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Increased production capabilities by job rotation through simulation.

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INCREASED PRODUCTION CAPABILITIES BY JOB ROTATION THROUGH SIMULATION

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BY JOB ROTATION THROUGH SIMULATION

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ABSTRACT

Implementing Job Rotation as a manufacturing method is beneficial to production efficiency, reduction of labor cost, operator satisfaction, and Work-related Musculoskeletal Disorders (WMSDs) reduction. In this thesis, the steps of simulating the change from a single station operator work center to a job rotational work center in an automotive components production facility are investigated, analyzed and performed. The objective is to show how the use of rotational manufacturing positively impacts the working environment by operators sharing the workload, but also that production is not negatively impacted and can thrive when implemented correctly. The production facility provided a real-world application of the change of manufacturing method and allowed for research and data collection of both non-rotational and rotational work centers producing similar components. The facility also provided historical information of medically documented WMSDs inside the facility and allowed for determination of which manufacturing method was related to the WMSDs. Through analysis of the operations by observations, research, and previously documented time studies the case was developed to present the benefits along with the drawbacks of converting a non-rotational work center to a rotational work center.

The detailed savings of the manufacturing method change are highlighted throughout the document. The time between documented WMSDs with workforces utilizing job rotation occur at a rate of 84.00 shifts of operation. The non rotation work

center is averaging a reported WMSD every 11.67 shifts. The switch of manufacturing methods from non-rotational to rotational would reduce the frequency of WMSD incidents by 620%. The efficiency of the associates in a rotational work center, evaluated by observations through time study is 100% when analyzing the documented standard time for the required operations through the course of a full shift. The operators of the non-rotational workforce are operating at an efficiency rate of 95% when reviewing all segments of time for their respective standard. When re-evaluating the operations simulating the change to a job rotation work center the efficiency increased 5% as compared to the same level of performance of the non-rotational work center. Hence, the changing of the method of one operator one job manufacturing environment with a rotational work method has significant benefits. In summary the benefits include no negative impact to production, developing associates with more skills, more operator knowledge, and developing a facility that has more built in flexibility when managing attendance, training, hiring, cost, labor, and production efficiency.

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I. INTRODUCTION

To be successful in business it is important for a company to investigate all possible methods of production. Many methods have been discussed within the realm of assembly lines and more specifically how the assembly line can be applied to the automotive industry. Such discussion dates back to the origin of the assembly line specifically developed for the automotive industry by Ransom Eli Olds, in 1901 and then motorized by Henry Ford and his team of engineers in 1913. The various methodss of assembly line operations range from; an entirely manual line relying on workers, semi automated relying on the combination of workers and machines, to a fully automated line where production is achieved completely by machine. The objective is not to redefine the assembly line nor to develop new applications of the assembly line, but to take the assembly line method and determine better utilization, that is how to best utilize the worker and reduce the impact to the worker in a manual or semi automated assembly line.

The focus of this thesis is to investigate the application of job rotation, establishing a production schedule where an associate performs several operations throughout the course of a shift. Job rotation has been viewed by management as an effective, simple solution to reduce or eliminate the possibilities of health risks, including injury and fatigue, the decrease in production performance, job satisfaction, labor costs, and the development of Work-related Muscular Skeletal Disorders (WMSDs). Job rotation has been used in many areas of production and has been found to be both beneficial and effective if applied properly. Job rotation is viewed as an Administrative Control and when "Using job rotation, with caution and as a preventive measure, not as a response to symptoms. The principle of job rotation is to alleviate physical fatigue and stress of a particular set of muscles and tendons by rotating employees among use different muscle-tendon groups." (OSHA.gov/Publications) This view of job rotation is echoed by the National Institute of Safety and Health (NIOSH) in that job rotation should only be used as a temporary solution until a permanent solution to the situation can be developed. It is the purpose of this document to ask the question, "Can the use of a rotational work schedule be used as a permanent method of assembly line production to prevent WMSDs but also to sustain and improve production efficiency?"

A. Company Background

The facility of interest has non-rotational and rotational manufacturing occurring is representative of the average automotive supplier located in the United States. The facility has happened upon hard economic times due to market in-balance, oil prices, and other economic factors. A Tier I supplier to U.S. automakers was once considered a secure future, providing employment for years. The economic troubles and a shift to foreign labor for automakers have jeopardizing the future of the facility. Logistic advancements have allowed foreign completion to be as reliable as a local deliver. The company is eager to regain market share and become a more viable option for customers. The key for success is producing at a lower cost, to pass on the savings of the company to be a primary supplier. Recently the facility has been informed changes are necessary or the facility will close, when the current plant contracts are concluded.

Local management has made the decision to investigate options both internally and externally to regain competitiveness. The current floor operations are using both rotational and non-rotational methods in selected work cells. The decision on which manufacturing method is used is based on the cells work force pay code; this is directly related to the contractual agreement between the company and the union operators. The agreement is designed to guarantee work for the union members and to eliminate the transferring to lower pay levels of rotational work cells. The non-rotational work cell has different pay benefits for the workers based on the job that they are currently performing. The original purpose was to ensure that the training of an operator was for a specific process that is critical for quality purposes and therefore would afford the operator the ability to retain the higher pay level. There is a large amount of resistance by the workforce to disallow the change from non-rotational to rotational due to the pay levels being based on job classification and seniority. The company wants a push to rotational to show the workforce that if applied it would allow for the company to become more competitive when bidding for supplier contracts and therefore more desirable, ensuring production remains. The goals are to show the benefits to the customer and to show the workforce the facility will survive; potentially at a decreased level, the situation is a better alternative to the elimination all work. Using this as the jumping off point for the research into how to institute and the reasons to institute rotational manufacturing this thesis has been developed.

The areas of research covered are threefold. The first area will be in the current production level of a working cell at the automotive facility. The thesis will show how a rotational cell allows the same level of production that is currently being produced by a non-rotational work cell at a lower cost. The next will investigate Health and Safety issues that have arisen in both rotational and non-rotational work cells at the facility. This addresses the concerns of the work force of maintaining and improving the current working conditions with respect to well-being. The final objective will investigate the costs related to production, health and safety, and any correlation between the areas. The analysis of cost will be what drives any initiative to be taken. Using this analysis the thesis will demonstrate that rotational manufacturing style allows the company to increase its competitiveness when bidding on current and future contracts.

B. Production

Developing a plan that will give the company an advantage in the marketplace will focus on how the company utilizes its largest resource, labor. The reduction of labor is not simply a straightforward decrease in the number of workers currently producing; it also includes the resources for quality inspection, supervision, technical and setup needs that are not directly assigned to the final cost. All of the indirect labor needs to be reduced. This can be shown with decrease in quality problems, longer production runs, shorter turnover, and decreased down time. The area that is critical to the method of production is quality. Regardless of which method is decided upon, the product must meet requirements or additional resources are necessary for rework or to scrap the product. Creating a simulation of the production scenarios will allow for the conclusion of which manufacturing method should be used to produce quality, inexpensive components.

The different methods of production; non-rotational and rotational are to be analyzed to determine the rate of production, the accuracy of the build, and the quality of the product with respect to the specifications determined by the customer. A time study is created to capture movements and processes for each operation. The development of the work standard will reflect the amount of production capable during an established amount of time. Utilizing the time studies and the work standards, development of a simulation for each cellular manufacturing style will be possible. The use of a simulation will allow for the company to see results of each production method without the cost of running each scenario and without the risking down time and poor production quality. The data collected will allow the company to develop a production plan without fear of the unexpected from changing manufacturing methods. The product will be evaluated on several levels related to the worker in each manufacturing method. Developing a study that includes the previously mentioned work standard, a detailed comparative study of each task will be created and categorized to best determine a true relation of one to one on which method will best benefit the company in a forward moving direction. Such a study will allow the company to decide upon a method that benefits the company by increasing its appeal for new business.

C. Cost

The common denominator in a facility is expense. Every decision, every movement, every hour, every final component can be calculated to a dollar amount. It goes without saying that if you reduce your cost you can increase your profitability. Using this idea every decision on how the facility is to operate comes from an analysis that can be viewed upon as a savings. In the current economy it is difficult to maintain the level of profits that have been seen in the past, every dollar saved is a dollar that makes the facility look more appealing for business.

The analysis of cost will be focused on the employees of the facility. The cost of personnel has become the greatest factor in the success of the facility. The relation between personnel and production is a direct relation. The more production hours that are required, the more personnel hours required. The amount of hours is not only time spent producing, it is also; time ensuring quality, time for repairing a part, time to change between products, down time required fixing a broken machine. Anytime personnel are required to perform an action or service that does not result in the production of a quality product is a decrease in profit.

The development of the simulation previously stated will allow for a direct comparison of cost related to production. What will not be shown by the simulation is the cost incurred when a person cannot work. These hidden costs occur when an employee is unable to perform their task due to injury, fatigue, restricted movement or other inhibitor.

Based on the current production methods being utilized a variety of situations occur when a staffing change is required. The optimal scenario is an operator from a different area will be able to move into the position and be fully trained to keep pace with the line regardless of the production method. The more accurate description of the events that take place is; an operator is placed in an unfamiliar operation and performs below established rate of product. Each cycle until reaching the level required will be a negative impacted to cost. This event is more significant in a non-rotational cell where operators are only familiar with one operation.

In a rotational cell, an operator is loaned-in and comes from another rotational cell. A rotational operator is trained with a larger skill set to utilize when moving to a different cell. A rotational operator can easily adjust to a new operation instead of requiring completely new training. An additional advantage is if a rotational operator struggles, that position is impacted for only a fraction of the day.

These factors will allow for the comparison of how to successfully fulfill the requirements of a customer with respect to quantity, quality, and price of product. The use of cost shows the decision of production should also consider situations that arise outside of the cell, issues related to ergonomics, safety, health, and absenteeism. Encompassing all of the possible scenarios will allow for the better decision on which method should be implemented across the facility as an equitable choice for business; current models, next generation models, and new models.

D. Ergonomics

Many times poor ergonomics are only considered after an impact to cost. The truth is that from the beginning until the discovery it has affected the cost, quality, production rate, and the associate. What is hard to apply is the cost that is occurred to production. All cost associated with an ergonomic issue; medical visits, prescriptions, work restrictions, time off, etc. should be evenly distributed to the time before and after identification. Countable costs such as medical visits and prescriptions can easily be identified and placed against the overall profit of production. Looking at the cost of work it is necessary to consider the fact that before an issue was identified, the associate experienced restricted performance due to the lack of ergonomic consideration. Every movement that increased the duress of a muscle to approach a strain or every rotation that caused an increase in inflammation also limited the rate of production for that specific product and increasingly all that would follow until the problem was recognized. It is easy to capture the time after recognition that is required to allow for a health issue to heal, it is harder to determine the time when the health issue first generated. The best information available is the knowledge of the worker of when they first recognized an issue present, even this is not accurate. Using the analysis of the simulation and the data collected the use of the selected manufacturing method will address the potential savings from an ergonomics position.

E. Objective

The knowledge gained from the research and analysis is to aide in identifying viable options for the company to continuously improve operations, employee satisfaction, and customer satisfaction. The evaluation and research by the student will make them more marketable in future opportunities. Identifying the proper use and providing the correct applications of job rotation is critical to ensure the production method is beneficial. The information can be applied to other companies in similar working environments. Reducing cost by moving production outside of the United States is a continuous obstacle that local companies are faced with when competing with business. Any advantage that can be gained needs to be implemented to ensure future prosperity. Any company that has operations that experience the same type of repetition, movements, and elements can benefit from such research.

II. LITERATURE REVIEW

The recent increases in cost of health coverage, disability cases, and worker compensation cases has forced companies to view alternative methods to reduce the risks and hazards that are found at the work place. The work place has begun to search for less costly solutions to existing problems. Many solutions that have been created are quick fixes to problems that exist but do not resolve the underlying problem. The increase of Work-related Musculoskeletal Disorders (WMSD) have placed pressure on companies to investigate how the actions that are currently occurring are going to affect their work force in the upcoming weeks, months, even years. Academia has answered their requests with increased research in areas of prevention, solutions, and resolutions to onsite work hazards that affect the health and safety of employees. The investigation of work force related WMSD has developed several different alternatives for a solution. The solution of focus for the discussion is the method of using a rotation work force to decrease the cases of WMSD occurring in a work environment. There is discrepancy of how this solution should be applied to achieve the reduction in WMSD, the following works are reviewed and compared to better establish the different opinions and acknowledgements of the usage of the rotation work force method.

A. Review

Putting into perspective the situation of how WMSD have impacted the working environment and the motivation to determine new solutions, Occupational Safety and Health Administration (OSHA) reported in "1997, that employers reported a total of 626,000 lost workday Musculoskeletal Disorders (MSD) to the Bureau of Labor Statistics (BLS), and these disorders accounted for $1 of every $3 spent for workers' compensation in that year. This means that employers are annually paying more than $15 billion in workers' compensation costs for these disorders, and other expenses associated with work-related MSDs" (Department of Labor 2000). The need to consider WMSD in the work place is clear and is crucial for an employer to maintain a satisfied workforce and excel in today's global marketplace. The concern then gravitates to what and how is the proper way to reduce or eliminate the WMSD that are already present in the work force. Deciding on the use of job rotation is only the first step of implementing a solution. The idea of job rotation is simple enough, take a job that is problematic when it is repeated throughout a work shift and rotate the work force to dissipate the load from one worker to *n* workers. How can implementation be achieved so as not to increase the load of several workers instead of one? How does accomplishing the rotation minimize the impact on efficiency and quality of work?

A critical step in determining how to implement job rotation is in the analysis of the operations found in the work environment. There are several methods used that rely on extensive calculations to determine the WMSD risks that are placed on the operator. A regularly used method is to review historic data to determine the reports of injuries that can be traced back to a potential candidate of operation that has produced WMSD. The second method is more of a reactive method than a proactive method and can be determined to be more costly in the long run. The National Institute of Occupational

Safety and Health (NIOSH) have developed Lifting Equation that allow for analysis of jobs to determine the risk level of creating a Low Back Disorder (LBD). As the name indicates the area that is going to be analyzed is the area used for lifting; the lower back.

Other tools are; the Strain Index developed by Moore and Garg (1995) to focus on the Upper Extremity Disorders (UpED) specifically; hand, wrist and elbow, Rodgers' Muscle Fatigue analysis, which focuses on the entire body by breaking the body down into groups: neck, shoulder, back, arms, wrists and fingers, legs, feet, RULA (Rapid Upper Limb Assessment) with the focus on as the name indicates the upper limbs. This is a critical step in determining an accurate measure of the potential for a WMSD to occur. Ensuring that the appropriate criteria is being reviewed and considered will allow for a more defined problem statement of the situation.

The selection of analysis tools to be used can be determined by an individual, a team/committee, a corporation, independent auditor, government, etc. Using a tool that focuses on hands when a pinch force is occurring is commonly accepted even if different tools are available; the results are verified for reliability of the tool. Using the results from the research different practices are identified. The method, the effectiveness, and duration to implement job rotation is viewed differently by different components of a company. Job rotation as an administrative control in some cases is viewed as a final resolution, in areas of health and worker satisfaction it is only an interim solution to a still present problem when considering WMSDs.

The main focus of job rotation is to reduce or eliminate the strain that a group of muscles or soft tissues in the body is placed under for the duration of a working shift. The additional benefits that job rotation provides are broader than those that focus specifically on the health and safety of the operator. Major perceptions of the benefits are; cross-trained workforce, reduced boredom and monotony, increased innovation/motivation, increased production, reduced absenteeism, and lower turnover rates (Triggs and King 2000; Jorgensen, et al 2005; Kuijer, Visser, and Kemper 1999). These particular benefits appear to be codependent on each other. It can only gain the benefit of reduced boredom and monotony by increasing the variety of knowledge which requires a cross-trained workforce. Increased innovation and motivation is due to a worker no longer suffering from boredom with the job. With the new motivation of an operator the production will increase. Reduced absenteeism and turnover rate is in correlation to how an operator "feels" about his/her job, also the expense incurred during training of new associates. The idea of job rotation developing and producing a cross-trained workforce will allow for a diversified workforce that is more flexible in staffing. These are views developed by management on the side of implementing job rotation.

