7(20) 0	100	34.14
12	0 7(40) 15(60) 0	100	40.00
13	0 17(10) 25(90) 0	100	113.14
14	0 17(80) 18(20) 0	100	102.43
15	0 18(40) 26(60) 0	100	80.00
16	0 19(10) 27(90) 0	100	113.14
17	0 19(80) 21(20) 0	100	102.43
18	0 21(40) 29(60) 0	100	80.00
19	0 22(10) 30(85) 57(5) 30(0) 0	100	117.14
20	0 22(80) 20(20) 0	100	102.43
21	0 20(40) 28(60) 0	100	80.00
22	0 24(10) 32(85) 59(5) 32(0) 0	100	117.14
23	0 24(80) 23(20) 0	100	102.43
24	0 23(40) 31(55) 58(5) 0	100	84.00
25	65(0) 33(10) 41(90) 65(0)	100	56.57
26	65(0) 33(80) 34(20) 65(0)	100	34.14
27	65(0) 34(40) 42(60) 65(0)	100	40.00
28	65(0) 35(10) 43(90) 65(0)	100	56.57
29	65(0) 35(80) 37(20) 65(0)	100	34.14
30	65(0) 37(40) 45(60) 65(0)	100	40.00
31	65(0) 38(10) 46(90) 65(0)	100	56.57
32	65(0) 38(80) 36(20) 65(0)	100	34.14
33	65(0) 36(40) 44(60) 65(0)	100	40.00

(cont.)

Table B.72 continued.

	Route	Load	Distance
34	65(0) 40(10) 48(90) 65(0)	100	56.57
35	65(0) 40(80) 39(20) 65(0)	100	34.14
36	65(0) 39(40) 47(60) 65(0)	100	40.00
37	65(0) 49(10) 57(90) 65(0)	100	113.14
38	65(0) 49(80) 50(20) 65(0)	100	102.43
39	65(0) 50(40) 58(60) 65(0)	100	80.00
40	65(0) 51(10) 59(90) 65(0)	100	113.14
41	65(0) 51(80) 53(20) 65(0)	100	102.43
42	65(0) 53(40) 61(60) 65(0)	100	80.00
43	65(0) 54(10) 62(90) 65(0)	100	113.14
44	65(0) 54(80) 52(20) 65(0)	100	102.43
45	65(0) 52(40) 60(60) 65(0)	100	80.00
46	65(0) 56(10) 64(90) 65(0)	100	113.14
47	65(0) 56(80) 55(20) 65(0)	100	102.43
48	65(0) 55(40) 63(60) 65(0)	100	80.00
		Total Distance	3422.19

Table B.73: Estimated solution to SQ6.

	Route	Load	Distance
1	0 1(10) 9(90) 0	100	56.57
2	0 1(80) 2(20) 0	100	34.14
3	0 2(40) 10(60) 0	100	40.00
4	0 3(10) 11(90) 0	100	56.57
5	0 3(80) 5(20) 0	100	34.14
6	0 5(40) 13(60) 0	100	40.00
7	0 6(10) 14(90) 0	100	56.57
8	0 6(80) 4(20) 0	100	34.14
9	0 4(40) 12(60) 0	100	40.00
10	0 8(10) 16(90) 0	100	56.57
11	0 8(80) 7(20) 0	100	34.14
12	0 7(40) 15(60) 0	100	40.00
13	0 17(10) 25(90) 0	100	113.14
14	0 17(80) 18(20) 0	100	102.43
15	0 18(40) 26(60) 0	100	80.00
16	0 19(10) 27(90) 0	100	113.14
17	0 19(80) 21(20) 0	100	102.43
18	0 21(40) 29(60) 0	100	80.00
19	0 22(10) 30(85) 57(5) 30(0) 0	100	117.14
20	0 22(80) 20(20) 0	100	102.43
21	0 20(40) 28(60) 0	100	80.00
22	0 24(10) 32(85) 59(5) 32(0) 0	100	117.14
23	0 24(80) 23(20) 0	100	102.43
24	0 23(40) 31(55) 58(5) 0	100	84.00
25	97(0) 33(10) 41(90) 97(0)	100	56.57
26	97(0) 33(80) 34(20) 97(0)	100	34.14
27	97(0) 34(40) 42(60) 97(0)	100	40.00
28	97(0) 35(10) 43(90) 97(0)	100	56.57
29	97(0) 35(80) 37(20) 97(0)	100	34.14
30	97(0) 37(40) 45(60) 97(0)	100	40.00
31	97(0) 38(10) 46(90) 97(0)	100	56.57
32	97(0) 38(80) 36(20) 97(0)	100	34.14
33	97(0) 36(40) 44(60) 97(0)	100	40.00

(cont.)

Table B.73 continued.

	Route	Load	Distance
34	97(0) 40(10) 48(90) 97(0)	100	56.57
35	97(0) 40(80) 39(20) 97(0)	100	34.14
36	97(0) 39(40) 47(60) 97(0)	100	40.00
37	97(0) 49(10) 57(90) 97(0)	100	113.14
38	97(0) 49(80) 50(20) 97(0)	100	102.43
39	97(0) 50(40) 58(60) 97(0)	100	80.00
40	97(0) 51(10) 59(90) 97(0)	100	113.14
41	97(0) 51(80) 53(20) 97(0)	100	102.43
42	97(0) 53(40) 61(60) 97(0)	100	80.00
43	97(0) 54(10) 62(90) 97(0)	100	113.14
44	97(0) 54(80) 52(20) 97(0)	100	102.43
45	97(0) 52(40) 60(60) 97(0)	100	80.00
46	97(0) 56(10) 64(90) 97(0)	100	113.14
47	97(0) 56(80) 55(20) 97(0)	100	102.43
48	97(0) 55(40) 63(60) 97(0)	100	80.00
49	98(0) 65(10) 73(90) 98(0)	100	56.57
50	98(0) 65(80) 66(20) 98(0)	100	34.14
51	98(0) 66(40) 74(60) 98(0)	100	40.00
52	98(0) 67(10) 75(90) 98(0)	100	56.57
53	98(0) 67(80) 69(20) 98(0)	100	34.14
54	98(0) 69(40) 77(60) 98(0)	100	40.00
55	98(0) 70(10) 78(90) 98(0)	100	56.57
56	98(0) 70(80) 68(20) 98(0)	100	34.14
57	98(0) 68(40) 76(60) 98(0)	100	40.00
58	98(0) 72(10) 80(90) 98(0)	100	56.57
59	98(0) 72(80) 71(20) 98(0)	100	34.14
60	98(0) 71(40) 79(60) 98(0)	100	40.00
61	98(0) 81(10) 89(90) 98(0)	100	113.14
62	98(0) 81(80) 82(20) 98(0)	100	102.43
63	98(0) 82(40) 90(60) 98(0)	100	80.00
64	98(0) 83(10) 91(90) 98(0)	100	113.14
65	98(0) 83(80) 85(20) 98(0)	100	102.43
66	98(0) 85(40) 93(60) 98(0)	100	80.00

(cont.)

Table B.73 continued.

	Route	Load	Distance
67	98(0) 86(10) 94(85) 64(5) 94(0) 98(0)	100	117.14
68	98(0) 86(80) 84(20) 98(0)	100	102.43
69	98(0) 84(40) 92(55) 61(5) 98(0)	100	84.00
70	98(0) 88(10) 96(90) 98(0)	100	113.14
71	98(0) 88(80) 87(20) 98(0)	100	102.43
72	98(0) 87(40) 95(60) 98(0)	100	80.00
		Total Distance	5135.29

Table B.74: Estimated solution to SQ7.

	Route	Load	Distance
1	0 1(10) 9(90) 0	100	56.57
2	0 1(80) 2(20) 0	100	34.14
3	0 2(40) 10(60) 0	100	40.00
4	0 3(10) 11(90) 0	100	56.57
5	0 3(80) 5(20) 0	100	34.14
6	0 5(40) 13(60) 0	100	40.00
7	0 6(10) 14(90) 0	100	56.57
8	0 6(80) 4(20) 0	100	34.14
9	0 4(40) 12(60) 0	100	40.00
10	0 8(10) 16(90) 0	100	56.57
11	0 8(80) 7(20) 0	100	34.14
12	0 7(40) 15(60) 0	100	40.00
13	0 17(10) 25(90) 0	100	113.14
14	0 17(80) 18(20) 0	100	102.43
15	0 18(40) 26(60) 0	100	80.00
16	0 19(10) 27(85) 121(5) 27(0) 0	100	117.14
17	0 19(80) 21(20) 0	100	102.43
18	0 21(40) 29(55) 124(5) 0	100	84.00
19	0 22(10) 30(85) 57(5) 30(0) 0	100	117.14
20	0 22(80) 20(20) 0	100	102.43
21	0 20(40) 28(60) 0	100	80.00
22	0 24(10) 32(85) 59(5) 32(0) 0	100	117.14
23	0 24(80) 23(20) 0	100	102.43
24	0 23(40) 31(55) 58(5) 0	100	84.00
25	129(0) 33(10) 41(90) 129(0)	100	56.57
26	129(0) 33(80) 34(20) 129(0)	100	34.14
27	129(0) 34(40) 42(60) 129(0)	100	40.00
28	129(0) 35(10) 43(90) 129(0)	100	56.57
29	129(0) 35(80) 37(20) 129(0)	100	34.14
30	129(0) 37(40) 45(60) 129(0)	100	40.00
31	129(0) 38(10) 46(90) 129(0)	100	56.57
32	129(0) 38(80) 36(20) 129(0)	100	34.14
33	129(0) 36(40) 44(60) 129(0)	100	40.00

(cont.)

Table B.74 continued.

	Route	Load	Distance
34	129(0) 40(10) 48(90) 129(0)	100	56.57
35	129(0) 40(80) 39(20) 129(0)	100	34.14
36	129(0) 39(40) 47(60) 129(0)	100	40.00
37	129(0) 49(10) 57(90) 129(0)	100	113.14
38	129(0) 49(80) 50(20) 129(0)	100	102.43
39	129(0) 50(40) 58(60) 129(0)	100	80.00
40	129(0) 51(10) 59(90) 129(0)	100	113.14
41	129(0) 51(80) 53(20) 129(0)	100	102.43
42	129(0) 53(40) 61(60) 129(0)	100	80.00
43	129(0) 54(10) 62(90) 129(0)	100	113.14
44	129(0) 54(80) 52(20) 129(0)	100	102.43
45	129(0) 52(40) 60(60) 129(0)	100	80.00
46	129(0) 56(10) 64(90) 129(0)	100	113.14
47	129(0) 56(80) 55(20) 129(0)	100	102.43
48	129(0) 55(40) 63(60) 129(0)	100	80.00
49	130(0) 65(10) 73(90) 130(0)	100	56.57
50	130(0) 65(80) 66(20) 130(0)	100	34.14
51	130(0) 66(40) 74(60) 130(0)	100	40.00
52	130(0) 67(10) 75(90) 130(0)	100	56.57
53	130(0) 67(80) 69(20) 130(0)	100	34.14
54	130(0) 69(40) 77(60) 130(0)	100	40.00
55	130(0) 70(10) 78(90) 130(0)	100	56.57
56	130(0) 70(80) 68(20) 130(0)	100	34.14
57	130(0) 68(40) 76(60) 130(0)	100	40.00
58	130(0) 72(10) 80(90) 130(0)	100	56.57
59	130(0) 72(80) 71(20) 130(0)	100	34.14
60	130(0) 71(40) 79(60) 130(0)	100	40.00
61	130(0) 81(10) 89(85) 126(5) 89(0) 130(0)	100	117.14
62	130(0) 81(80) 82(20) 130(0)	100	102.43
63	130(0) 82(40) 90(55) 127(5) 130(0)	100	84.00
64	130(0) 83(10) 91(85) 128(5) 91(0) 130(0)	100	117.14
65	130(0) 83(80) 85(20) 130(0)	100	102.43
66	130(0) 85(40) 93(60) 130(0)	100	80.00

(cont.)

Table B.74 continued.

	Route	Load	Distance
67	130(0) 86(10) 94(85) 64(5) 94(0) 130(0)	100	117.14
68	130(0) 86(80) 84(20) 130(0)	100	102.43
69	130(0) 84(40) 92(55) 61(5) 130(0)	100	84.00
70	130(0) 88(10) 96(90) 130(0)	100	113.14
71	130(0) 88(80) 87(20) 130(0)	100	102.43
72	130(0) 87(40) 95(60) 130(0)	100	80.00
73	131(0) 97(10) 105(90) 131(0)	100	56.57
74	131(0) 97(80) 98(20) 131(0)	100	34.14
75	131(0) 98(40) 106(60) 131(0)	100	40.00
76	131(0) 99(10) 107(90) 131(0)	100	56.57
77	131(0) 99(80) 101(20) 131(0)	100	34.14
78	131(0) 101(40) 109(60) 131(0)	100	40.00
79	131(0) 102(10) 110(90) 131(0)	100	56.57
80	131(0) 102(80) 100(20) 131(0)	100	34.14
81	131(0) 100(40) 108(60) 131(0)	100	40.00
82	131(0) 104(10) 112(90) 131(0)	100	56.57
83	131(0) 104(80) 103(20) 131(0)	100	34.14
84	131(0) 103(40) 111(60) 131(0)	100	40.00
85	131(0) 113(10) 121(90) 131(0)	100	113.14
86	131(0) 113(80) 114(20) 131(0)	100	102.43
87	131(0) 114(40) 122(60) 131(0)	100	80.00
88	131(0) 115(10) 123(90) 131(0)	100	113.14
89	131(0) 115(80) 117(20) 131(0)	100	102.43
90	131(0) 117(40) 125(60) 131(0)	100	80.00
91	131(0) 118(10) 126(90) 131(0)	100	113.14
92	131(0) 118(80) 116(20) 131(0)	100	102.43
93	131(0) 116(40) 124(60) 131(0)	100	80.00
94	131(0) 120(10) 128(90) 131(0)	100	113.14
95	131(0) 120(80) 119(20) 131(0)	100	102.43
96	131(0) 119(40) 127(60) 131(0)	100	80.00
		Total Distance	6860.39

Table B.75: Estimated solution to SQ8.

	Route	Load	Distance
1	0 1(10) 9(90) 0	100	56.57
2	0 1(80) 2(20) 0	100	34.14
3	0 2(40) 10(60) 0	100	40.00
4	0 3(10) 11(90) 0	100	56.57
5	0 3(80) 5(20) 0	100	34.14
6	0 5(40) 13(60) 0	100	40.00
7	0 6(10) 14(90) 0	100	56.57
8	0 6(80) 4(20) 0	100	34.14
9	0 4(40) 12(60) 0	100	40.00
10	0 8(10) 16(90) 0	100	56.57
11	0 8(80) 7(20) 0	100	34.14
12	0 7(40) 15(60) 0	100	40.00
13	0 17(10) 25(90) 0	100	113.14
14	0 17(80) 18(20) 0	100	102.43
15	0 18(40) 26(60) 0	100	80.00
16	0 19(10) 27(85) 121(5) 27(0) 0	100	117.14
17	0 19(80) 21(20) 0	100	102.43
18	0 21(40) 29(55) 124(5) 0	100	84.00
19	0 22(10) 30(85) 57(5) 30(0) 0	100	117.14
20	0 22(80) 20(20) 0	100	102.43
21	0 20(40) 28(60) 0	100	80.00
22	0 24(10) 32(85) 59(5) 32(0) 0	100	117.14
23	0 24(80) 23(20) 0	100	102.43
24	0 23(40) 31(55) 58(5) 0	100	84.00
25	161(0) 33(10) 41(90) 161(0)	100	56.57
26	161(0) 33(80) 34(20) 161(0)	100	34.14
27	161(0) 34(40) 42(60) 161(0)	100	40.00
28	161(0) 35(10) 43(90) 161(0)	100	56.57
29	161(0) 35(80) 37(20) 161(0)	100	34.14
30	161(0) 37(40) 45(60) 161(0)	100	40.00
31	161(0) 38(10) 46(90) 161(0)	100	56.57
32	161(0) 38(80) 36(20) 161(0)	100	34.14
33	161(0) 36(40) 44(60) 161(0)	100	40.00

(cont.)

Table B.75 continued.

	Route	Load	Distance
34	161(0) 40(10) 48(90) 161(0)	100	56.57
35	161(0) 40(80) 39(20) 161(0)	100	34.14
36	161(0) 39(40) 47(60) 161(0)	100	40.00
37	161(0) 49(10) 57(90) 161(0)	100	113.14
38	161(0) 49(80) 50(20) 161(0)	100	102.43
39	161(0) 50(40) 58(60) 161(0)	100	80.00
40	161(0) 51(10) 59(90) 161(0)	100	113.14
41	161(0) 51(80) 53(20) 161(0)	100	102.43
42	161(0) 53(40) 61(60) 161(0)	100	80.00
43	161(0) 54(10) 62(90) 161(0)	100	113.14
44	161(0) 54(80) 52(20) 161(0)	100	102.43
45	161(0) 52(40) 60(60) 161(0)	100	80.00
46	161(0) 56(10) 64(90) 161(0)	100	113.14
47	161(0) 56(80) 55(20) 161(0)	100	102.43
48	161(0) 55(40) 63(60) 161(0)	100	80.00
49	162(0) 65(10) 73(90) 162(0)	100	56.57
50	162(0) 65(80) 66(20) 162(0)	100	34.14
51	162(0) 66(40) 74(60) 162(0)	100	40.00
52	162(0) 67(10) 75(90) 162(0)	100	56.57
53	162(0) 67(80) 69(20) 162(0)	100	34.14
54	162(0) 69(40) 77(60) 162(0)	100	40.00
55	162(0) 70(10) 78(90) 162(0)	100	56.57
56	162(0) 70(80) 68(20) 162(0)	100	34.14
57	162(0) 68(40) 76(60) 162(0)	100	40.00
58	162(0) 72(10) 80(90) 162(0)	100	56.57
59	162(0) 72(80) 71(20) 162(0)	100	34.14
60	162(0) 71(40) 79(60) 162(0)	100	40.00
61	162(0) 81(10) 89(85) 126(5) 89(0) 162(0)	100	117.14
62	162(0) 81(80) 82(20) 162(0)	100	102.43
63	162(0) 82(40) 90(55) 127(5) 162(0)	100	84.00
64	162(0) 83(10) 91(85) 128(5) 91(0) 162(0)	100	117.14
65	162(0) 83(80) 85(20) 162(0)	100	102.43
66	162(0) 85(40) 93(60) 162(0)	100	80.00

(cont.)

Table B.75 continued.

	Route	Load	Distance
67	162(0) 86(10) 94(90) 162(0)	100	113.14
68	162(0) 86(80) 84(20) 162(0)	100	102.43
69	162(0) 84(40) 92(55) 61(5) 162(0)	100	84.00
70	162(0) 88(10) 96(90) 162(0)	100	113.14
71	162(0) 88(80) 87(20) 162(0)	100	102.43
72	162(0) 87(40) 95(60) 162(0)	100	80.00
73	163(0) 97(10) 105(90) 163(0)	100	56.57
74	163(0) 97(80) 98(20) 163(0)	100	34.14
75	163(0) 98(40) 106(60) 163(0)	100	40.00
76	163(0) 99(10) 107(90) 163(0)	100	56.57
77	163(0) 99(80) 101(20) 163(0)	100	34.14
78	163(0) 101(40) 109(60) 163(0)	100	40.00
79	163(0) 102(10) 110(90) 163(0)	100	56.57
80	163(0) 102(80) 100(20) 163(0)	100	34.14
81	163(0) 100(40) 108(60) 163(0)	100	40.00
82	163(0) 104(10) 112(90) 163(0)	100	56.57
83	163(0) 104(80) 103(20) 163(0)	100	34.14
84	163(0) 103(40) 111(60) 163(0)	100	40.00
85	163(0) 113(10) 121(90) 163(0)	100	113.14
86	163(0) 113(80) 114(20) 163(0)	100	102.43
87	163(0) 114(40) 122(60) 163(0)	100	80.00
88	163(0) 115(10) 123(90) 163(0)	100	113.14
89	163(0) 115(80) 117(20) 163(0)	100	102.43
90	163(0) 117(40) 125(60) 163(0)	100	80.00
91	163(0) 118(10) 126(90) 163(0)	100	113.14
92	163(0) 118(80) 116(20) 163(0)	100	102.43
93	163(0) 116(40) 124(60) 163(0)	100	80.00
94	163(0) 120(10) 128(90) 163(0)	100	113.14
95	163(0) 120(80) 119(20) 163(0)	100	102.43
96	163(0) 119(40) 127(60) 163(0)	100	80.00
97	164(0) 129(10) 137(90) 164(0)	100	56.57
98	164(0) 129(80) 130(20) 164(0)	100	34.14
99	164(0) 130(40) 138(60) 164(0)	100	40.00

(cont.)

Table B.75 continued.

	Route	Load	Distance
100	164(0) 131(10) 139(90) 164(0)	100	56.57
101	164(0) 131(80) 133(20) 164(0)	100	34.14
102	164(0) 133(40) 141(60) 164(0)	100	40.00
103	164(0) 134(10) 142(90) 164(0)	100	56.57
104	164(0) 134(80) 132(20) 164(0)	100	34.14
105	164(0) 132(40) 140(60) 164(0)	100	40.00
106	164(0) 136(10) 144(90) 164(0)	100	56.57
107	164(0) 136(80) 135(20) 164(0)	100	34.14
108	164(0) 135(40) 143(60) 164(0)	100	40.00
109	164(0) 145(10) 153(85) 62(5) 153(0) 164(0)	100	117.14
110	164(0) 145(80) 146(20) 164(0)	100	102.43
111	164(0) 146(40) 154(55) 63(5) 164(0)	100	84.00
112	164(0) 147(10) 155(85) 64(5) 155(0) 164(0)	100	117.14
113	164(0) 147(80) 149(20) 164(0)	100	102.43
114	164(0) 149(40) 157(60) 164(0)	100	80.00
115	164(0) 150(10) 158(90) 164(0)	100	113.14
116	164(0) 150(80) 148(20) 164(0)	100	102.43
117	164(0) 148(40) 156(60) 164(0)	100	80.00
118	164(0) 152(10) 160(90) 164(0)	100	113.14
119	164(0) 152(80) 151(20) 164(0)	100	102.43
120	164(0) 151(40) 159(60) 164(0)	100	80.00
		Total Distance	8573.48

Table B.76: Estimated solution to SQ9.

	Route	Load	Distance
1	0 33(10) 41(90) 0	100	169.71
2	0 25(20) 33(80) 0	100	141.42
3	0 17(30) 25(70) 0	100	113.14
4	0 9(40) 17(60) 0	100	84.85
5	0 1(50) 9(50) 0	100	56.57
6	0 34(40) 42(60) 0	100	120.00
7	0 18(20) 26(60) 34(20) 0	100	100.00
8	0 10(60) 18(40) 0	100	60.00
9	0 1(40) 2(60) 0	100	34.14
10	0 35(10) 43(90) 0	100	169.71
11	0 27(20) 35(80) 0	100	141.42
12	0 19(30) 27(70) 0	100	113.14
13	0 11(40) 19(60) 0	100	84.85
14	0 3(50) 11(50) 0	100	56.57
15	0 37(40) 45(60) 0	100	120.00
16	0 21(20) 29(60) 37(20) 0	100	100.00
17	0 13(60) 21(40) 0	100	60.00
18	0 3(40) 5(60) 0	100	34.14
19	0 38(10) 46(85) 89(5) 46(0) 0	100	173.71
20	0 30(20) 38(80) 0	100	141.42
21	0 22(30) 30(70) 0	100	113.14
22	0 14(40) 22(60) 0	100	84.85
23	0 6(50) 14(50) 0	100	56.57
24	0 36(40) 44(60) 0	100	120.00
25	0 20(20) 28(60) 36(20) 0	100	100.00
26	0 12(60) 20(40) 0	100	60.00
27	0 6(40) 4(60) 0	100	34.14
28	0 40(10) 48(85) 91(5) 48(0) 0	100	173.71
29	0 32(20) 40(80) 0	100	141.42
30	0 24(30) 32(70) 0	100	113.14
31	0 16(40) 24(60) 0	100	84.85
32	0 8(50) 16(50) 0	100	56.57
33	0 39(40) 47(55) 90(5) 0	100	124.00

(cont.)

Table B.76 continued.

	Route	Load	Distance
34	0 23(20) 31(60) 39(20) 0	100	100.00
35	0 15(60) 23(40) 0	100	60.00
36	0 8(40) 7(60) 0	100	34.14
37	97(0) 81(10) 89(90) 97(0)	100	169.71
38	97(0) 73(20) 81(80) 97(0)	100	141.42
39	97(0) 65(30) 73(70) 97(0)	100	113.14
40	97(0) 57(40) 65(60) 97(0)	100	84.85
41	97(0) 49(50) 57(50) 97(0)	100	56.57
42	97(0) 82(40) 90(60) 97(0)	100	120.00
43	97(0) 66(20) 74(60) 82(20) 97(0)	100	100.00
44	97(0) 58(60) 66(40) 97(0)	100	60.00
45	97(0) 49(40) 50(60) 97(0)	100	34.14
46	97(0) 83(10) 91(90) 97(0)	100	169.71
47	97(0) 75(20) 83(80) 97(0)	100	141.42
48	97(0) 67(30) 75(70) 97(0)	100	113.14
49	97(0) 59(40) 67(60) 97(0)	100	84.85
50	97(0) 51(50) 59(50) 97(0)	100	56.57
51	97(0) 85(40) 93(60) 97(0)	100	120.00
52	97(0) 69(20) 77(60) 85(20) 97(0)	100	100.00
53	97(0) 61(60) 69(40) 97(0)	100	60.00
54	97(0) 51(40) 53(60) 97(0)	100	34.14
55	97(0) 86(10) 94(90) 97(0)	100	169.71
56	97(0) 78(20) 86(80) 97(0)	100	141.42
57	97(0) 70(30) 78(70) 97(0)	100	113.14
58	97(0) 62(40) 70(60) 97(0)	100	84.85
59	97(0) 54(50) 62(50) 97(0)	100	56.57
60	97(0) 84(40) 92(60) 97(0)	100	120.00
61	97(0) 68(20) 76(60) 84(20) 97(0)	100	100.00
62	97(0) 60(60) 68(40) 97(0)	100	60.00
63	97(0) 54(40) 52(60) 97(0)	100	34.14
64	97(0) 88(10) 96(90) 97(0)	100	169.71
65	97(0) 80(20) 88(80) 97(0)	100	141.42
66	97(0) 72(30) 80(70) 97(0)	100	113.14

(cont.)

Table B.76 continued.

	Route	Load	Distance
67	97(0) 64(40) 72(60) 97(0)	100	84.85
68	97(0) 56(50) 64(50) 97(0)	100	56.57
69	97(0) 87(40) 95(60) 97(0)	100	120.00
70	97(0) 71(20) 79(60) 87(20) 97(0)	100	100.00
71	97(0) 63(60) 71(40) 97(0)	100	60.00
72	97(0) 56(40) 55(60) 97(0)	100	34.14
		Total Distance	7050.62

Table B.77: Estimated solution to SQ10.

	Route	Load	Distance
1	0 33(10) 41(90) 0	100	169.71
2	0 25(20) 33(80) 0	100	141.42
3	0 17(30) 25(70) 0	100	113.14
4	0 9(40) 17(60) 0	100	84.85
5	0 1(50) 9(50) 0	100	56.57
6	0 34(40) 42(60) 0	100	120.00
7	0 18(20) 26(60) 34(20) 0	100	100.00
8	0 10(60) 18(40) 0	100	60.00
9	0 1(40) 2(60) 0	100	34.14
10	0 35(10) 43(90) 0	100	169.71
11	0 27(20) 35(80) 0	100	141.42
12	0 19(30) 27(70) 0	100	113.14
13	0 11(40) 19(60) 0	100	84.85
14	0 3(50) 11(50) 0	100	56.57
15	0 37(40) 45(60) 0	100	120.00
16	0 21(20) 29(60) 37(20) 0	100	100.00
17	0 13(60) 21(40) 0	100	60.00
18	0 3(40) 5(60) 0	100	34.14
19	0 38(10) 46(85) 89(5) 46(0) 0	100	173.71
20	0 30(20) 38(80) 0	100	141.42
21	0 22(30) 30(70) 0	100	113.14
22	0 14(40) 22(60) 0	100	84.85
23	0 6(50) 14(50) 0	100	56.57
24	0 36(40) 44(60) 0	100	120.00
25	0 20(20) 28(60) 36(20) 0	100	100.00
26	0 12(60) 20(40) 0	100	60.00
27	0 6(40) 4(60) 0	100	34.14
28	0 40(10) 48(85) 91(5) 48(0) 0	100	173.71
29	0 32(20) 40(80) 0	100	141.42
30	0 24(30) 32(70) 0	100	113.14
31	0 16(40) 24(60) 0	100	84.85
32	0 8(50) 16(50) 0	100	56.57
33	0 39(40) 47(55) 90(5) 0	100	124.00

(cont.)

Table B.77 continued.

	Route	Load	Distance
34	0 23(20) 31(60) 39(20) 0	100	100.00
35	0 15(60) 23(40) 0	100	60.00
36	0 8(40) 7(60) 0	100	34.14
37	145(0) 81(10) 89(90) 145(0)	100	169.71
38	145(0) 73(20) 81(80) 145(0)	100	141.42
39	145(0) 65(30) 73(70) 145(0)	100	113.14
40	145(0) 57(40) 65(60) 145(0)	100	84.85
41	145(0) 49(50) 57(50) 145(0)	100	56.57
42	145(0) 82(40) 90(60) 145(0)	100	120.00
43	145(0) 66(20) 74(60) 82(20) 145(0)	100	100.00
44	145(0) 58(60) 66(40) 145(0)	100	60.00
45	145(0) 49(40) 50(60) 145(0)	100	34.14
46	145(0) 83(10) 91(90) 145(0)	100	169.71
47	145(0) 75(20) 83(80) 145(0)	100	141.42
48	145(0) 67(30) 75(70) 145(0)	100	113.14
49	145(0) 59(40) 67(60) 145(0)	100	84.85
50	145(0) 51(50) 59(50) 145(0)	100	56.57
51	145(0) 85(40) 93(60) 145(0)	100	120.00
52	145(0) 69(20) 77(60) 85(20) 145(0)	100	100.00
53	145(0) 61(60) 69(40) 145(0)	100	60.00
54	145(0) 51(40) 53(60) 145(0)	100	34.14
55	145(0) 86(10) 94(90) 145(0)	100	169.71
56	145(0) 78(20) 86(80) 145(0)	100	141.42
57	145(0) 70(30) 78(70) 145(0)	100	113.14
58	145(0) 62(40) 70(60) 145(0)	100	84.85
59	145(0) 54(50) 62(50) 145(0)	100	56.57
60	145(0) 84(40) 92(60) 145(0)	100	120.00
61	145(0) 68(20) 76(60) 84(20) 145(0)	100	100.00
62	145(0) 60(60) 68(40) 145(0)	100	60.00
63	145(0) 54(40) 52(60) 145(0)	100	34.14
64	145(0) 88(10) 96(90) 145(0)	100	169.71
65	145(0) 80(20) 88(80) 145(0)	100	141.42
66	145(0) 72(30) 80(70) 145(0)	100	113.14

(cont.)

Table B.77 continued.

	Route	Load	Distance
67	145(0) 64(40) 72(60) 145(0)	100	84.85
68	145(0) 56(50) 64(50) 145(0)	100	56.57
69	145(0) 87(40) 95(60) 145(0)	100	120.00
70	145(0) 71(20) 79(60) 87(20) 145(0)	100	100.00
71	145(0) 63(60) 71(40) 145(0)	100	60.00
72	145(0) 56(40) 55(60) 145(0)	100	34.14
73	146(0) 129(10) 137(90) 146(0)	100	169.71
74	146(0) 121(20) 129(80) 146(0)	100	141.42
75	146(0) 113(30) 121(70) 146(0)	100	113.14
76	146(0) 105(40) 113(60) 146(0)	100	84.85
77	146(0) 97(50) 105(50) 146(0)	100	56.57
78	146(0) 130(40) 138(60) 146(0)	100	120.00
79	146(0) 114(20) 122(60) 130(20) 146(0)	100	100.00
80	146(0) 106(60) 114(40) 146(0)	100	60.00
81	146(0) 97(40) 98(60) 146(0)	100	34.14
82	146(0) 131(10) 139(90) 146(0)	100	169.71
83	146(0) 123(20) 131(80) 146(0)	100	141.42
84	146(0) 115(30) 123(70) 146(0)	100	113.14
85	146(0) 107(40) 115(60) 146(0)	100	84.85
86	146(0) 99(50) 107(50) 146(0)	100	56.57
87	146(0) 133(40) 141(60) 146(0)	100	120.00
88	146(0) 117(20) 125(60) 133(20) 146(0)	100	100.00
89	146(0) 109(60) 117(40) 146(0)	100	60.00
90	146(0) 99(40) 101(60) 146(0)	100	34.14
91	146(0) 134(10) 142(85) 96(5) 142(0) 146(0)	100	173.71
92	146(0) 126(20) 134(80) 146(0)	100	141.42
93	146(0) 118(30) 126(70) 146(0)	100	113.14
94	146(0) 110(40) 118(60) 146(0)	100	84.85
95	146(0) 102(50) 110(50) 146(0)	100	56.57
96	146(0) 132(40) 140(55) 93(5) 146(0)	100	124.00
97	146(0) 116(20) 124(60) 132(20) 146(0)	100	100.00
98	146(0) 108(60) 116(40) 146(0)	100	60.00
99	146(0) 102(40) 100(60) 146(0)	100	34.14

(cont.)

Table B.77 continued.

	Route	Load	Distance
100	146(0) 136(10) 144(90) 146(0)	100	169.71
101	146(0) 128(20) 136(80) 146(0)	100	141.42
102	146(0) 120(30) 128(70) 146(0)	100	113.14
103	146(0) 112(40) 120(60) 146(0)	100	84.85
104	146(0) 104(50) 112(50) 146(0)	100	56.57
105	146(0) 135(40) 143(60) 146(0)	100	120.00
106	146(0) 119(20) 127(60) 135(20) 146(0)	100	100.00
107	146(0) 111(60) 119(40) 146(0)	100	60.00
108	146(0) 104(40) 103(60) 146(0)	100	34.14
		Total Distance	10577.93

Table B.78: Estimated solution to SQ11.

	Route	Load	Distance
1	0 33(10) 41(90) 0	100	169.71
2	0 25(20) 33(80) 0	100	141.42
3	0 17(30) 25(70) 0	100	113.14
4	0 9(40) 17(60) 0	100	84.85
5	0 1(50) 9(50) 0	100	56.57
6	0 34(40) 42(60) 0	100	120.00
7	0 18(20) 26(60) 34(20) 0	100	100.00
8	0 10(60) 18(40) 0	100	60.00
9	0 1(40) 2(60) 0	100	34.14
10	0 35(10) 43(85) 185(5) 43(0) 0	100	173.71
11	0 27(20) 35(80) 0	100	141.42
12	0 19(30) 27(70) 0	100	113.14
13	0 11(40) 19(60) 0	100	84.85
14	0 3(50) 11(50) 0	100	56.57
15	0 37(40) 45(55) 188(5) 0	100	124.00
16	0 21(20) 29(60) 37(20) 0	100	100.00
17	0 13(60) 21(40) 0	100	60.00
18	0 3(40) 5(60) 0	100	34.14
19	0 38(10) 46(85) 89(5) 46(0) 0	100	173.71
20	0 30(20) 38(80) 0	100	141.42
21	0 22(30) 30(70) 0	100	113.14
22	0 14(40) 22(60) 0	100	84.85
23	0 6(50) 14(50) 0	100	56.57
24	0 36(40) 44(60) 0	100	120.00
25	0 20(20) 28(60) 36(20) 0	100	100.00
26	0 12(60) 20(40) 0	100	60.00
27	0 6(40) 4(60) 0	100	34.14
28	0 40(10) 48(85) 91(5) 48(0) 0	100	173.71
29	0 32(20) 40(80) 0	100	141.42
30	0 24(30) 32(70) 0	100	113.14
31	0 16(40) 24(60) 0	100	84.85
32	0 8(50) 16(50) 0	100	56.57
33	0 39(40) 47(55) 90(5) 0	100	124.00

(cont.)

Table B.78 continued.

	Route	Load	Distance
34	0 23(20) 31(60) 39(20) 0	100	100.00
35	0 15(60) 23(40) 0	100	60.00
36	0 8(40) 7(60) 0	100	34.14
37	193(0) 81(10) 89(90) 193(0)	100	169.71
38	193(0) 73(20) 81(80) 193(0)	100	141.42
39	193(0) 65(30) 73(70) 193(0)	100	113.14
40	193(0) 57(40) 65(60) 193(0)	100	84.85
41	193(0) 49(50) 57(50) 193(0)	100	56.57
42	193(0) 82(40) 90(60) 193(0)	100	120.00
43	193(0) 66(20) 74(60) 82(20) 193(0)	100	100.00
44	193(0) 58(60) 66(40) 193(0)	100	60.00
45	193(0) 49(40) 50(60) 193(0)	100	34.14
46	193(0) 83(10) 91(90) 193(0)	100	169.71
47	193(0) 75(20) 83(80) 193(0)	100	141.42
48	193(0) 67(30) 75(70) 193(0)	100	113.14
49	193(0) 59(40) 67(60) 193(0)	100	84.85
50	193(0) 51(50) 59(50) 193(0)	100	56.57
51	193(0) 85(40) 93(60) 193(0)	100	120.00
52	193(0) 69(20) 77(60) 85(20) 193(0)	100	100.00
53	193(0) 61(60) 69(40) 193(0)	100	60.00
54	193(0) 51(40) 53(60) 193(0)	100	34.14
55	193(0) 86(10) 94(90) 193(0)	100	169.71
56	193(0) 78(20) 86(80) 193(0)	100	141.42
57	193(0) 70(30) 78(70) 193(0)	100	113.14
58	193(0) 62(40) 70(60) 193(0)	100	84.85
59	193(0) 54(50) 62(50) 193(0)	100	56.57
60	193(0) 84(40) 92(60) 193(0)	100	120.00
61	193(0) 68(20) 76(60) 84(20) 193(0)	100	100.00
62	193(0) 60(60) 68(40) 193(0)	100	60.00
63	193(0) 54(40) 52(60) 193(0)	100	34.14
64	193(0) 88(10) 96(90) 193(0)	100	169.71
65	193(0) 80(20) 88(80) 193(0)	100	141.42
66	193(0) 72(30) 80(70) 193(0)	100	113.14

(cont.)

Table B.78 continued.

	Route	Load	Distance
67	193(0) 64(40) 72(60) 193(0)	100	84.85
68	193(0) 56(50) 64(50) 193(0)	100	56.57
69	193(0) 87(40) 95(60) 193(0)	100	120.00
70	193(0) 71(20) 79(60) 87(20) 193(0)	100	100.00
71	193(0) 63(60) 71(40) 193(0)	100	60.00
72	193(0) 56(40) 55(60) 193(0)	100	34.14
73	194(0) 129(10) 137(85) 190(5) 137(0) 194(0)	100	173.71
74	194(0) 121(20) 129(80) 194(0)	100	141.42
75	194(0) 113(30) 121(70) 194(0)	100	113.14
76	194(0) 105(40) 113(60) 194(0)	100	84.85
77	194(0) 97(50) 105(50) 194(0)	100	56.57
78	194(0) 130(40) 138(55) 191(5) 194(0)	100	124.00
79	194(0) 114(20) 122(60) 130(20) 194(0)	100	100.00
80	194(0) 106(60) 114(40) 194(0)	100	60.00
81	194(0) 97(40) 98(60) 194(0)	100	34.14
82	194(0) 131(10) 139(85) 192(5) 139(0) 194(0)	100	173.71
83	194(0) 123(20) 131(80) 194(0)	100	141.42
84	194(0) 115(30) 123(70) 194(0)	100	113.14
85	194(0) 107(40) 115(60) 194(0)	100	84.85
86	194(0) 99(50) 107(50) 194(0)	100	56.57
87	194(0) 133(40) 141(60) 194(0)	100	120.00
88	194(0) 117(20) 125(60) 133(20) 194(0)	100	100.00
89	194(0) 109(60) 117(40) 194(0)	100	60.00
90	194(0) 99(40) 101(60) 194(0)	100	34.14
91	194(0) 134(10) 142(85) 96(5) 142(0) 194(0)	100	173.71
92	194(0) 126(20) 134(80) 194(0)	100	141.42
93	194(0) 118(30) 126(70) 194(0)	100	113.14
94	194(0) 110(40) 118(60) 194(0)	100	84.85
95	194(0) 102(50) 110(50) 194(0)	100	56.57
96	194(0) 132(40) 140(55) 93(5) 194(0)	100	124.00
97	194(0) 116(20) 124(60) 132(20) 194(0)	100	100.00
98	194(0) 108(60) 116(40) 194(0)	100	60.00
99	194(0) 102(40) 100(60) 194(0)	100	34.14

(cont.)

Table B.78 continued.

	Route	Load	Distance
100	194(0) 136(10) 144(90) 194(0)	100	169.71
101	194(0) 128(20) 136(80) 194(0)	100	141.42
102	194(0) 120(30) 128(70) 194(0)	100	113.14
103	194(0) 112(40) 120(60) 194(0)	100	84.85
104	194(0) 104(50) 112(50) 194(0)	100	56.57
105	194(0) 135(40) 143(60) 194(0)	100	120.00
106	194(0) 119(20) 127(60) 135(20) 194(0)	100	100.00
107	194(0) 111(60) 119(40) 194(0)	100	60.00
108	194(0) 104(40) 103(60) 194(0)	100	34.14
109	195(0) 177(10) 185(90) 195(0)	100	169.71
110	195(0) 169(20) 177(80) 195(0)	100	141.42
111	195(0) 161(30) 169(70) 195(0)	100	113.14
112	195(0) 153(40) 161(60) 195(0)	100	84.85
113	195(0) 145(50) 153(50) 195(0)	100	56.57
114	195(0) 178(40) 186(60) 195(0)	100	120.00
115	195(0) 162(20) 170(60) 178(20) 195(0)	100	100.00
116	195(0) 154(60) 162(40) 195(0)	100	60.00
117	195(0) 145(40) 146(60) 195(0)	100	34.14
118	195(0) 179(10) 187(90) 195(0)	100	169.71
119	195(0) 171(20) 179(80) 195(0)	100	141.42
120	195(0) 163(30) 171(70) 195(0)	100	113.14
121	195(0) 155(40) 163(60) 195(0)	100	84.85
122	195(0) 147(50) 155(50) 195(0)	100	56.57
123	195(0) 181(40) 189(60) 195(0)	100	120.00
124	195(0) 165(20) 173(60) 181(20) 195(0)	100	100.00
125	195(0) 157(60) 165(40) 195(0)	100	60.00
126	195(0) 147(40) 149(60) 195(0)	100	34.14
127	195(0) 182(10) 190(90) 195(0)	100	169.71
128	195(0) 174(20) 182(80) 195(0)	100	141.42
129	195(0) 166(30) 174(70) 195(0)	100	113.14
130	195(0) 158(40) 166(60) 195(0)	100	84.85
131	195(0) 150(50) 158(50) 195(0)	100	56.57
132	195(0) 180(40) 188(60) 195(0)	100	120.00

(cont.)

Table B.78 continued.

	Route	Load	Distance
133	195(0) 164(20) 172(60) 180(20) 195(0)	100	100.00
134	195(0) 156(60) 164(40) 195(0)	100	60.00
135	195(0) 150(40) 148(60) 195(0)	100	34.14
136	195(0) 184(10) 192(90) 195(0)	100	169.71
137	195(0) 176(20) 184(80) 195(0)	100	141.42
138	195(0) 168(30) 176(70) 195(0)	100	113.14
139	195(0) 160(40) 168(60) 195(0)	100	84.85
140	195(0) 152(50) 160(50) 195(0)	100	56.57
141	195(0) 183(40) 191(60) 195(0)	100	120.00
142	195(0) 167(20) 175(60) 183(20) 195(0)	100	100.00
143	195(0) 159(60) 167(40) 195(0)	100	60.00
144	195(0) 152(40) 151(60) 195(0)	100	34.14
		Total Distance	14117.24

Table B.79: Estimated solution to SQ12.

	Route	Load	Distance
1	0 33(10) 41(90) 0	100	169.71
2	0 25(20) 33(80) 0	100	141.42
3	0 17(30) 25(70) 0	100	113.14
4	0 9(40) 17(60) 0	100	84.85
5	0 1(50) 9(50) 0	100	56.57
6	0 34(40) 42(60) 0	100	120.00
7	0 18(20) 26(60) 34(20) 0	100	100.00
8	0 10(60) 18(40) 0	100	60.00
9	0 1(40) 2(60) 0	100	34.14
10	0 35(10) 43(85) 185(5) 43(0) 0	100	173.71
11	0 27(20) 35(80) 0	100	141.42
12	0 19(30) 27(70) 0	100	113.14
13	0 11(40) 19(60) 0	100	84.85
14	0 3(50) 11(50) 0	100	56.57
15	0 37(40) 45(55) 188(5) 0	100	124.00
16	0 21(20) 29(60) 37(20) 0	100	100.00
17	0 13(60) 21(40) 0	100	60.00
18	0 3(40) 5(60) 0	100	34.14
19	0 38(10) 46(85) 89(5) 46(0) 0	100	173.71
20	0 30(20) 38(80) 0	100	141.42
21	0 22(30) 30(70) 0	100	113.14
22	0 14(40) 22(60) 0	100	84.85
23	0 6(50) 14(50) 0	100	56.57
24	0 36(40) 44(60) 0	100	120.00
25	0 20(20) 28(60) 36(20) 0	100	100.00
26	0 12(60) 20(40) 0	100	60.00
27	0 6(40) 4(60) 0	100	34.14
28	0 40(10) 48(85) 91(5) 48(0) 0	100	173.71
29	0 32(20) 40(80) 0	100	141.42
30	0 24(30) 32(70) 0	100	113.14
31	0 16(40) 24(60) 0	100	84.85
32	0 8(50) 16(50) 0	100	56.57
33	0 39(40) 47(55) 90(5) 0	100	124.00

(cont.)

Table B.79 continued.

	Route	Load	Distance
34	0 23(20) 31(60) 39(20) 0	100	100.00
35	0 15(60) 23(40) 0	100	60.00
36	0 8(40) 7(60) 0	100	34.14
37	241(0) 81(10) 89(90) 241(0)	100	169.71
38	241(0) 73(20) 81(80) 241(0)	100	141.42
39	241(0) 65(30) 73(70) 241(0)	100	113.14
40	241(0) 57(40) 65(60) 241(0)	100	84.85
41	241(0) 49(50) 57(50) 241(0)	100	56.57
42	241(0) 82(40) 90(60) 241(0)	100	120.00
43	241(0) 66(20) 74(60) 82(20) 241(0)	100	100.00
44	241(0) 58(60) 66(40) 241(0)	100	60.00
45	241(0) 49(40) 50(60) 241(0)	100	34.14
46	241(0) 83(10) 91(90) 241(0)	100	169.71
47	241(0) 75(20) 83(80) 241(0)	100	141.42
48	241(0) 67(30) 75(70) 241(0)	100	113.14
49	241(0) 59(40) 67(60) 241(0)	100	84.85
50	241(0) 51(50) 59(50) 241(0)	100	56.57
51	241(0) 85(40) 93(60) 241(0)	100	120.00
52	241(0) 69(20) 77(60) 85(20) 241(0)	100	100.00
53	241(0) 61(60) 69(40) 241(0)	100	60.00
54	241(0) 51(40) 53(60) 241(0)	100	34.14
55	241(0) 86(10) 94(90) 241(0)	100	169.71
56	241(0) 78(20) 86(80) 241(0)	100	141.42
57	241(0) 70(30) 78(70) 241(0)	100	113.14
58	241(0) 62(40) 70(60) 241(0)	100	84.85
59	241(0) 54(50) 62(50) 241(0)	100	56.57
60	241(0) 84(40) 92(60) 241(0)	100	120.00
61	241(0) 68(20) 76(60) 84(20) 241(0)	100	100.00
62	241(0) 60(60) 68(40) 241(0)	100	60.00
63	241(0) 54(40) 52(60) 241(0)	100	34.14
64	241(0) 88(10) 96(90) 241(0)	100	169.71
65	241(0) 80(20) 88(80) 241(0)	100	141.42
66	241(0) 72(30) 80(70) 241(0)	100	113.14

(cont.)

Table B.79 continued.

	Route	Load	Distance
67	241(0) 64(40) 72(60) 241(0)	100	84.85
68	241(0) 56(50) 64(50) 241(0)	100	56.57
69	241(0) 87(40) 95(60) 241(0)	100	120.00
70	241(0) 71(20) 79(60) 87(20) 241(0)	100	100.00
71	241(0) 63(60) 71(40) 241(0)	100	60.00
72	241(0) 56(40) 55(60) 241(0)	100	34.14
73	242(0) 129(10) 137(85) 190(5) 137(0) 242(0)	100	173.71
74	242(0) 121(20) 129(80) 242(0)	100	141.42
75	242(0) 113(30) 121(70) 242(0)	100	113.14
76	242(0) 105(40) 113(60) 242(0)	100	84.85
77	242(0) 97(50) 105(50) 242(0)	100	56.57
78	242(0) 130(40) 138(55) 191(5) 242(0)	100	124.00
79	242(0) 114(20) 122(60) 130(20) 242(0)	100	100.00
80	242(0) 106(60) 114(40) 242(0)	100	60.00
81	242(0) 97(40) 98(60) 242(0)	100	34.14
82	242(0) 131(10) 139(85) 192(5) 139(0) 242(0)	100	173.71
83	242(0) 123(20) 131(80) 242(0)	100	141.42
84	242(0) 115(30) 123(70) 242(0)	100	113.14
85	242(0) 107(40) 115(60) 242(0)	100	84.85
86	242(0) 99(50) 107(50) 242(0)	100	56.57
87	242(0) 133(40) 141(60) 242(0)	100	120.00
88	242(0) 117(20) 125(60) 133(20) 242(0)	100	100.00
89	242(0) 109(60) 117(40) 242(0)	100	60.00
90	242(0) 99(40) 101(60) 242(0)	100	34.14
91	242(0) 134(10) 142(90) 242(0)	100	169.71
92	242(0) 126(20) 134(80) 242(0)	100	141.42
93	242(0) 118(30) 126(70) 242(0)	100	113.14
94	242(0) 110(40) 118(60) 242(0)	100	84.85
95	242(0) 102(50) 110(50) 242(0)	100	56.57
96	242(0) 132(40) 140(55) 93(5) 242(0)	100	124.00
97	242(0) 116(20) 124(60) 132(20) 242(0)	100	100.00
98	242(0) 108(60) 116(40) 242(0)	100	60.00
99	242(0) 102(40) 100(60) 242(0)	100	34.14

(cont.)

Table B.79 continued.

	Route	Load	Distance
100	242(0) 136(10) 144(90) 242(0)	100	169.71
101	242(0) 128(20) 136(80) 242(0)	100	141.42
102	242(0) 120(30) 128(70) 242(0)	100	113.14
103	242(0) 112(40) 120(60) 242(0)	100	84.85
104	242(0) 104(50) 112(50) 242(0)	100	56.57
105	242(0) 135(40) 143(60) 242(0)	100	120.00
106	242(0) 119(20) 127(60) 135(20) 242(0)	100	100.00
107	242(0) 111(60) 119(40) 242(0)	100	60.00
108	242(0) 104(40) 103(60) 242(0)	100	34.14
109	243(0) 177(10) 185(90) 243(0)	100	169.71
110	243(0) 169(20) 177(80) 243(0)	100	141.42
111	243(0) 161(30) 169(70) 243(0)	100	113.14
112	243(0) 153(40) 161(60) 243(0)	100	84.85
113	243(0) 145(50) 153(50) 243(0)	100	56.57
114	243(0) 178(40) 186(60) 243(0)	100	120.00
115	243(0) 162(20) 170(60) 178(20) 243(0)	100	100.00
116	243(0) 154(60) 162(40) 243(0)	100	60.00
117	243(0) 145(40) 146(60) 243(0)	100	34.14
118	243(0) 179(10) 187(90) 243(0)	100	169.71
119	243(0) 171(20) 179(80) 243(0)	100	141.42
120	243(0) 163(30) 171(70) 243(0)	100	113.14
121	243(0) 155(40) 163(60) 243(0)	100	84.85
122	243(0) 147(50) 155(50) 243(0)	100	56.57
123	243(0) 181(40) 189(60) 243(0)	100	120.00
124	243(0) 165(20) 173(60) 181(20) 243(0)	100	100.00
125	243(0) 157(60) 165(40) 243(0)	100	60.00
126	243(0) 147(40) 149(60) 243(0)	100	34.14
127	243(0) 182(10) 190(90) 243(0)	100	169.71
128	243(0) 174(20) 182(80) 243(0)	100	141.42
129	243(0) 166(30) 174(70) 243(0)	100	113.14
130	243(0) 158(40) 166(60) 243(0)	100	84.85
131	243(0) 150(50) 158(50) 243(0)	100	56.57
132	243(0) 180(40) 188(60) 243(0)	100	120.00

(cont.)

Table B.79 continued.

	Route	Load	Distance
133	243(0) 164(20) 172(60) 180(20) 243(0)	100	100.00
134	243(0) 156(60) 164(40) 243(0)	100	60.00
135	243(0) 150(40) 148(60) 243(0)	100	34.14
136	243(0) 184(10) 192(90) 243(0)	100	169.71
137	243(0) 176(20) 184(80) 243(0)	100	141.42
138	243(0) 168(30) 176(70) 243(0)	100	113.14
139	243(0) 160(40) 168(60) 243(0)	100	84.85
140	243(0) 152(50) 160(50) 243(0)	100	56.57
141	243(0) 183(40) 191(60) 243(0)	100	120.00
142	243(0) 167(20) 175(60) 183(20) 243(0)	100	100.00
143	243(0) 159(60) 167(40) 243(0)	100	60.00
144	243(0) 152(40) 151(60) 243(0)	100	34.14
145	244(0) 225(10) 233(85) 94(5) 233(0) 244(0)	100	173.71
146	244(0) 217(20) 225(80) 244(0)	100	141.42
147	244(0) 209(30) 217(70) 244(0)	100	113.14
148	244(0) 201(40) 209(60) 244(0)	100	84.85
149	244(0) 193(50) 201(50) 244(0)	100	56.57
150	244(0) 226(40) 234(55) 95(5) 244(0)	100	124.00
151	244(0) 210(20) 218(60) 226(20) 244(0)	100	100.00
152	244(0) 202(60) 210(40) 244(0)	100	60.00
153	244(0) 193(40) 194(60) 244(0)	100	34.14
154	244(0) 227(10) 235(85) 96(5) 235(0) 244(0)	100	173.71
155	244(0) 219(20) 227(80) 244(0)	100	141.42
156	244(0) 211(30) 219(70) 244(0)	100	113.14
157	244(0) 203(40) 211(60) 244(0)	100	84.85
158	244(0) 195(50) 203(50) 244(0)	100	56.57
159	244(0) 229(40) 237(60) 244(0)	100	120.00
160	244(0) 213(20) 221(60) 229(20) 244(0)	100	100.00
161	244(0) 205(60) 213(40) 244(0)	100	60.00
162	244(0) 195(40) 197(60) 244(0)	100	34.14
163	244(0) 230(10) 238(90) 244(0)	100	169.71
164	244(0) 222(20) 230(80) 244(0)	100	141.42
165	244(0) 214(30) 222(70) 244(0)	100	113.14

(cont.)

Table B.79 continued.

	Route	Load	Distance
166	244(0) 206(40) 214(60) 244(0)	100	84.85
167	244(0) 198(50) 206(50) 244(0)	100	56.57
168	244(0) 228(40) 236(60) 244(0)	100	120.00
169	244(0) 212(20) 220(60) 228(20) 244(0)	100	100.00
170	244(0) 204(60) 212(40) 244(0)	100	60.00
171	244(0) 198(40) 196(60) 244(0)	100	34.14
172	244(0) 232(10) 240(90) 244(0)	100	169.71
173	244(0) 224(20) 232(80) 244(0)	100	141.42
174	244(0) 216(30) 224(70) 244(0)	100	113.14
175	244(0) 208(40) 216(60) 244(0)	100	84.85
176	244(0) 200(50) 208(50) 244(0)	100	56.57
177	244(0) 231(40) 239(60) 244(0)	100	120.00
178	244(0) 215(20) 223(60) 231(20) 244(0)	100	100.00
179	244(0) 207(60) 215(40) 244(0)	100	60.00
180	244(0) 200(40) 199(60) 244(0)	100	34.14
		Total Distance	17644.55

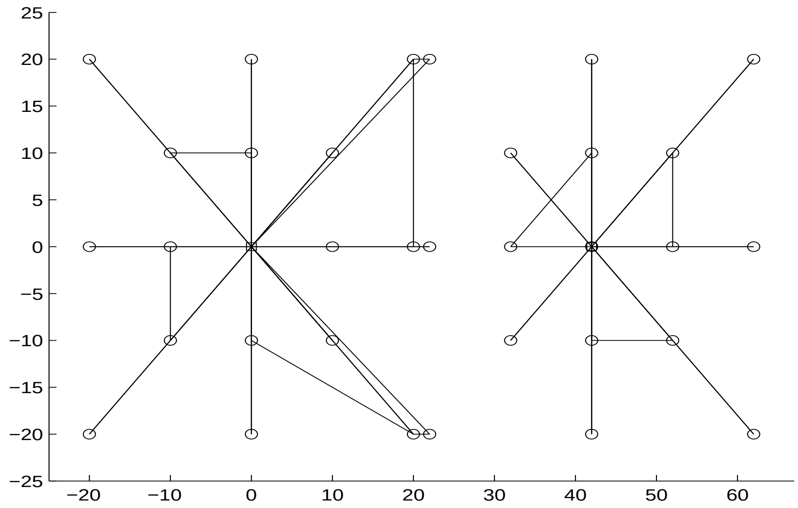


Figure B.1: IDH solution to SQ1.

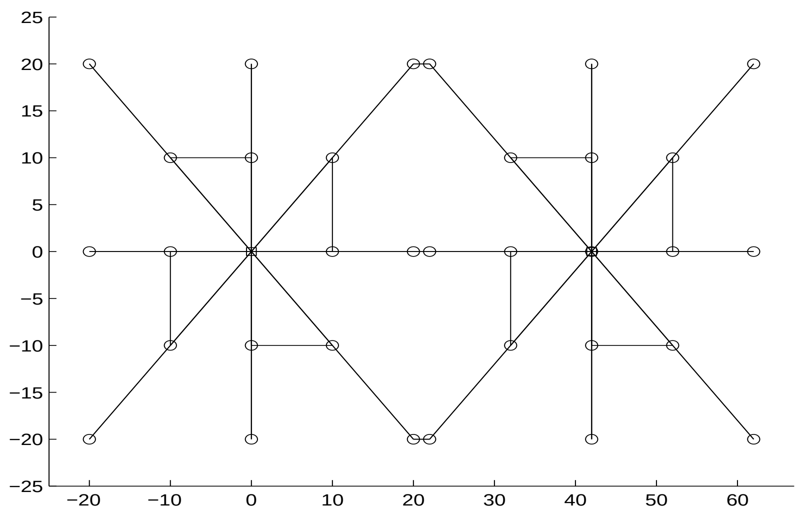


Figure B.2: Estimated solution to SQ1.

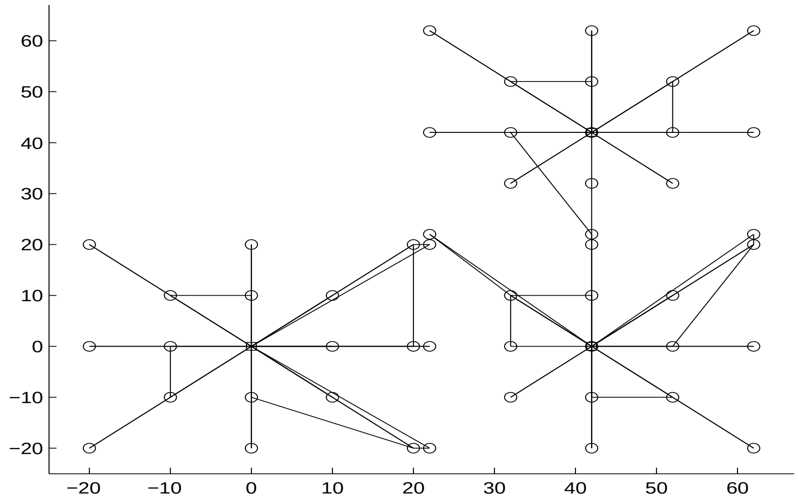


Figure B.3: IDH solution to SQ2.

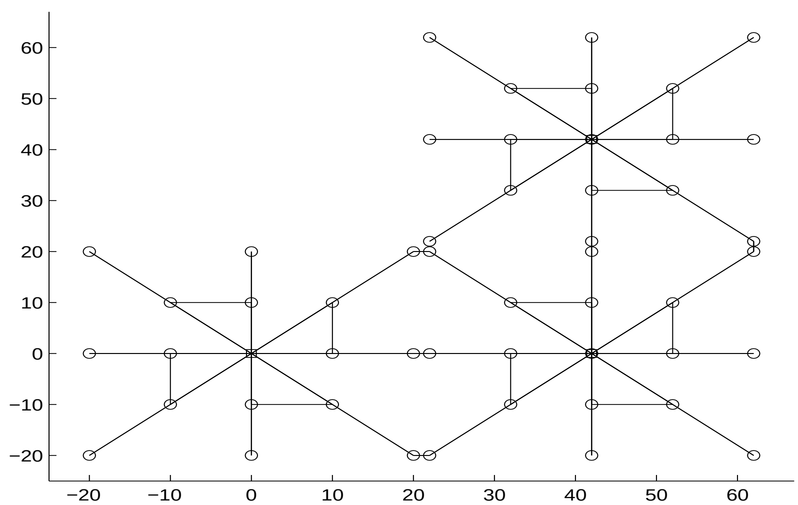


Figure B.4: Estimated solution to SQ2.

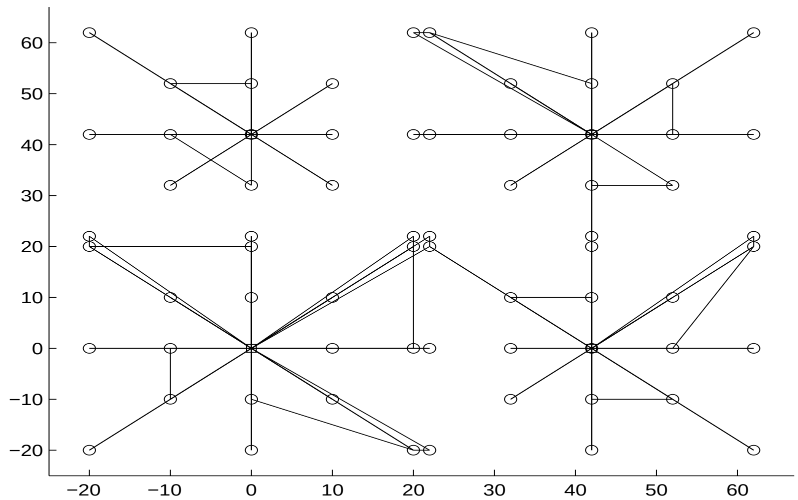


Figure B.5: IDH solution to SQ3.

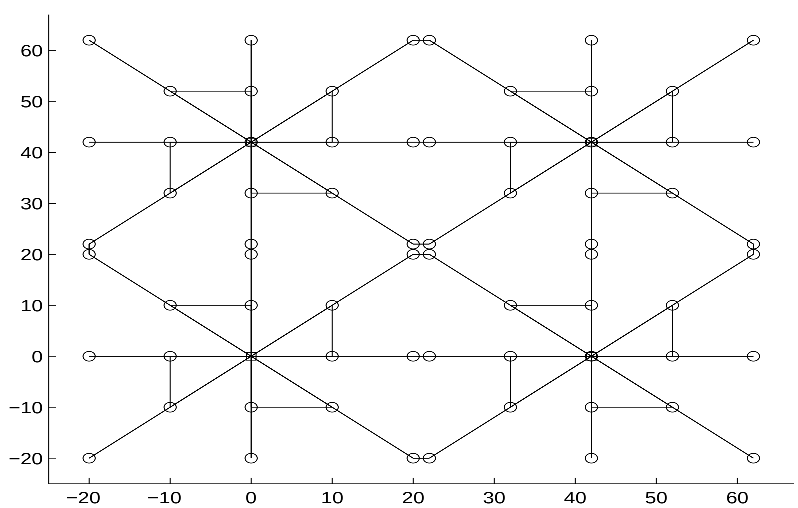


Figure B.6: Estimated solution to SQ3.

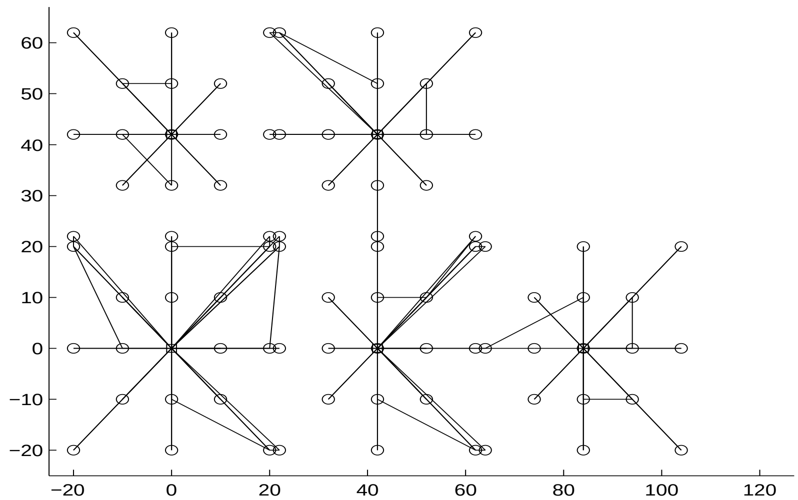


Figure B.7: IDH solution to SQ4.

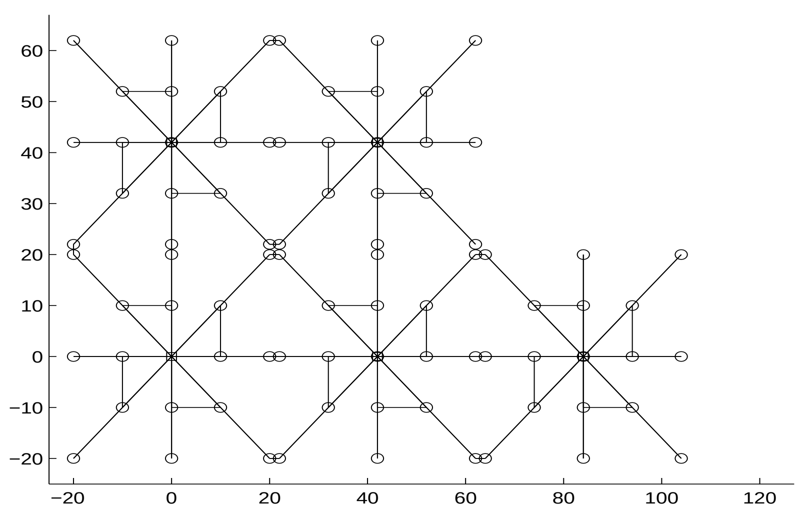


Figure B.8: Estimated solution to SQ4.

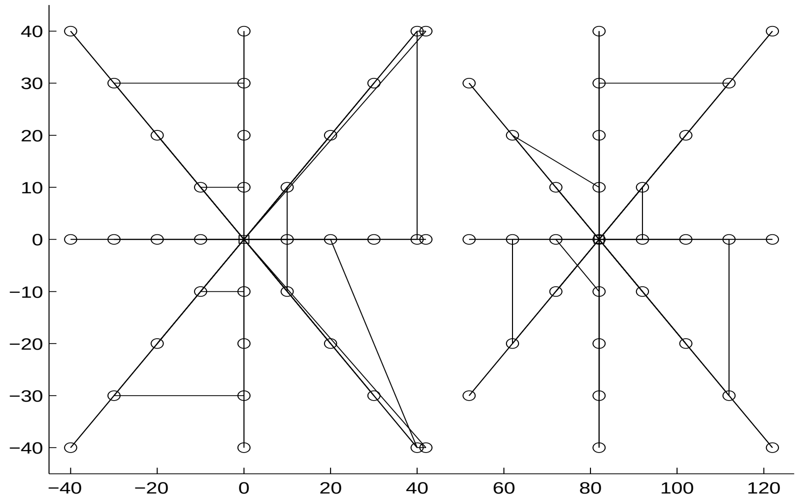


Figure B.9: IDH solution to SQ5.

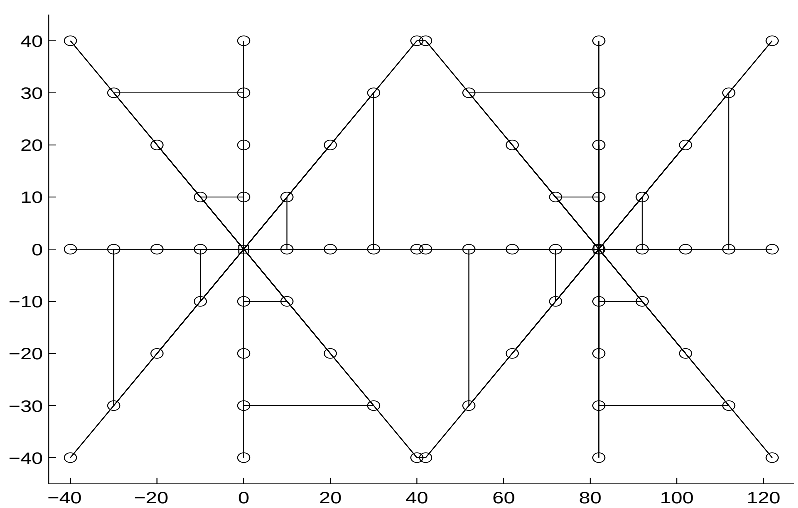


Figure B.10: Estimated solution to SQ5.

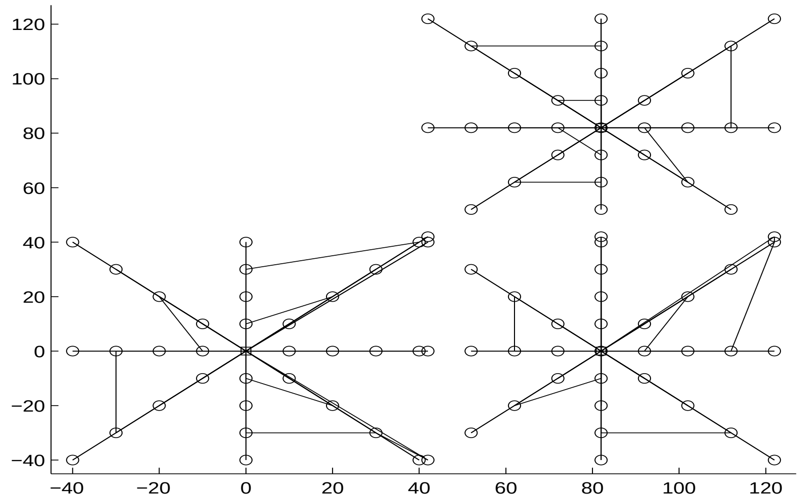


Figure B.11: IDH solution to SQ6.

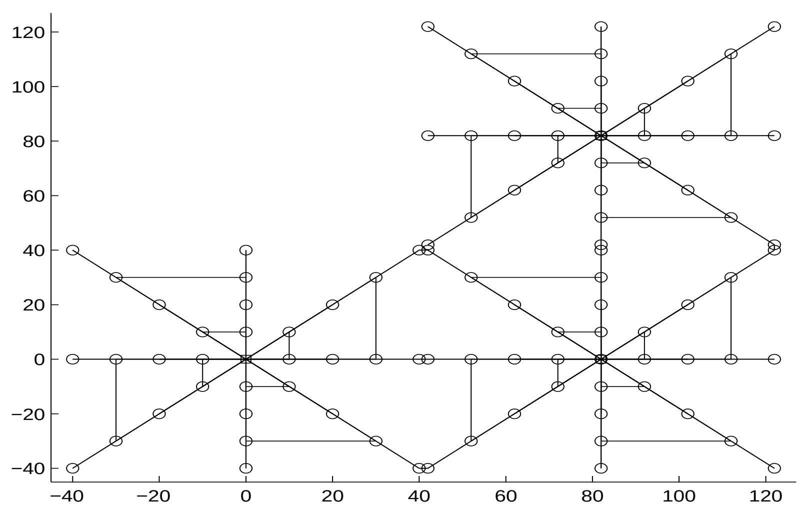


Figure B.12: Estimated solution to SQ6.

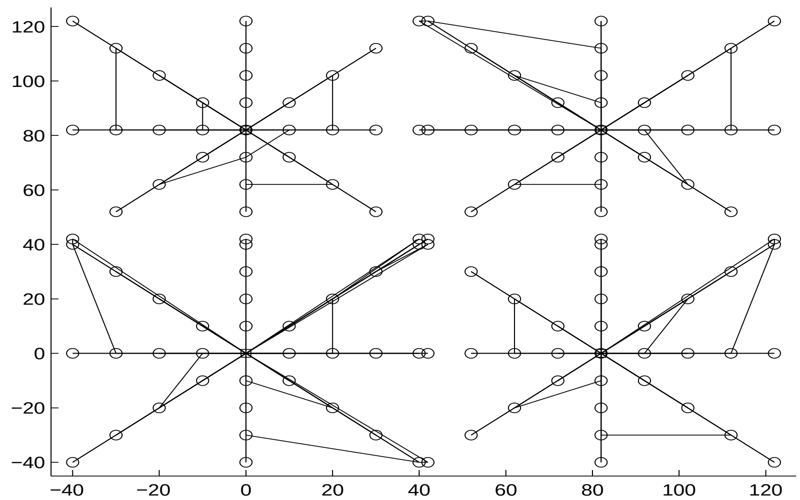


Figure B.13: IDH solution to SQ7.

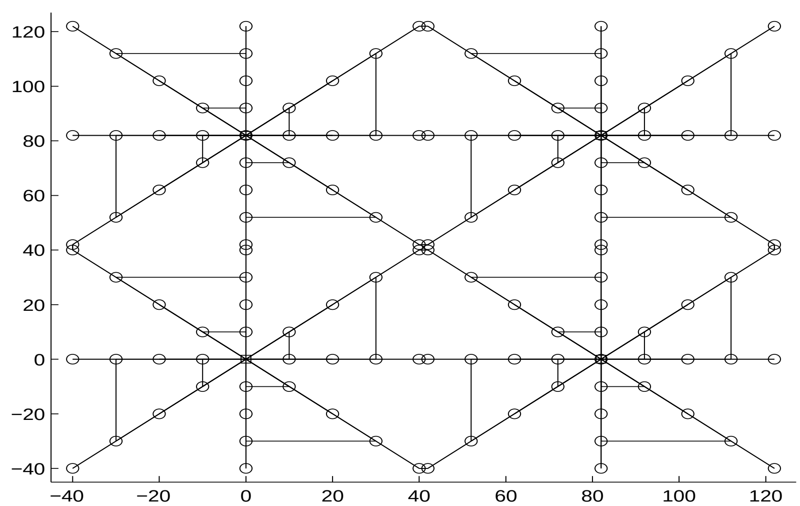


Figure B.14: Estimated solution to SQ7.

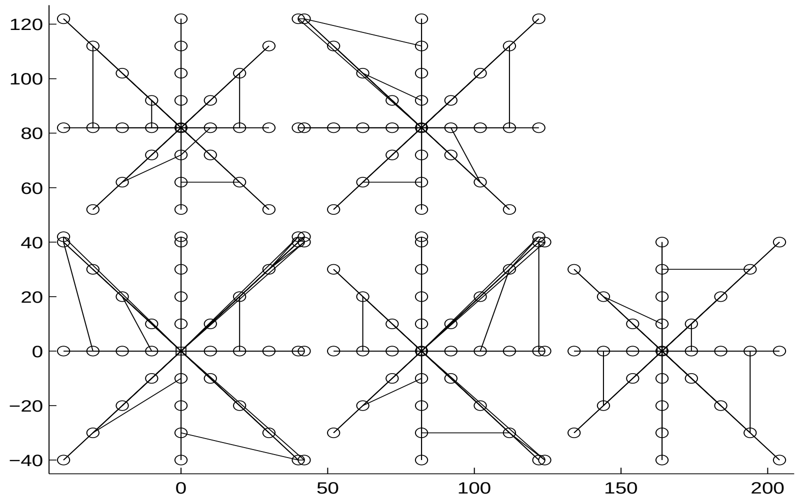


Figure B.15: IDH solution to SQ8.

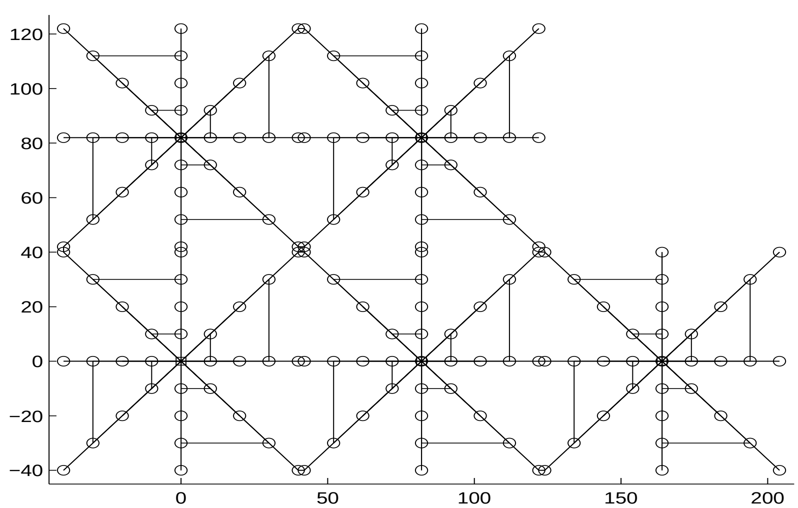


Figure B.16: Estimated solution to SQ8.

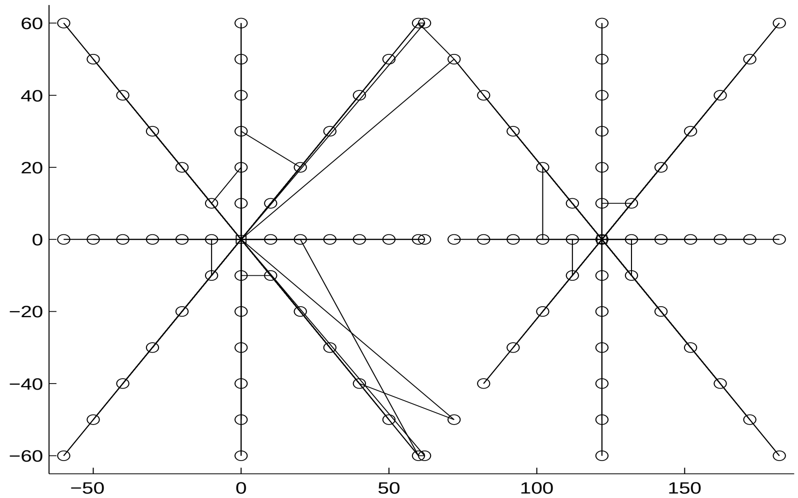


Figure B.17: IDH solution to SQ9.

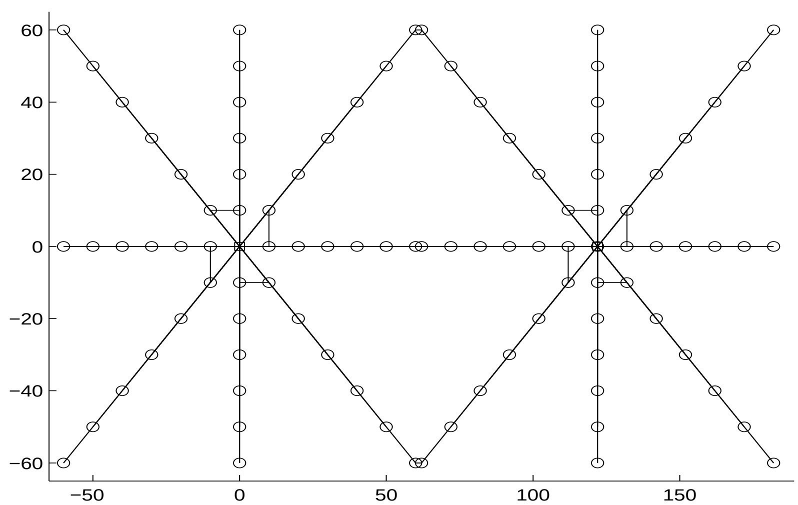


Figure B.18: Estimated solution to SQ9.

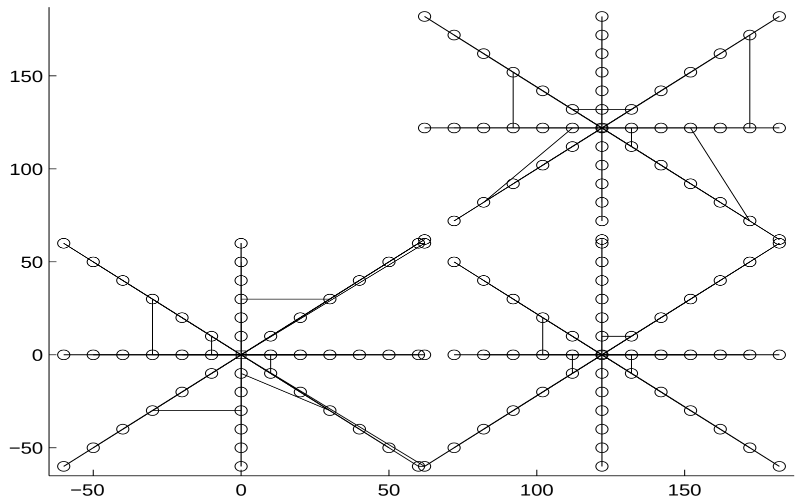


Figure B.19: IDH solution to SQ10.

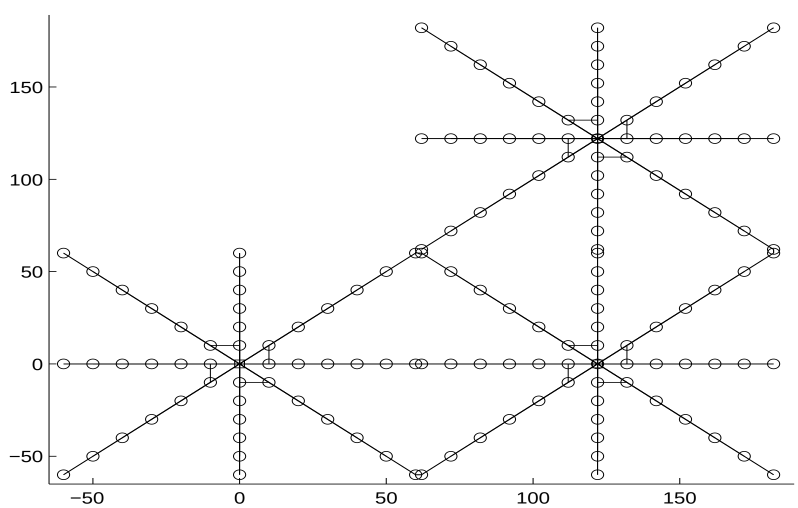


Figure B.20: Estimated solution to SQ10.

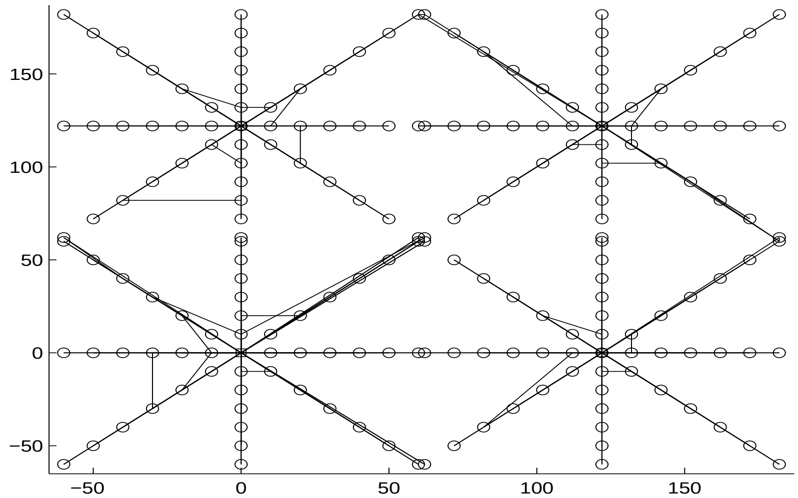


Figure B.21: IDH solution to SQ11.

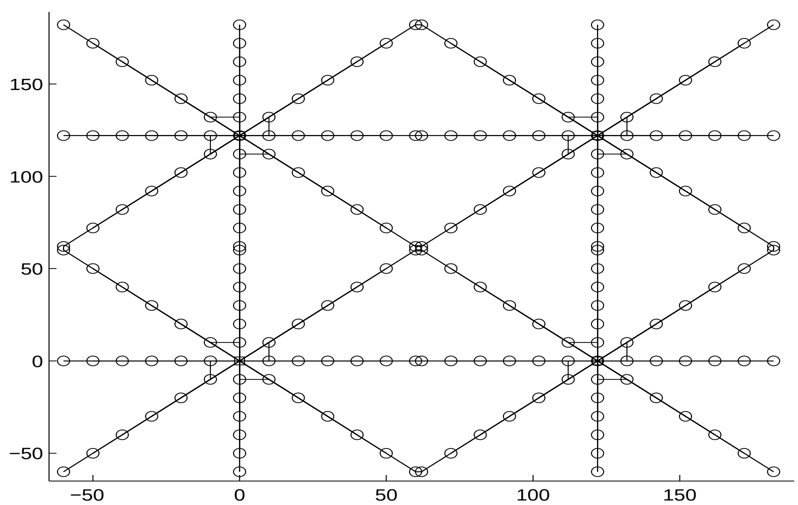


Figure B.22: Estimated solution to SQ11.

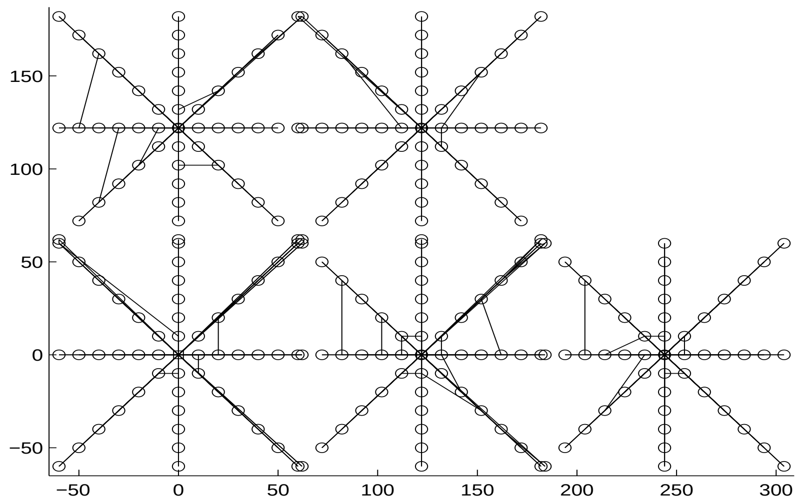


Figure B.23: IDH solution to SQ12.

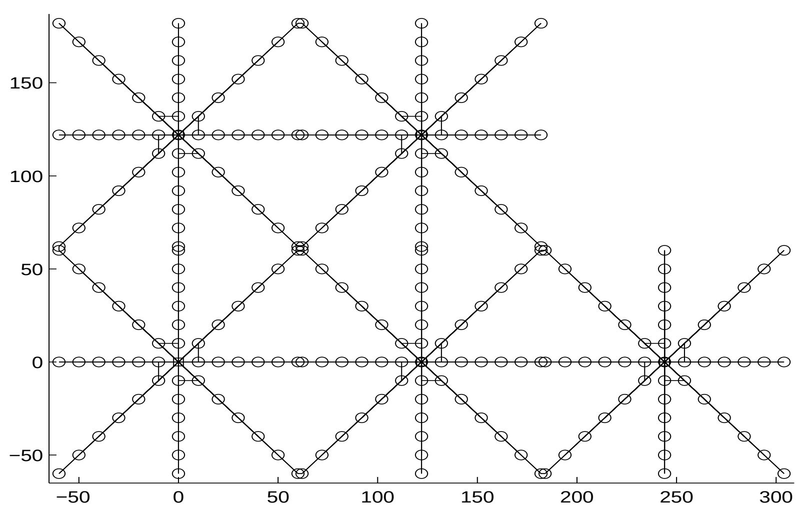


Figure B.24: Estimated solution to SQ12.

Appendix C

PVRP: Problems and Solutions

Table C.1: Symbol key.

N	Number of customers in a problem
P	Number of days in the time period
K	Number of vehicles
Q	Vehicle capacity
No.	Customer or route number
x	x-coordinate of a node's location
y	y-coordinate of a node's location
q	Customer demand
f	Customer frequency
W	Maximum number of customer reassignments

Note: node 0 is the depot.

Table C.2: Dimensions for 13 PVRPs.

Problem	N	P	K	Q	Allowable Patterns
P1	50	2	3	160	1,2
P2	50	5	3	160	1,2,3,4,5,11,12,13,28
P3	50	5	1	160	1,2,3,4,5
P4	75	2	5	140	1,2
P5	75	5	6	140	1,2,3,4,5,11,12,13,28
P6	75	10	1	140	1,2,3,4,5,6,7,8,9,10
P7	100	2	4	200	1,2
P8	100	5	5	200	1,2,3,4,5,11,12,13,28
P9	100	8	1	200	1,2,3,4,5,6,7,8
P10	100	5	4	200	1,2,3,4,5,11,12,13,17,18,19
P11	131	5	4	235	1,2,3,4,5,11,12,13,14,15,16,17, 18,19,20,21,22,23,24,25,26,27,28
P12	163	5	3	140	1,2,3,4,5,11,12,13,17,18,19
P13	417	7	9	2000	1,2,3,4,5,6,7,29,30,31,32,33,34,35

(cont.)

Table C.2 continued.

	Day									
Pattern	1	2	3	4	5	6	7	8	9	10
1	×									
2		×								
3			×							
4				×						
5					×					
6						×				
7							×			
8								×		
9									×	
10										×
11	×		×							
12		×		×						
13			×		×					
14	×			×						
15	×				×					
16		×			×					
17	×		×		×					
18	×	×		×						
19		×		×	×					
20	×	×			×					
21	×		×	×						
22		×	×		×					
23	×	×	×	×						
24	×	×	×		×					
25	×	×		×	×					
26	×		×	×	×					
27		×	×	×	×					
28	×	×	×	×	×					
29	×			×						
30	×				×					
31		×			×					
32		×				×				
33			×			×				
34			×				×			
35				×			×			

Table C.3: Dimensions for 19 PVRPs.

Problem	N	P	K	Q	Allowable Patterns
P14	20	4	2	20	1,2,3,4,7,8,12
P15	38	4	2	30	1,2,3,4,7,8,12
P16	56	4	2	40	1,2,3,4,7,8,12
P17	40	4	4	20	1,2,3,4,7,8,12
P18	76	4	4	30	1,2,3,4,7,8,12
P19	112	4	4	40	1,2,3,4,7,8,12
P20	184	4	4	60	1,2,3,4,7,8,12
P21	60	4	6	20	1,2,3,4,7,8,12
P22	114	4	6	30	1,2,3,4,7,8,12
P23	168	4	6	40	1,2,3,4,7,8,12
P24	51	6	3	20	1,2,3,4,5,6,9,10,11,13
P25	51	6	3	20	1,2,3,4,5,6,9,10,11,13
P26	51	6	3	20	1,2,3,4,5,6,9,10,11,13
P27	102	6	6	20	1,2,3,4,5,6,9,10,11,13
P28	102	6	6	20	1,2,3,4,5,6,9,10,11,13
P29	102	6	6	20	1,2,3,4,5,6,9,10,11,13
P30	153	6	9	20	1,2,3,4,5,6,9,10,11,13
P31	153	6	9	20	1,2,3,4,5,6,9,10,11,13
P32	153	6	9	20	1,2,3,4,5,6,9,10,11,13

	Day					
Pattern	1	2	3	4	5	6
1	×					
2		×				
3			×			
4				×		
5					×	
6						×
7	×		×			
8		×		×		
9	×			×		
10		×			×	
11			×			×
12	×	×	×	×		
13	×	×	×	×	×	×

Table C.4: Node locations, demands, and frequencies for P1–P3.

No.	x	y	q	f	No.	x	y	q	f	No.	x	y	q	f
0	30.00	40.00	0	0	17	27.00	23.00	3	1	34	61.00	33.00	26	5
1	37.00	52.00	7	1	18	17.00	33.00	41	5	35	62.00	63.00	17	2
2	49.00	49.00	30	5	19	13.00	13.00	9	1	36	63.00	69.00	6	1
3	52.00	64.00	16	2	20	57.00	58.00	28	5	37	32.00	22.00	9	1
4	20.00	26.00	9	1	21	62.00	42.00	8	1	38	45.00	35.00	15	2
5	40.00	30.00	21	2	22	42.00	57.00	8	1	39	59.00	15.00	14	2
6	21.00	47.00	15	2	23	16.00	57.00	16	2	40	5.00	6.00	7	1
7	17.00	63.00	19	2	24	8.00	52.00	10	1	41	10.00	17.00	27	5
8	31.00	62.00	23	2	25	7.00	38.00	28	5	42	21.00	10.00	13	2
9	52.00	33.00	11	2	26	27.00	68.00	7	1	43	5.00	64.00	11	2
10	51.00	21.00	5	1	27	30.00	48.00	15	2	44	30.00	15.00	16	2
11	42.00	41.00	19	2	28	43.00	67.00	14	2	45	39.00	10.00	10	1
12	31.00	32.00	29	5	29	58.00	48.00	6	1	46	32.00	39.00	5	1
13	5.00	25.00	23	2	30	58.00	27.00	19	2	47	25.00	32.00	25	2
14	12.00	42.00	21	2	31	37.00	69.00	11	2	48	25.00	55.00	17	2
15	36.00	16.00	10	1	32	38.00	46.00	12	2	49	48.00	28.00	18	2
16	52.00	41.00	15	2	33	46.00	10.00	23	2	50	56.00	37.00	10	1

Note: for P1 and P3, $f = 1$ for all customers.

Table C.5: Node locations, demands, and frequencies for P4–P6.

No.	x	y	q	f	No.	x	y	q	f	No.	x	y	q	f
0	40.00	40.00	0	0	26	41.00	46.00	18	2	52	54.00	38.00	19	2
1	22.00	22.00	18	2	27	55.00	34.00	17	2	53	55.00	57.00	22	2
2	36.00	26.00	26	2	28	35.00	16.00	29	5	54	67.00	41.00	16	2
3	21.00	45.00	11	1	29	52.00	26.00	13	1	55	10.00	70.00	7	1
4	45.00	35.00	30	5	30	43.00	26.00	22	2	56	6.00	25.00	26	2
5	55.00	20.00	21	2	31	31.00	76.00	25	2	57	65.00	27.00	14	1
6	33.00	34.00	19	2	32	22.00	53.00	28	5	58	40.00	60.00	21	2
7	50.00	50.00	15	1	33	26.00	29.00	27	2	59	70.00	64.00	24	2
8	55.00	45.00	16	2	34	50.00	40.00	19	2	60	64.00	4.00	13	1
9	26.00	59.00	29	5	35	55.00	50.00	10	1	61	36.00	6.00	15	1
10	40.00	66.00	26	2	36	54.00	10.00	12	1	62	30.00	20.00	18	2
11	55.00	65.00	37	5	37	60.00	15.00	14	1	63	20.00	30.00	11	1
12	35.00	51.00	16	2	38	47.00	66.00	24	2	64	15.00	5.00	28	5
13	62.00	35.00	12	1	39	30.00	60.00	16	2	65	50.00	70.00	9	1
14	62.00	57.00	31	5	40	30.00	50.00	33	5	66	57.00	72.00	37	5
15	62.00	24.00	8	1	41	12.00	17.00	15	1	67	45.00	42.00	30	5
16	21.00	36.00	19	2	42	15.00	14.00	11	1	68	38.00	33.00	10	1
17	33.00	44.00	20	2	43	16.00	19.00	18	2	69	50.00	4.00	8	1
18	9.00	56.00	13	1	44	21.00	48.00	17	2	70	66.00	8.00	11	1
19	62.00	48.00	15	1	45	50.00	30.00	21	2	71	59.00	5.00	3	1
20	66.00	14.00	22	2	46	51.00	42.00	27	2	72	35.00	60.00	1	1
21	44.00	13.00	28	5	47	50.00	15.00	19	2	73	27.00	24.00	6	1
22	26.00	13.00	12	1	48	48.00	21.00	20	2	74	40.00	20.00	10	1
23	11.00	28.00	6	1	49	12.00	38.00	5	1	75	40.00	37.00	20	2
24	7.00	43.00	27	2	50	15.00	56.00	22	2					
25	17.00	64.00	14	1	51	29.00	39.00	12	1					

Note: for P4 and P6, $f = 1$ for all customers.

Table C.6: Node locations, demands, and frequencies for P7–P10.

No.	x	y	q	f	No.	x	y	q	f	No.	x	y	q	f
0	35.00	35.00	0	0	34	65.00	55.00	14	2	68	56.00	39.00	36	5
1	41.00	49.00	10	1	35	63.00	65.00	8	1	69	37.00	47.00	6	1
2	35.00	17.00	7	1	36	2.00	60.00	5	1	70	37.00	56.00	5	1
3	55.00	45.00	13	2	37	20.00	20.00	8	1	71	57.00	68.00	15	2
4	55.00	20.00	19	2	38	5.00	5.00	16	2	72	47.00	16.00	25	2
5	15.00	30.00	26	5	39	60.00	12.00	31	5	73	44.00	17.00	9	1
6	25.00	30.00	3	1	40	40.00	25.00	9	1	74	46.00	13.00	8	1
7	20.00	50.00	5	1	41	42.00	7.00	5	1	75	49.00	11.00	18	2
8	10.00	43.00	9	1	42	24.00	12.00	5	1	76	49.00	42.00	13	2
9	55.00	60.00	16	2	43	23.00	3.00	7	1	77	53.00	43.00	14	2
10	30.00	60.00	16	2	44	11.00	14.00	18	2	78	61.00	52.00	3	1
11	20.00	65.00	12	2	45	6.00	38.00	16	2	79	57.00	48.00	23	2
12	50.00	35.00	19	2	46	2.00	48.00	1	1	80	56.00	37.00	6	1
13	30.00	25.00	23	2	47	8.00	56.00	27	5	81	55.00	54.00	26	5
14	15.00	10.00	20	2	48	13.00	52.00	36	5	82	15.00	47.00	16	2
15	30.00	5.00	8	1	49	6.00	68.00	30	5	83	14.00	37.00	11	2
16	10.00	20.00	19	2	50	47.00	47.00	13	2	84	11.00	31.00	7	1
17	5.00	30.00	2	1	51	49.00	58.00	10	1	85	16.00	22.00	41	5
18	20.00	40.00	12	2	52	27.00	43.00	9	1	86	4.00	18.00	35	5
19	15.00	60.00	17	2	53	37.00	31.00	14	2	87	28.00	18.00	26	5
20	45.00	65.00	9	1	54	57.00	29.00	18	2	88	26.00	52.00	9	1
21	45.00	20.00	11	2	55	63.00	23.00	2	1	89	26.00	35.00	15	2
22	45.00	10.00	18	2	56	53.00	12.00	6	1	90	31.00	67.00	3	1
23	55.00	5.00	29	5	57	32.00	12.00	7	1	91	15.00	19.00	1	1
24	65.00	35.00	3	1	58	36.00	26.00	18	2	92	22.00	22.00	2	1
25	65.00	20.00	6	1	59	21.00	24.00	28	5	93	18.00	24.00	22	2
26	45.00	30.00	17	2	60	17.00	34.00	3	1	94	26.00	27.00	27	5
27	35.00	40.00	16	2	61	12.00	24.00	13	2	95	25.00	24.00	20	2
28	41.00	37.00	16	2	62	24.00	58.00	19	2	96	22.00	27.00	11	2
29	64.00	42.00	9	1	63	27.00	69.00	10	1	97	25.00	21.00	12	2
30	40.00	60.00	21	2	64	15.00	77.00	9	1	98	19.00	21.00	10	1
31	31.00	52.00	27	5	65	62.00	77.00	20	2	99	20.00	26.00	9	1
32	35.00	69.00	23	2	66	49.00	73.00	25	2	100	18.00	18.00	17	2
33	53.00	52.00	11	2	67	67.00	5.00	25	2					

Note: for P7 and P9, $f = 1$ for all customers, and for P10, $f = 5$ changes to $f = 3$.

Table C.7: Node locations, demands, and frequencies for P11.

No.	x	y	q	f	No.	x	y	q	f	No.	x	y	q	f
0	0.000	0.000	0	0	35	-4.469	-0.719	22	2	70	1.563	0.750	4	1
1	-20.656	-6.313	54	4	36	-11.906	-4.500	10	2	71	2.844	-4.938	8	1
2	17.781	0.075	10	5	37	-3.250	-1.906	33	2	72	7.875	-2.594	12	1
3	-9.156	-9.250	8	1	38	-2.281	2.156	7	2	73	-5.344	-1.563	16	1
4	-10.469	-6.875	105	2	39	-1.688	-4.594	21	2	74	-5.750	-4.500	10	1
5	-20.656	-6.031	26	4	40	7.563	-12.219	19	1	75	-11.625	-7.000	10	1
6	-8.156	-4.156	20	3	41	2.406	-5.500	12	1	76	-18.688	-7.094	8	1
7	-19.031	-6.063	9	3	42	3.281	-3.063	31	1	77	-10.094	-19.468	18	1
8	-14.219	-12.313	8	3	43	9.875	-3.063	10	1	78	-24.063	-17.500	2	1
9	-16.000	-17.218	24	3	44	15.250	-0.906	5	1	79	-15.656	-11.906	26	1
10	2.781	-15.688	12	3	45	8.656	-3.063	16	1	80	4.313	-11.500	33	1
11	2.663	-11.063	31	3	46	5.906	-4.500	23	1	81	6.344	-19.250	20	1
12	9.125	-13.781	10	3	47	-7.344	1.625	11	1	82	20.156	-9.344	3	1
13	9.125	-24.218	9	3	48	-6.844	9.594	11	1	83	11.438	-4.969	9	1
14	3.531	-5.188	11	3	49	-3.594	5.594	5	1	84	1.469	1.750	7	1
15	-4.438	-4.594	18	3	50	-5.750	4.438	9	1	85	13.500	1.938	3	1
16	-1.500	1.344	41	3	51	-2.063	-5.781	13	1	86	2.844	-3.063	17	1
17	7.094	2.531	6	3	52	-23.156	-5.063	16	1	87	1.250	-3.063	18	1
18	-7.906	-11.563	35	2	53	-26.125	-6.625	19	1	88	-0.281	-4.281	9	1
19	-6.688	-4.719	18	2	54	-14.405	-7.125	8	1	89	-1.688	-5.281	9	1
20	3.250	-11.375	22	2	55	-12.719	-8.813	5	1	90	-6.656	-2.688	14	1
21	5.031	-12.093	25	2	56	-11.218	-13.813	5	1	91	-3.594	-3.594	26	1
22	11.844	-17.406	12	2	57	-5.813	-15.750	6	1	92	-8.188	0.188	25	1
23	2.813	-9.344	17	2	58	-6.000	-13.625	11	1	93	-2.156	-4.969	4	1
24	2.375	-5.531	23	2	59	-4.219	-13.813	9	1	94	-2.813	-6.000	13	1
25	-3.281	-4.250	11	2	60	-11.125	-11.250	10	1	95	-2.375	-0.625	12	1
26	-7.125	-3.188	26	2	61	2.313	-10.188	10	1	96	-4.875	-4.969	6	1
27	-5.750	7.375	11	2	62	2.813	-10.813	11	1	97	4.656	-6.000	8	1
28	-19.500	-7.125	23	2	63	3.750	-12.313	18	1	98	4.750	0.940	5	1
29	-8.875	-8.594	21	2	64	4.156	-13.188	11	1	99	18.500	5.781	14	1
30	-13.563	-13.625	11	2	65	5.281	-12.313	11	1	100	7.125	-2.250	29	1
31	-5.183	-13.813	15	2	66	5.063	-7.219	23	1	101	2.813	-2.250	10	1
32	3.781	-12.406	28	2	67	-0.531	-4.906	5	1	102	2.813	0.250	12	1
33	-5.688	-4.156	26	2	68	-0.750	-3.969	4	1	103	1.750	-3.125	14	1
34	0.688	1.250	17	2	69	-5.688	4.844	18	1	104	0.531	-3.281	7	1

(cont.)

Table C.7 continued.

No.	x	y	q	f	No.	x	y	q	f	No.	x	y	q	f
105	-1.625	-0.906	16	1	114	-14.250	-13.250	19	1	123	-4.875	-3.250	3	1
106	2.781	-17.593	5	1	115	-14.438	-16.156	8	1	124	-6.875	-3.375	16	1
107	3.469	-11.375	13	1	116	-1.531	-10.625	6	1	125	2.281	-6.844	3	1
108	7.219	-13.219	16	1	117	3.188	-12.000	8	1	126	-19.091	-6.166	8	1
109	7.469	-14.500	15	1	118	4.969	-9.031	6	1	127	-20.656	-6.413	64	1
110	-8.625	-12.000	10	1	119	2.813	-6.156	4	1	128	-9.265	-9.250	5	3
111	-9.344	-0.813	5	1	120	6.875	-0.625	3	1	129	-9.156	-9.350	41	1
112	-6.531	-3.969	9	1	121	-5.781	-6.281	5	1	130	-10.569	-6.875	15	2
113	-9.625	-9.813	7	1	122	-4.969	-4.469	10	1	131	-10.469	-6.975	135	1

Table C.8: Node locations, demands, and frequencies for P12.

No.	x	y	q	f	No.	x	y	q	f	No.	x	y	q	f
0	13.54	7.07	0	0	35	-12.46	-17.50	2	1	70	8.04	-21.46	7	1
1	-20.61	-8.04	2	1	36	-9.06	-10.87	5	1	71	8.10	-21.46	3	1
2	-21.23	-8.15	2	1	37	-9.97	-12.91	3	1	72	15.74	-22.03	30	3
3	-21.63	-8.15	12	2	38	-7.64	-12.63	3	1	73	11.78	-20.89	6	1
4	-22.14	-8.32	3	1	39	-5.55	-15.23	3	1	74	13.14	-22.08	3	1
5	-37.43	-11.44	54	3	40	-2.72	-9.63	6	1	75	12.91	-22.88	3	1
6	-35.33	-12.91	3	1	41	-2.77	-19.25	3	1	76	13.36	-25.54	2	1
7	-34.48	-10.99	9	1	42	-2.72	-20.84	3	1	77	16.53	-24.46	3	1
8	-19.53	-15.12	4	1	43	-6.57	-28.48	19	2	78	16.53	-24.97	2	1
9	-17.21	-13.42	3	1	44	-6.57	-34.94	4	1	79	16.76	-25.93	6	1
10	-16.59	-16.76	41	3	45	3.40	-36.13	3	1	80	16.53	-43.88	9	1
11	-17.27	-17.33	2	1	46	5.04	-28.43	3	1	81	18.01	-21.40	4	1
12	-17.44	-17.78	2	1	47	1.25	-26.16	9	1	82	7.02	-19.59	3	1
13	-17.84	-18.23	3	1	48	9.12	-24.46	22	3	83	6.97	-19.08	3	1
14	-16.08	-19.59	9	1	49	9.29	-23.78	3	1	84	6.46	-19.59	3	1
15	-16.08	-15.57	8	1	50	9.23	-23.22	3	1	85	6.34	-19.53	3	1
16	-15.35	-20.84	9	1	51	7.64	-23.73	3	1	86	7.87	-17.33	3	1
17	-17.84	-20.89	6	1	52	8.04	-22.31	4	1	87	9.00	-16.36	3	1
18	-19.93	-24.91	2	1	53	6.85	-22.48	2	1	88	5.10	-16.93	9	1
19	-24.01	-24.01	3	1	54	6.79	-22.48	2	1	89	5.15	-15.97	2	1
20	-25.76	-22.31	6	1	55	6.62	-21.74	2	1	90	1.25	-12.34	2	1
21	-25.82	-24.01	2	1	56	5.78	-21.74	3	1	91	2.15	-10.87	5	1
22	-26.16	-28.37	4	1	57	5.72	-20.84	5	1	92	5.10	-10.99	2	1
23	-26.16	-29.27	4	1	58	3.91	-20.67	6	1	93	5.10	-11.15	2	1
24	-28.59	-31.71	8	1	59	4.64	-20.05	8	1	94	3.79	-8.49	3	1
25	-31.26	-33.41	18	2	60	6.00	-20.61	3	1	95	4.42	-9.00	3	1
26	-28.99	-31.20	8	1	61	6.34	-20.61	3	1	96	5.27	-10.08	3	1
27	-22.25	-28.26	3	1	62	8.15	-20.61	3	1	97	5.66	-10.42	12	2
28	-19.42	-25.03	3	1	63	8.66	-15.57	3	1	98	6.29	-10.02	2	1
29	-16.82	-19.99	3	1	64	7.19	-20.72	6	1	99	6.40	-9.40	8	1
30	-15.97	-25.08	2	1	65	7.19	-20.78	3	1	100	7.02	-9.06	3	1
31	-10.53	-29.44	3	1	66	7.25	-21.29	6	1	101	16.76	-13.02	9	1
32	-10.53	-25.03	3	1	67	7.59	-21.18	5	1	102	16.76	-16.65	8	1
33	-11.55	-22.65	3	1	68	8.04	-21.40	2	1	103	32.22	0.14	10	2
34	-10.53	-22.20	2	1	69	8.04	-21.35	2	1	104	12.46	-1.13	3	1

(cont.)

Table C.8 continued.

No.	x	y	q	f	No.	x	y	q	f	No.	x	y	q	f
105	-1.13	-8.66	3	1	125	-8.83	-5.89	3	1	145	-11.67	-6.34	2	1
106	-2.61	-12.29	3	1	126	-8.55	-7.19	3	1	146	-16.42	-4.13	6	1
107	-2.77	-10.99	3	1	127	-5.04	-5.83	2	1	147	-12.17	-4.13	4	1
108	-4.08	-10.87	3	1	128	-2.61	-5.83	3	1	148	-11.32	-4.64	3	1
109	-3.17	-8.95	3	1	129	-4.30	-2.72	9	1	149	-10.36	-4.59	6	1
110	5.15	-9.57	2	1	130	-2.72	-2.21	9	1	150	-8.61	-3.40	13	2
111	-6.74	-9.97	2	1	131	-1.70	-1.98	6	1	151	-8.55	-3.74	2	1
112	-10.47	-11.38	3	1	132	-2.09	-1.19	21	3	152	-8.10	-1.30	2	1
113	-10.42	-9.74	3	1	133	3.79	0.17	3	1	153	-8.10	-1.36	10	2
114	-15.23	-10.25	20	3	134	4.47	0.79	3	1	154	-6.46	-3.96	7	1
115	-13.25	-9.63	4	1	135	2.66	4.53	5	1	155	-5.89	-3.45	5	1
116	-13.25	-10.82	2	1	136	1.25	2.26	3	1	156	-4.98	-2.49	4	1
117	-9.57	-8.83	4	1	137	-18.97	-12.46	105	3	157	-6.62	-3.34	3	1
118	-8.04	-8.32	3	1	138	-15.12	-7.14	11	2	158	-6.51	-2.89	5	1
119	-9.00	-8.10	3	1	139	-14.78	-7.53	3	1	159	-6.51	-1.08	3	1
120	-10.25	-7.53	3	1	140	-14.84	-6.57	3	1	160	-6.51	1.08	3	1
121	-10.19	-7.70	3	1	141	-14.16	-6.40	3	1	161	-5.10	2.26	2	1
122	-10.31	-7.53	5	1	142	-14.16	-6.23	3	1	162	-5.15	3.45	2	1
123	-9.80	-7.14	2	1	143	-12.51	-6.23	5	1	163	-4.13	3.91	5	1
124	-9.46	-7.93	3	1	144	-12.46	-6.12	3	1					

Table C.9: Node locations, demands, and frequencies for P13.

No.	x	y	q	f	No.	x	y	q	f	No.	x	y	q	f
0	330.37	850.34	0	0	35	304.10	872.87	160	2	70	306.12	882.06	290	1
1	347.70	866.17	250	2	36	304.26	872.24	220	2	71	338.16	857.60	245	1
2	348.17	876.69	150	2	37	344.80	853.47	180	2	72	308.94	877.77	271	1
3	336.67	858.33	300	2	38	347.06	853.66	240	2	73	312.83	864.52	175	1
4	323.90	870.08	224	2	39	347.69	849.67	133	2	74	345.05	877.29	290	1
5	332.33	875.95	210	2	40	342.49	887.19	215	2	75	310.90	870.66	280	1
6	338.40	872.79	250	2	41	312.45	854.26	200	1	76	304.05	876.82	255	1
7	305.23	879.03	220	2	42	324.70	850.13	250	1	77	334.30	861.01	250	1
8	341.82	867.99	300	2	43	346.78	865.68	300	1	78	313.09	857.13	360	1
9	318.26	866.27	180	2	44	348.17	876.69	180	1	79	325.20	862.03	270	1
10	329.90	858.65	190	2	45	347.25	865.78	320	1	80	343.44	863.11	215	1
11	318.79	851.51	160	2	46	347.15	866.27	250	1	81	336.55	868.09	300	1
12	335.42	865.29	270	2	47	347.25	865.78	250	1	82	346.89	866.91	290	1
13	340.09	860.66	210	2	48	347.15	866.27	230	1	83	325.11	878.49	195	1
14	337.59	870.54	255	2	49	347.25	865.78	410	1	84	332.75	863.54	331	1
15	335.11	868.13	228	2	50	348.17	876.69	205	1	85	334.44	869.74	250	1
16	333.73	866.09	220	2	51	336.69	858.38	340	1	86	334.65	869.12	315	1
17	310.00	872.58	165	2	52	331.99	875.32	325	1	87	324.09	862.78	380	1
18	344.46	857.15	215	2	53	323.30	862.71	215	1	88	336.21	866.17	355	1
19	312.81	862.56	155	2	54	323.91	862.50	195	1	89	315.28	878.83	345	1
20	335.63	868.14	200	2	55	347.54	876.75	275	1	90	332.01	867.88	280	1
21	344.42	869.42	210	2	56	326.08	854.50	280	1	91	345.54	869.81	335	1
22	343.22	865.01	220	2	57	331.99	875.32	330	1	92	325.19	858.87	330	1
23	348.06	869.73	280	2	58	318.06	859.41	250	1	93	329.42	871.33	282	1
24	314.31	869.26	190	2	59	313.92	856.82	345	1	94	319.19	877.42	310	1
25	335.46	867.57	240	2	60	324.64	864.58	315	1	95	306.74	878.92	215	1
26	331.48	853.64	265	2	61	323.61	863.37	330	1	96	336.87	878.31	330	1
27	341.71	861.55	230	2	62	323.91	862.51	350	1	97	341.38	879.86	290	1
28	344.83	858.59	255	2	63	323.71	863.02	300	1	98	333.86	866.09	300	1
29	331.99	875.32	225	2	64	342.62	862.05	340	1	99	334.11	868.98	295	1
30	339.53	860.20	170	2	65	313.09	858.09	327	1	100	336.67	866.67	259	1
31	348.06	869.73	165	2	66	312.45	854.26	295	1	101	335.33	867.67	360	1
32	347.30	877.01	200	2	67	328.41	851.70	350	1	102	308.11	880.89	260	1
33	345.54	869.81	175	2	68	306.98	881.66	290	1	103	347.32	869.73	268	1
34	328.46	866.38	190	2	69	306.67	881.00	245	1	104	310.24	874.94	285	1

(cont.)

Table C.9 continued.

No.	x	y	q	f	No.	x	y	q	f	No.	x	y	q	f
105	345.54	869.81	380	1	140	317.21	858.16	250	1	175	330.37	850.34	220	1
106	314.17	860.72	220	1	141	326.31	873.53	260	1	176	320.72	842.27	171	1
107	326.08	854.51	226	1	142	339.28	856.11	260	1	177	319.65	837.82	155	1
108	335.78	867.59	290	1	143	346.57	860.24	250	1	178	325.53	838.89	190	1
109	346.57	860.24	330	1	144	328.57	851.99	250	1	179	324.77	849.47	325	1
110	338.16	856.60	175	1	145	350.00	910.00	250	1	180	324.57	837.33	160	1
111	304.10	882.76	330	1	146	307.75	852.35	230	1	181	322.50	834.67	215	1
112	306.47	881.52	237	1	147	305.17	864.77	460	1	182	333.64	847.87	165	1
113	342.29	876.21	445	1	148	303.64	871.76	265	1	183	335.81	850.79	150	1
114	306.96	880.96	245	1	149	307.19	861.15	315	1	184	313.77	849.42	240	1
115	323.61	863.37	350	1	150	306.46	870.75	290	1	185	336.77	840.03	145	1
116	339.84	859.51	265	1	151	303.68	872.00	225	1	186	339.86	833.79	325	1
117	310.38	858.50	305	1	152	308.87	856.62	400	1	187	339.30	845.35	200	1
118	331.67	863.24	220	1	153	304.18	865.45	225	1	188	326.24	836.55	315	1
119	335.50	868.00	331	1	154	304.26	872.24	290	1	189	330.52	841.65	190	1
120	315.58	852.49	257	1	155	306.07	866.03	465	1	190	336.67	842.83	200	1
121	335.84	863.91	360	1	156	302.54	856.47	185	1	191	323.88	833.51	305	1
122	339.16	864.46	380	1	157	301.56	856.47	180	1	192	338.83	845.23	206	1
123	312.50	854.33	360	1	158	297.96	852.92	220	1	193	338.73	845.33	220	1
124	341.52	856.78	277	1	159	301.67	858.00	160	1	194	335.73	844.16	250	1
125	323.62	862.96	400	1	160	307.03	848.42	300	1	195	336.67	847.17	130	1
126	323.63	862.98	310	1	161	304.44	850.44	300	1	196	336.67	843.67	176	1
127	336.67	858.38	255	1	162	301.56	856.57	185	1	197	338.21	841.17	168	1
128	336.69	858.36	366	1	163	301.46	856.47	221	1	198	338.53	840.22	200	1
129	328.28	857.30	335	1	164	306.07	866.03	215	1	199	338.06	837.59	340	1
130	317.17	862.62	235	1	165	307.60	865.66	430	1	200	338.00	841.67	204	1
131	323.33	862.83	360	1	166	304.41	865.76	350	1	201	317.74	844.41	210	1
132	326.41	853.78	325	1	167	301.67	858.00	100	1	202	339.40	842.07	150	1
133	310.06	863.24	219	1	168	303.68	872.00	245	1	203	342.76	851.94	200	1
134	339.20	878.00	360	1	169	297.26	849.93	250	1	204	338.35	843.16	200	1
135	321.38	857.10	265	1	170	309.60	855.14	315	1	205	332.45	842.53	245	1
136	330.98	867.54	270	1	171	303.68	872.10	300	1	206	338.48	844.31	250	1
137	349.78	857.63	240	1	172	304.17	872.33	265	1	207	336.67	842.83	250	1
138	330.75	868.44	380	1	173	332.45	842.53	240	1	208	338.21	841.17	300	1
139	313.63	853.34	275	1	174	326.24	836.56	165	1	209	338.41	841.02	220	1

(cont.)

Table C.9 continued.

No.	x	y	q	f	No.	x	y	q	f	No.	x	y	q	f
210	339.33	842.17	150	1	245	328.41	836.20	275	1	280	337.09	851.47	275	1
211	342.04	834.55	285	1	246	328.10	836.76	230	1	281	334.22	845.21	128	1
212	338.06	841.71	180	1	247	328.20	836.66	220	1	282	317.70	847.94	250	1
213	337.24	842.83	166	1	248	337.94	846.59	275	1	283	344.68	844.28	285	1
214	338.08	846.34	200	1	249	350.19	851.82	240	1	284	335.42	842.33	290	1
215	340.00	833.83	205	1	250	334.34	820.15	250	1	285	325.58	842.36	250	1
216	341.23	840.03	340	1	251	334.38	819.41	245	1	286	333.25	833.89	315	1
217	338.14	843.58	190	1	252	347.67	847.97	250	1	287	346.84	844.72	390	1
218	328.53	846.06	260	1	253	334.63	819.86	232	1	288	341.69	847.99	250	1
219	337.05	842.42	150	1	254	343.00	838.33	325	1	289	337.26	843.36	230	1
220	337.55	843.87	205	1	255	341.01	845.19	265	1	290	338.06	841.71	200	1
221	324.77	849.47	200	1	256	343.53	829.28	260	1	291	336.11	838.52	250	1
222	336.69	838.58	215	1	257	328.49	836.77	245	1	292	339.94	850.04	240	1
223	330.35	839.40	211	1	258	321.67	831.33	230	1	293	335.73	844.16	200	1
224	328.79	843.28	245	1	259	342.94	838.25	274	1	294	335.37	852.53	275	1
225	337.00	846.67	250	1	260	342.41	844.81	240	1	295	342.80	831.09	275	1
226	338.84	845.31	179	1	261	332.94	839.61	315	1	296	315.67	841.67	250	1
227	336.67	843.67	250	1	262	337.35	827.46	290	1	297	348.75	839.60	200	1
228	333.64	847.87	260	1	263	330.93	820.18	370	1	298	349.50	853.00	165	1
229	335.24	843.56	242	1	264	340.74	842.96	423	1	299	345.32	839.84	250	1
230	320.72	842.27	155	1	265	345.98	837.62	280	1	300	338.61	846.77	300	1
231	336.67	840.00	140	1	266	326.24	836.56	300	1	301	341.36	828.26	195	1
232	337.11	841.06	178	1	267	333.33	845.50	365	1	302	348.78	833.99	255	1
233	338.83	845.33	405	1	268	342.76	851.94	160	1	303	328.75	851.78	250	1
234	339.33	845.33	250	1	269	326.58	837.54	300	1	304	328.87	848.30	190	1
235	337.50	847.47	280	1	270	340.66	846.72	350	1	305	334.68	819.92	290	1
236	339.40	842.07	250	1	271	342.29	838.84	455	1	306	334.34	820.15	375	1
237	339.33	842.17	220	1	272	323.02	840.24	220	1	307	340.24	843.44	250	1
238	338.00	841.67	200	1	273	325.42	828.92	230	1	308	337.33	849.13	300	1
239	325.00	828.00	215	1	274	339.51	839.89	260	1	309	345.12	835.26	180	1
240	330.86	832.30	260	1	275	328.49	836.77	340	1	310	331.75	848.74	265	1
241	334.36	819.67	240	1	276	340.66	846.72	265	1	311	345.32	839.84	220	1
242	334.63	824.99	270	1	277	329.98	824.05	300	1	312	335.97	834.68	200	1
243	334.67	820.17	170	1	278	310.42	848.78	280	1	313	343.69	849.38	250	1
244	334.38	819.41	289	1	279	340.98	835.68	400	1	314	345.05	849.49	322	1

(cont.)

Table C.9 continued.

No.	x	y	q	f	No.	x	y	q	f	No.	x	y	q	f
315	324.87	849.48	295	1	350	334.00	884.17	410	1	385	354.50	867.95	370	1
316	324.77	849.47	430	1	351	317.04	891.26	190	1	386	355.21	843.59	375	1
317	333.52	816.96	250	1	352	312.31	904.56	270	1	387	350.09	852.84	310	1
318	334.68	819.92	250	1	353	339.88	884.79	315	1	388	356.51	883.91	315	1
319	299.46	901.21	180	1	354	303.98	890.80	240	1	389	352.40	858.31	265	1
320	325.00	921.33	250	1	355	324.50	886.50	265	1	390	352.25	882.38	250	1
321	299.46	901.21	250	1	356	303.98	890.81	290	1	391	356.13	870.41	430	1
322	307.81	898.57	220	1	357	342.49	887.19	290	1	392	355.93	892.60	305	1
323	302.00	932.50	250	1	358	305.32	896.67	600	1	393	351.06	899.59	215	1
324	304.58	910.70	250	1	359	341.92	887.22	270	1	394	351.52	899.81	235	1
325	302.50	932.58	164	1	360	323.20	891.61	185	1	395	351.07	899.77	150	1
326	304.09	908.99	100	1	361	323.11	901.79	320	1	396	351.17	899.67	245	1
327	302.10	932.06	200	1	362	303.98	890.80	225	1	397	350.57	898.92	245	1
328	302.00	932.33	200	1	363	354.44	846.00	250	1	398	360.37	893.83	265	1
329	299.88	902.43	170	1	364	351.49	848.67	210	1	399	357.34	843.43	200	1
330	302.79	897.73	140	1	365	353.53	862.05	415	1	400	353.71	853.89	205	1
331	335.71	884.20	335	1	366	356.13	870.41	262	1	401	350.07	852.03	140	1
332	334.11	910.08	295	1	367	351.49	848.67	135	1	402	351.86	861.09	375	1
333	324.62	886.60	235	1	368	354.84	864.52	350	1	403	351.06	899.59	138	1
334	317.04	891.26	181	1	369	354.44	846.00	260	1	404	350.44	896.63	235	1
335	313.02	892.99	250	1	370	355.00	850.17	235	1	405	359.19	887.60	205	1
336	303.83	885.29	313	1	371	350.30	851.85	205	1	406	350.74	850.63	200	1
337	303.83	887.00	290	1	372	350.28	852.33	195	1	407	356.05	851.90	185	1
338	303.92	886.34	260	1	373	356.05	844.64	190	1	408	352.59	889.99	220	1
339	304.16	889.26	300	1	374	351.49	848.67	190	1	409	351.17	899.67	250	1
340	304.26	889.16	245	1	375	350.09	852.29	150	1	410	351.25	853.24	160	1
341	316.77	886.48	380	1	376	352.63	851.76	250	1	411	354.44	846.10	250	1
342	315.68	913.66	245	1	377	351.49	848.67	300	1	412	354.34	846.10	280	1
343	346.19	899.67	255	1	378	351.51	865.71	330	1	413	351.36	900.08	1000	1
344	304.40	885.46	245	1	379	351.99	870.29	261	1	414	350.08	852.08	250	1
345	324.21	901.34	165	1	380	350.21	857.11	273	1	415	341.82	867.99	67	1
346	349.04	885.67	300	1	381	353.26	845.28	280	1	416	345.54	869.81	119	1
347	342.00	905.73	190	1	382	357.93	842.74	205	1	417	345.64	869.91	125	1
348	323.41	908.69	235	1	383	350.07	852.03	160	1					
349	334.63	888.18	240	1	384	356.55	888.75	245	1					

Table C.10: Node locations, demands, and frequencies for P14.

No.	x	y	q	f	No.	x	y	q	f	No.	x	y	q	f
0	0.000	0.000	0	0	7	-17.321	-10.000	2	2	14	21.213	21.213	1	1
1	10.000	0.000	5	4	8	17.321	-10.000	2	2	15	-21.213	21.213	1	1
2	-10.000	0.000	5	4	9	34.641	20.000	2	2	16	-28.978	7.765	1	1
3	50.000	0.000	5	4	10	-34.641	20.000	2	2	17	-28.978	-7.765	1	1
4	-50.000	0.000	5	4	11	-34.641	-20.000	2	2	18	-21.213	-21.213	1	1
5	17.321	10.000	2	2	12	34.641	-20.000	2	2	19	21.213	-21.213	1	1
6	-17.321	10.000	2	2	13	28.978	7.765	1	1	20	28.978	-7.765	1	1

Table C.11: Node locations, demands, and frequencies for P15.

No.	x	y	q	f	No.	x	y	q	f	No.	x	y	q	f
0	0.000	0.000	0	0	13	-34.641	-20.000	2	2	26	-28.978	7.765	1	1
1	10.000	0.000	5	4	14	34.641	-20.000	2	2	27	-28.987	-7.765	1	1
2	-10.000	0.000	5	4	15	51.962	30.000	2	2	28	-21.213	-21.213	1	1
3	50.000	0.000	5	4	16	-51.962	30.000	2	2	29	21.213	-21.213	1	1
4	-50.000	0.000	5	4	17	-51.962	-30.000	2	2	30	28.978	-7.765	1	1
5	90.000	0.000	5	4	18	51.962	-30.000	2	2	31	67.615	18.117	1	1
6	-90.000	0.000	5	4	19	69.282	40.000	2	2	32	49.497	49.497	1	1
7	17.321	10.000	2	2	20	-69.282	40.000	2	2	33	-49.497	49.497	1	1
8	-17.321	10.000	2	2	21	-69.282	-40.000	2	2	34	-67.615	18.117	1	1
9	-17.321	-10.000	2	2	22	69.282	-40.000	2	2	35	-67.615	-18.117	1	1
10	17.321	-10.000	2	2	23	28.978	7.765	1	1	36	-49.497	-49.497	1	1
11	34.641	20.000	2	2	24	21.213	21.213	1	1	37	49.497	-49.497	1	1
12	-34.641	20.000	2	2	25	-21.213	21.213	1	1	38	67.615	-18.117	1	1

Table C.12: Node locations, demands, and frequencies for P16.

No.	x	y	q	f	No.	x	y	q	f	No.	x	y	q	f
0	0.000	0.000	0	0	19	-51.962	-30.000	2	2	38	-21.213	-21.213	1	1
1	10.000	0.000	5	4	20	51.962	-30.000	2	2	39	21.213	-21.213	1	1
2	-10.000	0.000	5	4	21	69.282	40.000	2	2	40	28.978	-7.765	1	1
3	50.000	0.000	5	4	22	-69.282	40.000	2	2	41	67.615	18.117	1	1
4	-50.000	0.000	5	4	23	-69.282	-40.000	2	2	42	49.497	49.497	1	1
5	90.000	0.000	5	4	24	69.282	-40.000	2	2	43	-49.497	49.497	1	1
6	-90.000	0.000	5	4	25	86.603	50.000	2	2	44	-67.615	18.117	1	1
7	130.000	0.000	5	4	26	-86.603	50.000	2	2	45	-67.615	-18.117	1	1
8	-130.000	0.000	5	4	27	-86.603	-50.000	2	2	46	-49.497	-49.497	1	1
9	17.231	10.000	2	2	28	86.603	-50.000	2	2	47	49.497	-49.497	1	1
10	-17.231	10.000	2	2	29	103.923	60.000	2	2	48	67.615	-18.117	1	1
11	-17.231	-10.000	2	2	30	-103.923	60.000	2	2	49	106.252	28.470	1	1
12	17.321	-10.000	2	2	31	-103.923	-60.000	2	2	50	77.782	77.782	1	1
13	34.641	20.000	2	2	32	103.923	-60.000	2	2	51	-77.782	77.782	1	1
14	-34.641	20.000	2	2	33	28.978	7.765	1	1	52	-106.252	28.470	1	1
15	-34.641	-20.000	2	2	34	21.213	21.213	1	1	53	-106.252	-28.470	1	1
16	34.641	-20.000	2	2	35	-21.213	21.213	1	1	54	-77.782	-77.782	1	1
17	51.962	30.000	2	2	36	-28.978	7.765	1	1	55	77.782	-77.782	1	1
18	-51.962	30.000	2	2	37	-28.978	-7.765	1	1	56	106.252	-28.470	1	1

Table C.13: Node locations, demands, and frequencies for P17.

No.	x	y	q	f	No.	x	y	q	f	No.	x	y	q	f
0	0.000	0.000	0	0	14	-5.176	-19.319	2	2	28	3.916	29.743	1	1
1	10.000	0.000	5	4	15	5.176	-19.319	2	2	29	-3.916	29.743	1	1
2	0.000	10.000	5	4	16	19.319	-5.176	2	2	30	-11.481	27.716	1	1
3	-10.000	0.000	5	4	17	38.637	10.353	2	2	31	-27.716	11.481	1	1
4	0.000	-10.000	5	4	18	10.353	38.367	2	2	32	-29.743	3.916	1	1
5	50.000	0.000	5	4	19	-10.353	38.637	2	2	33	-29.743	-3.916	1	1
6	0.000	50.000	5	4	20	-38.637	10.353	2	2	34	-27.716	-11.481	1	1
7	-50.000	0.000	5	4	21	-38.637	-10.353	2	2	35	-11.480	-27.716	1	1
8	0.000	-50.000	5	4	22	-10.353	-38.637	2	2	36	-3.916	-29.743	1	1
9	19.319	5.176	2	2	23	10.353	-38.637	2	2	37	3.916	-29.743	1	1
10	5.176	19.319	2	2	24	38.637	-10.353	2	2	38	11.481	-27.716	1	1
11	-5.176	19.319	2	2	25	29.743	3.916	1	1	39	27.716	-11.480	1	1
12	-19.319	5.176	2	2	26	27.716	11.481	1	1	40	29.743	-3.916	1	1
13	-19.319	-5.176	2	2	27	11.481	27.716	1	1					

Table C.14: Node locations, demands, and frequencies for P18.

No.	x	y	q	f	No.	x	y	q	f	No.	x	y	q	f
0	0.000	0.000	0	0	26	-10.353	-38.637	2	2	52	-29.743	3.916	1	1
1	10.000	0.000	5	4	27	10.353	-38.637	2	2	53	-29.743	-3.916	1	1
2	0.000	10.000	5	4	28	38.637	-10.353	2	2	54	-27.716	-11.481	1	1
3	-10.000	0.000	5	4	29	57.956	15.529	2	2	55	-11.480	-27.716	1	1
4	0.000	-10.000	5	4	30	15.529	57.956	2	2	56	-3.916	-29.743	1	1
5	50.000	0.000	5	4	31	-15.529	57.956	2	2	57	3.916	-29.743	1	1
6	0.000	50.000	5	4	32	-57.956	15.529	2	2	58	11.481	-27.716	1	1
7	-50.000	0.000	5	4	33	-57.956	-15.529	2	2	59	27.719	-11.481	1	1
8	0.000	-50.000	5	4	34	-15.529	-57.956	2	2	60	29.743	-3.916	1	1
9	90.000	0.000	5	4	35	15.529	-57.956	2	2	61	69.401	9.137	1	1
10	0.000	90.000	5	4	36	57.956	-15.529	2	2	62	64.672	26.788	1	1
11	-90.000	0.000	5	4	37	77.274	20.706	2	2	63	26.788	64.672	1	1
12	0.000	-90.000	5	4	38	20.706	77.274	2	2	64	9.137	69.401	1	1
13	19.319	5.176	2	2	39	-20.706	77.274	2	2	65	-9.137	69.401	1	1
14	5.176	19.319	2	2	40	-77.274	20.706	2	2	66	-26.788	64.672	1	1
15	-5.176	19.319	2	2	41	-77.274	-20.706	2	2	67	-64.672	26.788	1	1
16	-19.319	5.176	2	2	42	-20.706	-77.274	2	2	68	-69.401	9.137	1	1
17	-19.319	-5.176	2	2	43	20.706	-77.274	2	2	69	-69.401	-9.137	1	1
18	-5.176	-19.319	2	2	44	77.274	-20.706	2	2	70	-64.672	-26.788	1	1
19	5.176	-19.319	2	2	45	29.743	3.916	1	1	71	-26.788	-64.672	1	1
20	19.319	-5.176	2	2	46	27.716	11.481	1	1	72	-9.137	-69.401	1	1
21	38.637	10.353	2	2	47	11.481	27.716	1	1	73	9.137	-69.401	1	1
22	10.353	38.367	2	2	48	3.916	29.743	1	1	74	26.788	-64.672	1	1
23	-10.353	38.367	2	2	49	-3.916	29.743	1	1	75	64.672	-26.788	1	1
24	-38.637	10.353	2	2	50	-11.481	27.716	1	1	76	69.401	-9.137	1	1
25	-38.637	-10.353	2	2	51	-27.716	11.481	1	1					

Table C.15: Node locations, demands, and frequencies for P19.

No.	x	y	q	f	No.	x	y	q	f	No.	x	y	q	f
0	0.000	0.000	0	0	38	-15.529	-57.956	2	2	76	-3.916	-29.743	1	1
1	10.000	0.000	5	4	39	15.529	-57.956	2	2	77	3.916	-29.743	1	1
2	0.000	10.000	5	4	40	57.956	-15.529	2	2	78	11.481	-27.716	1	1
3	-10.000	0.000	5	4	41	77.274	20.706	2	2	79	27.716	-11.481	1	1
4	0.000	-10.000	5	4	42	20.706	77.274	2	2	80	29.743	-3.916	1	1
5	50.000	0.000	5	4	43	-20.706	77.274	2	2	81	69.401	9.137	1	1
6	0.000	50.000	5	4	44	-77.274	20.706	2	2	82	64.672	26.788	1	1
7	-50.000	0.000	5	4	45	-77.274	-20.706	2	2	83	26.788	64.672	1	1
8	0.000	-50.000	5	4	46	-20.706	-77.274	2	2	84	9.137	69.401	1	1
9	90.000	0.000	5	4	47	20.706	-77.274	2	2	85	-9.137	69.401	1	1
10	0.000	90.000	5	4	48	77.274	-20.706	2	2	86	-26.788	64.672	1	1
11	-90.000	0.000	5	4	49	96.593	25.882	2	2	87	-64.672	26.788	1	1
12	0.000	-90.000	5	4	50	25.882	96.593	2	2	88	-69.401	9.137	1	1
13	130.000	0.000	5	4	51	-25.882	96.593	2	2	89	-69.401	-9.137	1	1
14	0.000	130.000	5	4	52	-96.593	25.882	2	2	90	-64.672	-26.788	1	1
15	-130.000	0.000	5	4	53	-96.593	-25.882	2	2	91	-26.788	-64.672	1	1
16	0.000	-130.000	5	4	54	-25.882	-96.593	2	2	92	-9.137	-69.401	1	1
17	19.319	5.176	2	2	55	25.882	-96.593	2	2	93	9.137	-69.401	1	1
18	5.176	19.319	2	2	56	96.593	-25.882	2	2	94	26.788	-64.672	1	1
19	-5.176	19.319	2	2	57	115.911	31.058	2	2	95	64.672	-26.788	1	1
20	-19.319	5.176	2	2	58	31.058	115.911	2	2	96	69.401	-9.137	1	1
21	-19.319	-5.176	2	2	59	-31.058	115.911	2	2	97	109.059	14.358	1	1
22	-5.176	-19.319	2	2	60	-115.911	31.058	2	2	98	101.627	42.095	1	1
23	5.176	-19.319	2	2	61	-115.911	-31.058	2	2	99	42.095	101.627	1	1
24	19.319	-5.176	2	2	62	-31.058	-115.911	2	2	100	14.358	109.059	1	1
25	38.637	10.353	2	2	63	31.058	-115.911	2	2	101	-14.358	109.059	1	1
26	10.353	38.637	2	2	64	115.910	-31.058	2	2	102	-42.095	101.627	1	1
27	-10.353	38.637	2	2	65	29.743	3.916	1	1	103	-101.627	42.095	1	1
28	-38.637	10.353	2	2	66	27.716	11.481	1	1	104	-109.059	14.358	1	1
29	-38.637	-10.353	2	2	67	11.481	27.716	1	1	105	-109.059	-14.358	1	1
30	-10.353	-38.637	2	2	68	3.916	29.743	1	1	106	-101.627	-42.095	1	1
31	10.353	-38.637	2	2	69	-3.916	29.743	1	1	107	-42.095	-101.627	1	1
32	38.637	-10.353	2	2	70	-11.481	27.716	1	1	108	-14.385	-109.059	1	1
33	57.956	15.529	2	2	71	-27.716	11.481	1	1	109	14.358	-109.059	1	1
34	15.529	57.956	2	2	72	-29.743	3.916	1	1	110	42.095	-101.627	1	1
35	-15.529	57.956	2	2	73	-29.743	-3.916	1	1	111	101.627	-42.095	1	1
36	-57.956	15.529	2	2	74	-27.716	-11.481	1	1	112	109.590	-14.358	1	1
37	-57.956	-15.529	2	2	75	-11.480	-27.716	1	1					

Table C.16: Node locations, demands, and frequencies for P20.

No.	x	y	q	f	No.	x	y	q	f	No.	x	y	q	f
0	0.000	0.000	0	0	35	-10.353	38.637	2	2	70	-31.058	-115.911	2	2
1	10.000	0.000	5	4	36	-38.637	10.353	2	2	71	31.058	-115.911	2	2
2	0.000	10.000	5	4	37	-38.637	-10.353	2	2	72	115.910	-31.058	2	2
3	-10.000	0.000	5	4	38	-10.353	-38.637	2	2	73	135.230	36.235	2	2
4	0.000	-10.000	5	4	39	10.353	-38.637	2	2	74	36.235	135.230	2	2
5	50.000	0.000	5	4	40	38.637	-10.353	2	2	75	-36.235	135.230	2	2
6	0.000	50.000	5	4	41	57.956	15.529	2	2	76	-135.230	36.235	2	2
7	-50.000	0.000	5	4	42	15.529	57.956	2	2	77	-135.230	-36.235	2	2
8	0.000	-50.000	5	4	43	-15.529	57.956	2	2	78	-36.235	-135.230	2	2
9	90.000	0.000	5	4	44	-57.956	15.529	2	2	79	36.235	-135.230	2	2
10	0.000	90.000	5	4	45	-57.956	-15.529	2	2	80	135.230	-36.235	2	2
11	-90.000	0.000	5	4	46	-15.529	-57.956	2	2	81	154.548	41.411	2	2
12	0.000	-90.000	5	4	47	15.529	-57.956	2	2	82	41.411	154.548	2	2
13	130.000	0.000	5	4	48	57.956	-15.529	2	2	83	-41.411	154.548	2	2
14	0.000	130.000	5	4	49	77.274	20.706	2	2	84	-154.548	41.411	2	2
15	-130.000	0.000	5	4	50	20.706	77.274	2	2	85	-154.548	-41.411	2	2
16	0.000	-130.000	5	4	51	-20.706	77.274	2	2	86	-41.411	-154.548	2	2
17	170.000	0.000	5	4	52	-77.274	20.706	2	2	87	41.411	-154.548	2	2
18	0.000	170.000	5	4	53	-77.274	-20.706	2	2	88	154.548	-41.411	2	2
19	-170.000	0.000	5	4	54	-20.706	-77.274	2	2	89	173.867	46.587	2	2
20	0.000	-170.000	5	4	55	20.706	-77.274	2	2	90	46.587	173.867	2	2
21	210.000	0.000	5	4	56	77.274	-20.706	2	2	91	-46.587	173.867	2	2
22	0.000	210.000	5	4	57	96.593	25.882	2	2	92	-173.867	46.587	2	2
23	-210.000	0.000	5	4	58	25.882	96.593	2	2	93	-173.867	-46.587	2	2
24	0.000	-210.000	5	4	59	-25.882	96.593	2	2	94	-46.587	-173.867	2	2
25	19.319	5.176	2	2	60	-96.593	25.882	2	2	95	46.587	-173.867	2	2
26	5.176	19.319	2	2	61	-96.593	-25.882	2	2	96	173.867	-46.587	2	2
27	-5.176	19.319	2	2	62	-25.882	-96.593	2	2	97	193.185	51.764	2	2
28	-19.319	5.176	2	2	63	25.882	-96.593	2	2	98	51.764	193.185	2	2
29	-19.319	-5.176	2	2	64	96.593	-25.882	2	2	99	-51.764	193.185	2	2
30	-5.176	-19.319	2	2	65	115.911	31.058	2	2	100	-193.185	51.764	2	2
31	5.176	-19.319	2	2	66	31.058	115.911	2	2	101	-193.185	-51.764	2	2
32	19.319	-5.176	2	2	67	-31.058	115.911	2	2	102	-51.764	-193.185	2	2
33	38.637	10.353	2	2	68	-115.911	31.058	2	2	103	51.764	-193.185	2	2
34	10.353	38.637	2	2	69	-115.911	-31.058	2	2	104	193.185	-51.764	2	2

(cont.)

Table C.16 continued.

No.	x	y	q	f	No.	x	y	q	f	No.	x	y	q	f
105	29.743	3.916	1	1	132	-9.137	-69.401	1	1	159	-138.582	57.403	1	1
106	27.716	11.481	1	1	133	9.137	-69.401	1	1	160	-148.717	19.579	1	1
107	11.481	27.716	1	1	134	26.788	-64.672	1	1	161	-148.717	-19.579	1	1
108	3.916	29.743	1	1	135	64.672	-26.788	1	1	162	-138.582	-57.403	1	1
109	-3.916	29.743	1	1	136	69.401	-9.137	1	1	163	-57.402	-138.582	1	1
110	-11.481	27.716	1	1	137	109.059	14.358	1	1	164	-19.579	-148.717	1	1
111	-27.716	11.481	1	1	138	101.627	42.095	1	1	165	19.579	-148.717	1	1
112	-29.743	3.916	1	1	139	42.095	101.627	1	1	166	57.403	-138.582	1	1
113	-29.743	-3.916	1	1	140	14.358	109.059	1	1	167	138.582	-57.402	1	1
114	-27.716	-11.481	1	1	141	-14.358	109.059	1	1	168	148.717	-19.579	1	1
115	-11.480	-27.716	1	1	142	-42.095	101.627	1	1	169	188.375	24.800	1	1
116	-3.916	-29.743	1	1	143	-101.627	42.095	1	1	170	175.537	72.710	1	1
117	3.916	-29.743	1	1	144	-109.059	14.358	1	1	171	72.710	175.537	1	1
118	11.481	-27.716	1	1	145	-109.059	-14.358	1	1	172	24.800	188.375	1	1
119	27.716	-11.481	1	1	146	-101.627	-42.095	1	1	173	-24.800	188.375	1	1
120	29.743	-3.916	1	1	147	-42.095	-101.627	1	1	174	-72.710	175.537	1	1
121	69.401	9.137	1	1	148	-14.385	-109.059	1	1	175	-175.537	72.710	1	1
122	64.672	26.788	1	1	149	14.358	-109.059	1	1	176	-188.375	24.800	1	1
123	26.788	64.672	1	1	150	42.095	-101.627	1	1	177	-188.375	-24.800	1	1
124	9.137	69.401	1	1	151	101.627	-42.095	1	1	178	-175.537	-72.710	1	1
125	-9.137	69.401	1	1	152	109.590	-14.358	1	1	179	-72.710	-175.537	1	1
126	-26.788	64.672	1	1	153	148.717	19.579	1	1	180	-24.800	-188.375	1	1
127	-64.672	26.788	1	1	154	138.582	57.403	1	1	181	24.800	-188.375	1	1
128	-69.401	9.137	1	1	155	57.403	138.582	1	1	182	72.710	-175.537	1	1
129	-69.401	-9.137	1	1	156	19.579	148.717	1	1	183	175.537	-72.710	1	1
130	-64.672	-26.788	1	1	157	-19.579	148.717	1	1	184	188.375	-24.800	1	1
131	-26.788	-64.672	1	1	158	-57.403	138.582	1	1					

Table C.17: Node locations, demands, and frequencies for P21.