What is required to give the worker a positive perception of job rotation? Many obstacles are already present in the work environment that inhibits the ideas of job rotation. The frame-work of the organization, different pay scales, individual opinions, duration of time of employment is components that aid in the difficulty of producing a job rotation environment. Worker perceptions may stimulate motivation and commitment, effects which enhance effort, performance and productivity (Faucett 2005). The other side is many workers view producing in a job rotation as an opportunity to show a skill set that has not been displayed previously. A chance for management to see a worker excel in a different area or skill set.

The question of who is suitable to be cross-trained arises and to what level of cross-training is needed to produce positive results. The conduciveness of an operation to be performed by several different operators is not based solely on the operation but on the individual worker him/herself. Cross-training is beneficial, especially when the variation of demand is significant (Campbell 1999). The ability of the operator to retain the pertinent information for different operations is related to the level of variations presented by the operation. When operations are similar the learning curve of the different operations is increased, but the ability to maintain the differences between the operations becomes more difficult. Essentially the ability to overlap training allows for greater ease in operation transition which correlates with the potential of performing a similar but wrong operation. Due to the slight variability the probability of the operations using the same muscle groups is significant and will not produce the needed variety in movements. The distinction is not recognized by the mind or body and becomes a member of the current task list.

A variation of significant magnitude will allow for better results in alleviating a monotonous routine. The large job variation with a gradual learning curve will allow a more easily recognized difference in operations. The ability of the different operations to focus on different areas of the anatomy will aide in the objective of dispersing the load on different muscle groups and different ranges of motions. With the onset of new requirements being placed on an operator the ability of the operator to retain the correlating information will begin to test the operators' mental capacity. The task complexity and experience significantly affect the learning and forgetting rates of workers based on field study (Nembhard 2000).

Simulation studies developed by Shafer et al.(2001) have shown to be significant results of the role of individual learning and forgetting characteristics on the overall performance of an assembly line. The changing of operations will decrease the ability of an operator to become proficient at an operation to their highest potential. "They never really reached their highest sustainable level" (Nembhard 2001). Though the highest sustainable level may never be reached, a rotational worker properly allocated will be able to sustain an elevated level for the duration of employment over an operator whom is non-rotational. In rare cases of operators who will only have a single operation for their entire career rotational learning inhibits their ability to have their highest level of output, it does provide however the ability to prevent the worker from being injured or bored with the single operation. Rotational methods produce a more reliable workforce that can be counted on to perform at a high level.

Developing an assignment of workers based on the individual learning ability will allow for a company to achieve a higher yield of not only production but of quality. The major trade off or "cost" of cross-training in terms of lost utility, which can be interpreted as a loss of efficiency as well (Sayin and Karabatti 2007). Additional components that are needed to be included in the discussion of operator retention are the pool of operators and operations. It is the responsibility during analysis to include individual capacities and not solely the operations. Finding the harmonious combination of operators and operations will allow for the greatest utility and will minimize associated costs with training.

A variety of operators is required to produce a beneficial job rotation that contains both short and long term learners. If employers could trade their variable workforce for a troop of "average" workers, they'd be behind in the long run (Nembhard 2001). The assignment of short and long term learning operators requires a look at the operations' duration. If a short term worker is used in a long run operation then their benefits will reach their highest level at an earlier stage, though this may sound ideal Nembhard (2001) has indicated that a long term learning operator will be able to exceed the level of operation of a short term learning operator. Conversely a long term operator will not achieve their highest potential in a short run operation and will not be able to achieve the level of a short term learning operator. An average learning worker will be able to provide sustainable results but will not deliver an optimal in either scenario. The consideration of the work force on an individual basis would allow for the assignment of operators related to the duration of the operations. The proper application would allow for a company to maintain the desired level of production needed to fulfill their requirements and compete in the market. It also needs to be recognized that an average worker will allow for the greatest reliability in scheduling of production and routine. The tradeoff from average worker to average worker will not be a significant decrease or increase in rates. The place for an average worker is still available and will deliver desired results if in the proper application where short term and long term learning workers are placed in applications that are interpretations of how the product is viewed. Determining the duration of short term and long term runs is critical in determining the relevance of which method to utilize. Is short term defined as a few shifts or even less, is long term running the same process day in and day for a month or for a year, which will negate the benefits of instituting a rotational work force? Rotational schedules should be optimal for short and average learning workers because the operations do not require continuous exposure to the same operation, the basic desire of job rotation.

The analysis of the operation is vital to the success of the application of job rotation. The direction of the analysis turns to the operation itself. The need for the job rotation is justifiable if there is significant evidence that the operation itself is the cause and development of a WMSD. The tools required to analyze the operation on the basis of whether or not there is a risk factor that could potentially lead to a WMSD are available. Job assessment tools such as Rodgers/Kodak Fatigue, RULA, Strain Index, etc. are commonly found in the work environment. The determination of how to proceed in implementing the job rotation schedule varies among the researchers. The variables that affect the assignment of operators in an environment draw upon the different education and research developed for the specific program of how a job rotation should be assigned. The importance or weight of the same variable will also differ between programs and will thus conclude to different outcomes in assignment. A variety of tools should be utilized to better determine the appropriate level of impact an operation has on an operator. A single input is not as comprehensive as multiple analyses to better isolate the trigger that causes a WMSD.

The differences between the methodologies of how to establish job rotation first begin with the selection of which jobs need consideration for rotation. The number of jobs that can be rotated raises the concerns related to the learning and losing paradigm. The availability of *n* operators for *x* operations can cause limitations in the establishment of a rotational scheme. Work forces are being reduced to allow for the companies to still maintain some competitive aspects against foreign suppliers. Many automotive manufacturers are facing similar problems as the facility in Indiana, where reduction in sales has affected not only the main automaker but the entire supply chain.

The reduction is now testing the capability and capacities of the remaining work force.

The need for an injury free workforce is very important to a company with a reduced pool of workers to choose from. It allows for a larger spectrum of operators to select from and decreases the company's indirect costs, keeping their prices more profitable. The ability of the operator to perform different tasks allows for more diversified work force. When the question of implementing a job rotation arises do all of the operations need to be in consideration or should only the highest and lowest probability of injury risk be considered is a question that begins to mold how the job rotation is established for each application. Developing a job rotation plan requires determining the set of jobs to be included in the rotation, the sequence of jobs, and the job interval length (Tharmmaphornphilas and Norman 2004).

A variation of muscle groups used in operations should be grouped together to gain the most benefit of a job rotation schedule. Sequencing can occur randomly or due to the task sequence with the objective of not allowing the same group of muscles to be used in consecutive operations. Defining a sequence so to ensure that or to at the very minimal limit the exposure of the same muscle groups being used are not repeated in the consecutive operations should be the focus of the rotational schedule. The idea of ensuring the consecutive operations do not share the same body group at an elevated level will be utilized in the development of a simulation. The duration of time each operation is performed can be easily regulated by hourly intervals or by stops in production due to regularly occurring breaks in the shift. Tharmmaphornphilas and Norman (2004) use the Job Severity Index (JSI) to analyze the operation in a simulated manufacturing environment. The JSI developed by Liles et.al. (1984), is a unit less measure relating the required lifting exertion to a worker's lifting capacity. The focus of the study is on the prevention of low back injury and does not take into consideration other muscle groups that could be applied across several different operations. This is a clear indication that several resources tools are required to best accomplish the assignment of a job rotation schedule so it can be applied to the entire operator and not selective regions.

The lower back seems to be the target of many studies of operations where job rotation is introduced as a potential solution. Frazier et al.(2003) focus on lower back injuries that occur in an automotive assembly facility. The study focuses on two operations among thousands that occur daily. The two operations were selected for their noticeable differences in postures. The NIOSH recommendation of selecting operations for job rotation that use different groups or areas of muscles and tendons would justify the selection of the two operations for further analysis in the inclusion of a job rotation schedule. The study was only allowed to analyze one operator due to production requirements for the facility. A small number of operation cycles were observed and recorded on video tape for analysis. Using the information from the video tape along with the physical properties of the equipment, materials, and environment the model was developed to be more complex then the Tharmmaphornphilas and Norman (2004) study.

Custom software was developed to include the estimated moment of force, reaction forces on major body points, with the lumbar spine being the major jointed body part of focus. The actions required to perform the operation were analyzed to produce the probability of a lower back pain to occur causing the operator enough discomfort that the pain would be reported to management. Reviewing the peak cumulative loads placed on the L4/L5 disc of the spine enabled the development of a Low Back Pain Reporting Index

(LBPRI). The LBPRI has a 0.0 to 1.0 scale that allows for a quantitative measure to be assigned to the amount of pain reported from an operation that has been properly analyzed. This method allows for the study of the actual worker performing the operations through the entire range of motions and forces.

Development of such an index allows for the grouping of operations that can be categorized from no risk to high risk LBPRI. This tool provides a better method of the assignment of operators to operations in a job rotation schedule. The operations observed at the Indiana facility were chosen due to their relation of being contained in the same cell. Operators are in designated departments in the facility and are able to shift cells, but this only occurs during a shift if production runs are completed or manufacturing problems occur. The operators in the department are self contained inside an individual cell lending to a limited amount of operations to choose to be included in the job rotation schedule.

The two previous examples of studies do not develop a process of assigning job rotation outside of the focus on low back injury. It is a single criterion that would allow for an initial rotation schedule that is beneficial for the reduction of lower back injury but could potentially increase or decrease the risk of injury in other areas of the body, but it is unable to capture the information from the analyses. The studies could proceed further and continue to review other areas by using different tools and measurements to help eliminate or reduce injuries to the entire body and work force. The event of such actions would require a large amount of resources that could potentially be better utilized redesigning the operation if applicable.

The decision to redesign the operation or proceed to evaluate the impacts on other areas of the body would need to be decided upon by ergonomists, engineers, workforce, management, etc. involved. Developing a detailed evaluation of all criteria involved would be the ideal scenario for producing a job rotational schedule. The practicality of such an event is not realistic. The resources in most facilities are across many different departments and operations. The idea of allocating an analyst per operator/operation that would be required is simply not feasible. The interim choice until the day when someway one analyst per operator/operation is available is to decide upon the best tool or tools and apply their results appropriately. Performing follow up tests and evaluations to ensure that the original problem was in fact resolved and that no new issues have arisen is critical to the success and sustainability of the development of a schedule.

The decision to implement job rotation to reduce the risks of WMSD can lead to the discussion of which factors are important. Is the job the main component to be considered; focusing on the operation, movements, forces, elements related to the environment? Analyzing the job requirements to determine the physical load that is being placed on the body is a method commonly used in highly physical jobs.

Kuijer et. al, (1999) focus their research on refuse collecting in the Netherlands. The analysis focused on a small group of workers whom performed several tasks based on their level of seniority. This is a parallel criterion to the current situation in the automotive facility being investigated. The research separated the workers to keep a group of un-alternating schedules and a group that would perform job rotation throughout the day.

In the search for determining the correct criteria that are needed to be included to develop the methodology for the assignment of a job rotation schedule what should and should not be included. The allocation of tasks to workstations may have a substantial impact on the prevalence and severity of work-related musculoskeletal disorders for the people assigned to the work stations (Carnahan et. Al. 2001). The goal to minimize the cycle time so to increase production can have a stressful affect on the operator. A combination of demands at home and work can lead to prolonged stress over the course of the day, which maintains high levels of arousal, delays recovery and ultimately contributes to musculoskeletal problems (Melin and Lundberg 1997).

The high level of arousal can be contributed to stress being a continuous component of a work day. Many factors including job demand, control over job-related decisions, monotony, job satisfaction, supervisor and co-worker support and work pace, have demonstrated significant associations with reports of musculoskeletal pain and disorders related to the back, upper extremity, neck and shoulder (Faucett 2005). In order to alleviate an outside component such as stress, rates of production will remain constant across the different cells as it was prior to the researches beginning. Operators will be given several shifts to adjust to the new rotational schedules if applicable and develop their daily routines accordingly.

The development of a job rotation schedule will affect both the operators and the management team established. The operators will receive the most direct impact of the job rotation schedule. The operators will be required to learn new operations, required to differentiate between models on an assembly line, take on new responsibilities in relation to quality, etc. The management team will be required in many corporations to establish the job rotation schedule. Upper management will delegate the duties down the corporate ladder some instances down to the lowest level of management. These "area" managers will develop the job rotation schedule based on what they feel will work the best. The consideration of operator input on which operations are more strenuous could be considered, the work intervals will most likely be either hourly or based on predetermined scheduled breaks.

The idea of job rotation being evaluated based on a single input of what a manager determines based on convenience is very common. Jorgensen et al.(2005), developed a survey to try and determine how many companies were using job rotation schedules in their manufacturing. Focusing on the Midwest of America, 178 companies contacted responded to the survey. Of the 178 companies surveyed 76 indicated that the company participated in job rotation. The 'method' used to develop rotation schemes was primarily driven by supervisor decisions, followed by ergonomic job analyses (Jorgensen et al.2005) with the next common input being from employees. The survey also investigated the "perceived benefits" since the inception of job rotation. The increase in operator skill, decrease in work related injury, and increases in employee satisfaction were among the highest "benefits" reported. The results however determined a negative correlation between the number of years a company had been utilizing job rotation with turnover and absenteeism (Jorgensen et al. 2005). A major finding of the results contradicted what NIOSH and OSHA have established for the use of job rotation as a temporary control to further prevent WMSDs while engineering actions are being taken to correct the concerns. The findings of the survey stated that the median duration for a company to be using job rotation was 5 years. The "results suggest that job rotation maybe being used as a permanent intervention strategy, rather than an interim control strategy" (Jorgensen et al. 2005).

The decisions of which components have the greatest affect on deciding how to implement a job rotation schedule are still being determined and new ideas are being investigated. The possibility of a single method that would be able to transverse all operations is not likely to be discovered due to the complexity of the human element. The knowledge gained from various operations will allow for researchers to consider new information that would not have been originally considered in the development of a method for a specific industry or application.

In the specific situation with regards to the facility in Indiana it will be impractical to physically change the production methods for determination in which will produce the best results with respect to production and the decrease in WMSDs. This specific case lends itself to the idea of running simulation in place of the physical change. Simulations "are conducted to analyze and improve the efficiency and effectiveness of manufacturing organizations, systems, and processes" (McLean and Shao 2003). The benefit of the simulation will allow for the current process to be compared with the proposed changes without the costly affects of downtime, rearrange, retooling, and new training on the proposed system. Specific to the automotive manufacturing facility "the objective is to minimize the makespan, set-up cost , inventory holding cost, backlogging cost, total idle time and load imbalance" (Yan et al. 2003).

The formation of a simulation is easily achieved in theory but it often misrepresents the proposed system changes. The simulation lends itself to allowing the possibility of an error in several steps of its process. The main cause of error is in the challenge of the simulation itself, "unfortunately human error is inevitable and it is more likely when under pressure" (Wood and Harger 2003). Errors can be found in the data collection, simulation modeling, and the reporting of results.

Data collection begins the process of developing a simulation; only with the appropriate information can a model have a chance of being valid. "Validation is the process of determining whether a simulation model is an accurate representation of the system, for the particular objectives of the study" (Law 2003). "Validity, is a judgment regarding how well suited a particular representation is for a specific application" (Hughes and Rolek 2003). The previous examples only represent a very small population of the importance of developing a simulation that can achieve validation. This will also be the focus that is to be achieved with the simulation of the manufacturing facility.

An area inside the simulation that that has been the target of many research papers is the identification of representing the human component. "Traditionally, representations of the human operators have been relatively ineffectual as a result of oversimplified assumptions underlying the models" (Hughes and Rolek 03). Hughes and Rolek go a step further in stating, "the limited degree to which crew behavior is accurately represent in these simulations is generally regarded as inadequate, and as such, limits the overall validity and utility of the models." The acknowledgement and proper identification of the operators will not only provide an accurate simulation with respect to production quantity and quality but also with the combined focus of the potential of WMSDs it is critical for the simulation to be successful.

There are several tools recommended by Law to help reduce the possibility of inaccurately representing a system in a simulation. The "Seven-Step Approach" is a process developed by Law through previous practice and teachings of simulation. Paying particular attention to the steps; 1. Formulate the Problem, 2. Collect Information/Data and, 5. Is the Programmed Model Valid it is the purpose to ensure that the model is valid and the results are appropriate for the purpose of the model. The model will be valid by paying attention to the criteria and ensuring the data used is current and appropriate. The simulation will be used to address the impact a job rotation schedule has inside a cellular production system.