No.	x	y	q	f	No.	x	y	q	f	No.	x	y	q	f
0	0.000	0.000	0	0	21	-6.840	-18.794	2	2	42	7.765	28.978	1	1
1	10.000	0.000	5	4	22	6.840	-18.794	2	2	43	-7.765	28.978	1	1
2	5.000	8.660	5	4	23	12.859	-15.321	2	2	44	-12.679	27.189	1	1
3	-5.000	8.660	5	4	24	19.696	-3.473	2	2	45	-17.207	24.575	1	1
4	-10.000	0.000	5	4	25	39.392	6.946	2	2	46	-21.213	21.213	1	1
5	-5.000	-8.660	5	4	26	25.712	30.642	2	2	47	-28.987	7.765	1	1
6	5.000	-8.660	5	4	27	13.681	37.588	2	2	48	-29.886	2.615	1	1
7	50.000	0.000	5	4	28	-13.621	37.588	2	2	49	-29.886	-2.615	1	1
8	25.000	43.301	5	4	29	-25.712	30.642	2	2	50	-28.978	-7.765	1	1
9	-25.000	43.301	5	4	30	-39.392	6.946	2	2	51	-21.213	-21.213	1	1
10	-50.000	0.000	5	4	31	-39.392	-6.946	2	2	52	-17.207	-24.575	1	1
11	-25.000	-43.301	5	4	32	-25.718	-30.642	2	2	53	-12.679	-27.189	1	1
12	25.000	-43.301	5	4	33	-13.681	-37.588	2	2	54	-7.765	-28.978	1	1
13	19.696	3.473	2	2	34	13.681	-37.588	2	2	55	7.765	-28.978	1	1
14	12.856	15.321	2	2	35	25.712	-30.642	2	2	56	12.679	-27.189	1	1
15	6.840	18.794	2	2	36	39.392	-6.946	2	2	57	17.207	-24.575	1	1
16	-6.840	18.794	2	2	37	29.889	2.615	1	1	58	21.213	-21.213	1	1
17	-12.856	15.321	2	2	38	28.978	7.765	1	1	59	28.978	-7.765	1	1
18	-19.696	3.473	2	2	39	21.213	21.213	1	1	60	29.886	-2.615	1	1
19	-19.696	-3.473	2	2	40	17.207	24.575	1	1					
20	-12.856	-15.321	2	2	41	12.679	27.189	1	1					

Table C.18: Node locations, demands, and frequencies for P22.

No.	x	y	q	f	No.	x	y	q	f	No.	x	y	q	f
0	0.000	0.000	0	0	35	-25.712	30.642	2	2	70	17.207	24.575	1	1
1	10.000	0.000	5	4	36	-39.392	6.946	2	2	71	12.679	27.189	1	1
2	5.000	8.660	5	4	37	-39.392	-6.946	2	2	72	7.765	28.978	1	1
3	-5.000	8.660	5	4	38	-25.718	-30.642	2	2	73	-7.765	28.978	1	1
4	-10.000	0.000	5	4	39	-13.681	-37.588	2	2	74	-12.679	27.189	1	1
5	-5.000	-8.660	5	4	40	13.681	-37.588	2	2	75	-17.207	24.575	1	1
6	5.000	-8.660	5	4	41	25.712	-30.642	2	2	76	-21.213	21.213	1	1
7	50.000	0.000	5	4	42	39.392	-6.946	2	2	77	-28.978	7.765	1	1
8	25.000	43.301	5	4	43	59.088	10.419	2	2	78	-29.886	2.615	1	1
9	-25.000	43.301	5	4	44	38.567	45.963	2	2	79	-29.886	-2.615	1	1
10	-50.000	0.000	5	4	45	20.521	56.382	2	2	80	-28.978	-7.765	1	1
11	-25.000	-43.301	5	4	46	-20.521	56.382	2	2	81	-21.213	-21.213	1	1
12	25.000	-43.301	5	4	47	-38.567	45.963	2	2	82	-17.207	-24.575	1	1
13	90.000	0.000	5	4	48	-59.088	10.419	2	2	83	-12.679	-27.189	1	1
14	45.000	77.942	5	4	49	-59.088	-10.419	2	2	84	-7.765	-28.978	1	1
15	-45.000	77.942	5	4	50	-38.567	-45.963	2	2	85	7.765	-28.978	1	1
16	-90.000	0.000	5	4	51	-20.521	-56.382	2	2	86	12.679	-27.189	1	1
17	-45.000	-77.942	5	4	52	20.521	-56.382	2	2	87	17.207	-24.575	1	1
18	45.000	-77.942	5	4	53	38.567	-45.963	2	2	88	21.213	-21.213	1	1
19	19.696	3.473	2	2	54	59.088	-10.419	2	2	89	28.978	-7.765	1	1
20	12.856	15.321	2	2	55	78.785	13.892	2	2	90	29.886	-2.615	1	1
21	6.840	18.794	2	2	56	51.423	61.284	2	2	91	69.734	6.101	1	1
22	-6.840	18.794	2	2	57	27.362	75.175	2	2	92	67.615	18.117	1	1
23	-12.856	15.321	2	2	58	-27.362	75.175	2	2	93	49.497	49.497	1	1
24	-19.696	3.473	2	2	59	-51.423	61.284	2	2	94	40.150	57.341	1	1
25	-19.696	-3.473	2	2	60	-78.785	13.892	2	2	95	29.583	63.442	1	1
26	-12.856	-15.321	2	2	61	-78.785	-13.892	2	2	96	18.117	67.615	1	1
27	-6.840	-18.794	2	2	62	-51.423	-61.284	2	2	97	-18.117	67.615	1	1
28	6.840	-18.794	2	2	63	-27.362	-75.175	2	2	98	-29.583	63.422	1	1
29	12.859	-15.321	2	2	64	27.362	-75.175	2	2	99	-40.150	57.341	1	1
30	19.696	-3.473	2	2	65	51.423	-61.284	2	2	100	-49.497	49.497	1	1
31	39.392	6.946	2	2	66	78.785	-13.892	2	2	101	-67.615	18.117	1	1
32	25.712	30.642	2	2	67	29.889	2.615	1	1	102	-69.734	6.101	1	1
33	13.681	37.588	2	2	68	28.978	7.765	1	1	103	-69.734	-6.101	1	1
34	-13.621	37.588	2	2	69	21.213	21.213	1	1	104	-67.615	-18.117	1	1

(cont.)

Table C.18 continued.

No.	x	y	q	f	No.	x	y	q	f	No.	x	y	q	f
105	-49.497	-49.497	1	1	109	18.117	-67.615	1	1	113	67.615	-18.117	1	1
106	-40.150	-57.341	1	1	110	29.583	-63.442	1	1	114	69.743	-6.101	1	1
107	-29.583	-63.442	1	1	111	40.150	-57.341	1	1					
108	-18.117	-67.615	1	1	112	49.497	-49.497	1	1					

Table C.19: Node locations, demands, and frequencies for P23.

No.	x	y	q	f	No.	x	y	q	f	No.	x	y	q	f
0	0.000	0.000	0	0	35	12.859	-15.321	2	2	70	27.362	-75.175	2	2
1	10.000	0.000	5	4	36	19.696	-3.473	2	2	71	51.423	-61.284	2	2
2	5.000	8.660	5	4	37	39.392	6.946	2	2	72	78.785	-13.892	2	2
3	-5.000	8.660	5	4	38	25.712	30.642	2	2	73	98.481	17.365	2	2
4	-10.000	0.000	5	4	39	13.681	37.588	2	2	74	64.279	76.604	2	2
5	-5.000	-8.660	5	4	40	-13.621	37.588	2	2	75	34.202	93.969	2	2
6	5.000	-8.660	5	4	41	-25.712	30.642	2	2	76	-34.202	93.969	2	2
7	50.000	0.000	5	4	42	-39.392	6.946	2	2	77	-64.279	76.604	2	2
8	25.000	43.301	5	4	43	-39.392	-6.946	2	2	78	-98.481	17.365	2	2
9	-25.000	43.301	5	4	44	-25.718	-30.642	2	2	79	-98.481	-17.365	2	2
10	-50.000	0.000	5	4	45	-13.681	-37.588	2	2	80	-64.279	-76.604	2	2
11	-25.000	-43.301	5	4	46	13.681	-37.588	2	2	81	-34.202	-93.969	2	2
12	25.000	-43.301	5	4	47	25.712	-30.642	2	2	82	34.202	-93.969	2	2
13	90.000	0.000	5	4	48	39.392	-6.946	2	2	83	64.279	-76.604	2	2
14	45.000	77.942	5	4	49	59.088	10.419	2	2	84	98.481	-17.365	2	2
15	-45.000	77.942	5	4	50	38.567	45.963	2	2	85	118.177	20.838	2	2
16	-90.000	0.000	5	4	51	20.521	56.382	2	2	86	77.135	91.925	2	2
17	-45.000	-77.942	5	4	52	-20.521	56.382	2	2	87	41.042	112.763	2	2
18	45.000	-77.942	5	4	53	-38.567	45.963	2	2	88	-41.042	112.763	2	2
19	130.000	0.000	5	4	54	-59.088	10.419	2	2	89	-77.135	91.925	2	2
20	65.000	112.583	5	4	55	-59.088	-10.419	2	2	90	-118.177	20.838	2	2
21	-65.000	112.583	5	4	56	-38.567	-45.963	2	2	91	-118.177	-20.838	2	2
22	-130.000	0.000	5	4	57	-20.521	-56.382	2	2	92	-77.134	-91.925	2	2
23	-65.000	-112.583	5	4	58	20.521	-56.382	2	2	93	-41.042	-112.763	2	2
24	65.000	-112.583	5	4	59	38.567	-45.963	2	2	94	41.042	-112.763	2	2
25	19.696	3.473	2	2	60	59.088	-10.419	2	2	95	77.135	-91.925	2	2
26	12.856	15.321	2	2	61	78.785	13.892	2	2	96	118.177	-20.838	2	2
27	6.840	18.794	2	2	62	51.423	61.284	2	2	97	29.889	2.615	1	1
28	-6.840	18.794	2	2	63	27.362	75.175	2	2	98	28.978	7.765	1	1
29	-12.856	15.321	2	2	64	-27.362	75.175	2	2	99	21.213	21.213	1	1
30	-19.696	3.473	2	2	65	-51.423	61.284	2	2	100	17.207	24.575	1	1
31	-19.696	-3.473	2	2	66	-78.785	13.892	2	2	101	12.679	27.189	1	1
32	-12.856	-15.321	2	2	67	-78.785	-13.892	2	2	102	7.765	28.978	1	1
33	-6.840	-18.794	2	2	68	-51.423	-61.284	2	2	103	-7.765	28.978	1	1
34	6.840	-18.794	2	2	69	-27.362	-75.175	2	2	104	-12.679	27.189	1	1

(cont.)

Table C.19 continued.

No.	x	y	q	f	No.	x	y	q	f	No.	x	y	q	f
105	-17.207	24.575	1	1	127	-18.117	67.615	1	1	149	46.488	99.694	1	1
106	-21.213	21.213	1	1	128	-29.583	63.422	1	1	150	28.470	106.252	1	1
107	-28.978	7.765	1	1	129	-40.150	57.341	1	1	151	-28.470	106.252	1	1
108	-29.886	2.615	1	1	130	-49.497	49.497	1	1	152	-46.488	99.694	1	1
109	-29.886	-2.615	1	1	131	-67.615	18.117	1	1	153	-63.093	90.107	1	1
110	-28.978	-7.765	1	1	132	-69.734	6.101	1	1	154	-77.782	77.782	1	1
111	-21.213	-21.213	1	1	133	-69.734	-6.101	1	1	155	-106.252	28.470	1	1
112	-17.207	-24.575	1	1	134	-67.615	-18.117	1	1	156	-109.581	9.587	1	1
113	-12.679	-27.189	1	1	135	-49.497	-49.497	1	1	157	-109.581	-9.587	1	1
114	-7.765	-28.978	1	1	136	-40.150	-57.341	1	1	158	-106.252	-28.470	1	1
115	7.765	-28.978	1	1	137	-29.583	-63.442	1	1	159	-77.782	-77.782	1	1
116	12.679	-27.189	1	1	138	-18.117	-67.615	1	1	160	-63.093	-90.107	1	1
117	17.207	-24.575	1	1	139	18.117	-67.615	1	1	161	-46.488	-99.694	1	1
118	21.213	-21.213	1	1	140	29.583	-63.442	1	1	162	-28.470	-106.252	1	1
119	28.978	-7.765	1	1	141	40.150	-57.341	1	1	163	28.470	-106.252	1	1
120	29.886	-2.615	1	1	142	49.497	-49.497	1	1	164	46.488	-99.694	1	1
121	69.734	6.101	1	1	143	67.615	-18.117	1	1	165	63.093	-90.107	1	1
122	67.615	18.117	1	1	144	69.743	-6.101	1	1	166	77.782	-77.782	1	1
123	49.497	49.497	1	1	145	109.581	9.587	1	1	167	106.252	-28.470	1	1
124	40.150	57.341	1	1	146	106.252	28.470	1	1	168	109.581	-9.587	1	1
125	29.583	63.442	1	1	147	77.782	77.782	1	1					
126	18.117	67.615	1	1	148	63.093	90.107	1	1					

Table C.20: Node locations, demands, and frequencies for P24–P26.

No.	x	y	q_1	q_2	q_3	f	No.	x	y	q_1	q_2	q_3	f
0	0.000	0.000	0	0	0	0	26	-67.169	27.887	2	2	2	1
1	57.735	0.000	4	5	5	6	27	-77.169	22.113	2	2	2	1
2	28.867	50.000	4	5	5	6	28	-77.169	-22.113	2	2	2	1
3	-28.868	50.000	4	5	5	6	29	-67.169	-27.887	2	2	2	1
4	-57.735	0.000	4	5	5	6	30	-57.735	-44.226	2	2	2	1
5	-28.867	-50.000	4	5	5	6	31	-57.735	-55.774	2	2	2	1
6	28.867	-50.000	4	5	5	6	32	-9.434	-72.113	2	2	2	1
7	86.603	50.000	3	2	3	2	33	-19.434	-77.887	2	2	2	1
8	0.000	100.000	3	2	3	2	34	9.434	-72.113	2	2	2	1
9	-86.603	50.000	3	2	3	2	35	19.434	-77.887	2	2	2	1
10	-86.603	-50.000	3	2	3	2	36	57.735	-44.226	2	2	2	1
11	0.000	-100.000	3	2	3	2	37	57.735	-55.774	2	2	2	1
12	86.603	-50.000	3	2	3	2	38	77.169	-22.113	2	2	2	1
13	0.000	40.000	3	2	3	2	39	67.169	-27.887	2	2	2	1
14	-34.641	-20.000	3	2	3	2	40	13.434	47.887	2	2	2	1
15	34.461	-20.000	3	2	3	2	41	15.434	42.113	2	2	2	1
16	67.169	27.887	2	2	2	1	42	-13.434	47.887	2	2	2	1
17	77.169	22.113	2	2	2	1	43	-15.434	42.113	2	2	2	1
18	57.735	55.773	2	2	2	1	44	-44.188	-7.691	2	2	2	1
19	57.735	44.226	2	2	2	1	45	-48.188	-12.309	2	2	2	1
20	19.434	77.887	2	2	2	1	46	-28.754	-34.423	2	2	2	1
21	9.434	72.113	2	2	2	1	47	-34.754	-35.577	2	2	2	1
22	-19.434	77.887	2	2	2	1	48	28.754	-34.423	2	2	2	1
23	-9.434	72.113	2	2	2	1	49	34.754	-35.577	2	2	2	1
24	-57.735	55.773	2	2	2	1	50	44.188	-7.691	2	2	2	1
25	-57.735	44.226	2	2	2	1	51	48.188	-12.309	2	2	2	1

Note: demands are denoted by q_1 for P24, q_2 for P25, and q_3 for P26.

Table C.21: Node locations, demands, and frequencies for P27–P29.

No.	x	y	q_1	q_2	q_3	f	No.	x	y	q_1	q_2	q_3	f
0	0.000	0.000	0	0	0	0	35	19.434	77.887	2	2	2	1
1	57.735	0.000	4	5	5	6	36	9.434	72.113	2	2	2	1
2	28.867	50.000	4	5	5	6	37	-19.434	77.887	2	2	2	1
3	-28.868	50.000	4	5	5	6	38	-9.434	72.113	2	2	2	1
4	-57.735	0.000	4	5	5	6	39	-57.735	55.773	2	2	2	1
5	-28.867	-50.000	4	5	5	6	40	-57.735	44.226	2	2	2	1
6	28.867	-50.000	4	5	5	6	41	-67.169	27.887	2	2	2	1
7	288.675	0.000	4	5	5	6	42	-77.169	22.113	2	2	2	1
8	144.337	250.000	4	5	5	6	43	-77.169	-22.113	2	2	2	1
9	-144.338	250.000	4	5	5	6	44	-67.169	-27.887	2	2	2	1
10	-288.675	0.000	4	5	5	6	45	-57.735	-44.226	2	2	2	1
11	-144.337	-250.000	4	5	5	6	46	-57.735	-55.774	2	2	2	1
12	144.337	-250.000	4	5	5	6	47	-9.434	-72.113	2	2	2	1
13	86.603	50.000	3	2	3	2	48	-19.434	-77.887	2	2	2	1
14	0.000	100.000	3	2	3	2	49	9.434	-72.113	2	2	2	1
15	-86.603	50.000	3	2	3	2	50	19.434	-77.887	2	2	2	1
16	-86.603	-50.000	3	2	3	2	51	57.735	-44.226	2	2	2	1
17	0.000	-100.000	3	2	3	2	52	57.735	-55.774	2	2	2	1
18	86.603	-50.000	3	2	3	2	53	77.169	-22.113	2	2	2	1
19	0.000	40.000	3	2	3	2	54	67.169	-27.887	2	2	2	1
20	-34.641	-20.000	3	2	3	2	55	13.434	47.887	2	2	2	1
21	34.461	-20.000	3	2	3	2	56	15.434	42.113	2	2	2	1
22	433.013	250.000	3	2	3	2	57	-13.434	47.887	2	2	2	1
23	0.000	500.000	3	2	3	2	58	-15.434	42.113	2	2	2	1
24	-433.013	250.000	3	2	3	2	59	-44.188	-7.691	2	2	2	1
25	-433.013	-250.000	3	2	3	2	60	-48.188	-12.309	2	2	2	1
26	0.000	-500.000	3	2	3	2	61	-28.754	-34.423	2	2	2	1
27	433.013	-250.000	3	2	3	2	62	-34.754	-35.577	2	2	2	1
28	0.000	200.000	3	2	3	2	63	28.754	-34.423	2	2	2	1
29	-173.205	-100.000	3	2	3	2	64	34.754	-35.577	2	2	2	1
30	173.205	-100.000	3	2	3	2	65	44.188	-7.691	2	2	2	1
31	67.169	27.887	2	2	2	1	66	48.188	-12.309	2	2	2	1
32	77.169	22.113	2	2	2	1	67	335.844	139.434	2	2	2	1
33	57.735	55.773	2	2	2	1	68	385.844	110.566	2	2	2	1
34	57.735	44.226	2	2	2	1	69	288.675	278.867	2	2	2	1

(cont.)

Table C.21 continued.

No.	x	y	q_1	q_2	q_3	f	No.	x	y	q_1	q_2	q_3	f
70	288.675	221.132	2	2	2	1	87	288.675	-221.132	2	2	2	1
71	97.169	389.434	2	2	2	1	88	288.675	-278.868	2	2	2	1
72	47.169	360.566	2	2	2	1	89	385.844	-110.566	2	2	2	1
73	-97.169	389.434	2	2	2	1	90	335.884	-139.434	2	2	2	1
74	-47.169	360.566	2	2	2	1	91	67.169	239.434	2	2	2	1
75	-288.675	278.867	2	2	2	1	92	77.169	210.566	2	2	2	1
76	-288.675	221.132	2	2	2	1	93	-67.169	239.434	2	2	2	1
77	-335.844	139.434	2	2	2	1	94	-77.169	210.566	2	2	2	1
78	-385.844	110.566	2	2	2	1	95	-220.940	-38.453	2	2	2	1
79	-385.844	-110.566	2	2	2	1	96	-240.940	-61.547	2	2	2	1
80	-335.844	-139.434	2	2	2	1	97	-143.771	-172.113	2	2	2	1
81	-288.675	-221.132	2	2	2	1	98	-173.771	-177.887	2	2	2	1
82	-288.675	-278.868	2	2	2	1	99	143.771	-172.113	2	2	2	1
83	-47.169	-360.566	2	2	2	1	100	173.771	-177.887	2	2	2	1
84	-97.169	-389.434	2	2	2	1	101	220.940	-38.453	2	2	2	1
85	47.169	-360.566	2	2	2	1	102	240.940	-61.547	2	2	2	1
86	97.169	-389.434	2	2	2	1							

Note: demands are denoted by q_1 for P27, q_2 for P28, and q_3 for P29.

Table C.22: Node locations, demands, and frequencies for P30–P32.

No.	x	y	q_1	q_2	q_3	f	No.	x	y	q_1	q_2	q_3	f
0	0.000	0.000	0	0	0	0	35	-173.205	-100.000	3	2	3	2
1	57.735	0.000	4	5	5	6	36	173.205	-100.000	3	2	3	2
2	28.867	50.000	4	5	5	6	37	1299.038	750.000	3	2	3	2
3	-28.868	50.000	4	5	5	6	38	0.000	1500.000	3	2	3	2
4	-57.735	0.000	4	5	5	6	39	-1299.038	750.000	3	2	3	2
5	-28.867	-50.000	4	5	5	6	40	-1299.038	-750.000	3	2	3	2
6	28.867	-50.000	4	5	5	6	41	0.000	-1500.000	3	2	3	2
7	288.675	0.000	4	5	5	6	42	1299.038	-750.000	3	2	3	2
8	144.337	250.000	4	5	5	6	43	0.000	600.000	3	2	3	2
9	-144.338	250.000	4	5	5	6	44	-519.615	-300.000	3	2	3	2
10	-288.675	0.000	4	5	5	6	45	519.615	-300.000	3	2	3	2
11	-144.337	-250.000	4	5	5	6	46	67.169	27.887	2	2	2	1
12	144.337	-250.000	4	5	5	6	47	77.169	22.113	2	2	2	1
13	866.025	0.000	4	5	5	6	48	57.735	55.773	2	2	2	1
14	433.012	750.000	4	5	5	6	49	57.735	44.226	2	2	2	1
15	-433.013	750.000	4	5	5	6	50	19.434	77.887	2	2	2	1
16	-866.025	0.000	4	5	5	6	51	9.434	72.113	2	2	2	1
17	-433.012	-750.000	4	5	5	6	52	-19.434	77.887	2	2	2	1
18	433.012	-750.000	4	5	5	6	53	-9.434	72.113	2	2	2	1
19	86.603	50.000	3	2	3	2	54	-57.735	55.773	2	2	2	1
20	0.000	100.000	3	2	3	2	55	-57.735	44.226	2	2	2	1
21	-86.603	50.000	3	2	3	2	56	-67.169	27.887	2	2	2	1
22	-86.603	-50.000	3	2	3	2	57	-77.169	22.113	2	2	2	1
23	0.000	-100.000	3	2	3	2	58	-77.169	-22.113	2	2	2	1
24	86.603	-50.000	3	2	3	2	59	-67.169	-27.887	2	2	2	1
25	0.000	40.000	3	2	3	2	60	-57.735	-44.226	2	2	2	1
26	-34.641	-20.000	3	2	3	2	61	-57.735	-55.774	2	2	2	1
27	34.461	-20.000	3	2	3	2	62	-9.434	-72.113	2	2	2	1
28	433.013	250.000	3	2	3	2	63	-19.434	-77.887	2	2	2	1
29	0.000	500.000	3	2	3	2	64	9.434	-72.113	2	2	2	1
30	-433.013	250.000	3	2	3	2	65	19.434	-77.887	2	2	2	1
31	-433.013	-250.000	3	2	3	2	66	57.735	-44.226	2	2	2	1
32	0.000	-500.000	3	2	3	2	67	57.735	-55.774	2	2	2	1
33	433.013	-250.000	3	2	3	2	68	77.169	-22.113	2	2	2	1
34	0.000	200.000	3	2	3	2	69	67.169	-27.887	2	2	2	1

(cont.)

Table C.22 continued.

No.	x	y	q_1	q_2	q_3	f	No.	x	y	q_1	q_2	q_3	f
70	13.434	47.887	2	2	2	1	105	335.884	-139.434	2	2	2	1
71	15.434	42.113	2	2	2	1	106	67.169	239.434	2	2	2	1
72	-13.434	47.887	2	2	2	1	107	77.169	210.566	2	2	2	1
73	-15.434	42.113	2	2	2	1	108	-67.169	239.434	2	2	2	1
74	-44.188	-7.691	2	2	2	1	109	-77.169	210.566	2	2	2	1
75	-48.188	-12.309	2	2	2	1	110	-220.940	-38.453	2	2	2	1
76	-28.754	-34.423	2	2	2	1	111	-240.940	-61.547	2	2	2	1
77	-34.754	-35.577	2	2	2	1	112	-143.771	-172.113	2	2	2	1
78	28.754	-34.423	2	2	2	1	113	-173.771	-177.887	2	2	2	1
79	34.754	-35.577	2	2	2	1	114	143.771	-172.113	2	2	2	1
80	44.188	-7.691	2	2	2	1	115	173.771	-177.887	2	2	2	1
81	48.188	-12.309	2	2	2	1	116	220.940	-38.453	2	2	2	1
82	335.844	139.434	2	2	2	1	117	240.940	-61.547	2	2	2	1
83	385.844	110.566	2	2	2	1	118	1007.532	418.301	2	2	2	1
84	288.675	278.867	2	2	2	1	119	1157.531	331.699	2	2	2	1
85	288.675	221.132	2	2	2	1	120	866.025	836.602	2	2	2	1
86	97.169	389.434	2	2	2	1	121	866.025	663.397	2	2	2	1
87	47.169	360.566	2	2	2	1	122	291.506	1168.301	2	2	2	1
88	-97.169	389.434	2	2	2	1	123	141.506	1081.699	2	2	2	1
89	-47.169	360.566	2	2	2	1	124	-291.506	1168.301	2	2	2	1
90	-288.675	278.867	2	2	2	1	125	-141.506	1081.698	2	2	2	1
91	-288.675	221.132	2	2	2	1	126	-866.025	836.602	2	2	2	1
92	-335.844	139.434	2	2	2	1	127	-866.025	663.397	2	2	2	1
93	-385.844	110.566	2	2	2	1	128	-1007.532	418.301	2	2	2	1
94	-385.844	-110.566	2	2	2	1	129	-1157.531	331.699	2	2	2	1
95	-335.844	-139.434	2	2	2	1	130	-1157.531	-331.699	2	2	2	1
96	-288.675	-221.132	2	2	2	1	131	-1007.532	-418.301	2	2	2	1
97	-288.675	-278.868	2	2	2	1	132	-866.025	-663.397	2	2	2	1
98	-47.169	-360.566	2	2	2	1	133	-866.025	-836.602	2	2	2	1
99	-97.169	-389.434	2	2	2	1	134	-141.506	-1081.698	2	2	2	1
100	47.169	-360.566	2	2	2	1	135	-291.506	-1168.301	2	2	2	1
101	97.169	-389.434	2	2	2	1	136	141.506	-1081.698	2	2	2	1
102	288.675	-221.132	2	2	2	1	137	291.506	-1168.301	2	2	2	1
103	288.675	-278.868	2	2	2	1	138	866.025	-663.397	2	2	2	1
104	385.844	-110.566	2	2	2	1	139	866.025	-836.603	2	2	2	1

(cont.)

Table C.22 continued.

No.	x	y	q_1	q_2	q_3	f	No.	x	y	q_1	q_2	q_3	f
140	1157.531	-331.699	2	2	2	1	147	-722.820	-184.641	2	2	2	1
141	1007.531	-418.301	2	2	2	1	148	-431.314	-516.340	2	2	2	1
142	201.506	718.301	2	2	2	1	149	-521.314	-533.660	2	2	2	1
143	231.506	631.699	2	2	2	1	150	431.314	-516.339	2	2	2	1
144	-201.506	718.301	2	2	2	1	151	521.314	-533.660	2	2	2	1
145	-231.506	631.699	2	2	2	1	152	662.820	-115.359	2	2	2	1
146	-662.820	-115.359	2	2	2	1	153	722.820	-184.641	2	2	2	1

Note: demands are denoted by q_1 for P30, q_2 for P31, and q_3 for P32.

Table C.23: IPH solution to P1.

Day 1

No.	Route	Load	Distance
1	0 8 26 31 28 3 36 35 20 22 1 32 0	149	118.52
2	0 12 37 44 15 45 33 39 10 49 5 46 0	160	99.25

Day 2

No.	Route	Load	Distance
1	0 6 14 25 24 43 7 23 48 27 0	152	98.45
2	0 11 2 29 21 16 50 34 30 9 38 0	159	99.33
3	0 18 13 41 40 19 42 17 4 47 0	157	109.06
		Total Distance	524.61

Table C.24: IPH solution to P2.

Day 1

No.	Route	Load	Distance
1	0 1 22 2 20 29 34 50 16 11 0	149	103.08
2	0 6 14 25 24 43 7 23 48 27 0	152	98.45
3	0 12 17 44 42 40 41 18 0	136	97.56

Day 2

No.	Route	Load	Distance
1	0 8 31 28 3 36 35 20 2 32 0	157	105.73
2	0 12 15 45 33 39 30 34 9 38 0	157	103.30
3	0 18 25 13 41 4 47 0	153	79.23

Day 3

No.	Route	Load	Distance
1	0 11 2 20 16 34 49 5 0	157	100.79
2	0 6 14 25 43 7 23 48 27 0	142	98.12
3	0 12 37 44 42 19 41 18 0	144	81.46

Day 4

No.	Route	Load	Distance
1	0 8 26 31 28 3 35 20 2 32 0	158	105.66
2	0 12 33 39 10 30 34 9 38 46 0	147	106.66
3	0 18 25 13 41 47 0	144	79.18

Day 5

No.	Route	Load	Distance
1	0 2 20 21 34 49 5 12 0	160	98.34
2	0 18 41 25 0	96	76.53
		Total Distance	1334.11

Table C.25: IPH solution to P3.

Day 1

No.	Route	Load	Distance
1	0 12 37 44 15 45 33 39 10 49 5 46 0	160	99.25

Day 2

No.	Route	Load	Distance
1	0 18 13 41 40 19 42 17 4 47 0	157	109.06

Day 3

No.	Route	Load	Distance
1	0 6 14 25 24 43 7 23 48 27 0	152	98.45

Day 4

No.	Route	Load	Distance
1	0 8 26 31 28 3 36 35 20 22 1 32 0	149	118.52

Day 5

No.	Route	Load	Distance
1	0 11 2 29 21 16 50 34 30 9 38 0	159	99.33
		Total Distance	524.61

Table C.26: IPH solution to P4.

Day 1

No.	Route	Load	Distance
1	0 4 52 46 34 67 0	125	34.56
2	0 6 33 1 73 62 2 75 0	134	59.46
3	0 7 35 8 19 54 13 57 15 29 45 0	140	89.77
4	0 11 65 31 10 58 26 0	136	95.72
5	0 12 72 39 25 55 50 18 24 49 16 0	140	118.63

Day 2

No.	Route	Load	Distance
1	0 17 3 44 32 9 40 0	138	59.40
2	0 22 64 42 43 41 56 23 63 51 0	139	111.41
3	0 27 5 37 20 70 60 71 69 36 47 0	140	108.48
4	0 30 48 21 61 28 74 68 0	134	77.85
5	0 38 66 59 14 53 0	138	94.15
		Total Distance	849.44

Table C.27: IPH solution to P5.

Day 1

No.	Route	Load	Distance
1	0 4 67 0	60	19.46
2	0 7 14 66 11 26 0	138	80.81
3	0 40 9 25 55 18 32 51 0	136	97.58
4	0 62 64 61 21 28 75 0	138	109.30

Day 2

No.	Route	Load	Distance
1	0 11 66 59 14 35 0	139	90.26
2	0 12 72 39 9 31 10 58 0	134	87.38
3	0 16 24 50 32 40 0	129	80.64
4	0 2 28 22 64 43 1 73 0	137	94.44
5	0 30 74 21 5 37 20 15 57 0	139	98.47
6	0 67 46 34 4 0	106	27.76

Day 3

No.	Route	Load	Distance
1	0 62 64 41 56 23 33 6 0	139	104.63
2	0 67 4 0	60	19.46
3	0 8 14 19 54 13 27 52 0	126	80.45
4	0 17 44 32 9 40 0	127	57.01
5	0 26 38 66 11 53 0	138	76.58
6	0 75 28 21 47 48 45 0	137	70.08

Day 4

No.	Route	Load	Distance
1	0 5 20 70 60 71 36 69 21 30 0	140	105.56
2	0 11 66 59 14 0	129	90.13
3	0 12 39 9 31 10 58 0	133	83.68
4	0 16 49 24 50 32 40 0	134	81.27
5	0 68 2 28 64 42 43 1 0	140	93.70
6	0 67 46 34 4 0	106	27.76

Day 5

No.	Route	Load	Distance
1	0 4 45 29 48 47 21 0	131	64.96
2	0 6 33 63 56 64 28 0	140	108.04
3	0 17 3 44 32 9 40 0	138	59.40
4	0 38 65 66 11 53 0	129	77.16
5	0 52 27 54 14 8 67 0	129	78.64
		Total Distance	2064.62

Table C.28: IPH solution to P6.

Day 1

No.	Route	Load	Distance
1	0 35 14 59 11 53 7 0	139	84.34

Day 2

No.	Route	Load	Distance
1	0 12 72 31 25 55 18 50 44 3 51 0	138	119.32

Day 3

No.	Route	Load	Distance
1	0 5 37 20 70 60 71 36 47 48 0	135	94.14

Day 4

No.	Route	Load	Distance
1	0 2 28 61 69 21 74 30 0	138	88.71

Day 5

No.	Route	Load	Distance
1	0 26 58 10 38 65 66 0	135	81.63

Day 6

No.	Route	Load	Distance
1	0 6 33 63 23 56 24 49 16 0	140	92.69

Day 7

No.	Route	Load	Distance
1	0 17 40 32 9 39 0	126	57.01

Day 8

No.	Route	Load	Distance
1	0 15 57 13 54 19 8 46 67 0	138	80.40

Day 9

No.	Route	Load	Distance
1	0 68 62 22 64 42 41 43 1 73 0	136	94.63

Day 10

No.	Route	Load	Distance
1	0 34 52 27 29 45 4 75 0	139	47.07
		Total Distance	839.93

Table C.29: IPH solution to P7.

Day 1

No.	Route	Load	Distance
1	0 12 80 68 24 29 34 78 79 3 77 76 28 0	169	90.26
2	0 26 4 56 23 67 39 25 55 54 0	153	107.08
3	0 50 33 81 51 9 35 71 65 66 20 30 70 1 69 0	195	126.90
4	0 53 40 21 73 72 74 75 22 41 15 43 42 57 2 58 0	169	100.15

Day 2

No.	Route	Load	Distance
1	0 6 96 99 61 16 86 38 14 44 91 100 37 92 95 0	192	100.27
2	0 13 87 97 98 85 93 59 94 0	189	55.57
3	0 27 31 10 32 90 63 64 49 19 11 62 88 0	191	124.84
4	0 52 7 82 48 47 36 46 8 45 17 84 5 60 83 18 89 0	200	124.38
		Total Distance	829.44

Table C.30: IPH solution to P8.

Day 1

No.	Route	Load	Distance
1	0 5 83 45 46 36 49 47 48 88 31 0	188	121.50
2	0 40 73 74 75 23 39 25 55 24 29 34 81 68 0	200	137.07
3	0 87 44 86 16 85 59 94 0	194	79.82

Day 2

No.	Route	Load	Distance
1	0 6 96 59 93 85 100 98 92 97 95 94 0	193	56.58
2	0 13 87 42 15 43 14 38 86 61 5 89 0	194	114.81
3	0 18 82 48 47 49 19 62 31 0	184	96.31
4	0 26 4 39 67 23 72 21 58 53 0	189	95.12
5	0 28 12 68 77 3 79 81 33 50 0	171	68.12

Day 3

No.	Route	Load	Distance
1	0 5 16 86 44 91 85 59 94 0	195	79.01
2	0 27 70 30 32 66 65 71 9 34 78 81 76 0	197	134.70
3	0 31 10 11 64 49 47 48 8 45 83 60 0	196	127.23
4	0 68 54 39 23 75 22 2 87 0	183	107.56

Day 4

No.	Route	Load	Distance
1	0 5 61 86 38 14 100 37 97 87 13 0	196	100.72
2	0 26 4 39 67 23 56 72 21 58 53 0	195	96.01
3	0 28 12 68 77 3 79 81 33 50 0	171	68.12
4	0 31 62 19 49 47 48 82 18 89 0	199	97.31
5	0 94 95 59 85 93 99 96 0	158	47.75

Day 5

No.	Route	Load	Distance
1	0 1 51 81 9 35 71 65 66 20 30 69 27 0	182	122.16
2	0 5 84 17 86 85 59 94 0	166	78.77
3	0 31 10 32 90 63 11 49 47 48 7 52 0	198	114.21
4	0 76 68 80 54 39 23 22 41 57 87 0	189	111.39
		Total Distance	2054.25

Table C.31: IPH solution to P9.

Day 1

No.	Route	Load	Distance
1	0 27 31 10 32 90 63 64 49 19 11 62 88 0	191	124.84

Day 2

No.	Route	Load	Distance
1	0 50 33 81 51 9 35 71 65 66 20 30 70 1 69 0	195	126.90

Day 3

No.	Route	Load	Distance
1	0 52 7 82 48 47 36 46 8 45 17 84 5 60 83 18 89 0	200	124.38

Day 4

No.	Route	Load	Distance
1	0 53 40 21 73 72 74 75 22 41 15 43 42 57 2 58 0	169	100.15

Day 5

No.	Route	Load	Distance
1	0 6 96 99 61 16 86 38 14 44 91 100 37 92 95 0	192	100.27

Day 6

No.	Route	Load	Distance
1	0 12 80 68 24 29 34 78 79 3 77 76 28 0	169	90.26

Day 7

No.	Route	Load	Distance
1	0 13 87 97 98 85 93 59 94 0	189	55.57

Day 8

No.	Route	Load	Distance
1	0 26 4 56 23 67 39 25 55 54 0	153	107.08
		Total Distance	829.44

Table C.32: IPH solution to P10.

Day 1

No.	Route	Load	Distance
1	0 94 96 59 93 85 98 97 87 13 0	200	56.90
2	0 26 21 72 56 39 23 75 22 73 58 53 0	196	89.76
3	0 27 31 70 30 32 66 65 71 9 81 0	194	120.45

Day 2

No.	Route	Load	Distance
1	0 12 68 29 24 54 55 25 67 23 39 4 0	197	130.09
2	0 31 10 62 19 49 36 47 48 82 0	193	104.38
3	0 92 37 14 44 38 86 16 61 5 60 89 0	175	101.94

Day 3

No.	Route	Load	Distance
1	0 6 96 99 59 93 85 100 97 95 94 0	190	56.02
2	0 18 83 45 8 7 11 63 90 32 66 20 30 1 69 27 0	188	139.57
3	0 28 26 21 72 75 22 41 87 13 58 53 0	191	83.35
4	0 50 33 81 51 9 71 65 35 34 78 79 3 77 76 0	199	118.79

Day 4

No.	Route	Load	Distance
1	0 2 57 15 43 14 44 38 86 16 61 5 89 0	191	117.12
2	0 12 68 80 54 4 39 67 23 74 40 0	200	109.46
3	0 31 10 62 19 49 47 48 82 52 0	197	101.03

Day 5

No.	Route	Load	Distance
1	0 18 83 5 84 17 45 46 48 47 49 64 11 88 0	198	148.18
2	0 28 76 77 68 3 79 34 81 33 50 0	179	82.86
3	0 87 42 100 91 86 85 59 95 94 0	200	85.53
		Total Distance	1645.42

Table C.33: IPH solution to P11.

Day 1

No.	Route	Load	Distance
1	0 16 35 73 90 26 124 112 33 123 37 105 0	222	18.22
2	0 38 27 48 1 8 30 9 115 56 110 18 58 31 94 93 0	227	75.88
3	0 68 39 25 15 96 121 29 3 4 6 95 0	231	30.26
4	0 87 24 23 11 20 107 80 21 10 13 12 83 2 120 0	235	74.61

Day 2

No.	Route	Load	Distance
1	0 16 130 7 5 127 28 79 8 60 113 128 0	234	52.86
2	0 34 17 85 2 82 22 13 81 10 64 32 118 66 97 14 86 0	196	76.62

Day 3

No.	Route	Load	Distance
1	0 15 29 128 131 19 74 33 0	233	28.46
2	0 36 7 1 5 52 53 78 9 77 57 31 59 116 67 88 0	228	77.05
3	0 70 17 2 12 109 108 40 65 21 20 11 61 125 24 41 104 0	224	56.09

Day 4

No.	Route	Load	Distance
1	0 6 130 75 54 5 1 9 30 114 8 18 128 0	235	63.31
2	0 16 38 35 37 91 25 51 89 39 0	183	19.07
3	0 102 98 2 12 22 13 106 10 32 63 117 11 62 23 119 14 71 103 0	225	75.05

Day 5

No.	Route	Load	Distance
1	0 26 6 36 7 126 5 1 28 76 55 129 0	230	47.38
2	0 15 122 19 4 111 92 47 50 69 27 49 0	235	38.01
3	0 34 84 17 99 2 44 43 45 72 100 46 14 42 101 0	201	48.82
		Total Distance	781.68

Table C.34: IPH solution to P12.

Day 1

No.	Route	Load	Distance
1	0 48 76 77 78 79 80 45 44 43 31 32 34 33 14 10 36 111 0	138	150.07
2	0 116 9 8 137 114 115 145 0	140	81.17
3	0 132 151 148 144 143 142 141 140 1 2 3 4 7 5 146 161 162 163 0	140	110.68

Day 2

No.	Route	Load	Distance
1	0 103 72 73 62 61 60 57 59 58 10 15 112 113 117 118 127 0	138	120.30
2	0 114 137 138 139 0	139	76.87

Day 3

No.	Route	Load	Distance
1	0 104 100 99 98 97 92 93 63 87 86 85 84 64 65 54 53 51 48 46 47 43 42 132 0	140	102.27
2	0 105 11 12 13 19 20 21 26 25 5 3 147 150 153 0	140	142.73

Day 4

No.	Route	Load	Distance
1	0 103 81 72 74 71 67 66 55 56 41 35 10 37 38 108 107 40 109 0	133	121.88
2	0 128 114 137 138 0	139	76.94

Day 5

No.	Route	Load	Distance
1	0 91 90 106 39 16 29 17 30 28 18 27 22 23 24 25 6 5 160 135 0	140	147.19
2	0 94 95 110 96 97 89 88 83 82 69 68 70 52 50 49 48 75 72 102 101 0	133	73.31
3	0 136 132 159 152 153 150 149 123 120 122 121 124 119 126 125 154 157 158 155 156 129 130 131 133 134 0	137	62.97
		Total Distance	1266.39

Table C.35: IPH solution to P13.

Day 1

No.	Route	Load	Distance
1	0 18 28 48 82 417 416 105 33 21 0	1999	54.12
2	0 12 25 101 119 20 15 16 0	1849	37.87
3	0 34 60 115 61 63 144 303 0	1985	36.83
4	0 37 383 371 406 377 367 374 364 252 39 0	1963	46.83
5	0 67 133 165 164 155 149 0	1994	59.67
6	0 72 111 336 338 344 102 94 0	1989	93.16
7	0 170 152 167 159 162 157 156 146 184 0	1995	62.78
8	0 195 248 214 193 192 226 233 300 0	1915	20.62
9	0 262 241 251 244 317 263 277 0	1984	69.53

Day 2

No.	Route	Load	Distance
1	0 3 128 51 127 26 0	1526	20.76
2	0 7 76 35 171 168 151 148 73 19 0	2000	80.88
3	0 10 77 121 13 30 116 71 0	1690	36.62
4	0 11 120 139 66 41 123 0	1547	37.01
5	0 23 31 379 385 1 45 43 0	1946	64.22
6	0 194 293 196 227 220 289 213 190 284 0	1967	22.65
7	0 218 269 266 174 188 180 178 304 0	1880	30.64
8	0 350 331 349 343 395 409 396 0	1885	114.72

Day 3

No.	Route	Load	Distance
1	0 2 55 32 74 113 6 85 0	1860	68.02
2	0 4 141 5 52 57 29 93 0	1856	57.94
3	0 27 109 143 402 389 380 137 0	1963	53.07
4	0 75 17 154 36 166 153 147 0	1990	73.12
5	0 130 9 24 89 335 334 351 341 0	1951	98.53
6	0 187 234 307 216 274 199 198 281 0	1968	36.04
7	0 242 243 318 305 253 306 250 0	1837	61.71
8	0 271 254 259 309 215 186 312 0	1964	47.32

(cont.)

Table C.35 continued.

Day 4

No.	Route	Load	Distance
1	0 122 8 21 33 91 22 64 0	1960	50.51
2	0 14 97 357 40 359 353 134 0	1995	78.53
3	0 16 98 25 20 15 86 99 34 0	1988	43.55
4	0 59 78 117 65 140 135 0	1852	44.01
5	0 142 124 28 18 38 37 268 203 183 0	1937	39.89
6	0 175 308 235 225 228 182 0	1475	17.34
7	0 229 232 209 197 208 200 219 207 310 0	1977	25.13
8	0 285 272 230 176 296 201 282 0	1506	40.64
9	0 260 283 287 311 299 264 0	1808	41.17

Day 5

No.	Route	Load	Distance
1	0 3 88 100 81 108 12 0	1774	39.16
2	0 42 221 179 316 315 0	1500	12.01
3	0 58 163 158 169 161 160 278 0	1821	74.11
4	0 103 23 31 388 405 398 384 390 0	1993	106.74
5	0 206 217 204 210 237 236 202 290 212 238 0	1990	25.90
6	0 265 302 256 301 295 211 279 0	1950	60.54
7	0 297 386 382 399 373 369 363 381 0	1960	61.34
8	0 313 314 39 249 401 414 375 372 387 0	1990	41.78
9	0 345 348 320 325 323 328 327 342 352 0	1979	187.35

Day 6

No.	Route	Load	Distance
1	0 10 118 136 138 90 84 26 0	1936	37.77
2	0 11 106 19 150 36 172 35 7 104 0	1975	82.44
3	0 29 5 413 394 404 0	1905	110.61
4	0 30 13 27 80 46 1 47 49 0	1985	47.27
5	0 83 355 333 360 361 332 347 145 0	1935	146.87
6	0 87 126 125 131 53 92 0	1995	29.16
7	0 189 223 275 257 245 247 246 224 0	1956	29.18

(cont.)

Table C.35 continued.

Day 6

No.	Route	Load	Distance
8	0 255 270 276 288 292 280 294 0	1920	28.39
9	0 322 324 326 329 319 321 330 358 0	1910	136.89

Day 7

No.	Route	Load	Distance
1	0 4 356 354 362 339 340 337 9 0	1994	98.70
2	0 14 6 32 50 44 2 415 8 22 0	1827	68.19
3	0 17 95 69 112 70 68 114 24 0	1877	80.85
4	0 38 298 410 376 400 407 370 411 412 0	1970	59.37
5	0 96 40 397 403 393 392 408 346 0	1968	112.61
6	0 110 378 366 391 368 365 0	1962	67.52
7	0 129 79 62 54 107 56 132 0	1981	28.62
8	0 173 205 261 291 222 231 185 267 0	1915	28.64
9	0 177 181 191 258 239 273 240 286 0	1925	57.33
		Total Distance	3624.77

Table C.36: IPH solution to P14.

Day 1

No.	Route	Load	Distance
1	0 1 20 3 12 19 8 0	16	123.48
2	0 2 4 11 18 7 0	15	120.57

Day 2

No.	Route	Load	Distance
1	0 1 13 3 9 14 5 0	16	123.48
2	0 2 4 10 6 0	14	115.22

Day 3

No.	Route	Load	Distance
1	0 1 3 12 8 0	14	115.22
2	0 7 11 4 17 2 0	15	118.13

Day 4

No.	Route	Load	Distance
1	0 1 3 9 5 0	14	115.22
2	0 2 16 4 10 15 6 0	16	123.48
		Total Distance	954.81

Table C.37: IPH solution to P15.

Day 1

No.	Route	Load	Distance
1	0 1 23 3 5 31 19 32 15 11 7 0	26	245.26
2	0 2 4 6 35 21 17 13 9 0	24	220.74

Day 2

No.	Route	Load	Distance
1	0 1 3 5 38 22 18 14 29 10 0	25	226.10
2	0 2 26 4 6 34 20 16 12 25 8 0	26	229.01

Day 3

No.	Route	Load	Distance
1	0 1 30 3 5 19 15 11 24 7 0	25	223.31
2	0 2 27 4 6 21 36 17 13 28 9 0	26	244.91

Day 4

No.	Route	Load	Distance
1	0 1 3 5 22 37 18 14 10 0	24	236.65
2	0 2 4 6 20 33 16 12 8 0	24	236.65
		Total Distance	1862.63

Table C.38: IPH solution to P16.

Day 1

No.	Route	Load	Distance
1	0 1 40 3 48 5 7 56 32 55 28 24 47 20 16 39 12 0	38	403.39
2	0 2 36 4 44 6 8 30 26 22 18 14 35 10 0	35	337.71

Day 2

No.	Route	Load	Distance
1	0 1 3 5 7 49 29 50 25 21 17 13 9 0	34	359.46
2	0 2 4 45 6 8 31 27 23 19 15 38 11 0	34	334.79

Day 3

No.	Route	Load	Distance
1	0 1 33 3 5 7 32 28 24 20 16 12 0	33	318.34
2	0 2 37 4 6 8 52 30 51 26 22 43 18 14 10 0	36	383.97

Day 4

No.	Route	Load	Distance
1	0 1 3 41 5 7 29 25 21 42 17 13 34 9 0	35	356.39
2	0 2 4 6 8 53 31 54 27 23 46 19 15 11 0	35	381.05
		Total Distance	2875.10

Table C.39: IPH solution to P17.

Day 1

No.	Route	Load	Distance
1	0 1 9 25 17 5 24 40 16 0	20	114.36
2	0 2 6 7 3 0	20	170.71
3	0 4 14 36 22 8 23 38 15 0	20	114.36

Day 2

No.	Route	Load	Distance
1	0 1 5 8 4 0	20	170.71
2	0 2 11 30 19 6 18 27 10 0	20	114.30
3	0 13 34 21 7 20 31 12 3 0	20	114.36

Day 3

No.	Route	Load	Distance
1	0 9 26 17 5 24 39 16 1 0	20	114.36
2	0 2 6 7 3 0	20	170.71
3	0 4 15 37 23 8 22 35 14 0	20	114.36

Day 4

No.	Route	Load	Distance
1	0 1 5 8 4 0	20	170.71
2	0 2 10 28 18 6 19 29 11 0	20	114.35
3	0 3 12 32 20 7 21 33 13 0	20	114.36
		Total Distance	1597.66

Table C.40: IPH solution to P18.

Day 1

No.	Route	Load	Distance
1	0 1 45 5 9 44 75 36 28 59 20 0	26	203.65
2	0 2 49 6 10 39 66 31 23 50 15 0	26	203.64
3	0 3 7 11 41 33 25 54 17 0	24	195.78
4	0 4 56 8 12 42 34 26 55 18 0	25	196.54

Day 2

No.	Route	Load	Distance
1	0 1 5 61 9 37 62 29 21 46 13 0	26	206.87
2	0 2 6 10 38 30 22 14 0	23	194.30
3	0 3 7 69 11 40 32 24 51 16 0	25	199.76
4	0 4 8 12 43 35 27 58 19 0	24	195.78

Day 3

No.	Route	Load	Distance
1	0 1 60 5 9 44 36 28 20 0	24	195.06
2	0 2 48 6 65 10 39 31 23 15 0	25	199.04
3	0 3 53 7 11 41 70 33 25 17 0	25	202.17
4	0 4 57 8 72 12 42 71 34 26 18 0	26	206.15

Day 4

No.	Route	Load	Distance
1	0 1 5 76 9 37 29 21 13 0	24	198.28
2	0 2 6 64 10 38 63 30 22 47 14 0	26	206.86
3	0 3 52 7 68 11 40 67 32 24 16 0	26	206.15
4	0 4 8 73 12 43 74 35 27 19 0	25	205.39
		Total Distance	3215.43

Table C.41: IPH solution to P19.

Day 1

No.	Route	Load	Distance
1	0 1 65 5 9 13 64 56 48 95 40 32 79 24 0	35	293.45
2	0 2 6 10 14 58 50 42 34 26 67 18 0	33	285.58
3	0 3 7 89 11 15 60 103 52 44 87 36 28 20 0	35	310.21
4	0 4 77 8 92 12 109 16 62 54 46 91 38 30 22 0	36	305.20

Day 2

No.	Route	Load	Distance
1	0 1 80 5 96 9 97 13 57 98 49 41 82 33 25 66 17 0	38	321.71
2	0 2 68 6 85 10 100 14 59 102 51 43 35 27 70 19 0	37	314.60
3	0 3 72 7 11 15 61 106 53 45 90 37 29 74 21 0	36	308.48
4	0 4 76 8 12 108 16 63 110 55 47 39 31 23 0	35	309.18

Day 3

No.	Route	Load	Distance
1	0 1 5 9 13 112 64 111 56 48 40 32 24 0	34	307.84
2	0 2 69 6 84 10 14 58 99 50 42 83 34 26 18 0	36	310.97
3	0 3 73 7 11 104 15 60 52 44 36 28 71 20 0	35	295.60
4	0 4 8 93 12 16 62 107 54 46 38 30 75 22 0	35	304.59

Day 4

No.	Route	Load	Distance
1	0 1 5 81 9 13 57 49 41 33 25 17 0	33	288.08
2	0 2 6 10 101 14 59 51 43 86 35 27 19 0	34	300.46
3	0 3 7 88 11 105 15 61 53 45 37 29 21 0	34	297.34
4	0 4 8 12 16 63 55 47 94 39 31 78 23 0	34	292.69
		Total Distance	4845.97

Table C.42: IPH solution to P20.

Day 1

No.	Route	Load	Distance
1	0 1 5 121 9 13 168 17 21 97 89 81 154 73 65 138 57 49 122 41 33 106 25 0	56	532.05
2	0 2 6 124 10 14 157 18 22 173 99 174 91 83 158 75 67 59 51 126 43 35 0	54	554.98
3	0 3 7 11 145 15 19 23 176 100 175 92 84 76 68 143 60 52 127 44 36 111 28 0	56	536.72
4	0 4 8 133 12 149 16 164 20 24 103 95 87 79 71 150 63 55 134 47 39 118 31 0	56	517.28

Day 2

No.	Route	Load	Distance
1	0 1 105 5 9 152 13 153 17 21 184 104 183 96 88 80 72 64 56 48 40 32 0	55	529.87
2	0 27 6 10 140 14 18 22 172 98 90 82 74 66 139 58 50 123 42 34 107 26 2 0	57	504.93
3	0 3 113 7 128 11 15 19 23 101 178 93 85 77 69 146 61 53 45 37 114 29 0	55	519.24
4	0 4 116 8 12 16 20 24 180 102 179 94 86 163 78 70 62 54 46 38 30 0	54	528.65

Day 3

No.	Route	Load	Distance
1	0 1 5 136 9 13 17 21 169 97 170 89 81 73 65 57 49 41 33 25 0	53	507.84
2	0 2 108 6 10 141 14 18 22 99 91 83 75 67 142 59 51 43 35 110 0	52	490.45
3	0 3 112 7 11 15 161 19 23 100 92 84 159 76 68 60 52 44 36 28 0	53	505.22
4	0 4 117 8 12 148 16 20 24 181 103 182 95 87 166 79 71 63 55 47 39 31 0	55	537.93

Day 4

No.	Route	Load	Distance
1	0 1 120 5 9 137 13 17 21 104 96 88 167 80 72 151 64 56 135 48 40 119 32 0	56	522.08
2	0 2 27 109 6 125 10 14 156 18 22 98 171 90 82 155 74 66 58 50 42 34 26 0	57	543.80
3	0 3 7 129 11 144 15 160 19 23 177 101 93 85 162 77 69 61 53 130 45 37 29 0	56	530.66
4	0 4 8 132 12 16 165 20 24 102 94 86 78 70 147 62 54 131 46 38 115 30 0	55	508.02
		Total Distance	8369.72

Table C.43: IPH solution to P21.

Day 1

No.	Route	Load	Distance
1	0 24 59 36 7 25 38 13 1 0	20	107.00
2	0 2 3 4 5 0	20	50.00
3	0 6 12 11 10 0	20	200.00
4	0 15 42 27 8 9 29 46 17 0	20	156.70

Day 2

No.	Route	Load	Distance
1	0 1 7 26 8 40 14 0	20	152.29
2	0 2 43 28 9 16 3 0	20	107.94
3	0 4 19 50 31 10 30 48 18 0	20	107.00
4	0 5 20 51 32 11 33 53 21 0	20	107.01
5	0 6 22 56 34 12 35 58 23 0	20	107.00

Day 3

No.	Route	Load	Distance
1	0 24 60 36 7 25 37 13 1 0	20	107.00
2	0 2 3 4 5 0	20	50.00
3	0 10 11 12 6 0	20	200.00
4	0 15 41 8 27 9 29 45 17 0	20	155.64

Day 4

No.	Route	Load	Distance
1	0 1 7 8 26 39 14 0	20	153.35
2	0 2 28 9 44 16 3 0	20	107.94
3	0 4 19 49 31 10 30 47 18 0	20	107.00
4	0 5 20 52 32 11 33 54 21 0	20	107.01
5	0 6 22 55 34 12 35 57 23 0	20	107.00
		Total Distance	2189.90

Table C.44: IPH solution to P22.

Day 1

No.	Route	Load	Distance
1	0 1 30 90 7 54 113 66 13 55 43 31 68 0	30	204.22
2	0 2 20 70 8 14 57 45 33 21 0	26	188.66
3	0 3 23 76 35 9 47 15 58 97 46 34 73 0	30	201.81
4	0 4 24 78 36 10 48 102 16 61 49 37 80 0	30	198.43
5	0 5 27 83 39 11 51 17 62 105 50 38 81 0	30	201.83
6	0 6 28 86 40 52 110 18 65 111 53 12 29 0	30	199.24

Day 2

No.	Route	Load	Distance
1	0 1 19 7 91 13 114 42 89 6 0	27	188.58
2	0 2 69 32 44 93 56 14 95 8 71 3 0	30	199.95
3	0 4 5 0	10	30.00
4	0 22 74 9 98 15 59 60 16 10 25 0	30	273.26
5	0 26 11 17 63 108 109 64 18 12 41 0	30	279.01

Day 3

No.	Route	Load	Distance
1	0 1 31 43 92 55 13 66 54 7 30 0	28	203.67
2	0 2 20 8 14 57 96 45 33 21 0	26	192.09
3	0 3 34 46 58 15 99 47 9 35 23 0	28	197.22
4	0 4 79 37 49 104 61 16 48 10 36 77 24 0	30	201.59
5	0 5 82 38 50 62 17 107 51 11 39 84 27 0	30	198.19
6	0 6 28 85 40 52 18 65 112 53 12 87 29 0	30	199.21

Day 4

No.	Route	Load	Distance
1	0 1 19 67 7 13 42 6 0	25	186.33
2	0 2 32 44 56 14 94 8 72 22 3 0	30	200.39
3	0 4 5 0	10	30.00
4	0 75 9 15 59 100 101 60 16 103 10 25 0	30	278.43
5	0 26 11 106 17 63 64 18 12 41 88 0	30	275.88
		Total Distance	4327.96

Table C.45: IPH solution to P23.

Day 1

No.	Route	Load	Distance
1	0 1 37 7 49 122 61 73 146 85 19 145 13 60 48 119 36 0	40	299.46
2	0 2 38 50 123 62 74 147 86 20 149 14 125 8 101 27 0	37	291.99
3	0 3 9 15 153 21 89 154 77 65 53 41 29 0	34	286.03
4	0 4 30 42 54 131 66 78 90 22 16 132 10 109 31 0	37	280.02
5	0 5 32 112 44 56 68 80 92 23 17 11 45 6 0	40	282.04
6	0 35 117 47 12 59 142 71 83 95 24 94 82 18 70 58 46 115 0	40	316.15

Day 2

No.	Route	Load	Distance
1	0 1 26 8 14 20 87 75 63 126 51 39 2 0	38	283.68
2	0 3 105 9 129 15 21 88 76 64 52 40 28 0	34	276.12
3	0 4 108 10 133 16 22 91 158 79 67 134 55 43 5 0	39	291.70
4	0 6 34 116 12 143 72 84 167 96 19 13 121 7 97 25 0	40	316.25
5	0 33 11 57 69 17 81 161 23 93 163 164 24 165 18 141 0	40	428.65

Day 3

No.	Route	Load	Distance
1	0 1 99 38 50 62 74 86 20 148 14 124 8 27 2 0	40	285.38
2	0 3 104 9 15 152 21 89 77 65 130 53 41 106 29 0	36	282.76
3	0 4 31 10 16 156 22 90 155 78 66 54 42 107 30 0	37	287.50
4	0 5 32 111 44 56 135 68 80 159 92 23 17 137 11 45 114 0	39	291.02
5	0 6 36 120 48 60 144 13 168 19 85 73 61 49 7 37 98 0	40	294.18
6	0 35 118 47 12 59 71 83 95 24 94 82 18 70 139 58 46 0	39	315.70

Day 4

No.	Route	Load	Distance
1	0 1 26 100 8 14 20 87 150 75 63 51 39 102 2 0	40	288.72
2	0 3 9 128 15 21 88 151 76 64 127 52 40 103 28 0	36	287.57
3	0 4 10 16 157 22 91 79 67 55 43 110 5 0	37	282.76
4	0 6 34 57 138 69 81 162 93 23 160 17 136 11 113 33 0	37	298.58
5	0 12 140 18 24 166 84 96 19 13 72 7 25 0	40	417.03

Total Distance 6683.29

Table C.46: IPH solution to P24.

Day 1

No.	Route	Load	Distance
1	0 1 51 15 49 6 5 0	19	235.67
2	0 2 3 24 9 26 4 0	19	290.96

Day 2

No.	Route	Load	Distance
1	0 1 17 7 18 2 3 0	19	290.96
2	0 4 5 33 11 34 6 0	19	290.96

Day 3

No.	Route	Load	Distance
1	0 1 39 12 36 6 0	15	233.23
2	0 13 40 2 20 8 23 3 0	20	246.65
3	0 4 29 10 31 5 47 14 0	20	246.65

Day 4

No.	Route	Load	Distance
1	0 1 50 15 48 6 5 0	19	235.56
2	0 4 27 9 25 3 2 0	19	290.96

Day 5

No.	Route	Load	Distance
1	0 1 16 7 19 2 0	15	233.23
2	0 6 35 11 32 5 46 0	17	235.92
3	0 43 42 3 4 44 0	14	184.71

Day 6

No.	Route	Load	Distance
1	0 1 38 12 37 6 0	15	233.23
2	0 3 22 8 21 2 41 13 0	20	246.65
3	0 5 30 10 28 4 45 14 0	20	246.65
		Total Distance	3741.98

Table C.47: IPH solution to P25.

Day 1

No.	Route	Load	Distance
1	0 1 51 15 49 6 0	16	177.94
2	0 2 40 13 42 3 0	16	177.78
3	0 4 28 29 10 31 5 0	18	244.77

Day 2

No.	Route	Load	Distance
1	0 4 26 9 24 3 43 0	18	235.92
2	0 6 35 11 33 5 46 14 0	20	246.65
3	0 41 2 18 7 16 1 50 0	20	238.62

Day 3

No.	Route	Load	Distance
1	0 2 21 20 8 23 3 0	18	244.77
2	0 5 47 45 4 0	14	173.49
3	0 48 6 37 12 39 38 1 0	20	247.47

Day 4

No.	Route	Load	Distance
1	0 15 1 2 13 3 0	19	247.10
2	0 6 5 30 10 4 0	19	289.82

Day 5

No.	Route	Load	Distance
1	0 2 19 7 17 1 0	16	233.23
2	0 3 25 9 27 4 44 14 0	20	246.65
3	0 5 32 11 34 6 0	16	233.23

Day 6

No.	Route	Load	Distance
1	0 1 12 36 6 5 0	19	289.82
2	0 2 8 22 3 4 0	19	289.82
		Total Distance	3817.08

Table C.48: IPH solution to P26.

Day 1

No.	Route	Load	Distance
1	0 1 51 49 6 48 0	16	176.19
2	0 2 40 13 42 3 0	17	177.78
3	0 4 44 14 47 5 0	17	177.78

Day 2

No.	Route	Load	Distance
1	0 1 16 7 18 2 0	17	233.23
2	0 3 24 9 27 4 0	17	233.23
3	0 5 33 11 34 6 15 0	20	245.85

Day 3

No.	Route	Load	Distance
1	0 2 20 8 23 3 0	17	233.23
2	0 46 5 31 10 29 4 0	19	235.92
3	0 6 37 12 39 1 0	17	233.23

Day 4

No.	Route	Load	Distance
1	0 1 2 13 43 3 0	20	234.91
2	0 4 45 14 5 6 0	20	234.91

Day 5

No.	Route	Load	Distance
1	0 2 19 7 17 1 50 0	19	235.92
2	0 3 25 9 26 4 0	17	233.23
3	0 5 32 11 35 6 15 0	20	245.85

Day 6

No.	Route	Load	Distance
1	0 1 38 12 36 6 0	17	233.23
2	0 3 22 8 21 2 41 0	19	235.92
3	0 5 30 10 28 4 0	17	233.23
		Total Distance	3833.64

Table C.49: IPH solution to P27.

Day 1

No.	Route	Load	Distance
1	0 1 7 89 27 87 12 0	19	1166.14
2	0 3 38 37 14 35 36 2 0	19	256.32
3	0 4 10 96 29 98 11 0	19	888.91
4	0 5 47 48 17 50 49 6 0	19	256.32
5	0 15 9 93 28 91 8 92 0	20	921.87

Day 2

No.	Route	Load	Distance
1	0 1 31 13 34 2 56 19 0	20	246.65
2	0 3 9 73 23 72 8 0	19	1166.13
3	0 4 10 79 25 82 11 0	19	1166.14
4	0 6 12 100 30 102 7 0	19	888.91
5	0 20 62 5 61 0	11	131.59

Day 3

No.	Route	Load	Distance
1	0 1 53 54 18 52 6 21 0	20	257.40
2	0 2 8 69 22 67 7 0	19	1166.13
3	0 4 41 40 3 57 58 0	16	202.02
4	0 5 10 77 24 76 9 0	19	1199.77
5	0 12 85 26 84 11 97 16 0	20	1190.18

Day 4

No.	Route	Load	Distance
1	0 1 7 90 27 88 12 0	19	1166.12
2	0 2 8 28 94 9 14 0	20	905.37
3	0 5 4 42 15 39 3 0	19	290.96
4	0 6 17 11 29 95 10 0	20	920.84

Day 5

No.	Route	Load	Distance
1	0 1 32 13 33 2 55 19 0	20	246.65
2	0 3 9 74 23 71 8 0	19	1166.13
3	0 5 11 81 25 80 10 0	19	1166.14
4	0 6 12 99 30 101 7 0	19	888.91
5	0 20 60 4 59 0	11	131.59

(cont.)

Table C.49 continued.

Day 6

No.	Route	Load	Distance
1	0 2 8 70 22 68 7 0	19	1166.14
2	0 3 9 75 24 78 10 0	19	1166.13
3	0 4 43 44 16 45 46 5 0	19	256.32
4	0 11 83 26 86 12 18 51 0	20	1187.79
5	0 63 6 64 21 66 1 65 0	19	183.33
		Total Distance	21946.89

Table C.50: IPH solution to P28.

Day 1

No.	Route	Load	Distance
1	0 2 1 21 63 6 0	19	234.98
2	0 3 9 93 28 8 0	19	885.88
3	0 11 82 25 80 10 95 16 0	20	1190.18
4	0 12 100 30 101 7 53 54 0	20	897.16
5	0 59 4 60 62 5 61 0	18	178.88

Day 2

No.	Route	Load	Distance
1	0 1 2 19 3 0	17	234.31
2	0 4 10 96 29 11 0	19	885.88
3	0 6 49 47 48 5 0	16	204.76
4	0 7 89 27 87 12 17 50 0	20	1195.34
5	0 14 9 74 23 72 8 33 0	20	1189.88

Day 3

No.	Route	Load	Distance
1	0 1 6 5 4 0	20	288.67
2	0 2 35 36 38 37 3 0	18	216.31
3	0 31 13 7 68 22 69 8 0	20	1187.79
4	0 15 9 76 24 78 10 42 0	20	1189.88
5	0 18 12 86 26 84 11 20 0	20	1191.77

Day 4

No.	Route	Load	Distance
1	0 2 1 65 21 6 0	19	234.99
2	0 3 4 43 45 5 0	19	261.52
3	0 7 102 30 99 12 52 51 0	20	897.16
4	0 8 91 28 94 9 39 40 0	20	897.16
5	0 10 79 25 81 11 97 16 0	20	1190.18

Day 5

No.	Route	Load	Distance
1	0 1 66 64 6 5 0	19	231.23
2	0 2 56 19 58 3 0	16	177.78
3	0 4 10 29 98 11 0	19	885.88
4	0 9 73 23 71 8 92 14 0	20	1190.18
5	0 17 12 88 27 90 7 32 0	20	1189.87

(cont.)

Table C.50 continued.

Day 6

No.	Route	Load	Distance
1	0 1 2 55 57 3 0	19	231.23
2	0 6 5 44 4 20 0	19	259.69
3	0 8 70 22 67 7 13 34 0	20	1187.79
4	0 9 75 24 77 10 15 41 0	20	1187.79
5	0 18 12 85 26 83 11 46 0	20	1189.88
		Total Distance	22384.04

Table C.51: IPH solution to P29.

Day 1

No.	Route	Load	Distance
1	0 2 1 65 21 6 0	20	234.99
2	0 3 4 60 20 5 0	20	234.91
3	0 9 73 23 71 8 13 0	20	1185.63
4	0 11 81 25 79 10 15 0	20	1185.63
5	0 12 88 27 90 7 101 0	19	1179.60

Day 2

No.	Route	Load	Distance
1	0 1 32 31 34 33 2 0	18	216.31
2	0 3 39 40 41 42 4 0	18	216.31
3	0 5 48 47 49 50 6 0	18	216.31
4	0 7 68 22 70 8 28 0	20	1230.21
5	0 10 77 24 75 9 14 0	20	1185.63
6	0 12 86 26 84 11 17 0	20	1185.62

Day 3

No.	Route	Load	Distance
1	0 1 66 64 6 5 0	19	231.23
2	0 2 19 58 3 4 0	20	234.91
3	0 11 97 29 96 10 16 0	20	908.40
4	0 12 99 30 102 7 18 0	20	908.40
5	0 37 94 9 93 91 8 92 0	20	895.12

Day 4

No.	Route	Load	Distance
1	0 1 54 51 6 63 21 0	19	206.41
2	0 3 38 36 35 2 0	16	204.76
3	0 4 59 20 62 5 61 0	19	180.48
4	0 8 72 23 74 9 15 0	20	1185.63
5	0 11 82 25 80 10 95 0	19	1179.61
6	0 12 87 27 89 7 13 0	20	1185.63

Day 5

No.	Route	Load	Distance
1	0 1 2 55 57 3 0	19	231.23
2	0 4 44 45 5 6 0	19	250.95
3	0 28 8 69 22 67 7 0	20	1230.21

(cont.)

Table C.51 continued.

Day 5

No.	Route	Load	Distance
4	0 14 9 76 24 78 10 0	20	1185.63
5	0 12 85 26 83 11 17 0	20	1185.62

Day 6

No.	Route	Load	Distance
1	0 1 53 18 52 6 0	17	233.23
2	0 2 56 19 3 0	15	177.18
3	0 4 43 16 46 5 0	17	233.23
4	0 8 7 30 100 12 0	20	1174.56
5	0 9 10 29 98 11 0	20	1174.56
		Total Distance	22668.10

Table C.52: IPH solution to P30.

Day 1

No.	Route	Load	Distance
1	0 1 68 69 66 67 6 5 0	20	274.04
2	0 3 53 51 50 2 70 25 0	19	218.18
3	0 4 10 110 112 11 23 0	19	906.96
4	0 7 104 33 45 18 12 0	20	2007.35
5	0 109 9 15 144 87 8 107 0	20	1998.19
6	0 16 131 40 133 17 32 99 0	20	3680.95
7	0 20 14 121 37 119 13 152 0	20	3553.83

Day 2

No.	Route	Load	Distance
1	0 1 81 27 79 6 0	15	177.94
2	0 2 8 106 34 52 3 0	19	655.28
3	0 5 60 61 22 59 4 74 0	19	247.47
4	0 9 15 125 38 122 14 0	19	3498.40
5	0 10 30 16 147 97 96 35 0	20	2180.36
6	0 11 17 134 41 137 18 0	19	3498.40
7	0 12 103 153 13 83 7 80 0	20	2043.19

Day 3

No.	Route	Load	Distance
1	0 2 48 19 47 1 6 0	19	290.96
2	0 3 21 4 75 26 5 0	20	292.65
3	0 7 105 102 12 114 36 24 0	20	1033.22
4	0 8 14 142 43 29 9 0	20	2010.71
5	0 10 16 128 39 127 15 0	19	3498.40
6	0 11 17 148 44 31 94 95 0	20	2001.93
7	0 150 18 139 42 140 13 28 0	20	3672.80

Day 4

No.	Route	Load	Distance
1	0 1 2 71 25 72 3 0	19	235.52
2	0 4 58 10 111 113 11 63 0	20	882.88
3	0 6 64 65 23 62 5 77 0	19	252.35
4	0 7 33 45 151 18 12 0	20	2010.71

(cont.)

Table C.52 continued.

Day 4

No.	Route	Load	Distance
5	0 8 14 120 37 118 13 0	19	3498.40
6	0 9 15 145 88 89 108 20 0	19	1811.99
7	0 32 17 132 40 130 16 146 0	20	3672.80

Day 5

No.	Route	Load	Distance
1	0 1 27 78 6 5 76 0	19	237.67
2	0 2 8 84 85 7 117 116 0	20	1047.44
3	0 73 3 55 56 57 4 0	16	207.46
4	0 9 90 91 30 16 10 0	19	2006.83
5	0 12 101 100 98 11 35 22 0	20	1087.89
6	0 13 18 136 41 135 17 0	19	4364.43
7	0 15 124 38 123 14 86 34 0	20	3538.02

Day 6

No.	Route	Load	Distance
1	0 2 49 19 46 1 0	15	233.23
2	0 3 54 21 4 26 5 0	20	293.18
3	0 6 12 115 36 7 24 0	20	905.37
4	0 8 14 143 43 29 9 0	20	2010.71
5	0 10 31 44 149 17 11 0	20	2010.71
6	0 15 126 39 129 16 93 92 0	19	3546.50
7	0 82 28 13 141 42 138 18 0	20	3643.21
		Total Distance	75238.50

Table C.53: IPH solution to P31.

Day 1

No.	Route	Load	Distance
1	0 1 116 7 8 0	17	880.65
2	0 2 71 25 73 3 0	16	177.78
3	0 4 60 61 5 6 0	19	258.42
4	0 9 89 88 145 144 15 30 0	20	2095.94
5	0 11 113 35 111 10 110 22 0	20	912.95
6	0 12 18 151 150 103 115 0	18	1870.01
7	0 14 120 37 119 13 28 82 0	20	3643.21
8	0 16 131 40 132 17 99 98 0	20	3546.50

Day 2

No.	Route	Load	Distance
1	0 1 2 70 72 3 0	19	231.23
2	0 6 67 12 11 23 0	19	896.67
3	0 7 83 13 152 104 105 27 0	20	1861.07
4	0 9 108 34 107 8 19 0	18	908.40
5	0 10 146 16 147 44 31 95 0	20	1992.03
6	0 15 124 38 123 14 143 20 0	20	3545.96
7	0 26 77 5 59 58 4 74 0	20	216.80
8	0 114 18 137 41 134 17 148 0	20	3543.29

Day 3

No.	Route	Load	Distance
1	0 2 3 21 57 4 0	19	289.82
2	0 76 5 6 0	12	175.90
3	0 8 14 43 29 9 0	19	2001.63
4	0 10 16 39 127 15 0	19	3481.25
5	0 11 17 32 101 12 0	19	1949.09
6	0 18 138 42 140 13 45 33 0	20	3690.64
7	0 66 24 36 117 7 47 1 0	20	657.78

Day 4

No.	Route	Load	Distance
1	0 80 1 68 69 79 6 78 0	20	210.74
2	0 3 52 53 51 2 25 0	18	217.58

(cont.)

Table C.53 continued.

Day 4

No.	Route	Load	Distance
3	0 4 22 112 11 5 0	19	616.87
4	0 8 7 18 12 0	20	2207.14
5	0 9 15 30 93 10 0	19	1949.09
6	0 14 121 37 118 13 28 85 0	20	3643.21
7	0 16 130 40 133 17 96 35 0	20	3547.94

Day 5

No.	Route	Load	Distance
1	0 2 48 49 46 1 81 27 0	20	218.18
2	0 3 55 56 4 75 26 0	18	206.64
3	0 5 62 63 23 65 64 6 0	20	256.32
4	0 7 13 153 102 12 0	19	1971.24
5	0 10 16 44 31 11 0	19	2001.63
6	0 15 125 38 122 14 84 19 0	20	3530.43
7	0 18 136 41 135 17 149 97 0	20	3612.44
8	0 20 9 109 34 106 8 50 0	20	912.66

Day 6

No.	Route	Load	Distance
1	0 1 7 36 24 6 0	19	656.90
2	0 2 3 4 5 0	20	288.67
3	0 8 14 142 43 29 86 87 0	20	2001.93
4	0 11 17 32 100 12 0	19	1949.09
5	0 15 126 39 129 128 16 94 0	20	3699.70
6	0 18 139 42 141 13 45 33 0	20	3690.64
7	0 21 10 92 91 90 9 54 0	20	1047.56
		Total Distance	77263.61

Table C.54: IPH solution to P32.

Day 1

No.	Route	Load	Distance
1	0 1 81 79 6 5 0	19	231.23
2	0 2 107 8 106 34 20 0	20	659.07
3	0 25 73 3 55 56 4 0	19	206.64
4	0 7 13 153 45 33 105 0	20	1944.20
5	0 9 92 93 16 10 0	19	1926.31
6	0 12 100 98 99 11 23 0	19	1043.31
7	0 14 122 38 124 15 21 0	20	3513.40
8	0 17 135 41 137 18 101 0	19	3526.50

Day 2

No.	Route	Load	Distance
1	0 1 47 19 48 2 0	17	233.23
2	0 3 9 90 91 10 0	19	1003.41
3	0 5 61 60 58 4 26 0	19	228.15
4	0 6 12 36 117 7 0	20	885.88
5	0 8 143 142 14 28 82 0	19	2016.35
6	0 11 17 149 44 31 97 0	20	1981.93
7	0 13 141 42 138 18 32 0	20	3632.38
8	0 15 127 39 129 16 30 0	20	3632.38

Day 3

No.	Route	Load	Distance
1	0 1 7 116 24 69 27 0	20	604.32
2	0 2 70 72 3 0	14	173.49
3	0 4 59 22 35 113 11 0	20	661.07
4	0 5 62 64 65 6 0	16	204.76
5	0 8 43 144 15 9 0	20	2000.63
6	0 10 16 40 133 17 0	20	3481.25
7	0 12 18 150 103 102 115 66 0	20	1806.95
8	0 13 119 37 120 14 29 0	20	3632.38

Day 4

No.	Route	Load	Distance
1	0 3 54 21 57 4 0	17	233.23

(cont.)

Table C.54 continued.

Day 4

No.	Route	Load	Distance
2	0 5 11 12 23 0	18	885.52
3	0 7 83 13 152 45 33 0	20	1995.95
4	0 9 89 87 8 34 20 0	20	1030.16
5	0 10 16 147 146 94 95 111 0	20	1897.55
6	0 14 123 38 125 15 88 0	19	3526.50
7	0 18 136 41 134 17 63 0	19	3501.82
8	0 25 2 1 6 78 0	20	246.45

Day 5

No.	Route	Load	Distance
1	0 2 49 19 46 1 80 0	19	235.92
2	0 3 109 108 9 10 0	19	911.20
3	0 4 74 26 76 5 0	17	177.78
4	0 6 12 114 36 7 0	20	885.88
5	0 8 86 14 28 84 85 0	19	1997.19
6	0 11 17 148 44 31 96 0	20	1944.19
7	0 13 140 42 139 18 32 0	20	3632.38
8	0 15 126 39 128 16 30 0	20	3632.38

Day 6

No.	Route	Load	Distance
1	0 1 68 24 67 6 27 0	20	245.85
2	0 71 2 50 51 53 52 3 0	20	219.01
3	0 4 75 77 5 0	14	173.49
4	0 7 104 151 18 12 0	19	1979.82
5	0 8 43 145 15 9 0	20	2000.63
6	0 11 112 35 110 10 22 0	20	908.40
7	0 13 118 37 121 14 29 0	20	3632.38
8	0 16 131 130 40 132 17 0	19	3671.61
		Total Distance	78794.46

Table C.55: Initial solution to P2.

Day 1

No.	Route	Load	Distance
1	0 12 4 41 19 42 44 45 10 38 46 0	138	115.53
2	0 18 25 43 23 48 27 0	128	90.88
3	0 26 31 36 20 29 21 34 50 2 22 32 0	152	155.69

Day 2

No.	Route	Load	Distance
1	0 6 25 13 41 18 47 0	159	85.59
2	0 8 3 20 2 11 0	116	85.64
3	0 12 5 49 39 30 34 9 16 0	153	100.33

Day 3

No.	Route	Load	Distance
1	0 12 41 42 44 33 34 38 0	149	133.36
2	0 18 25 14 43 7 23 48 0	153	98.59
3	0 27 31 28 35 20 2 32 0	127	96.39

Day 4

No.	Route	Load	Distance
1	0 6 25 13 41 18 47 0	159	85.59
2	0 8 3 20 2 11 0	116	85.64
3	0 12 5 49 39 30 34 9 16 0	153	100.33

Day 5

No.	Route	Load	Distance
1	0 1 7 24 14 25 40 41 18 0	160	144.48
2	0 12 0	29	16.12
3	0 17 37 15 33 34 2 20 35 28 0	160	157.19
		Total Distance	1551.36

Table C.56: Initial solution to P5.

Day 1

No.	Route	Load	Distance
1	0 4 52 34 67 40 0	131	57.56
2	0 8 14 11 66 65 0	130	86.52
3	0 26 72 39 9 55 32 44 3 51 0	139	99.81
4	0 48 47 21 69 36 70 15 13 54 0	134	125.78
5	0 63 49 23 42 64 22 28 62 75 0	140	119.50

Day 2

No.	Route	Load	Distance
1	0 2 28 64 43 1 6 0	138	93.68
2	0 4 30 21 20 27 0	119	90.33
3	0 14 66 11 53 0	127	81.57
4	0 17 40 24 16 33 0	126	80.87
5	0 32 9 31 38 58 0	127	95.22
6	0 46 67 0	57	22.57

Day 3

No.	Route	Load	Distance
1	0 4 52 54 8 34 67 0	130	60.39
2	0 10 39 9 50 32 44 0	138	86.52
3	0 11 66 59 14 0	129	90.13
4	0 26 12 40 56 64 62 0	139	119.15
5	0 28 21 47 48 5 45 0	138	79.04
6	0 75 0	20	6.00

Day 4

No.	Route	Load	Distance
1	0 2 28 64 43 1 6 0	138	93.68
2	0 4 30 21 20 27 0	119	90.33
3	0 14 66 11 53 0	127	81.57
4	0 17 40 24 16 33 0	126	80.87
5	0 32 9 31 38 58 0	127	95.22
6	0 46 67 0	57	22.57

(cont.)

Table C.56 continued.

Day 5

No.	Route	Load	Distance
1	0 4 19 59 14 35 67 0	140	85.08
2	0 7 11 66 10 12 0	131	83.16
3	0 32 50 18 25 9 40 0	139	81.42
4	0 45 29 5 57 37 60 71 21 74 0	137	112.40
5	0 68 28 61 64 41 56 73 0	129	119.63
		Total Distance	2340.54

Table C.57: Initial solution to P8.

Day 1

No.	Route	Load	Distance
1	0 2 87 97 37 86 38 43 41 23 39 25 55 56 73 0	199	181.18
2	0 6 60 83 8 46 45 17 84 5 61 85 92 59 96 94 0	200	108.67
3	0 53 76 68 80 24 29 78 81 9 35 71 20 70 31 69 0	196	137.16
4	0 88 10 63 11 64 49 47 48 82 7 18 89 0	197	128.05

Day 2

No.	Route	Load	Distance
1	0 5 16 86 44 14 100 85 93 0	198	87.93
2	0 13 87 59 95 94 0	124	46.88
3	0 21 72 22 75 23 39 54 26 0	167	90.52
4	0 28 12 68 77 79 81 33 0	145	68.07
5	0 31 30 32 19 49 47 48 0	181	120.15

Day 3

No.	Route	Load	Distance
1	0 4 39 67 23 87 97 59 94 0	197	113.42
2	0 27 31 10 62 11 49 47 48 82 0	199	101.69
3	0 50 81 9 66 65 71 34 3 68 76 0	191	130.57
4	0 53 58 0	32	18.63
5	0 89 18 83 45 5 61 86 38 85 96 0	196	116.69

Day 4

No.	Route	Load	Distance
1	0 5 16 86 44 14 100 85 93 0	198	87.93
2	0 13 87 59 95 94 0	124	46.88
3	0 21 72 22 75 23 39 54 26 0	167	90.52
4	0 28 12 68 77 79 81 33 0	145	68.07
5	0 31 30 32 19 49 47 48 0	181	120.15

Day 5

No.	Route	Load	Distance
1	0 1 50 51 66 65 34 81 3 68 0	167	130.05
2	0 5 86 91 85 98 59 99 94 0	177	78.23
3	0 27 31 62 90 49 36 47 48 52 0	172	113.81
4	0 40 4 39 67 23 74 57 15 42 87 58 0	185	128.48
		Total Distance	2313.75

Table C.58: Initial solution to P10.

Day 1

No.	Route	Load	Distance
1	0 5 59 85 44 86 14 87 0	194	99.23
2	0 6 95 94 0	50	32.38
3	0 12 68 54 4 39 23 22 58 0	188	98.11
4	0 48 47 49 62 31 30 81 0	186	131.97

Day 2

No.	Route	Load	Distance
1	0 5 83 8 47 49 48 0	139	105.48
2	0 13 87 16 85 93 59 96 94 0	197	67.93
3	0 21 72 23 67 39 0	121	91.97
4	0 31 32 66 81 79 68 0	160	106.17

Day 3

No.	Route	Load	Distance
1	0 18 82 19 11 63 62 10 30 27 0	139	105.89
2	0 26 12 54 4 75 22 58 53 0	141	79.56
3	0 28 76 77 3 34 65 71 9 33 50 0	145	110.62
4	0 89 45 61 86 38 14 44 100 98 97 95 0	192	119.42

Day 4

No.	Route	Load	Distance
1	0 1 32 66 81 79 68 0	143	107.35
2	0 5 83 48 47 49 31 0	157	108.43
3	0 13 87 16 85 93 59 96 94 0	197	67.93
4	0 21 72 23 67 39 0	121	91.97

Day 5

No.	Route	Load	Distance
1	0 26 73 74 41 75 56 25 55 24 29 80 3 77 76 0	129	125.45
2	0 27 69 70 20 51 9 71 65 35 34 78 33 50 28 0	162	127.29
3	0 52 18 82 7 88 10 90 64 11 19 36 46 45 17 84 60 89 0	157	169.32
4	0 53 40 2 57 42 15 43 38 86 61 91 100 37 97 92 99 0	170	134.14
		Total Distance	2080.63

Table C.59: Initial solution to P11.

Day 1

No.	Route	Load	Distance
1	0 16 41 24 20 107 21 64 10 13 12 2 43 42 0	229	79.03
2	0 25 15 33 19 29 3 4 26 0	233	29.71
3	0 27 92 7 1 28 8 30 9 31 39 67 0	206	73.06

Day 2

No.	Route	Load	Distance
1	0 17 99 2 45 22 13 32 63 80 11 14 103 87 0	220	85.05
2	0 34 16 38 48 69 35 90 6 15 51 37 0	214	43.31
3	0 111 36 127 5 52 53 78 8 77 58 18 128 130 0	234	87.64

Day 3

No.	Route	Load	Distance
1	0 33 29 128 131 26 124 0	229	28.87
2	0 39 31 9 28 1 5 7 47 73 105 0	215	63.49
3	0 72 2 82 12 40 21 10 20 11 23 66 24 86 0	224	68.83

Day 4

No.	Route	Load	Distance
1	0 25 15 96 122 74 19 121 128 113 60 8 30 9 115 56 110 57 59 116 89 93 68 88 104 0	220	60.82
2	0 34 84 70 98 120 17 85 2 44 83 12 109 22 13 81 106 10 117 62 61 118 125 119 97 14 71 101 0	231	90.02
3	0 35 6 130 75 55 54 76 1 5 126 7 36 50 49 38 0	216	54.55

Day 5

No.	Route	Load	Distance
1	0 14 23 11 32 65 108 46 100 2 17 102 16 0	235	62.17
2	0 27 5 1 79 114 18 129 94 0	225	62.03
3	0 91 4 6 112 123 37 95 0	208	25.83
		Total Distance	914.42

Table C.60: Initial solution to P12.

Day 1

No.	Route	Load	Distance
1	0 38 117 115 114 9 10 29 28 19 27 22 25 7 4 3 2 147 0	139	149.62
2	0 97 41 42 33 32 31 43 45 46 56 60 61 67 51 48 49 72 103 0	134	142.24
3	0 132 156 155 150 153 159 160 0	59	51.69

Day 2

No.	Route	Load	Distance
1	0 39 37 10 17 5 132 0	128	122.55
2	0 72 48 53 88 0	63	70.51
3	0 114 137 138 139 0	139	76.87

Day 3

No.	Route	Load	Distance
1	0 96 91 40 108 36 113 15 14 13 8 20 23 26 24 25 6 3 146 143 122 149 154 0	137	156.21
2	0 99 97 43 44 47 58 59 57 84 64 66 62 71 70 52 50 73 79 81 102 103 0	140	138.29
3	0 131 130 158 150 153 162 163 135 0	55	51.64

Day 4

No.	Route	Load	Distance
1	0 10 5 138 132 0	127	114.65
2	0 48 80 72 101 0	70	103.90
3	0 114 137 129 0	134	75.88

Day 5

No.	Route	Load	Distance
1	0 94 95 110 90 107 106 34 35 11 12 16 30 18 21 5 1 140 141 142 145 123 120 121 124 119 118 126 125 127 128 133 134 0	140	149.56
2	0 100 98 92 93 89 85 83 82 65 55 54 68 69 76 78 77 75 74 86 87 63 104 0	56	82.87
3	0 105 109 111 112 116 137 144 148 151 157 152 161 136 0	136	82.62
		Total Distance	1569.11

Table C.61: Initial solution to P13.

Day 1

No.	Route	Load	Distance
1	0 6 32 405 145 333 83 94 60 0	1960	151.79
2	0 16 20 86 99 57 136 118 0	1850	52.69
3	0 38 298 407 370 377 367 39 314 225 0	1965	54.71
4	0 79 126 230 224 218 0	1240	51.11
5	0 102 114 68 336 362 321 326 334 0	1864	135.36
6	0 140 24 172 151 164 167 157 156 161 0	1910	88.32
7	0 183 292 28 43 82 33 415 110 294 0	1927	57.79
8	0 214 193 192 204 237 210 197 213 289 281 0	1888	27.48
9	0 246 258 242 262 301 254 297 260 0	1980	81.92

Day 2

No.	Route	Load	Distance
1	0 8 134 408 416 46 49 45 0	1979	98.00
2	0 10 98 101 88 12 121 0	1835	37.90
3	0 13 30 127 3 26 0	1200	28.82
4	0 21 23 379 368 389 380 400 375 0	1994	75.45
5	0 34 93 131 62 132 67 0	1857	46.67
6	0 78 19 159 158 146 41 66 123 0	1980	75.61
7	0 104 35 7 112 344 325 361 355 0	1896	187.96
8	0 179 296 272 266 188 247 261 0	1945	48.62
9	0 195 381 256 241 209 232 284 310 0	1863	90.40

Day 3

No.	Route	Load	Distance
1	0 4 9 75 17 111 171 36 133 0	1918	96.07
2	0 15 29 5 50 2 44 417 31 1 18 0	1953	81.30
3	0 40 404 409 347 320 345 335 341 0	1935	168.42
4	0 128 51 27 25 90 138 0	1836	47.79
5	0 144 107 61 65 59 11 282 0	1888	52.30
6	0 178 181 191 174 245 0	1150	39.76
7	0 202 295 243 305 306 263 240 0	1890	71.59

(cont.)

Table C.61 continued.

Day 3

No.	Route	Load	Distance
8	0 203 37 383 363 382 299 274 199 219 0	1995	69.49
9	0 235 288 187 226 196 293 194 267 0	1900	28.13

Day 4

No.	Route	Load	Distance
1	0 16 6 74 32 357 350 52 0	1985	88.95
2	0 20 14 105 91 33 22 122 0	1945	55.71
3	0 24 69 322 348 393 392 390 84 0	1991	164.04
4	0 28 109 378 365 137 38 0	1810	58.22
5	0 125 89 154 148 152 160 0	2000	93.70
6	0 130 58 269 277 318 286 223 0	1861	96.21
7	0 175 308 234 233 248 0	1450	21.85
8	0 207 190 291 279 208 200 217 0	1794	38.69
9	0 252 39 406 369 287 283 276 0	1783	53.81

Day 5

No.	Route	Load	Distance
1	0 3 8 47 402 143 313 206 0	1975	67.53
2	0 12 100 81 119 34 87 53 0	1945	48.05
3	0 23 385 366 55 359 331 0	1792	99.62
4	0 117 19 150 35 162 163 278 120 0	1853	89.61
5	0 189 275 180 239 244 312 198 231 229 0	1976	75.51
6	0 227 238 290 264 307 270 300 0	1973	29.64
7	0 285 201 221 315 303 0	1205	32.85
8	0 311 386 373 411 374 410 371 401 414 0	1980	62.66
9	0 338 356 330 319 327 332 395 394 384 0	1995	209.71

Day 6

No.	Route	Load	Distance
1	0 9 168 7 337 72 141 4 63 0	1990	104.99
2	0 10 353 349 343 403 398 346 97 0	1993	129.75
3	0 11 169 166 147 165 135 0	1915	81.90
4	0 21 391 1 64 27 13 30 0	1840	68.50
5	0 25 15 85 5 96 113 77 0	1953	66.40

(cont.)

Table C.61 continued.

Day 6

No.	Route	Load	Distance
6	0 26 129 92 56 0	1210	22.24
7	0 142 37 364 265 271 251 257 0	1875	94.21
8	0 228 220 212 236 216 255 280 0	1775	35.42
9	0 339 354 329 324 323 342 352 360 0	1910	184.06

Day 7

No.	Route	Load	Distance
1	0 22 48 103 31 388 2 14 108 0	1893	89.15
2	0 29 40 397 413 396 0	1930	110.51
3	0 54 115 17 36 155 153 149 0	1935	76.14
4	0 71 116 80 18 124 0	1217	40.17
5	0 76 95 70 340 358 328 351 0	1995	181.46
6	0 106 73 170 139 184 42 316 0	1905	58.81
7	0 173 205 250 253 317 273 177 176 304 0	1963	76.36
8	0 182 399 412 376 249 372 387 268 0	1800	61.52
9	0 185 222 186 215 211 309 302 259 0	1884	53.34
		Total Distance	4966.77

Table C.62: Initial solution to P14.

Day 1

No.	Route	Load	Distance
1	0 1 12 3 9 5 0	16	132.17
2	0 2 10 4 11 0	14	132.17

Day 2

No.	Route	Load	Distance
1	0 1 8 3 13 14 0	14	124.51
2	0 2 7 4 16 15 6 0	16	126.38

Day 3

No.	Route	Load	Distance
1	0 1 12 3 9 5 0	16	132.17
2	0 2 10 4 11 0	14	132.17

Day 4

No.	Route	Load	Distance
1	0 1 3 20 19 8 0	14	119.81
2	0 2 6 4 17 18 7 0	16	126.38
		Total Distance	1025.75

Table C.63: Initial solution to P15.

Day 1

No.	Route	Load	Distance
1	0 1 14 18 22 5 19 15 3 7 0	27	276.07
2	0 2 4 17 21 6 20 16 0	23	270.16

Day 2

No.	Route	Load	Distance
1	0 1 23 24 11 5 3 30 29 10 0	23	228.19
2	0 2 8 25 26 12 6 4 27 13 28 9 0	27	243.37

Day 3

No.	Route	Load	Distance
1	0 1 14 18 22 5 19 15 3 7 0	27	276.07
2	0 2 4 17 21 6 20 16 0	23	270.16

Day 4

No.	Route	Load	Distance
1	0 1 11 32 31 5 38 37 3 10 0	23	308.50
2	0 2 8 12 33 34 4 6 35 36 13 9 0	27	314.98
		Total Distance	2187.49

Table C.64: Initial solution to P16.

Day 1

No.	Route	Load	Distance
1	0 1 3 20 24 28 32 7 5 29 25 21 9 0	36	427.08
2	0 2 4 22 26 30 6 8 31 27 23 19 0	34	421.42

Day 2

No.	Route	Load	Distance
1	0 1 33 34 13 42 17 41 7 5 3 40 16 39 12 0	34	358.06
2	0 2 10 35 36 14 43 18 44 8 6 4 37 15 38 11 0	36	361.74

Day 3

No.	Route	Load	Distance
1	0 1 3 20 24 28 32 7 5 29 25 21 9 0	36	427.08
2	0 2 4 22 26 30 6 8 31 27 23 19 0	34	421.42

Day 4

No.	Route	Load	Distance
1	0 1 13 17 50 49 5 7 56 55 47 48 3 16 12 0	34	506.51
2	0 2 10 14 18 51 52 6 8 53 54 46 45 4 15 11 0	36	507.19
		Total Distance	3430.49

Table C.65: Initial solution to P17.

Day 1

No.	Route	Load	Distance
1	0 1 16 24 5 17 9 0	18	111.40
2	0 2 0	5	20.00
3	0 3 22 8 23 4 0	19	119.83
4	0 18 6 19 20 7 21 0	18	181.43

Day 2

No.	Route	Load	Distance
1	0 1 25 5 26 0	12	105.83
2	0 2 11 30 29 6 28 27 10 0	18	118.59
3	0 3 12 31 7 32 13 0	16	110.69
4	0 4 14 8 15 0	14	102.89

Day 3

No.	Route	Load	Distance
1	0 1 16 24 5 17 9 0	18	111.40
2	0 2 0	5	20.00
3	0 3 22 8 23 4 0	19	119.83
4	0 18 6 19 20 7 21 0	18	181.43

Day 4

No.	Route	Load	Distance
1	0 1 40 5 39 0	12	105.83
2	0 2 10 6 11 0	14	102.89
3	0 3 12 33 7 34 13 0	16	110.69
4	0 4 15 38 37 8 36 35 14 0	18	118.59
		Total Distance	1741.33

Table C.66: Initial solution to P18.

Day 1

No.	Route	Load	Distance
1	0 1 28 36 44 9 37 29 5 13 0	27	217.62
2	0 2 6 30 38 10 39 31 0	23	216.06
3	0 3 7 32 40 11 41 33 0	23	216.06
4	0 4 26 8 34 42 12 43 35 27 0	27	221.88

Day 2

No.	Route	Load	Distance
1	0 1 45 46 21 9 5 60 59 20 0	23	200.30
2	0 2 15 49 50 23 6 10 22 47 48 14 0	27	206.98
3	0 3 17 53 54 25 7 11 24 51 52 16 0	27	207.05
4	0 4 18 55 56 12 8 57 58 19 0	23	198.34

Day 3

No.	Route	Load	Distance
1	0 1 28 36 44 9 37 29 5 13 0	27	217.62
2	0 2 6 30 38 10 39 31 0	23	216.06
3	0 3 7 32 40 11 41 33 0	23	216.06
4	0 4 26 8 34 42 12 43 35 27 0	27	221.88

Day 4

No.	Route	Load	Distance
1	0 1 21 62 61 9 76 75 5 20 0	23	234.51
2	0 2 15 23 66 65 10 64 63 6 22 14 0	27	238.89
3	0 3 17 25 7 70 69 11 68 67 24 16 0	27	238.98
4	0 4 19 74 73 12 72 71 8 18 0	23	234.17
		Total Distance	3502.45

Table C.67: Initial solution to P19.

Day 1

No.	Route	Load	Distance
1	0 1 40 48 56 64 13 57 49 41 9 5 17 0	36	344.03
2	0 2 6 10 43 51 59 14 58 50 42 0	32	342.51
3	0 3 7 37 45 11 53 61 15 60 52 44 36 0	36	346.67
4	0 4 8 38 46 54 62 16 63 55 12 47 39 0	36	346.67

Day 2

No.	Route	Load	Distance
1	0 1 65 66 25 33 82 13 9 81 5 32 79 80 24 0	34	301.32
2	0 2 19 69 70 27 35 86 85 10 14 84 83 34 6 26 67 68 18 0	40	338.69
3	0 3 21 73 74 29 7 88 11 15 87 28 71 72 20 0	34	300.03
4	0 4 23 77 78 31 16 12 8 30 75 76 22 0	32	286.60

Day 3

No.	Route	Load	Distance
1	0 1 40 48 56 64 13 57 49 41 9 5 17 0	36	344.03
2	0 2 6 10 43 51 59 14 58 50 42 0	32	342.51
3	0 3 7 37 45 11 53 61 15 60 52 44 36 0	36	346.67
4	0 4 8 38 46 54 62 16 63 55 12 47 39 0	36	346.67

Day 4

No.	Route	Load	Distance
1	0 1 25 33 9 98 97 13 112 111 95 96 5 32 24 0	34	382.74
2	0 2 19 27 35 102 101 14 100 99 10 34 6 26 18 0	36	372.09
3	0 3 20 28 7 89 11 103 104 15 105 106 90 29 21 0	34	362.68
4	0 4 23 31 8 93 94 110 109 16 108 107 12 92 91 30 22 0	36	399.22
		Total Distance	5503.13

Table C.68: Initial solution to P20.

Day 1

No.	Route	Load	Distance
1	0 1 56 64 72 13 80 88 96 104 17 21 97 89 81 73 65 57 9 5 25 0	58	620.07
2	0 2 6 10 58 66 14 74 82 90 98 22 18 99 91 83 75 67 59 0	54	618.57
3	0 3 7 11 61 69 15 77 85 93 101 19 23 100 92 84 76 68 60 0	54	618.57
4	0 4 8 12 62 70 16 78 86 94 102 24 20 103 95 87 79 71 63 0	54	618.57

Day 2

No.	Route	Load	Distance
1	0 1 33 5 41 49 9 152 13 168 17 153 154 170 169 21 184 183 167 151 48 40 32 0	52	687.03
2	0 2 26 34 42 50 155 171 172 22 173 174 158 157 18 156 14 10 51 43 6 35 27 0	54	678.33
3	0 3 29 37 7 45 53 146 162 178 177 23 176 175 159 160 19 161 15 145 11 52 44 36 28 0	56	688.54
4	0 4 30 38 46 54 147 148 16 165 20 164 163 179 180 24 181 182 166 150 149 12 55 47 8 39 31 0	58	745.96

Day 3

No.	Route	Load	Distance
1	0 1 56 64 72 13 80 88 96 104 17 21 97 89 81 73 65 57 9 5 25 0	58	620.07
2	0 2 6 10 58 66 14 74 82 90 98 22 18 99 91 83 75 67 59 0	54	618.57
3	0 3 7 11 61 69 15 77 85 93 101 19 23 100 92 84 76 68 60 0	54	618.57
4	0 4 8 12 62 70 16 78 86 94 102 24 20 103 95 87 79 71 63 0	54	618.57

Day 4

No.	Route	Load	Distance
1	0 1 105 106 33 5 121 41 122 49 138 21 17 13 137 9 136 135 48 40 119 120 32 0	52	527.12
2	0 2 26 108 107 34 42 123 50 124 10 140 139 22 18 14 141 142 51 126 43 125 6 35 110 109 27 0	58	595.30
3	0 3 29 113 114 37 45 130 53 129 11 144 15 19 23 143 52 127 44 128 7 36 111 112 28 0	56	537.87
4	0 4 31 117 118 39 8 133 47 134 55 24 20 16 12 132 54 131 46 38 115 116 30 0	54	514.27
		Total Distance	9925.96

Table C.69: Initial solution to P21.

Day 1

No.	Route	Load	Distance
1	0 2 1 24 23 6 0	19	64.28
2	0 3 4 5 0	15	40.00
3	0 13 25 7 36 35 12 34 0	20	158.08
4	0 26 8 27 28 9 29 0	18	158.07
5	0 30 10 31 32 11 33 0	18	158.08

Day 2

No.	Route	Load	Distance
1	0 2 1 6 5 0	20	50.00
2	0 3 17 46 45 9 44 43 16 0	18	111.78
3	0 4 18 47 10 48 19 0	16	105.09
4	0 14 15 42 41 8 40 39 38 7 37 0	20	176.42
5	0 21 20 11 12 22 0	16	157.95

Day 3

No.	Route	Load	Distance
1	0 2 1 24 23 6 0	19	64.28
2	0 3 4 5 0	15	40.00
3	0 13 25 7 36 35 12 34 0	20	158.08
4	0 26 8 27 28 9 29 0	18	158.07
5	0 30 10 31 32 11 33 0	18	158.08

Day 4

No.	Route	Load	Distance
1	0 3 2 1 6 0	20	50.00
2	0 4 18 49 10 50 19 0	16	105.09
3	0 5 20 51 52 11 53 54 21 0	18	111.78
4	0 15 14 8 9 17 16 0	18	164.90
5	0 22 55 56 12 57 58 59 7 60 0	18	169.47
		Total Distance	2359.48

Table C.70: Initial solution to P22.

Day 1

No.	Route	Load	Distance
1	0 1 42 54 66 13 55 43 7 19 0	27	200.24
2	0 2 8 44 56 14 57 45 0	23	199.53
3	0 3 9 47 59 15 58 46 0	23	199.53
4	0 4 10 49 61 16 60 48 0	23	199.53
5	0 5 39 11 51 63 17 62 50 38 0	27	202.41
6	0 6 41 12 53 65 18 64 52 40 0	27	202.41

Day 2

No.	Route	Load	Distance
1	0 1 6 0	10	30.00
2	0 2 20 69 70 32 14 8 33 72 71 21 0	27	195.86
3	0 3 23 76 75 35 9 15 34 73 74 22 0	27	195.87
4	0 4 24 78 77 36 16 10 37 80 79 25 0	27	195.86
5	0 5 27 28 85 86 88 89 90 7 13 31 68 67 30 0	30	239.53
6	0 26 81 82 83 84 11 17 18 12 87 29 0	29	288.83

Day 3

No.	Route	Load	Distance
1	0 1 42 54 66 13 55 43 7 19 0	27	200.24
2	0 2 8 44 56 14 57 45 0	23	199.53
3	0 3 9 47 59 15 58 46 0	23	199.53
4	0 4 10 49 61 16 60 48 0	23	199.53
5	0 5 39 11 51 63 17 62 50 38 0	27	202.41
6	0 6 41 12 53 65 18 64 52 40 0	27	202.41

Day 4

No.	Route	Load	Distance
1	0 1 30 31 7 92 91 13 114 113 29 6 0	30	222.38
2	0 2 20 32 8 93 94 14 95 96 33 21 0	27	215.33
3	0 3 23 35 9 100 99 15 98 97 34 22 0	27	215.34
4	0 4 24 36 10 101 102 16 103 104 37 25 0	27	215.33
5	0 5 26 27 0	9	47.25
6	0 11 105 106 17 107 108 109 110 18 111 112 12 28 0	30	320.74
		Total Distance	4789.66

Table C.71: Initial solution to P23.

Day 1

No.	Route	Load	Distance
1	0 1 60 72 84 96 19 85 73 13 61 7 25 0	36	307.74
2	0 2 8 62 74 86 20 87 75 14 63 0	32	307.06
3	0 3 9 64 15 76 88 21 89 77 65 53 0	34	307.06
4	0 4 10 55 67 79 91 22 90 78 16 66 54 0	36	308.92
5	0 5 11 56 68 80 92 23 93 81 17 69 57 0	36	308.92
6	0 6 12 59 71 83 95 24 94 82 18 70 58 0	36	308.92

Day 2

No.	Route	Load	Distance
1	0 1 6 5 0	15	40.00
2	0 2 26 38 8 50 14 147 148 20 149 150 51 39 27 0	36	326.17
3	0 3 28 40 52 151 152 21 153 154 15 9 41 29 4 0	39	325.31
4	0 30 31 43 42 10 133 16 155 156 22 157 158 134 135 136 11 44 32 0	40	393.36
5	0 33 45 138 137 17 159 160 23 161 162 163 164 24 165 166 18 140 139 46 34 0	40	496.87
6	0 35 47 12 141 142 143 167 168 19 145 146 13 144 49 7 37 48 36 0	40	399.23

Day 3

No.	Route	Load	Distance
1	0 1 60 72 84 96 19 85 73 13 61 7 25 0	36	307.74
2	0 2 8 62 74 86 20 87 75 14 63 0	32	307.06
3	0 3 9 64 15 76 88 21 89 77 65 53 0	34	307.06
4	0 4 10 55 67 79 91 22 90 78 16 66 54 0	36	308.92
5	0 5 11 56 68 80 92 23 93 81 17 69 57 0	36	308.92
6	0 6 12 59 71 83 95 24 94 82 18 70 58 0	36	308.92

Day 4

No.	Route	Load	Distance
1	0 1 36 120 48 119 118 47 117 116 115 34 35 6 0	26	135.78
2	0 2 26 99 100 38 8 50 123 124 14 20 125 126 51 39 102 101 27 0	40	307.73
3	0 3 29 106 105 41 130 129 21 15 128 127 52 9 40 103 104 28 0	38	306.63
4	0 4 31 109 110 43 10 132 16 22 131 42 107 108 30 0	34	281.92
5	0 5 32 112 111 44 23 17 11 45 114 113 33 0	32	275.66
6	0 46 12 18 24 19 13 121 122 49 7 37 97 98 0	40	419.71
		Total Distance	7405.60

Table C.72: Initial solution to P24.

Day 1

No.	Route	Load	Distance
1	0 3 42 40 41 2 1 50 0	20	240.03
2	0 4 45 44 0	8	124.27
3	0 46 5 11 6 49 48 0	17	242.44

Day 2

No.	Route	Load	Distance
1	0 1 38 36 37 0	10	208.44
2	0 2 21 3 9 4 0	17	304.61
3	0 6 35 34 32 33 5 30 0	18	260.74

Day 3

No.	Route	Load	Distance
1	0 1 7 12 6 15 0	17	343.57
2	0 3 8 2 13 0	14	243.76
3	0 5 10 4 14 0	14	243.76

Day 4

No.	Route	Load	Distance
1	0 1 39 6 11 5 0	17	304.61
2	0 4 28 29 0	8	171.45
3	0 18 2 23 22 3 24 25 26 0	20	327.51

Day 5

No.	Route	Load	Distance
1	0 2 20 19 16 17 1 51 0	18	263.33
2	0 4 27 9 3 43 0	15	234.78
3	0 6 5 31 47 0	12	225.24

Day 6

No.	Route	Load	Distance
1	0 1 7 12 6 15 0	17	343.57
2	0 3 8 2 13 0	14	243.76
3	0 5 10 4 14 0	14	243.76
		Total Distance	4569.60

Table C.73: Initial solution to P25.

Day 1

No.	Route	Load	Distance
1	0 2 41 42 3 0	14	176.07
2	0 6 49 51 1 50 0	16	176.19
3	0 44 4 45 47 5 46 0	18	178.88

Day 2

No.	Route	Load	Distance
1	0 1 38 39 36 0	11	190.32
2	0 2 40 3 4 0	17	231.14
3	0 5 31 33 32 34 35 6 0	20	260.54

Day 3

No.	Route	Load	Distance
1	0 3 9 4 10 14 0	16	330.94
2	0 5 11 6 0	12	230.94
3	0 13 8 2 7 1 12 15 0	20	430.94

Day 4

No.	Route	Load	Distance
1	0 2 20 21 3 0	14	200.68
2	0 4 28 29 30 5 0	16	204.76
3	0 19 17 1 37 6 48 0	18	277.25

Day 5

No.	Route	Load	Distance
1	0 1 16 18 2 23 22 43 0	20	282.68
2	0 3 24 25 26 27 4 0	18	216.31
3	0 5 6 0	10	173.20

Day 6

No.	Route	Load	Distance
1	0 3 9 4 10 14 0	16	330.94
2	0 5 11 6 0	12	230.94
3	0 13 8 2 7 1 12 15 0	20	430.94
		Total Distance	4553.65

Table C.74: Initial solution to P26.

Day 1

No.	Route	Load	Distance
1	0 41 2 1 51 50 0	16	184.70
2	0 42 3 4 45 44 0	16	189.59
3	0 46 5 11 6 49 48 0	19	242.44

Day 2

No.	Route	Load	Distance
1	0 2 1 38 36 37 0	16	266.17
2	0 3 9 4 30 31 0	17	309.25
3	0 5 33 32 34 35 6 0	18	216.31

Day 3

No.	Route	Load	Distance
1	0 1 7 12 6 15 0	19	343.57
2	0 3 8 2 13 0	16	243.76
3	0 5 10 4 14 0	16	243.76

Day 4

No.	Route	Load	Distance
1	0 1 39 6 11 5 0	20	304.61
2	0 2 40 23 22 0	11	198.45
3	0 3 24 25 26 4 28 29 0	20	260.74

Day 5

No.	Route	Load	Distance
1	0 1 6 5 47 0	17	238.52
2	0 2 21 20 18 19 16 17 0	17	265.18
3	0 4 27 9 3 43 0	17	234.78

Day 6

No.	Route	Load	Distance
1	0 1 7 12 6 15 0	19	343.57
2	0 3 8 2 13 0	16	243.76
3	0 5 10 4 14 0	16	243.76
		Total Distance	4572.90

Table C.75: Initial solution to P27.

Day 1

No.	Route	Load	Distance
1	0 1 7 68 67 22 8 0	19	1218.15
2	0 2 56 57 3 58 0	14	178.76
3	0 4 60 5 48 50 6 0	18	271.15
4	0 11 29 10 75 9 28 0	20	1373.00
5	0 21 18 100 27 12 99 52 0	19	1115.39

Day 2

No.	Route	Load	Distance
1	0 1 101 7 90 12 54 66 0	20	981.10
2	0 2 55 19 3 4 59 0	19	237.61
3	0 5 47 49 6 0	12	193.21
4	0 14 9 23 71 69 8 32 0	20	1430.22
5	0 45 97 11 25 79 10 95 0	19	1189.97

Day 3

No.	Route	Load	Distance
1	0 2 1 51 6 0	14	246.87
2	0 3 15 4 20 5 0	18	292.04
3	0 13 70 8 72 74 9 24 0	20	1689.40
4	0 16 10 80 82 11 17 0	18	1057.92
5	0 26 86 12 88 89 7 30 0	20	1635.88

Day 4

No.	Route	Load	Distance
1	0 1 18 6 21 0	14	243.57
2	0 2 34 33 35 38 37 3 0	18	271.11
3	0 4 10 77 9 94 28 0	19	1012.78
4	0 5 11 29 43 42 41 40 0	19	712.44
5	0 12 27 7 22 8 91 0	20	1769.94

Day 5

No.	Route	Load	Distance
1	0 3 4 44 46 62 5 0	18	278.26
2	0 19 2 1 65 0	13	188.72
3	0 31 7 87 12 6 63 64 0	20	966.67
4	0 36 14 8 23 73 9 39 0	20	1186.33
5	0 76 78 10 25 81 11 83 0	19	1751.93

(cont.)

Table C.75 continued.

Day 6

No.	Route	Load	Distance
1	0 2 1 6 0	12	230.94
2	0 3 15 4 20 61 5 0	20	292.65
3	0 13 92 8 7 102 30 53 0	20	987.11
4	0 16 96 10 24 9 93 0	18	1236.57
5	0 17 12 85 26 84 11 98 0	20	1223.52
		Total Distance	25463.21

Table C.76: Initial solution to P28.

Day 1

No.	Route	Load	Distance
1	0 1 53 66 64 6 47 48 0	20	296.26
2	0 4 10 76 75 9 0	19	1003.41
3	0 5 46 11 12 52 0	19	881.44
4	0 7 89 68 67 69 71 8 0	20	1518.94
5	0 56 2 57 3 58 60 0	18	247.19

Day 2

No.	Route	Load	Distance
1	0 1 54 6 49 5 0	19	262.80
2	0 3 40 42 43 44 4 0	18	259.56
3	0 8 23 9 24 10 0	19	1732.05
4	0 21 12 26 11 25 29 45 0	20	1661.73
5	0 30 27 7 22 28 2 55 0	20	1731.31

Day 3

No.	Route	Load	Distance
1	0 1 32 34 13 7 18 51 0	20	664.55
2	0 3 39 14 35 2 19 0	18	289.33
3	0 4 20 5 17 6 0	19	292.04
4	0 12 86 11 10 16 0	19	1311.58
5	0 15 9 74 72 8 70 33 0	20	1208.40

Day 4

No.	Route	Load	Distance
1	0 1 2 3 4 0	20	288.68
2	0 5 81 80 79 10 96 95 0	20	1000.81
3	0 6 99 100 90 102 7 101 0	20	925.41
4	0 12 85 83 11 98 97 0	18	1010.10
5	0 92 8 91 93 9 94 0	18	894.41

Day 5

No.	Route	Load	Distance
1	0 1 2 36 38 3 0	19	250.95
2	0 4 25 11 26 12 0	19	1663.36
3	0 23 73 9 24 77 10 29 0	20	1730.21
4	0 30 27 7 22 8 28 37 0	20	1722.70
5	0 62 5 6 63 21 65 0	18	214.68

(cont.)

Table C.76 continued.

Day 6

No.	Route	Load	Distance
1	0 1 2 3 19 0	17	243.76
2	0 4 15 9 8 14 0	19	920.48
3	0 6 50 17 5 61 20 59 0	20	265.93
4	0 16 11 84 82 10 78 41 0	20	1504.51
5	0 18 12 88 87 7 13 31 0	20	1044.56
		Total Distance	27041.16

Table C.77: Initial solution to P29.

Day 1

No.	Route	Load	Distance
1	0 1 18 30 100 99 6 0	20	549.32
2	0 2 19 0	8	128.28
3	0 3 9 28 91 8 0	20	885.88
4	0 4 60 62 5 63 0	16	220.30
5	0 12 27 90 7 68 67 0	19	1440.30
6	0 17 11 25 10 29 0	19	1238.27

Day 2

No.	Route	Load	Distance
1	0 1 101 7 22 13 0	18	1091.97
2	0 2 55 0	7	123.05
3	0 3 9 23 71 8 0	20	1160.42
4	0 4 15 10 79 95 16 0	20	885.65
5	0 6 49 47 5 20 0	17	206.03
6	0 11 26 12 54 66 21 0	20	1181.29

Day 3

No.	Route	Load	Distance
1	0 1 6 0	10	173.21
2	0 4 43 45 46 5 0	16	215.34
3	0 9 74 72 8 69 70 31 0	20	1249.02
4	0 24 78 10 80 11 48 0	19	1455.66
5	0 52 12 86 88 89 7 53 0	20	1295.73
6	0 56 2 14 3 57 0	17	241.21

Day 4

No.	Route	Load	Distance
1	0 1 6 17 5 0	18	288.67
2	0 2 35 38 37 40 3 58 0	20	269.02
3	0 4 0	5	115.47
4	0 12 27 7 30 18 0	19	1218.78
5	0 19 9 94 28 8 33 0	20	896.28
6	0 29 11 25 10 77 42 0	20	1441.61

Day 5

No.	Route	Load	Distance
1	0 2 1 21 6 0	18	234.41

(cont.)

Table C.77 continued.

Day 5

No.	Route	Load	Distance
2	0 3 39 15 4 44 59 0	19	279.23
3	0 5 20 0	8	128.29
4	0 12 26 83 11 81 97 0	19	1396.17
5	0 13 8 22 7 65 0	18	1174.98
6	0 16 10 76 9 73 23 0	20	1470.89

Day 6

No.	Route	Load	Distance
1	0 1 32 34 2 0	14	203.79
2	0 3 41 4 0	12	189.14
3	0 36 14 92 8 7 102 0	19	930.13
4	0 61 5 50 6 51 64 0	18	249.37
5	0 87 12 85 84 82 11 98 0	20	1500.12
6	0 93 9 75 24 10 96 0	19	1236.20
		Total Distance	26963.47

Table C.78: Initial solution to P30.

Day 1

No.	Route	Load	Distance
1	0 2 72 3 4 5 0	18	288.87
2	0 9 91 92 10 94 113 11 0	20	1413.67
3	0 16 39 15 38 14 89 0	20	5312.01
4	0 31 130 131 17 41 18 101 0	20	4691.88
5	0 68 116 7 83 82 8 106 107 0	20	1061.62
6	0 79 6 67 69 1 81 80 0	18	220.17
7	0 115 12 103 45 13 119 118 0	19	2869.63

Day 2

No.	Route	Load	Distance
1	0 1 27 6 0	11	176.67
2	0 2 53 3 0	10	189.14
3	0 4 22 5 77 26 0	16	244.36
4	0 7 33 153 13 42 18 0	20	3706.18
5	0 9 14 28 84 8 34 0	20	2199.58
6	0 10 35 11 12 114 36 0	20	1238.63
7	0 30 16 128 127 15 145 43 0	20	3233.52
8	0 95 44 149 17 99 32 100 0	18	2225.78

Day 3

No.	Route	Load	Distance
1	0 1 24 6 5 76 0	17	291.37
2	0 3 20 51 2 71 25 0	18	245.50
3	0 4 110 10 111 96 97 11 0	20	1041.37
4	0 7 13 141 139 18 12 0	20	3056.81
5	0 19 8 86 29 9 108 73 0	20	1217.97
6	0 21 90 15 125 14 120 37 0	20	4386.22
7	0 23 98 17 40 129 16 146 0	20	4217.99

Day 4

No.	Route	Load	Distance
1	0 1 47 46 49 48 50 2 0	18	260.54
2	0 3 52 54 55 56 57 4 0	18	260.54
3	0 12 7 85 8 9 109 0	20	1536.50

(cont.)

Table C.78 continued.

Day 4

No.	Route	Load	Distance
4	0 13 45 150 18 41 17 0	20	4389.69
5	0 14 122 38 15 39 16 0	20	5213.30
6	0 59 58 10 31 11 112 61 0	19	1177.15
7	0 60 5 63 62 64 65 6 66 0	20	305.18

Day 5

No.	Route	Load	Distance
1	0 1 8 34 3 2 0	19	743.28
2	0 4 26 5 6 27 0	18	246.93
3	0 7 152 13 42 138 33 0	18	3320.14
4	0 9 30 16 147 44 10 0	20	2211.95
5	0 18 137 136 134 135 133 17 148 0	20	3948.47
6	0 22 35 11 32 12 36 0	20	1282.85
7	0 28 14 143 43 144 15 126 0	20	3580.37

Day 6

No.	Route	Load	Distance
1	0 1 78 6 23 5 0	17	291.51
2	0 2 8 87 88 9 10 0	20	1307.61
3	0 11 17 132 40 16 93 0	19	3509.35
4	0 12 102 105 104 7 117 24 0	19	1067.78
5	0 15 124 123 14 142 29 20 0	20	3221.54
6	0 18 151 140 13 37 121 19 0	20	4608.24
7	0 70 25 3 21 4 75 74 0	20	277.87
		Total Distance	86289.77

Table C.79: Initial solution to P31.

Day 1

No.	Route	Load	Distance
1	0 2 53 52 3 0	14	200.68
2	0 4 59 58 111 10 56 0	18	641.04
3	0 5 60 61 63 65 6 0	18	268.99
4	0 7 103 18 101 12 0	19	1988.91
5	0 11 17 44 16 94 0	19	2676.66
6	0 13 120 14 15 92 0	19	3992.13
7	0 55 54 9 109 106 8 107 0	20	902.06
8	0 79 67 66 69 68 1 80 0	17	212.16

Day 2

No.	Route	Load	Distance
1	0 1 2 25 3 0	17	234.31
2	0 4 10 35 11 22 0	19	902.35
3	0 5 77 26 0	9	128.89
4	0 6 23 12 36 7 0	19	917.82
5	0 8 84 28 37 118 13 27 0	20	3337.89
6	0 9 30 39 16 40 31 95 0	20	4820.24
7	0 14 122 38 125 15 145 34 0	20	3555.90
8	0 33 42 18 41 17 32 99 0	20	5146.64

Day 3

No.	Route	Load	Distance
1	0 1 47 46 49 48 2 71 0	20	219.00
2	0 4 3 73 0	12	175.90
3	0 6 62 5 76 0	14	191.83
4	0 11 96 16 10 110 0	19	1933.62
5	0 12 18 137 17 98 0	19	3056.06
6	0 19 7 13 152 45 114 24 0	20	1984.69
7	0 20 29 15 144 43 14 86 0	20	2819.71
8	0 51 50 8 108 9 21 57 0	20	904.47

Day 4

No.	Route	Load	Distance
1	0 1 2 3 4 0	20	288.68

(cont.)

Table C.79 continued.

Day 4

No.	Route	Load	Distance
2	0 5 6 0	10	173.20
3	0 8 121 14 143 9 0	19	2619.99
4	0 10 113 11 12 0	17	1155.68
5	0 44 149 133 131 130 16 147 146 0	19	3347.06
6	0 115 18 136 134 135 17 148 0	20	3122.63
7	0 116 7 153 13 141 138 151 0	20	2846.54
8	0 129 128 127 126 15 124 123 142 0	19	4272.65

Day 5

No.	Route	Load	Distance
1	0 2 1 81 27 0	14	186.63
2	0 3 9 10 4 0	20	866.03
3	0 6 5 26 0	12	186.02
4	0 7 83 85 8 34 25 0	18	1083.02
5	0 13 42 139 18 150 33 36 0	20	3615.24
6	0 22 35 112 11 100 12 23 0	20	1032.27
7	0 28 37 14 38 15 39 30 0	20	6464.10
8	0 32 41 17 40 16 31 97 0	20	5146.65

Day 6

No.	Route	Load	Distance
1	0 1 2 70 72 3 0	19	231.23
2	0 4 75 74 0	9	124.27
3	0 5 11 64 6 0	17	610.98
4	0 10 93 16 132 17 0	19	2899.63
5	0 19 8 87 89 88 9 21 0	20	1062.80
6	0 20 29 14 43 15 90 91 0	20	2830.63
7	0 24 117 7 105 102 12 78 0	20	1010.88
8	0 82 13 119 140 18 45 104 0	20	3944.97
		Total Distance	90333.72

Table C.80: Initial solution to P32.

Day 1

No.	Route	Load	Distance
1	0 2 72 3 4 0	17	231.14
2	0 5 113 11 12 115 0	19	944.13
3	0 8 82 83 7 116 68 81 0	20	1017.65
4	0 10 92 91 9 89 106 107 0	20	1245.98
5	0 14 118 119 13 45 103 0	19	3235.75
6	0 16 131 130 39 15 38 0	20	5803.78
7	0 79 6 67 69 1 80 0	18	214.06
8	0 94 31 17 41 18 101 0	20	3674.74

Day 2

No.	Route	Load	Distance
1	0 1 7 36 114 12 0	20	885.88
2	0 2 53 9 34 3 0	20	688.46
3	0 4 10 95 35 22 0	18	803.22
4	0 8 84 28 14 43 0	18	2141.32
5	0 11 99 32 17 149 44 0	20	2150.40
6	0 26 77 5 6 27 0	18	199.25
7	0 30 16 128 127 15 145 0	19	3072.64
8	0 33 153 13 42 18 100 0	20	3674.65

Day 3

No.	Route	Load	Distance
1	0 1 6 23 5 0	18	288.67
2	0 4 21 3 73 25 0	18	244.36
3	0 8 86 29 9 108 20 0	20	1204.40
4	0 12 18 139 141 13 0	19	3056.81
5	0 24 7 19 2 51 71 0	20	678.95
6	0 37 120 14 125 15 90 0	19	4382.28
7	0 76 11 97 96 111 10 110 0	20	1041.00
8	0 98 17 40 129 16 146 0	19	4216.83

Day 4

No.	Route	Load	Distance
1	0 1 47 46 49 48 2 0	18	216.31

(cont.)

Table C.80 continued.

Day 4

No.	Route	Load	Distance
2	0 3 56 57 58 59 4 0	18	256.46
3	0 5 63 62 64 65 6 0	18	216.31
4	0 7 13 45 12 66 0	20	1998.86
5	0 10 16 31 112 61 60 0	19	1894.54
6	0 11 17 41 18 150 0	20	3504.53
7	0 15 39 38 122 14 85 0	20	5027.07
8	0 52 50 8 109 9 54 55 0	20	931.61

Day 5

No.	Route	Load	Distance
1	0 3 2 1 27 0	18	243.74
2	0 5 35 22 4 26 0	19	438.77
3	0 6 12 36 7 0	18	882.85
4	0 9 43 144 15 126 30 0	20	2805.30
5	0 10 16 147 44 11 0	20	2000.63
6	0 18 138 42 13 152 33 0	20	3615.24
7	0 28 14 143 8 34 0	18	1977.94
8	0 32 137 136 134 135 133 17 148 0	20	3869.97

Day 6

No.	Route	Load	Distance
1	0 1 78 6 23 5 0	20	291.51
2	0 3 20 2 70 25 0	18	244.36
3	0 8 87 142 29 88 9 0	19	1705.63
4	0 11 10 4 75 74 0	19	874.83
5	0 15 124 123 14 121 37 0	19	4573.97
6	0 17 132 40 16 93 21 0	20	3513.28
7	0 19 7 117 12 24 0	18	905.99
8	0 102 18 151 140 13 104 105 0	20	3168.73
		Total Distance	90254.82

Table C.81: IPH-RCH solution to P2 with $W = 5$.

Day 1

No.	Route	Load	Distance
1	0 12 4 41 19 42 44 45 33 10 38 0	156	118.31
2	0 18 25 43 23 26 48 27 0	135	110.37
3	0 32 22 2 20 36 35 29 21 34 50 46 0	156	127.50

Day 2

No.	Route	Load	Distance
1	0 2 20 3 28 31 8 0	122	87.93
2	0 6 25 13 41 18 47 0	159	85.59
3	0 11 16 34 30 9 49 5 12 0	158	81.21

Day 3

No.	Route	Load	Distance
1	0 12 38 2 20 35 32 0	131	95.46
2	0 14 25 43 7 23 48 27 0	127	94.54
3	0 18 41 42 44 33 39 34 0	160	136.15

Day 4

No.	Route	Load	Distance
1	0 2 20 3 28 31 8 0	122	87.93
2	0 6 25 13 41 18 47 0	159	85.59
3	0 11 16 34 30 9 49 5 12 0	158	81.21

Day 5

No.	Route	Load	Distance
1	0 1 2 20 34 39 15 37 17 12 0	156	134.98
2	0 7 24 14 25 40 41 18 0	153	134.18
		Total Distance	1460.94

Table C.82: IPH-RCH solution to P5 with $W = 8$.

Day 1

No.	Route	Load	Distance
1	0 3 44 32 9 39 72 40 0	135	69.40
2	0 4 52 46 34 67 0	125	34.56
3	0 8 14 66 11 26 0	139	82.48
4	0 51 63 23 42 64 22 28 62 0	127	108.41
5	0 54 13 57 15 36 69 21 48 75 0	138	111.60

Day 2

No.	Route	Load	Distance
1	0 2 28 64 43 1 6 0	138	93.68
2	0 4 27 20 47 21 30 0	138	89.66
3	0 14 66 11 53 0	127	81.57
4	0 17 32 18 24 49 16 33 0	139	91.47
5	0 40 9 31 38 58 0	132	89.80
6	0 67 0	30	10.77

Day 3

No.	Route	Load	Distance
1	0 4 52 54 8 46 34 0	127	59.78
2	0 26 10 39 9 50 32 0	139	83.11
3	0 11 66 59 14 0	129	90.13
4	0 12 40 44 56 64 62 0	138	119.37
5	0 75 28 21 48 5 45 0	139	75.41
6	0 67 0	30	10.77

Day 4

No.	Route	Load	Distance
1	0 1 43 64 28 2 0	119	93.64
2	0 4 27 20 47 21 30 0	138	89.66
3	0 6 33 16 24 32 17 0	140	82.38
4	0 14 66 11 53 0	127	81.57
5	0 40 9 31 38 58 0	132	89.80
6	0 67 0	30	10.77

(cont.)

Table C.82 continued.

Day 5

No.	Route	Load	Distance
1	0 4 19 59 14 35 67 0	140	85.08
2	0 7 11 66 65 10 12 0	140	83.18
3	0 32 50 55 25 9 40 0	133	88.19
4	0 45 29 5 37 70 60 71 21 74 0	134	96.25
5	0 68 28 61 64 41 56 73 0	129	119.63
		Total Distance	2222.10

Table C.83: IPH-RCH solution to P8 with $W = 10$.

Day 1

No.	Route	Load	Distance
1	0 6 96 59 97 87 2 73 22 41 23 56 39 25 55 0	193	126.15
2	0 18 83 45 46 8 82 48 47 49 64 63 10 69 0	199	144.71
3	0 76 68 80 24 29 78 81 9 71 20 70 31 0	168	121.66
4	0 89 60 5 84 17 86 38 61 85 37 92 94 0	195	108.28

Day 2

No.	Route	Load	Distance
1	0 5 16 86 44 14 100 85 93 0	198	87.93
2	0 13 87 59 95 94 0	124	46.88
3	0 53 58 21 72 75 23 39 54 26 0	181	87.82
4	0 28 12 68 77 79 81 33 50 0	158	68.09
5	0 31 30 32 90 11 19 49 47 48 0	196	120.94

Day 3

No.	Route	Load	Distance
1	0 4 39 67 23 22 87 97 94 0	187	108.67
2	0 27 81 9 66 65 71 34 3 68 76 0	194	132.39
3	0 31 10 62 49 47 48 82 18 89 0	198	101.81
4	0 83 45 5 61 86 38 85 59 96 0	197	115.01

Day 4

No.	Route	Load	Distance
1	0 5 16 86 44 14 100 85 93 0	198	87.93
2	0 13 87 59 95 94 0	124	46.88
3	0 53 58 21 72 75 23 39 54 26 0	181	87.82
4	0 28 12 68 77 79 81 33 50 0	158	68.09
5	0 31 30 32 11 19 49 47 48 0	193	120.81

Day 5

No.	Route	Load	Distance
1	0 1 51 66 65 35 34 81 3 68 0	162	124.62
2	0 5 86 91 85 98 59 99 94 0	177	78.23
3	0 27 31 88 62 49 36 47 48 7 52 0	183	100.62
4	0 40 4 39 67 23 74 57 15 43 42 87 0	174	133.61
		Total Distance	2218.95

Table C.84: IPH-RCH solution to P10 with $W = 10$.

Day 1

No.	Route	Load	Distance
1	0 12 54 4 39 23 22 58 0	152	90.07
2	0 31 62 49 47 48 5 6 94 0	195	113.14
3	0 87 42 14 44 86 85 59 95 0	193	85.43

Day 2

No.	Route	Load	Distance
1	0 13 87 41 23 67 39 72 21 0	175	107.42
2	0 31 30 32 66 81 79 68 0	181	111.04
3	0 83 8 45 5 85 93 59 96 94 0	191	79.85

Day 3

No.	Route	Load	Distance
1	0 18 82 48 47 49 19 11 63 10 62 0	195	116.85
2	0 26 12 54 4 75 22 58 53 0	141	79.56
3	0 28 76 77 3 34 65 71 9 33 50 27 0	161	112.55
4	0 89 61 16 86 38 14 44 100 98 97 95 0	195	102.57

Day 4

No.	Route	Load	Distance
1	0 1 31 30 32 66 81 79 68 0	191	119.25
2	0 13 87 23 67 39 72 21 0	170	106.43
3	0 83 45 5 85 93 59 96 94 0	182	74.29

Day 5

No.	Route	Load	Distance
1	0 26 73 74 75 56 25 55 24 29 80 68 3 77 76 28 0	176	113.91
2	0 27 69 70 10 90 20 51 9 71 65 35 34 78 81 33 50 0	191	144.66
3	0 52 88 7 82 48 19 11 64 49 36 47 46 17 84 60 18 0	200	158.67
4	0 53 40 2 57 15 43 38 86 16 61 91 100 37 97 92 99 89 0	199	127.32
		Total Distance	1843.01

Table C.85: IPH-RCH solution to P11 with $W = 14$.

Day 1

No.	Route	Load	Distance
1	0 16 92 7 1 28 8 30 9 31 39 0	231	63.68
2	0 25 15 33 19 29 3 4 26 0	233	29.71
3	0 41 24 20 107 21 64 10 13 12 2 43 45 42 0	204	75.14

Day 2

No.	Route	Load	Distance
1	0 16 38 27 48 69 35 90 6 15 37 0	195	37.96
2	0 34 17 99 2 22 13 10 32 63 80 11 14 103 87 0	233	80.70
3	0 67 51 18 128 130 55 8 78 53 52 5 127 36 111 0	228	78.45

Day 3

No.	Route	Load	Distance
1	0 33 29 128 131 26 124 0	229	28.87
2	0 39 31 57 77 9 28 1 5 7 73 105 0	228	62.83
3	0 120 72 2 82 12 108 40 21 20 11 23 24 86 0	208	61.40

Day 4

No.	Route	Load	Distance
1	0 25 15 96 122 74 19 121 128 113 60 8 30 9 115 56 110 58 59 116 89 93 68 88 104 0	225	58.51
2	0 34 84 70 98 17 85 2 44 83 12 109 22 13 81 106 10 117 62 61 125 119 14 71 101 0	214	82.00
3	0 35 6 130 75 54 76 1 5 126 7 36 47 50 27 49 38 0	233	56.14

Day 5

No.	Route	Load	Distance
1	0 6 5 1 79 114 18 129 94 0	234	54.43
2	0 14 23 11 32 65 118 66 97 46 100 2 17 102 0	215	55.92
3	0 16 95 37 123 112 4 91 0	229	27.23
		Total Distance	852.96

Table C.86: IPH-RCH solution to P12 with $W = 17$.

Day 1

No.	Route	Load	Distance
1	0 117 115 114 9 10 29 28 27 22 25 4 3 2 147 150 159 0	140	131.26
2	0 41 42 34 33 32 31 43 44 45 80 46 56 60 61 67 51 48 49 72 103 0	137	172.40
3	0 132 156 155 153 160 0	43	49.05

Day 2

No.	Route	Load	Distance
1	0 37 10 6 5 138 139 132 0	136	115.31
2	0 72 88 0	39	66.42
3	0 114 137 122 0	130	75.85

Day 3

No.	Route	Load	Distance
1	0 40 108 36 113 15 13 14 17 23 24 25 26 20 8 3 146 143 149 150 154 0	140	136.36
2	0 99 97 96 91 43 47 58 59 57 84 64 62 71 70 52 50 48 81 103 0	140	122.55
3	0 131 130 158 153 162 163 135 0	42	49.58

Day 4

No.	Route	Load	Distance
1	0 38 10 5 7 138 132 0	139	115.02
2	0 72 102 101 0	47	58.64
3	0 114 137 129 0	134	75.88

Day 5

No.	Route	Load	Distance
1	0 94 95 90 107 106 39 35 11 12 16 30 18 19 21 5 1 140 144 145 123 120 121 124 119 118 126 125 127 128 133 134 0	139	142.03
2	0 100 98 110 97 92 93 89 86 83 85 82 65 69 68 66 55 54 53 48 76 79 78 77 75 74 73 87 63 104 0	112	86.01
3	0 105 109 111 112 116 137 141 142 148 151 157 152 161 136 0	139	82.83
		Total Distance	1479.19

Table C.87: IPH-RCH solution to P13 with $W = 42$.

Day 1

No.	Route	Load	Distance
1	0 24 150 172 151 164 167 157 156 161 0	1950	86.53
2	0 33 388 405 55 32 20 86 99 0	1980	98.99
3	0 43 82 415 6 57 83 333 94 0	1977	97.33
4	0 79 126 61 60 136 16 118 0	1935	43.18
5	0 102 114 68 336 337 322 334 351 0	1989	113.21
6	0 183 292 314 39 298 38 28 110 294 0	1955	46.52
7	0 197 254 297 370 407 377 367 364 260 0	1998	66.53
8	0 218 224 246 262 242 239 258 230 0	1895	69.16
9	0 225 214 193 192 237 210 204 213 289 281 0	1970	26.21

Day 2

No.	Route	Load	Distance
1	0 3 127 121 88 101 12 0	1900	38.01
2	0 8 21 416 46 49 45 13 30 0	1989	52.57
3	0 10 98 93 34 131 62 132 0	1997	49.89
4	0 19 104 7 112 111 344 338 355 0	1997	106.89
5	0 23 379 368 389 380 400 375 195 0	1914	75.95
6	0 26 0	265	6.96
7	0 67 179 272 266 188 247 310 0	1995	37.62
8	0 78 159 158 169 146 41 123 0	1780	73.62
9	0 261 241 251 301 256 209 232 284 0	1943	70.64

Day 3

No.	Route	Load	Distance
1	0 4 29 5 50 2 417 31 1 27 18 0	1999	88.63
2	0 9 75 17 35 36 171 133 65 0	1851	73.68
3	0 40 404 347 348 345 361 335 341 0	1990	150.47
4	0 128 51 25 15 90 138 0	1834	42.76
5	0 144 107 140 59 11 282 0	1481	42.96
6	0 178 174 181 191 240 245 0	1410	46.82
7	0 202 274 299 382 399 363 383 37 203 0	1855	65.91

(cont.)

Table C.87 continued.

Day 3

No.	Route	Load	Distance
8	0 219 295 243 306 305 244 263 0	1919	71.71
9	0 235 288 187 226 196 293 194 267 0	1900	28.13

Day 4

No.	Route	Load	Distance
1	0 22 33 91 105 32 74 122 0	1980	65.26
2	0 28 109 378 365 137 38 39 0	1943	62.58
3	0 52 6 14 20 16 84 175 0	1801	56.36
4	0 58 152 160 269 223 0	1461	70.82
5	0 125 89 69 154 148 24 130 0	1970	87.21
6	0 200 208 217 234 233 248 308 0	1924	28.34
7	0 207 190 291 279 318 277 286 0	1965	70.08
8	0 252 406 369 381 287 283 276 0	1930	53.09
9	0 350 357 393 409 392 384 390 0	1965	117.15

Day 5

No.	Route	Load	Distance
1	0 3 12 119 34 87 53 303 0	1936	48.02
2	0 8 47 23 359 331 81 100 0	1994	91.44
3	0 120 19 117 162 163 278 296 201 0	1863	77.32
4	0 143 366 391 385 402 313 0	1937	70.88
5	0 189 275 257 180 285 221 315 0	1680	35.89
6	0 206 307 264 255 270 300 0	1838	27.61
7	0 227 290 238 198 199 312 231 229 0	1772	37.00
8	0 311 386 373 411 374 410 371 401 414 0	1980	62.66
9	0 330 321 319 329 320 332 145 394 395 0	1920	187.08

Day 6

No.	Route	Load	Distance
1	0 1 346 408 398 403 343 349 353 0	1983	131.39
2	0 10 96 134 97 113 21 30 0	1995	69.17
3	0 11 147 166 165 9 135 0	1845	66.70
4	0 26 142 13 27 64 37 280 0	1760	42.80
5	0 56 92 129 0	945	21.17

(cont.)

Table C.87 continued.

Day 6

No.	Route	Load	Distance
6	0 63 4 141 5 85 15 25 77 0	1962	59.08
7	0 72 362 356 354 339 7 35 168 0	1951	102.21
8	0 212 216 271 265 236 220 228 0	1970	40.84
9	0 352 326 324 327 328 323 325 342 360 0	1864	178.98

Day 7

No.	Route	Load	Distance
1	0 17 95 70 358 340 76 36 0	1990	113.71
2	0 29 40 397 413 396 0	1930	110.51
3	0 42 139 66 170 184 316 304 0	1995	46.55
4	0 54 115 73 155 153 149 106 0	1945	65.92
5	0 71 116 0	510	26.37
6	0 80 22 48 103 31 44 2 14 108 0	1973	69.26
7	0 124 18 387 372 249 376 412 268 0	1927	57.81
8	0 176 177 273 317 253 250 173 205 182 0	1938	77.75
9	0 185 222 186 215 211 309 302 259 0	1884	53.34
		Total Distance	4353.27

Table C.88: IPH-RCH solution to P14 with $W = 2$.