B. Literature Summary

The importance of accurate tracking of information, relevant information in the areas of WMSDs, production schedules, and model development are critical to the work that is to follow. Utilizing the studies of the research and development will follow the examples of the previously stated literature along with establishing a working comparison of actual events occurring within the same facility. The greater benefit of the simulation is to introduce the concept of not only that the rotational work-force can be a permanent manufacturing method and increase production, performance, and morale.

C. Proposal from Literature

The evaluation of the current processes will create the baseline for establishing the current manufacturing method. Analyzing the operator's performance and ergonomic risk of exposure is to develop a countermeasure to the current condition.

The Indiana facility currently has both rotational and non-rotational schedules being utilized in manufacturing. Identifying the groups to represent the rotational and non-rotational work forces will allow for an accurate comparison. The simulations analyze the current and proposed manufacturing methods without disrupting or jeopardizing the production requirements.

III. METHODOLOGY

The elements that make the internal components of the facility unique will be considered from various views. The medical information documented during the study is analyzed. The analysis includes the recorded occurrence, the body part of the operator, and the area of the facility. The products that are for internal and external customers is considered, along with the manufacturing method. The last area is the most critical component in developing a successful simulation

A. Facility History And Information

The facility has defining attributes that aide in the development of subcategorizing itself. The facility has been in operation for nearly thirty years under the current parent company. Changes in production have caused the facility to change its appearance many times over. The facility itself is a great opportunity for investigation of establishing proper parameters for comparing manufacturing methods. It is expected that changes have been made to all aspects of business; head count, products, management, etc. The facility was continually undergoing change during the duration of study, new models entered production, current models were relocated to different areas of the plant floor, staffing was reallocated, and models left for other facilities. Any adjustment to the facility presents new options in evaluating the company.

The facility is a customer, a supplier, and a generator of goods. Areas inside the facility use raw materials, outside sourced components, and internally sourced components in production. Each area presents its own unique characteristics and challenges when developing criteria for selecting the appropriate criteria. The determination of which areas and what products will be the focus to develop a simulation can not be based solely on the areas of the facility.

The manpower allocations of the facility throughout the years have changed in total numbers and numbers within inside departments. The employees of the facility have been able to be transferred and promoted. The information of any changes has been recorded by the human resource department on a monthly basis. Department differences are established due to rules and regulations between the workforce and the company. The variations were created to for the purpose of differentiating compensation between specific departments and specific job classifications. These variations identify areas of different manufacturing methods applied to the workforce.

B. <u>Production</u>

The varying products and different forms of production are areas that need further investigation. Looking at the different products that are produced is the beginning of understanding how the production inside the facility is different. The diversity of the products include plastic components, metal tubes, metal flanges, pressure regulators, windshield washer bottle assembly, canister vent valves, fuel delivery modules, fuel pumps, and fuel vacuum senders; each has different models and different fuel types available (gasoline or diesel). The different products themselves are a good place to start the investigation of which areas run similar products for comparison. A windshield washer bottle assembly does not look anything like a fuel vacuum sender when investigating the products on physical characteristics only. The physical comparison begins to highlight areas of interest based solely on product.

The next step is looking at the components of the products. Identifying the component helps in categorizing areas of the facility. Several areas inside the facility have similar products, produced for the same purpose of operation but are made of different materials. Material is reflected in the type of production chosen. Certain materials and products are more applicable to certain styles of production. An ABS plastic is more durable and can have more force applied to it then a rubber component which can rip and tear in certain applications. The material used is based on what the engineering requirements are for the final product.

The assembly of the product is an area for evaluation because; after physical attributes it is the largest distinction between products, the amount of automation impacts operator numbers, and the type of production determines; rotational or non-rotational manufacturing. There are fully automated, semi-automated, and manual production lines that are located throughout the facility. The fully automated products supply other areas inside the facility. There are semi automated lines that produce internal and external products. The third option is a manual line that can also produce internal and external products. The work cells apply different conveyance of incomplete products. Types of conveyance are either belted driven, gravity feed, or manual. These differences allow grouping or isolation when developing the comparison of different work cells. The review of the product types and production method attributes help in the comparison of components.

The facility produces both current production year products and service products in the same cell for many areas creating the need to remain dynamic. The company provides the facility with a detailed forecast of volume for the current models, in addition a total volume of all service is provided to the facility. Service models are designated to run inside a work cell along with the current models. The current model parts are broken out into individual forecasts for scheduling and manning purposes. Service models are forecasted together as a bulk requirement to provide the percentage of production time that is needed for production. Service models produce challenges not only in scheduling for actual build time but also including time for changeover and the increased amount of down time due to older equipment. These factors of service eliminate service cells from consideration, the assumption being the forecast is not reliable to develop an accurate representation of the work cell.

The reliability of a part being produced consistently at a regulated volume is more critical to determine the impact of a production method. The forecasts have changed as demands have changed over the course of the study. The volumes and the components will be considered for current models during the 21 month study. Production model years change very little even if a dramatic vehicle redesign occurs.

The production information contains production volume, rates, shifts, and operator population. Selecting only volume as the critical determinate will not accurately portray the work cell, the shift, rate, and operator population needs to be also considered. The number of shifts a work cell operates impacts the number of products needed for production. The rate of production impacts the number of shifts and also the number of operators. The comparison will include all of the information from the work cell including any adjustments to operator population that maybe a cause of quality requirements. The information regarding operators, shifts, departments, and work cells was updated on a monthly basis by the human resource department. Changes that do not pass from one month to the next are not reflected. The monthly data will be applied as daily data for the operator population for all working days inside that month. The information is independent for each work cell and does not allow for an operator to be counted in two different departments or work cells. The work cell indication is attached to the operator population and will allow for calculations of rotational and non-rotational work cells independently for comparison. The identification of such work cells is critical in analysis of the medical injury/illness reports.

C. Identify Injury/Illness Potential

The manufacturing facility has an onsite medical center staffed with three full time registered nurses, one part time registered nurse, and a medical doctor who is on call twenty-four hours, seven days a week. Any member of the staff is capable of documenting any operators' occurrences. Each member is trained to respond and record all work related incidents. Through diagnosis the occurrences are evaluated and recorded into the following categories; classification, level, OSHA Indicator, Ergo Indicator, Department/Location, and Primary Body Part.

The largest subcategories are injury/illness. An injury is a single event that creates the occurrence that is being reported such as a cut, scrap, bruise, etc. An illness is the repetition of a motion or event that has caused an illness to develop over time and is now being identified and reported as an occurrence; examples of illnesses are carpal tunnel syndrome and tendonitis. The reported injury or illness is identified by the circumstances that potentially could have caused the injury or illness. The OSHA Indicator, when present, is noted in the records and requires the additional documentation to aide in the diagnosis and research. The Ergo Indicator purpose is to notify the facility's ergonomic committee to begin evaluation of the operation.

The Department/Location is the area inside the facility and the shift used to track other occurrences in the area. The Primary Body Part identifies the anatomical area of the operator that is impacted. The report contains other information related to personal information of the operator and facility related information, this information is used for clinical use and identification that is not applicable for this study, i.e. name, payroll number, this information has not been included.

Diagnosis provided by the medical department identifies the occurrences from different work cells independently. Operators rarely transfer outside of their assigned departments, but can transfer among work cells which have the same pay rate. An operator transferring into a different manufacturing method is too rare an occasion for consideration. The assumption of no transfers is used when evaluating work centers during selection and analysis of potential dangers.

The body regions have been established to focus on the movements and causes of each occurrence. The regions are Upper Limb, Head and Neck, Back and Lower Back, and the Lower Limb. The Upper Limb will include the shoulders, arms, elbows, and any occurrences in the hands. The Lower Limbs will include the hips and the feet into the collection of occurrences.

The departments are defined and due to restrictions of the workforce the assumption is no department will differ from the established manufacturing method. An operator is only exposed to the same basic operation during production. The differences in a model will only allow for small dimensional variations of components. The work cells are viewed as independent entities and can not be communized to cause a generalization of the process.

The medical information is utilized in the selection of operations that are reviewed for use in the analysis of the comparison of rotational work cell and the non-rotational work cell. The medical information collected will correlate with the historical production information. The Forecasted Production Volumes (FPV) for the work areas allow for the development of an average production week for a work cell. The models have a predicted volume for the year and the volume is to be evenly distributed throughout the work weeks of the year.

The work cell operations are researched to determine the level of potential injury exposure to the operators. Tools such as NIOSH Lifting Equation, Strain Index, Liberty Mutual Tables, Rapid Upper Limb Assessment (RULA), and Rodgers/Kodak Muscle Fatigue are used for ergonomic assessment of the operations. An assessment is only as reliable as the training of the individual performing the evaluation. The tools used for the determination of possible WMSD related situations are chosen for the universal application of the operations that are performed in the different work methods. The assessment tools have been implemented at the website: www.ergoweb.com which is used to process the data recovered during the study, access is provided by the facility.

The Rodgers/Kodak Muscle Fatigue Assessment is used for the consideration of the entire body. The Rodgers/Kodak takes into consideration the effort level, frequency, and duration. The major body regions have been separated to get a better focus on the possible body components of concern. The selection of the Rodgers/Kodak tool is based on the criteria of ease of use of the tools for reporting. The use of the Borg scale and the visual aides increase the accuracy of reporting.

The principle of Rodgers/Kodak is the hypothesis that a fatigued muscle is more susceptible to injury than a well rested muscle. In the application of Rodgers/Kodak it is best if an operation is performed for duration of an hour or greater, which is appropriate for the facility being evaluated where the minimum operating segment is an hour and the maximum normally scheduled is a shift. The analysis places the operation into four levels of effort; Light, Moderate, Heavy and a Fourth level in which the effort can not be exerted by most people. Each named level corresponds with a range of points on a 10 point Borg scale; Light (0-3), Moderate (4-7), and Heavy (8-10), the Fourth level is not represented on the Borg scale, it is still acknowledged as a possibility of a score if the work load can not be maintained. Each of the levels are then given a ranking to correspond with the Borg scale; Light ranked (1), Moderate ranked (2), Heavy ranked (3), and the Fourth Level (Extreme) ranked (4).

The analysis of the operations focuses on the body components; neck/shoulders, back, arms/elbows, wrists/hands/fingers, legs/knees, and ankles/feet/toes. Each region is analyzed with respect to 3 levels of exertion; Effort Level, Continuous Effort Time, Efforts per Minute. Effort level views and analyzes the positioning of the body components with specific detail to each region. Rodgers/Kodak provides descriptions of the body positioning to aide in the analysis of the different regions. Continuous Effort Time is simply stated as the duration of non-interrupted muscle activity. The durations are calculated in seconds and ranked (from 1-4) as follows; Less than 6 s (1), 6-20 s (2), 20-30 s (3), Greater than 30 s (4). The last analysis is the Efforts per Minute that assign a ranking to the number of occurrences an operation is repeated in any given minute of normal production. The rankings allow for 1 occurrence or less per minute to be ranked (1), 1 to 5 occurrences per minute ranked (2), 5 to 15 occurrences ranked (3), and greater than 15 ranked (4). The term occurrence indicates the repetition of an action such as a reach with the right arm a certain amount of units in distance, regardless of the function, each reach is recorded. This allows for the component or operation to be negotiable but allows for the body movement to be identified as impacting the same region numerous times, providing an accurate account of compounding motions during production.

The ranking of the three different categories gains insight into which areas should be the focus of change. The scores are arranged in a table that indicates the priority level of the needed change. The groups in the table are the combination of scores that would cause the least muscle fatigue on the left of the table to operations that can cause the most severe muscle fatigue on the right side of the table. The analysis and chart allows for ranking and identification of operations that have an increased risk to accelerate muscle fatigue. The rankings provide information on operations level of muscle fatigue.

The analysis indicated that the majority of operators were seated during the operations, The Rodgers/Kodak does not properly account for such production. A secondary analysis tool is chosen. The evaluation of high WMSD needs the ability to isolate the upper extremities movements and forces. Rapid Upper Limb Analysis (RULA) was chosen; RULA is an analysis reduces the impact of the lower limbs on the score of the analysis. The inclusion of non utilized body components could cause a misdiagnosis that misrepresents the severity of an occurrence.

RULA evaluates the body by dividing the body components into two separate groups. The upper extremities know as Group A are the arms, forearms, wrists and hands. The other body components that make up Group B are the neck, trunk and lower extremities.

Evaluation of Group A begins with ranking the posture of the body components by a predefined range of degrees of flexion and extension and any rotation involved. RULA provides an easily followed guide that allows for the user to read a description of flexion/extension along with a diagram and determine which value is correct. Once the correct value is selected a ranking is established for the part and the score is determined. The posturing is completed for each group of body components and a general score for the postures is produced from a table.

The *Posture Risk Factors* are comprised based on the load applied to the body part from the orientation it is placed in. The table scores each component and then determines a final score. The score table represents a hierarchy of scores representing a series of if-then statements producing a final score. Group A and Group B have independent tables to reflect the scores and severity for each body grouping.

The next step in the evaluation of an operation is to consider the effort output achieved for the duration of the operation, known as the *Static Muscle Contraction Factor*. A score related specifically to the muscle exertion of each group independently is considered. The scoring is either 1 or 0 and is separate from the posture risk score. A score of 1 indicates that the muscle groups being utilized are held static for longer than a minute. A score of 0 indicates the muscle contraction less than a minute in length.

A *Force Risk Factor* of 0-3 is recorded of the force exerted during the cycle of operation. This score considers the repetitive nature of an operation. A 0 score is for a process that requires a load or force less than or equal to 4.4 lbs and is held intermittently. A 1 score is possible for loads or forces between 4.4-22 lbs and is held intermittently. There are two possible ways to obtain a score of 2; one involves a load or force between 4.4-22 lbs and the motion is either static or repetition occurs more than four times a minute, the other way is a load or force greater than 22 lbs applied intermittently. A score of 3 is possible to be achieved by either a load or force greater than 22 lbs that is static or repetitive or any magnitude of load or force that is experienced through a rapid build-up or jolting action.

The final determination of RULA applies all three scores for each group to a final score. This is done by adding the Posture Risk Factor, Static Muscle Contraction Factor and the Force Risk Factor. A total score for Group A, now referred to as Score C will be referenced with the score from Group B, now referred to as Score D, in the Grand Score Table.

TABLE I

RULA GRAND SCORE

		Score D (Neck, Trunk, Legs)						
		1	2	3	4	5	6	7+
Score C (Upper Limb)	1	1	2	3	3	4	5	5
	2	2	2	3	4	4	5	5
	3	3	3	3	4	4	5	6
	4	3	3	3	4	5	6	6
	5	4	4	4	5	6	7	7
	6	4	4	5	6	6	7	7
	7	5	5	6	6	7	7	7
	8+	5	5	6	7	7	7	7

The Grand Score allows for the depiction of the severity of a job in its current environment and under its current conditions. A Grand Score can range from 1-7, 1 being instances of lowest priority and 7 being instances of greatest priority and the need for immediate review of process and appropriate changes to the procedures. The evaluation of the current operations allows for identification of areas of concern and areas of acceptable magnitude in a work cell.

D. <u>Simulation</u>

Using a simulation represents the activities in the facility without impact to manufacturing. Calculating the amount of exposure utilizing the different manufacturing methods and making changes to production where applicable. The simulations will accurately represent current manufacturing cells inside the facility. Using actual cell cycle times, observed fatigue rating, break schedules, and one piece flow will most closely represent the current conditions.

The Rockwell Automation Technology Software package of Arena Version 12, Training/Evaluation Mode (STUDENT) is utilized for developing the simulation. The software allows for the creation of entities and processes to represent the components of the current manufacturing methods. The ability of tool can establish one piece flow, creation of new entities, disposal of completed products, and the change of production performance throughout the course of a shift.

The simulations will run for sixty-five replications, representing thirteen weeks with 5 work days in each week. The duration of each work day is represented by a single shift. A shift is comprised four-hundred eighty minutes minus scheduled paid breaks and movement for job rotations if applicable. A work center incurs forty minutes of paid break. The replication cycle will last four-hundred forty minutes for non-rotational methodology simulations. The replication cycle of a rotational methodology simulation will last three and a half minutes less. The less time is allowing the operators half a minute to transfer themselves and personal effects to the next work station. The accumulated time is reduced from the total available production time.

The work centers are created as one piece flow systems, a few exceptions are made due to the process limits of the training/evaluation mode in the software. The majority of operations are broken into three separate process components. The first process is a Basic Process - Process that functions a Seize Delay action. The Seize Delay occupies the Resource (Operator) and delays the entity for the duration of processing of the station in minutes. The processing time changes throughout the course of the shift, discussed later in this section. The next process is an Advanced Process – Hold, this process keeps the entity from moving on to the next process. The Hold, searches to confirm if the next resource in the work center is available to receive an entity directly or if it would be placed into a queue. The Hold does not allow for the entity to be passed from the current resource to the next resource if the next resource is being utilized. In this manner one piece flow of material is achieved. When the resource is available then the entity is transferred to the third process a Basic Process – Process, Delay Release, where it is delayed zero minutes and releases the entity to the next process. This frees up the resource to allow for the next entity to be transferred into the first of the three processes and the simulated process to occur.

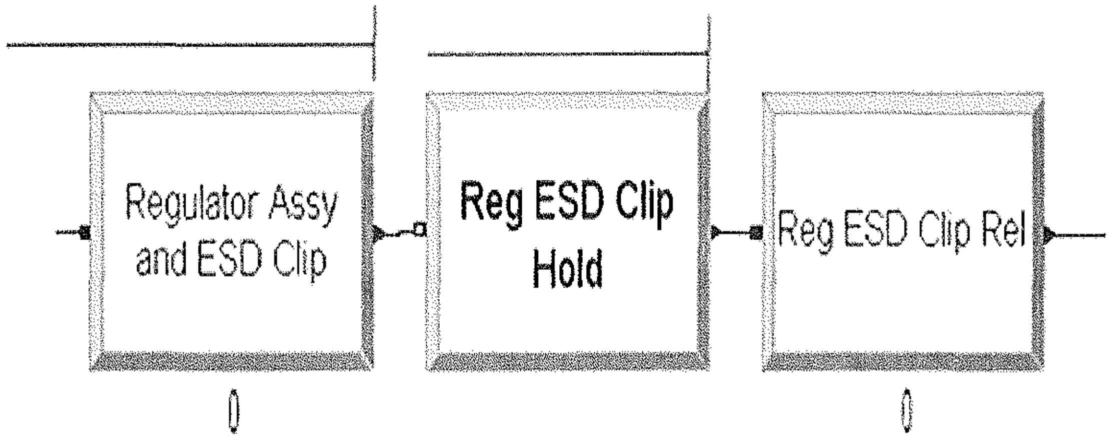

FIGURE 1- Simulation Work Station Development

An Advance Process- Match is used when adding a sub assembly into the work center. The Match process ensures that a process does not begin until both components are available for the resource. Only one entity is passed to the entity limit of the training/evaluation mode. A Dispose – Basic Process is used to minimize the entities.

The 307-1 (non-rotational) work center utilizes a Basic Process – Separate to accommodate for the creation of two entities of Flange Assy and Float Rod Assy by the same Resource. During the Hold process of this series of functions it is only considering the resource of the Leak Tester. This selection is to limit the Siman objects under 300, the Leak Tester has a longer standard process time. The reason of why there is not a Hold and Delay Release Process of the Leak Test work station is due to the completed Leak Test entity and the completed Sub Build entity are then matched before moving on to the next process. The limit of the Siman objects is the main reason behind not having the additional processes. The idea of one piece flow is still achieved by not allowing the Sub Build to be released until the Heat Shrink resource is available. The Leak Test Entity is matched with the Sub Build entity and both move forward.

The time required to transfer the entities inside the operation are captured inside the processing time of the work station. These times were captured during the original study so no additional time is required to simulate the travel of the entity throughout the work center.

The production assigned to a work cell does not identify different models running during the shift or replication cycles. The work elements of producing different models does not vary significantly enough to deem that the operators are allowing for active muscle groups to rest during alternate production model runs. The production process represents the same without regard to the different models.

Simulating production performance in each of the simulations requires the development of an equation that is time directed. During the research of the selected work centers half hour accounts of production performances were established for each of the operations. Small samples were recorded and compared to the established standard of the work station. The performance factor was then multiplied by the number of units that were standard for production based on the work station. These calculated units were then compared to the standard units for the work center for the time segment. This comparison produced a performance percentage for the half hour time segment of the work station compared to the established rate. In an instance where a half hour contained a non work the performance percentage was only applied to the production time.

TABLE II

LEAK TESTER PRODUCTION PERFORMANCE

Leak Tester Rotational Cell				
Performance Ratings		Standard	Operation Rate	Work Center Rate
		0.39278	1120	918
Peak	Low		Parts not needed	202
110%	85%		Inherit Delay(min)	79.29
	0.47912	Constraint Operation 100%		

Time Duration	15	20	25	30
Required Work Center Units	31.295	41.727	52.159	62.591

Hour	Basic Min	Production (Units)	Duration Worked (min)	Performance Rating	Parts Required	Performance to Parts Required
0.5	0.413	73	30	95%	62.6	116%
1	0.385	78	30	102%	62.6	124%
1.5	0.357	84	30	110%	62.6	134%
2	0.357	84	30	110%	62.6	134%
2.5	0.367	82	30	107%	62.6	131%
3	0.357	42	15	110%	31.3	134%
3.5	0.378	79	30	104%	62.6	127%
4	0.385	78	30	102%	62.6	124%
4.5	0.367	68	25	107%	52.2	131%
5	0.381	79	30	103%	62.6	126%
5.5	0.401	75	30	98%	62.6	120%
6	0.413	73	30	95%	62.6	116%
6.5	0.427	70	30	92%	62.6	112%
7	0.451	33	15	87%	31.3	106%
7.5	0.436	69	30	90%	62.6	110%
8	0.462	54	25	85%	52.2	104%
	Total	1120	440			

The ratio of Performance to Parts Required is plotted with the time being the X axis. The graphs did not create a single slope linear equation so the option of creating a trend line was utilized. The type of line was selected to be a polynomial 2nd order. The choice for this type is that it accurately developed a trend line that followed the performance of an operator through the course of a shift at a work station.

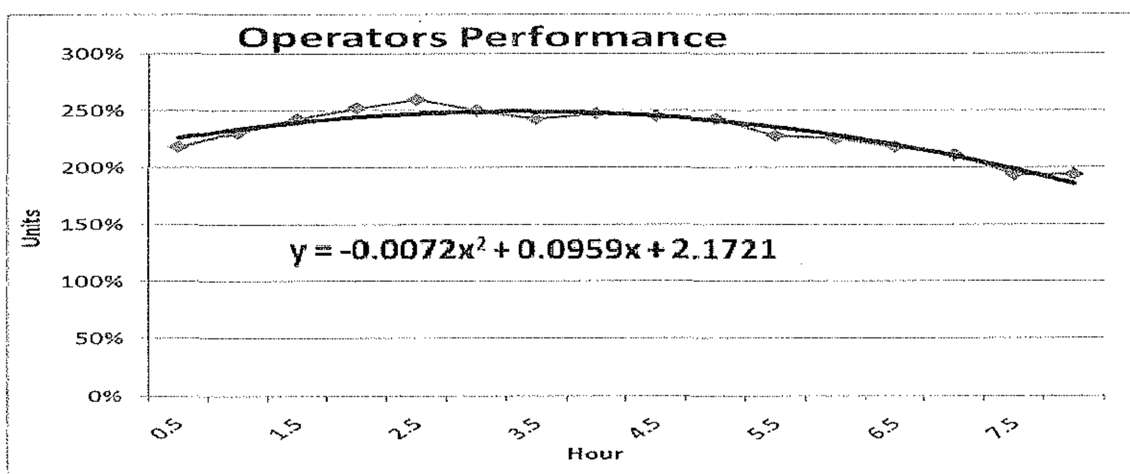

FIGURE 2 – Performance To Parts Required

The equation focuses on what outputs is coming from the work station and disregards which operator is working at the work station. This allows for the equation that is generated from the trend line to be applied to the work station and not the operator (resource) for both a rotational and non-rotational work station.

The equations are established for the base current work cell simulations with the variable dependent on time. As time progresses the equations are recalculated by using an assign module running parallel to the work center simulation. The performance calculations are rerun with the most recent time, provided by the assign module. The calculated performance for each work station changes throughout the production time of the shift to represent the performance at each station.

Developing the criteria for simulating the change from the current to the opposite production method requires investigation into the key components of the current facility simulations. The amount of production time available is switched from non-rotational to rotational and vice versa. The performance trend lines are switched between the different production methods; this is accomplished by an evaluation of the work stations. A detailed analysis of the work components is developed to identify the similar work components between the two production methods. The analysis is based on job description, component production, work station layout, and observational knowledge. The ergonomic data is utilized to eliminate ties between process and to identify an additional degree for comparison.

E. <u>Analysis Method</u>

Supporting information is collected to further develop the identification of a Work-related Muscular Skeletal Disorder (WMSD) opportunity. The time an operator spends in a station and the rate of production during the time spent are recorded. This information allows theoretical opportunities for a WMSD to occur. The longer an operator remains in a station, the more cycles occur allowing more exposure.

Fatigue affects the movements and reduces the abilities of the body to properly replenish energy to the muscles decreasing the operators' abilities to perform the process. Fatigue increases the risk of failure which is categorized as a WMSD. The analysis will calculate the amount of exposures as the number of cycles during a shift.

The translations of fatigue into numbers of potential WMSD events will allow for the comparison of similar operations that are using different manufacturing methods. Due to the incapability of knowing when an element causes a WMSD, due to the variability of workers, a total number of cycles exposing the team member to potential WMSD elements will be the basis of comparison between the production methods.

IV. ANALYSIS

The research, development, and execution of the work described in the methodology are discussed in the following sections. The explanations of the creation of the selection of criteria and performance of results are highlighted. The execution of research, development and assumptions are presented.

A. Work Cell Selection

1. Medical Evaluation

A total of 481 injury/illness occurrences were recorded by the onsite medical center in a twenty-one month period. These fall into eighteen categories highlighted in Table II from the production of January, 2005 through September, 2006.

TABLE III

PLANT MEDICAL HISTORY BY CATERGORY

	Totals	
Description INJ/ILL	2005	2006
Laceration/Abrasions	94	62
Contusions	41	17
CTD's	53	31
Burns	4	4
Foreign Bodies	30	25
Sprain/Strain Inj	43	14
Fracture	1	0
Insect Bite	6	1
Noise	1	1
Resp sym/vapors etc	12	0
Electrical Shock	3	1
Dermatitis/Skin	7	1
Stress Reaction	0	0
Sys/Tox Effects	1	0
Heat Stress	16	2
Headache	4	0
Crush Injury	2	0
Friction Blister	2	2

Reviewing only the names of TABLE III it is obvious that the level of severity differs dramatically among the categories. Injury/Illness is a generic term used to try to capture the potential of events that would cause adverse effects to an operator. The Injury/Illness is used by the medical department as a starting point for identification only and should be viewed as such.

All of the information is important inside the Injury/Illness category for identifying potential dangers and risks at the facility. This study focuses on the CTD (cumulative trauma disorders) recorded at the plant, also referred to as WMSDs (Work-related Musculoskeletal Disorder). The terms CTDs and WMSDs are interchangeable for the purpose of this study. The data provided a total of 84 CTDs reported during the twenty-one month period of investigation, this represents 17.5% of all Injury/Illnesses reported. CTDs are the second highest percentage of all eighteen sub categories. The results produced an average of 4 CTDs cases diagnosed by the medical department each month. More than 10% of the hourly work force has reported an injury/illness calssified as a CTD/WMSD. One out of every ten employees has visited the medical department negatively impacting production.

In 2005 there were a total of nineteen departments in the facility; fourteen reported a total of fifty-three CTDs. In 2005 74% of the work centers were impacted by a CTD. In the first nine months of 2006 eight departments reported a total of thirty-one CTDs, on pace to report forty-one for the full year. In 2006 the number of work centers was reduced down to 17, indicating that 47% of work centers reported CTDs in the first nine months.

Several of the same departments reported CTDs in 2005 and the first nine months of 2006 year. There is not enough evidence to support making the decision solely on departments that reported CTDs during 2005 and 2006 segments. There is no consideration of performance, production, headcount, or production method.

2. Production Evaluation

To minimize the analysis effort; any department that did not operate both years was eliminated from the study. This eliminated two departments from consideration. The number is not significant but the reality of the situation is an additional five departments were reduced from multi-shift operations to single shifts. The total headcount in the facility reduced from 853 employees to 748 during the twenty-one month period for a reduction of twelve percent of the work force. The reduction in production volumes of the five departments that went to single shift operations is discarded.

Several of the departments where involved in some form of a model change between during the study. The elimination of departments that had a model change and shift reductions during the study period has reduced the departments to; Department 317 and Department 303. The analysis has lead to a comparison of a canister vent valve and a bus wire operation. The assembly in Department 317 requires eight operators rotating in a single work center. Department 303 is a single operator that loads the machines for batch production, monitors the process, and unloads the machine after completion. The process of selecting the appropriate work centers to be compared and analyzed is re-evaluated.

The evaluation has been modified to focus more on the selection of similar products verse the new model selection. The logic behind the change is similar products will require similar operations and will provide better opportunities for comparing processes. Further analysis shows new models introduced did not have a significant impact to the operations. A new model will be created for any change of a component to the product. This change can impact the assembly or impact an internal component of a purchased part, such as a pump or valve. The understanding of how significant a change to the product is from the previous model will be evaluated after the selection of work centers.

Continuing the selection of departments focusing on product type, there are clear candidates that immediately stand out for consideration of the study. The work cells chosen for further investigation are Departments 302, 307, 308, and 310. Department 302 and 307 are non-rotational departments and department 308 and 310 are rotational departments. Samplings of the specific CTDs are in APPENDIX I., the personnel information has been removed to maintain privacy. A review of the twenty-one month period of the volume of occurrences and during what months they occurred is displayed in TABLE IV for the non-rotational departments and TABLE V for the rotational departments. Each department displays the recorded information and the shift of the reported occurrence. The number of hourly personal is also provided for comparison to reported CTDs.

TABLE IV

NON-ROTATIONAL WORK CENTER MEDICAL HISTORY

Non-Rotational

2005		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Days Worked		20	20	21	21	21	22	11	23	21	21	19	17
302-2	Heads	79	77	79	78	79	81	77	76	75	79	74	74
	CTDs	0	1	0	1	0	1	0	1	0	1	1	1
302-3	Heads	38	38	41	38	39	43	45	45	43	42	38	38
	CTDs	4	0	0	1	0	1	0	0	1	1	0	0
307-2	Heads	57	58	58	56	55	58	52	52	51	54	54	54
	CTDs	1	0	0	1	1	0	0	0	0	0	1	0
307-3	Heads	37	37	38	39	38	45	40	40	40	40	35	36
	CTDs	0	0	0	0	0	1	0	0	0	0	0	0

2006		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Days Worked		20	20	23	18	22	22	11	23	20			
302-2	Heads	74	74	74	60	60	62	61	62	62			
	CTDs	1	0	1	0	1	0	0	0	1			
302-3	Heads	39	38	38	35	38	37	37	37	41			
	CTDs	2	0	0	0	1	1	1	0	0			
307-2	Heads	54	54	54	58	58	58	59	59	75			
	CTDs	0	0	1	0	1	0	0	0	1			
307-3	Heads	35	34	32	37	36	42	43	41	22			
	CTDs	1	0	0	1	1	0	1	0	0			

TABLE V

ROTATIONAL WORK CENTER MEDICAL HISTORY

Rotational

2005		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Days Worked		20	20	21	21	21	22	11	23	21	21	19	17
308-2	Heads	55	55	55	53	56	59	57	57	55	55	56	56
	CTDs	1	0	0	0	0	0	0	0	0	0	0	0
308-3	Heads	16	16	33	33	34	34	19	18	19	19	19	19
	CTDs	0	0	0	0	1	0	0	0	0	1	2	0
310-2	Heads	36	37	37	36	36	36	35	35	34	33	32	33
	CTDs	0	0	0	0	0	0	0	0	0	0	0	0
310-3	Heads	17	17	0	0	0	0	15	16	16	16	0	0
	CTDs	0	0	0	0	0	0	0	0	0	0	0	0

2006		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Days Worked		20	20	23	18	22	22	11	23	20			
308-2	Heads	55	56	56	62	62	60	60	60	61	0	0	0
	CTDs	0	0	0	0	0	0	0	0	0	0	0	0
308-3	Heads	19	18	19	19	19	18	18	19	118	0	0	0
	CTDs	0	0	0	0	0	0	0	0	0	0	0	0
310-2	Heads	32	32	32	25	25	24	24	24	24	0	0	0
	CTDs	0	0	0	0	0	0	0	0	0	0	0	0
310-3	Heads	0	0	0	0	0	0	0	0	0	0	0	0
	CTDs	0	0	0	0	0	0	0	0	0	0	0	0

As it is evident from the tables the amount of CTDs or WMSDs are heavily concentrated in the non-rotational departments. A direct comparison of totals of the different production methods is in TABLE VI. Several of the key comparison have been highlighted to bring attention and to further showcase what the historical data has proven about the production methods.