Day 1

No.	Route	Load	Distance
1	0 1 12 3 9 5 0	16	132.17
2	0 2 4 11 0	12	115.22

Day 2

No.	Route	Load	Distance
1	0 1 8 3 13 14 0	14	124.51
2	0 2 7 16 4 10 15 6 0	18	136.62

Day 3

No.	Route	Load	Distance
1	0 1 12 3 9 5 0	16	132.17
2	0 2 4 11 18 0	13	118.70

Day 4

No.	Route	Load	Distance
1	0 1 3 20 19 8 0	14	119.81
2	0 2 6 10 4 17 7 0	17	121.89
		Total Distance	1001.08

Table C.89: IPH-RCH solution to P15 with $W = 4$.

Day 1

No.	Route	Load	Distance
1	0 1 14 18 22 5 19 15 3 7 0	27	276.07
2	0 2 4 17 36 21 6 20 33 16 0	25	313.36

Day 2

No.	Route	Load	Distance
1	0 1 23 24 11 5 3 30 29 10 0	23	228.19
2	0 8 25 26 12 6 4 27 13 28 9 2 0	27	243.37

Day 3

No.	Route	Load	Distance
1	0 1 14 18 37 22 5 19 32 15 3 7 0	29	319.27
2	0 2 4 17 21 6 20 16 0	23	270.16

Day 4

No.	Route	Load	Distance
1	0 1 11 31 5 38 3 10 0	21	211.80
2	0 2 8 12 34 6 35 4 13 9 0	25	223.50
		Total Distance	2085.71

Table C.90: IPH-RCH solution to P16 with $W = 6$.

Day 1

No.	Route	Load	Distance
1	0 1 3 20 24 28 32 7 5 29 25 21 17 9 0	38	427.08
2	0 2 36 4 22 26 30 6 8 31 27 23 19 15 0	37	424.34

Day 2

No.	Route	Load	Distance
1	0 1 33 34 13 41 7 5 3 40 16 39 12 0	31	318.75
2	0 10 35 14 18 44 8 6 4 37 11 2 0	31	286.63

Day 3

No.	Route	Load	Distance
1	0 1 3 20 24 28 32 7 5 29 25 21 17 9 0	38	427.08
2	0 2 4 22 26 30 6 8 31 27 23 19 15 38 0	37	424.90

Day 4

No.	Route	Load	Distance
1	0 1 13 42 50 49 5 7 56 55 47 48 3 16 12 0	33	505.22
2	0 2 11 4 45 46 54 53 8 6 52 51 43 18 14 10 0	35	501.50
		Total Distance	3315.50

Table C.91: IPH-RCH solution to P17 with $W = 4$.

Day 1

No.	Route	Load	Distance
1	0 1 16 24 5 17 9 0	18	111.40
2	0 3 35 22 8 23 4 0	20	119.93
3	0 2 18 6 20 7 0	19	176.50

Day 2

No.	Route	Load	Distance
1	0 1 25 5 26 0	12	105.83
2	0 2 11 29 30 19 6 28 27 10 0	20	124.31
3	0 3 12 31 32 7 21 13 0	18	115.00
4	0 4 14 8 15 0	14	102.89

Day 3

No.	Route	Load	Distance
1	0 16 24 5 17 9 1 0	18	111.40
2	0 3 22 8 23 38 4 0	20	121.47
3	0 2 18 6 20 7 0	19	176.50

Day 4

No.	Route	Load	Distance
1	0 1 40 5 39 0	12	105.83
2	0 2 10 6 19 11 0	16	107.15
3	0 3 12 33 7 21 34 13 0	18	111.98
4	0 4 15 37 8 36 14 0	16	102.92
		Total Distance	1693.11

Table C.92: IPH-RCH solution to P18 with $W = 8$.

Day 1

No.	Route	Load	Distance
1	0 1 28 36 75 44 9 37 62 29 5 13 0	29	231.83
2	0 2 6 30 38 10 39 31 0	23	216.06
3	0 3 7 32 67 40 11 41 70 33 0	25	230.26
4	0 26 8 34 71 42 12 43 35 27 4 0	28	228.98

Day 2

No.	Route	Load	Distance
1	0 1 45 46 21 9 5 60 59 20 0	23	200.30
2	0 15 49 50 23 6 10 22 47 48 14 2 0	27	206.98
3	0 17 53 54 25 7 11 24 51 52 16 3 0	27	207.05
4	0 18 55 56 12 8 57 58 19 4 0	23	198.34

Day 3

No.	Route	Load	Distance
1	0 1 28 36 44 9 37 29 5 13 0	27	217.62
2	0 2 6 30 63 38 10 39 66 31 0	25	230.26
3	0 3 7 32 40 11 41 33 0	23	216.06
4	0 26 34 42 12 43 74 35 8 27 4 0	28	228.98

Day 4

No.	Route	Load	Distance
1	0 1 21 61 9 76 5 20 0	21	188.87
2	0 2 15 23 6 65 10 64 22 14 0	25	193.28
3	0 17 25 7 69 11 68 24 16 3 0	25	193.33
4	0 19 73 12 72 8 18 4 0	21	188.53
		Total Distance	3376.73

Table C.93: IPH-RCH solution to P19 with $W = 12$.

Day 1

No.	Route	Load	Distance
1	0 1 40 48 56 64 13 57 49 9 5 17 0	34	326.44
2	0 2 6 10 51 102 59 14 58 50 42 34 0	33	339.94
3	0 3 7 37 45 53 61 15 60 52 11 44 36 0	36	346.67
4	0 4 8 38 91 46 12 54 107 62 16 63 55 47 39 0	38	368.80

Day 2

No.	Route	Load	Distance
1	0 1 65 66 25 33 82 41 13 9 81 5 32 79 80 24 0	36	301.35
2	0 2 19 69 70 27 35 85 43 14 10 84 6 26 67 68 18 0	38	302.38
3	0 3 21 73 74 29 7 88 11 15 104 87 28 71 72 20 0	35	300.91
4	0 4 23 77 78 31 16 12 8 30 75 76 22 0	32	286.60

Day 3

No.	Route	Load	Distance
1	0 1 40 48 56 64 13 57 98 49 9 5 17 0	35	341.47
2	0 2 6 10 51 59 14 58 99 50 42 83 34 0	34	347.05
3	0 3 7 37 45 53 61 15 60 103 52 11 44 36 0	37	361.70
4	0 4 8 38 46 12 54 62 16 63 55 47 39 0	36	346.67

Day 4

No.	Route	Load	Distance
1	0 1 25 33 41 9 97 13 112 111 95 96 5 32 24 0	35	342.91
2	0 19 27 35 86 43 101 14 100 10 6 26 18 2 0	35	290.19
3	0 3 20 28 7 89 11 15 105 106 90 29 21 0	32	304.91
4	0 4 23 31 8 93 94 110 109 16 108 12 92 30 22 0	34	332.46
		Total Distance	5240.44

Table C.94: IPH-RCH solution to P20 with $W = 19$.

Day 1

No.	Route	Load	Distance
1	0 1 48 56 64 72 80 88 96 104 21 17 13 81 73 65 57 9 5 25 0	56	560.80
2	0 2 6 10 59 67 75 83 91 99 18 22 98 90 82 74 14 66 58 124 0	55	620.50
3	0 3 7 11 61 69 77 85 93 101 23 19 15 84 76 68 60 52 0	52	559.27
4	0 4 8 12 63 16 79 87 95 103 24 20 102 94 86 78 70 62 0	52	606.72

Day 2

No.	Route	Load	Distance
1	0 1 33 5 41 49 9 152 13 168 17 153 154 170 97 89 169 21 184 183 167 151 135 40 32 0	55	710.66
2	0 2 26 34 42 50 139 155 171 172 18 22 173 174 158 157 14 10 51 43 6 35 27 0	54	659.41
3	0 3 28 36 7 44 128 11 145 15 161 19 160 159 175 100 92 176 23 177 178 162 146 53 45 37 29 0	59	703.84
4	0 4 31 39 47 55 12 149 71 150 166 182 181 24 20 180 179 163 164 16 148 54 46 8 38 30 0	58	704.78

Day 3

No.	Route	Load	Distance
1	0 1 48 56 64 72 80 88 96 104 21 17 13 81 73 65 57 9 121 5 25 0	57	564.78
2	0 2 6 10 58 66 74 82 90 98 22 18 99 91 83 75 14 67 142 59 125 0	56	635.53
3	0 3 7 129 11 61 69 77 85 93 101 23 19 15 84 76 68 60 52 0	53	563.25
4	0 4 8 12 62 147 70 78 86 94 102 24 20 103 95 87 79 16 63 133 0	54	623.69

Day 4

No.	Route	Load	Distance
1	0 1 105 106 33 41 122 49 138 89 97 21 17 13 137 9 136 5 40 119 120 32 0	52	513.18
2	0 2 26 108 107 34 6 42 123 50 10 140 156 22 18 14 141 51 126 43 35 110 109 27 0	55	496.61
3	0 3 28 112 111 36 44 127 143 92 100 23 19 15 144 11 53 130 45 7 37 114 113 29 0	56	532.68
4	0 4 31 117 118 39 47 134 55 71 165 24 20 16 12 132 54 131 46 8 38 115 116 30 0	56	501.93
		Total Distance	9557.63

Table C.95: IPH-RCH solution to P21 with $W = 6$.

Day 1

No.	Route	Load	Distance
1	0 2 1 6 0	15	40.00
2	0 3 4 5 0	15	40.00
3	0 13 25 7 36 35 12 34 0	20	158.08
4	0 14 26 8 27 28 9 29 0	20	158.07
5	0 18 30 10 31 32 11 33 0	20	158.08

Day 2

No.	Route	Load	Distance
1	0 2 1 6 0	15	40.00
2	0 3 17 46 45 9 44 43 16 0	18	111.78
3	0 4 47 10 48 19 5 0	19	110.65
4	0 15 42 8 40 39 38 7 37 24 0	19	168.24
5	0 21 20 11 12 58 23 22 0	19	167.03

Day 3

No.	Route	Load	Distance
1	0 2 1 6 0	15	40.00
2	0 3 4 5 0	15	40.00
3	0 13 25 7 36 35 12 34 0	20	158.08
4	0 14 26 8 27 28 9 29 0	20	158.07
5	0 18 30 10 31 32 11 33 0	20	158.08

Day 4

No.	Route	Load	Distance
1	0 1 24 59 7 60 2 0	19	110.54
2	0 3 16 9 8 41 15 0	20	151.31
3	0 4 19 50 49 10 17 0	16	116.22
4	0 5 20 51 52 11 53 54 21 0	18	111.78
5	0 6 22 55 56 12 57 23 0	17	106.55
		Total Distance	2302.54

Table C.96: IPH-RCH solution to P22 with $W = 12$.

Day 1

No.	Route	Load	Distance
1	0 1 30 42 54 66 13 55 92 43 7 19 0	30	203.77
2	0 2 8 44 56 14 57 45 0	23	199.53
3	0 3 9 47 100 59 15 58 46 0	24	202.96
4	0 4 10 49 104 61 16 60 101 48 77 0	26	206.62
5	0 5 39 11 51 63 17 62 50 38 26 0	29	202.41
6	0 6 41 12 53 112 65 18 64 52 40 0	28	205.84

Day 2

No.	Route	Load	Distance
1	0 1 67 68 31 13 7 90 89 88 87 29 6 0	30	213.62
2	0 2 20 69 70 32 14 8 33 72 71 21 0	27	195.86
3	0 3 23 76 75 35 9 15 34 73 74 22 0	27	195.87
4	0 4 24 78 36 10 16 37 80 25 5 0	30	190.99
5	0 27 84 83 82 81 11 17 18 12 86 85 28 0	30	294.06

Day 3

No.	Route	Load	Distance
1	0 1 30 42 54 66 13 55 43 7 19 0	29	200.34
2	0 2 8 44 93 56 14 57 45 0	24	202.96
3	0 3 9 47 59 15 58 97 46 0	24	202.96
4	0 4 10 48 60 16 61 49 79 0	24	199.76
5	0 5 39 11 51 63 17 62 105 50 38 26 0	30	205.84
6	0 6 41 12 53 65 18 64 52 40 0	27	202.41

Day 4

No.	Route	Load	Distance
1	0 1 31 7 91 13 114 113 29 6 0	27	203.19
2	0 2 20 32 8 94 14 95 96 33 21 0	26	198.52
3	0 3 23 35 9 99 15 98 34 22 0	25	186.32
4	0 5 25 37 10 103 16 102 36 24 4 0	30	191.90
5	0 27 11 106 17 107 108 109 110 18 111 12 28 0	30	287.61
		Total Distance	4593.37

Table C.97: IPH-RCH solution to P23 with $W = 17$.

Day 1

No.	Route	Load	Distance
1	0 1 48 60 72 84 96 19 85 73 13 61 49 7 25 0	40	309.63
2	0 2 8 62 74 147 86 20 87 75 14 63 0	33	314.77
3	0 3 9 64 15 76 151 88 21 89 77 65 53 0	35	314.77
4	0 4 10 55 67 79 91 22 90 78 16 66 54 42 0	38	308.92
5	0 5 11 56 68 80 92 23 93 81 17 69 57 0	36	308.92
6	0 6 12 58 70 18 82 94 24 95 83 71 59 47 35 0	40	308.92

Day 2

No.	Route	Load	Distance
1	0 26 38 8 50 14 148 20 149 51 39 27 2 0	34	276.84
2	0 3 28 40 52 152 21 153 15 9 41 29 30 4 0	39	284.37
3	0 5 32 44 11 136 135 158 157 22 156 16 133 10 43 31 0	39	326.96
4	0 6 12 141 142 143 168 19 145 13 144 7 37 36 1 0	40	325.91
5	0 33 45 138 137 17 160 23 161 162 163 164 24 165 18 140 139 46 34 0	38	436.56

Day 3

No.	Route	Load	Distance
1	0 1 123 62 74 86 20 87 150 75 14 63 8 2 0	39	320.04
2	0 3 9 64 15 76 88 21 89 154 77 65 53 0	35	314.77
3	0 4 10 55 134 67 16 79 91 22 90 155 78 66 54 42 0	40	320.06
4	0 5 11 56 68 80 159 92 23 93 81 17 69 57 0	37	316.63
5	0 6 12 58 70 18 82 94 24 95 83 71 59 47 35 0	40	308.92
6	0 25 7 49 122 61 73 146 85 19 96 84 13 72 60 48 0	37	320.57

Day 4

No.	Route	Load	Distance
1	0 1 36 120 119 118 117 116 34 6 0	19	92.27
2	0 2 26 99 100 38 8 50 124 14 20 125 126 51 39 102 101 27 0	39	295.52
3	0 3 29 106 105 41 130 129 21 15 128 127 52 9 40 103 104 28 0	38	306.63
4	0 4 30 108 107 131 22 16 132 10 43 110 109 31 0	32	281.12
5	0 5 32 112 111 44 23 17 11 45 114 113 33 0	32	275.66
6	0 98 97 37 7 121 13 19 167 166 24 18 12 46 115 0	40	404.39
		Total Distance	7073.15

Table C.98: IPH-RCH solution to P24 with $W = 6$.

Day 1

No.	Route	Load	Distance
1	0 3 42 40 41 2 1 50 0	20	240.03
2	0 4 45 44 0	8	124.27
3	0 46 5 11 6 49 48 0	17	242.44

Day 2

No.	Route	Load	Distance
1	0 3 9 4 0	11	230.94
2	0 6 35 34 32 33 5 0	16	216.31
3	0 2 18 7 1 38 36 37 0	19	325.05

Day 3

No.	Route	Load	Distance
1	0 1 12 6 15 0	14	243.57
2	0 3 8 21 2 13 0	16	244.90
3	0 5 30 10 4 14 0	16	244.90

Day 4

No.	Route	Load	Distance
1	0 1 39 6 11 5 0	17	304.61
2	0 4 28 29 0	8	171.45
3	0 2 23 22 3 24 25 26 0	18	275.53

Day 5

No.	Route	Load	Distance
1	0 2 19 7 16 17 1 51 0	19	252.35
2	0 4 27 9 3 43 0	15	234.78
3	0 6 5 47 0	10	180.78

Day 6

No.	Route	Load	Distance
1	0 1 12 6 15 0	14	243.57
2	0 3 8 20 2 13 0	16	244.90
3	0 5 31 10 4 14 0	16	244.90
		Total Distance	4265.28

Table C.99: IPH-RCH solution to P25 with $W = 6$.

Day 1

No.	Route	Load	Distance
1	0 2 41 42 3 0	14	176.07
2	0 44 45 4 10 5 47 46 0	20	248.55
3	0 49 6 12 1 51 50 0	18	247.32

Day 2

No.	Route	Load	Distance
1	0 1 38 39 36 6 0	16	204.76
2	0 3 8 2 40 0	14	238.52
3	0 4 31 5 33 32 34 0	18	275.53

Day 3

No.	Route	Load	Distance
1	0 1 7 2 13 0	14	243.76
2	0 3 9 4 14 0	14	243.76
3	0 5 11 35 6 15 0	16	244.71

Day 4

No.	Route	Load	Distance
1	0 1 12 37 6 48 0	16	234.78
2	0 2 20 21 3 0	14	200.68
3	0 4 28 29 10 30 5 0	18	244.77

Day 5

No.	Route	Load	Distance
1	0 1 16 18 2 8 22 23 0	20	317.50
2	0 4 27 26 25 24 3 43 0	20	219.00
3	0 5 6 0	10	173.20

Day 6

No.	Route	Load	Distance
1	0 1 17 7 19 2 13 0	18	246.04
2	0 3 9 4 14 0	14	243.76
3	0 5 11 6 15 0	14	243.57
		Total Distance	4246.28

Table C.100: IPH-RCH solution to P26 with $W = 6$.

Day 1

No.	Route	Load	Distance
1	0 41 2 1 51 50 0	16	184.70
2	0 42 3 4 45 44 0	16	189.59
3	0 46 5 11 6 49 48 0	19	242.44

Day 2

No.	Route	Load	Distance
1	0 2 7 1 38 15 0	18	285.25
2	0 3 9 4 0	13	230.94
3	0 5 33 32 34 35 6 0	18	216.31

Day 3

No.	Route	Load	Distance
1	0 1 12 37 6 0	15	232.08
2	0 3 8 2 13 0	16	243.76
3	0 5 31 10 4 14 0	18	244.90

Day 4

No.	Route	Load	Distance
1	0 1 39 6 11 5 0	20	304.61
2	0 2 40 23 22 0	11	198.45
3	0 3 24 25 26 4 28 29 0	20	260.74

Day 5

No.	Route	Load	Distance
1	0 1 15 6 5 47 0	20	241.99
2	0 2 21 20 18 19 7 17 16 0	20	297.65
3	0 4 27 9 3 43 0	17	234.78

Day 6

No.	Route	Load	Distance
1	0 1 12 36 6 0	15	232.08
2	0 3 8 2 13 0	16	243.76
3	0 5 30 10 4 14 0	18	244.90
		Total Distance	4328.92

Table C.101: IPH-RCH solution to P27 with $W = 11$.

Day 1

No.	Route	Load	Distance
1	0 1 18 100 12 99 52 21 0	20	653.24
2	0 2 56 57 3 58 0	14	178.76
3	0 4 60 5 48 50 6 0	18	271.15
4	0 7 68 67 22 70 8 28 0	20	1287.95
5	0 9 75 24 10 29 11 0	20	1465.92

Day 2

No.	Route	Load	Distance
1	0 3 9 23 71 8 14 0	20	1179.91
2	0 6 49 47 5 45 4 59 0	20	269.58
3	0 12 88 27 90 7 101 54 0	19	1182.20
4	0 19 55 2 32 1 66 0	17	221.68
5	0 95 10 79 25 82 11 97 0	19	1193.09

Day 3

No.	Route	Load	Distance
1	0 1 13 7 30 51 6 0	20	691.80
2	0 2 8 72 74 9 10 0	20	1254.75
3	0 3 15 4 16 5 0	18	346.41
4	0 11 83 26 86 12 17 0	18	1185.62
5	0 20 0	3	80.00

Day 4

No.	Route	Load	Distance
1	0 1 21 6 5 0	15	234.41
2	0 2 34 33 35 38 3 40 0	18	303.99
3	0 4 43 29 11 12 18 0	20	960.42
4	0 7 22 69 8 91 28 37 0	20	1231.44
5	0 9 76 24 77 10 42 41 0	19	1174.39

Day 5

No.	Route	Load	Distance
1	0 3 39 4 44 62 5 0	18	279.01
2	0 6 12 87 27 89 7 0	19	1166.14
3	0 8 23 73 9 94 14 36 0	20	1186.63
4	0 10 78 80 25 81 11 46 0	19	1425.34
5	0 19 2 31 1 65 64 63 0	19	240.20

(cont.)

Table C.101 continued.

Day 6

No.	Route	Load	Distance
1	0 1 53 7 102 30 6 0	19	666.10
2	0 2 13 8 92 93 9 0	19	915.29
3	0 3 15 10 96 16 4 0	20	671.76
4	0 5 61 20 0	9	128.89
5	0 17 12 85 26 84 11 98 0	20	1223.52
		Total Distance	23269.58

Table C.102: IPH-RCH solution to P28 with $W = 11$.

Day 1

No.	Route	Load	Distance
1	0 1 52 12 11 46 0	19	907.77
2	0 2 56 57 3 58 0	16	178.76
3	0 5 48 47 6 64 0	16	208.26
4	0 8 69 70 67 7 53 66 0	20	1028.13
5	0 9 76 10 4 60 0	19	953.26

Day 2

No.	Route	Load	Distance
1	0 1 21 6 49 5 0	19	250.34
2	0 2 3 40 42 4 0	19	261.52
3	0 7 22 8 71 23 28 55 0	20	1662.86
4	0 54 30 12 26 11 29 45 0	20	1284.78
5	0 9 75 24 78 10 43 44 0	20	1174.39

Day 3

No.	Route	Load	Distance
1	0 2 1 18 51 6 0	19	289.82
2	0 5 11 25 10 16 0	19	1174.19
3	0 15 9 74 72 8 33 34 0	20	993.83
4	0 17 12 27 89 7 13 32 0	20	1209.11
5	0 19 35 14 3 39 4 20 0	20	325.52

Day 4

No.	Route	Load	Distance
1	0 1 2 3 4 0	20	288.68
2	0 5 98 81 80 10 96 95 0	20	948.01
3	0 6 101 102 90 7 0	16	839.39
4	0 92 8 91 93 9 94 0	18	894.41
5	0 97 11 83 85 12 100 99 0	20	1023.58

Day 5

No.	Route	Load	Distance
1	0 1 65 63 6 5 0	19	235.23
2	0 2 38 37 3 4 0	19	258.42
3	0 10 77 24 9 73 23 28 0	20	1666.13
4	0 12 86 26 84 11 29 62 0	20	1232.65
5	0 21 30 7 68 22 8 36 0	20	1231.80

(cont.)

Table C.102 continued.

Day 6

No.	Route	Load	Distance
1	0 1 31 2 19 3 0	19	250.24
2	0 4 15 9 8 14 0	19	920.48
3	0 6 50 17 5 61 20 59 0	20	265.93
4	0 16 11 82 25 79 10 41 0	20	1192.93
5	0 18 12 88 87 27 7 13 0	20	1257.14
		Total Distance	24407.57

Table C.103: IPH-RCH solution to P29 with $W = 11$.

Day 1

No.	Route	Load	Distance
1	0 1 2 19 0	13	186.02
2	0 3 9 28 91 8 0	20	885.88
3	0 4 60 62 5 0	14	173.49
4	0 11 81 25 79 10 29 0	20	1230.21
5	0 17 12 100 99 6 63 0	19	644.71
6	0 18 30 27 90 7 68 67 0	20	1362.95

Day 2

No.	Route	Load	Distance
1	0 1 7 101 54 66 21 0	19	600.83
2	0 2 55 0	7	123.05
3	0 20 5 47 49 6 0	17	206.03
4	0 9 74 23 71 8 13 0	20	1185.63
5	0 12 86 26 84 11 16 0	20	1185.63
6	0 3 15 10 95 4 0	20	626.93

Day 3

No.	Route	Load	Distance
1	0 1 6 5 0	15	230.94
2	0 2 56 57 3 0	14	176.07
3	0 4 43 45 46 11 48 0	18	633.75
4	0 9 76 24 77 78 10 0	19	1223.87
5	0 14 72 8 69 22 70 31 0	19	1320.27
6	0 52 12 88 87 89 7 53 0	20	1085.19

Day 4

No.	Route	Load	Distance
1	0 1 33 35 2 0	14	244.91
2	0 4 42 40 3 58 19 0	19	217.21
3	0 5 17 6 0	13	230.94
4	0 7 27 12 30 18 0	19	1218.78
5	0 8 28 94 9 37 38 0	19	894.14
6	0 11 82 25 80 10 29 0	20	1230.21

Day 5

No.	Route	Load	Distance
1	0 2 13 7 1 65 0	20	615.01

(cont.)

Table C.103 continued.

Day 5

No.	Route	Load	Distance
2	0 3 39 15 4 44 59 0	19	279.23
3	0 8 23 73 9 10 0	20	1449.09
4	0 12 26 83 11 97 16 0	20	1184.46
5	0 20 5 6 21 0	16	198.65

Day 6

No.	Route	Load	Distance
1	0 1 32 34 2 36 0	16	248.22
2	0 3 41 4 0	12	189.14
3	0 6 50 5 0	12	200.68
4	0 14 92 8 22 7 102 0	20	1216.64
5	0 64 51 12 85 11 98 61 0	20	992.60
6	0 93 9 75 24 10 96 0	19	1236.20
		Total Distance	24927.55

Table C.104: IPH-RCH solution to P30 with $W = 16$.

Day 1

No.	Route	Load	Distance
1	0 2 72 3 4 0	14	231.14
2	0 10 92 91 90 9 89 106 107 0	20	1303.72
3	0 5 6 79 81 1 80 0	18	233.92
4	0 8 14 118 119 13 83 82 0	20	3058.34
5	0 11 17 135 41 18 45 0	20	3673.48
6	0 67 115 12 103 7 116 68 69 0	20	1059.54
7	0 15 126 39 129 16 94 35 0	20	3538.02

Day 2

No.	Route	Load	Distance
1	0 4 22 5 77 26 6 0	20	332.33
2	0 27 1 2 53 3 0	17	259.67
3	0 7 33 153 13 42 18 0	20	3706.18
4	0 8 84 28 14 43 9 0	20	2208.59
5	0 10 95 31 44 149 17 99 0	20	2044.52
6	0 30 16 128 127 15 145 34 0	20	3089.71
7	0 11 32 100 101 12 114 36 0	20	1285.25

Day 3

No.	Route	Load	Distance
1	0 4 21 3 73 25 0	16	244.36
2	0 76 5 0	6	118.16
3	0 6 24 1 19 2 71 0	20	349.11
4	0 7 13 141 139 18 12 0	20	3056.81
5	0 110 10 111 96 97 11 23 0	19	1059.71
6	0 15 125 38 122 14 120 37 0	20	5015.55
7	0 51 20 108 9 29 86 8 0	20	1206.57
8	0 98 17 133 40 130 16 146 0	19	3584.65

Day 4

No.	Route	Load	Distance
1	0 1 47 46 49 48 50 2 0	18	260.54
2	0 3 52 109 54 55 56 57 4 0	20	517.01
3	0 5 63 62 64 65 6 66 0	18	260.74

(cont.)

Table C.104 continued.

Day 4

No.	Route	Load	Distance
4	0 7 45 13 14 8 0	19	2857.58
5	0 9 15 39 16 10 0	19	3464.10
6	0 12 150 18 137 41 17 0	19	3529.09
7	0 59 58 35 112 11 61 60 0	17	660.64

Day 5

No.	Route	Load	Distance
1	0 1 36 12 11 113 22 0	20	984.57
2	0 2 8 34 3 0	15	651.91
3	0 4 26 5 6 27 0	18	246.93
4	0 7 152 13 140 42 138 33 0	20	3337.29
5	0 9 30 16 147 44 10 0	20	2211.95
6	0 15 144 43 143 14 28 85 0	20	2811.53
7	0 31 148 17 134 136 18 32 0	20	3166.20

Day 6

No.	Route	Load	Distance
1	0 1 19 2 70 25 3 0	20	292.65
2	0 4 21 10 93 9 20 0	20	1057.87
3	0 7 104 105 102 151 18 12 0	20	2077.23
4	0 8 14 121 37 13 117 0	19	3492.01
5	0 11 17 132 40 131 16 0	19	3498.40
6	0 74 75 5 23 24 6 78 0	20	369.22
7	0 87 29 142 123 38 124 15 88 0	20	3395.12
		Total Distance	79801.93

Table C.105: IPH-RCH solution to P31 with $W = 16$.

Day 1

No.	Route	Load	Distance
1	0 2 53 52 3 0	14	200.68
2	0 4 58 59 60 61 5 0	18	216.31
3	0 6 67 66 69 68 1 80 0	20	219.01
4	0 7 13 14 8 0	20	2598.08
5	0 31 44 17 41 137 18 103 0	20	3701.58
6	0 55 54 109 9 92 10 56 0	20	982.48
7	0 63 11 101 12 65 79 0	18	1026.39
8	0 107 106 15 39 16 94 111 0	20	3596.00

Day 2

No.	Route	Load	Distance
1	0 2 1 27 6 0	17	234.41
2	0 3 9 34 8 25 0	19	889.00
3	0 4 77 5 0	12	173.40
4	0 7 13 118 119 37 121 28 0	20	3462.66
5	0 12 32 18 139 42 33 36 0	20	3460.53
6	0 15 125 38 123 122 14 84 0	20	3699.70
7	0 23 11 95 10 35 22 26 0	20	1029.25
8	0 30 16 130 40 133 17 99 0	20	3660.47

Day 3

No.	Route	Load	Distance
1	0 1 47 46 49 48 2 71 0	20	219.00
2	0 4 57 21 3 73 0	16	234.78
3	0 6 5 76 0	12	175.90
4	0 7 13 152 45 18 0	19	2657.64
5	0 24 114 12 98 11 62 0	18	977.03
6	0 29 145 15 144 43 14 86 0	20	2819.72
7	0 19 8 108 9 20 50 51 0	20	919.71
8	0 96 17 16 10 110 0	19	2657.37

Day 4

No.	Route	Load	Distance
1	0 1 115 12 11 113 0	19	963.25

(cont.)

Table C.105 continued.

Day 4

No.	Route	Load	Distance
2	0 2 8 14 142 143 0	19	1864.13
3	0 3 4 5 6 0	20	288.67
4	0 9 15 126 127 39 129 128 0	20	3628.11
5	0 10 146 16 147 149 44 31 0	20	2384.21
6	0 18 136 41 134 135 17 148 0	20	3712.03
7	0 116 7 153 13 141 138 151 0	20	2846.54

Day 5

No.	Route	Load	Distance
1	0 1 81 27 0	9	128.89
2	0 2 25 3 4 0	17	234.31
3	0 5 23 12 36 6 0	19	686.88
4	0 7 85 8 34 9 0	19	1251.18
5	0 10 97 11 112 35 22 26 0	20	1070.52
6	0 15 124 38 14 120 37 28 0	20	4998.40
7	0 30 16 131 40 17 32 100 0	20	3760.04
8	0 33 150 18 42 140 13 83 0	20	3643.33

Day 6

No.	Route	Load	Distance
1	0 1 19 2 70 3 0	19	288.87
2	0 4 75 74 0	9	124.27
3	0 5 64 6 78 0	14	191.83
4	0 8 82 13 45 18 0	19	2840.56
5	0 11 17 132 16 93 0	19	2865.13
6	0 21 10 91 90 9 20 72 0	20	1045.95
7	0 12 102 105 104 7 117 24 0	20	1067.78
8	0 87 29 14 43 15 88 89 0	20	2841.47
		Total Distance	82537.45

Table C.106: IPH-RCH solution to P32 with $W = 16$.

Day 1

No.	Route	Load	Distance
1	0 2 72 3 4 0	17	231.14
2	0 5 10 92 91 9 0	19	999.71
3	0 6 79 69 68 1 81 80 0	20	214.15
4	0 14 121 118 119 13 45 0	19	3263.68
5	0 15 126 39 129 16 94 0	19	3526.50
6	0 31 17 41 136 18 103 0	20	3643.32
7	0 67 115 12 101 100 11 113 0	20	1079.24
8	0 107 106 8 82 83 7 116 0	20	1060.91

Day 2

No.	Route	Load	Distance
1	0 1 7 36 114 12 0	20	885.88
2	0 2 53 34 9 3 0	20	671.62
3	0 4 10 95 35 22 0	18	803.22
4	0 8 84 28 14 142 43 0	20	2150.40
5	0 11 99 32 17 149 44 0	20	2150.40
6	0 26 77 5 6 27 0	18	199.25
7	0 30 16 128 127 15 145 0	19	3072.64
8	0 33 153 13 140 42 18 0	20	3645.98

Day 3

No.	Route	Load	Distance
1	0 1 24 7 19 71 0	18	648.26
2	0 2 51 20 3 73 25 0	20	245.50
3	0 4 76 5 23 6 0	20	291.51
4	0 8 86 29 108 9 21 0	20	1238.21
5	0 12 18 139 141 13 0	19	3056.81
6	0 15 125 38 14 120 37 0	20	4998.40
7	0 17 133 40 130 16 146 0	19	3538.83
8	0 98 11 97 96 111 10 110 0	20	1262.38

Day 4

No.	Route	Load	Distance
1	0 1 47 46 49 48 2 0	18	216.31

(cont.)

Table C.106 continued.

Day 4

No.	Route	Load	Distance
2	0 3 56 57 58 59 4 0	18	256.46
3	0 5 63 62 64 65 6 0	18	216.31
4	0 7 13 45 12 66 0	20	1998.86
5	0 10 31 11 112 61 60 0	19	1172.89
6	0 16 39 15 14 85 0	20	4375.95
7	0 17 135 41 137 18 150 0	19	3538.83
8	0 52 50 8 109 9 54 55 0	20	931.61

Day 5

No.	Route	Load	Distance
1	0 1 2 3 0	15	230.94
2	0 5 22 4 26 0	16	243.76
3	0 6 12 36 27 0	16	641.43
4	0 7 28 14 143 8 0	20	1991.22
5	0 9 15 144 43 89 34 0	20	1944.75
6	0 10 44 147 16 30 90 0	20	2183.17
7	0 18 138 42 13 152 33 0	20	3615.24
8	0 32 134 17 148 11 35 0	20	2518.19

Day 6

No.	Route	Load	Distance
1	0 1 24 6 5 0	18	288.68
2	0 3 20 2 70 25 0	18	244.36
3	0 14 37 13 151 18 0	20	4333.08
4	0 17 132 40 131 16 93 0	19	3526.50
5	0 19 8 87 9 21 74 0	20	1001.12
6	0 23 11 10 4 75 0	20	893.09
7	0 29 123 122 38 124 15 88 0	19	3490.75
8	0 78 12 102 105 104 7 117 0	20	1062.48
		Total Distance	83793.91

Table C.107: IPH-RCR solution to P2.

Day 1

No.	Route	Load	Distance
1	0 4 41 40 19 42 44 15 37 17 12 0	132	108.52
2	0 18 25 24 43 23 26 31 48 27 0	156	126.04
3	0 32 2 20 29 21 34 50 38 46 0	140	93.18

Day 2

No.	Route	Load	Distance
1	0 6 25 13 41 18 47 0	159	85.59
2	0 8 3 20 2 11 0	116	85.64
3	0 12 5 49 10 39 30 34 9 16 0	158	100.92

Day 3

No.	Route	Load	Distance
1	0 12 41 42 44 45 33 34 38 0	159	133.89
2	0 18 25 14 43 7 23 48 0	153	98.59
3	0 27 1 22 31 28 36 35 20 2 32 0	148	109.15

Day 4

No.	Route	Load	Distance
1	0 6 25 13 41 18 47 0	159	85.59
2	0 8 3 20 2 11 0	116	85.64
3	0 12 5 49 39 30 34 9 16 0	153	100.33

Day 5

No.	Route	Load	Distance
1	0 7 28 35 20 2 34 33 0	157	172.71
2	0 12 18 41 25 14 0	146	85.29
		Total Distance	1471.09

Table C.108: IPH-RCR solution to P5.

Day 1

No.	Route	Load	Distance
1	0 3 44 32 9 39 40 0	134	63.22
2	0 8 14 66 11 26 0	139	82.48
3	0 34 52 54 13 48 4 75 0	136	78.13
4	0 47 21 61 64 28 62 0	137	116.49
5	0 67 0	30	10.77

Day 2

No.	Route	Load	Distance
1	0 2 28 64 43 1 6 0	138	93.68
2	0 4 46 67 0	87	27.68
3	0 35 14 66 11 53 0	137	81.69
4	0 17 32 18 24 49 16 33 0	139	91.47
5	0 30 21 36 37 20 57 27 0	129	93.09
6	0 40 9 31 38 58 0	132	89.80

Day 3

No.	Route	Load	Distance
1	0 4 52 54 8 34 67 0	130	60.39
2	0 11 66 59 14 0	129	90.13
3	0 12 40 9 39 10 26 0	138	68.92
4	0 28 21 47 5 48 45 0	138	77.83
5	0 44 32 50 56 64 62 0	139	131.12
6	0 75 0	20	6.00

Day 4

No.	Route	Load	Distance
1	0 2 28 64 42 43 1 73 0	136	94.24
2	0 4 46 67 0	87	27.68
3	0 6 33 16 24 32 17 0	140	82.38
4	0 14 66 11 53 0	127	81.57
5	0 27 15 20 70 60 71 69 21 30 0	132	101.93
6	0 40 9 31 38 58 0	132	89.80

(cont.)

Table C.108 continued.

Day 5

No.	Route	Load	Distance
1	0 4 45 29 5 21 74 68 0	133	66.86
2	0 7 14 59 19 67 0	115	79.97
3	0 11 66 65 10 72 12 0	126	83.38
4	0 28 22 64 41 56 23 63 51 0	139	108.80
5	0 32 50 55 25 9 40 0	133	88.19
		Total Distance	2167.67

Table C.109: IPH-RCR solution to P8.

Day 1

No.	Route	Load	Distance
1	0 5 61 86 38 43 15 23 39 56 73 53 0	194	146.78
2	0 18 82 48 11 64 49 47 46 8 45 83 60 89 0	197	138.65
3	0 31 10 20 71 9 81 29 24 68 76 0	170	123.14
4	0 87 97 37 98 85 59 99 96 94 0	172	58.20

Day 2

No.	Route	Load	Distance
1	0 69 1 33 81 79 77 68 12 28 0	161	72.32
2	0 5 16 86 44 14 100 85 93 0	198	87.93
3	0 13 87 92 59 95 94 0	126	47.11
4	0 26 54 55 25 39 23 75 22 74 72 21 40 0	192	95.01
5	0 31 30 32 90 19 49 36 47 48 0	189	124.14

Day 3

No.	Route	Load	Distance
1	0 4 39 67 23 87 97 59 94 0	197	113.42
2	0 27 31 10 62 11 49 47 48 82 0	199	101.69
3	0 50 81 9 66 65 71 34 78 3 68 76 0	194	130.65
4	0 53 58 0	32	18.63
5	0 89 18 83 45 5 61 86 38 91 85 96 0	197	116.81

Day 4

No.	Route	Load	Distance
1	0 5 16 86 44 14 100 85 93 0	198	87.93
2	0 13 87 59 95 94 0	124	46.88
3	0 26 54 39 23 75 22 72 21 0	167	90.52
4	0 28 12 80 68 77 79 81 33 0	151	69.18
5	0 31 70 30 32 63 19 49 47 48 0	196	121.38

Day 5

No.	Route	Load	Distance
1	0 4 39 67 23 41 57 42 87 2 58 0	172	121.06
2	0 6 5 84 17 86 85 59 94 0	169	79.33
3	0 52 7 48 47 49 62 88 31 27 0	178	96.63
4	0 50 51 66 65 35 34 81 3 68 0	165	125.50
		Total Distance	2212.91

Table C.110: IPH-RCR solution to P11.

Day 1

No.	Route	Load	Distance
1	0 16 39 68 88 41 24 20 21 10 13 12 40 83 2 120 70 0	233	82.46
2	0 25 15 33 19 29 3 4 26 0	233	29.71
3	0 50 69 27 48 7 1 28 8 30 9 77 57 31 59 116 0	232	78.68

Day 2

No.	Route	Load	Distance
1	0 6 36 5 127 8 60 110 18 113 128 130 96 15 0	234	56.44
2	0 16 38 35 37 95 105 0	131	12.67
3	0 34 17 99 2 82 22 13 81 64 32 63 107 11 61 125 119 14 71 0	228	81.94

Day 3

No.	Route	Load	Distance
1	0 24 23 11 20 10 21 65 108 109 12 2 72 100 0	233	61.30
2	0 26 7 5 1 28 79 9 115 56 58 31 67 0	232	61.75
3	0 39 93 94 121 29 128 131 33 123 0	233	29.52

Day 4

No.	Route	Load	Distance
1	0 34 84 17 85 2 12 22 13 106 10 80 118 66 97 14 42 86 101 0	230	76.91
2	0 36 7 1 5 52 53 78 9 30 114 8 55 75 130 128 0	233	75.97
3	0 38 35 73 90 124 6 19 74 122 15 25 91 0	188	22.80

Day 5

No.	Route	Load	Distance
1	0 16 49 27 47 92 111 126 5 1 76 54 37 0	235	54.17
2	0 104 87 103 14 23 62 11 117 32 46 45 43 44 2 17 98 102 0	232	54.77
3	0 89 51 18 129 4 6 112 0	232	32.58
		Total Distance	811.67

Table C.111: IPH-RCR solution to P12.

Day 1

No.	Route	Load	Distance
1	0 97 86 62 69 52 48 46 43 44 45 80 79 78 77 72 81 103 0	139	152.98
2	0 120 114 15 10 11 12 13 19 22 26 25 4 3 150 0	140	128.32
3	0 134 133 132 159 153 152 160 161 162 163 135 0	59	49.08

Day 2

No.	Route	Load	Distance
1	0 100 99 98 89 88 85 84 64 65 67 66 55 56 54 53 51 48 76 72 102 0	124	75.18
2	0 109 108 38 37 10 8 5 2 139 157 132 0	140	115.77
3	0 114 137 138 156 0	140	76.49

Day 3

No.	Route	Load	Distance
1	0 94 95 110 96 97 92 93 91 90 41 42 34 33 32 31 43 47 58 59 57 60 61 82 83 101 103 0	129	127.22
2	0 105 40 107 106 39 35 16 14 29 17 30 28 18 27 23 24 25 21 20 3 148 149 150 153 0	139	135.43

Day 4

No.	Route	Load	Distance
1	0 72 75 74 73 48 49 50 71 70 68 87 63 104 0	91	71.90
2	0 111 36 112 10 6 5 138 132 0	140	115.04
3	0 121 137 114 122 123 125 0	138	75.98

Day 5

No.	Route	Load	Distance
1	0 127 126 124 115 137 9 116 113 117 119 118 128 0	138	77.66
2	0 131 130 129 155 154 145 144 143 142 141 140 1 7 5 146 147 151 158 136 0	140	110.11
		Total Distance	1311.17

Table C.112: IPH-RCR solution to P18.

Day 1

No.	Route	Load	Distance
1	0 1 13 5 29 37 9 44 75 36 28 59 0	29	225.91
2	0 2 49 6 30 63 38 10 39 31 50 0	26	224.43
3	0 3 52 7 33 41 11 40 32 51 0	25	217.33
4	0 4 26 8 34 42 12 43 74 35 27 58 0	29	229.96

Day 2

No.	Route	Load	Distance
1	0 1 20 5 76 9 21 46 0	21	189.13
2	0 2 14 22 6 10 65 23 15 0	24	189.30
3	0 3 16 24 7 11 69 25 17 0	24	189.35
4	0 4 18 56 8 12 73 19 0	21	184.57

Day 3

No.	Route	Load	Distance
1	0 1 28 36 44 9 37 62 29 5 45 13 0	29	224.74
2	0 2 48 6 31 66 39 10 38 30 47 0	26	224.43
3	0 3 53 7 32 67 40 11 41 70 33 54 0	27	231.53
4	0 4 27 35 43 12 42 71 34 8 26 55 0	29	229.96

Day 4

No.	Route	Load	Distance
1	0 1 21 61 9 5 60 20 0	21	184.91
2	0 2 14 22 64 10 6 23 15 0	24	189.30
3	0 3 17 25 7 11 68 24 16 0	24	189.35
4	0 4 18 72 12 8 57 19 0	21	184.57
		Total Distance	3308.77

Table C.113: IPH-RCR solution to P23.

Day 1

No.	Route	Load	Distance
1	0 1 120 60 72 13 84 167 96 19 85 73 61 121 7 97 25 0	40	316.20
2	0 2 101 8 62 74 147 86 20 87 150 75 14 63 126 102 0	37	324.76
3	0 3 9 64 15 76 151 88 21 89 77 65 53 106 0	36	315.00
4	0 4 109 10 55 67 16 79 91 22 90 155 78 66 131 54 107 0	40	320.63
5	0 5 112 11 57 69 17 81 93 23 92 80 68 135 56 111 0	39	312.92
6	0 6 117 12 58 140 70 18 82 94 24 95 166 83 71 59 118 0	40	320.63

Day 2

No.	Route	Load	Distance
1	0 1 36 37 49 145 19 168 13 144 7 48 119 35 6 0	39	283.05
2	0 2 26 38 8 50 148 20 14 125 51 39 27 0	34	272.51
3	0 3 28 40 52 127 152 21 15 9 41 29 4 0	37	275.43
4	0 5 33 45 11 134 157 22 16 10 43 42 30 31 0	39	321.38
5	0 32 44 17 23 162 163 164 24 165 18 141 12 47 46 34 0	40	419.58

Day 3

No.	Route	Load	Distance
1	0 1 7 60 143 72 84 96 19 85 146 73 13 61 122 98 25 0	40	322.23
2	0 2 100 8 63 14 75 87 20 86 74 62 123 99 0	35	309.34
3	0 3 105 53 130 65 77 154 89 21 88 76 15 64 9 104 0	38	318.77
4	0 4 108 10 54 66 16 78 90 22 91 158 79 67 55 110 0	39	317.20
5	0 5 113 11 56 68 80 159 92 23 93 81 17 69 138 57 114 0	40	320.63
6	0 6 116 12 59 142 71 83 95 24 94 82 18 70 139 58 115 0	40	316.35

Day 4

No.	Route	Load	Distance
1	0 1 26 38 8 50 124 14 20 149 51 39 27 2 0	39	278.10
2	0 3 29 41 9 129 153 21 15 128 52 40 103 28 0	34	269.50
3	0 4 30 42 10 132 156 22 16 133 43 31 5 0	36	273.29
4	0 6 35 34 46 45 11 137 161 23 160 17 136 44 32 33 0	38	313.33
5	0 36 48 37 7 49 13 19 24 18 12 47 0	40	415.70
		Total Distance	6936.54

Table C.114: IPH-RCR solution to P25.

Day 1

No.	Route	Load	Distance
1	0 1 16 19 2 3 0	19	250.95
2	0 4 29 30 5 6 0	19	250.95

Day 2

No.	Route	Load	Distance
1	0 2 21 23 3 4 0	19	250.95
2	0 5 32 34 6 1 0	19	250.95

Day 3

No.	Route	Load	Distance
1	0 1 17 7 2 20 8 13 0	20	333.23
2	0 3 24 9 4 28 10 14 0	20	333.23
3	0 5 33 11 6 37 12 15 0	20	333.23

Day 4

No.	Route	Load	Distance
1	0 41 2 40 42 3 43 0	18	178.88
2	0 44 4 45 47 5 46 0	18	178.88
3	0 48 6 49 51 1 50 0	18	178.88

Day 5

No.	Route	Load	Distance
1	0 2 1 39 36 6 0	19	250.95
2	0 3 25 26 4 5 0	19	250.95

Day 6

No.	Route	Load	Distance
1	0 2 18 7 1 38 12 15 0	20	333.23
2	0 4 27 9 3 22 8 13 0	20	333.23
3	0 6 35 11 5 31 10 14 0	20	333.23
		Total Distance	4041.72

Table C.115: IPH-RCR solution to P29.

Day 1

No.	Route	Load	Distance
1	0 1 53 54 18 51 6 0	19	244.77
2	0 3 9 93 28 8 0	20	885.88
3	0 4 44 45 5 48 17 0	19	294.36
4	0 11 81 25 79 10 29 0	20	1230.21
5	0 12 88 27 89 7 30 0	20	1230.21
6	0 19 55 2 56 0	12	131.58

Day 2

No.	Route	Load	Distance
1	0 2 35 36 38 3 57 58 0	20	213.57
2	0 5 61 20 60 4 59 0	19	180.48
3	0 6 63 21 66 1 65 0	19	180.57
4	0 8 69 22 68 7 13 0	20	1185.63
5	0 12 85 26 84 11 16 0	20	1185.63
6	0 15 10 9 74 23 72 0	20	1402.07

Day 3

No.	Route	Load	Distance
1	0 1 32 31 34 2 0	16	204.76
2	0 3 37 14 92 8 33 0	19	622.27
3	0 4 43 98 11 97 46 62 0	20	651.27
4	0 6 49 47 5 0	14	193.21
5	0 9 76 24 77 10 96 0	19	1204.03
6	0 52 99 12 87 90 7 101 0	20	993.77

Day 4

No.	Route	Load	Distance
1	0 1 6 50 17 5 0	20	289.82
2	0 2 19 3 41 4 0	20	250.24
3	0 8 28 94 9 39 40 0	19	894.14
4	0 11 82 25 80 10 29 0	20	1230.21
5	0 12 27 7 30 18 0	19	1218.78

Day 5

No.	Route	Load	Distance
1	0 2 1 21 64 6 0	20	235.05
2	0 3 42 4 20 5 0	20	261.78

(cont.)

Table C.115 continued.

Day 5

No.	Route	Load	Distance
3	0 8 70 22 67 7 13 0	20	1185.63
4	0 12 86 26 83 11 16 0	20	1185.63
5	0 15 10 9 73 23 71 0	20	1439.80

Day 6

No.	Route	Load	Distance
1	0 1 6 5 4 0	20	288.67
2	0 2 8 91 14 3 0	20	636.80
3	0 7 102 100 12 11 0	19	1156.14
4	0 9 75 24 78 10 95 0	19	1179.61
		Total Distance	23686.57

Table C.116: IPH-RCR solution to P31.

Day 1

No.	Route	Load	Distance
1	0 1 114 115 12 6 0	19	647.27
2	0 2 50 51 53 3 0	16	204.76
3	0 5 76 75 4 74 0	16	178.76
4	0 7 13 141 138 18 0	19	2898.24
5	0 8 14 142 144 15 0	19	2602.40
6	0 11 10 9 109 52 0	19	1168.89
7	0 92 93 16 44 148 17 97 0	20	2733.83

Day 2

No.	Route	Load	Distance
1	0 1 7 117 36 12 0	19	885.88
2	0 2 25 73 3 4 0	19	234.91
3	0 8 28 121 37 119 118 13 0	20	3540.01
4	0 9 30 39 129 16 40 31 0	20	4826.55
5	0 15 124 38 123 122 14 34 0	20	3705.58
6	0 22 10 110 35 112 11 23 0	20	927.89
7	0 26 77 5 63 62 6 27 0	20	226.73
8	0 32 17 41 137 18 42 33 0	20	5115.23

Day 3

No.	Route	Load	Distance
1	0 1 47 46 19 48 49 2 0	20	256.32
2	0 3 4 5 6 0	20	288.67
3	0 7 13 45 151 18 0	19	2657.64
4	0 8 14 43 29 86 106 20 0	20	1979.22
5	0 9 88 145 15 90 91 21 0	20	1861.84
6	0 10 16 147 149 17 0	19	2602.40
7	0 11 99 98 100 101 12 24 0	20	1101.04

Day 4

No.	Route	Load	Distance
1	0 1 81 79 6 0	14	173.49
2	0 4 58 59 60 61 5 0	18	216.31
3	0 9 10 111 113 11 0	19	1156.14

(cont.)

Table C.116 continued.

Day 4

No.	Route	Load	Distance
4	0 15 126 127 128 16 146 94 0	20	3117.48
5	0 44 17 135 134 136 18 150 0	20	3304.10
6	0 55 54 3 72 70 2 71 0	20	232.17
7	0 64 65 12 102 105 7 116 0	20	987.85
8	0 107 8 14 13 152 0	19	2651.98

Day 5

No.	Route	Load	Distance
1	0 1 80 27 78 6 0	16	177.82
2	0 2 8 34 108 9 0	19	885.88
3	0 5 26 4 3 25 0	19	247.12
4	0 11 96 31 95 10 35 22 0	20	1230.21
5	0 13 140 42 139 18 41 32 0	20	4998.40
6	0 15 125 38 14 120 37 28 0	20	4998.40
7	0 17 133 40 130 16 39 30 0	20	4998.40
8	0 23 12 103 33 104 7 36 0	20	1249.70

Day 6

No.	Route	Load	Distance
1	0 1 68 69 24 66 67 6 0	20	256.32
2	0 2 20 9 10 21 0	19	920.48
3	0 3 56 57 4 5 0	19	258.42
4	0 8 84 85 82 83 7 19 0	20	1101.04
5	0 11 17 132 131 16 0	19	2898.24
6	0 12 18 45 153 13 0	19	2657.64
7	0 89 15 43 14 143 29 87 0	20	2839.21
		Total Distance	82200.85

Table C.117: IPH-RCH solution to P2 with $W = 10$.

Day 1

No.	Route	Load	Distance
1	0 12 4 41 19 42 44 45 33 10 38 0	156	118.31
2	0 18 25 24 43 7 23 48 0	142	95.51
3	0 26 31 28 20 29 21 34 50 2 32 46 0	157	130.65

Day 2

No.	Route	Load	Distance
1	0 2 20 35 36 3 22 8 27 0	143	104.63
2	0 6 25 13 41 18 47 0	159	85.59
3	0 11 16 34 30 9 49 5 12 0	158	81.21

Day 3

No.	Route	Load	Distance
1	0 12 18 25 14 0	119	57.79
2	0 32 2 20 28 31 7 43 23 48 0	158	127.40
3	0 38 34 39 33 44 42 40 41 0	141	150.09

Day 4

No.	Route	Load	Distance
1	0 2 20 35 3 8 27 0	129	93.32
2	0 6 25 13 41 18 47 0	159	85.59
3	0 11 16 34 30 9 49 5 12 0	158	81.21

Day 5

No.	Route	Load	Distance
1	0 1 2 20 34 39 15 37 17 12 0	156	134.98
2	0 14 25 41 18 0	117	77.96
		Total Distance	1424.22

Table C.118: IPH-RCH solution to P5 with $W = 21$.

Day 1

No.	Route	Load	Distance
1	0 3 44 32 9 39 40 0	134	63.22
2	0 4 75 0	50	15.46
3	0 8 14 66 11 26 0	139	82.48
4	0 21 48 15 57 13 54 67 0	128	98.56
5	0 28 22 64 42 41 56 23 63 0	138	108.26

Day 2

No.	Route	Load	Distance
1	0 2 28 64 43 1 6 0	138	93.68
2	0 27 20 37 36 47 21 30 0	134	92.96
3	0 9 31 10 38 58 0	125	90.99
4	0 11 66 59 14 0	129	90.13
5	0 51 16 24 32 40 17 0	139	76.58
6	0 4 34 46 67 0	106	27.76

Day 3

No.	Route	Load	Distance
1	0 75 4 52 54 8 67 0	131	59.69
2	0 53 11 66 14 0	127	81.57
3	0 26 12 39 9 32 40 0	140	58.21
4	0 44 50 18 56 64 33 0	133	133.90
5	0 45 5 48 21 28 62 0	137	79.59

Day 4

No.	Route	Load	Distance
1	0 2 28 64 43 1 6 0	138	93.68
2	0 4 27 20 47 21 30 0	138	89.66
3	0 9 31 10 38 58 0	125	90.99
4	0 11 66 59 14 0	129	90.13
5	0 16 49 24 32 40 17 0	132	77.05
6	0 34 46 67 0	76	23.62

Day 5

No.	Route	Load	Distance
1	0 4 52 19 14 35 67 0	135	66.46
2	0 7 53 11 66 65 72 12 0	137	84.42
3	0 32 50 55 25 9 40 0	133	88.19
4	0 45 29 5 70 60 71 69 21 74 0	128	99.11
5	0 68 28 61 64 62 73 33 0	133	104.73
		Total Distance	2161.07

Table C.119: IPH-RCH solution to P8 with $W = 25$.

Day 1

No.	Route	Load	Distance
1	0 18 83 45 8 46 48 47 49 64 10 31 0	194	137.62
2	0 55 25 39 23 41 15 43 38 86 17 84 5 60 89 0	192	160.63
3	0 68 80 24 29 78 81 9 30 70 69 0	131	103.60
4	0 87 92 37 85 59 96 94 0	143	57.49

Day 2

No.	Route	Load	Distance
1	0 5 16 86 44 14 100 85 93 0	198	87.93
2	0 12 68 77 3 79 81 33 50 76 28 0	184	71.75
3	0 13 87 97 59 95 94 0	136	46.91
4	0 26 54 39 23 75 72 73 21 40 58 53 0	199	90.05
5	0 31 32 63 11 49 47 48 82 0	181	112.59

Day 3

No.	Route	Load	Distance
1	0 27 30 20 66 65 71 9 81 34 68 0	198	129.56
2	0 31 10 62 19 49 47 48 18 89 0	199	102.38
3	0 4 39 67 23 22 2 87 94 0	182	108.05
4	0 83 45 5 61 86 38 85 59 96 6 0	200	115.16

Day 4

No.	Route	Load	Distance
1	0 5 16 86 44 14 100 85 93 0	198	87.93
2	0 12 68 77 3 79 81 33 50 76 28 0	184	71.75
3	0 13 87 97 59 95 94 0	136	46.91
4	0 26 54 39 23 75 72 21 58 53 0	181	87.82
5	0 31 32 90 11 49 47 48 82 0	174	112.18

Day 5

No.	Route	Load	Distance
1	0 1 51 66 65 71 35 34 81 68 0	164	129.54
2	0 5 61 86 91 85 98 59 99 94 0	190	78.66
3	0 27 31 88 62 19 49 36 47 48 7 52 0	200	101.29
4	0 4 39 67 23 56 74 22 57 42 87 0	174	120.60
		Total Distance	2160.38

Table C.120: IPH-RCH solution to P11 with $W = 70$.

Day 1

No.	Route	Load	Distance
1	0 87 24 125 23 62 11 20 117 10 81 13 12 2 72 100 0	235	72.72
2	0 25 15 96 121 29 3 4 6 26 95 0	232	28.87
3	0 36 7 5 1 28 8 30 9 77 57 31 93 39 68 0	233	65.69

Day 2

No.	Route	Load	Distance
1	0 15 128 18 9 78 53 52 5 127 130 74 0	234	73.98
2	0 16 38 49 27 69 50 35 37 105 0	162	23.34
3	0 34 84 17 99 2 82 22 13 10 64 32 63 80 14 103 0	205	82.38

Day 3

No.	Route	Load	Distance
1	0 33 19 131 6 124 73 0	231	25.68
2	0 39 94 29 128 55 76 28 1 5 7 36 26 90 0	235	47.99
3	0 86 14 97 66 118 21 65 40 108 109 12 2 120 102 0	186	54.99

Day 4

No.	Route	Load	Distance
1	0 6 130 75 54 1 126 7 111 92 47 48 27 38 16 0	235	58.71
2	0 34 17 85 2 83 12 22 13 106 10 11 61 119 24 41 71 42 101 0	222	76.84
3	0 104 88 67 89 51 116 59 31 58 56 115 9 30 114 8 60 113 128 122 15 91 0	235	54.51

Day 5

No.	Route	Load	Distance
1	0 16 112 4 19 33 123 37 0	235	26.82
2	0 25 129 18 110 8 79 1 5 35 0	233	52.98
3	0 70 98 17 2 44 43 45 46 21 32 107 20 11 23 14 0	226	54.66
		Total Distance	800.17

Table C.121: IPH-RCH solution to P12 with $W = 110$.

Day 1

No.	Route	Load	Distance
1	0 86 83 46 80 45 44 43 31 32 16 14 10 8 9 114 121 0	139	150.34
2	0 106 39 34 33 30 28 22 26 25 5 146 153 159 132 0	140	139.79

Day 2

No.	Route	Load	Distance
1	0 105 40 107 108 37 10 35 58 56 54 48 73 72 103 0	140	123.39
2	0 134 127 119 137 114 124 126 0	139	76.09

Day 3

No.	Route	Load	Distance
1	0 94 91 90 41 42 43 47 52 71 70 68 69 67 66 61 60 57 59 88 89 97 96 110 95 0	123	92.25
2	0 29 17 18 27 23 24 25 5 3 2 138 147 150 0	140	139.18
3	0 136 132 153 152 160 161 162 163 135 0	53	49.07

Day 4

No.	Route	Load	Distance
1	0 103 81 72 74 75 48 49 50 62 87 63 104 0	90	88.11
2	0 133 128 111 36 112 10 15 114 115 122 120 123 125 154 155 129 130 131 0	138	79.31
3	0 118 117 113 116 137 139 143 144 149 151 156 0	140	76.77

Day 5

No.	Route	Load	Distance
1	0 100 99 98 97 92 93 85 84 82 64 65 55 53 51 48 76 79 78 77 72 102 101 0	136	77.13
2	0 109 38 11 12 13 19 21 20 6 5 7 4 3 1 140 141 145 157 132 0	139	123.57
3	0 137 138 142 148 150 158 0	140	76.60
		Total Distance	1291.61

Table C.122: IPH-RCH solution to P18 with $W = 26$.

Day 1

No.	Route	Load	Distance
1	0 1 5 29 37 9 44 36 28 59 20 0	28	217.54
2	0 2 48 6 30 38 10 39 31 23 50 15 0	29	218.29
3	0 3 53 7 32 40 11 41 70 33 54 0	26	224.43
4	0 4 8 35 43 12 42 71 34 26 55 18 0	29	224.64

Day 2

No.	Route	Load	Distance
1	0 1 60 5 9 21 46 13 0	21	184.64
2	0 2 6 10 64 22 47 14 0	21	184.80
3	0 3 16 51 24 7 11 69 25 17 0	25	190.83
4	0 4 56 8 12 27 58 19 0	21	184.64

Day 3

No.	Route	Load	Distance
1	0 1 45 5 29 62 37 9 44 75 36 28 20 0	30	231.02
2	0 2 6 30 63 38 10 39 66 31 23 15 0	29	230.26
3	0 3 7 33 41 11 40 67 32 52 0	25	223.67
4	0 4 57 8 35 74 43 12 42 34 26 18 0	29	223.92

Day 4

No.	Route	Load	Distance
1	0 1 5 76 9 61 21 13 0	21	187.30
2	0 2 49 6 65 10 22 14 0	21	187.14
3	0 3 16 24 68 11 7 25 17 0	24	189.35
4	0 4 8 72 12 73 27 19 0	21	187.30
		Total Distance	3289.77

Table C.123: IPH-RCH solution to P23 with $W = 5$.

Day 1

No.	Route	Load	Distance
1	0 1 98 50 62 74 86 20 87 75 14 8 38 2 0	40	310.01
2	0 3 104 9 15 76 88 21 89 154 77 65 130 53 41 29 0	39	308.72
3	0 4 109 10 55 67 16 22 90 155 78 66 54 42 30 0	38	293.69
4	0 5 113 11 56 68 80 92 23 93 81 17 69 138 57 33 0	40	312.69
5	0 6 117 12 58 139 70 18 82 94 24 95 83 71 59 47 0	40	312.69
6	0 25 97 37 7 49 122 61 73 146 85 19 168 84 13 72 60 48 119 0	40	316.02

Day 2

No.	Route	Load	Distance
1	0 1 36 120 7 144 13 145 19 96 167 143 118 35 34 6 0	39	299.08
2	0 2 26 8 125 14 148 20 149 63 51 39 27 0	33	270.63
3	0 3 28 40 52 64 152 21 153 15 9 105 4 0	36	274.20
4	0 5 32 112 44 134 79 158 91 22 157 16 133 10 43 31 0	37	306.11
5	0 45 11 17 160 23 162 163 164 24 165 18 140 12 46 0	40	411.64

Day 3

No.	Route	Load	Distance
1	0 1 48 7 60 72 13 84 19 85 73 61 49 37 25 0	40	303.83
2	0 2 101 8 14 75 150 87 20 86 147 74 62 123 50 38 99 0	39	316.88
3	0 3 9 129 15 76 151 88 21 89 77 65 53 41 106 29 0	39	307.45
4	0 4 108 10 55 67 16 22 90 78 66 54 42 30 0	37	285.98
5	0 5 11 56 135 68 80 159 92 23 93 81 17 69 57 33 0	40	320.06
6	0 6 116 12 58 70 18 82 94 24 95 83 71 142 59 47 0	40	312.69

Day 4

No.	Route	Load	Distance
1	0 1 26 100 8 124 14 20 63 126 51 39 102 27 2 0	39	275.38
2	0 3 9 128 15 21 64 127 52 40 103 28 0	31	268.97
3	0 4 31 110 43 10 132 16 79 91 22 156 131 107 0	33	294.14
4	0 5 32 111 44 136 17 23 161 137 11 45 114 34 35 6 0	40	283.88
5	0 36 7 121 13 19 96 166 24 18 141 12 46 115 0	40	398.12
		Total Distance	6782.89

Table C.124: IPH-RCH solution to P25 with $W = 31$.

Day 1

No.	Route	Load	Distance
1	0 2 41 13 42 3 0	16	177.78
2	0 4 28 10 31 5 46 0	18	235.92
3	0 6 36 12 38 1 50 0	18	235.92

Day 2

No.	Route	Load	Distance
1	0 1 51 15 49 6 0	16	177.94
2	0 2 21 8 22 3 0	16	233.23
3	0 4 45 47 5 33 11 34 0	20	276.80

Day 3

No.	Route	Load	Distance
1	0 6 1 7 19 2 0	19	289.82
2	0 3 9 4 14 5 0	19	292.04

Day 4

No.	Route	Load	Distance
1	0 1 39 12 37 6 0	16	233.23
2	0 2 40 13 43 3 0	16	177.78
3	0 4 29 10 30 5 0	16	233.23

Day 5

No.	Route	Load	Distance
1	0 1 2 20 8 23 0	16	276.52
2	0 4 26 25 3 0	14	193.22
3	0 5 32 11 35 6 48 15 0	20	246.42

Day 6

No.	Route	Load	Distance
1	0 1 17 16 7 18 2 0	18	244.77
2	0 3 24 9 27 4 44 14 0	20	246.65
3	0 6 5 0	10	173.20
		Total Distance	3944.48

Table C.125: IPH-RCH solution to P29 with $W = 61$.

Day 1

No.	Route	Load	Distance
1	0 2 8 28 93 9 0	20	885.88
2	0 3 4 60 62 5 0	19	231.23
3	0 6 52 51 54 1 66 65 0	20	213.57
4	0 7 90 27 88 12 99 0	19	1179.60
5	0 10 79 25 82 11 17 0	20	1185.63

Day 2

No.	Route	Load	Distance
1	0 56 2 55 58 3 0	16	178.76
2	0 4 42 10 95 29 16 0	20	655.61
3	0 21 6 49 47 5 20 0	20	218.66
4	0 9 74 23 71 8 14 0	20	1185.63
5	0 11 84 26 86 12 50 0	19	1170.39
6	0 13 7 102 30 53 1 0	20	674.77

Day 3

No.	Route	Load	Distance
1	0 1 2 19 57 3 0	20	234.91
2	0 4 43 44 45 46 5 0	18	216.31
3	0 6 18 100 12 11 0	20	925.48
4	0 101 7 67 22 69 8 0	19	1179.61
5	0 9 76 24 78 10 15 0	20	1185.63

Day 4

No.	Route	Load	Distance
1	0 1 6 5 4 0	20	288.67
2	0 2 35 36 38 37 3 0	18	216.31
3	0 9 94 28 91 8 92 0	19	902.38
4	0 48 11 81 25 80 10 0	19	1170.39
5	0 17 12 87 27 89 7 0	20	1185.63

Day 5

No.	Route	Load	Distance
1	0 1 7 13 33 2 0	20	613.45
2	0 3 40 10 96 29 16 0	20	678.09
3	0 4 59 20 61 5 0	17	177.78
4	0 9 73 23 72 8 14 0	20	1185.63

(cont.)

Table C.125 continued.

Day 5

No.	Route	Load	Distance
5	0 11 83 26 85 12 30 0	20	1230.21
6	0 21 64 6 63 0	12	131.43

Day 6

No.	Route	Load	Distance
1	0 19 2 34 31 32 1 0	19	217.58
2	0 5 4 41 39 3 0	19	261.52
3	0 18 7 68 22 70 8 0	20	1185.63
4	0 9 75 24 77 10 15 0	20	1185.63
5	0 6 12 11 98 97 0	19	910.05
		Total Distance	23062.03

Table C.126: IPH-RCH solution to P31 with $W = 81$.

Day 1

No.	Route	Load	Distance
1	0 1 68 69 66 6 0	16	204.76
2	0 2 50 51 3 4 0	19	258.42
3	0 5 61 22 110 10 21 54 0	20	647.22
4	0 7 13 14 8 0	20	2598.08
5	0 9 15 127 39 16 0	19	3481.25
6	0 11 17 149 44 31 96 35 0	20	1947.90
7	0 12 18 150 103 115 114 67 0	20	1785.20

Day 2

No.	Route	Load	Distance
1	0 2 1 27 78 6 0	19	234.98
2	0 3 9 106 8 19 0	19	886.50
3	0 4 74 26 5 0	14	177.18
4	0 7 13 118 119 37 121 28 0	20	3462.66
5	0 10 146 16 130 40 132 95 0	20	3347.68
6	0 14 122 38 125 15 30 91 0	20	3643.21
7	0 17 41 137 18 138 42 141 0	20	5030.91
8	0 23 12 100 32 99 11 112 0	20	1199.10

Day 3

No.	Route	Load	Distance
1	0 1 47 46 49 48 2 0	18	216.31
2	0 3 55 56 57 4 0	16	204.76
3	0 5 63 62 64 6 0	16	204.76
4	0 7 13 153 45 33 36 24 0	20	1933.36
5	0 8 14 43 15 29 0	19	2782.54
6	0 10 16 147 17 97 0	19	2629.12
7	0 11 98 101 18 12 0	19	1941.84
8	0 25 53 20 34 108 9 109 52 0	19	661.55

Day 4

No.	Route	Load	Distance
1	0 1 2 70 72 3 0	19	231.23
2	0 4 59 60 5 6 0	19	250.95

(cont.)

Table C.126 continued.

Day 4

No.	Route	Load	Distance
3	0 7 13 152 102 12 0	19	1924.37
4	0 8 14 143 86 9 0	19	1944.25
5	0 15 126 39 129 128 16 94 0	20	3699.70
6	0 18 136 134 17 148 44 31 0	20	3099.54
7	0 22 11 113 35 111 10 21 0	20	927.89

Day 5

No.	Route	Load	Distance
1	0 2 1 80 27 0	14	186.58
2	0 3 4 26 76 5 0	19	234.91
3	0 6 12 11 23 65 0	19	895.23
4	0 9 90 30 92 93 10 58 0	20	1228.13
5	0 15 124 38 123 14 120 37 0	20	5015.55
6	0 16 131 40 133 17 135 41 0	20	5015.55
7	0 19 7 82 85 84 8 107 0	20	1056.78
8	0 28 13 140 42 139 18 32 0	20	3766.35

Day 6

No.	Route	Load	Distance
1	0 1 81 79 6 0	14	173.49
2	0 2 71 25 73 3 0	16	177.78
3	0 4 75 77 5 0	14	173.49
4	0 7 83 13 104 117 116 24 0	20	1839.72
5	0 8 14 142 43 29 87 20 0	20	1945.35
6	0 9 15 144 145 88 89 34 0	20	1893.45
7	0 10 16 17 11 0	20	2598.08
8	0 12 18 151 45 33 105 36 0	20	1947.92
		Total Distance	79705.58

Appendix D

VRP: Problems and Solutions

Table D.1: Symbol key.

N	Number of customers in a problem
K	Number of vehicles
c	Customer service cost
C	Maximum route cost
Q	Vehicle capacity
No.	Customer or route number
x	x-coordinate of a node's location
y	y-coordinate of a node's location
q	Customer demand

Table D.2: Dimensions for 15 VRPs.