TABLE VI

NON-ROTATIONAL COMPARISON TO ROTATIONAL MEDICAL DATA

	Non-Rotational	Rotational
Reported CTDs	36	5
Weeks Worked	84	84
Total Hours Worked	1301040	765920
Hrs/CTD	36140	153184
Avg Weeks Between Reports	2.33	16.80
Avg Facility Hours Between Reports	93.33	672.00
Avg Days Between Occurences	11.67	84.00

The departments are comprised of several cells that run different products. In most scenarios the products are similar in nature and could be viewed as such. The shift depiction can be used to eliminate the different times of the day, though it is not practical to control when operators awake or what is done prior to work, the working period should be the same duration of the day to aide in eliminating any controllable differences.

The departments for consideration are still 302, 307, 308, and 310. Department 302 runs a larger variety of older models that are heavily dependent on metal components. Departments 307 and 308 are models that consist of a majority of plastic components. Department 310 volume is reducing and no longer will run two shift operations. The department work force is rotating among three different work centers during the course of a week; the consistency in the reports of production verse WMSDs is not useable. Department 307 is comprised of five cells 307-1, 307-2, 307-3, 307-4, and 307-5. Cell 307-4 and 307-5 produce legacy or service parts, accurate production forecasts are not available for these cells. Department 308 contains cells 308-1, 308-2, 308-3, and 308-6. Cell 308-6 is strictly legacy parts. The current production model in Cell 308-1 is moving to service, no forecast is available after June 2006. The weekly volume of the model in 308-2 does not sustain the cell five days a week and is not an option. The current model in 308-3 is produced using two stainless steel rods for support as a major component. The models in 307-2 and 307-3 do not have such a component, but the model in 307-1 does have a support system of two stainless steel rods. The two models are visually similar enough to precede to the next step of evaluation of the production operations.

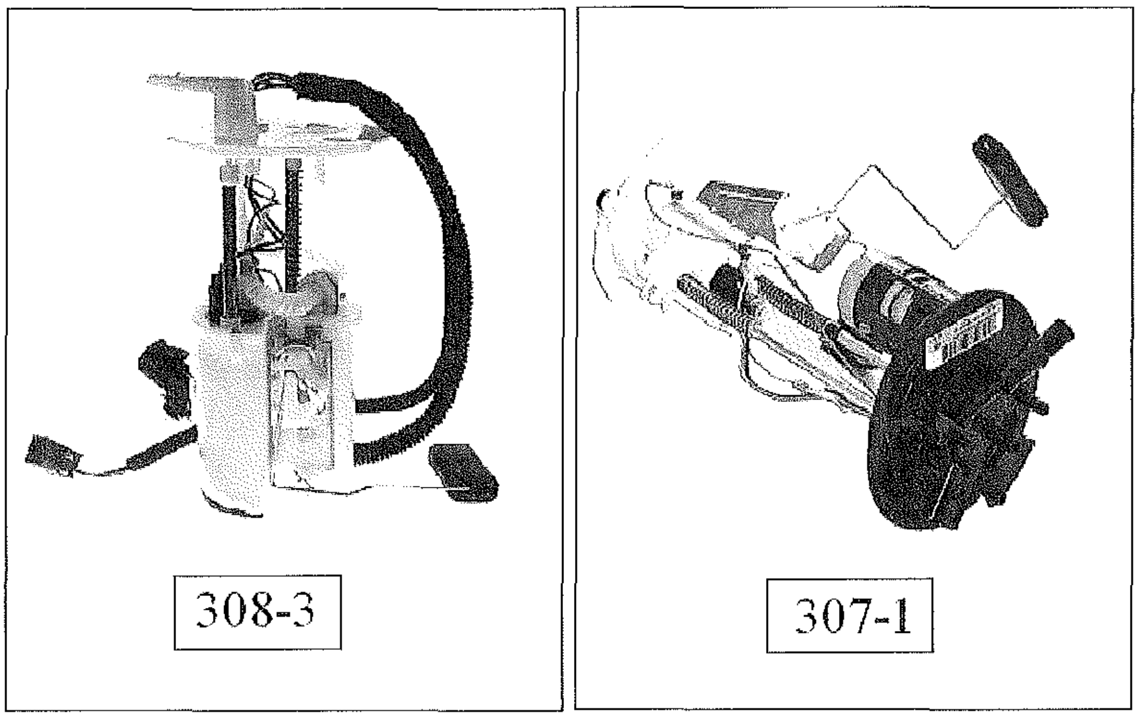

FIGURE 3 – Work Cell Products

The individual job descriptions are reviewed to compare how the assembly of the final product is achieved. The final products are similar in appearance and performance, but that is not an indication that the assembly steps are similar enough for the study. A list of the job titles in order of sequence is listed in TABLE VI. The list of jobs is specific for the highest volume model in each of the cells. The additional models vary by internal components to the pump (assembled at a supplier), the length of convoluted tubes (supplier), and the length of the support rods (built in house in different department, 312). These changes are due to the variations in engines and the fuel tank capacities of their respective vehicle models, i.e. 13 gal, 17 gal fuel tank. The variations impact the production by minor modifications to the clamps and testing fixtures only.

TABLE VII

WORK CENTER JOB COMPARISON

Non-rotational		Rotational	
*1	Flange Assy/Float Rod	*1	Regulator Testing
2	Helium Leak Test	2	Rod Press
*3	Sub- Build	3	Leak Test
4	Heat Shrink	4	Conv Hose/Regulator Assy to flange
*5	Regulator Assy and ESD Clip	5	Reservoir Flange Assy
6	FLVV Assembly and Test	6	Regulator to the Reservoir
7	Pump Bracket Assy	7	Support Tube to Reservoir
8	Filter and Conv. Hose to Pump	*8	Card to case/Float Rod Assy
9	End Cap	*9	Sub-Build
10	Conv. Hose to Flange	10	Heat Shrink
11	2nd Conv. Hose to Flange	11	Sub Screw and Wire Wrap
12	Pressure Test Subscrew	12	Assy Leak Test
13	Check Plate	13	Check Plate

* indicates an off line operation, still included as a job available for rotation

The job descriptions for each operation in either cell can be found for both products in APPENDIX III. Comparing these reveals that there operations are similar. The differences lay in how the operations are sequenced inside the respective work cells. This causes some situations where processes in the non-rotational cell can not be directly compared to their counterpart in the rotational cell due to the steps before and after. However the operation can be isolated and is contained inside both cells and is available for review when looking at the cells at the elemental level. A specific situation of this occurs in the non-rotational operation of *Pressure Test Subscrew* and the rotational cell operation of *Sub Screw and Wire Wrap*. The operations of picking up the screw placing it in the head of driver, position the pink wire, and seating the screw are the same. The orientation of where the screw is seated along with the additional is what causes the variations to be present.

Another consideration is how the work stations and cells are laid out. The arrangement of the equipment and the flow of materials are similar between the two work centers. The layout contributes to the similarities between the different processes.

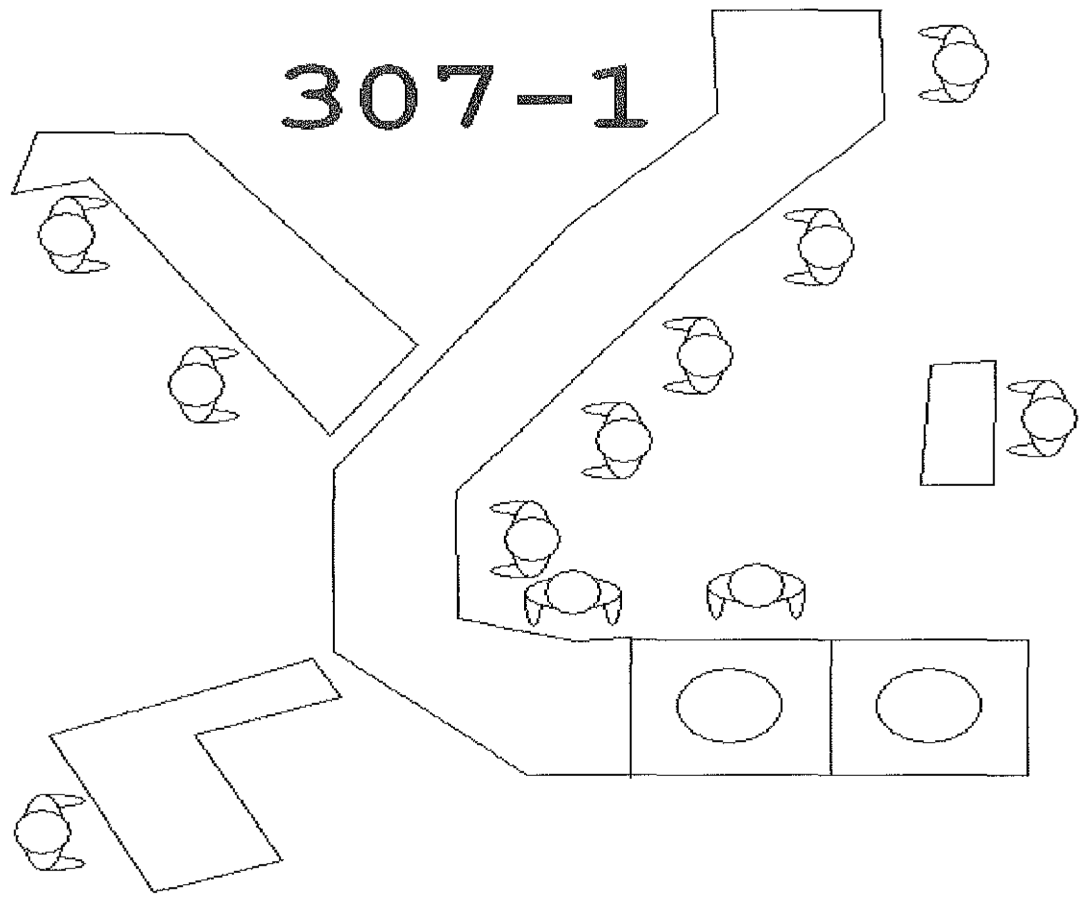

FIGURE 4 – Work Center 307-1 Layout

The materials flows of the processes both uses one piece flow and are passed from operator to operator directly. Each work center also has sub-assemblies that join in line with the main component.

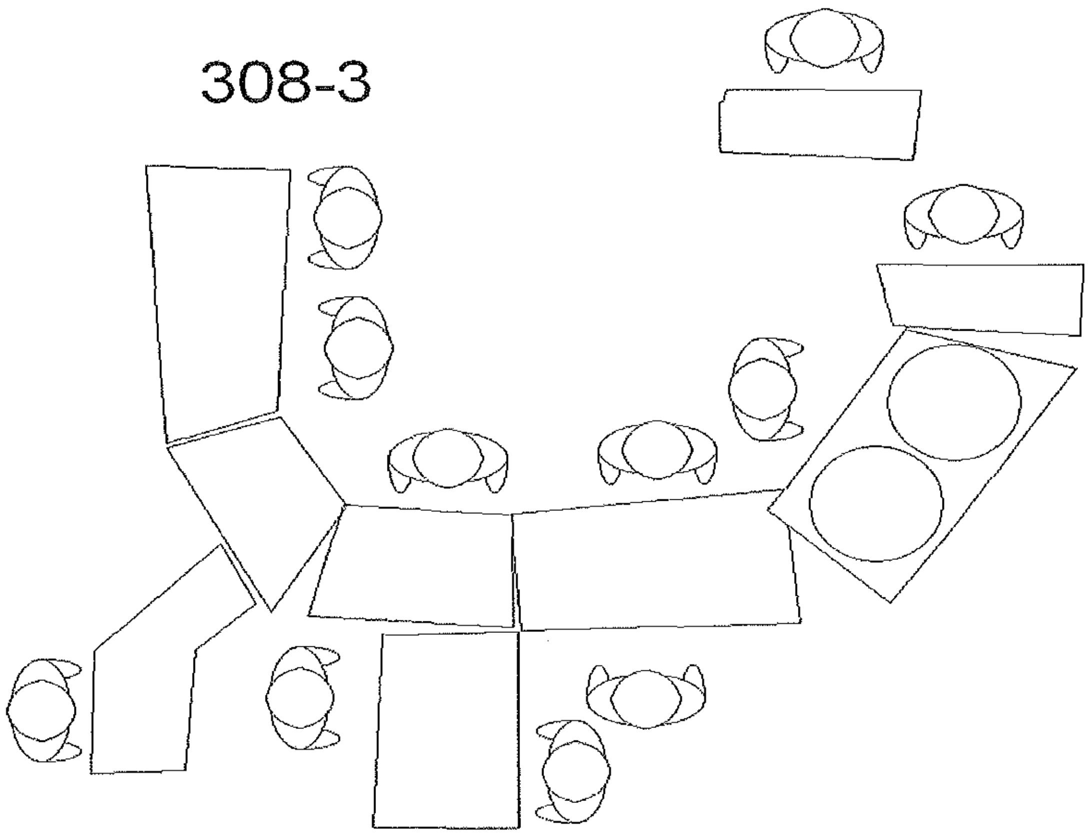

FIGURE 5 – Work Center 308-1 Layout

The operations have been established to best balance the workload across the work cell and with respect to the takt time. It is not possible to be completely even across the entire department due to complexity of different components, quality specifications, along with the engineering requirements. This level of unevenness is best illustrated by the inherit delay available to some operations and not in others. The inherent delay is directly related to operations waiting on their predecessor in the cell to complete a part so they are able to begin work or the successor to complete a part so they may pass the part.

The selection of department and cells to be utilized for the study is established to consist of 308-3 and 307-1. The production models used will be the current production models for each cell respectively. The second shift operating from 7:00 am until 3:30 pm is chosen. The operating schedules are consistent and have the same duration for break periods and lunch periods

B. Ergonomic Risk Assessment

The jobs themselves are reviewed first in description of movements and actions to determine the level of compatibility among the cells. The job titles are the same listed in TABLE VI in the proper process flows. The operations appear to be similar in many attributes based on the evaluation of the cells prior to selection. The analysis of the impact that is being placed on the operator can be evaluated by selecting any of many software applications designed to evaluate the cumulative impact on the body, including the NIOSH Lifting equation, Rodgers/Kodak fatigue analysis, RULA, Strain Index, and more.

In this study the Rodgers/Kodak fatigue analysis is used due to its versatility and proven reliability in manufacturing applications, it has also been utilized in other facilities owned by the company.

Applying the Rodgers/Kodak fatigue analysis requires the study of the operator in their surroundings during normal operations. The software provides a survey to be performed while observing. A copy of a blank survey can be found in APPENDIX II. The survey requires the analyst to view many repeated cycles. The repetition is important because Rodgers/Kodak bases the movements on increments during the duration of one minute. This will require reviews of multiple operators in the rotational work cell to develop an accurate representation of the operations. Additional information can be discovered by reviewing the work standard generated by the Industrial Engineer. The work standard will have information related to repetition of operations and the production targets for a shift. The use of the work standard will also provide information if the operator is performing above, below, or at the expected level when the survey is completed. A nominal level is ideal and should be achieved when possible so not to increase the rate of fatigue. The ideal rate is what is targeted by the work standard and is capable due to the consideration of the takt time when the standard was developed. A low level of production is not considered to be more fatiguing but will cause the production to suffer inside the cell and can affect other operators inside the cell by increasing the inherent delays. Situations of below production are rare due to close monitoring by management, the decrease in production causes conflicts with order fulfillment.