Problem	N	K	c	C	Q
VRP1	50	5	0	∞	160
VRP2	75	10	0	∞	140
VRP3	100	8	0	∞	200
VRP4	150	12	0	∞	200
VRP5	199	17	0	∞	200
VRP6	50	6	10	200	160
VRP7	75	11	10	160	140
VRP8	100	9	10	230	200
VRP9	150	14	10	200	200
VRP10	199	18	10	200	200
VRP11	120	7	0	∞	200
VRP12	100	10	0	∞	200
VRP13	120	11	50	720	200
VRP14	100	11	90	1040	200
VRP15	240	10	0	650	550

Table D.3: Dimensions for 15 VRPs with small capacities.

Problem	N	K	c	C	Q
VRP1-SC	50	10	0	∞	80
VRP2-SC	75	21	0	∞	70
VRP3-SC	100	16	0	∞	100
VRP4-SC	150	24	0	∞	100
VRP5-SC	199	34	0	∞	100
VRP6-SC	50	12	3	100	80
VRP7-SC	75	22	1	100	70
VRP8-SC	100	18	2	115	100
VRP9-SC	150	28	2	105	100
VRP10-SC	199	36	2	105	100
VRP11-SC	120	14	0	∞	100
VRP12-SC	100	20	0	∞	100
VRP13-SC	120	22	12	360	100
VRP14-SC	100	22	22	520	100
VRP15-SC	240	20	0	400	275

Table D.4: Node locations and demands for VRP1 and VRP6.

No.	x	y	q	No.	x	y	q	No.	x	y	q	No.	x	y	q
0	30	40	0	13	5	25	23	26	27	68	7	39	59	15	14
1	37	52	7	14	12	42	21	27	30	48	15	40	5	6	7
2	49	49	30	15	36	16	10	28	43	67	14	41	10	17	27
3	52	64	16	16	52	41	15	29	58	48	6	42	21	10	13
4	20	26	9	17	27	23	3	30	58	27	19	43	5	64	11
5	40	30	21	18	17	33	41	31	37	69	11	44	30	15	16
6	21	47	15	19	13	13	9	32	38	46	12	45	39	10	10
7	17	63	19	20	57	58	28	33	46	10	23	46	32	39	5
8	31	62	23	21	62	42	8	34	61	33	26	47	25	32	25
9	52	33	11	22	42	57	8	35	62	63	17	48	25	55	17
10	51	21	5	23	16	57	16	36	63	69	6	49	48	28	18
11	42	41	19	24	8	52	10	37	32	22	9	50	56	37	10
12	31	32	29	25	7	38	28	38	45	35	15				

Table D.5: Node locations and demands for VRP2 and VRP7.

No.	x	y	q	No.	x	y	q	No.	x	y	q	No.	x	y	q
0	40	40	0	19	62	48	15	38	47	66	24	57	65	27	14
1	22	22	18	20	66	14	22	39	30	60	16	58	40	60	21
2	36	26	26	21	44	13	28	40	30	50	33	59	70	64	24
3	21	45	11	22	26	13	12	41	12	17	15	60	64	4	13
4	45	35	30	23	11	28	6	42	15	14	11	61	36	6	15
5	55	20	21	24	7	43	27	43	16	19	18	62	30	20	18
6	33	34	19	25	17	64	14	44	21	48	17	63	20	30	11
7	50	50	15	26	41	46	18	45	50	30	21	64	15	5	28
8	55	45	16	27	55	34	17	46	51	42	27	65	50	70	9
9	26	59	29	28	35	16	29	47	50	15	19	66	57	72	37
10	40	66	26	29	52	26	13	48	48	21	20	67	45	42	30
11	55	65	37	30	43	26	22	49	12	38	5	68	38	33	10
12	35	51	16	31	31	76	25	50	15	56	22	69	50	4	8
13	62	35	12	32	22	53	28	51	29	39	12	70	66	8	11
14	62	57	31	33	26	29	27	52	54	38	19	71	59	5	3
15	62	24	8	34	50	40	19	53	55	57	22	72	35	60	1
16	21	36	19	35	55	50	10	54	67	41	16	73	27	24	6
17	33	44	20	36	54	10	12	55	10	70	7	74	40	20	10
18	9	56	13	37	60	15	14	56	6	25	26	75	40	37	20

Table D.6: Node locations and demands for VRP3 and VRP8.

No.	x	y	q	No.	x	y	q	No.	x	y	q	No.	x	y	q
0	35	35	0	26	45	30	17	52	27	43	9	78	61	52	3
1	41	49	10	27	35	40	16	53	37	31	14	79	57	48	23
2	35	17	7	28	41	37	16	54	57	29	18	80	56	37	6
3	55	45	13	29	64	42	9	55	63	23	2	81	55	54	26
4	55	20	19	30	40	60	21	56	53	12	6	82	15	47	16
5	15	30	26	31	31	52	27	57	32	12	7	83	14	37	11
6	25	30	3	32	35	69	23	58	36	26	18	84	11	31	7
7	20	50	5	33	53	52	11	59	21	24	28	85	16	22	41
8	10	43	9	34	65	55	14	60	17	34	3	86	4	18	35
9	55	60	16	35	63	65	8	61	12	24	13	87	28	18	26
10	30	60	16	36	2	60	5	62	24	58	19	88	26	52	9
11	20	65	12	37	20	20	8	63	27	69	10	89	26	35	15
12	50	35	19	38	5	5	16	64	15	77	9	90	31	67	3
13	30	25	23	39	60	12	31	65	62	77	20	91	15	19	1
14	15	10	20	40	40	25	9	66	49	73	25	92	22	22	2
15	30	5	8	41	42	7	5	67	67	5	25	93	18	24	22
16	10	20	19	42	24	12	5	68	56	39	36	94	26	27	27
17	5	30	2	43	23	3	7	69	37	47	6	95	25	24	20
18	20	40	12	44	11	14	18	70	37	56	5	96	22	27	11
19	15	60	17	45	6	38	16	71	57	68	15	97	25	21	12
20	45	65	9	46	2	48	1	72	47	16	25	98	19	21	10
21	45	20	11	47	8	56	27	73	44	17	9	99	20	26	9
22	45	10	18	48	13	52	36	74	46	13	8	100	18	18	17
23	55	5	29	49	6	68	30	75	49	11	18				
24	65	35	3	50	47	47	13	76	49	42	13				
25	65	20	6	51	49	58	10	77	53	43	14				

Table D.7: Node locations and demands for VRP4 and VRP9.

No.	x	y	q	No.	x	y	q	No.	x	y	q	No.	x	y	q
0	35	35	0	38	45	35	15	76	45	30	17	114	15	77	9
1	37	52	7	39	59	15	14	77	35	40	16	115	62	77	20
2	49	49	30	40	5	6	7	78	41	37	16	116	49	73	25
3	52	64	16	41	10	17	27	79	64	42	9	117	67	5	25
4	20	26	9	42	21	10	13	80	40	60	21	118	56	39	36
5	40	30	21	43	5	64	11	81	31	52	27	119	37	47	6
6	21	47	15	44	30	15	16	82	35	69	23	120	37	56	5
7	17	63	19	45	39	10	10	83	53	52	11	121	57	68	15
8	31	62	23	46	32	39	5	84	65	55	14	122	47	16	25
9	52	33	11	47	25	32	25	85	63	65	8	123	44	17	9
10	51	21	5	48	25	55	17	86	2	60	5	124	46	13	8
11	42	41	19	49	48	28	18	87	20	20	8	125	49	11	18
12	31	32	29	50	56	37	10	88	5	5	16	126	49	42	13
13	5	25	23	51	41	49	10	89	60	12	31	127	53	43	14
14	12	42	21	52	35	17	7	90	40	25	9	128	61	52	3
15	36	16	10	53	55	45	13	91	42	7	5	129	57	48	23
16	52	41	15	54	55	20	19	92	24	12	5	130	56	37	6
17	27	23	3	55	15	30	26	93	23	3	7	131	55	54	26
18	17	33	41	56	25	30	3	94	11	14	18	132	15	47	16
19	13	13	9	57	20	50	5	95	6	38	16	133	14	37	11
20	57	58	28	58	10	43	9	96	2	48	1	134	11	31	7
21	62	42	8	59	55	60	16	97	8	56	27	135	16	22	41
22	42	57	8	60	30	60	16	98	13	52	36	136	4	18	35
23	16	57	16	61	20	65	12	99	6	68	30	137	28	18	26
24	8	52	10	62	50	35	19	100	47	47	13	138	26	52	9
25	7	38	28	63	30	25	23	101	49	58	10	139	26	35	15
26	27	68	7	64	15	10	20	102	27	43	9	140	31	67	3
27	30	48	15	65	30	5	8	103	37	31	14	141	15	19	1
28	43	67	14	66	10	20	19	104	57	29	18	142	22	22	2
29	58	48	6	67	5	30	2	105	63	23	2	143	18	24	22
30	58	27	19	68	20	40	12	106	53	12	6	144	26	27	27
31	37	69	11	69	15	60	17	107	32	12	7	145	25	24	20
32	38	46	12	70	45	65	9	108	36	26	18	146	22	27	11
33	46	10	23	71	45	20	11	109	21	24	28	147	25	21	12
34	61	33	26	72	45	10	18	110	17	34	3	148	19	21	10
35	62	63	17	73	55	5	29	111	12	24	13	149	20	26	9
36	63	69	6	74	65	35	3	112	24	58	19	150	18	18	17
37	32	22	9	75	65	20	6	113	27	69	10				

Table D.8: Node locations and demands for VRP5 and VRP10.

No.	x	y	q	No.	x	y	q	No.	x	y	q	No.	x	y	q
0	35	35	0	35	55	50	10	70	62	42	8	105	25	30	3
1	22	22	18	36	54	10	12	71	42	57	8	106	20	50	5
2	36	26	26	37	60	15	14	72	16	57	16	107	10	43	9
3	21	45	11	38	47	66	24	73	8	52	10	108	55	60	16
4	45	35	30	39	30	60	16	74	7	38	28	109	30	60	16
5	55	20	21	40	30	50	33	75	27	68	7	110	20	65	12
6	33	34	19	41	12	17	15	76	30	48	15	111	50	35	19
7	50	50	15	42	15	14	11	77	43	67	14	112	30	25	23
8	55	45	16	43	16	19	18	78	58	48	6	113	15	10	20
9	26	59	29	44	21	48	17	79	58	27	19	114	30	5	8
10	40	66	26	45	50	30	21	80	37	69	11	115	10	20	19
11	55	65	37	46	51	42	27	81	38	46	12	116	5	30	2
12	35	51	16	47	50	15	19	82	46	10	23	117	20	40	12
13	62	35	12	48	48	21	20	83	61	33	26	118	15	60	17
14	62	57	31	49	12	38	5	84	62	63	17	119	45	65	9
15	62	24	8	50	37	52	7	85	63	69	6	120	45	20	11
16	21	36	19	51	49	49	30	86	32	22	9	121	45	10	18
17	33	44	20	52	52	64	16	87	45	35	15	122	55	5	29
18	9	56	13	53	20	26	9	88	59	15	14	123	65	35	3
19	62	48	15	54	40	30	21	89	5	6	7	124	65	20	6
20	66	14	22	55	21	47	15	90	10	17	27	125	45	30	17
21	44	13	28	56	17	63	19	91	21	10	13	126	35	40	16
22	26	13	12	57	31	62	23	92	5	64	11	127	41	37	16
23	11	28	6	58	52	33	11	93	30	15	16	128	64	42	9
24	7	43	27	59	51	21	5	94	39	10	10	129	40	60	21
25	17	64	14	60	42	41	19	95	32	39	5	130	31	52	27
26	41	46	18	61	31	32	29	96	25	32	25	131	35	69	23
27	55	34	17	62	5	25	23	97	25	55	17	132	53	52	11
28	35	16	29	63	12	42	21	98	48	28	18	133	65	55	14
29	52	26	13	64	36	16	10	99	56	37	10	134	63	65	8
30	43	26	22	65	52	41	15	100	41	49	10	135	2	60	5
31	31	76	25	66	27	23	3	101	35	17	7	136	20	20	8
32	22	53	28	67	17	33	41	102	55	45	13	137	5	5	16
33	26	29	27	68	13	13	9	103	55	20	19	138	60	12	31
34	50	40	19	69	57	58	28	104	15	30	26	139	40	25	9

(cont.)

Table D.8 continued.

No.	x	y	q	No.	x	y	q	No.	x	y	q	No.	x	y	q
140	42	7	5	155	53	12	6	170	57	68	15	185	4	18	35
141	24	12	5	156	32	12	7	171	47	16	25	186	28	18	26
142	23	3	7	157	36	26	18	172	44	17	9	187	26	52	9
143	11	14	18	158	21	24	28	173	46	13	8	188	26	35	15
144	6	38	16	159	17	34	3	174	49	11	18	189	31	67	3
145	2	48	1	160	12	24	13	175	49	42	13	190	15	19	1
146	8	56	27	161	24	58	19	176	53	43	14	191	22	22	2
147	13	52	36	162	27	69	10	177	61	52	3	192	18	24	22
148	6	68	30	163	15	77	9	178	57	48	23	193	26	27	27
149	47	47	13	164	62	77	20	179	56	37	6	194	25	24	20
150	49	58	10	165	49	73	25	180	55	54	26	195	22	27	11
151	27	43	9	166	67	5	25	181	15	47	16	196	25	21	12
152	37	31	14	167	56	39	36	182	14	37	11	197	19	21	10
153	57	29	18	168	37	47	6	183	11	31	7	198	20	26	9
154	63	23	2	169	37	56	5	184	16	22	41	199	18	18	17

Table D.9: Node locations and demands for VRP11 and VRP13.

No.	x	y	q	No.	x	y	q	No.	x	y	q	No.	x	y	q
0	10	45	0	31	84	5	10	62	93	84	7	93	20	44	7
1	25	1	25	32	84	9	3	63	93	89	16	94	22	44	10
2	25	3	7	33	85	1	7	64	94	86	14	95	16	45	9
3	31	5	13	34	87	5	2	65	95	80	17	96	20	45	11
4	32	5	6	35	85	8	4	66	99	89	13	97	25	45	17
5	31	7	14	36	87	7	4	67	37	83	17	98	30	55	12
6	32	9	5	37	86	41	18	68	50	80	13	99	20	50	11
7	34	9	11	38	86	44	14	69	35	85	14	100	22	51	7
8	46	9	19	39	86	46	12	70	35	87	16	101	18	49	9
9	35	7	5	40	85	55	17	71	44	86	7	102	16	48	11
10	34	6	15	41	89	43	20	72	46	89	13	103	20	55	12
11	35	5	15	42	89	46	14	73	46	83	9	104	18	53	7
12	47	6	17	43	89	52	16	74	46	87	11	105	14	50	8
13	40	5	13	44	92	42	10	75	46	89	35	106	15	51	6
14	39	3	12	45	92	52	9	76	48	83	5	107	16	54	5
15	36	3	18	46	94	42	11	77	50	85	28	108	28	33	12
16	73	6	13	47	94	44	7	78	50	88	7	109	33	38	13
17	73	8	18	48	94	48	13	79	54	86	3	110	30	50	7
18	24	36	12	49	96	42	5	80	54	90	10	111	13	40	7
19	76	6	17	50	99	46	4	81	10	35	7	112	15	36	8
20	76	10	4	51	99	50	21	82	10	40	12	113	18	31	11
21	76	13	7	52	83	80	13	83	18	30	11	114	25	37	13
22	78	3	12	53	83	83	11	84	17	35	10	115	30	46	11
23	78	9	13	54	85	81	12	85	16	38	8	116	25	52	10
24	79	3	8	55	85	85	14	86	14	40	11	117	16	33	7
25	79	5	16	56	85	89	10	87	15	42	21	118	25	35	4
26	79	11	15	57	87	80	8	88	11	42	4	119	5	40	20
27	82	3	6	58	87	86	16	89	18	40	15	120	5	50	13
28	82	7	5	59	90	77	19	90	21	39	16				
29	90	15	9	60	90	88	5	91	20	40	4				
30	84	3	11	61	93	82	17	92	18	41	16				

Table D.10: Node locations and demands for VRP12 and VRP14.

No.	x	y	q	No.	x	y	q	No.	x	y	q	No.	x	y	q
0	40	50	0	26	25	55	10	52	25	35	10	78	88	35	20
1	45	68	10	27	23	52	10	53	44	5	20	79	87	30	10
2	45	70	30	28	23	55	20	54	42	10	40	80	85	25	10
3	42	66	10	29	20	50	10	55	42	15	10	81	85	35	30
4	42	68	10	30	20	55	10	56	40	5	30	82	75	55	20
5	42	65	10	31	10	35	20	57	40	15	40	83	72	55	10
6	40	69	20	32	10	40	30	58	38	5	30	84	70	58	20
7	40	66	20	33	8	40	40	59	38	15	10	85	68	60	30
8	38	68	20	34	8	45	20	60	35	5	20	86	66	55	10
9	38	70	10	35	5	35	10	61	50	30	10	87	65	55	20
10	35	66	10	36	5	45	10	62	50	35	20	88	65	60	30
11	35	69	10	37	2	40	20	63	50	40	50	89	63	58	10
12	25	85	20	38	0	40	30	64	48	30	10	90	60	55	10
13	22	75	30	39	0	45	20	65	48	40	10	91	60	60	10
14	22	85	10	40	35	30	10	66	47	35	10	92	67	85	20
15	20	80	40	41	35	32	10	67	47	40	10	93	65	85	40
16	20	85	40	42	33	32	20	68	45	30	10	94	65	82	10
17	18	75	20	43	33	35	10	69	45	35	10	95	62	80	30
18	15	75	20	44	32	30	10	70	95	30	30	96	60	80	10
19	15	80	10	45	30	30	10	71	95	35	20	97	60	85	30
20	30	50	10	46	30	32	30	72	53	30	10	98	58	75	20
21	30	52	20	47	30	35	10	73	92	30	10	99	55	80	10
22	28	52	20	48	28	30	10	74	53	35	50	100	55	85	20
23	28	55	10	49	28	35	10	75	45	65	20				
24	25	50	10	50	26	32	10	76	90	35	10				
25	25	52	40	51	25	30	10	77	88	30	10				

Table D.11: Node locations and demands for VRP15.

No.	x	y	q	No.	x	y	q	No.	x	y	q	No.	x	y	q
0	0	0	0	35	18	-24	30	70	-9	-59	30	105	-73	-53	10
1	30	0	10	36	21	-21	10	71	0	-60	30	106	-64	-64	30
2	30	5	30	37	24	-18	10	72	9	-59	10	107	-53	-73	30
3	29	9	30	38	27	-14	30	73	19	-57	10	108	-41	-80	10
4	27	14	10	39	29	-9	30	74	27	-53	30	109	-28	-86	10
5	24	18	10	40	30	-5	10	75	35	-49	30	110	-14	-89	30
6	21	21	30	41	60	0	10	76	42	-42	10	111	0	-90	30
7	18	24	30	42	59	9	30	77	49	-35	10	112	14	-89	10
8	14	27	10	43	57	19	30	78	53	-27	30	113	28	-86	10
9	9	29	10	44	53	27	10	79	57	-19	30	114	41	-80	30
10	5	30	30	45	49	35	10	80	59	-9	10	115	53	-73	30
11	0	30	30	46	42	42	30	81	90	0	10	116	64	-64	10
12	-5	30	10	47	35	49	30	82	89	14	30	117	73	-53	10
13	-9	29	10	48	27	53	10	83	86	28	30	118	80	-41	30
14	-14	27	30	49	19	57	10	84	80	41	10	119	86	-28	30
15	-18	24	30	50	9	59	30	85	73	53	10	120	89	-14	10
16	-21	21	10	51	0	60	30	86	64	64	30	121	120	0	10
17	-24	18	10	52	-9	59	10	87	53	73	30	122	119	19	30
18	-27	14	30	53	-19	57	10	88	41	80	10	123	114	37	30
19	-29	9	30	54	-27	53	30	89	28	86	10	124	107	54	10
20	-30	5	10	55	-35	49	30	90	14	89	30	125	97	71	10
21	-30	0	10	56	-42	42	10	91	0	90	30	126	85	85	30
22	-30	-5	30	57	-49	35	10	92	-14	89	10	127	71	97	30
23	-29	-9	30	58	-53	27	30	93	-28	86	10	128	54	107	10
24	-27	-14	10	59	-57	19	30	94	-41	80	30	129	37	114	10
25	-24	-18	10	60	-59	9	10	95	-53	73	30	130	19	119	30
26	-21	-21	30	61	-60	0	10	96	-64	64	10	131	0	120	30
27	-18	-24	30	62	-59	-9	30	97	-73	53	10	132	-19	119	10
28	-14	-27	10	63	-57	-19	30	98	-80	41	30	133	-37	114	10
29	-9	-29	10	64	-53	-27	10	99	-86	28	30	134	-54	107	30
30	-5	-30	30	65	-49	-35	10	100	-89	14	10	135	-71	97	30
31	0	-30	30	66	-42	-42	30	101	-90	0	10	136	-85	85	10
32	5	-30	10	67	-35	-49	30	102	-89	-14	30	137	-97	71	10
33	9	-29	10	68	-27	-53	10	103	-86	-28	30	138	-107	54	30
34	14	-27	30	69	-19	-57	10	104	-80	-41	10	139	-114	37	30

(cont.)

Table D.11 continued.

No.	x	y	q	No.	x	y	q	No.	x	y	q	No.	x	y	q
140	-119	19	10	166	106	106	30	192	23	-148	10	218	-160	82	30
141	-120	0	10	167	88	121	30	193	46	-143	10	219	-171	56	30
142	-119	-19	30	168	68	134	10	194	68	-134	30	220	-178	28	10
143	-114	-37	30	169	46	143	10	195	88	-121	30	221	-180	0	10
144	-107	-54	10	170	23	148	30	196	106	-106	10	222	-178	-28	30
145	-97	-71	10	171	0	150	30	197	121	-88	10	223	-171	-56	30
146	-85	-85	30	172	-23	148	10	198	134	-68	30	224	-160	-82	10
147	-71	-97	30	173	-46	143	10	199	143	-46	30	225	-146	-106	10
148	-54	-107	10	174	-68	134	30	200	148	-23	10	226	-127	-127	30
149	-37	-114	10	175	-88	121	30	201	180	0	10	227	-106	-146	30
150	-19	-119	30	176	-106	106	10	202	178	28	30	228	-82	-160	10
151	0	-120	30	177	-121	88	10	203	171	56	30	229	-56	-171	10
152	19	-119	10	178	-134	68	30	204	160	82	10	230	-28	-178	30
153	37	-114	10	179	-143	46	30	205	146	106	10	231	0	-180	30
154	54	-107	30	180	-148	23	10	206	127	127	30	232	28	-178	10
155	71	-97	30	181	-150	0	10	207	106	146	30	233	56	-171	10
156	85	-85	10	182	-148	-23	30	208	82	160	10	234	82	-160	30
157	97	-71	10	183	-143	-46	30	209	56	171	10	235	106	-146	30
158	107	-54	30	184	-134	-68	10	210	28	178	30	236	127	-127	10
159	114	-37	30	185	-121	-88	10	211	0	180	30	237	146	-106	10
160	119	-19	10	186	-106	-106	30	212	-28	178	10	238	160	-82	30
161	150	0	10	187	-88	-121	30	213	-56	171	10	239	171	-56	30
162	148	23	30	188	-68	-134	10	214	-82	160	30	240	178	-28	10
163	143	46	30	189	-46	-143	10	215	-106	146	30				
164	134	68	10	190	-23	-148	30	216	-127	127	10				
165	121	88	10	191	0	-150	30	217	-146	106	10				

Table D.12: VIPH solution to VRP1.

No.	Route	Load	Cost	Distance
1	0 12 37 44 15 45 33 39 10 49 5 46 0	160	99.25	99.25
2	0 18 13 41 40 19 42 17 4 47 0	157	109.06	109.06
3	0 32 1 22 20 35 36 3 28 31 26 8 0	149	118.52	118.52
4	0 6 14 25 24 43 7 23 48 27 0	152	98.45	98.45
5	0 38 9 30 34 50 16 21 29 2 11 0	159	99.33	99.33
			Total Distance	524.61

Table D.13: VIPH solution to VRP2.

No.	Route	Load	Cost	Distance
1	0 51 63 23 56 41 64 42 43 73 0	133	107.99	107.99
2	0 17 3 44 32 9 39 12 0	137	61.92	61.92
3	0 47 36 69 71 60 70 20 37 5 29 0	136	103.47	103.47
4	0 30 48 21 61 28 74 68 0	134	77.85	77.85
5	0 53 11 38 10 31 72 0	135	96.30	96.30
6	0 46 8 35 19 54 13 57 15 45 0	139	85.22	85.22
7	0 58 65 66 59 14 7 0	137	95.35	95.35
8	0 4 27 52 34 67 26 0	133	42.84	42.84
9	0 75 2 62 22 1 33 6 0	140	66.99	66.99
10	0 16 49 24 18 55 25 50 40 0	140	110.66	110.66
			Total Distance	848.57

Table D.14: VIPH solution to VRP3.

No.	Route	Load	Cost	Distance
1	0 76 77 3 79 29 24 55 25 39 67 23 41 22 73 0	200	134.20	134.20
2	0 1 51 9 20 66 65 71 35 34 78 81 33 50 28 0	196	134.48	134.48
3	0 94 96 99 93 85 91 100 37 98 92 59 6 0	179	58.29	58.29
4	0 69 70 30 32 90 63 64 49 19 11 62 10 31 0	198	131.58	131.58
5	0 89 60 5 61 16 86 38 44 14 42 43 15 57 2 0	199	126.21	126.21
6	0 27 52 88 7 82 48 47 36 46 8 45 17 84 83 18 0	181	124.96	124.96
7	0 26 12 68 80 54 4 56 75 74 72 21 40 0	192	86.61	86.61
8	0 53 58 87 97 95 13 0	113	44.41	44.41
			Total Distance	840.73

Table D.15: VIPH solution to VRP4.

No.	Route	Load	Cost	Distance
1	0 51 101 20 59 3 116 121 115 36 85 35 84 128 29 0	194	131.58	131.58
2	0 90 123 124 125 106 73 117 89 39 75 105 54 10 49 0	199	111.13	111.13
3	0 56 111 66 41 94 19 64 88 40 136 13 67 134 0	199	108.68	108.68
4	0 6 57 23 69 114 99 43 86 97 96 24 98 132 0	198	129.81	129.81
5	0 139 110 18 55 133 25 95 58 14 68 0	182	70.50	70.50
6	0 47 146 149 4 109 143 135 141 150 148 87 142 147 17 0	198	60.77	60.77
7	0 71 122 33 72 91 45 15 52 107 65 93 42 92 44 137 37 0	200	106.78	106.78
8	0 46 102 138 48 112 7 61 26 113 140 82 31 28 70 80 22 0	196	101.47	101.47
9	0 38 62 50 130 118 21 79 74 34 30 104 9 76 0	197	77.82	77.82
10	0 11 100 2 83 131 129 53 127 16 126 78 0	193	61.60	61.60
11	0 12 144 145 63 108 5 103 0	152	39.71	39.71
12	0 27 81 60 8 120 1 119 32 77 0	127	58.96	58.96
			Total Distance	1058.81

Table D.16: VIPH solution to VRP5.

No.	Route	Load	Cost	Distance
1	0 150 52 11 170 164 85 134 84 14 133 177 19 78 0	198	114.14	114.14
2	0 194 197 42 68 143 137 89 185 90 41 115 160 0	200	99.62	99.62
3	0 180 69 108 165 38 119 77 10 129 71 0	197	97.40	97.40
4	0 117 181 147 72 118 56 25 110 161 97 187 95 0	192	80.26	80.26
5	0 145 73 18 146 135 92 148 163 31 162 75 189 131 80 169 50 0	197	146.67	146.67
6	0 120 174 155 36 122 88 37 138 166 20 124 154 15 0	198	113.32	113.32
7	0 125 29 79 153 83 13 123 128 70 167 179 99 34 0	196	78.75	78.75
8	0 149 51 7 132 35 178 102 8 176 65 46 175 0	200	58.26	58.26
9	0 130 39 109 57 9 32 106 44 55 3 151 0	196	67.30	67.30
10	0 66 196 191 1 136 199 43 190 184 192 158 53 198 195 0	199	58.05	58.05
11	0 16 182 49 63 107 24 74 144 116 62 23 183 104 0	200	86.09	86.09
12	0 112 186 93 22 141 91 113 142 114 156 28 64 101 86 0	192	90.16	90.16
13	0 139 172 21 94 140 121 82 173 171 47 5 103 59 0	199	81.30	81.30
14	0 6 61 193 33 105 96 67 159 188 0	189	44.67	44.67
15	0 54 30 48 98 45 58 27 111 87 4 0	194	55.84	55.84
16	0 127 60 26 100 81 168 12 40 76 17 126 0	181	50.25	50.25
17	0 152 2 157 0	58	18.63	18.63
			Total Distance	1340.70

Table D.17: VIPH solution to VRP6.

No.	Route	Load	Cost	Distance
1	0 11 16 29 21 50 34 30 9 38 46 0	134	191.00	91.00
2	0 12 37 44 15 45 33 39 10 49 5 0	155	199.12	99.12
3	0 14 25 24 43 7 23 6 0	120	161.63	91.63
4	0 48 26 31 8 27 0	73	120.27	70.27
5	0 47 4 17 42 19 40 41 13 18 0	157	199.06	109.06
6	0 32 2 20 35 36 3 28 22 1 0	138	189.18	99.18
			Total Distance	560.24

Table D.18: VIPH solution to VRP7.

No.	Route	Load	Cost	Distance
1	0 4 20 70 60 71 69 0	87	158.76	98.76
2	0 6 73 1 42 64 22 62 0	112	159.92	89.92
3	0 7 35 14 59 19 8 46 0	138	151.36	81.36
4	0 9 25 55 18 50 32 0	113	152.97	92.97
5	0 12 72 39 31 10 58 26 0	123	151.69	81.69
6	0 16 49 24 3 44 40 17 0	132	146.84	76.84
7	0 27 15 57 13 54 52 34 67 0	135	157.54	77.54
8	0 30 74 21 61 28 2 68 0	140	144.38	74.38
9	0 33 43 41 56 23 63 51 0	115	155.24	85.24
10	0 38 65 66 11 53 0	129	127.16	77.16
11	0 45 29 5 37 36 47 48 75 0	140	153.82	73.82
			Total Distance	909.68

Table D.19: VIPH solution to VRP8.

No.	Route	Load	Cost	Distance
1	0 7 82 48 36 49 64 63 90 32 10 0	153	226.86	126.86
2	0 50 33 78 34 35 71 65 66 20 1 0	128	219.25	119.25
3	0 6 96 99 93 16 86 38 44 14 57 2 58 0	185	226.33	106.33
4	0 53 40 73 75 56 23 67 39 25 55 4 26 0	185	228.14	108.14
5	0 54 24 29 79 81 9 51 30 70 31 69 27 0	180	229.26	109.26
6	0 89 60 5 84 17 61 85 91 100 98 37 92 59 94 0	200	220.26	80.26
7	0 52 88 62 11 19 47 46 8 45 83 18 0	142	216.31	106.31
8	0 13 95 97 87 42 43 15 41 22 74 72 21 0	168	212.30	92.30
9	0 12 80 68 3 77 76 28 0	117	122.12	52.12
			Total Distance	900.84

Table D.20: VIPH solution to VRP9.

No.	Route	Load	Cost	Distance
1	0 143 135 141 94 40 88 64 19 150 87 142 0	161	199.54	89.54
2	0 10 54 105 75 39 89 117 73 106 0	137	196.89	106.89
3	0 17 147 148 111 66 41 136 13 67 134 55 0	177	197.31	87.31
4	0 5 76 49 30 104 34 74 79 21 16 78 0	170	185.24	75.24
5	0 46 139 47 56 146 149 4 109 145 144 12 0	181	155.38	45.38
6	0 77 27 138 48 112 61 7 69 23 57 6 102 0	169	194.60	74.60
7	0 103 108 37 44 107 65 93 42 92 137 63 0	146	187.23	77.23
8	0 51 22 70 116 115 36 121 3 101 0	119	198.57	108.57
9	0 98 97 86 43 99 114 113 26 0	135	192.65	112.65
10	0 128 84 85 35 59 20 131 83 2 100 0	166	191.04	91.04
11	0 18 110 133 14 58 25 95 96 24 132 68 0	168	198.80	88.80
12	0 52 15 45 91 72 33 125 124 122 123 71 90 0	153	190.11	70.11
13	0 32 119 1 120 80 28 31 82 140 8 60 81 0	168	199.99	79.99
14	0 38 62 9 50 130 118 29 129 53 127 126 11 0	185	182.66	62.66
			Total Distance	1170.01

Table D.21: VIPH solution to VRP10.

No.	Route	Load	Cost	Distance
1	0 80 131 31 163 148 92 18 147 0	158	199.41	119.41
2	0 35 180 69 14 133 177 19 78 178 8 102 0	185	192.31	82.31
3	0 72 118 56 25 110 75 162 189 57 130 40 0	181	196.13	86.13
4	0 136 199 42 68 113 137 89 143 41 184 192 0	184	199.71	89.71
5	0 26 100 119 38 165 77 10 129 50 168 81 0	172	195.55	85.55
6	0 45 79 15 154 124 20 37 88 103 5 59 30 0	173	199.62	79.62
7	0 152 2 157 64 94 140 121 82 173 21 172 139 54 0	199	195.78	65.78
8	0 125 98 29 153 83 13 123 128 70 176 46 175 0	178	194.00	74.00
9	0 115 90 185 62 116 144 74 49 182 16 188 0	200	197.78	87.78
10	0 76 187 97 109 39 9 161 32 106 44 55 151 95 0	200	197.14	67.14
11	0 101 28 156 114 142 91 141 22 93 186 86 0	139	188.76	78.76
12	0 127 34 65 167 99 179 27 58 111 4 87 0	194	158.67	48.67
13	0 3 181 73 146 135 145 24 107 63 117 0	139	191.71	91.71
14	0 112 66 196 1 191 158 198 53 195 105 33 61 6 0	193	174.05	44.05
15	0 60 149 51 7 132 71 169 12 17 126 0	153	164.20	64.20
16	0 150 52 11 170 164 85 134 84 108 0	145	194.63	104.63
17	0 120 171 174 122 166 138 36 155 47 48 0	196	196.50	96.50
18	0 96 159 67 104 183 23 160 190 43 197 194 193 0	197	186.89	66.89
			Total Distance	1432.83

Table D.22: VIPH solution to VRP11.

No.	Route	Load	Cost	Distance
1	0 17 16 19 28 32 35 29 36 34 31 30 33 27 24 22 25 23 26 20 21 109 0	197	210.91	210.91
2	0 107 67 69 70 71 74 75 72 78 80 79 77 68 76 73 106 0	199	144.43	144.43
3	0 95 37 38 39 42 41 44 46 47 49 50 51 48 45 43 40 0	200	199.63	199.63
4	0 52 54 57 59 65 61 62 64 66 63 60 56 58 55 53 105 0	200	214.22	214.22
5	0 87 92 91 90 114 18 118 108 83 113 117 84 112 81 119 120 0	185	71.53	71.53
6	0 6 7 10 11 15 14 13 12 8 9 5 4 3 1 2 88 0	199	138.54	138.54
7	0 102 101 99 104 103 100 116 98 110 115 97 94 96 93 89 85 86 111 82 0	195	70.71	70.71
			Total Distance	1049.96

Table D.23: VIPH solution to VRP12.

No.	Route	Load	Cost	Distance
1	0 57 59 60 58 56 53 54 55 0	200	101.88	101.88
2	0 34 36 39 38 37 35 31 33 32 0	200	97.23	97.23
3	0 91 89 88 85 84 82 83 86 87 90 0	170	76.07	76.07
4	0 10 12 14 16 15 19 18 17 13 0	200	96.04	96.04
5	0 69 68 64 61 72 80 79 77 73 70 71 76 78 81 0	200	137.02	137.02
6	0 47 49 52 50 51 48 45 46 44 40 41 42 43 0	160	64.81	64.81
7	0 99 100 97 93 92 94 95 96 98 0	190	95.94	95.94
8	0 75 1 2 4 6 9 11 8 7 3 5 0	170	56.17	56.17
9	0 66 62 74 63 65 67 0	150	43.59	43.59
10	0 20 24 25 27 29 30 28 26 23 22 21 0	170	50.80	50.80
			Total Distance	819.56

Table D.24: VIPH solution to VRP13.

No.	Route	Load	Cost	Distance
1	0 56 58 60 63 66 64 62 61 65 59 0	134	708.22	208.22
2	0 29 32 35 36 34 31 30 33 27 28 0	61	695.83	195.83
3	0 37 41 44 47 46 49 50 51 48 45 0	118	690.86	190.86
4	0 17 16 19 22 24 25 23 26 20 21 0	123	670.54	170.54
5	0 38 39 42 43 40 52 54 57 55 53 0	131	712.07	212.07
6	0 68 76 77 79 80 78 75 72 74 71 73 0	141	686.62	136.62
7	0 18 118 108 8 12 13 14 15 11 10 9 7 0	153	717.70	117.70
8	0 114 109 6 5 4 3 1 2 83 113 117 81 0	132	716.81	116.81
9	0 87 94 97 115 110 98 67 70 69 116 100 99 0	153	716.77	116.77
10	0 88 111 86 112 84 85 89 92 91 90 93 96 95 0	126	690.09	40.09
11	0 82 119 120 105 106 107 103 104 101 102 0	103	553.47	53.47
			Total Distance	1558.96

Table D.25: VIPH solution to VRP14.

No.	Route	Load	Cost	Distance
1	0 57 59 60 58 56 53 54 55 0	200	821.88	101.88
2	0 34 36 39 38 37 35 31 33 32 0	200	907.23	97.23
3	0 91 89 88 85 84 82 83 86 87 90 0	170	976.07	76.07
4	0 10 12 14 16 15 19 18 17 13 0	200	906.04	96.04
5	0 41 40 44 42 43 0	60	495.47	45.47
6	0 1 99 100 97 93 92 94 95 96 98 0	200	996.70	96.70
7	0 63 80 79 77 73 70 71 76 78 81 0	200	1028.04	128.04
8	0 75 2 4 6 9 11 8 7 3 5 0	160	956.17	56.17
9	0 69 66 68 64 61 72 74 62 65 67 0	150	957.79	57.79
10	0 21 22 24 25 27 29 30 28 26 23 0	160	949.41	49.41
11	0 20 49 52 50 51 48 45 46 47 0	110	871.56	61.56
			Total Distance	866.37

Table D.26: VIPH solution to VRP15.

No.	Route	Load	Cost	Distance
1	0 20 60 100 140 180 181 182 183 184 185 186 187 188 148 147 146 145 144 143 142 141 101 61 21 0	400	620.11	620.11
2	0 32 72 112 152 153 154 155 156 157 158 159 199 198 197 196 195 194 193 192 191 151 111 71 31 0	500	620.11	620.11
3	0 2 42 82 122 162 163 164 165 166 167 207 206 205 204 203 202 201 161 121 81 41 1 0	460	647.16	647.16
4	0 40 79 78 77 76 75 74 73 113 114 115 116 117 118 119 83 123 124 125 126 127 87 86 85 84 44 4 0	550	555.27	555.27
5	0 38 39 80 120 160 200 240 239 238 237 236 235 234 233 232 231 230 190 150 110 70 30 0	480	647.89	647.89
6	0 29 69 109 149 189 229 228 227 226 225 224 223 222 221 220 219 179 139 99 59 19 0	410	642.45	642.45
7	0 18 58 98 138 178 218 217 216 215 214 213 212 211 210 209 208 168 128 88 48 8 7 0	440	647.16	647.16
8	0 9 49 89 129 169 170 171 172 173 174 175 176 177 137 136 135 134 133 132 131 130 90 51 11 10 0	490	626.96	626.96
9	0 17 16 15 14 13 12 52 53 54 55 56 57 97 96 95 94 93 92 91 50 47 46 45 43 3 5 6 0	530	417.20	417.20
10	0 22 62 102 103 104 105 106 107 108 68 67 66 65 64 63 23 24 25 26 27 28 33 34 35 36 37 0	540	377.14	377.14
			Total Distance	5801.46

Table D.27: VIPH solution to VRP1-SC.

No.	Route	Load	Cost	Distance
1	0 32 22 28 31 26 8 0	75	77.36	77.36
2	0 13 41 40 19 42 0	79	101.17	101.17
3	0 5 37 44 17 12 0	78	59.19	59.19
4	0 50 21 34 30 9 46 0	79	81.35	81.35
5	0 25 14 6 27 0	79	56.84	56.84
6	0 1 3 36 35 20 29 0	80	97.51	97.51
7	0 49 10 39 33 45 15 0	80	91.62	91.62
8	0 11 2 16 38 0	79	56.25	56.25
9	0 48 23 7 43 24 0	73	80.58	80.58
10	0 47 4 18 0	75	39.62	39.62
		Total Distance		741.50

Table D.28: VIPH solution to VRP2-SC.

No.	Route	Load	Cost	Distance
1	0 36 69 71 60 70 20 0	69	101.71	101.71
2	0 22 64 42 41 0	66	93.49	93.49
3	0 35 53 11 0	69	62.18	62.18
4	0 73 43 56 23 63 0	67	81.77	81.77
5	0 7 59 14 0	70	76.99	76.99
6	0 21 47 48 0	67	60.56	60.56
7	0 34 52 46 0	65	30.65	30.65
8	0 57 15 37 5 29 0	70	73.86	73.86
9	0 6 51 17 26 0	69	36.35	36.35
10	0 9 31 39 0	70	79.71	79.71
11	0 40 32 0	61	44.89	44.89
12	0 62 1 33 0	63	56.47	56.47
13	0 3 50 18 55 25 0	67	94.67	94.67
14	0 68 28 61 74 0	64	69.15	69.15
15	0 8 19 54 13 0	59	62.40	62.40
16	0 58 10 72 12 0	64	54.89	54.89
17	0 4 45 27 0	68	36.70	36.70
18	0 75 30 2 0	68	35.96	35.96
19	0 16 49 24 44 0	68	71.19	71.19
20	0 67 0	30	10.77	10.77
21	0 38 65 66 0	70	75.44	75.44
			Total Distance	1309.83

Table D.29: VIPH solution to VRP3-SC.

No.	Route	Load	Cost	Distance
1	0 20 66 65 71 35 34 78 0	94	117.43	117.43
2	0 55 25 39 67 23 56 0	99	101.89	101.89
3	0 7 47 36 49 64 11 88 0	97	110.07	110.07
4	0 91 44 86 16 61 17 84 60 0	98	90.91	90.91
5	0 92 98 37 100 85 93 0	100	53.34	53.34
6	0 48 19 62 31 0	99	71.95	71.95
7	0 4 54 24 29 79 3 77 0	99	86.64	86.64
8	0 21 72 75 41 22 74 73 0	94	67.95	67.95
9	0 10 63 90 32 30 70 69 27 0	100	80.50	80.50
10	0 76 50 33 81 9 51 1 0	99	71.27	71.27
11	0 89 6 96 99 59 97 95 0	98	45.68	45.68
12	0 28 68 80 12 26 0	94	48.03	48.03
13	0 87 42 14 38 43 15 57 2 0	96	102.50	102.50
14	0 52 18 82 8 46 45 83 5 0	100	89.89	89.89
15	0 53 40 58 13 94 0	91	37.90	37.90
			Total Distance	1175.96

Table D.30: VIPH solution to VRP4-SC.

No.	Route	Load	Cost	Distance
1	0 61 114 99 43 86 97 0	94	109.81	109.81
2	0 70 116 121 115 36 85 35 0	100	113.49	113.49
3	0 10 39 117 73 106 125 0	97	95.25	95.25
4	0 111 136 40 88 94 19 141 0	99	93.53	93.53
5	0 102 98 24 96 95 25 0	100	80.10	80.10
6	0 22 28 31 82 140 113 26 8 0	99	85.91	85.91
7	0 118 21 79 74 34 130 50 0	98	69.15	69.15
8	0 123 122 124 33 72 91 45 0	98	64.25	64.25
9	0 104 30 105 75 89 54 0	95	78.92	78.92
10	0 142 150 41 66 13 67 134 110 0	100	77.99	77.99
11	0 87 148 135 143 4 149 0	99	48.99	48.99
12	0 126 53 129 131 83 100 0	99	59.90	59.90
13	0 18 55 109 0	95	48.01	48.01
14	0 27 81 138 60 80 120 1 0	100	68.11	68.11
15	0 37 44 107 65 93 64 42 92 147 17 0	100	85.33	85.33
16	0 29 128 84 20 59 3 101 119 0	99	87.94	87.94
17	0 146 145 137 52 15 71 90 0	94	62.80	62.80
18	0 77 6 132 58 14 133 68 0	100	63.20	63.20
19	0 32 51 2 127 16 11 0	100	52.31	52.31
20	0 63 144 56 47 139 0	93	32.98	32.98
21	0 78 38 62 9 49 76 0	96	39.81	39.81
22	0 46 57 23 69 7 112 48 0	98	70.23	70.23
23	0 12 108 5 103 0	82	26.10	26.10
			Total Distance	1614.12

Table D.31: VIPH solution to VRP5-SC.

No.	Route	Load	Cost	Distance
1	0 75 162 31 163 148 92 135 145 0	98	128.37	128.37
2	0 37 138 166 20 124 154 0	100	94.12	94.12
3	0 66 42 68 143 137 89 185 0	99	93.11	93.11
4	0 69 14 133 177 19 78 0	97	80.08	80.08
5	0 72 118 56 25 110 161 0	97	73.56	73.56
6	0 21 173 82 121 140 94 101 0	99	64.32	64.32
7	0 190 41 90 115 62 116 23 183 0	100	79.94	79.94
8	0 8 102 178 35 180 132 0	99	60.43	60.43
9	0 71 165 170 164 85 134 84 0	99	113.48	113.48
10	0 153 79 83 13 123 128 70 0	95	73.95	73.95
11	0 191 136 199 43 184 160 0	99	59.25	59.25
12	0 107 24 144 74 49 182 0	96	63.68	63.68
13	0 119 38 77 10 129 169 0	99	73.24	73.24
14	0 7 108 11 52 150 0	94	74.19	74.19
15	0 59 103 5 47 171 172 0	98	58.98	58.98
16	0 32 9 97 187 76 0	98	56.29	56.29
17	0 174 155 36 122 88 15 29 0	100	88.93	88.93
18	0 167 179 99 27 58 111 0	99	47.53	47.53
19	0 105 198 53 192 197 1 158 0	99	46.80	46.80
20	0 86 93 156 114 142 113 91 141 22 0	97	85.03	85.03
21	0 50 80 131 189 57 109 39 0	99	73.33	73.33
22	0 95 3 55 44 181 63 117 0	97	56.50	56.50
23	0 16 159 67 104 195 0	100	45.99	45.99
24	0 64 28 186 196 194 0	97	49.42	49.42
25	0 54 139 120 48 98 45 0	100	47.94	47.94
26	0 40 130 12 168 81 0	94	39.46	39.46
27	0 73 146 18 147 106 151 0	100	71.06	71.06
28	0 60 149 51 100 26 0	90	43.39	43.39
29	0 193 33 96 188 0	94	29.37	29.37
30	0 127 4 87 125 30 0	100	32.41	32.41

(cont.)

Table D.31 continued.

No.	Route	Load	Cost	Distance
31	0 175 46 176 65 34 0	88	40.17	40.17
32	0 152 157 2 112 0	81	26.84	26.84
33	0 126 17 0	36	18.69	18.69
34	0 6 61 0	48	10.06	10.06
		Total Distance		2099.89

Table D.32: VIPH solution to VRP6-SC.

No.	Route	Load	Cost	Distance
1	0 20 35 36 0	51	98.54	89.54
2	0 44 42 4 18 0	79	85.71	73.71
3	0 1 31 28 3 22 32 0	68	98.62	80.62
4	0 9 50 34 21 29 11 0	80	98.92	80.92
5	0 13 25 14 0	72	75.82	66.82
6	0 46 2 16 12 0	79	73.41	61.41
7	0 47 19 40 41 0	68	97.10	85.10
8	0 6 24 43 7 23 0	71	92.85	77.85
9	0 5 33 45 15 37 17 0	76	96.30	78.30
10	0 27 8 26 48 0	62	70.21	58.21
11	0 38 30 39 10 49 0	71	97.37	82.37
			Total Distance	834.84

Table D.33: VIPH solution to VRP7-SC.

No.	Route	Load	Cost	Distance
1	0 6 33 73 62 0	70	54.28	50.28
2	0 71 60 70 20 45 0	70	97.17	92.17
3	0 50 18 55 25 0	56	96.18	92.18
4	0 22 64 42 1 0	69	93.10	89.10
5	0 38 65 66 0	70	78.44	75.44
6	0 43 41 56 23 0	65	87.58	83.58
7	0 68 61 69 36 47 0	64	94.04	89.04
8	0 26 58 10 72 0	66	58.54	54.54
9	0 14 59 19 0	70	82.73	79.73
10	0 2 28 74 0	65	54.01	51.01
11	0 57 15 37 5 29 0	70	78.86	73.86
12	0 39 31 9 0	70	82.71	79.71
13	0 16 24 49 63 0	62	79.81	75.81
14	0 35 53 11 0	69	65.18	62.18
15	0 52 54 13 27 0	64	62.52	58.52
16	0 30 21 48 0	70	59.92	56.92
17	0 7 8 46 0	58	40.39	37.39
18	0 32 44 3 51 0	68	55.35	51.35
19	0 17 40 12 0	69	34.95	31.95
20	0 4 75 0	50	17.46	15.46
21	0 34 67 0	49	22.77	20.77
		Total Distance		1321.00

Table D.34: VIPH solution to VRP8-SC.

No.	Route	Load	Cost	Distance
1	0 28 27 0	32	22.03	18.03
2	0 55 25 39 67 23 56 0	99	113.89	101.89
3	0 9 71 65 35 81 0	85	113.79	103.79
4	0 17 86 38 44 14 0	91	113.98	103.98
5	0 19 49 64 11 62 0	87	113.34	103.34
6	0 100 91 16 61 85 99 0	100	76.40	64.40
7	0 52 7 48 47 36 46 82 0	99	104.47	90.47
8	0 24 29 34 78 79 3 77 76 0	92	102.98	86.98
9	0 21 72 74 75 22 41 73 0	94	81.96	67.96
10	0 69 70 30 20 66 51 33 50 0	100	105.17	89.17
11	0 1 32 90 63 10 88 31 0	98	99.95	85.95
12	0 6 96 59 93 98 37 92 97 0	96	65.36	49.36
13	0 95 87 42 43 15 57 2 40 0	89	94.85	78.85
14	0 18 83 8 45 84 5 60 89 0	99	87.39	71.39
15	0 12 68 80 54 4 0	98	76.49	66.49
16	0 53 26 58 13 94 0	99	54.98	44.98
			Total Distance	1227.02

Table D.35: VIPH solution to VRP9-SC.

No.	Route	Load	Cost	Distance
1	0 77 81 60 23 138 27 0	99	82.79	70.79
2	0 131 20 35 85 36 121 0	100	103.11	91.11
3	0 10 89 117 73 106 0	96	102.37	92.37
4	0 69 99 43 86 97 0	90	104.60	94.60
5	0 59 115 0	36	104.33	100.33
6	0 110 25 95 96 24 98 57 0	99	95.27	81.27
7	0 111 136 40 88 94 19 0	98	104.70	92.70
8	0 134 67 13 66 41 141 150 142 0	98	94.07	78.07
9	0 16 127 53 129 29 128 84 83 0	99	90.83	74.83
10	0 50 130 34 74 79 21 118 0	98	83.15	69.15
11	0 90 123 124 125 33 72 91 45 0	100	82.17	66.17
12	0 8 26 113 140 82 31 22 1 119 0	98	101.69	83.69
13	0 104 30 105 75 39 54 49 0	96	88.66	74.66
14	0 17 147 87 148 135 143 56 0	99	64.15	50.15
15	0 32 51 100 2 126 11 0	97	60.09	48.09
16	0 139 146 149 4 109 145 0	92	53.34	41.34
17	0 37 137 52 15 122 71 0	88	72.98	60.98
18	0 18 55 47 0	92	48.35	42.35
19	0 46 102 6 132 58 14 133 68 0	98	77.16	61.16
20	0 63 92 42 64 93 65 107 44 0	99	100.52	84.52
21	0 101 3 116 28 70 80 120 0	100	101.60	87.60
22	0 5 76 9 62 38 78 0	99	50.31	38.31
23	0 12 144 108 103 0	88	39.69	31.69
24	0 7 114 61 112 48 0	76	104.01	94.01
			Total Distance	1709.95

Table D.36: VIPH solution to VRP10-SC.

No.	Route	Load	Cost	Distance
1	0 60 127 125 54 0	73	41.48	33.48
2	0 18 146 135 92 148 0	86	104.69	94.69
3	0 59 138 20 124 154 15 79 0	93	94.77	80.77
4	0 52 11 85 134 84 108 0	100	103.59	91.59
5	0 10 77 165 38 119 0	98	94.19	84.19
6	0 199 42 137 89 185 160 0	99	103.03	91.03
7	0 168 71 150 69 14 133 177 0	100	97.19	83.19
8	0 155 36 122 166 37 88 0	100	104.99	92.99
9	0 56 25 163 110 161 0	73	104.00	94.00
10	0 189 75 162 31 131 80 129 0	100	104.48	90.48
11	0 172 174 82 121 140 94 64 101 0	100	82.70	66.70
12	0 1 191 43 190 115 62 116 23 183 159 0	99	97.35	77.35
13	0 107 24 145 73 147 181 0	99	89.24	77.24
14	0 102 8 178 35 180 132 0	99	72.43	60.43
15	0 153 83 13 123 128 70 19 78 0	97	95.19	79.19
16	0 197 184 192 198 53 105 0	94	59.69	47.69
17	0 28 156 114 142 91 141 22 93 0	97	92.77	76.77
18	0 120 171 47 173 21 139 0	100	67.96	55.96
19	0 95 106 72 118 32 97 187 0	97	82.41	68.41
20	0 167 99 179 27 58 111 0	99	59.53	47.53
21	0 50 169 57 39 109 9 0	96	73.60	61.60
22	0 33 195 158 193 0	93	44.32	36.32
23	0 182 49 74 144 63 117 0	93	72.60	60.60
24	0 30 48 103 5 29 0	95	62.14	52.14
25	0 16 67 104 0	86	49.26	43.26
26	0 112 194 196 186 86 0	90	52.52	42.52
27	0 76 40 130 12 0	91	46.29	38.29
28	0 81 100 7 51 149 26 0	98	59.56	47.56
29	0 66 113 68 143 90 41 136 0	100	86.88	72.88
30	0 34 65 176 46 175 0	88	50.17	40.17

(cont.)

Table D.36 continued.

No.	Route	Load	Cost	Distance
31	0 98 45 4 87 0	84	42.69	34.69
32	0 188 96 61 6 0	88	31.23	23.23
33	0 152 157 2 0	58	24.63	18.63
34	0 126 17 44 55 3 151 0	88	54.76	42.76
35	0 170 164 0	35	103.89	99.89
			Total Distance	2208.18

Table D.37: VIPH solution to VRP11-SC.

No.	Route	Load	Cost	Distance
1	0 56 60 63 66 64 62 61 65 0	99	206.03	206.03
2	0 40 43 45 51 50 49 47 46 44 0	100	188.83	188.83
3	0 16 22 24 27 33 30 31 34 36 29 35 32 28 20 0	98	199.57	199.57
4	0 37 41 48 42 39 38 95 0	100	173.17	173.17
5	0 69 70 72 78 80 79 77 73 0	100	133.89	133.89
6	0 9 11 15 14 13 12 8 0	99	116.10	116.10
7	0 17 19 25 23 26 21 109 0	99	163.58	163.58
8	0 100 53 55 58 59 57 54 52 0	100	186.52	186.52
9	0 84 117 113 83 108 118 18 114 90 91 0	100	52.21	52.21
10	0 98 68 76 74 75 71 67 0	100	122.29	122.29
11	0 93 94 97 115 110 116 103 104 107 106 105 0	100	51.57	51.57
12	0 81 112 85 89 92 96 99 101 102 0	96	41.82	41.82
13	0 120 119 82 111 86 87 0	84	34.14	34.14
14	0 6 7 10 5 4 3 1 2 88 0	100	107.40	107.40
			Total Distance	1777.12

Table D.38: VIPH solution to VRP12-SC.

No.	Route	Load	Cost	Distance
1	0 76 71 70 73 77 79 80 0	100	127.06	127.06
2	0 53 56 58 60 0	100	99.45	99.45
3	0 94 92 93 95 0	100	89.25	89.25
4	0 18 19 16 14 12 0	100	90.51	90.51
5	0 55 54 57 59 0	100	82.50	82.50
6	0 31 35 33 32 0	100	77.99	77.99
7	0 13 15 17 0	90	74.88	74.88
8	0 81 78 82 83 84 0	100	111.94	111.94
9	0 87 86 85 88 89 0	100	62.06	62.06
10	0 34 36 39 38 37 0	100	86.68	86.68
11	0 98 96 97 100 99 1 0	100	85.49	85.49
12	0 49 52 50 51 48 45 46 47 0	100	55.64	55.64
13	0 69 68 64 61 72 74 0	100	53.66	53.66
14	0 43 42 44 40 41 0	60	45.47	45.47
15	0 7 6 9 8 11 10 0	90	46.16	46.16
16	0 90 91 75 2 4 3 5 0	100	68.17	68.17
17	0 66 62 63 65 67 0	100	39.76	39.76
18	0 21 22 25 0	80	30.33	30.33
19	0 20 24 27 29 30 28 26 23 0	90	47.43	47.43
			Total Distance	1374.44

Table D.39: VIPH solution to VRP13-SC.

No.	Route	Load	Cost	Distance
1	0 56 60 63 66 64 62 61 65 0	99	302.03	206.03
2	0 110 40 43 45 51 50 49 46 44 0	100	294.18	186.18
3	0 22 24 27 33 30 31 34 36 29 35 32 28 25 0	97	357.52	201.52
4	0 37 41 47 48 42 39 38 0	98	259.20	175.20
5	0 69 70 72 78 80 79 77 73 0	100	229.89	133.89
6	0 9 11 15 14 13 12 8 0	99	200.10	116.10
7	0 88 2 1 3 4 5 10 7 6 0	100	215.40	107.40
8	0 17 16 19 23 26 20 21 109 0	100	259.85	163.85
9	0 100 53 55 58 59 57 54 52 0	100	282.52	186.52
10	0 84 117 113 83 108 118 18 114 90 91 0	100	172.21	52.21
11	0 98 68 76 74 75 71 67 0	100	206.47	122.47
12	0 96 93 94 97 115 116 103 104 107 105 0	98	170.84	50.84
13	0 119 81 112 85 89 92 87 0	95	118.30	34.30
14	0 120 106 99 101 102 95 86 111 82 0	89	152.08	44.08
			Total Distance	1780.59

Table D.40: VIPH solution to VRP14-SC.

No.	Route	Load	Cost	Distance
1	0 21 22 25 0	80	96.33	30.33
2	0 76 71 70 73 77 79 80 0	100	281.06	127.06
3	0 53 56 58 60 0	100	187.45	99.45
4	0 94 92 93 95 0	100	177.25	89.25
5	0 18 19 16 14 12 0	100	200.51	90.51
6	0 55 54 57 59 0	100	170.50	82.50
7	0 31 35 33 32 0	100	165.99	77.99
8	0 13 15 17 0	90	140.88	74.88
9	0 81 78 82 83 84 0	100	221.94	111.94
10	0 87 86 85 88 89 0	100	172.06	62.06
11	0 34 36 39 38 37 0	100	196.68	86.68
12	0 98 96 97 100 99 1 0	100	217.49	85.49
13	0 49 52 50 51 48 45 46 47 0	100	231.64	55.64
14	0 69 68 64 61 72 74 0	100	185.66	53.66
15	0 43 42 44 40 41 0	60	155.47	45.47
16	0 7 6 8 9 11 10 0	90	178.16	46.16
17	0 90 91 75 2 4 3 5 0	100	222.17	68.17
18	0 23 26 28 30 29 27 24 20 0	90	223.43	47.43
19	0 66 62 63 65 67 0	100	149.76	39.76
			Total Distance	1374.44

Table D.41: VIPH solution to VRP15-SC.

No.	Route	Load	Cost	Distance
1	0 39 79 119 159 199 239 240 200 160 120 80 40 0	240	388.25	388.25
2	0 29 69 109 149 189 229 230 190 150 110 70 30 0	240	388.25	388.25
3	0 19 59 99 139 179 219 220 180 140 100 60 20 0	240	388.25	388.25
4	0 38 78 118 158 198 238 237 197 157 117 77 37 0	240	388.25	388.25
5	0 36 76 116 156 196 236 235 195 155 115 75 35 0	240	388.25	388.25
6	0 34 74 114 154 194 234 233 193 153 113 73 33 0	240	388.25	388.25
7	0 32 72 112 152 192 232 231 191 151 111 71 31 0	240	388.25	388.25
8	0 28 68 108 148 188 228 227 187 147 107 67 27 0	240	388.25	388.25
9	0 26 66 106 146 186 226 225 185 145 105 65 25 0	240	388.25	388.25
10	0 24 64 104 144 184 224 223 183 143 103 63 23 0	240	388.25	388.25
11	0 22 62 102 142 182 222 221 181 141 101 61 21 0	240	388.25	388.25
12	0 18 58 98 138 178 218 217 177 137 97 57 17 0	240	388.25	388.25
13	0 16 56 96 136 176 216 215 175 135 95 55 15 0	240	388.25	388.25
14	0 14 54 94 134 174 214 213 173 133 93 53 13 0	240	388.25	388.25
15	0 12 52 92 132 172 212 211 171 131 91 51 11 0	240	388.25	388.25
16	0 10 50 90 130 170 210 209 169 129 89 49 9 0	240	388.25	388.25
17	0 8 48 88 128 168 208 207 167 127 87 47 7 0	240	388.25	388.25
18	0 6 46 86 126 166 206 205 165 125 85 45 5 0	240	388.25	388.25
19	0 4 44 84 124 164 204 203 163 123 83 43 3 0	240	388.25	388.25
20	0 2 42 82 122 162 202 201 161 121 81 41 1 0	240	388.25	388.25
			Total Distance	7764.91

Table D.42: ERTR solution to VRP1.

No.	Route	Load	Cost	Distance
1	0 6 14 25 24 43 7 23 48 27 0	152	98.45	98.45
2	0 8 26 31 28 3 36 35 20 22 1 32 0	149	118.52	118.52
3	0 11 2 29 21 16 50 34 30 9 38 0	159	99.33	99.33
4	0 12 37 44 15 45 33 39 10 49 5 46 0	160	99.25	99.25
5	0 18 13 41 40 19 42 17 4 47 0	157	109.06	109.06
			Total Distance	524.61

Table D.43: ERTR solution to VRP2.

No.	Route	Load	Cost	Distance
1	0 2 62 22 28 61 21 74 0	138	89.34	89.34
2	0 6 33 16 49 24 3 17 0	128	76.96	76.96
3	0 7 11 66 65 38 26 0	140	76.48	76.48
4	0 12 72 39 9 32 44 40 0	140	65.88	65.88
5	0 27 13 54 57 15 5 48 30 68 0	140	87.51	87.51
6	0 35 53 14 59 19 8 52 0	137	89.38	89.38
7	0 45 29 37 20 70 60 71 69 36 47 0	136	103.47	103.47
8	0 51 50 18 55 25 31 10 58 0	140	120.22	120.22
9	0 63 23 56 41 64 42 43 1 73 0	139	106.59	106.59
10	0 67 46 34 4 75 0	126	29.08	29.08
			Total Distance	844.88

Table D.44: ERTR solution to VRP3.

No.	Route	Load	Cost	Distance
1	0 6 99 61 16 86 38 44 14 43 42 87 13 0	194	111.50	111.50
2	0 12 80 68 24 29 34 78 79 3 77 76 28 0	169	90.26	90.26
3	0 26 4 56 23 67 39 25 55 54 0	153	107.08	107.08
4	0 27 31 10 32 90 63 64 49 19 11 62 88 0	191	124.84	124.84
5	0 50 33 81 51 9 35 71 65 66 20 30 70 1 69 0	195	126.90	126.90
6	0 52 7 82 48 47 36 46 8 45 17 84 5 60 83 18 89 0	200	124.38	124.38
7	0 53 40 21 73 72 74 75 22 41 15 57 2 58 0	157	83.10	83.10
8	0 94 95 97 92 37 98 100 91 85 93 59 96 0	199	59.35	59.35
			Total Distance	827.39

Table D.45: ERTR solution to VRP4.

No.	Route	Load	Cost	Distance
1	0 5 71 123 122 124 125 33 72 91 45 15 52 108 103 0	197	70.74	70.74
2	0 11 100 2 83 131 20 59 121 3 101 51 0	194	83.62	83.62
3	0 12 47 139 0	69	23.16	23.16
4	0 17 142 111 66 41 136 13 67 134 55 18 0	198	87.27	87.27
5	0 27 81 60 8 26 113 140 82 31 80 120 1 32 77 0	196	83.78	83.78
6	0 37 137 44 107 65 93 92 42 64 88 40 94 19 141 150 87 147 0	199	118.47	118.47
7	0 38 62 9 104 34 74 79 21 130 50 118 16 78 0	192	75.77	75.77
8	0 46 138 48 112 7 61 114 99 43 86 69 23 57 6 102 0	198	118.61	118.61
9	0 56 110 133 14 58 25 95 96 24 97 98 132 68 0	193	97.00	97.00
10	0 63 145 109 148 135 143 4 149 146 144 0	200	51.04	51.04
11	0 76 49 30 105 75 39 89 117 73 106 54 10 90 0	200	110.25	110.25
12	0 119 22 70 28 116 115 36 85 35 84 128 29 129 53 127 126 0	199	116.86	116.86
			Total Distance	1036.57

Table D.46: ERTR solution to VRP5.

No.	Route	Load	Cost	Distance
1	0 3 55 44 106 32 72 118 56 25 110 161 97 187 0	199	77.81	77.81
2	0 4 87 111 58 27 99 179 167 65 34 127 0	194	48.67	48.67
3	0 6 0	19	4.47	4.47
4	0 12 80 131 189 75 162 31 163 148 92 135 146 18 151 0	199	133.38	133.38
5	0 16 159 67 183 116 62 185 89 137 142 114 156 93 86 0	200	113.93	113.93
6	0 26 132 180 69 84 134 85 164 170 108 150 100 81 0	197	107.17	107.17
7	0 54 30 48 47 155 36 122 174 171 120 152 0	197	73.46	73.46
8	0 59 103 5 88 37 138 166 20 124 154 15 29 98 0	198	95.36	95.36
9	0 60 149 51 7 35 178 78 102 8 176 46 175 0	199	57.09	57.09
10	0 61 33 193 194 158 53 198 195 96 188 0	200	42.47	42.47
11	0 71 119 38 52 11 165 77 10 129 169 50 168 0	198	96.23	96.23
12	0 95 76 40 9 57 109 39 130 17 126 0	200	59.93	59.93
13	0 104 23 160 184 190 43 199 197 136 1 191 196 66 112 0	198	68.27	68.27
14	0 105 192 115 90 41 143 68 42 113 91 141 22 186 0	200	81.59	81.59
15	0 117 181 147 73 145 24 144 74 107 63 49 182 0	192	90.58	90.58
16	0 125 45 153 79 83 13 123 128 70 19 133 14 177 0	196	99.89	99.89
17	0 139 172 21 173 82 121 140 94 64 28 101 2 157 0	200	65.43	65.43
		Total Distance		1315.71

Table D.47: ERTR solution to VRP6.

No.	Route	Load	Cost	Distance
1	0 1 8 26 7 43 24 23 48 27 0	125	193.61	103.61
2	0 5 49 10 39 33 45 15 37 12 0	139	182.96	92.96
3	0 6 14 25 18 0	105	94.05	54.05
4	0 11 16 29 21 50 34 30 9 38 46 0	134	191.00	91.00
5	0 17 44 42 19 40 41 13 4 47 0	132	199.07	109.07
6	0 22 31 28 3 36 35 20 2 32 0	142	198.30	108.30
			Total Distance	558.99

Table D.48: ERTR solution to VRP7.

No.	Route	Load	Cost	Distance
1	0 4 20 70 60 71 69 0	87	158.76	98.76
2	0 6 73 1 42 64 22 62 0	112	159.92	89.92
3	0 7 35 14 59 19 8 46 0	138	151.36	81.36
4	0 9 25 55 18 50 32 0	113	152.97	92.97
5	0 12 72 39 31 10 58 26 0	123	151.69	81.69
6	0 16 49 24 3 44 40 17 0	132	146.84	76.84
7	0 27 15 57 13 54 52 34 67 0	135	157.54	77.54
8	0 30 74 21 61 28 2 68 0	140	144.38	74.38
9	0 33 43 41 56 23 63 51 0	115	155.24	85.24
10	0 38 65 66 11 53 0	129	127.16	77.16
11	0 45 29 5 37 36 47 48 75 0	140	153.82	73.82
			Total Distance	909.68

Table D.49: ERTR solution to VRP8.

No.	Route	Load	Cost	Distance
1	0 1 51 20 66 65 71 35 9 81 33 50 0	163	227.93	117.93
2	0 5 84 17 45 46 8 83 60 89 0	90	178.60	88.60
3	0 6 96 99 59 93 85 91 100 37 98 92 95 94 0	199	188.26	58.26
4	0 12 80 68 24 29 34 78 79 3 77 76 28 0	169	210.26	90.26
5	0 13 97 87 42 43 14 44 38 86 16 61 0	194	224.53	114.53
6	0 18 82 48 47 36 49 64 11 19 7 52 0	178	227.55	117.55
7	0 26 4 56 23 67 39 25 55 54 0	153	197.08	107.08
8	0 27 69 70 30 32 90 63 10 62 88 31 0	155	200.12	90.12
9	0 53 40 21 73 72 74 75 22 41 15 57 2 58 0	157	213.10	83.10
			Total Distance	867.41

Table D.50: ERTR solution to VRP9.

No.	Route	Load	Cost	Distance
1	0 1 120 80 70 116 28 31 82 140 8 0	141	195.71	95.71
2	0 3 121 115 36 85 35 84 128 11 0	118	199.33	109.33
3	0 5 10 54 39 89 117 73 106 125 122 0	193	196.13	96.13
4	0 12 144 145 142 87 148 109 4 149 146 47 0	178	157.49	47.49
5	0 27 81 60 26 113 61 7 69 23 57 46 0	149	193.43	83.43
6	0 37 137 44 107 65 93 42 92 147 17 63 0	129	188.33	78.33
7	0 38 9 34 74 75 105 30 104 49 76 0	135	181.84	81.84
8	0 56 111 66 136 13 67 134 55 18 110 139 0	187	191.23	81.23
9	0 62 50 130 118 21 79 29 129 53 127 16 126 78 0	188	199.21	69.21
10	0 68 133 14 58 25 95 96 24 132 6 102 0	148	198.08	88.08
11	0 77 32 119 51 22 101 59 20 131 83 2 100 0	186	193.98	73.98
12	0 98 97 86 43 99 114 112 48 138 0	163	199.85	109.85
13	0 103 90 71 123 124 33 72 91 45 15 52 108 0	142	184.60	64.60
14	0 143 135 141 41 94 40 88 64 19 150 0	178	191.69	91.69
			Total Distance	1170.90

Table D.51: ERTR solution to VRP10.

No.	Route	Load	Cost	Distance
1	0 2 157 101 28 64 94 140 121 82 21 172 139 0	192	184.04	64.04
2	0 5 103 88 37 138 166 20 124 154 15 0	162	194.66	94.66
3	0 6 61 112 186 22 141 91 142 114 156 93 86 0	174	196.71	76.71
4	0 12 80 131 31 162 75 189 57 39 109 0	150	190.10	90.10
5	0 17 76 40 187 32 106 44 55 3 151 95 0	167	161.38	51.38
6	0 26 100 51 7 35 178 78 8 102 176 46 175 0	195	180.76	60.76
7	0 27 179 99 167 70 128 123 13 83 153 79 29 0	177	199.41	79.41
8	0 30 48 59 47 155 36 122 174 173 171 120 152 0	189	197.57	77.57
9	0 33 158 199 113 137 89 185 62 116 183 0	182	199.85	99.85
10	0 34 65 19 177 133 14 69 180 132 149 60 0	194	190.22	80.22
11	0 54 125 98 45 58 111 4 87 127 0	168	130.74	40.74
12	0 66 196 42 68 143 41 90 115 160 23 104 96 0	184	195.80	75.80
13	0 67 159 182 49 74 144 145 24 107 63 16 188 0	196	199.58	79.58
14	0 81 71 119 38 165 77 10 129 169 50 168 0	157	194.98	84.98
15	0 97 161 110 163 148 92 135 146 147 0	166	199.85	109.85
16	0 105 195 53 198 192 184 190 43 197 136 191 1 194 193 0	199	194.16	54.16
17	0 108 84 134 85 164 170 11 52 150 0	145	194.63	104.63
18	0 117 181 73 18 72 118 56 25 9 130 126 0	189	198.53	88.53
			Total Distance	1412.97

Table D.52: ERTR solution to VRP11.