The results of the Rodgers/Kodak analysis did not reflect the hypothesis and the support of the documented CTD. A re-evaluation of what component(s) in Rodgers/Kodak fatigue analysis skewed the results is necessary. Sample results of the Rodgers/Kodak fatigue analysis completed survey and score is listed in APPENDIX II. Viewing the surveys it is clear that the operations due not generate the fatigue levels expected.

TABLE VIII

307-1 RODGERS/KODAK ANALYSIS RESULTS

Rodgers Kodak Low=1 Moderate=2

	Non-rotational	Neck	R. Shoulder	L. Shoulder	Back	R. Arm	L. Arm	R. Hand	L. Hand	R. Leg	L. Leg	R. Foot	L. Foot
*1	Flange Assy/Float Rod	1	1	1	1	1	1	1	1	1	1	1	1
2	Helium Leak Test	1	1	1	2	1	1	2	2	1	1	1	1
*3	Sub-Build	1	1	1	1	1	1	1	1	1	1	1	1
4	Heat Shrink	1	1	1	1	1	1	1	1	1	1	1	1
*5	Regulator Assy and ESD Clip	1	1	1	1	1	1	1	1	1	1	1	1
6	FLVV Assembly and Test	1	1	1	2	1	1	2	2	1	1	1	1
7	Pump Bracket Assy	1	1	1	1	2	1	2	1	1	1	1	1
8	Filter and Conv. Hose to Pump	1	1	1	1	1	1	1	1	1	1	1	1
9	End Cap	1	1	1	1	2	1	2	1	1	1	1	1
10	Conv. Hose to Flange	1	1	1	1	2	1	2	1	1	1	1	1
11	2nd Conv. Hose to Flange	1	1	1	1	2	1	2	1	1	1	1	1
12	Pressure Test Subscrew	1	2	1	1	2	1	2	1	1	1	1	1
13	Check Plate	1	1	1	1	1	1	1	1	1	1	1	1

TABLE IX

308-3 RODGERS/KODAK ANALYSIS RESULTS

Rodgers Kodak   Low =1   Moderate =2

	Rotational	Neck	R. Shoulder	L. Shoulder	Back	R. Arm	L. Arm	R. Hand	L. Hand	R. Leg	L. Leg	R. Foot	L. Foot
*1	Regulator Testing	1	1	1	1	1	1	1	1	1	1	1	1
2	Rod Press	1	1	1	1	1	1	2	2	1	1	1	1
3	Leak Test	1	1	1	2	1	1	2	2	1	1	1	1
4	Conv Hose/Regulator Assy to flange	1	1	1	1	2	1	2	2	1	1	1	1
5	Reservoir Flange Assy	1	2	1	1	2	2	2	2	1	1	1	1
6	Regulator to the Reservoir	1	2	1	1	2	2	2	2	1	1	1	1
7	Support Tube to Reservoir	1	2	2	1	2	2	2	2	1	1	1	1
*8	Card to case/Float Rod Assy	1	1	1	1	1	1	1	1	1	1	1	1
*9	Sub-Build	1	1	1	1	1	1	1	1	1	1	1	1
10	Heat Shrink	1	1	1	1	1	1	2	2	1	1	1	1
11	Sub Screw and Wire Wrap	1	2	1	1	2	1	2	1	1	1	1	1
12	Assy Leak Test	1	1	1	1	2	1	2	1	1	1	1	1
13	Check Plate	1	1	1	1	1	1	1	1	1	1	1	1

The reports of CTDs filed into the Medical database would indicate elevated levels of fatigue that would cause CTDs. The Rodgers/Kodak reports indicate low or moderate concerns of the current working condition. The results do not show the impact of having the operators seated during the duration of the work shift. The inclusion of the lower limbs is suspected to skew the analysis of the operations and set them at a lower fatigue level than actual. The decision is made to review the operations with the RULA tool that reduces the scoring impact of the lower limbs.

RULA focuses on the upper limbs and extremities as indicated by the name. The software provides a survey sheet that is performed during study of the operations. An example is in APPENDIX II. The advantage of RULA is the production of a numerical score that can be plotted to visually represent the severity of the operations. The analysis can result in single score or a composition of several scores. This is a very useful tool in deciding and reviewing the rotational pattern of a department cell. An example from 307-1operations' Score C's are in FIGURE 3.

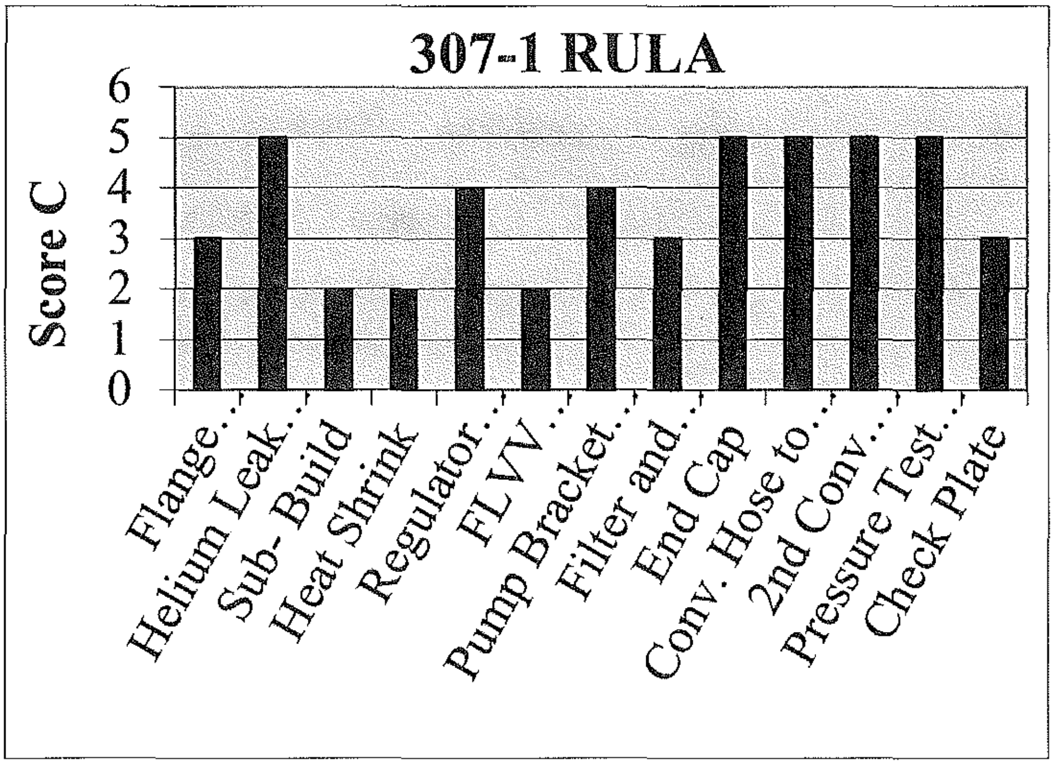

FIGURE 6 – Work Center 307-1 RULA Results

The identification of the high and low risk operations are immediate. The full analysis results are in APPENDIX II. The results aide in the development of the most beneficial rotation by alternating levels of fatigue. The rotations will be crucial to reduce fatigue by ensuring that the severity of muscle groups do not remain at elevated levels for consecutive operations.

C. Simulation Results

The simulated achievements of the current work cell operations produced results as would be expected in the production environment. Each simulation scenario was capable of running the sixty-five replications representing 3-months of production. A total of four simulations were performed representing current and alternative conditions for both work cells.

The initial simulations of the Rotational and the Non-rotational work cells establish the basis for future comparisons to the additional simulations. These simulations are representative of the current condition at the facility. The key performance indicators to be reviewed are the average time a piece was in a process, the accumulated time over the shift, the operator utilization, maximum process time, and minimum process time.

TABLE X

NON-ROTATIONAL PRODUCTION EVALUATION

		Average Mins		Mins	
Non Rotational	Operator Utilization	Process Time	Accumulated Processing Time	Max Process Time	Min Process Time
Flange Float Rod equ	71.0%	0.3486	312.39	0.3932	0
Helium Leak Test	75.0%	0.3683	330	0.4025	0
Sub Build	84.5%	0.4145	371.43	0.4448	0
Heat Shrink	53.6%	0.2613	234.16	0.3068	0
Reg Assy and ESD Clip	90.9%	0.4117	368.84	0.4876	0.3898
FLVV Assy and Test	77.3%	0.3798	340.3	0.4284	0.362
Pump Brckt Assy	88.6%	0.3798	340.34	0.4284	0.362
Filter and Conv Hose	95.2%	0.3713	332.68	0.4058	0.3596
End Cap	91.8%	0.4509	403.98	0.4674	0.4433
Conv Hose to Flange	63.1%	0.31	277.78	0.3371	0.299
2nd Conv Hose to Flange	84.5%	0.415	371.82	0.4651	0.3984
Pressure Test Subscrew	86.6%	0.4251	380.86	0.4751	0.4093
Check Plate	83.1%	0.408	365.54	0.4468	0.3959

TABLE XI

ROTATIONAL PRODUCTION EVALUATION

		Average Mins		Mins	
Rotational	Operator Utilization	Process Time	Accumulated Processing Time	Max Process Time	Min Process Time
Reg Test	0.5946	0.1704	152.71	0.1951	0.163
Rod Press	0.6185	0.2669	239.15	0.3053	0
Leak Tester	0.8219	0.3849	344.83	0.4402	0
Conv Hos Reg	0.8788	0.4183	374.83	0.4795	0.3998
Res Flange	0.7774	0.3561	319.1	0.4058	0.341
Reg to Res	0.8244	0.3778	338.47	0.4292	0.3618
Sup Tube	0.8867	0.4154	372.18	0.4762	0.3971
FR2C2C	0.6692	0.265	237.43	0.2946	0.2548
Sub Build	0.7771	0.3107	278.39	0.3551	0.2972
Heat Shrink	0.7597	0.3161	283.2	0.3607	0.3025
Sub Screw	0.9671	0.4711	422.15	0.5424	0.45
Assy Leak Test	0.7135	0.3476	311.42	0.3984	0.3324
Check Plate	0.5925	0.2886	258.61	0.3322	0.2757
Reg Assy	0.7367	0.3363	301.3	0.3828	0.3219

The modified simulations will be viewed as a comparison to the current condition. The information provides the current condition Non-rotational work cell (307-1) with the modification to the rotational manufacturing method. The production time is reduced to allow the rotation of operators to the different stations. The duration for a station change is the same as work cell 308-3, thirty seconds. The reduced production time still allows for the required amount of product and assumed quality of product was produced during a shift. The indicators are listed below, (+ = After Condition > Current, - = After Condition < Current):

TABLE XII

MODIFIED NON-ROTATIONAL PRODUCTION EVALUATION

Changes from Current		Average Mins		Mins	
Non Rotational	Operator Utilization	Process Time	Accumulated Processing Time	Max Process Time	Min Process Time
Flange Float Rod equ	-16.8%	-0.0845	-73.41	-0.1034	0
Helium Leak Test	3.8%	0.0155	13.86	0.0294	0
Sub Build	-8.6%	-0.1049	-94	-0.0934	0
Heat Shrink	23.7%	0.0536	47.98	0.0497	0
Reg Assy and ESD Clip	-16.7%	-0.2416	-216.47	-0.3246	-0.1967
FLVV Assy and Test	-3.9%	-0.1131	-101.32	-0.1254	-0.1064
Pump Brckt Assy	8.5%	0.0376	33.66	0.0468	0.0378
Filter and Conv Hose	1.8%	-0.0247	-22.1	-0.0133	-0.0272
End Cap	-1.2%	-0.0365	-32.68	0.0038	-0.0462
Conv Hose to Flange	21.9%	0.0454	40.7	0.0652	0.042
2nd Conv Hose to Flange	3.4%	-0.038	-34	-0.039	-0.0804
Pressure Test Subscrew	9.9%	0.0449	40.3	0.0623	0.0407
Check Plate	-24.0%	-0.1201	-107.56	-0.1182	-0.1202
Line Average	0.13%	-0.0436	-38.8492	-0.0431	-0.0351

Comparing the current results to the simulated results of the after condition reveals an increase of 0.13% has in operator utilization. The significance is in the increase is actually below what was expected by reducing the run time by 3.5 minutes (0.8%). The increase in downtime due to the rotation of operator did not impact the workstation at the expected percentage. The additional benefits of changing to the rotational production method show a decrease in all other key performance indicators related to time. This decrease is due to the ability of the operator to maintain a high level of performance for a longer duration throughout the shift as they operators are rotated to the different areas.

Further inspection of the individual results reveals the processes are extremely unbalanced in work load. The average cycle times have been reduced allowing for the potential of rest during the operations and between scheduled breaks, allowing the operator to maintain the higher level of performance.

The rotational work cell has been modified with the counter hypothesis method of production inside the facility, non-rotational. In the simulation the operators no longer were required to rotate among the different work stations inside the cell, increase the production time. The simulation implemented indicates the following impact to the current condition, (+ = After Condition > Current, - = After Condition < Current):

TABLE XIII

MODIFIED ROTATIONAL PRODUCTION EVALUATION

Changes from Current		Average Mins		Mins	
Rotational	Operator Utilization	Process Time	Accumulated Processing Time	Max Process Time	Min Process Time
Reg Test	38.9%	0.2436	218.26	0.3047	0.2268
Rod Press	36.5%	0.2159	193.4	0.21	0
Leak Tester	-7.0%	-0.0158	-14.08	-0.0304	0
Conv Hos Reg	-10.4%	-0.0379	-33.99	-0.0511	-0.0378
Res Flange	-14.5%	-0.0456	-40.9	-0.0687	-0.042
Reg to Res	2.1%	0.0375	33.62	0.0359	0.0371
Sup Tube	3.3%	0.0361	32.33	-0.0069	0.0462
FR2C2C	31.3%	0.0853	76.42	0.1084	0.077
Sub Build	20.7%	0.1046	93.7	0.0897	0.1072
Heat Shrink	-22.4%	-0.053	-47.47	-0.0416	-0.0567
Sub Screw	-9.8%	-0.0444	-39.85	-0.06	-0.0407
Assy Leak Test	4.5%	0.0249	22.34	0.0151	0.0272
Check Plate	24.1%	0.1206	108.06	0.121	0.1202
Reg Assy	24.6%	0.0776	69.58	0.117	0.0679
Line Average	7.64%	0.052	46.374	0.048	0.032

The operator utilization increased by 7.64% which is 8.44% more than increase in production minutes. Unlike in moving from the Non-rotational to the Rotational production method where all time-related key performance indicators were reduced this simulation represents the opposite condition. Now the operator is working for a longer duration each cycle of the process on average, decreasing the amount of rest.

Analyzing the fatigue that impacted each of the operators for the Non-rotational work center it is apparent that some operations are more demanding than others. TABLE XIII indicates the observations during the time studies of the operators' performance with respect to the cycle time. Many operators are capable of performing below 100% performance and not impacting production due to the unbalance of the operations at the various stations. Other operators must maintain a high level of performance throughout the shift to meet the production target for the shift. The mean or average performance for the entire shift is also recorded, along with the range of performance and the median.

TABLE XIV

NON-ROTATIONAL FATIGUE ANALYSIS

Current	Fatigue Analysis					Diff Start
Non Rotational	Start	Mean	Median	Range	Ending	and End
Flange Float Rod equ	95.0%	95.4%	97.5%	27.0%	80.0%	15.0%
Helium Leak Test	94.0%	96.1%	96.5%	21.0%	85.0%	9.0%
Sub Build	89.0%	91.8%	92.0%	12.0%	85.0%	4.0%
Heat Shrink	105.0%	102.0%	108.5%	30.0%	80.0%	25.0%
Reg Assy and ESD Clip	105.0%	98.4%	102.5%	29.0%	80.0%	25.0%
FLVV Assy and Test	95.0%	96.3%	96.5%	10.0%	90.0%	5.0%
Pump Brckt Assy	92.0%	94.8%	95.5%	21.0%	85.0%	7.0%
Filter and Conv Hose	98.0%	95.4%	96.5%	20.0%	83.0%	15.0%
End Cap	93.0%	92.3%	91.5%	8.0%	90.0%	3.0%
Conv Hose to Flange	90.0%	95.3%	94.5%	21.0%	85.0%	5.0%
2nd Conv Hose to Flange	88.0%	93.5%	93.0%	20.0%	84.0%	4.0%
Pressure Test Subscrew	102.0%	96.9%	98.5%	25.0%	85.0%	17.0%
Check Plate	104.0%	100.3%	101.5%	20.0%	92.0%	12.0%
Line Average	96.2%	96.0%	97.3%	20.3%	84.9%	11.2%

The starting fatigue ranges from 88% to 105% of the respective operations. The ending fatigue ranges from 80% to 92% of the respective operations inside the work center. The operation that initially started the lowest (2nd Conv Hose to Flange) does not finish the lowest of the operations, indicating that the operation is not the most demanding from a fatigue standpoint. The demanding operations are the operations that have the lowest range of performance. These operations can not decrease significantly and be able to still produce the required amount. The high level performance requirements throughout the shift are the most taxing on an operator and are the areas of concern. The End Cap and the FLVV Assy and Test operations have the two lowest ranges of performance. The FLVV Assy and Test is expected due to it being the constraint of the work cell and End Cap operation is the operation immediately following it. The low amount of range indicates that the operator must remain focused and on task throughout the course of the shift.