No.	Route	Load	Cost	Distance
1	0 8 12 13 14 15 11 10 9 7 6 5 4 3 1 2 88 0	199	134.96	134.96
2	0 17 16 19 25 22 24 27 33 30 31 34 36 29 35 32 28 26 23 20 21 109 0	197	207.94	207.94
3	0 40 43 45 48 51 50 49 47 46 44 41 42 39 38 37 95 0	200	199.63	199.63
4	0 52 54 57 59 65 61 62 64 66 63 60 56 58 55 53 100 0	199	213.63	213.63
5	0 82 111 86 85 89 91 90 114 18 118 108 83 113 117 84 112 81 119 0	188	66.96	66.96
6	0 87 92 93 96 94 97 115 110 98 116 103 104 99 101 102 105 120 0	193	74.56	74.56
7	0 106 73 76 68 77 79 80 78 75 72 74 71 70 69 67 107 0	199	144.43	144.43
			Total Distance	1042.12

Table D.53: ERTR solution to VRP12.

No.	Route	Load	Cost	Distance
1	0 5 3 7 8 11 9 6 4 2 1 75 0	170	56.17	56.17
2	0 10 12 14 16 15 19 18 17 13 0	200	96.04	96.04
3	0 20 24 25 27 29 30 28 26 23 22 21 0	170	50.80	50.80
4	0 32 33 31 35 37 38 39 36 34 0	200	97.23	97.23
5	0 43 42 41 40 44 45 46 48 51 50 52 49 47 0	160	64.81	64.81
6	0 55 54 53 56 58 60 59 57 0	200	101.88	101.88
7	0 66 62 74 63 65 67 0	150	43.59	43.59
8	0 69 68 64 61 72 80 79 77 73 70 71 76 78 81 0	200	137.02	137.02
9	0 90 87 86 83 82 84 85 88 89 91 0	170	76.07	76.07
10	0 98 96 95 94 92 93 97 100 99 0	190	95.94	95.94
			Total Distance	819.56

Table D.54: ERTR solution to VRP13.

No.	Route	Load	Cost	Distance
1	0 17 16 19 22 24 27 25 23 20 21 0	114	671.98	171.98
2	0 26 28 31 30 33 34 36 35 32 29 0	70	693.03	193.03
3	0 37 41 44 47 46 49 50 51 48 39 0	121	688.34	188.34
4	0 38 42 45 43 40 59 57 54 53 52 0	133	710.15	210.15
5	0 55 58 56 60 63 66 64 62 61 65 0	129	709.92	209.92
6	0 68 76 77 79 80 78 75 72 74 71 73 0	141	686.62	136.62
7	0 82 112 117 83 6 5 4 3 1 2 81 119 0	135	707.58	107.58
8	0 84 113 7 9 10 11 15 14 13 12 8 108 0	158	717.94	117.94
9	0 87 92 89 91 90 114 109 118 18 85 86 111 88 0	144	703.97	53.97
10	0 95 96 93 94 97 115 110 98 67 69 70 120 0	144	718.66	118.66
11	0 102 101 99 100 116 103 104 107 106 105 0	86	538.45	38.45
			Total Distance	1546.62

Table D.55: ERTR solution to VRP14.

No.	Route	Load	Cost	Distance
1	0 1 99 100 97 93 92 94 95 96 98 0	200	996.70	96.70
2	0 5 3 7 8 11 9 6 4 2 75 0	160	956.17	56.17
3	0 10 12 14 16 15 19 18 17 13 0	200	906.04	96.04
4	0 20 49 52 50 51 48 45 46 47 0	110	871.56	61.56
5	0 21 22 24 25 27 29 30 28 26 23 0	160	949.41	49.41
6	0 32 33 31 35 37 38 39 36 34 0	200	907.23	97.23
7	0 41 40 44 42 43 0	60	495.47	45.47
8	0 55 54 53 56 58 60 59 57 0	200	821.88	101.88
9	0 63 80 79 77 73 70 71 76 78 81 0	200	1028.04	128.04
10	0 67 65 62 74 72 61 64 68 66 69 0	150	957.79	57.79
11	0 90 87 86 83 82 84 85 88 89 91 0	170	976.07	76.07
			Total Distance	866.37

Table D.56: ERTR solution to VRP15.

No.	Route	Load	Cost	Distance
1	0 1 40 79 78 118 158 198 238 239 240 201 202 203 204 205 206 166 126 86 85 45 46 6 5 0	540	629.06	629.06
2	0 2 3 43 42 41 80 119 120 81 82 83 123 122 121 160 159 199 200 161 162 163 164 165 125 124 84 44 4 0	540	626.96	626.96
3	0 7 47 87 127 128 168 167 207 208 209 210 211 212 213 214 215 175 135 95 94 54 14 13 0	550	647.16	647.16
4	0 8 48 88 89 90 91 92 132 131 130 129 169 170 171 172 173 174 134 133 93 53 52 51 50 49 9 10 11 12 0	530	601.28	601.28
5	0 17 16 15 55 56 57 97 96 136 176 216 217 218 219 179 178 177 137 138 139 99 98 58 59 60 19 18 0	550	610.23	610.23
6	0 20 21 63 103 104 105 145 144 143 142 141 181 182 183 184 185 186 187 147 146 106 107 67 66 65 64 24 0	550	613.50	613.50
7	0 23 22 61 62 102 101 100 140 180 220 221 222 223 224 225 226 227 228 188 148 108 68 28 27 26 25 0	460	643.18	643.18
8	0 32 31 30 29 69 70 110 109 149 150 151 191 190 189 229 230 231 232 192 152 153 113 112 111 71 72 73 74 33 0	550	643.18	643.18
9	0 34 35 75 76 116 115 114 154 155 195 194 193 233 234 235 236 237 197 196 156 157 117 77 36 37 38 39 0	530	638.48	638.48
			Total Distance	5653.04

Table D.57: ERTR solution to VRP1-SC.

No.	Route	Load	Cost	Distance
1	0 1 3 36 35 20 29 0	80	97.51	97.51
2	0 5 37 44 17 12 0	78	59.19	59.19
3	0 6 24 25 14 0	74	63.88	63.88
4	0 8 26 31 28 22 32 0	75	77.36	77.36
5	0 11 2 16 38 0	79	56.25	56.25
6	0 13 41 40 19 42 0	79	101.17	101.17
7	0 15 45 33 39 10 49 0	80	91.62	91.62
8	0 18 4 47 0	75	39.62	39.62
9	0 23 43 7 48 27 0	78	75.02	75.02
10	0 46 9 30 34 21 50 0	79	81.35	81.35
			Total Distance	742.97

Table D.58: ERTR solution to VRP2-SC.

No.	Route	Load	Cost	Distance
1	0 1 42 64 22 0	69	89.10	89.10
2	0 3 50 18 55 25 0	67	94.67	94.67
3	0 4 67 0	60	19.46	19.46
4	0 6 33 63 51 0	69	47.68	47.68
5	0 8 7 58 26 0	70	57.14	57.14
6	0 9 32 0	57	53.02	53.02
7	0 11 53 35 0	69	62.18	62.18
8	0 12 40 17 0	69	31.95	31.95
9	0 14 59 19 0	70	79.73	79.73
10	0 16 49 24 44 0	68	71.19	71.19
11	0 20 70 60 71 69 36 0	69	101.71	101.71
12	0 21 47 48 0	67	60.56	60.56
13	0 23 56 41 43 0	65	83.58	83.58
14	0 28 61 62 73 0	68	75.41	75.41
15	0 29 5 37 15 57 0	70	73.86	73.86
16	0 30 74 2 68 0	68	42.80	42.80
17	0 34 52 46 0	65	30.65	30.65
18	0 38 65 66 0	70	75.44	75.44
19	0 39 31 10 72 0	68	80.27	80.27
20	0 45 27 13 54 0	66	62.45	62.45
21	0 75 0	20	6.00	6.00
			Total Distance	1298.85

Table D.59: ERTR solution to VRP3-SC.

No.	Route	Load	Cost	Distance
1	0 3 79 33 81 9 51 0	99	73.70	73.70
2	0 5 61 84 17 45 83 60 89 0	93	78.90	78.90
3	0 6 96 99 93 59 94 0	100	41.36	41.36
4	0 7 48 47 36 46 8 82 0	99	93.27	93.27
5	0 12 80 24 29 68 77 76 0	100	70.93	70.93
6	0 13 87 42 14 43 15 57 0	96	83.28	83.28
7	0 16 86 38 44 91 98 0	99	91.47	91.47
8	0 18 19 49 64 11 62 0	99	107.75	107.75
9	0 26 54 4 72 21 40 0	99	64.11	64.11
10	0 27 31 1 50 28 0	82	52.40	52.40
11	0 52 88 10 63 90 32 30 70 0	96	84.14	84.14
12	0 53 73 74 75 22 41 2 58 0	97	66.89	66.89
13	0 55 25 39 67 23 56 0	99	101.89	101.89
14	0 69 20 66 65 71 35 34 78 0	100	117.68	117.68
15	0 85 100 37 92 97 95 0	100	54.18	54.18
			Total Distance	1181.94

Table D.60: ERTR solution to VRP4-SC.

No.	Route	Load	Cost	Distance
1	0 3 121 115 36 85 35 84 128 0	99	109.22	109.22
2	0 6 24 97 98 57 46 0	98	71.33	71.33
3	0 9 104 30 34 74 79 21 130 0	100	74.94	74.94
4	0 10 54 39 89 106 122 0	100	71.63	71.63
5	0 11 83 131 2 100 0	99	55.21	55.21
6	0 12 144 56 47 139 0	99	29.40	29.40
7	0 16 127 53 29 129 126 77 0	100	57.48	57.48
8	0 19 64 88 40 94 41 141 0	98	91.06	91.06
9	0 20 59 101 80 1 119 32 0	100	76.56	76.56
10	0 23 69 7 61 112 48 0	100	73.03	73.03
11	0 27 81 8 60 138 102 0	99	59.60	59.60
12	0 37 52 15 45 91 72 33 124 123 0	99	64.38	64.38
13	0 38 62 50 118 78 0	96	44.78	44.78
14	0 51 22 70 116 28 31 82 0	100	91.59	91.59
15	0 63 17 147 109 145 0	86	41.48	41.48
16	0 68 14 58 95 25 133 0	97	61.86	61.86
17	0 76 49 5 103 0	70	30.67	30.67
18	0 90 71 125 73 117 75 105 0	100	97.79	97.79
19	0 108 44 107 65 93 42 92 137 0	100	76.23	76.23
20	0 110 18 55 149 4 146 0	99	46.57	46.57
21	0 111 66 136 13 67 134 0	99	78.78	78.78
22	0 120 140 26 113 114 99 43 86 96 132 0	97	123.38	123.38
23	0 142 87 148 150 135 143 0	100	53.34	53.34
			Total Distance	1580.31

Table D.61: ERTR solution to VRP5-SC.

No.	Route	Load	Cost	Distance
1	0 6 96 33 61 0	100	24.48	24.48
2	0 16 117 3 55 44 17 0	94	48.13	48.13
3	0 26 149 51 7 100 81 0	98	47.56	47.56
4	0 30 59 5 103 29 98 0	98	51.55	51.55
5	0 32 161 9 187 76 0	100	56.41	56.41
6	0 34 65 46 175 60 0	93	37.75	37.75
7	0 35 178 78 19 102 8 176 0	97	62.98	62.98
8	0 39 109 57 189 131 80 169 0	97	73.31	73.31
9	0 40 130 12 168 126 0	98	38.92	38.92
10	0 45 153 83 13 123 128 70 0	97	70.74	70.74
11	0 48 47 174 173 171 139 0	99	58.90	58.90
12	0 49 74 144 116 62 160 23 183 0	100	80.78	80.78
13	0 50 129 10 77 38 71 0	100	72.33	72.33
14	0 54 125 87 4 127 0	99	27.97	27.97
15	0 66 196 22 141 91 142 114 156 93 86 0	92	77.22	77.22
16	0 73 146 18 147 106 151 0	100	71.06	71.06
17	0 75 162 31 163 148 92 135 145 0	98	128.37	128.37
18	0 79 15 154 124 20 166 36 155 0	100	94.88	94.88
19	0 88 37 138 122 120 0	99	79.90	79.90
20	0 94 140 121 82 21 172 0	93	62.53	62.53
21	0 95 72 118 56 25 110 97 0	100	73.55	73.55
22	0 101 64 28 186 112 0	95	46.15	46.15
23	0 105 115 185 90 41 190 0	100	72.83	72.83
24	0 108 11 170 52 150 0	94	80.66	80.66
25	0 111 58 27 99 179 167 0	99	47.53	47.53
26	0 113 137 89 143 68 42 199 191 0	100	87.71	87.71
27	0 119 165 164 85 134 84 133 0	99	113.07	113.07
28	0 132 180 69 14 177 0	99	73.32	73.32
29	0 136 197 43 184 192 0	99	52.31	52.31
30	0 152 2 157 0	58	18.63	18.63
31	0 159 67 104 53 198 195 0	99	46.55	46.55
32	0 181 24 107 63 182 188 0	99	64.05	64.05
33	0 193 158 1 194 0	93	38.58	38.58
			Total Distance	2080.72

Table D.62: ERTR solution to VRP6-SC.

No.	Route	Load	Cost	Distance
1	0 1 31 26 8 48 27 0	80	91.98	73.98
2	0 2 3 28 22 32 0	80	92.56	77.56
3	0 4 41 19 42 44 17 0	77	98.30	80.30
4	0 6 23 7 43 24 0	71	93.14	78.14
5	0 9 30 39 10 49 0	67	97.86	82.86
6	0 11 12 0	48	40.32	34.32
7	0 14 25 47 0	74	61.92	52.92
8	0 16 29 21 34 50 38 0	80	98.90	80.90
9	0 18 13 40 0	71	99.39	90.39
10	0 20 36 35 0	51	99.47	90.47
11	0 37 15 45 33 5 46 0	78	92.19	74.19
			Total Distance	816.03

Table D.63: ERTR solution to VRP7-SC.

No.	Route	Load	Cost	Distance
1	0 2 28 74 0	65	54.01	51.01
2	0 3 50 18 55 25 0	67	99.67	94.67
3	0 4 67 0	60	21.46	19.46
4	0 6 16 49 24 0	70	74.81	70.81
5	0 7 10 31 0	66	86.57	83.57
6	0 8 54 13 27 0	61	63.50	59.50
7	0 9 39 72 58 0	67	61.72	57.72
8	0 11 53 35 0	69	65.18	62.18
9	0 14 59 19 0	70	82.73	79.73
10	0 15 20 70 60 71 36 0	69	99.72	93.72
11	0 17 32 44 0	65	50.99	47.99
12	0 21 61 69 47 0	70	93.99	89.99
13	0 22 64 43 63 0	69	96.12	92.12
14	0 26 12 40 0	67	36.13	33.13
15	0 33 1 73 62 0	69	62.61	58.61
16	0 34 52 46 0	65	33.65	30.65
17	0 38 65 66 0	70	78.44	75.44
18	0 42 41 56 23 51 0	70	93.28	88.28
19	0 45 29 30 68 0	66	47.50	43.50
20	0 48 5 37 57 0	69	79.94	75.94
21	0 75 0	20	7.00	6.00
			Total Distance	1314.04

Table D.64: ERTR solution to VRP8-SC.

No.	Route	Load	Cost	Distance
1	0 1 51 20 32 30 70 69 27 0	100	98.68	82.68
2	0 6 93 91 44 38 14 100 92 0	99	103.22	87.22
3	0 7 47 36 49 19 88 0	93	107.66	95.66
4	0 12 68 80 54 26 0	96	65.50	55.50
5	0 13 87 42 43 15 57 2 53 0	97	89.73	73.73
6	0 18 60 84 17 86 16 61 99 0	100	99.89	83.89
7	0 28 77 3 29 24 55 25 4 58 0	100	111.88	93.88
8	0 31 10 90 63 64 11 62 0	96	112.05	98.05
9	0 33 81 35 34 78 79 76 0	98	101.70	87.70
10	0 37 98 85 5 89 0	100	64.93	54.93
11	0 39 67 23 56 73 0	100	103.57	93.57
12	0 40 21 72 74 75 22 41 0	94	80.72	66.72
13	0 50 9 71 65 66 0	89	114.88	104.88
14	0 52 82 48 46 8 45 83 0	98	100.05	86.05
15	0 94 95 97 59 96 0	98	51.63	41.63
			Total Distance	1206.08

Table D.65: ERTR solution to VRP9-SC.

No.	Route	Load	Cost	Distance
1	0 1 31 82 140 113 26 8 60 0	100	97.00	81.00
2	0 5 71 122 123 108 103 0	98	59.50	47.50
3	0 6 43 99 69 23 57 46 0	99	104.45	90.45
4	0 7 114 61 112 48 0	76	104.01	94.01
5	0 10 54 39 75 105 30 104 38 0	98	91.26	75.26
6	0 12 144 145 63 0	99	39.51	31.51
7	0 17 147 87 150 141 135 148 0	92	69.93	55.93
8	0 32 22 70 116 28 80 120 119 0	100	98.86	82.86
9	0 37 44 107 65 93 42 92 137 0	91	91.27	75.27
10	0 41 94 40 88 64 19 142 0	99	104.87	90.87
11	0 47 55 18 110 0	95	51.27	43.27
12	0 50 130 34 74 79 21 118 0	98	83.15	69.15
13	0 51 59 20 84 128 29 129 0	100	94.96	80.96
14	0 52 15 45 91 72 33 125 124 0	99	82.97	66.97
15	0 56 146 109 143 4 149 139 0	97	58.25	44.25
16	0 68 14 58 95 25 133 0	97	73.86	61.86
17	0 76 49 9 62 11 78 0	100	56.47	44.47
18	0 77 27 81 138 102 0	76	53.93	43.93
19	0 83 131 35 85 36 3 101 0	94	104.94	90.94
20	0 89 117 73 106 90 0	100	102.72	92.72
21	0 98 24 97 86 96 132 0	95	104.38	92.38
22	0 100 2 53 127 16 126 0	98	62.89	50.89
23	0 111 66 136 13 67 134 0	99	90.78	78.78
24	0 115 121 0	35	103.89	99.89
			Total Distance	1685.11

Table D.66: ERTR solution to VRP10-SC.

No.	Route	Load	Cost	Distance
1	0 6 33 193 112 0	96	36.49	28.49
2	0 7 69 84 134 85 170 150 0	99	104.97	90.97
3	0 11 164 0	57	103.88	99.88
4	0 17 189 75 162 31 131 80 0	99	103.61	89.61
5	0 19 177 133 14 180 132 0	100	89.90	77.90
6	0 26 149 51 34 60 0	99	57.78	47.78
7	0 29 15 154 124 20 138 88 0	96	95.26	81.26
8	0 32 56 163 9 76 0	100	104.25	94.25
9	0 35 178 78 70 128 123 13 83 0	97	92.42	76.42
10	0 37 166 122 36 155 120 0	97	104.90	92.90
11	0 45 153 79 5 103 0	98	67.74	57.74
12	0 48 171 173 21 172 139 0	99	65.49	53.49
13	0 53 198 160 62 116 23 183 104 0	95	87.89	71.89
14	0 54 30 64 28 101 86 0	98	57.45	45.45
15	0 59 47 174 82 121 140 94 0	98	83.43	69.43
16	0 61 157 2 152 0	87	30.38	22.38
17	0 65 8 102 176 46 175 0	98	57.91	45.91
18	0 66 186 22 141 91 142 114 156 93 0	97	94.81	76.81
19	0 81 71 77 10 129 169 50 168 0	99	84.48	68.48
20	0 95 40 130 12 126 0	97	48.54	38.54
21	0 96 67 16 188 0	100	45.60	37.60
22	0 100 119 38 165 52 108 0	100	99.74	87.74
23	0 105 115 185 89 137 113 0	100	103.77	91.77
24	0 107 24 144 74 49 182 159 0	99	78.85	64.85
25	0 109 39 57 161 97 187 0	100	73.36	61.36
26	0 110 25 72 106 44 55 3 151 0	99	90.71	74.71
27	0 111 58 27 179 99 167 0	99	59.53	47.53
28	0 117 63 145 73 146 18 181 0	100	96.07	82.07
29	0 118 148 92 135 147 0	99	104.58	94.58
30	0 125 98 4 87 127 0	96	43.26	33.26
31	0 191 136 42 68 143 90 41 197 0	100	83.98	67.98
32	0 192 184 190 43 199 0	99	63.52	53.52
33	0 194 196 1 158 195 0	89	51.64	41.64
			Total Distance	2168.22

Table D.67: ERTR solution to VRP11-SC.

No.	Route	Load	Cost	Distance
1	0 5 10 11 4 3 1 2 88 0	99	105.80	105.80
2	0 6 7 9 15 14 13 12 8 0	100	116.93	116.93
3	0 17 19 25 24 22 16 108 118 0	100	162.77	162.77
4	0 20 23 28 31 27 30 33 34 36 35 32 29 26 21 0	100	198.57	198.57
5	0 37 41 44 46 49 47 42 38 0	99	174.70	174.70
6	0 40 43 45 51 50 48 39 93 0	99	184.66	184.66
7	0 52 54 57 62 61 65 59 110 0	100	189.71	189.71
8	0 53 55 58 64 66 63 60 56 0	99	201.41	201.41
9	0 67 71 74 75 70 69 0	100	118.82	118.82
10	0 73 72 78 80 79 77 76 68 98 0	100	135.87	135.87
11	0 82 112 84 113 83 117 81 119 0	86	42.83	42.83
12	0 87 92 89 90 85 86 111 0	94	27.91	27.91
13	0 91 18 114 109 115 97 94 96 95 0	100	55.36	55.36
14	0 102 101 99 100 116 103 104 107 106 105 120 0	99	48.12	48.12
			Total Distance	1763.47

Table D.68: ERTR solution to VRP12-SC.

No.	Route	Load	Cost	Distance
1	0 5 3 2 1 75 91 90 0	100	67.56	67.56
2	0 7 4 6 9 8 11 10 0	100	48.23	48.23
3	0 12 14 16 19 18 0	100	90.51	90.51
4	0 13 15 17 0	90	74.88	74.88
5	0 20 24 27 29 30 28 26 23 0	90	47.43	47.43
6	0 21 22 25 0	80	30.33	30.33
7	0 31 35 33 32 0	100	77.99	77.99
8	0 34 36 39 38 37 0	100	86.68	86.68
9	0 41 40 44 42 43 0	60	45.47	45.47
10	0 47 46 45 48 51 50 52 49 0	100	55.64	55.64
11	0 53 56 58 60 0	100	99.45	99.45
12	0 55 54 57 59 0	100	82.50	82.50
13	0 66 62 63 65 67 0	100	39.76	39.76
14	0 69 68 64 61 72 74 0	100	53.66	53.66
15	0 76 71 70 73 77 79 80 0	100	127.06	127.06
16	0 81 78 82 83 84 0	100	111.94	111.94
17	0 87 86 85 88 89 0	100	62.06	62.06
18	0 94 92 93 95 0	100	89.25	89.25
19	0 98 96 97 100 99 0	90	84.73	84.73
			Total Distance	1375.14

Table D.69: ERTR solution to VRP13-SC.

No.	Route	Load	Cost	Distance
1	0 5 10 11 4 3 1 2 88 0	99	201.80	105.80
2	0 6 7 9 15 14 13 12 8 0	100	212.93	116.93
3	0 20 26 29 32 35 36 34 31 30 33 27 16 108 0	100	354.15	198.15
4	0 21 23 28 25 24 22 19 17 118 0	100	277.21	169.21
5	0 37 41 44 46 49 47 42 38 0	99	270.70	174.70
6	0 40 43 45 51 50 48 39 93 0	99	280.66	184.66
7	0 52 54 57 62 61 65 59 110 0	100	285.71	189.71
8	0 53 55 58 64 66 63 60 56 0	99	297.41	201.41
9	0 67 69 70 74 77 76 73 0	100	208.09	124.09
10	0 71 72 75 78 80 79 68 98 0	100	227.18	131.18
11	0 82 112 84 113 83 117 81 119 0	86	138.83	42.83
12	0 87 92 89 90 85 86 111 0	94	111.91	27.91
13	0 91 18 114 109 115 97 94 96 95 0	100	163.36	55.36
14	0 102 101 99 100 116 103 104 107 106 105 120 0	99	180.12	48.12
			Total Distance	1770.06

Table D.70: ERTR solution to VRP14-SC.

No.	Route	Load	Cost	Distance
1	0 4 99 100 97 96 98 0	100	218.99	86.99
2	0 5 3 7 6 9 8 10 0	100	199.74	45.74
3	0 11 13 15 17 0	100	166.04	78.04
4	0 12 14 16 19 18 0	100	200.51	90.51
5	0 20 24 27 29 30 28 26 23 0	90	223.43	47.43
6	0 21 22 25 0	80	96.33	30.33
7	0 31 35 33 32 0	100	165.99	77.99
8	0 34 36 39 38 37 0	100	196.68	86.68
9	0 41 40 44 45 48 51 50 52 49 0	90	256.29	58.29
10	0 43 42 46 47 0	70	131.58	43.58
11	0 53 56 58 60 0	100	187.45	99.45
12	0 55 54 57 59 0	100	170.50	82.50
13	0 66 62 63 65 67 0	100	149.76	39.76
14	0 69 68 64 61 72 74 0	100	185.66	53.66
15	0 75 1 2 91 90 0	80	174.45	64.45
16	0 76 71 70 73 77 79 80 0	100	281.06	127.06
17	0 81 78 82 83 84 0	100	221.94	111.94
18	0 87 86 85 88 89 0	100	172.06	62.06
19	0 94 92 93 95 0	100	177.25	89.25
			Total Distance	1375.73

Table D.71: ERTR solution to VRP15-SC.

No.	Route	Load	Cost	Distance
1	0 1 41 81 121 161 201 202 162 122 82 42 2 0	240	388.25	388.25
2	0 3 43 83 123 163 203 204 164 124 84 44 4 0	240	388.25	388.25
3	0 5 45 85 125 165 205 206 166 126 86 46 6 0	240	388.25	388.25
4	0 7 47 87 127 167 207 208 168 128 88 48 8 0	240	388.25	388.25
5	0 9 49 89 129 169 209 210 170 130 90 50 10 0	240	388.25	388.25
6	0 11 51 91 131 171 211 212 172 132 92 52 12 0	240	388.25	388.25
7	0 13 53 93 133 173 213 214 174 134 94 54 14 0	240	388.25	388.25
8	0 15 55 95 135 175 215 216 176 136 96 56 16 0	240	388.25	388.25
9	0 17 57 97 137 177 217 218 178 138 98 58 18 0	240	388.25	388.25
10	0 19 59 99 139 179 219 220 180 140 100 60 20 0	240	388.25	388.25
11	0 21 61 101 141 181 221 222 182 142 102 62 22 0	240	388.25	388.25
12	0 23 63 103 143 183 223 224 184 144 104 64 24 0	240	388.25	388.25
13	0 25 65 105 145 185 225 226 186 146 106 66 26 0	240	388.25	388.25
14	0 27 67 107 147 187 227 228 188 148 108 68 28 0	240	388.25	388.25
15	0 29 69 109 149 189 229 230 190 150 110 70 30 0	240	388.25	388.25
16	0 31 71 111 151 191 231 232 192 152 112 72 32 0	240	388.25	388.25
17	0 33 73 113 153 193 233 234 194 154 114 74 34 0	240	388.25	388.25
18	0 35 75 115 155 195 235 236 196 156 116 76 36 0	240	388.25	388.25
19	0 37 77 117 157 197 237 238 198 158 118 78 38 0	240	388.25	388.25
20	0 39 79 119 159 199 239 240 200 160 120 80 40 0	240	388.25	388.25
			Total Distance	7764.91

Appendix E

MDVRP: Problems and Solutions

Table E.1: Symbol key.

N	Number of customers in a problem
M	Number of depots
C	Maximum route length
Q	Vehicle capacity
No.	Customer or route number
x	x-coordinate of a node's location
y	y-coordinate of a node's location
q	Customer demand

Note: nodes 0 and $N+1$, ..., $N+M-1$ are depots.

Table E.2: Dimensions for 23 MDVRPs.

Problem	N	M	C	Q
MD1	50	4	∞	80
MD2	50	4	∞	160
MD3	75	5	∞	140
MD4	100	2	∞	100
MD5	100	2	∞	200
MD6	100	3	∞	100
MD7	100	4	∞	100
MD8	249	2	310	500
MD9	249	3	310	500
MD10	249	4	310	500
MD11	249	5	310	500
MD12	80	2	∞	60
MD13	80	2	200	60
MD14	80	2	180	60
MD15	160	4	∞	60
MD16	160	4	200	60
MD17	160	4	180	60
MD18	240	6	∞	60
MD19	240	6	200	60
MD20	240	6	180	60
MD21	360	9	∞	60
MD22	360	9	200	60
MD23	360	9	180	60

Table E.3: Node locations and demands for MD1 and MD2.

No.	x	y	q	No.	x	y	q	No.	x	y	q	No.	x	y	q
0	20	20	0	14	12	42	21	28	43	67	14	42	21	10	13
1	37	52	7	15	36	16	10	29	58	48	6	43	5	64	11
2	49	49	30	16	52	41	15	30	58	27	19	44	30	15	16
3	52	64	16	17	27	23	3	31	37	69	11	45	39	10	10
4	20	26	9	18	17	33	41	32	38	46	12	46	32	39	5
5	40	30	21	19	13	13	9	33	46	10	23	47	25	32	25
6	21	47	15	20	57	58	28	34	61	33	26	48	25	55	17
7	17	63	19	21	62	42	8	35	62	63	17	49	48	28	18
8	31	62	23	22	42	57	8	36	63	69	6	50	56	37	10
9	52	33	11	23	16	57	16	37	32	22	9	51	30	40	0
10	51	21	5	24	8	52	10	38	45	35	15	52	50	30	0
11	42	41	19	25	7	38	28	39	59	15	14	53	60	50	0
12	31	32	29	26	27	68	7	40	5	6	7				
13	5	25	23	27	30	48	15	41	10	17	27				

Table E.4: Node locations and demands for MD3.

No.	x	y	q	No.	x	y	q	No.	x	y	q	No.	x	y	q
0	40	40	0	20	66	14	22	40	30	50	33	60	64	4	13
1	22	22	18	21	44	13	28	41	12	17	15	61	36	6	15
2	36	26	26	22	26	13	12	42	15	14	11	62	30	20	18
3	21	45	11	23	11	28	6	43	16	19	18	63	20	30	11
4	45	35	30	24	7	43	27	44	21	48	17	64	15	5	28
5	55	20	21	25	17	64	14	45	50	30	21	65	50	70	9
6	33	34	19	26	41	46	18	46	51	42	27	66	57	72	37
7	50	50	15	27	55	34	17	47	50	15	19	67	45	42	30
8	55	45	16	28	35	16	29	48	48	21	20	68	38	33	10
9	26	59	29	29	52	26	13	49	12	38	5	69	50	4	8
10	40	66	26	30	43	26	22	50	15	56	22	70	66	8	11
11	55	65	37	31	31	76	25	51	29	39	12	71	59	5	3
12	35	51	16	32	22	53	28	52	54	38	19	72	35	60	1
13	62	35	12	33	26	29	27	53	55	57	22	73	27	24	6
14	62	57	31	34	50	40	19	54	67	41	16	74	40	20	10
15	62	24	8	35	55	50	10	55	10	70	7	75	40	37	20
16	21	36	19	36	54	10	12	56	6	25	26	76	50	22	0
17	33	44	20	37	60	15	14	57	65	27	14	77	55	55	0
18	9	56	13	38	47	66	24	58	40	60	21	78	25	45	0
19	62	48	15	39	30	60	16	59	70	64	24	79	20	20	0

Table E.5: Node locations and demands for MD4.

No.	x	y	q	No.	x	y	q	No.	x	y	q	No.	x	y	q
0	35	20	0	26	45	30	17	52	27	43	9	78	61	52	3
1	41	49	10	27	35	40	16	53	37	31	14	79	57	48	23
2	35	17	7	28	41	37	16	54	57	29	18	80	56	37	6
3	55	45	13	29	64	42	9	55	63	23	2	81	55	54	26
4	55	20	19	30	40	60	21	56	53	12	6	82	15	47	16
5	15	30	26	31	31	52	27	57	32	12	7	83	14	37	11
6	25	30	3	32	35	69	23	58	36	26	18	84	11	31	7
7	20	50	5	33	53	52	11	59	21	24	28	85	16	22	41
8	10	43	9	34	65	55	14	60	17	34	3	86	4	18	35
9	55	60	16	35	63	65	8	61	12	24	13	87	28	18	26
10	30	60	16	36	2	60	5	62	24	58	19	88	26	52	9
11	20	65	12	37	20	20	8	63	27	69	10	89	26	35	15
12	50	35	19	38	5	5	16	64	15	77	9	90	31	67	3
13	30	25	23	39	60	12	31	65	62	77	20	91	15	19	1
14	15	10	20	40	40	25	9	66	49	73	25	92	22	22	2
15	30	5	8	41	42	7	5	67	67	5	25	93	18	24	22
16	10	20	19	42	24	12	5	68	56	39	36	94	26	27	27
17	5	30	2	43	23	3	7	69	37	47	6	95	25	24	20
18	20	40	12	44	11	14	18	70	37	56	5	96	22	27	11
19	15	60	17	45	6	38	16	71	57	68	15	97	25	21	12
20	45	65	9	46	2	48	1	72	47	16	25	98	19	21	10
21	45	20	11	47	8	56	27	73	44	17	9	99	20	26	9
22	45	10	18	48	13	52	36	74	46	13	8	100	18	18	17
23	55	5	29	49	6	68	30	75	49	11	18	101	35	50	0
24	65	35	3	50	47	47	13	76	49	42	13				
25	65	20	6	51	49	58	10	77	53	43	14				

Table E.6: Node locations and demands for MD5.

No.	x	y	q	No.	x	y	q
0	15	35	0	101	55	35	0

Note: Customer locations and demands are the same as MD4.

Table E.7: Node locations and demands for MD6.

No.	x	y	q	No.	x	y	q	No.	x	y	q
0	15	20	0	101	50	20	0	102	35	55	0

Note: Customer locations and demands are the same as MD4.

Table E.8: Node locations and demands for MD7.

No.	x	y	q	No.	x	y	q	No.	x	y	q	No.	x	y	q
0	15	35	0	101	55	35	0	102	35	20	0	103	35	50	0

Note: Customer locations and demands are the same as MD4.

Table E.9: Node locations and demands for MD8.

No.	x	y	q	No.	x	y	q	No.	x	y	q	No.	x	y	q
0	-33	33	0	35	37	-90	9	70	-46	-82	15	105	64	20	25
1	-99	-97	6	36	-83	49	74	71	-86	-79	4	106	-96	85	39
2	-59	50	72	37	35	-1	83	72	-43	-30	58	107	93	-29	42
3	0	14	93	38	7	59	96	73	-44	7	73	108	-40	-84	77
4	-17	-66	28	39	12	48	42	74	-3	-20	5	109	86	35	68
5	-69	-19	5	40	57	95	80	75	36	41	12	110	91	36	50
6	31	12	43	41	92	28	22	76	-30	-94	3	111	62	-8	42
7	5	-41	1	42	-3	97	56	77	79	-62	8	112	-24	4	71
8	-12	10	36	43	-7	52	43	78	51	70	31	113	11	96	85
9	-64	70	53	44	42	-15	12	79	-61	-26	48	114	-53	62	78
10	-12	85	63	45	77	-43	73	80	6	94	3	115	-28	-71	64
11	-18	64	25	46	59	-49	32	81	-19	-62	52	116	7	-4	5
12	-77	-16	50	47	25	91	8	82	-20	51	99	117	95	-9	93
13	-53	88	57	48	69	-19	79	83	-81	37	29	118	-3	17	18
14	83	-24	1	49	-82	-14	79	84	7	31	12	119	53	-90	38
15	24	41	66	50	74	-70	4	85	52	12	50	120	58	-19	29
16	17	21	37	51	69	59	14	86	83	-91	98	121	-83	84	81
17	42	96	51	52	29	33	17	87	-7	-92	4	122	-1	49	4
18	-65	0	47	53	-97	9	19	88	82	-74	56	123	-4	17	23
19	-47	-26	88	54	-58	9	44	89	-70	85	24	124	-82	-3	11
20	85	36	75	55	28	93	5	90	-83	-30	33	125	-43	47	86
21	-35	-54	48	56	7	73	37	91	71	-61	45	126	6	-6	2
22	54	-21	40	57	-28	73	100	92	85	11	98	127	70	99	31
23	64	-17	8	58	-76	55	62	93	66	-48	4	128	68	-29	54
24	55	89	69	59	41	42	90	94	78	-87	36	129	-94	-30	87
25	17	-25	93	60	92	40	57	95	9	-79	72	130	-94	-20	17
26	-61	66	29	61	-84	-29	44	96	-36	4	26	131	-21	77	81
27	-61	26	5	62	-12	42	37	97	66	39	71	132	64	37	72
28	17	-72	53	63	51	-45	80	98	92	-17	84	133	-70	-19	10
29	79	38	8	64	-37	46	60	99	-46	-79	21	134	88	65	50
30	-62	-2	24	65	-97	35	95	100	-30	-63	99	135	2	29	25
31	-90	-68	53	66	14	89	56	101	-42	63	33	136	33	57	71
32	52	66	13	67	60	58	56	102	20	42	84	137	-70	6	85
33	-54	-50	47	68	-63	-75	9	103	15	98	74	138	-38	-56	51
34	8	-84	57	69	-18	34	39	104	1	-17	93	139	-80	-95	29

(cont.)

Table E.9 continued.

No.	x	y	q	No.	x	y	q	No.	x	y	q	No.	x	y	q
140	-5	-39	55	168	19	93	40	196	70	-14	90	224	-26	43	99
141	8	-22	45	169	40	27	49	197	0	95	35	225	-11	60	83
142	-61	-76	100	170	-61	56	96	198	-45	7	76	226	40	61	54
143	76	-22	38	171	43	33	58	199	38	-24	3	227	82	35	86
144	49	-71	11	172	-18	-39	15	200	50	-37	11	228	-92	12	2
145	-30	-68	82	173	-69	19	21	201	59	71	98	229	-93	-86	14
146	1	34	50	174	75	-18	56	202	-73	-96	92	230	-66	63	42
147	77	79	39	175	31	85	67	203	-29	72	1	231	-72	-87	14
148	-58	64	6	176	25	58	10	204	-47	12	2	232	-57	-84	55
149	82	-97	87	177	-16	36	36	205	-88	-61	63	233	23	52	2
150	-80	55	83	178	91	15	84	206	-88	36	57	234	-56	-62	18
151	81	-86	22	179	60	-39	59	207	-46	-3	50	235	-19	59	17
152	39	-49	24	180	49	-47	85	208	26	-37	19	236	63	-14	22
153	-67	72	69	181	42	33	60	209	-39	-67	24	237	-13	38	28
154	-25	-89	97	182	16	-81	33	210	92	27	14	238	-19	87	3
155	-44	-95	65	183	-78	53	62	211	-80	-31	18	239	44	-84	96
156	32	-68	97	184	53	-80	70	212	93	-50	77	240	98	-17	53
157	-17	49	79	185	-46	-26	79	213	-20	-5	28	241	-16	62	15
158	93	49	79	186	-25	-54	98	214	-22	73	72	242	3	66	36
159	99	81	46	187	69	-46	99	215	-4	-7	49	243	26	22	98
160	10	-49	52	188	0	-78	18	216	54	-48	58	244	-38	-81	78
161	63	-41	39	189	-84	74	55	217	-70	39	84	245	70	-80	92
162	38	39	94	190	-16	16	75	218	54	-82	58	246	17	-35	65
163	-28	39	97	191	-63	-14	94	219	29	41	41	247	96	-83	64
164	-2	-47	18	192	51	-77	89	220	-87	51	98	248	-77	80	43
165	38	8	3	193	-39	61	13	221	-96	-36	77	249	-14	44	50
166	-42	-6	23	194	5	97	19	222	49	8	57	250	33	-33	0
167	-67	88	19	195	-55	39	19	223	-5	54	39				

Table E.10: Node locations and demands for MD9.

No.	x	y	q	No.	x	y	q	No.	x	y	q
0	70	0	0	250	-50	60	0	251	-50	-60	0

Note: Customer locations and demands are the same as MD8.

Table E.11: Node locations and demands for MD10.

No.	x	y	q	No.	x	y	q	No.	x	y	q	No.	x	y	q
0	75	0	0	250	0	75	0	251	-75	0	0	252	0	-75	0

Note: Customer locations and demands are the same as MD8.

Table E.12: Node locations and demands for MD11.

No.	x	y	q	No.	x	y	q	No.	x	y	q
0	70	0	0	250	40	80	0	251	40	-80	0
252	-60	20	0	253	-60	-20	0				

Note: Customer locations and demands are the same as MD8.

Table E.13: Node locations and demands for MD12–MD14.

No.	x	y	q	No.	x	y	q	No.	x	y	q	No.	x	y	q
0	0	0	0	21	0	30	4	42	100	0	12	63	140	0	4
1	-10	-10	12	22	30	-30	4	43	100	10	12	64	140	30	4
2	-10	0	12	23	30	0	4	44	110	-10	12	65	70	-40	2
3	-10	10	12	24	30	30	4	45	110	10	12	66	70	0	2
4	0	-10	12	25	-40	-40	2	46	120	-10	12	67	70	40	2
5	0	10	12	26	-40	0	2	47	120	0	12	68	110	-40	2
6	10	-10	12	27	-40	40	2	48	120	10	12	69	110	40	2
7	10	0	12	28	0	-40	2	49	90	-20	8	70	150	-40	2
8	10	10	12	29	0	40	2	50	90	0	8	71	150	0	2
9	-20	-20	8	30	40	-40	2	51	90	20	8	72	150	40	2
10	-20	0	8	31	40	0	2	52	110	-20	8	73	60	-50	1
11	-20	20	8	32	40	40	2	53	110	20	8	74	60	0	1
12	0	-20	8	33	-50	-50	1	54	130	-20	8	75	60	50	1
13	0	20	8	34	-50	0	1	55	130	0	8	76	110	-50	1
14	20	-20	8	35	-50	50	1	56	130	20	8	77	110	50	1
15	20	0	8	36	0	-50	1	57	80	-30	4	78	160	-50	1
16	20	20	8	37	0	50	1	58	80	0	4	79	160	0	1
17	-30	-30	4	38	50	-50	1	59	80	30	4	80	160	50	1
18	-30	0	4	39	50	0	1	60	110	-30	4	81	110	0	0
19	-30	30	4	40	50	50	1	61	110	30	4				
20	0	-30	4	41	100	-10	12	62	140	-30	4				

Table E.14: Node locations and demands for MD15–MD17.

No.	x	y	q	No.	x	y	q	No.	x	y	q	No.	x	y	q
0	0	0	0	35	-50	50	1	70	150	-40	2	105	70	70	2
1	-10	-10	12	36	0	-50	1	71	150	0	2	106	70	110	2
2	-10	0	12	37	0	50	1	72	150	40	2	107	70	150	2
3	-10	10	12	38	50	-50	1	73	60	-50	1	108	110	70	2
4	0	-10	12	39	50	0	1	74	60	0	1	109	110	150	2
5	0	10	12	40	50	50	1	75	60	50	1	110	150	70	2
6	10	-10	12	41	100	-10	12	76	110	-50	1	111	150	110	2
7	10	0	12	42	100	0	12	77	110	50	1	112	150	150	2
8	10	10	12	43	100	10	12	78	160	-50	1	113	60	60	1
9	-20	-20	8	44	110	-10	12	79	160	0	1	114	60	110	1
10	-20	0	8	45	110	10	12	80	160	50	1	115	60	160	1
11	-20	20	8	46	120	-10	12	81	100	100	12	116	110	60	1
12	0	-20	8	47	120	0	12	82	100	110	12	117	110	160	1
13	0	20	8	48	120	10	12	83	100	120	12	118	160	60	1
14	20	-20	8	49	90	-20	8	84	110	100	12	119	160	110	1
15	20	0	8	50	90	0	8	85	110	120	12	120	160	160	1
16	20	20	8	51	90	20	8	86	120	100	12	121	-10	100	12
17	-30	-30	4	52	110	-20	8	87	120	110	12	122	-10	110	12
18	-30	0	4	53	110	20	8	88	120	120	12	123	-10	120	12
19	-30	30	4	54	130	-20	8	89	90	90	8	124	0	100	12
20	0	-30	4	55	130	0	8	90	90	110	8	125	0	120	12
21	0	30	4	56	130	20	8	91	90	130	8	126	10	100	12
22	30	-30	4	57	80	-30	4	92	110	90	8	127	10	110	12
23	30	0	4	58	80	0	4	93	110	130	8	128	10	120	12
24	30	30	4	59	80	30	4	94	130	90	8	129	-20	90	8
25	-40	-40	2	60	110	-30	4	95	130	110	8	130	-20	110	8
26	-40	0	2	61	110	30	4	96	130	130	8	131	-20	130	8
27	-40	40	2	62	140	-30	4	97	80	80	4	132	0	90	8
28	0	-40	2	63	140	0	4	98	80	110	4	133	0	130	8
29	0	40	2	64	140	30	4	99	80	140	4	134	20	90	8
30	40	-40	2	65	70	-40	2	100	110	80	4	135	20	110	8
31	40	0	2	66	70	0	2	101	110	140	4	136	20	130	8
32	40	40	2	67	70	40	2	102	140	80	4	137	-30	80	4
33	-50	-50	1	68	110	-40	2	103	140	110	4	138	-30	110	4
34	-50	0	1	69	110	40	2	104	140	140	4	139	-30	140	4

(cont.)

Table E.14 continued.

No.	x	y	q	No.	x	y	q	No.	x	y	q	No.	x	y	q
140	0	80	4	146	-40	110	2	152	40	150	2	158	50	60	1
141	0	140	4	147	-40	150	2	153	-50	60	1	159	50	110	1
142	30	80	4	148	0	70	2	154	-50	110	1	160	50	160	1
143	30	110	4	149	0	150	2	155	-50	160	1	161	110	0	0
144	30	140	4	150	40	70	2	156	0	60	1	162	110	110	0
145	-40	70	2	151	40	110	2	157	0	160	1	163	0	110	0

Table E.15: Node locations and demands for MD18–MD20.

No.	x	y	q	No.	x	y	q	No.	x	y	q	No.	x	y	q
0	0	0	0	35	-50	50	1	70	150	-40	2	105	70	70	2
1	-10	-10	12	36	0	-50	1	71	150	0	2	106	70	110	2
2	-10	0	12	37	0	50	1	72	150	40	2	107	70	150	2
3	-10	10	12	38	50	-50	1	73	60	-50	1	108	110	70	2
4	0	-10	12	39	50	0	1	74	60	0	1	109	110	150	2
5	0	10	12	40	50	50	1	75	60	50	1	110	150	70	2
6	10	-10	12	41	100	-10	12	76	110	-50	1	111	150	110	2
7	10	0	12	42	100	0	12	77	110	50	1	112	150	150	2
8	10	10	12	43	100	10	12	78	160	-50	1	113	60	60	1
9	-20	-20	8	44	110	-10	12	79	160	0	1	114	60	110	1
10	-20	0	8	45	110	10	12	80	160	50	1	115	60	160	1
11	-20	20	8	46	120	-10	12	81	100	100	12	116	110	60	1
12	0	-20	8	47	120	0	12	82	100	110	12	117	110	160	1
13	0	20	8	48	120	10	12	83	100	120	12	118	160	60	1
14	20	-20	8	49	90	-20	8	84	110	100	12	119	160	110	1
15	20	0	8	50	90	0	8	85	110	120	12	120	160	160	1
16	20	20	8	51	90	20	8	86	120	100	12	121	-10	100	12
17	-30	-30	4	52	110	-20	8	87	120	110	12	122	-10	110	12
18	-30	0	4	53	110	20	8	88	120	120	12	123	-10	120	12
19	-30	30	4	54	130	-20	8	89	90	90	8	124	0	100	12
20	0	-30	4	55	130	0	8	90	90	110	8	125	0	120	12
21	0	30	4	56	130	20	8	91	90	130	8	126	10	100	12
22	30	-30	4	57	80	-30	4	92	110	90	8	127	10	110	12
23	30	0	4	58	80	0	4	93	110	130	8	128	10	120	12
24	30	30	4	59	80	30	4	94	130	90	8	129	-20	90	8
25	-40	-40	2	60	110	-30	4	95	130	110	8	130	-20	110	8
26	-40	0	2	61	110	30	4	96	130	130	8	131	-20	130	8
27	-40	40	2	62	140	-30	4	97	80	80	4	132	0	90	8
28	0	-40	2	63	140	0	4	98	80	110	4	133	0	130	8
29	0	40	2	64	140	30	4	99	80	140	4	134	20	90	8
30	40	-40	2	65	70	-40	2	100	110	80	4	135	20	110	8
31	40	0	2	66	70	0	2	101	110	140	4	136	20	130	8
32	40	40	2	67	70	40	2	102	140	80	4	137	-30	80	4
33	-50	-50	1	68	110	-40	2	103	140	110	4	138	-30	110	4
34	-50	0	1	69	110	40	2	104	140	140	4	139	-30	140	4

(cont.)

Table E.15 continued.

No.	x	y	q	No.	x	y	q	No.	x	y	q	No.	x	y	q
140	0	80	4	167	-100	110	12	194	-160	110	1	221	-110	30	4
141	0	140	4	168	-100	120	12	195	-160	160	1	222	-80	-30	4
142	30	80	4	169	-130	90	8	196	-110	60	1	223	-80	0	4
143	30	110	4	170	-130	110	8	197	-110	160	1	224	-80	30	4
144	30	140	4	171	-130	130	8	198	-60	60	1	225	-150	-40	2
145	-40	70	2	172	-110	90	8	199	-60	110	1	226	-150	0	2
146	-40	110	2	173	-110	130	8	200	-60	160	1	227	-150	40	2
147	-40	150	2	174	-90	90	8	201	-120	-10	12	228	-110	-40	2
148	0	70	2	175	-90	110	8	202	-120	0	12	229	-110	40	2
149	0	150	2	176	-90	130	8	203	-120	10	12	230	-70	-40	2
150	40	70	2	177	-140	80	4	204	-110	-10	12	231	-70	0	2
151	40	110	2	178	-140	110	4	205	-110	10	12	232	-70	40	2
152	40	150	2	179	-140	140	4	206	-100	-10	12	233	-160	-50	1
153	-50	60	1	180	-110	80	4	207	-100	0	12	234	-160	0	1
154	-50	110	1	181	-110	140	4	208	-100	10	12	235	-160	50	1
155	-50	160	1	182	-80	80	4	209	-130	-20	8	236	-110	-50	1
156	0	60	1	183	-80	110	4	210	-130	0	8	237	-110	50	1
157	0	160	1	184	-80	140	4	211	-130	20	8	238	-60	-50	1
158	50	60	1	185	-150	70	2	212	-110	-20	8	239	-60	0	1
159	50	110	1	186	-150	110	2	213	-110	20	8	240	-60	50	1
160	50	160	1	187	-150	150	2	214	-90	-20	8	241	110	0	0
161	-120	100	12	188	-110	70	2	215	-90	0	8	242	110	110	0
162	-120	110	12	189	-110	150	2	216	-90	20	8	243	0	110	0
163	-120	120	12	190	-70	70	2	217	-140	-30	4	244	-110	110	0
164	-110	100	12	191	-70	110	2	218	-140	0	4	245	-110	0	0
165	-110	120	12	192	-70	150	2	219	-140	30	4				
166	-100	100	12	193	-160	60	1	220	-110	-30	4				

Table E.16: Node locations and demands for MD21–MD23.

No.	x	y	q	No.	x	y	q	No.	x	y	q	No.	x	y	q
0	0	0	0	35	-50	50	1	70	150	-40	2	105	70	70	2
1	-10	-10	12	36	0	-50	1	71	150	0	2	106	70	110	2
2	-10	0	12	37	0	50	1	72	150	40	2	107	70	150	2
3	-10	10	12	38	50	-50	1	73	60	-50	1	108	110	70	2
4	0	-10	12	39	50	0	1	74	60	0	1	109	110	150	2
5	0	10	12	40	50	50	1	75	60	50	1	110	150	70	2
6	10	-10	12	41	100	-10	12	76	110	-50	1	111	150	110	2
7	10	0	12	42	100	0	12	77	110	50	1	112	150	150	2
8	10	10	12	43	100	10	12	78	160	-50	1	113	60	60	1
9	-20	-20	8	44	110	-10	12	79	160	0	1	114	60	110	1
10	-20	0	8	45	110	10	12	80	160	50	1	115	60	160	1
11	-20	20	8	46	120	-10	12	81	100	100	12	116	110	60	1
12	0	-20	8	47	120	0	12	82	100	110	12	117	110	160	1
13	0	20	8	48	120	10	12	83	100	120	12	118	160	60	1
14	20	-20	8	49	90	-20	8	84	110	100	12	119	160	110	1
15	20	0	8	50	90	0	8	85	110	120	12	120	160	160	1
16	20	20	8	51	90	20	8	86	120	100	12	121	-10	100	12
17	-30	-30	4	52	110	-20	8	87	120	110	12	122	-10	110	12
18	-30	0	4	53	110	20	8	88	120	120	12	123	-10	120	12
19	-30	30	4	54	130	-20	8	89	90	90	8	124	0	100	12
20	0	-30	4	55	130	0	8	90	90	110	8	125	0	120	12
21	0	30	4	56	130	20	8	91	90	130	8	126	10	100	12
22	30	-30	4	57	80	-30	4	92	110	90	8	127	10	110	12
23	30	0	4	58	80	0	4	93	110	130	8	128	10	120	12
24	30	30	4	59	80	30	4	94	130	90	8	129	-20	90	8
25	-40	-40	2	60	110	-30	4	95	130	110	8	130	-20	110	8
26	-40	0	2	61	110	30	4	96	130	130	8	131	-20	130	8
27	-40	40	2	62	140	-30	4	97	80	80	4	132	0	90	8
28	0	-40	2	63	140	0	4	98	80	110	4	133	0	130	8
29	0	40	2	64	140	30	4	99	80	140	4	134	20	90	8
30	40	-40	2	65	70	-40	2	100	110	80	4	135	20	110	8
31	40	0	2	66	70	0	2	101	110	140	4	136	20	130	8
32	40	40	2	67	70	40	2	102	140	80	4	137	-30	80	4
33	-50	-50	1	68	110	-40	2	103	140	110	4	138	-30	110	4
34	-50	0	1	69	110	40	2	104	140	140	4	139	-30	140	4

(cont.)

Table E.16 continued.

No.	x	y	q	No.	x	y	q	No.	x	y	q	No.	x	y	q
140	0	80	4	175	-90	110	8	210	-130	0	8	245	-110	-100	12
141	0	140	4	176	-90	130	8	211	-130	20	8	246	-100	-120	12
142	30	80	4	177	-140	80	4	212	-110	-20	8	247	-100	-110	12
143	30	110	4	178	-140	110	4	213	-110	20	8	248	-100	-100	12
144	30	140	4	179	-140	140	4	214	-90	-20	8	249	-130	-130	8
145	-40	70	2	180	-110	80	4	215	-90	0	8	250	-130	-110	8
146	-40	110	2	181	-110	140	4	216	-90	20	8	251	-130	-90	8
147	-40	150	2	182	-80	80	4	217	-140	-30	4	252	-110	-130	8
148	0	70	2	183	-80	110	4	218	-140	0	4	253	-110	-90	8
149	0	150	2	184	-80	140	4	219	-140	30	4	254	-90	-130	8
150	40	70	2	185	-150	70	2	220	-110	-30	4	255	-90	-110	8
151	40	110	2	186	-150	110	2	221	-110	30	4	256	-90	-90	8
152	40	150	2	187	-150	150	2	222	-80	-30	4	257	-140	-140	4
153	-50	60	1	188	-110	70	2	223	-80	0	4	258	-140	-110	4
154	-50	110	1	189	-110	150	2	224	-80	30	4	259	-140	-80	4
155	-50	160	1	190	-70	70	2	225	-150	-40	2	260	-110	-140	4
156	0	60	1	191	-70	110	2	226	-150	0	2	261	-110	-80	4
157	0	160	1	192	-70	150	2	227	-150	40	2	262	-80	-140	4
158	50	60	1	193	-160	60	1	228	-110	-40	2	263	-80	-110	4
159	50	110	1	194	-160	110	1	229	-110	40	2	264	-80	-80	4
160	50	160	1	195	-160	160	1	230	-70	-40	2	265	-150	-150	2
161	-120	100	12	196	-110	60	1	231	-70	0	2	266	-150	-110	2
162	-120	110	12	197	-110	160	1	232	-70	40	2	267	-150	-70	2
163	-120	120	12	198	-60	60	1	233	-160	-50	1	268	-110	-150	2
164	-110	100	12	199	-60	110	1	234	-160	0	1	269	-110	-70	2
165	-110	120	12	200	-60	160	1	235	-160	50	1	270	-70	-150	2
166	-100	100	12	201	-120	-10	12	236	-110	-50	1	271	-70	-110	2
167	-100	110	12	202	-120	0	12	237	-110	50	1	272	-70	-70	2
168	-100	120	12	203	-120	10	12	238	-60	-50	1	273	-160	-160	1
169	-130	90	8	204	-110	-10	12	239	-60	0	1	274	-160	-110	1
170	-130	110	8	205	-110	10	12	240	-60	50	1	275	-160	-60	1
171	-130	130	8	206	-100	-10	12	241	-120	-120	12	276	-110	-160	1
172	-110	90	8	207	-100	0	12	242	-120	-110	12	277	-110	-60	1
173	-110	130	8	208	-100	10	12	243	-120	-100	12	278	-60	-160	1
174	-90	90	8	209	-130	-20	8	244	-110	-120	12	279	-60	-110	1

(cont.)

Table E.16 continued.

No.	x	y	q	No.	x	y	q	No.	x	y	q	No.	x	y	q
280	-60	-60	1	303	30	-110	4	326	120	-120	12	349	110	-70	2
281	-10	-120	12	304	30	-80	4	327	120	-110	12	350	150	-150	2
282	-10	-110	12	305	-40	-150	2	328	120	-100	12	351	150	-110	2
283	-10	-100	12	306	-40	-110	2	329	90	-130	8	352	150	-70	2
284	0	-120	12	307	-40	-70	2	330	90	-110	8	353	60	-160	1
285	0	-100	12	308	0	-150	2	331	90	-90	8	354	60	-110	1
286	10	-120	12	309	0	-70	2	332	110	-130	8	355	60	-60	1
287	10	-110	12	310	40	-150	2	333	110	-90	8	356	110	-160	1
288	10	-100	12	311	40	-110	2	334	130	-130	8	357	110	-60	1
289	-20	-130	8	312	40	-70	2	335	130	-110	8	358	160	-160	1
290	-20	-110	8	313	-50	-160	1	336	130	-90	8	359	160	-110	1
291	-20	-90	8	314	-50	-110	1	337	80	-140	4	360	160	-60	1
292	0	-130	8	315	-50	-60	1	338	80	-110	4	361	110	0	0
293	0	-90	8	316	0	-160	1	339	80	-80	4	362	110	110	0
294	20	-130	8	317	0	-60	1	340	110	-140	4	363	0	110	0
295	20	-110	8	318	50	-160	1	341	110	-80	4	364	-110	110	0
296	20	-90	8	319	50	-110	1	342	140	-140	4	365	-110	0	0
297	-30	-140	4	320	50	-60	1	343	140	-110	4	366	-110	-110	0
298	-30	-110	4	321	100	-120	12	344	140	-80	4	367	0	-110	0
299	-30	-80	4	322	100	-110	12	345	70	-150	2	368	110	-110	0
300	0	-140	4	323	100	-100	12	346	70	-110	2				
301	0	-80	4	324	110	-120	12	347	70	-70	2				
302	30	-140	4	325	110	-100	12	348	110	-150	2				

Table E.17: MDIPH solution to MD1.

No.	Route	Load	Distance
1	0 25 18 4 0	78	47.00
2	0 13 41 40 19 42 0	79	66.55
3	0 17 37 15 33 45 44 0	71	60.06
4	51 47 12 51	54	23.50
5	51 46 11 32 1 27 6 51	73	53.44
6	51 22 28 31 26 8 48 51	80	79.47
7	51 14 24 43 7 23 51	77	81.40
8	52 9 34 30 39 10 52	75	50.41
9	52 49 5 38 52	54	25.22
10	53 21 50 16 2 29 53	69	42.14
11	53 20 3 36 35 53	67	47.67
		Total Distance	576.87

Table E.18: MDIPH solution to MD2.

No.	Route	Load	Distance
1	0 42 19 40 41 13 18 47 4 0	154	87.04
2	51 46 27 48 23 7 43 24 25 14 6 51	157	101.91
3	52 10 39 33 45 15 44 37 17 12 5 49 52	158	95.30
4	52 38 11 2 16 50 21 34 30 9 52	153	74.27
5	53 29 32 1 22 8 26 31 28 3 36 35 20 53	155	115.02
		Total Distance	473.53

Table E.19: MDIPH solution to MD3.

No.	Route	Load	Distance
1	0 26 12 40 17 51 6 68 0	128	50.89
2	0 75 4 34 46 67 0	126	29.08
3	76 48 21 74 2 30 76	106	41.52
4	76 29 45 27 52 54 13 57 15 76	120	65.57
5	76 5 37 20 70 60 71 69 36 47 76	123	63.78
6	77 14 59 19 8 7 35 77	111	60.49
7	77 38 65 66 11 53 77	129	43.16
8	78 3 49 24 18 50 32 44 78	123	59.34
9	78 25 55 31 10 58 72 39 9 78	139	99.29
10	79 42 64 22 61 28 62 73 79	119	72.13
11	79 43 41 56 23 63 16 33 1 79	140	59.22
		Total Distance	644.46

Table E.20: MDIPH solution to MD4.

No.	Route	Load	Distance
1	0 2 41 22 75 74 72 21 0	92	44.81
2	0 57 15 43 14 44 91 100 37 97 0	98	66.93
3	0 42 38 86 16 61 98 92 0	100	81.62
4	0 87 95 94 13 0	96	28.69
5	0 6 89 60 83 45 17 84 5 96 0	94	81.25
6	0 23 67 39 56 73 0	100	73.68
7	0 58 53 28 12 26 40 0	93	48.83
8	0 4 25 55 24 29 68 80 54 0	99	95.22
9	0 85 93 99 59 0	100	41.56
10	101 69 27 76 77 3 79 50 101	98	58.00
11	101 1 33 81 9 51 30 70 101	99	54.15
12	101 11 64 49 36 47 19 101	100	93.52
13	101 10 32 90 63 62 31 101	98	55.51
14	101 52 18 8 46 48 82 7 88 101	97	76.59
15	101 20 66 65 71 35 34 78 101	94	98.85
		Total Distance	999.21

Table E.21: MDIPH solution to MD5.

No.	Route	Load	Distance
1	0 93 85 91 100 37 98 59 95 94 96 60 0	188	50.40
2	0 99 92 97 87 42 43 15 57 2 41 22 73 21 40 58 13 6 89 0	194	125.96
3	0 18 52 31 70 30 32 90 63 10 62 88 7 82 0	175	102.28
4	0 5 61 16 44 14 38 86 17 84 0	156	75.92
5	0 83 8 48 19 11 64 49 36 47 46 45 0	173	106.39
6	101 4 72 74 75 56 23 67 39 25 55 54 101	187	91.86
7	101 12 26 53 28 27 69 1 50 76 77 3 68 80 101	193	74.78
8	101 79 33 81 9 51 20 66 65 71 35 34 78 29 24 101	192	124.28
		Total Distance	751.89

Table E.22: MDIPH solution to MD6.

No.	Route	Load	Distance
1	0 16 86 38 44 0	88	42.39
2	0 61 84 17 45 46 8 83 60 5 0	88	72.35
3	0 93 59 95 92 37 98 0	90	23.97
4	0 99 96 89 6 94 13 97 0	100	48.18
5	0 85 0	41	4.47
6	0 91 14 43 15 57 2 87 42 100 0	98	67.39
7	101 4 54 80 68 12 101	98	46.49
8	101 25 55 24 29 34 78 79 3 77 76 101	100	94.12
9	101 72 75 41 22 74 73 21 101	94	38.49
10	101 26 28 27 53 58 40 101	90	55.57
11	101 39 67 23 56 101	91	50.53
12	102 70 9 35 71 65 66 20 102	98	83.80
13	102 31 62 63 90 32 10 102	98	51.93
14	102 69 1 50 33 81 51 30 102	97	53.18
15	102 11 64 49 36 47 19 102	100	88.59
16	102 52 18 82 48 7 88 102	87	59.12
		Total Distance	880.57

Table E.23: MDIPH solution to MD7.

No.	Route	Load	Distance
1	0 85 100 98 59 60 0	99	37.28
2	0 82 48 47 46 8 83 0	100	52.67
3	0 45 17 86 16 61 84 0	92	53.12
4	0 5 93 99 96 6 89 18 0	98	41.00
5	101 4 39 67 25 55 101	83	67.49
6	101 80 68 79 3 77 101	92	27.97
7	101 24 29 78 34 35 81 33 50 76 101	100	81.55
8	101 54 26 53 28 12 101	84	47.86
9	102 42 15 43 14 38 44 91 37 92 97 102	97	90.27
10	102 13 94 95 87 102	96	28.69
11	102 2 57 41 22 23 56 75 74 102	98	63.48
12	102 58 40 21 72 73 102	72	34.40
13	103 1 30 32 90 63 10 103	83	57.04
14	103 7 19 36 49 64 11 62 103	97	95.52
15	103 31 88 52 27 69 103	67	37.96
16	103 51 9 71 65 66 20 70 103	100	81.90
		Total Distance	898.20

Table E.24: MDIPH solution to MD8.

No.	Route	Load	Distance
1	0 112 213 215 126 116 3 118 123 8 190 163 0	497	144.77
2	0 135 84 16 52 162 59 75 219 15 102 0	478	161.77
3	0 146 39 233 136 226 176 38 223 43 225 0	490	175.69
4	0 175 47 55 17 24 40 127 147 201 78 32 122 0	496	288.07
5	0 183 36 220 65 206 83 217 0	499	143.78
6	0 27 173 228 53 124 49 12 133 191 30 18 137 54 0	491	191.66
7	0 79 33 31 205 221 129 130 61 90 211 5 204 0	494	277.97
8	0 96 166 72 185 19 207 198 73 0	473	133.14
9	0 242 56 66 168 103 113 80 194 197 42 11 241 235 0	498	182.03
10	0 69 177 237 62 249 157 82 224 0	467	60.06
11	0 114 148 26 9 153 230 170 2 195 0	464	111.31
12	0 58 150 189 106 121 248 89 167 13 101 0	496	193.72
13	0 214 131 10 238 57 203 193 125 64 0	479	132.10
14	250 7 21 138 234 71 229 1 139 202 231 68 142 209 145 250	492	308.03
15	250 115 244 108 70 99 232 155 76 154 87 188 250	497	238.86
16	250 37 6 243 169 181 171 85 222 250	498	150.89
17	250 246 140 172 186 100 81 4 160 208 250	483	153.82
18	250 25 141 104 74 164 95 34 182 28 250	469	166.69
19	250 245 94 151 86 149 247 88 50 250	459	185.69
20	250 110 60 158 159 134 51 67 97 132 165 250	498	287.28
21	250 92 178 210 41 109 20 227 29 105 44 199 250	495	191.32
22	250 111 236 196 174 143 48 23 120 22 250	404	109.88
23	250 200 128 14 98 117 240 107 212 77 91 46 250	500	189.46
24	250 180 63 216 93 187 45 161 179 250	497	97.89
25	250 152 144 192 184 218 119 239 35 156 250	492	139.09
		Total Distance	4414.99

Table E.25: MDIPH solution to MD9.

No.	Route	Load	Distance
1	0 236 120 22 200 63 180 216 46 161 179 23 0	463	117.72
2	0 111 48 143 174 196 0	305	56.49
3	0 44 199 208 246 25 141 104 74 215 126 116 37 0	474	190.11
4	0 152 144 192 184 218 239 35 119 245 50 77 0	499	232.31
5	0 105 171 181 59 75 162 169 85 222 0	495	122.41
6	0 29 134 159 147 127 40 24 17 55 47 175 78 32 0	498	288.84
7	0 227 20 109 41 210 178 92 0	447	89.65
8	0 110 60 158 51 201 67 97 132 0	497	169.75
9	0 117 240 98 107 45 187 128 0	498	129.06
10	0 14 212 247 86 149 94 151 88 91 93 0	490	214.73
11	0 165 6 243 52 219 15 102 233 176 136 226 0	489	181.62
12	250 13 167 89 248 121 106 189 153 9 26 148 250	475	129.81
13	250 2 183 36 220 150 58 230 250	493	84.71
14	250 157 249 62 177 69 163 64 125 250	484	96.91
15	250 190 8 123 118 3 16 84 135 146 237 224 250	496	179.60
16	250 82 43 223 122 39 38 242 225 241 235 193 250	487	142.78
17	250 114 203 57 131 214 101 250	365	74.11
18	250 195 27 54 18 30 207 166 213 112 96 73 198 204 250	488	196.10
19	250 173 137 124 53 228 65 206 83 217 170 250	499	180.05
20	250 11 56 66 168 103 113 80 194 197 42 10 238 250	496	174.49
21	251 211 90 61 221 129 130 49 12 133 5 33 251	467	149.14
22	251 72 185 19 191 79 251	367	104.71
23	251 209 87 188 34 95 182 28 156 160 7 164 140 172 251	499	223.80
24	251 100 145 4 81 186 21 138 251	458	79.10
25	251 115 154 76 155 108 244 70 99 251	420	109.74
26	251 68 142 232 231 202 139 1 229 71 31 205 234 251	457	161.31
		Total Distance	3879.06

Table E.26: MDIPH solution to MD10.

No.	Route	Load	Distance
1	0 92 178 210 41 110 109 20 227 0	497	88.55
2	0 29 60 158 159 134 51 67 97 132 105 0	478	203.95
3	0 85 171 181 162 169 6 37 165 222 0	497	147.95
4	0 196 48 174 143 14 98 240 117 0	494	85.33
5	0 111 236 23 120 22 200 179 161 93 187 45 128 0	480	131.84
6	0 44 199 208 152 180 63 216 46 91 77 212 107 0	485	202.45
7	250 193 101 148 9 153 189 106 121 248 89 167 13 238 250	495	210.14
8	250 131 57 26 230 170 114 203 214 250	499	142.49
9	250 10 42 197 194 80 113 103 168 66 250	431	85.24
10	250 176 136 226 59 75 219 102 39 38 250	500	126.08
11	250 122 146 84 135 123 118 3 16 243 52 15 233 56 250	482	164.91
12	250 225 157 249 69 177 237 62 43 223 242 250	470	96.21
13	250 241 235 82 224 163 64 125 11 250	498	116.20
14	250 47 55 17 24 40 127 147 201 32 78 175 250	492	193.48
15	251 173 217 183 150 58 2 195 27 54 18 251	499	145.31
16	251 124 130 129 221 31 205 211 90 61 49 251	482	151.00
17	251 30 207 166 213 8 190 112 96 73 198 204 251	484	152.23
18	251 12 133 5 79 72 185 19 191 251	432	98.25
19	251 228 53 65 206 220 36 83 137 251	459	134.07
20	252 81 186 21 138 100 145 115 252	494	94.15
21	252 244 108 155 76 154 87 34 182 95 252	486	135.81
22	252 188 99 70 232 231 202 139 1 229 71 68 142 234 33 209 4 252	494	252.69
23	252 164 140 172 74 104 215 116 126 141 25 246 7 160 252	498	189.96
24	252 119 245 94 151 86 149 247 88 50 252	497	219.62
25	252 28 156 144 192 184 218 239 35 252	483	121.56
		Total Distance	3689.47

Table E.27: MDIPH solution to MD11.

No.	Route	Load	Distance
1	0 111 236 23 120 22 44 199 200 63 179 161 128 48 0	478	136.87
2	0 92 178 210 41 110 109 20 227 0	497	93.59
3	0 196 174 143 14 107 98 240 117 0	457	96.14
4	0 105 169 243 16 6 37 165 222 85 0	445	147.17
5	250 67 51 97 132 29 60 158 134 159 147 250	492	194.37
6	250 78 32 201 127 40 24 250	322	95.09
7	250 226 59 75 162 171 181 52 219 136 250	497	116.30
8	250 242 225 241 235 11 203 57 214 131 238 10 250	496	164.38
9	250 175 66 80 197 42 194 113 103 168 47 55 17 250	499	112.21
10	250 56 38 223 43 122 39 102 15 233 176 250	423	141.43
11	251 35 87 154 76 155 108 244 209 81 4 188 182 251	488	209.38
12	251 34 95 28 160 164 7 141 25 246 208 152 251	499	190.05
13	251 119 245 94 151 86 149 247 88 50 251	497	142.21
14	251 156 192 184 218 239 251	410	57.14
15	251 144 91 77 212 45 187 93 46 216 180 251	492	144.48
16	252 163 224 82 157 249 62 237 252	489	118.40
17	252 69 177 146 84 135 3 118 123 8 190 73 204 252	482	165.03
18	252 27 230 9 153 13 167 89 248 121 106 189 252	487	198.03
19	252 217 58 183 150 220 36 83 252	492	95.93
20	252 195 2 170 26 148 114 101 193 64 125 252	492	124.44
21	252 173 206 65 228 53 124 137 18 30 54 252	405	141.48
22	252 207 166 172 140 74 104 126 116 215 213 112 96 198 252	498	202.87
23	253 33 138 21 100 145 115 186 253	489	136.25
24	253 234 99 70 232 142 68 231 202 139 1 229 71 31 205 253	493	228.57
25	253 72 185 19 191 253	319	52.43
26	253 79 211 90 61 221 129 130 49 12 133 5 253	468	97.00
		Total Distance	3601.26

Table E.28: MDIPH solution to MD12.