The average of the non-rotational work cell is listed at the bottom of TABLE XIV. The mean of the operations is actually below the average starting point for the work cell. The starting point is the highest level of performance during the course of the shift. The line average represents the entire line because the operators are sharing the fatigue of the more and less demanding operations thought the shift.

TABLE XV

ROTATIONAL FATIGUE ANALYSIS

Current	Fatigue Analysis					Diff Start
Rotational	Start	Mean	Median	Range	Ending	and End
Line Average	95.0%	99.8%	102.0%	25.0%	85.0%	10.0%

The Rotational work cell has a higher mean, higher median, higher ending point when reviewing the shift performance. The one negative when comparing Rotational production method to the Non-rotational work cell is that the starting point is less. The Rotational work cell is able to overcome the lower starting performance and provide a higher performance over the duration of the shift. The operators are capable to absorb fluctuation of the line and have the ability to perform throughout the shift with expected results as a whole work center not as individuals at individual operations.

The rotational production method applied to the Non-rotational work cell provides same capability to absorb fluctuation and share the workload. The modified operation cycle times are influenced by the reduction in fatigue. The production is achieved while reducing the operators physical burden.

The change of the Rotational work cell to the non-rotational work cell the operators no longer are able to walk away with the same impact. The review of the individual ending of each of the operations is shown below.

TABLE XVI

ROTATIONAL WORK CENTER EFFICIENCY CHANGES

	Original			**Counter Proposal**		
Rotational	Start	Mean	Ending	Start	Mean	Ending
Reg Test	95.0%	99.8%	85.0%	105.0%	98.4%	80.0%
Rod Press	95.0%	99.8%	85.0%	95.0%	96.3%	90.0%
Leak Tester	95.0%	99.8%	85.0%	94.0%	96.1%	85.0%
Conv Hos Reg	95.0%	99.8%	85.0%	92.0%	94.8%	85.0%
Res Flange	95.0%	99.8%	85.0%	90.0%	95.3%	85.0%
Reg to Res	95.0%	99.8%	85.0%	88.0%	93.5%	84.0%
Sup Tube	95.0%	99.8%	85.0%	93.0%	92.3%	90.0%
FR2C2C	95.0%	99.8%	85.0%	95.0%	95.4%	80.0%
Sub Build	95.0%	99.8%	85.0%	89.0%	91.8%	85.0%
Heat Shrink	95.0%	99.8%	85.0%	105.0%	102.0%	80.0%
Sub Screw	95.0%	99.8%	85.0%	102.0%	96.9%	85.0%
Assy Leak Test	95.0%	99.8%	85.0%	98.0%	95.4%	83.0%
Check Plate	95.0%	99.8%	85.0%	104.0%	100.3%	92.0%
Reg Assy	95.0%	99.8%	85.0%	105.0%	98.4%	80.0%
Line Average	95.0%	99.8%	85.0%	96.8%	96.2%	84.6%

Unbalancing the impact of fatigue will highlight the operations that are less fatiguing than others. The Rotational work cell moving to non-rotational now requires production to perform at a higher rate and then rapidly degenerates. There is an average increase of a 2.2% in fatigue. The impact related to the 440 minutes of operation time is equivalent to an additional 9.68 minutes of operations that gain no additional units or added value.

V. CONCLUSION

This thesis has presented an analysis of the outcome of modifying the manufacturing method in a small component assembly plant. The focus was the success of moving from a non-rotational manufacturing method to a rotational manufacturing method. The results and recommended next steps are summarized in the following sections.

A. Plant Research

The thesis was able to consider all areas of the facility. There was no reason to exclude an area of manufacturing from the initial inquiry. Each department consisted of duplicate work cells that produced similar products and also some products were similar across departments. The criterion of most importance was related to the selection of the manufacturing methods. The insurance of selecting two work cells that utilized different manufacturing methods was the basis of the thesis. Utilizing two different work cells allowed for a comparison of manufacturing methods and production. The work cell by work cell evaluation considered all elements that impact production. Searching for similar final products and similar number of workforce contributed to the decision of which areas medical records are investigated. The medical information was a beneficial resource for analysis. All names of individuals are kept confidential only information related to the injury/illness is disclosed. The medical information provided significant data in identifying work cells for comparison. When investigating the medical information it allowed for an initial confirmation of how a rotation work cell was having less medical recordable incidents than a non-rotational work cell.

The creation of the simulation represented the current and proposed after conditions of the work cells. Changing the manufacturing process was not possible due to the risk of loss of production and the work force contractual agreement. The decision on which type of manufacturing method was applied to a work cell was agreed upon by the company and the labor union.

The work cells and the medical information allowed for the interaction of various levels of workforce at the facility. Various departments inside the company were contacted for data related to the study; staffing, medical, production, and volumes. Being an Industrial Engineer at the facility I had access to documents and standards. The line engineers' experience and knowledge of the assembly lines provided any missing information. The interactions and information that was done for the creation of the thesis created a better more open work environment. The discussions on the plant floor were vital to the success of this thesis and aided the responsibilities of the IE position.

B. <u>Results</u>

The use of rotational manufacturing is an allowed temporary solution for OSHA until an operation can undergo a proper review and have the element that is potentially harmful be completely removed. The use of rotational manufacturing does not allow for the operation to be corrected but tries to minimize any impact to one associate by sharing the burden over many. The goal of the thesis is to look at rotational manufacturing as an opportunity to increase performance by reducing fatigue of the operators. The results of the simulation achieved this outcome. The Arena software simulated the additional time incurred for moving stations would not impact the production, it also showed that production was able to perform more efficiently for a longer duration of time. The selection to utilize the rotational method comes from the analysis of medical data. The lower number of CTDs in the rotational work centers versus non-rotational work centers is demonstrated.

Programming the simulation to compare the two processes proved to be difficult. The most difficult aspect involved modeling the one piece flow that is the standard for both types of manufacturing processes. The process required establishing conditional statements that would only allow one associate to be available to work on a new part if and only if the process that followed was able to take the current part in the work station. This allowed for a single piece flow to minimize the amount of work in process and to also reduce the over handling of products. This policy is implemented to reduce wasted movements and reduce the potential of damaging of the components or assembled parts. The use of the simulation allowed for a seize delay to represent the selection of a new part and the processing required at a work station. The release was then utilized when the next process in the sequence was available to receive a new part. The limits of the student version of the software, caused some difficulties. The student version limits the amount of processes that can be simulated. Each process was represented by three processes. Additional process increases came from the creation, matching, and the removal of sub assemblies. The removal was required because due to an entity restriction in the student version.

It was the intention that if the simulation could successfully show the rotational manufacturing method running in the non-rotational work cell then it would be clear that the amount of CTDs would be decreased. This is simple by taking the number of exposures to any negatively impacting work element and reducing the number by a factor of total associates in the work cell. As with any simulation of such a significant change in a manufacturing method the assumption needs to be stated that the associates would be able to perform at the levels of the current associate responsible for the job and receive the same benefits of the rotational worker. The current level of performance is direct enough to understand that it is a 1 to 1 replacement of associate performance. The other component that is being assumed is the use of the rotational manufacturing method is going to "energize" the workforce. An element that is significant in the development of the assumptions is the actual products. The products are for different models but their purpose and function was the same. The final vehicle was very similar the difference was in the powerplant, engine. The models each were to be used for a vehicle that used an I4 motor as the base powerplant and had an option V6 motor as the higher end level. The fuel tanks were both rear located and required a similar motor. The applications being for the same purpose and having so many similarities allowed for a successful comparison.

In a decision to opposite of the hypothesis the rotational work cell was simulated as a non-rotational work cell. The outcome proved that with the increased fatigue required more utilization of the workforce. The most problematic operations related to push, pinch, and force causing isolated operations that decreased at quick rate than the average of the work cell. The capacity to perform the required number of operations is still capable but the inherit delay has been reduced the capability to increase performance through changing the manufacturing method is very beneficial. This concept allows a manufacturing environment to increase performance through a varying production schedule. This also increase the flexibility of the work force in their capabilities of absorbing changes in production quantities and also changes in attendance.

C. Alternative Opportunities

Reviewing the process of developing the thesis several areas could have been accomplished in a different manner potentially impacting the results. The first is the selection of the work centers for comparison. An area for consideration was the experience levels of the operators. The reason for not allowing this criterion is in keeping a level ambiguity in the identity of the workers. A newer worker to the area will endure a time period of "work hardening" where muscles and joints because accustom to the demands of the operations. During this period of time an associate is more likely to incur an injury that can be diagnosed as an illness (CTD).

The selection of the ergonomic analysis tool could change the outcome. This is very evident in the report due to the selection of second ergonomic evaluation tool. The selection of the Rogers/Kodak as the first step of analysis was based on what was being used at facility as the first step in the evaluation process of an ergonomic concern. The idea is that it is the most user friendly, consistent, and reliable of the tools that were available. If starting with the Liberty Mutual or the NIOSH Revised Lifting Equation the results may not have required additional analysis. The alternatives where available but where not selected because of previous experience with Rodgers/Kodak. RULA was selected based on the review of the process. The limited or no use of the lower extremities required a tool to reflect such. The thesis could be redone many, many times again with every item the same except for the analysis tool. The results that were selected from RULA were deemed to be practical and plausible and passed the sanity check.

The dismissal of the work cells that were producing service components as the main production components was a decision easily accessible, available data. The complication in allowing a service work cell to be selected is the variety of work elements that occur in a shift, week, month, and year. The analysis would need to consider all products, quantities, and type of production. Each product required a full evaluation of every operation. The number to evaluate is staggering and how each operation could contribute to a reported CTD is not feasible.

D. Next Steps

Continuing inside the facility the suggested focus is on developing the ideal condition for rotating inside a work cell. Developing a database allows the creation of a matrix that pairs operations in a rotation schedule to not use similar muscle groups. The database would allow for the scheduling of a workers rotation to be the most beneficial. The database would be created by using the results of the RULA ergonomic evaluations performed in the study. The current rotational work cells could see the results of the new schedules. A non-rotational cell would develop a training/teaching schedule to fully train the associates before implementing a rotational schedule. The development of the training schedule will focus on only allowing operators to rotate to stations that they are proper trained. The evaluation of skills would be a direct visual tool that both supervisor and associate understand; an example is presented in Figure 7.

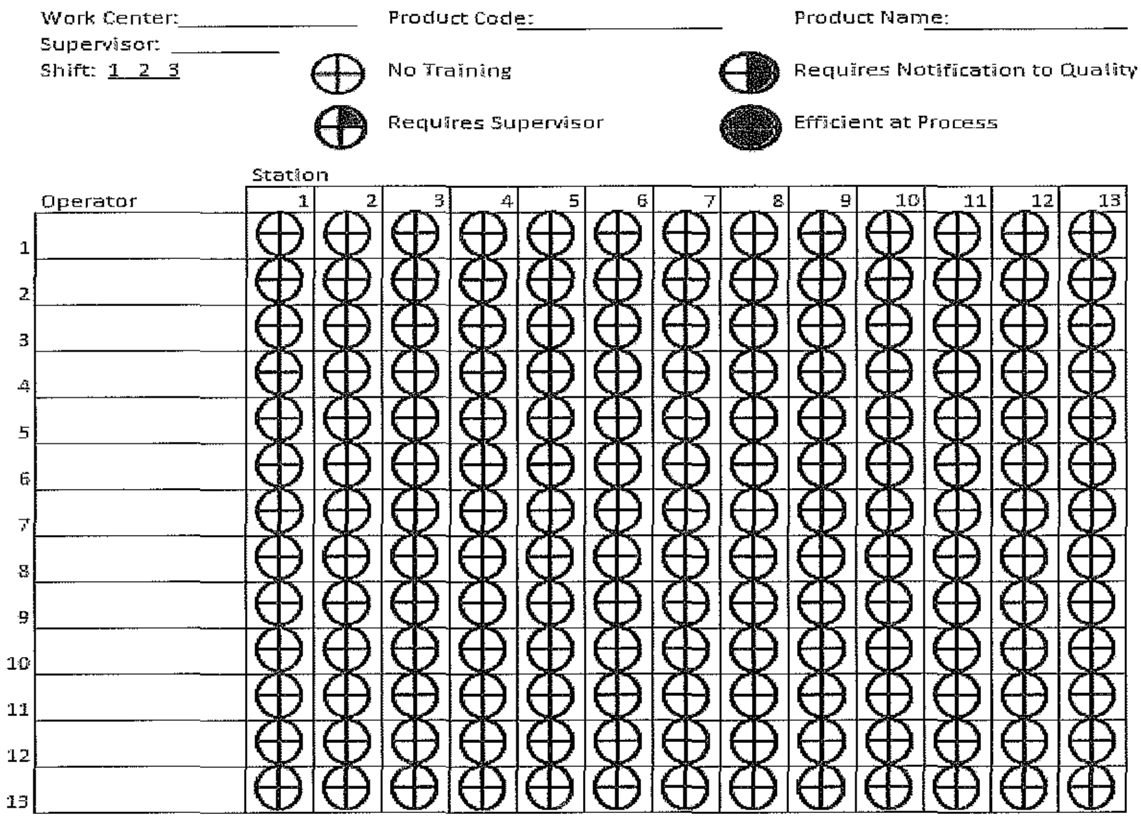

FIGURE 7 – Training Matrix

The investigation would address the unbalance of the work elements assigned to the operations. The rebalance of the line would allow for the associate to be utilized to fullest potential for the duration of the tact time. This will positively impact the work center from both the personnel and business side. A tool that can be used to identify the delays in the system is a Yamazumi table. A Yamazumi table stacks operation elements by the time elements and reflects them against a tact time. The table will show which operations will exceed the tact time and which operations have available production time. Standardized work is critical in using the Yamazumi tool effectively. A similar tool is a Balance Chart that represents the total sum of time for operation. FIGURE 4 is a Balance Chart of Work Cell 308-3. This is a visual tool that easily shows the capacity left in each process.