No.	Route	Load	Distance
1	0 2 10 18 26 34 33 25 17 9 1 0	54	170.71
2	0 3 11 19 27 35 37 29 21 13 5 0	54	170.71
3	0 4 12 20 28 36 22 14 6 0	51	128.48
4	0 7 15 23 31 39 67 75 40 32 24 16 8 0	57	189.57
5	81 42 50 58 66 74 30 38 73 65 57 49 41 81	57	189.57
6	81 44 52 60 68 76 78 70 62 54 46 81	54	170.71
7	81 45 53 61 69 77 59 51 43 81	51	128.48
8	81 47 55 63 71 79 80 72 64 56 48 81	54	170.71
		Total Distance	1318.95

Table E.29: MDIPH solution to MD13.

No.	Route	Load	Distance
1	0 6 14 22 30 38 73 65 39 31 23 15 7 0	57	189.57
2	0 5 13 21 29 37 24 16 8 0	51	128.48
3	0 2 10 18 26 34 35 27 19 11 3 0	54	170.71
4	0 1 9 17 25 33 36 28 20 12 4 0	54	170.71
5	81 47 55 63 71 79 78 70 62 54 46 81	54	170.71
6	81 42 50 58 66 74 32 40 75 67 59 51 43 81	57	189.57
7	81 41 49 57 76 68 60 52 44 81	51	128.48
8	81 45 53 61 69 77 80 72 64 56 48 81	54	170.71
		Total Distance	1318.95

Table E.30: MDIPH solution to MD14.

No.	Route	Load	Distance
1	0 1 9 17 25 33 36 28 20 12 4 0	54	170.71
2	0 3 11 19 27 35 34 26 18 10 2 0	54	170.71
3	0 6 14 22 30 38 73 31 23 15 7 0	54	174.56
4	0 5 13 21 29 37 40 32 24 16 8 0	54	170.71
5	81 41 49 57 65 39 74 66 58 50 42 81	54	161.29
6	81 45 53 61 69 77 75 67 59 51 43 81	54	170.71
7	81 46 54 62 70 78 76 68 60 52 44 81	54	170.71
8	81 47 55 63 71 79 80 72 64 56 48 81	54	170.71
		Total Distance	1360.12

Table E.31: MDIPH solution to MD15.

No.	Route	Load	Distance
1	0 2 10 18 26 34 33 25 17 9 1 0	54	170.71
2	0 3 11 19 27 35 153 145 137 129 148 156 37 29 21 13 0	60	221.42
3	0 4 12 20 28 36 30 22 14 6 0	53	147.80
4	0 7 8 5 0	36	40.00
5	161 50 58 66 74 39 31 23 15 16 24 32 40 75 67 59 51 161	60	233.14
6	161 48 45 43 42 161	48	54.14
7	161 47 55 63 71 79 78 70 62 54 46 161	54	170.71
8	161 41 49 57 65 38 73 76 68 60 52 44 161	55	188.93
9	161 56 64 72 80 118 110 102 94 92 100 108 116 77 69 61 53 161	60	233.14
10	162 82 81 84 86 162	48	54.14
11	162 83 91 99 107 160 115 117 109 101 93 85 162	55	188.93
12	162 87 95 103 111 119 120 112 104 96 88 162	54	170.71
13	163 124 121 140 132 126 127 163	60	86.50
14	163 122 130 138 146 154 155 147 139 131 123 163	54	170.71
15	163 125 133 141 149 157 152 144 136 128 163	53	147.80
16	163 135 143 151 159 114 106 98 90 89 97 105 113 158 150 142 134 163	60	233.14
		Total Distance	2511.92

Table E.32: MDIPH solution to MD16.

No.	Route	Load	Distance
1	0 1 9 17 25 33 34 26 18 10 2 0	54	170.71
2	0 4 12 20 28 36 22 14 6 0	51	128.48
3	0 7 15 23 31 59 67 75 40 32 24 16 8 0	60	198.99
4	0 3 11 19 27 35 153 145 156 37 29 21 13 5 0	58	196.08
5	161 41 49 57 65 73 38 30 39 74 66 58 50 42 161	58	196.08
6	161 47 55 63 71 79 64 56 48 161	51	128.48
7	161 43 51 69 61 53 45 161	46	96.57
8	161 44 52 60 68 76 78 70 62 54 46 161	54	170.71
9	162 82 90 98 106 142 150 158 113 105 97 89 81 162	60	198.99
10	162 83 91 99 117 109 101 93 85 162	51	128.48
11	162 87 95 103 111 119 120 112 104 96 88 162	54	170.71
12	162 86 94 102 110 118 80 72 77 116 108 100 92 84 162	58	196.08
13	163 121 129 137 154 146 138 130 122 163	51	128.48
14	163 125 133 141 149 157 155 147 139 131 123 163	54	170.71
15	163 127 135 143 151 159 114 107 115 160 152 144 136 128 163	58	196.08
16	163 126 134 148 140 132 124 163	46	96.57
		Total Distance	2572.23

Table E.33: MDIPH solution to MD17.

No.	Route	Load	Distance
1	0 2 10 18 26 34 33 25 17 9 1 0	54	170.71
2	0 3 11 19 27 35 153 29 21 13 5 0	54	174.56
3	0 6 14 22 30 38 36 28 20 12 4 0	54	170.71
4	0 7 15 23 31 75 40 32 24 16 8 0	54	174.56
5	161 44 52 60 68 76 73 65 57 49 41 161	54	170.71
6	161 48 56 64 72 80 118 69 61 53 45 161	54	174.56
7	161 46 54 62 70 78 79 71 63 55 47 161	54	170.71
8	161 43 51 59 67 39 74 66 58 50 42 161	54	161.29
9	162 85 93 101 109 117 115 107 99 91 83 162	54	170.71
10	162 88 96 104 112 120 119 111 103 95 87 162	54	170.71
11	162 86 94 102 110 77 116 108 100 92 84 162	54	161.29
12	162 81 89 97 105 113 158 106 98 90 82 162	54	174.56
13	163 124 132 140 148 156 37 145 137 129 121 163	54	161.29
14	163 123 131 139 147 155 154 146 138 130 122 163	54	170.71
15	163 125 133 141 149 157 160 152 144 136 128 163	54	170.71
16	163 127 135 143 151 159 114 150 142 134 126 163	54	161.29
		Total Distance	2709.09

Table E.34: MDIPH solution to MD18.

No.	Route	Load	Distance
1	0 1 9 17 25 33 238 230 222 214 231 239 34 26 18 10 0	60	221.42
2	0 4 12 20 28 36 30 22 14 6 0	53	147.80
3	0 7 8 5 3 2 0	60	60.00
4	0 15 23 31 39 74 66 58 50 51 59 67 75 40 32 24 16 0	60	233.14
5	0 13 21 29 37 156 148 140 129 137 145 153 198 190 232 240 35 27 19 11 0	58	293.78
6	241 41 49 57 65 38 73 76 68 60 52 44 241	55	188.93
7	241 56 64 72 80 118 110 102 94 92 100 108 116 77 69 61 53 241	60	233.14
8	241 42 43 45 48 241	48	54.14
9	241 47 55 63 71 79 78 70 62 54 46 241	54	170.71
10	242 82 81 84 86 242	48	54.14
11	242 83 91 99 107 160 115 117 109 101 93 85 242	55	188.93
12	242 88 96 104 112 120 119 111 103 95 87 242	54	170.71
13	242 89 97 105 113 158 150 142 134 135 143 151 159 114 106 98 90 242	60	233.14
14	243 124 121 132 126 127 243	56	68.28
15	243 125 133 141 149 157 152 144 136 128 243	53	147.80
16	243 122 130 138 146 154 199 191 192 200 155 147 139 131 123 243	60	204.85
17	244 164 166 174 182 183 175 167 244	60	108.28
18	244 162 170 178 186 194 195 187 179 171 163 244	54	170.71
19	244 165 173 181 189 197 184 176 168 244	51	128.48
20	244 161 169 177 185 193 235 227 219 211 229 237 196 188 180 172 244	60	221.42
21	245 212 220 228 236 209 217 225 233 234 226 218 210 202 245	57	228.48
22	245 201 204 206 223 215 207 245	60	86.50
23	245 205 203 213 221 224 216 208 245	60	116.57
		Total Distance	3731.37

Table E.35: MDIPH solution to MD19.

No.	Route	Load	Distance
1	0 4 12 20 28 36 22 14 6 0	51	128.48
2	0 1 9 17 25 33 238 230 239 34 26 18 10 2 0	58	196.08
3	0 3 11 19 27 35 153 145 137 29 21 13 5 0	60	198.99
4	0 7 15 23 31 24 16 8 0	50	114.05
5	241 41 49 57 65 73 38 30 39 74 66 58 50 42 241	58	196.08
6	241 44 52 60 68 76 78 70 62 54 46 241	54	170.71
7	241 45 53 61 69 97 105 113 75 67 59 51 43 241	60	198.99
8	241 47 55 63 71 79 64 56 48 241	51	128.48
9	242 81 89 106 98 90 82 242	46	96.57
10	242 84 92 100 108 116 77 72 80 118 110 102 94 86 242	58	196.08
11	242 85 93 101 109 117 99 91 83 242	51	128.48
12	242 88 96 104 112 120 119 111 103 95 87 242	54	170.71
13	243 124 132 140 148 156 37 32 40 158 150 142 134 126 243	58	196.08
14	243 121 129 146 138 130 122 243	46	96.57
15	243 128 136 144 152 160 115 107 114 159 151 143 135 127 243	58	196.08
16	243 125 133 141 149 157 139 131 123 243	51	128.48
17	244 167 175 183 191 199 154 147 155 200 192 184 176 168 244	58	196.08
18	244 162 170 178 186 194 177 169 161 244	51	128.48
19	244 163 171 179 187 195 197 189 181 173 165 244	54	170.71
20	244 164 172 180 188 224 232 240 198 190 182 174 166 244	60	198.99
21	245 202 210 218 226 234 233 225 217 209 201 245	54	170.71
22	245 203 211 219 227 235 193 185 196 237 229 221 213 205 245	58	196.08
23	245 204 212 220 228 236 222 214 206 245	51	128.48
24	245 207 215 223 231 216 208 245	46	96.57
		Total Distance	3827.06

Table E.36: MDIPH solution to MD20.

No.	Route	Load	Distance
1	0 8 16 24 32 74 39 31 23 15 7 0	54	161.29
2	0 6 14 22 30 38 36 28 20 12 4 0	54	170.71
3	0 3 11 19 27 35 153 29 21 13 5 0	54	174.56
4	0 1 9 17 25 239 34 26 18 10 2 0	54	161.29
5	241 42 50 58 66 40 75 67 59 51 43 241	54	174.56
6	241 41 49 57 65 73 76 68 60 52 44 241	54	170.71
7	241 48 56 64 72 80 118 69 61 53 45 241	54	174.56
8	241 46 54 62 70 78 79 71 63 55 47 241	54	170.71
9	242 81 89 97 105 159 114 106 98 90 82 242	54	161.29
10	242 85 93 101 109 117 115 107 99 91 83 242	54	170.71
11	242 84 92 100 108 116 77 110 102 94 86 242	54	161.29
12	242 87 95 103 111 119 120 112 104 96 88 242	54	170.71
13	243 122 130 138 146 154 155 147 139 131 123 243	54	170.71
14	243 121 129 137 145 37 156 148 140 132 124 243	54	161.29
15	243 125 133 141 149 157 160 152 144 136 128 243	54	170.71
16	243 127 135 143 151 113 158 150 142 134 126 243	54	174.56
17	244 165 173 181 189 197 195 187 179 171 163 244	54	170.71
18	244 162 170 178 186 194 193 185 177 169 161 244	54	170.71
19	244 166 174 182 190 198 240 188 180 172 164 244	54	174.56
20	244 167 175 183 191 199 200 192 184 176 168 244	54	170.71
21	245 207 215 223 231 33 238 230 222 214 206 245	54	174.56
22	245 201 209 217 225 233 236 228 220 212 204 245	54	170.71
23	245 202 210 218 226 234 235 227 219 211 203 245	54	170.71
24	245 205 213 221 229 237 196 232 224 216 208 245	54	161.29
		Total Distance	4063.64

Table E.37: MDIPH solution to MD21.

No.	Route	Load	Distance
1	0 4 1 2 3 5 0	60	60.00
2	0 6 14 22 30 38 320 312 304 296 309 317 36 28 20 12 0	60	221.42
3	0 13 21 29 37 156 148 140 132 129 137 145 153 35 27 19 11 0	60	233.14
4	0 7 15 23 31 39 74 66 67 75 40 32 24 16 8 0	60	204.85
5	0 9 17 25 33 238 230 222 214 215 223 231 239 34 26 18 10 0	60	233.14
6	361 42 41 44 361	36	40.00
7	361 46 54 62 70 79 71 63 55 47 361	53	147.80
8	361 50 58 59 51 43 45 48 361	60	122.43
9	362 82 81 84 86 362	48	54.14
10	362 87 95 103 111 119 120 112 104 96 88 362	54	170.71
11	362 85 93 101 109 117 115 160 107 99 91 83 362	55	188.93
12	362 94 102 110 118 80 72 64 56 53 61 69 77 116 108 100 92 362	60	233.14
13	363 122 121 124 126 127 363	60	60.00
14	363 125 133 141 149 157 152 144 136 128 363	53	147.80
15	363 123 131 139 147 155 200 192 184 176 191 199 154 146 138 130 363	60	221.42
16	363 134 142 150 158 113 105 97 89 90 98 106 114 159 151 143 135 363	60	233.14
17	364 165 173 181 189 197 195 187 179 171 163 364	54	170.71
18	364 174 182 190 198 240 232 224 216 213 221 229 237 196 188 180 172 364	60	233.14
19	364 167 168 175 183 166 164 364	60	86.50
20	364 162 170 178 186 194 193 235 185 177 169 161 364	55	188.93
21	365 202 210 218 226 234 227 219 211 203 365	53	147.80
22	365 212 220 228 236 277 269 261 259 267 275 233 225 217 209 201 365	56	218.99
23	365 205 208 207 206 204 365	60	60.00
24	366 241 249 257 265 273 276 268 260 252 244 366	54	170.71
25	366 243 251 274 266 258 250 242 366	47	114.34
26	366 245 253 248 366	32	48.28
27	366 247 255 263 271 297 305 313 278 270 262 254 246 366	60	198.99
28	367 283 291 299 307 315 280 272 264 256 279 314 306 298 290 367	58	219.19
29	367 286 287 288 301 293 285 367	60	86.50
30	367 282 281 289 316 308 300 292 284 367	59	120.20

(cont.)

Table E.37 continued.

No.	Route	Load	Distance
31	368 333 341 349 357 76 68 60 52 49 57 65 73 355 347 339 331 368	60	233.14
32	368 329 337 345 353 318 310 302 294 295 303 311 319 354 346 338 330 368	60	233.14
33	368 324 332 340 348 356 358 350 342 334 326 368	54	170.71
34	368 321 322 323 325 368	48	54.14
35	368 328 336 344 352 78 360 359 351 343 335 327 368	55	188.93
		Total Distance	5516.40

Table E.38: MDIPH solution to MD22.

No.	Route	Load	Distance
1	0 7 15 23 31 59 67 75 40 32 24 16 8 0	60	198.99
2	0 6 14 22 36 28 20 12 4 0	51	128.48
3	0 1 9 17 25 33 238 230 222 26 18 10 2 0	60	198.99
4	0 5 13 21 29 37 19 11 3 0	51	128.48
5	361 45 53 61 69 51 43 361	46	96.57
6	361 46 54 62 70 78 360 352 357 76 68 60 52 44 361	58	196.08
7	361 47 55 63 71 79 64 56 48 361	51	128.48
8	361 42 50 58 66 74 39 30 38 73 65 57 49 41 361	58	196.08
9	362 84 92 100 108 116 77 72 80 118 110 102 94 86 362	58	196.08
10	362 81 89 97 105 113 158 150 114 106 98 90 82 362	57	189.57
11	362 83 91 99 117 109 101 93 85 362	51	128.48
12	362 88 96 104 112 120 119 111 103 95 87 362	54	170.71
13	363 125 133 141 149 157 139 131 123 363	51	128.48
14	363 121 129 137 145 153 198 190 182 146 138 130 122 363	60	198.99
15	363 126 134 142 156 148 140 132 124 363	51	128.48
16	363 127 135 143 151 159 107 115 160 152 144 136 128 363	57	189.57
17	364 161 169 177 194 186 178 170 162 364	51	128.48
18	364 167 175 183 191 199 154 147 155 200 192 184 176 168 364	58	196.08
19	364 166 174 188 180 172 164 364	46	96.57
20	364 163 171 179 187 195 197 189 181 173 165 364	54	170.71
21	365 207 215 223 231 239 34 27 35 240 232 224 216 208 365	58	196.08
22	365 205 213 221 229 237 196 185 193 235 227 219 211 203 365	58	196.08
23	365 206 214 228 220 212 204 365	46	96.57
24	365 202 210 218 226 234 217 209 201 365	51	128.48
25	366 241 249 257 265 273 274 266 258 250 242 366	54	170.71
26	366 243 251 259 267 275 233 225 236 277 269 261 253 245 366	58	196.08
27	366 244 252 260 268 276 262 254 246 366	51	128.48
28	366 247 255 263 271 279 307 315 280 272 264 256 248 366	57	189.57
29	367 283 291 299 317 309 301 293 285 367	51	128.48
30	367 282 290 298 306 314 270 278 313 305 297 289 281 367	57	189.57

(cont.)

Table E.38 continued.

No.	Route	Load	Distance
31	367 287 295 303 311 319 347 355 320 312 304 296 288 367	57	189.57
32	367 286 294 302 316 308 300 292 284 367	51	128.48
33	368 321 329 337 345 353 318 310 354 346 338 330 322 368	57	189.57
34	368 323 331 339 349 341 333 325 368	50	114.05
35	368 324 332 340 348 356 358 350 342 334 326 368	54	170.71
36	368 328 336 344 359 351 343 335 327 368	51	128.48
		Total Distance	5735.40

Table E.39: MDIPH solution to MD23.

No.	Route	Load	Distance
1	0 1 9 17 25 33 238 26 18 10 2 0	54	174.56
2	0 3 11 19 27 35 37 29 21 13 5 0	54	170.71
3	0 4 12 20 28 320 38 30 22 14 6 0	54	174.56
4	0 7 15 23 31 39 40 32 24 16 8 0	54	170.71
5	361 47 55 63 71 79 80 72 64 56 48 361	54	170.71
6	361 46 54 62 70 357 76 68 60 52 44 361	54	161.29
7	361 42 50 58 66 74 73 65 57 49 41 361	54	170.71
8	361 45 53 61 69 77 75 67 59 51 43 361	54	170.71
9	362 84 92 100 108 116 113 105 97 89 81 362	54	170.71
10	362 88 96 104 112 120 117 109 101 93 85 362	54	170.71
11	362 86 94 102 110 118 119 111 103 95 87 362	54	170.71
12	362 83 91 99 107 115 160 106 98 90 82 362	54	174.56
13	363 123 131 139 147 155 157 149 141 133 125 363	54	170.71
14	363 124 132 140 148 156 158 150 142 134 126 363	54	170.71
15	363 127 135 143 151 159 114 152 144 136 128 363	54	161.29
16	363 122 130 138 146 154 199 145 137 129 121 363	54	161.29
17	364 161 169 177 185 193 196 188 180 172 164 364	54	170.71
18	364 162 170 178 186 194 195 187 179 171 163 364	54	170.71
19	364 166 174 182 190 198 153 191 183 175 167 364	54	174.56
20	364 165 173 181 189 197 200 192 184 176 168 364	54	170.71
21	365 205 213 221 229 237 240 232 224 216 208 365	54	170.71
22	365 201 209 217 225 277 236 228 220 212 204 365	54	161.29
23	365 203 211 219 227 235 234 226 218 210 202 365	54	170.71
24	365 206 214 222 230 34 239 231 223 215 207 365	54	161.29
25	366 243 251 259 267 275 233 269 261 253 245 366	54	174.56
26	366 242 250 258 266 274 273 265 257 249 241 366	54	170.71
27	366 247 255 263 271 279 280 272 264 256 248 366	54	170.71
28	366 246 254 262 270 278 276 268 260 252 244 366	54	170.71
29	367 282 290 298 306 314 315 307 299 291 283 367	54	170.71
30	367 281 289 297 305 313 316 308 300 292 284 367	54	170.71

(cont.)

Table E.39 continued.

No.	Route	Load	Distance
31	367 286 294 302 310 318 319 311 303 295 287 367	54	170.71
32	367 288 296 304 312 36 317 309 301 293 285 367	54	161.29
33	368 323 331 339 347 355 354 346 338 330 322 368	54	170.71
34	368 326 334 342 350 358 359 351 343 335 327 368	54	170.71
35	368 328 336 344 352 360 78 349 341 333 325 368	54	174.56
36	368 321 329 337 345 353 356 348 340 332 324 368	54	170.71
		Total Distance	6112.17

Table E.40: Best MDIPH solution to MD1.

No.	Route	Load	Distance
1	0 25 18 4 0	78	47.00
2	0 44 45 33 15 37 17 0	71	60.06
3	0 13 41 40 19 42 0	79	66.55
4	51 6 27 1 32 11 46 51	73	53.44
5	51 22 28 31 26 8 48 51	80	79.47
6	51 23 7 43 24 14 51	77	81.40
7	51 47 12 51	54	23.50
8	52 49 5 38 52	54	25.22
9	52 10 39 30 34 9 52	75	50.41
10	53 20 3 36 35 53	67	47.67
11	53 29 2 16 50 21 53	69	42.14
		Total Distance	576.87

Table E.41: Best MDIPH solution to MD2.

No.	Route	Load	Distance
1	0 4 47 18 13 41 40 19 42 0	154	87.04
2	51 46 27 48 23 7 43 24 25 14 6 51	157	101.91
3	52 10 39 33 45 15 44 37 17 12 5 49 52	158	95.30
4	52 9 30 34 21 50 16 2 11 38 52	153	74.27
5	53 20 35 36 3 28 31 26 8 22 1 32 29 53	155	115.02
		Total Distance	473.53

Table E.42: Best MDIPH solution to MD3.

No.	Route	Load	Distance
1	0 26 12 40 17 51 6 68 0	128	50.89
2	0 75 4 34 46 67 0	126	29.08
3	76 48 21 74 2 30 76	106	41.52
4	76 29 45 27 52 54 13 57 15 76	120	65.57
5	76 5 37 20 70 60 71 69 36 47 76	123	63.78
6	77 14 59 19 8 7 35 77	111	60.49
7	77 38 65 66 11 53 77	129	43.16
8	78 3 49 24 18 50 32 44 78	123	59.34
9	78 25 55 31 10 58 72 39 9 78	139	99.29
10	79 42 64 22 61 28 62 73 79	119	72.13
11	79 43 41 56 23 63 16 33 1 79	140	59.22
		Total Distance	644.46

Table E.43: Best MDIPH solution to MD4.

No.	Route	Load	Distance
1	0 2 41 22 75 74 72 21 0	92	44.81
2	0 57 15 43 14 44 91 100 37 97 0	98	66.93
3	0 42 38 86 16 61 98 92 0	100	81.62
4	0 87 95 94 13 0	96	28.69
5	0 6 89 60 83 45 17 84 5 96 0	94	81.25
6	0 23 67 39 56 73 0	100	73.68
7	0 58 53 28 12 26 40 0	93	48.83
8	0 4 25 55 24 29 68 80 54 0	99	95.22
9	0 85 93 99 59 0	100	41.56
10	101 69 27 76 77 3 79 50 101	98	58.00
11	101 1 33 81 9 51 30 70 101	99	54.15
12	101 11 64 49 36 47 19 101	100	93.52
13	101 10 32 90 63 62 31 101	98	55.51
14	101 52 18 8 46 48 82 7 88 101	97	76.59
15	101 20 66 65 71 35 34 78 101	94	98.85
		Total Distance	999.21

Table E.44: Best MDIPH solution to MD5.

No.	Route	Load	Distance
1	0 89 27 69 1 70 30 32 90 63 64 49 36 47 46 45 0	197	138.91
2	0 60 6 94 13 95 97 92 37 100 98 93 59 99 96 0	195	60.16
3	0 83 8 82 48 19 11 62 10 31 88 7 52 18 0	198	94.91
4	0 5 61 85 91 16 44 14 38 86 17 84 0	198	84.18
5	101 80 68 79 3 77 101	92	27.97
6	101 24 29 78 34 35 71 65 66 20 51 9 81 33 50 76 101	195	127.89
7	101 12 28 53 58 2 57 87 42 43 15 41 22 73 21 40 26 101	196	124.14
8	101 4 72 74 75 56 23 67 39 25 55 54 101	187	91.86
		Total Distance	750.03

Table E.45: Best MDIPH solution to MD6.

No.	Route	Load	Distance
1	0 99 96 6 94 13 95 92 0	95	37.91
2	0 37 97 87 2 57 15 43 42 14 0	100	70.08
3	0 100 98 59 93 0	77	18.37
4	0 91 44 38 86 16 0	89	42.58
5	0 61 84 17 45 8 83 60 5 0	87	58.55
6	0 85 0	41	4.47
7	101 26 12 28 53 58 40 101	93	55.08
8	101 21 73 74 22 41 75 72 101	94	38.49
9	101 39 67 23 56 101	91	50.53
10	101 4 25 55 24 29 68 80 54 101	99	67.85
11	102 88 7 82 46 36 49 64 11 63 90 102	100	106.54
12	102 48 47 19 62 102	99	57.29
13	102 10 32 66 20 30 70 102	99	55.18
14	102 31 52 18 89 27 69 1 102	95	60.81
15	102 76 77 3 79 81 33 102	100	57.06
16	102 50 78 34 35 65 71 9 51 102	99	95.71
		Total Distance	876.50

Table E.46: Best MDIPH solution to MD7.

No.	Route	Load	Distance
1	0 5 61 16 86 17 0	95	45.73
2	0 18 7 19 64 49 36 46 45 0	95	99.18
3	0 82 48 47 8 83 0	99	46.39
4	0 84 85 98 37 93 99 60 0	100	38.61
5	101 54 4 21 40 26 12 101	93	51.76
6	101 80 33 81 9 35 34 78 29 24 101	96	78.50
7	101 55 25 39 67 23 56 101	99	79.73
8	101 68 79 3 77 76 101	99	32.96
9	102 2 41 22 75 74 72 73 102	90	42.99
10	102 42 100 91 44 38 14 43 15 57 102	99	87.38
11	102 58 53 89 6 94 13 102	100	42.69
12	102 95 96 59 92 97 87 102	99	35.10
13	103 70 10 32 90 63 11 62 88 103	97	65.30
14	103 69 1 50 28 27 52 31 103	97	55.64
15	103 30 20 66 65 71 51 103	100	80.02
		Total Distance	881.97

Table E.47: Best MDIPH solution to MD8.

No.	Route	Load	Distance
1	0 112 213 215 126 116 3 118 123 8 190 163 0	497	144.77
2	0 135 84 16 52 162 59 75 219 15 102 0	478	161.77
3	0 146 39 233 136 226 176 38 223 43 225 0	490	175.69
4	0 175 47 55 17 24 40 127 147 201 78 32 122 0	496	288.07
5	0 183 36 220 65 206 83 217 0	499	143.78
6	0 27 173 228 53 124 49 12 133 191 30 18 137 54 0	491	191.66
7	0 79 33 31 205 221 129 130 61 90 211 5 204 0	494	277.97
8	0 96 166 72 185 19 207 198 73 0	473	133.14
9	0 242 56 66 168 103 113 80 194 197 42 11 241 235 0	498	182.03
10	0 69 177 237 62 249 157 82 224 0	467	60.06
11	0 114 148 26 9 153 230 170 2 195 0	464	111.31
12	0 58 150 189 106 121 248 89 167 13 101 0	496	193.72
13	0 214 131 10 238 57 203 193 125 64 0	479	132.10
14	250 7 21 138 234 71 229 1 139 202 231 68 142 209 145 250	492	308.03
15	250 115 244 108 70 99 232 155 76 154 87 188 250	497	238.86
16	250 37 6 243 169 181 171 85 222 250	498	150.89
17	250 246 140 172 186 100 81 4 160 208 250	483	153.82
18	250 25 141 104 74 164 95 34 182 28 250	469	166.69
19	250 245 94 151 86 149 247 88 50 250	459	185.69
20	250 110 60 158 159 134 51 67 97 132 165 250	498	287.28
21	250 92 178 210 41 109 20 227 29 105 44 199 250	495	191.32
22	250 111 236 196 174 143 48 23 120 22 250	404	109.88
23	250 200 128 14 98 117 240 107 212 77 91 46 250	500	189.46
24	250 180 63 216 93 187 45 161 179 250	497	97.89
25	250 152 144 192 184 218 119 239 35 156 250	492	139.09
		Total Distance	4414.99

Table E.48: Best MDIPH solution to MD9.

No.	Route	Load	Distance
1	0 152 144 192 184 218 239 35 119 245 50 77 0	499	232.31
2	0 23 93 91 88 151 94 149 86 247 212 14 0	498	215.66
3	0 236 179 161 46 216 180 63 200 22 120 111 0	497	118.45
4	0 37 116 126 215 74 104 141 25 246 208 199 44 0	474	190.11
5	0 174 143 48 196 0	263	49.52
6	0 128 187 45 107 98 240 117 0	498	129.06
7	0 29 134 159 147 127 40 24 17 55 47 175 78 32 0	498	288.84
8	0 132 97 67 201 51 158 60 110 0	497	169.75
9	0 105 59 226 136 176 233 102 15 219 169 0	492	171.91
10	0 92 178 210 41 109 20 227 0	447	89.65
11	0 85 171 181 162 75 52 243 6 165 222 0	492	130.27
12	250 13 167 89 248 121 106 189 153 9 26 148 250	475	129.81
13	250 2 183 36 220 150 58 230 250	493	84.71
14	250 82 43 223 122 39 38 242 225 241 235 193 250	487	142.78
15	250 157 249 62 177 69 163 64 125 250	484	96.91
16	250 190 8 123 118 3 16 84 135 146 237 224 250	496	179.60
17	250 114 203 57 131 214 101 250	365	74.11
18	250 195 27 54 18 30 207 166 213 112 96 73 198 204 250	488	196.10
19	250 173 137 124 53 228 65 206 83 217 170 250	499	180.05
20	250 11 56 66 168 103 113 80 194 197 42 10 238 250	496	174.49
21	251 33 5 133 12 49 130 129 221 61 90 211 251	467	149.14
22	251 68 142 232 231 202 139 1 229 71 31 205 234 251	457	161.31
23	251 72 185 19 191 79 251	367	104.71
24	251 172 140 164 7 160 156 28 182 95 34 188 87 209 251	499	223.80
25	251 99 70 244 108 155 76 154 115 251	420	109.74
26	251 100 145 4 81 186 21 138 251	458	79.10
		Total Distance	3871.91

Table E.49: Best MDIPH solution to MD10.

No.	Route	Load	Distance
1	0 37 165 6 16 243 52 181 171 169 85 0	498	160.52
2	0 111 236 23 120 22 200 63 216 180 152 208 199 44 222 0	490	175.88
3	0 46 50 245 94 151 86 149 247 88 77 14 0	500	225.70
4	0 196 48 174 143 98 240 117 0	493	83.41
5	0 29 60 158 159 134 51 67 97 132 105 0	478	203.95
6	0 227 20 109 110 41 210 178 92 0	497	88.55
7	0 128 179 161 187 93 91 45 212 107 0	492	163.16
8	250 10 131 57 214 250	316	63.82
9	250 203 148 26 9 153 189 106 121 248 89 167 13 238 250	479	208.43
10	250 11 193 101 125 64 163 224 225 250	496	125.17
11	250 39 102 15 219 75 162 59 233 56 250	468	117.01
12	250 66 175 17 55 47 168 103 113 80 194 197 42 250	499	127.68
13	250 241 235 82 157 249 43 223 38 242 250	474	86.36
14	250 122 146 84 135 3 118 123 8 190 69 177 237 62 250	476	155.24
15	250 176 136 226 32 78 201 147 127 40 24 250	496	189.11
16	251 211 205 31 71 229 1 139 202 231 68 142 234 33 5 133 251	482	238.45
17	251 228 53 65 206 220 150 183 217 251	500	143.06
18	251 173 27 195 2 170 114 230 58 36 83 251	498	157.62
19	251 18 30 19 185 72 79 191 251	438	96.95
20	251 137 54 204 198 73 96 112 213 166 207 251	478	124.54
21	251 12 61 90 221 129 130 49 124 251	398	94.98
22	252 115 244 108 70 99 232 155 76 154 87 188 252	497	142.48
23	252 35 239 119 218 184 192 144 156 252	468	130.21
24	252 164 140 172 74 104 215 116 126 141 25 246 7 160 252	498	189.96
25	252 95 34 182 28 252	215	49.81
26	252 145 100 209 138 21 186 81 4 252	482	104.01
		Total Distance	3646.06

Table E.50: Best MDIPH solution to MD11.

No.	Route	Load	Distance
1	0 37 165 6 16 243 52 181 171 169 0	448	150.73
2	0 222 85 105 132 97 29 227 20 0	444	121.17
3	0 117 240 98 107 14 143 174 196 0	457	96.14
4	0 48 128 161 179 63 200 199 44 22 120 23 236 111 0	478	136.87
5	0 92 178 210 41 110 60 158 109 0	472	114.23
6	250 201 67 51 134 159 147 127 40 24 250	483	163.16
7	250 10 238 131 214 57 203 11 235 241 225 242 250	496	164.38
8	250 56 38 122 223 43 62 237 146 135 84 39 136 250	484	174.73
9	250 175 66 80 197 42 194 113 103 168 47 55 17 250	499	112.21
10	250 176 233 102 15 219 75 162 59 226 32 78 250	497	117.60
11	251 35 182 34 87 188 95 28 156 251	343	124.12
12	251 50 88 247 149 86 151 94 245 119 251	497	142.21
13	251 144 91 77 212 45 187 93 46 216 180 251	492	144.48
14	251 152 208 246 25 141 104 74 140 164 7 160 251	470	180.46
15	251 192 184 218 239 251	313	33.10
16	252 173 206 65 228 53 124 137 18 30 54 252	405	141.48
17	252 83 36 220 150 183 58 217 252	492	95.93
18	252 195 2 170 26 148 114 101 193 64 125 252	492	124.44
19	252 27 230 9 153 13 167 89 248 121 106 189 252	487	198.03
20	252 69 177 249 157 82 224 163 252	499	116.47
21	252 204 96 112 213 215 126 116 3 118 123 8 190 252	428	165.70
22	253 5 133 12 49 130 129 221 61 90 211 79 253	468	97.00
23	253 205 31 71 229 1 139 202 231 232 142 68 33 253	486	209.94
24	253 19 185 166 207 73 198 191 253	483	86.28
25	253 72 172 186 81 4 115 145 100 253	496	150.44
26	253 21 138 209 244 108 154 76 155 70 99 234 253	497	189.48
		Total Distance	3550.78

Table E.51: Best MDIPH solution to MD12.

No.	Route	Load	Distance
1	0 2 10 18 26 34 33 25 17 9 1 0	54	170.71
2	0 3 11 19 27 35 37 29 21 13 5 0	54	170.71
3	0 4 12 20 28 36 22 14 6 0	51	128.48
4	0 7 15 23 31 39 67 75 40 32 24 16 8 0	57	189.57
5	81 42 50 58 66 74 30 38 73 65 57 49 41 81	57	189.57
6	81 44 52 60 68 76 78 70 62 54 46 81	54	170.71
7	81 45 53 61 69 77 59 51 43 81	51	128.48
8	81 47 55 63 71 79 80 72 64 56 48 81	54	170.71
		Total Distance	1318.95

Table E.52: Best MDIPH solution to MD13.

No.	Route	Load	Distance
1	0 7 15 23 31 39 67 75 40 32 24 16 8 0	57	189.57
2	0 5 13 21 29 37 35 27 19 11 3 0	54	170.71
3	0 4 12 20 28 36 22 14 6 0	51	128.48
4	0 2 10 18 26 34 33 25 17 9 1 0	54	170.71
5	81 47 55 63 71 79 80 72 64 56 48 81	54	170.71
6	81 45 53 61 69 77 59 51 43 81	51	128.48
7	81 44 52 60 68 76 78 70 62 54 46 81	54	170.71
8	81 42 50 58 66 74 30 38 73 65 57 49 41 81	57	189.57
		Total Distance	1318.95

Table E.53: Best MDIPH solution to MD14.

No.	Route	Load	Distance
1	0 4 12 20 28 36 38 30 22 14 6 0	54	170.71
2	0 1 9 17 25 33 34 26 18 10 2 0	54	170.71
3	0 3 11 19 27 35 37 29 21 13 5 0	54	170.71
4	0 7 15 23 31 75 40 32 24 16 8 0	54	174.56
5	81 44 52 60 68 76 73 65 57 49 41 81	54	170.71
6	81 46 54 62 70 78 79 71 63 55 47 81	54	170.71
7	81 42 50 58 66 74 39 67 59 51 43 81	54	161.29
8	81 45 53 61 69 77 80 72 64 56 48 81	54	170.71
		Total Distance	1360.12

Table E.54: Best MDIPH solution to MD15.

No.	Route	Load	Distance
1	0 1 9 17 25 33 34 26 18 10 2 0	54	170.71
2	0 7 8 5 3 0	48	54.14
3	0 4 12 20 28 36 38 73 30 22 14 6 0	55	188.93
4	161 50 58 66 74 39 31 23 15 16 24 32 40 75 67 59 51 161	60	233.14
5	161 48 45 43 42 161	48	54.14
6	161 47 55 63 71 79 78 70 62 54 46 161	54	170.71
7	161 41 49 57 65 76 68 60 52 44 161	53	147.80
8	161 56 64 72 80 118 110 102 94 92 100 108 116 77 69 61 53 161	60	233.14
9	162 82 81 84 86 162	48	54.14
10	162 85 93 101 109 117 115 160 107 99 91 83 162	55	188.93
11	162 87 95 103 111 119 120 112 104 96 88 162	54	170.71
12	163 129 137 145 153 35 27 19 11 13 21 29 37 156 148 140 132 163	60	233.14
13	163 123 131 139 147 155 154 146 138 130 122 163	54	170.71
14	163 127 126 124 121 163	48	54.14
15	163 135 143 151 159 114 106 98 90 89 97 105 113 158 150 142 134 163	60	233.14
16	163 125 133 141 149 157 152 144 136 128 163	53	147.80
		Total Distance	2505.42

Table E.55: Best MDIPH solution to MD16.

No.	Route	Load	Distance
1	0 5 13 21 29 37 156 145 153 35 27 19 11 3 0	58	196.08
2	0 2 10 18 26 34 33 25 17 9 1 0	54	170.71
3	0 6 14 22 36 28 20 12 4 0	51	128.48
4	0 7 15 23 31 59 67 75 40 32 24 16 8 0	60	198.99
5	161 41 49 57 65 73 38 30 39 74 66 58 50 42 161	58	196.08
6	161 46 54 62 70 78 76 68 60 52 44 161	54	170.71
7	161 43 51 69 61 53 45 161	46	96.57
8	161 47 55 63 71 79 64 56 48 161	51	128.48
9	162 84 92 100 108 116 77 72 80 118 110 102 94 86 162	58	196.08
10	162 88 96 104 112 120 119 111 103 95 87 162	54	170.71
11	162 82 90 98 106 142 150 158 113 105 97 89 81 162	60	198.99
12	162 85 93 101 109 117 99 91 83 162	51	128.48
13	163 122 130 138 146 154 137 129 121 163	51	128.48
14	163 124 132 140 148 134 126 163	46	96.57
15	163 123 131 139 147 155 157 149 141 133 125 163	54	170.71
16	163 127 135 143 151 159 114 107 115 160 152 144 136 128 163	58	196.08
		Total Distance	2572.23

Table E.56: Best MDIPH solution to MD17.

No.	Route	Load	Distance
1	0 1 9 17 25 33 36 28 20 12 4 0	54	170.71
2	0 2 10 18 26 34 35 27 19 11 3 0	54	170.71
3	0 8 16 24 32 40 158 29 21 13 5 0	54	174.56
4	0 7 15 23 31 73 38 30 22 14 6 0	54	174.56
5	161 43 51 59 67 75 113 69 61 53 45 161	54	174.56
6	161 41 49 57 65 39 74 66 58 50 42 161	54	161.29
7	161 44 52 60 68 76 78 70 62 54 46 161	54	170.71
8	161 47 55 63 71 79 80 72 64 56 48 161	54	170.71
9	162 82 90 98 106 160 115 107 99 91 83 162	54	174.56
10	162 86 94 102 110 118 119 111 103 95 87 162	54	170.71
11	162 85 93 101 109 117 120 112 104 96 88 162	54	170.71
12	162 84 92 100 108 116 77 105 97 89 81 162	54	161.29
13	163 121 129 137 145 153 154 146 138 130 122 163	54	170.71
14	163 124 132 140 148 156 37 150 142 134 126 163	54	161.29
15	163 125 133 141 149 157 155 147 139 131 123 163	54	170.71
16	163 127 135 143 151 159 114 152 144 136 128 163	54	161.29
		Total Distance	2709.09

Table E.57: Best MDIPH solution to MD18.

No.	Route	Load	Distance
1	0 1 9 17 25 33 238 230 222 214 231 239 34 26 18 10 0	60	221.42
2	0 6 14 22 30 36 28 20 12 4 0	53	147.80
3	0 7 8 5 3 2 0	60	60.00
4	0 13 21 29 37 156 148 140 132 129 137 145 153 35 27 19 11 0	60	233.14
5	0 15 23 31 39 74 66 58 50 51 59 67 75 40 32 24 16 0	60	233.14
6	241 41 49 57 65 38 73 76 68 60 52 44 241	55	188.93
7	241 53 61 69 77 116 108 100 92 94 102 110 118 80 72 64 56 241	60	233.14
8	241 42 43 45 48 241	48	54.14
9	241 47 55 63 71 79 78 70 62 54 46 241	54	170.71
10	242 89 97 105 113 158 150 142 134 135 143 151 159 114 106 98 90 242	60	233.14
11	242 86 84 81 82 242	48	54.14
12	242 87 95 103 111 119 120 112 104 96 88 242	54	170.71
13	242 83 91 99 107 117 109 101 93 85 242	53	147.80
14	243 127 126 124 121 122 243	60	60.00
15	243 125 133 141 149 157 160 115 152 144 136 128 243	55	188.93
16	243 130 138 146 154 199 191 176 184 192 200 155 147 139 131 123 243	60	221.42
17	244 163 171 179 187 195 197 189 181 173 165 244	54	170.71
18	244 164 166 183 175 167 168 244	60	86.50
19	244 172 180 188 196 237 229 221 213 216 224 232 240 198 190 182 174 244	60	233.14
20	244 162 170 178 186 194 193 235 185 177 169 161 244	55	188.93
21	245 206 207 215 223 208 205 245	60	86.50
22	245 203 211 219 227 234 226 218 210 202 245	53	147.80
23	245 201 209 217 225 233 236 228 220 212 204 245	54	170.71
		Total Distance	3702.85

Table E.58: Best MDIPH solution to MD19.

No.	Route	Load	Distance
1	0 1 9 17 36 28 20 12 4 0	51	128.48
2	0 6 14 22 30 38 73 65 74 39 31 23 15 7 0	58	196.08
3	0 2 10 18 26 19 11 3 0	50	114.05
4	0 5 13 21 29 16 8 0	46	96.57
5	241 41 49 57 76 68 60 52 44 241	51	128.48
6	241 42 50 58 66 24 32 40 75 67 59 51 43 241	60	198.99
7	241 46 54 62 70 78 79 71 63 55 47 241	54	170.71
8	241 45 53 61 69 77 116 110 118 80 72 64 56 48 241	58	196.08
9	242 81 89 108 100 92 84 242	46	96.57
10	242 82 90 98 106 114 159 152 160 115 107 99 91 83 242	58	196.08
11	242 88 96 104 112 120 117 109 101 93 85 242	54	170.71
12	242 86 94 102 119 111 103 95 87 242	51	128.48
13	243 124 132 140 148 156 37 27 35 153 145 137 129 121 243	58	196.08
14	243 122 130 138 146 154 199 192 200 155 147 139 131 123 243	58	196.08
15	243 125 133 141 149 157 144 136 128 243	51	128.48
16	243 127 135 143 151 97 105 113 158 150 142 134 126 243	60	198.99
17	244 164 172 180 188 196 237 227 235 193 185 177 169 161 244	58	196.08
18	244 163 171 179 187 195 194 186 178 170 162 244	54	170.71
19	244 168 176 184 197 189 181 173 165 244	51	128.48
20	244 166 174 191 183 175 167 244	46	96.57
21	245 207 215 223 231 239 34 25 33 238 230 222 214 206 245	58	196.08
22	245 203 211 219 234 226 218 210 202 245	51	128.48
23	245 204 212 220 228 236 233 225 217 209 201 245	54	170.71
24	245 205 213 221 229 182 190 198 240 232 224 216 208 245	60	198.99
		Total Distance	3827.06

Table E.59: Best MDIPH solution to MD20.

No.	Route	Load	Distance
1	0 8 16 24 32 74 39 31 23 15 7 0	54	161.29
2	0 6 14 22 30 38 36 28 20 12 4 0	54	170.71
3	0 3 11 19 27 35 153 29 21 13 5 0	54	174.56
4	0 1 9 17 25 239 34 26 18 10 2 0	54	161.29
5	241 42 50 58 66 40 75 67 59 51 43 241	54	174.56
6	241 41 49 57 65 73 76 68 60 52 44 241	54	170.71
7	241 48 56 64 72 80 118 69 61 53 45 241	54	174.56
8	241 46 54 62 70 78 79 71 63 55 47 241	54	170.71
9	242 81 89 97 105 159 114 106 98 90 82 242	54	161.29
10	242 85 93 101 109 117 115 107 99 91 83 242	54	170.71
11	242 84 92 100 108 116 77 110 102 94 86 242	54	161.29
12	242 87 95 103 111 119 120 112 104 96 88 242	54	170.71
13	243 122 130 138 146 200 155 147 139 131 123 243	54	174.56
14	243 121 129 137 145 37 156 148 140 132 124 243	54	161.29
15	243 126 134 142 150 158 113 151 143 135 127 243	54	174.56
16	243 128 136 144 152 160 157 149 141 133 125 243	54	170.71
17	244 162 170 178 186 194 193 185 177 169 161 244	54	170.71
18	244 163 171 179 187 195 197 189 181 173 165 244	54	170.71
19	244 167 175 183 191 199 154 192 184 176 168 244	54	161.29
20	244 164 172 180 188 240 198 190 182 174 166 244	54	174.56
21	245 207 215 223 231 33 238 230 222 214 206 245	54	174.56
22	245 201 209 217 225 233 236 228 220 212 204 245	54	170.71
23	245 202 210 218 226 234 235 227 219 211 203 245	54	170.71
24	245 205 213 221 229 237 196 232 224 216 208 245	54	161.29
		Total Distance	4058.07

Table E.60: Best MDIPH solution to MD21.

No.	Route	Load	Distance
1	0 3 5 8 7 0	48	54.14
2	0 11 19 27 35 153 145 137 129 132 140 148 156 37 29 21 13 0	60	233.14
3	0 2 1 4 6 0	48	54.14
4	361 49 57 65 73 355 347 339 331 333 341 349 357 76 68 60 52 361	60	233.14
5	361 45 43 42 41 44 361	60	60.00
6	361 53 61 69 77 116 108 94 102 110 118 80 72 64 56 48 361	60	221.42
7	361 46 54 62 70 360 78 79 71 63 55 47 361	55	188.93
8	361 50 58 66 74 39 31 23 15 16 24 32 40 75 67 59 51 361	60	233.14
9	362 82 81 100 92 84 86 362	60	86.50
10	362 87 95 103 111 119 120 112 104 96 88 362	54	170.71
11	362 85 93 101 109 117 115 160 107 99 91 83 362	55	188.93
12	363 134 142 150 158 113 105 97 89 90 98 106 114 159 151 143 135 363	60	233.14
13	363 123 131 139 147 155 200 192 184 176 191 199 154 146 138 130 363	60	221.42
14	363 128 136 144 152 157 149 141 133 125 363	53	147.80
15	363 127 126 124 121 122 363	60	60.00
16	364 161 169 177 185 235 193 194 186 178 170 162 364	55	188.93
17	364 163 171 179 187 195 197 189 181 173 165 364	54	170.71
18	364 167 168 175 183 166 164 364	60	86.50
19	365 216 224 232 240 198 190 182 174 172 180 188 196 237 229 221 213 365	60	233.14
20	365 203 211 219 227 234 226 218 210 202 365	53	147.80
21	365 201 209 217 225 233 275 267 259 251 269 277 236 228 220 212 365	60	221.42
22	365 204 206 207 208 205 365	60	60.00
23	365 214 222 230 238 33 25 17 9 10 18 26 34 239 231 223 215 365	60	233.14
24	366 241 249 257 265 273 274 266 258 250 242 366	54	170.71
25	366 244 252 260 268 276 278 313 270 262 254 246 366	55	188.93
26	366 245 243 253 261 248 247 366	60	86.50
27	367 286 294 302 310 318 353 345 337 329 346 354 319 311 303 295 367	60	221.42
28	367 296 304 312 320 38 30 22 14 12 20 28 36 317 309 301 293 367	60	233.14
29	367 282 283 285 288 287 367	60	60.00
30	367 281 289 297 305 316 308 300 292 284 367	53	147.80

(cont.)

Table E.60 continued.

No.	Route	Load	Distance
31	367 290 298 306 314 279 271 263 255 256 264 272 280 315 307 299 291 367	60	233.14
32	368 325 323 330 338 321 322 368 368	60	86.50
33	368 328 336 344 352 359 351 343 335 327 368	53	147.80
34	368 326 334 342 350 358 356 348 340 332 324 368	54	170.71
		Total Distance	5474.84

Table E.61: Best MDIPH solution to MD22.

No.	Route	Load	Distance
1	0 5 13 21 29 37 156 145 153 35 27 19 11 3 0	58	196.08
2	0 6 14 22 30 38 320 312 317 36 28 20 12 4 0	58	196.08
3	0 2 10 18 26 17 9 1 0	50	114.05
4	0 7 15 23 31 39 74 67 75 40 32 24 16 8 0	58	196.08
5	361 46 54 62 79 71 63 55 47 361	51	128.48
6	361 44 52 60 68 339 347 355 73 65 57 49 41 361	60	198.99
7	361 48 56 64 72 80 118 110 116 77 69 61 53 45 361	58	196.08
8	361 42 50 58 66 59 51 43 361	50	114.05
9	362 81 89 108 100 92 84 362	46	96.57
10	362 86 94 102 119 111 103 95 87 362	51	128.48
11	362 82 90 98 106 114 159 152 160 115 107 99 91 83 362	58	196.08
12	362 85 93 101 109 117 120 112 104 96 88 362	54	170.71
13	363 124 132 140 148 137 129 121 363	50	114.05
14	363 128 136 144 157 149 141 133 125 363	51	128.48
15	363 126 134 142 150 158 113 105 97 151 143 135 127 363	60	198.99
16	363 122 130 138 146 154 199 192 200 155 147 139 131 123 363	58	196.08
17	364 161 169 177 185 193 235 227 237 196 188 180 172 164 364	58	196.08
18	364 168 176 184 197 189 181 173 165 364	51	128.48
19	364 162 170 178 186 194 195 187 179 171 163 364	54	170.71
20	364 167 175 183 191 174 166 364	46	96.57
21	365 201 209 217 225 233 275 267 277 236 228 220 212 204 365	58	196.08
22	365 203 211 219 234 226 218 210 202 365	51	128.48
23	365 205 213 221 229 182 190 198 240 232 224 216 208 365	60	198.99
24	365 206 214 222 230 238 33 25 34 239 231 223 215 207 365	58	196.08
25	366 248 256 269 261 253 245 366	46	96.57
26	366 244 252 260 268 276 273 265 257 249 241 366	54	170.71
27	366 246 254 262 270 278 313 305 314 279 271 263 255 247 366	58	196.08
28	366 242 250 258 266 274 259 251 243 366	51	128.48
29	367 281 289 297 316 308 300 292 284 367	51	128.48
30	367 282 290 298 306 264 272 280 315 307 299 291 283 367	60	198.99

(cont.)

Table E.61 continued.

No.	Route	Load	Distance
31	367 285 293 301 309 304 296 288 367	50	114.05
32	367 286 294 302 310 318 353 345 354 319 311 303 295 287 367	58	196.08
33	368 328 336 344 352 360 78 70 76 357 349 341 333 325 368	58	196.08
34	368 326 334 342 350 358 359 351 343 335 327 368	54	170.71
35	368 321 329 337 356 348 340 332 324 368	51	128.48
36	368 323 331 346 338 330 322 368	46	96.57
		Total Distance	5702.16

Table E.62: Best MDIPH solution to MD23.

No.	Route	Load	Distance
1	0 2 10 18 26 238 33 25 17 9 1 0	54	174.56
2	0 4 12 20 28 320 38 30 22 14 6 0	54	174.56
3	0 3 11 19 27 35 37 29 21 13 5 0	54	170.71
4	0 7 15 23 31 39 40 32 24 16 8 0	54	170.71
5	361 41 49 57 65 73 74 66 58 50 42 361	54	170.71
6	361 44 52 60 68 76 357 70 62 54 46 361	54	161.29
7	361 43 51 59 67 75 113 69 61 53 45 361	54	174.56
8	361 48 56 64 72 80 79 71 63 55 47 361	54	170.71
9	362 85 93 101 109 117 120 112 104 96 88 362	54	170.71
10	362 83 91 99 107 115 160 106 98 90 82 362	54	174.56
11	362 87 95 103 111 119 118 110 102 94 86 362	54	170.71
12	362 84 92 100 108 116 77 105 97 89 81 362	54	161.29
13	363 123 131 139 147 155 157 149 141 133 125 363	54	170.71
14	363 124 132 140 148 156 158 150 142 134 126 363	54	170.71
15	363 127 135 143 151 159 114 152 144 136 128 363	54	161.29
16	363 122 130 138 146 154 199 145 137 129 121 363	54	161.29
17	364 161 169 177 185 193 196 188 180 172 164 364	54	170.71
18	364 162 170 178 186 194 195 187 179 171 163 364	54	170.71
19	364 166 174 182 190 198 153 191 183 175 167 364	54	174.56
20	364 165 173 181 189 197 200 192 184 176 168 364	54	170.71
21	365 205 213 221 229 237 240 232 224 216 208 365	54	170.71
22	365 203 211 219 227 235 234 226 218 210 202 365	54	170.71
23	365 204 212 220 228 236 277 225 217 209 201 365	54	161.29
24	365 207 215 223 231 239 34 230 222 214 206 365	54	161.29
25	366 243 251 259 267 275 233 269 261 253 245 366	54	174.56
26	366 242 250 258 266 274 273 265 257 249 241 366	54	170.71
27	366 247 255 263 271 315 280 272 264 256 248 366	54	174.56
28	366 246 254 262 270 278 276 268 260 252 244 366	54	170.71
29	367 288 296 304 312 36 317 309 301 293 285 367	54	161.29
30	367 287 295 303 311 319 318 310 302 294 286 367	54	170.71

(cont.)

Table E.62 continued.

No.	Route	Load	Distance
31	367 284 292 300 308 316 313 305 297 289 281 367	54	170.71
32	367 283 291 299 307 279 314 306 298 290 282 367	54	161.29
33	368 323 331 339 347 355 354 346 338 330 322 368	54	170.71
34	368 326 334 342 350 358 359 351 343 335 327 368	54	170.71
35	368 328 336 344 352 360 78 349 341 333 325 368	54	174.56
36	368 321 329 337 345 353 356 348 340 332 324 368	54	170.71
		Total Distance	6101.03

Bibliography

[1] J. Alegre, M. Laguna, and J. Pacheco, "Optimizing the periodic pick-up of raw materials for a manufacturer of auto parts," European Journal of Operational Research 179 (2007), 736-746.

[2] E. Angelelli and M. G. Speranza, "The period vehicle routing problem with intermediate facilities," European Journal of Operational Research 137 (2002), 233-247.

[3] C. Archetti and M. Speranza, "Vehicle routing in the 1-skip collection problem," Journal of Operational Research Society 55 (2004), 717-727.

[4] C. Archetti and M. Speranza, "The split delivery vehicle routing problem: a survey," in *The Vehicle Routing Problem: Latest Advances and New Challenges*, B. Golden, S. Raghavan, and E. Wasil (Editors), Springer, New York, 2008, pp. 103-122.

[5] C. Archetti, M. Savelsbergh, and M. Speranza, "Worst-case analysis for split delivery vehicle routing problems," Transportation Science 40 (2006), 226-234.

[6] C. Archetti, M. Speranza, and A. Hertz, "A tabu search algorithm for the split delivery vehicle routing problem," Transportation Science 40 (2006), 64-73.

[7] C. Archetti, M. Savelsbergh, and M. Speranza, "To split or not to split: That is the question," Transportation Research Part E 44 (2008), 114-123.

[8] C. Archetti, M. Speranza, and M. Savelsbergh, "An optimization-based heuristic for the split delivery vehicle routing problem," Transportation Science 42 (2008), 22-31.

[9] S. Baptista, R. C. Oliveira, and E. Zúquete, "A period vehicle routing case study," European Journal of Operational Research 139 (2002), 220-229.

[10] J. Belenguer, M. Martinez, and E. Mota, "A lower bound for the split delivery vehicle routing problem," Operations Research 48 (2000), 801-810.

[11] E. Beltrami and L. Bodin, "Networks and vehicle routing for municipal waste collection," Networks 4 (1974), 65-94.

[12] D. Bertsimas and J. N. Tsitsiklis, *Introduction to Linear Optimization*, Athena Scientific, Belmont, MA, 1997.

[13] F. Blakeley, B. Bozkaya, B. Cao, W. Hall, and J. Knolmajer, "Optimizing periodic maintenance operations for Schindler Elevator Corporation," Interfaces 33 (2003), 67-79.

[14] M. Boudia, C. Prins, and M. Reghioui, "An effective memetic algorithm with population management for the split delivery vehicle routing problem," in *Proceedings of the Fourth Annual International Workshop on Hybrid Metaheuristics HM (2007)*, Lecture Notes in Computer Science 4771, T. Bartz-Beielstein, M. Aguilera, C. Blum, B. Naujoks, A. Roli, G. Rudolph, and M. Sampels (Editors), Springer, Berlin, 2007, pp. 16-30.

[15] G. Brønmo, M. Christiansen, and B. Nygreen, "Ship routing and scheduling with flexible cargo sizes," Journal of the Operational Research Society 58 (2007), 1167-1177.

[16] A. Campbell, L. Clarke, and M. Savelsbergh, "Inventory routing in practice," in *The Vehicle Routing Problem*, P. Toth and D. Vigo (Editors), SIAM Press, Philadelphia, PA, 2002, pp. 309-330.

[17] M. W. Carter, J. M. Farvolden, G. Laporte, and J. Xu, "Solving an integrated logistics problem arising in grocery distribution," INFOR 34 (1996), 290-306.

[18] I-M. Chao, B. L. Golden, and E. Wasil, "A new heuristic for the multi-depot vehicle routing problem that improves upon best-known solutions," American Journal of Mathematical and Management Sciences 13 (1993), 371-406.

[19] I-M. Chao, B. Golden, and E. Wasil, "An improved heuristic for the period vehicle routing problem," Networks 26 (1995), 25-44.

[20] S. Chen, B. Golden, and E. Wasil, "The split delivery vehicle routing problem: Applications, algorithms, test problems, and computational results," Networks 49 (2007), 318-329.

[21] J. Chen and T. Wu, "Vehicle routing problem with simultaneous deliveries and pickups," Journal of the Operational Research Society 57 (2006), 579-587.

[22] N. Christofides and J. E. Beasley, "The period routing problem," Networks 14 (1984), 237-256.

[23] N. Christofides and S. Eilon, "An algorithm for the vehicle-dispatching problem," Operations Research Quarterly 20 (1969), 309-318.

[24] N. Christofides, A. Mingozzi, and P. Toth, "The vehicle routing problem," in *Combinatorial Optimization*, N. Christofides, A. Mingozzi, P.Toth, and C.Sandi (Editors), John Wiley, Chichester, UK, 1979, pp. 315-338.

[25] G. Clarke and J. Wright, "Scheduling of vehicles from a central depot to a number of delivery points," Operations Research 12 (1964), 568-581.

[26] J.-F. Cordeau, M. Gendreau, and G. Laporte, "A tabu search heuristic for periodic and multi-depot vehicle routing problems," Networks 30 (1997), 105-119.

[27] J.-F. Cordeau, G. Laporte, and A. Mercier, "Improved tabu search algorithm for the handling of route duration constraints in vehicle routing problems with time windows," The Journal of the Operational Research Society 55 (2004), 542-546.

[28] B. Crevier, J.-F. Cordeau, and G. Laporte, "The multi-depot vehicle routing problem with inter-depot routes," European Journal of Operational Research 176 (2007), 756-773.

[29] R. Dahl, Routesmart Technologies, Inc., www.routesmart.com, personal communication.

[30] G. B. Dantzig, *Linear Programming and Extensions*, Princeton University Press, Princeton, NJ, 1963.

[31] G. Desaulniers, "Branch-and-price-and-cut for the split delivery vehicle routing problem with time windows," Operations Research 58 (2010), 179-192.

[32] M. Dror and M. Ball, "Inventory/routing: reduction from an annual to short-period problem," Naval Research Logistics 34 (1987), 891-905.

[33] M. Dror and P. Trudeau, "Savings by split delivery routing," Transportation Science 23 (1989), 141-145.

[34] M. Dror and P. Trudeau, "Split delivery routing," Naval Research Logistics 37 (1990), 383-402.

[35] L. M. A. Drummond, L. S. Ochi, and D. S. Vianna, "An asynchronous parallel metaheuristic for the period vehicle routing problem," Future Generation Computer Systems 17 (2001), 379-386.

[36] B. Eksioglu, A. V. Vural, and A. Reisman, “The vehicle routing problem: a taxonomical review”, Computers & Industrial Engineering 57 (2009), 1472-1483.

[37] S. Eilon, C. Watson-Gandy, and N. Christofides, “Distribution Management: Mathematical Modeling and Practical Analysis”, Griffin, London, 1971.

[38] P. Francis, K. Smilowitz, and M. Tzur, “The period vehicle routing problem with service choice,” Transportation Science 40 (2006), 439-454.

[39] P. W. Frizzell and J. W. Griffin, “The split delivery vehicle scheduling problem with time windows and grid network distances,” Computers & Operations Research 22 (1995), 655-667.

[40] M. Gendreau, A. Hertz, and G. Laporte, “New insertion and postoptimization procedures for the traveling salesman problem,” Operations Research 40 (1992), 1086-1094.

[41] M. Gendreau, A. Hertz, G. Laporte, and M. Stan, “A generalized insertion heuristic for the traveling salesman problem with time windows,” Operations Research 46 (1998), 330-335.

[42] B. E. Gillett and J. G. Johnson, “Multi-terminal vehicle-dispatch algorithm,” Omega 4 (1976), 711-718.

[43] B. E. Gillett and L. R. Miller, “A heuristic algorithm for the vehicle dispatch problem,” Operations Research 22 (1974), 340-349.

[44] I. D. Giosa, I. L. Tansini, and I. O. Viera, “New assignment algorithms for the multi-depot vehicle routing problem,” The Journal of the Operational Research Society 53 (2002), 977-984.

[45] B. L. Golden, T. L. Magnanti, and H. Q. Nguyen, “Implementing vehicle routing algorithms,” Networks 7 (1977), 113-148.

[46] B. Golden, S. Raghavan, and E. Wasil, *The Vehicle Routing Problem: Latest Advances and New Challenges*, B. Golden, S. Raghavan, and E. Wasil (Editors), Springer, New York, 2008.

[47] B. L. Golden and E. A. Wasil, “Computerized vehicle routing in the soft drink industry,” Operations Research 35 (1987), 6-17.

[48] B. Golden, E. Wasil, J. Kelly, and I-M. Chao, "The impact of metaheuristics on solving the vehicle routing problem: Algorithms, problem sets, and computational results," in *Fleet Management and Logistics*, T. Crainic and G. Laporte (Editors), Kluwer, Boston, MA, 1998, pp. 33-56.

[49] L. B. Gonçalves, L. S. Ochi, and S. L. Martins, "A GRASP with adaptive memory for a period vehicle routing problem," in *Proceedings of the IEEE International Conference on Computational Intelligence for Modelling, Control and Automation (CIMCA2005) - Volume 01*, IEEE Computing Society, Washington D.C., 2005, pp. 721-727.

[50] C. Groër, B. Golden, and E. Wasil, "A cooperative parallel algorithm for solving the vehicle routing problem," INFORMS Journal on Computing, accepted for publication.

[51] D. Gulczynski, B. Golden, and E. Wasil, "Recent developments in modeling and solving the split delivery vehicle routing problem," in *Tutorials in Operations Research 2008: State-of-the-art Decision Making Tools in the Information-Intensive Age*, Z. Chen and S. Raghavan (Editors), INFORMS, Hanover, MD, 2008, pp. 170-180.

[52] D. Gulczynski, B. Golden, and E. Wasil, "The split delivery vehicle routing problem with minimum delivery amounts," Transportation Science Part E 46 (2010), 612-626.

[53] E. Hadjiconstantinou and R. Baldacci, "A multi-depot period vehicle routing problem arising in the utilities sector," Journal of the Operational Research Society 49 (1998), 1239-1248.

[54] V. C. Hemmelmayr, K. Doerner, R. Hartl, "A variable neighborhood search heuristic for periodic routing problems," European Journal of Operational Research 195 (2009), 791-802.

[55] S. Ho, and D. Haugland, "A tabu search heuristic for the vehicle routing problem with time windows and split deliveries," Computers & Operations Research 31 (2004), 1947-1964.

[56] ILOG CPLEX, Overview, available at,
http://www.aimms.com/features/solvers/cplex.

[57] M. Jin, K. Liu, and R. O. Bowden, "A two-stage algorithm with valid inequalities for the split delivery vehicle routing problem," International Journal of Production Economics 105 (2007), 228-242.

[58] M. Jin, K. Liu, and B. Eksioglu, "A column generation approach for the split delivery vehicle routing problem," Operation Research Letters 36 (2008), 265-270.

[59] G. Laporte, Y. Nobert, and S. Taillefer, "Solving a family of multi-depot vehicle routing and location-routing problems," Transportation Science 22 (1988), 161-172.

[60] H. C. W. Lau, T. M. Chan, W. T. Tsui, and W. K. Pang, "Application of genetic algorithms to solve the multidepot vehicle routing problem," IEEE Transactions on Automation Science and Engineering 7 (2010), 383-392.

[61] C.-G. Lee, M. A. Epelman, C. C. White III, and Y. A. Bozer, "A shortest path approach to the multiple-vehicle routing problem with split pick-ups," Transportation Research Part B 40 (2006), 265-284.

[62] L. Levy, Routesmart Technologies, Inc., www.routesmart.com, personal communication.

[63] F. Li, B. Golden, and E. Wasil, "Very large-scale vehicle routing: New test problems, algorithms, and results," Computers & Operations Research 32 (2005), 1165-1179.

[64] A. Lim and F. Wang, "Multi-depot vehicle routing problem: a one-stage approach," IEEE Transactions on Automation and Science Engineering 2 (2005), 397-402.

[65] S. Liu, L. Lei, and S. Park, "On the multi-product packing-delivery problem with a fixed route," Transportation Research Part E 44 (2008), 350-360.

[66] M. Martinez, "Rutas de vehiculos con demanda compartida," Ph. D. dissertation, Department of Statistics and O.R., University of Valencia, Valencia, Spain, 1995.

[67] Q. Meng, D.-H. Lee, and R. L. Cheu, "Multiobjective vehicle routing and scheduling problems with time window constraints in hazardous material transportation," Journal of Transportation Engineering 131 (2005), 699-707.

[68] D. Mester and O. Bräysy, "Active-guided evolution strategies for large-scale vehicle routing problems," Computers & Operations Research 34 (2007), 2964-2975.

[69] S. Mitra, "An algorithm for the generalized vehicle routing problem with backhauling," Asia-Pacific Journal of Operational Research 22 (2005), 153-169.

[70] S. Mitra, "A parallel clustering technique for the vehicle routing problem with split deliveries and pickups," Journal of the Operational Research Society 59 (2008), 1532-1546.

[71] E. Mota, V. Campos, and Á. Corberán, "A new metaheuristic for the vehicle routing problem with split deliveries," in *Lecture Notes in Computer Science 4446: Evolutionary Computation in Combinatorial Optimization*, C. Cotta and J. van Hemert (Editors), Springer, Berlin, 2007, pp. 121-129.

[72] P. Mullaseril, M. Dror, and J. Leung, "Split-delivery routeing heuristics in livestock feed distribution," Journal of the Operational Research Society 48 (1997), 107-116.

[73] M. Nowak, Ö. Ergun, and C. C. White III, "Pickup and delivery with split loads," Transportation Science 42 (2008), 32-43.

[74] A. Orden, "LP from the '40s to the '90s," Interfaces 23 (1993), 2-12.

[75] Pizza Hut Inc., FAQ, available at http://www.pizzahut.com/FAQ.aspx?tab=ourrestaurants.

[76] M. Polacek, R. F. Hartl, K. Doerner, and M. Reimann, "A variable neighborhood search for the multi depot vehicle routing problem with time windows," Journal of Heuristics 10 (2004), 613-627.

[77] O. M. Raft, "A modular algorithm for an extended vehicle scheduling problem," European Journal of Operational Research 11 (1982), 67-76.

[78] J. Renaud, G. Laporte, and F. F. Boctor, "A tabu search heuristic for the multi-depot vehicle routing problem," Computers & Operations Research 23 (1996), 229-235.

[79] Y. Rochat and É. Taillard, "Probabilistic diversification and intensification in local search for vehicle routing," Journal of Heuristics 1 (1995), 147-167.

[80] R. A. Russell and D. Gribbin, "A multiphase approach to the period routing problem," Networks 21 (1991), 747-765.

[81] R. Russell and W. Igo, "An assignment routing problem," Networks 9 (1979), 1-17.

[82] S. Salhi and G. Nagy, “A cluster insertion heuristic for single and multiple depot vehicle routing problems with backhauling,” The Journal of the Operational Research Society 50 (1999), 1034-1042.

[83] J. S. Shang, and C. K. Cuff, “Multicriteria pickup and delivery problem with transfer opportunity,” Computers & Industrial Engineering 30 (1996), 631-645.

[84] G. Sierksma and G. Tijssen, ”Routing helicopters for crew exchanges on off-shore locations,” Annals of Operations Research 76 (1998), 261-286.

[85] M. M. Solomon, “Algorithms for the vehicle routing and scheduling problem with time window constraints,” Operations Research 35 (1987), 254-265.

[86] K. Sörensen and M. Sevaux, “MA|PM: Memetic algorithms with population management,” Computers & Operations Research 33 (2006), 1214-1225.

[87] Staff, “Heating oil companies raise minimum delivery amounts,” *The Telegram-St. John’s, NL*, 20 April 2008, available at https://transcontinentalnewsnet.com/thetelegram/index.cfm?sid=127617&sc=79.

[88] C. C. R. Tan and J.E. Beasley, “A heuristic algorithm for the periodic vehicle routing problem,” Omega 12 (1984), 497-504.

[89] R. Tavakkoli-Moghaddam, N. Safaei, M. Kah, and M. Rabbani, “A new capacitated vehicle routing problem with split service for minimizing fleet cost by simulated annealing,” Journal of the Franklin Institute 344 (2007), 406-425.

[90] S. R. Thangiah, A. Fergany, and S. Awan, “Real-time split-delivery pickup and delivery time window problems with transfers,” Central European Journal of Operations Research 15 (2007), 329-349.

[91] S. R. Thangiah and S. Salhi, “Genetic clustering: an adaptive heuristic for the multidepot vehicle routing problem,” Applied Artificial Intelligence 15 (2001), 361-383.

[92] F. A. Tillman and T. M. Cain, “An upperbound algorithm for the single and multiple terminal delivery problem,” Management Science 18 (1972), 664-682.

[93] L. A. Wolsey, *Integer Programming*, John Wiley & Sons, Inc., New York, NY, 1998.

[94] A. Wren and A. Holliday, "Computer scheduling of vehicles from one or more depots to a number of delivery points," Operational Research Quarterly 23 (1972), 333-344.

[95] P. Yellow, "A computational modification to the savings method of vehicle scheduling," Operations Research Quarterly 21 (1970), 281-283.