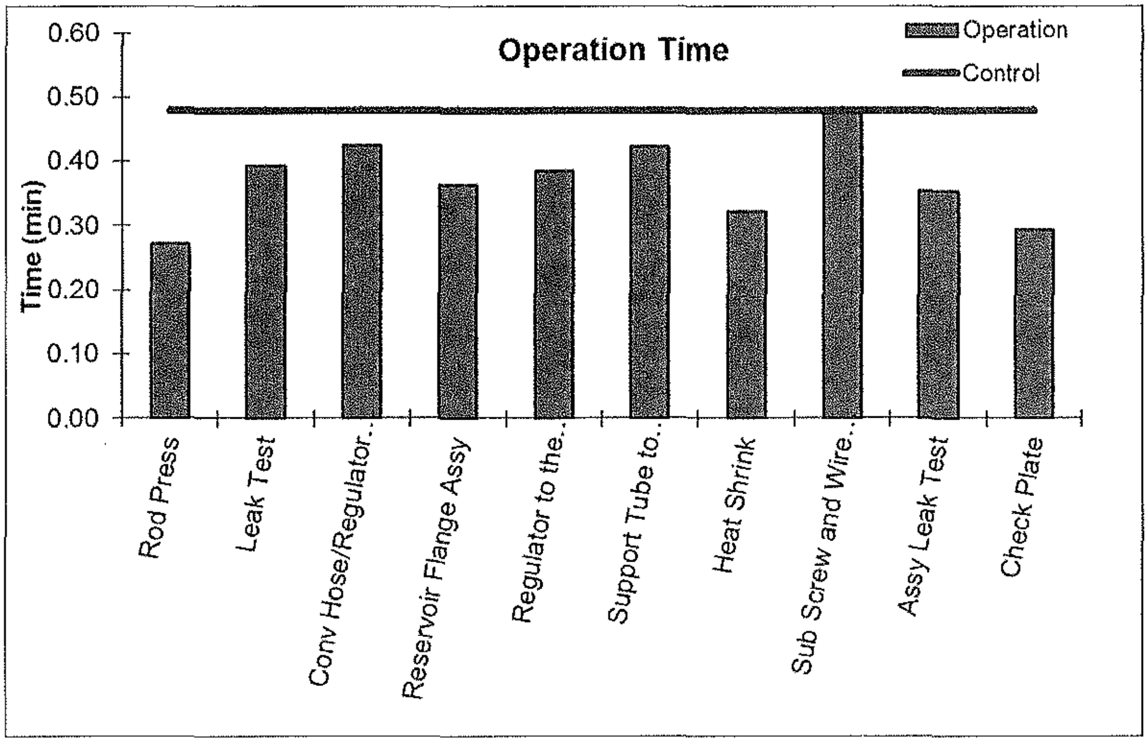

FIGURE 8 – Rotational Balance Chart

The process currently is operating with a 77.5% efficiency. This is caused by the non production time of the work center. The time wasted is 1.08 minutes each cycle of operation. The operation needs to be evaluated against the takt time or in this situation the "Control" to determine the ideal number of operators or ∑CT.

(1) ∑CT = Total Operation Time ÷ Takt Time(Control Time)

The "Control" is operating at rate of 0.48 minutes and the Total Operation Time is 3.71 minutes. The ∑CT is 7.75 Operators. It is not possible to utilize only 0.75 operators each cycle the number of operators is rounded to 8.

The following figure represents 308-3 after the elements have been redistributed to improve efficiency. The difference has created an increase of efficiency to 96.7% utilization an increase of 19.2%. FIGURE 5 illustrates the elimination of two processes due to the absorption of the work elements by the process that have excess work capacity not being utilized.

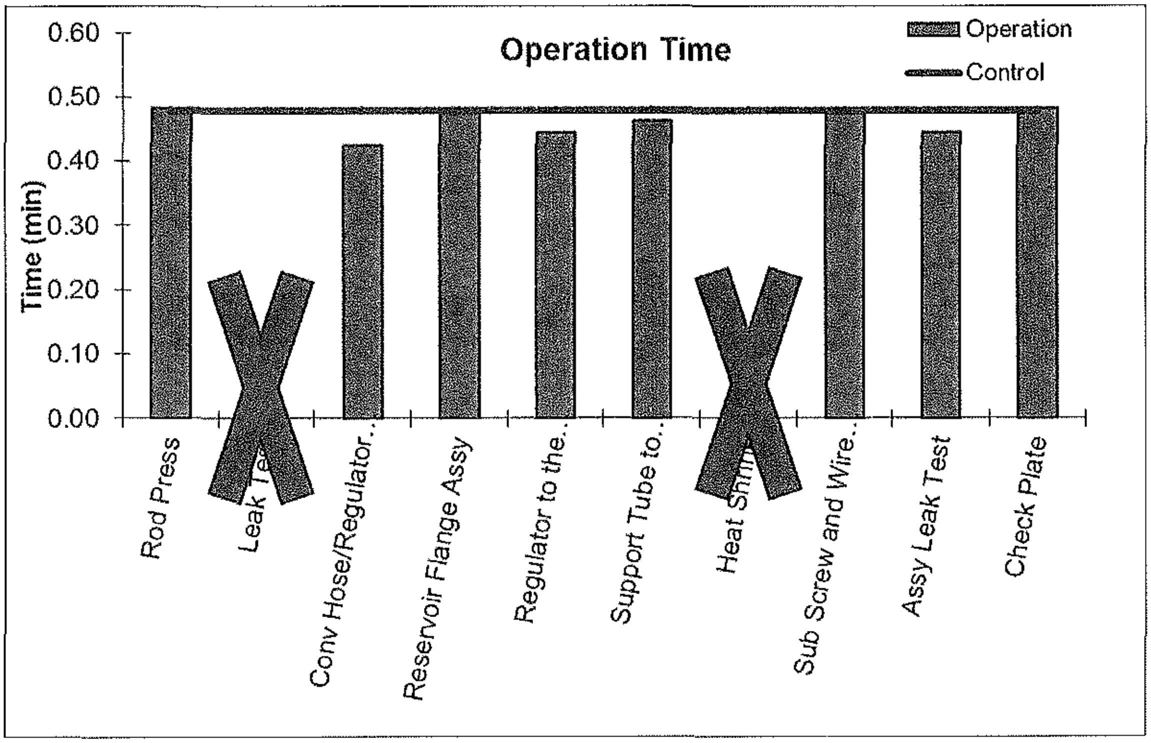

FIGURE 9 – Rotational Balance Chart After Condition

The benefits for the business side is the possibility of reduction of labor, the decrease of work in process, the reduction in material handling, the reduction in quality defects related to material handling, and better visibility of work cell performance. This is a much simpler process on paper than it is in reality. Investment of time, engineering, training and money will be required to gain the full benefits of the two process reduction. The idea is that any expenses will be recovered and a profit will be generated by the savings in labor. If this work center was modified by reducing two processes the budget to have the return on investment be realized in 3 months would be $36,535. That is a savings of $70.26 each hour of production. The labor cost impact is easily recognized by the reduction of processes, the additional benefits are related to the management of the work center. Creating a more efficient work center requires the processes to be more reliable and have available support when required. The abnormalities of the work center become more visible with a higher efficiency of operation. There is no longer an available 1.08 minutes each cycle to absorb fluctuation in production.

The processes must follow standardized work to fully realize the benefits of the process reduction. Standardizing each process identifies abnormalities. The proper enforcement and understanding needs to be communicated of how the work cell no longer can absorb abnormal conditions. This is a unique situation for team members and management, there is more urgency placed on correcting an abnormal condition, but the ability to identify abnormal conditions has been increased. The time to change the process to eliminate the same abnormal has been awarded. Change point management has been created as a byproduct of development of standards.

Developing standards, visualizing the system and reducing the labor costs is improving the survival of the company as a whole. The impact to the individual team members and management is increasing their knowledge. The decision to change to leaner production needs to be supported from all levels of management. The initiative must not only be seen in meetings and viewed on charts but must be exemplified by management and team members. The change to this type of manufacturing system is not a simple change of priorities but is a significant cultural change inside the work environment. This is a change that will have challenges along every step and every decision. This is why it is critical that the standards are created and are enforced.

Applying the recommendations will grant the business a more knowledgeable, leaner working environment. The business and the associates will both benefit from shared success.

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APPENDIX I. MEDICAL DATA

INJURY/ILLNESS DAILY LOG REPORT

Jan. 2005

Report Parameters:

Office of Visit	: Bedford Medical Office	Case Type	: All
DROT	: All	Department	: All
Occ/Non Occ	: Occupational	First Time of Visit	: Yes
Region/Country/State	: North America,United States,Indiana	Facility	: Bedford
Date Range	: 01/01/2005 00:00 To 01/31/2005 23:59	Investigation Status	: All

Case No.	: 2005-003-00177	Case Type Name	: Occ - First aid
Employee's Name	:	Recorded By	:
Inj/Ill Type	: EPICONDYLITIS	Injury/Illness	: Illness
State	: Indiana	Facility Name	: Bedford
IH Indicator	: No	ERGO Indicator	: No
OSHA Indicator	: No	Department/DROT	: 319022

Patient Statement : States my lt elbow has been hurting since a week before shutdown when I was squeezing a paste gun that wasn't working well. 319-2.

Visit Code	: 2005-003-00417	Disposition	: Return To Work (working)
Date of Visit In	: 1/3/05 2:30:00PM	Date of Visit Out	: 1/3/05 2:45:00PM
Revisit Required	: No	Revisit Date	:
Office of Visit	: Bedford Medical Office	Recorded By	:
Primary Body Part	: ELBOW LEFT	Primary Diagnosis	: Epicondylitis CTD

Total No. of Visits for Case 2005-003-00177 : 1

Case No.	: 2005-004-00150	Case Type Name	: Occ - First aid
Employee's Name	:	Recorded By	:
Inj/Ill Type	: SPRAIN/STRAIN (Injury)	Injury/Illness	: Injury
State	: Indiana	Facility Name	: Bedford
IH Indicator	: No	ERGO Indicator	: No
OSHA Indicator	: No	Department/DROT	: 307022

Patient Statement : States I lifted a box of FLVV's from the floor and felt a pop in the front of my left shoulder. My hand feels tingly. I already had a stiff neck when I woke up this morning.

Visit Code	: 2005-004-00334	Disposition	: Return To Work (working)
Date of Visit In	: 1/4/05 9:30:00AM	Date of Visit Out	: 1/4/05 9:50:00AM
Revisit Required	: No	Revisit Date	:
Office of Visit	: Bedford Medical Office	Recorded By	:
Primary Body Part	: SHOULDER LEFT	Primary Diagnosis	: Strain/Sprain

Total No. of Visits for Case 2005-004-00150 : 1

Case No.	: 2005-007-00237	Case Type Name	: Occ - First aid
Employee's Name	:	Recorded By	:
Inj/Ill Type	: SPRAIN/STRAIN (Illness)	Injury/Illness	: Illness
State	: Indiana	Facility Name	: Bedford
IH Indicator	: No	ERGO Indicator	: No
OSHA Indicator	: No	Department/DROT	: 302033

Patient Statement : I HAVE HAD PAIN IN MY RIGHT WRIST EVERY TIME I BEND IT SINCE MONDAY. I WORK IN 302-3 CELL 2. MY JOB IS THE SAME AS BEFORE.

Visit Code	: 2005-007-00471	Disposition	: Return To Work (working)
Date of Visit In	: 1/7/05 5:15:00PM	Date of Visit Out	: 1/7/05 5:35:00PM
Revisit Required	: No	Revisit Date	:
Office of Visit	: Bedford Medical Office	Recorded By	:
Primary Body Part	: WRIST RIGHT	Primary Diagnosis	: Strain/Sprain CTD

Total No. of Visits for Case 2005-007-00237 : 1

Case No.	: 2005-011-00066	Case Type Name	: Occ - OSHA Record - Rest. Days Only
Employee's Name	:	Recorded By	:
Inj/Ill Type	: SPRAIN/STRAIN (Injury)	Injury/Illness	: Injury
State	: Indiana	Facility Name	: Bedford
IH Indicator	: No	ERGO Indicator	: Yes
OSHA Indicator	: No	Department/DROT	: 309033

Patient Statement : Per Med Tx Worksheet from Security: EE said that he was lifting some tubs in his department and his right hip area began to hurt. He said it felt like he "strained something".

Visit Code	: 2005-011-00104	Disposition	: Return To Work (working)
Date of Visit In	: 1/10/05 10:50:00PM	Date of Visit Out	: 1/10/05 10:55:00PM
Revisit Required	: No	Revisit Date	:
Office of Visit	: Bedford Medical Office	Recorded By	:
Primary Body Part	: HIP RIGHT	Primary Diagnosis	: Strain/Sprain

Total No. of Visits for Case 2005-011-00066 : 1

Case No.	: 2005-012-00071	Case Type Name	: Occ - First aid
Employee's Name	:	Recorded By	:
Inj/Ill Type	: BURN - 2nd DEGREE	Injury/Illness	: Injury
State	: Indiana	Facility Name	: Bedford
IH Indicator	: No	ERGO Indicator	: No
OSHA Indicator	: No	Department/DROT	: 319022

Patient Statement : I was running the benz robot and checked a hot weld at the bracket. The hot weld burned thru my ROC glove and burned my right thumb.

Visit Code	: 2005-012-00127	Disposition	: Return To Work (working)
Date of Visit In	: 1/12/05 7:35:00AM	Date of Visit Out	: 1/12/05 7:58:00AM
Revisit Required	: No	Revisit Date	:
Office of Visit	: Bedford Medical Office	Recorded By	:
Primary Body Part	: THUMB RIGHT	Primary Diagnosis	: Burn; 2nd Degree

Total No. of Visits for Case 2005-012-00071 : 1

Case No.	: 2005-014-00147	Case Type Name	: Occ - First aid
Employee's Name	:	Recorded By	:
Inj/Ill Type	: EPICONDYLITIS	Injury/Illness	: Illness
State	: Indiana	Facility Name	: Bedford
IH Indicator	: No	ERGO Indicator	: No
OSHA Indicator	: No	Department/DROT	: 308022

Patient Statement : My left elbow has been bothering me of and on for over a year. I think it is from work in dept 308 cell 1. It hurts whenever I have to pick up the bottom mount module with my left hand.

Visit Code	: 2005-014-00242	Disposition	: Return To Work (working)
Date of Visit In	: 1/14/05 8:50:00AM	Date of Visit Out	: 1/14/05 9:20:00AM
Revisit Required	: Yes	Revisit Date	: 1/20/05 12:00:00AM
Office of Visit	: Bedford Medical Office	Recorded By	:
Primary Body Part	: ELBOW LEFT	Primary Diagnosis	: Epicondylitis

CTP

Total No. of Visits for Case 2005-014-00147 : 1

Case No. : 2005-019-00066
Case Type Name : Occ - First aid
Employee's Name :
Recorded By :
Inj/Ill Type : PUNCTURE
Injury/Illness : Injury
State : Indiana
Facility Name : Bedford
IH Indicator : No
ERGO Indicator : No
OSHA Indicator : No
Department/DROT : 304011
Patient Statement : Per Med Tx Worksheet Security: As she was picking up a skid, a nail from the skid went into her right index finger. (Gloves Unknown)

Visit Code : 2005-019-00099
Disposition : Return To Work (working)
Date of Visit In : 1/19/05 5:00:00AM
Date of Visit Out : 1/19/05 5:10:00AM
Revisit Required : No
Revisit Date :
Office of Visit : Bedford Medical Office
Recorded By :
Primary Body Part : FINGER INDEX RIGHT
Primary Diagnosis : Puncture Wound

Total No. of Visits for Case 2005-019-00066 : 1

Case No. : 2005-019-00325
Case Type Name : Occ - First aid
Employee's Name : :
Recorded By :
Inj/Ill Type : CONTUSION
Injury/Illness : Injury
State : Indiana
Facility Name : Bedford
IH Indicator : No
ERGO Indicator : No
OSHA Indicator : No
Department/DROT : 313033
Patient Statement : I was putting a tube in the burnisher and it slipped, swung around and hit my R hand near my thumb. Dept. 313-3, Job: burnisher.

Visit Code : 2005-019-00611
Disposition : Return To Work (working)
Date of Visit In : 1/19/05 7:03:00PM
Date of Visit Out : 1/19/05 7:18:00PM
Revisit Required : No
Revisit Date :
Office of Visit : Bedford Medical Office
Recorded By :
Primary Body Part : HAND RIGHT
Primary Diagnosis : Contusion/Bruise

Total No. of Visits for Case 2005-019-00325 : 1

Case No. : 2005-020-00188
Case Type Name : Occ - First aid
Employee's Name :
Recorded By :
Inj/Ill Type : Back Symptoms/Illness
Injury/Illness : Illness
State : Indiana
Facility Name : Bedford
IH Indicator : No
ERGO Indicator : Yes
OSHA Indicator : No
Department/DROT : 307022
Patient Statement : States my lower back is hurting from bending up and down, lifting full boxes with 8-12 parts, wt unknown. Work as packer for cell 1 307. Cardboard service packs bother me the most.

Visit Code : 2005-020-00328
Disposition : Return To Work (working)
Date of Visit In : 1/20/05 11:21:00AM
Date of Visit Out : 1/20/05 11:38:00AM
Revisit Required : No
Revisit Date :
Office of Visit : Bedford Medical Office
Recorded By :
Primary Body Part : BACK LOWER
Primary Diagnosis : Pain, Complaint CTD

Total No. of Visits for Case 2005-020-00188 : 1

Report Printed On: 02/01/2005

Case No.	: 2005-025-00061	Case Type Name	: Occ - OSHA Record - Rest. Days Only
Employee's Name	:	Recorded By	:
Inj/Ill Type	: SPRAIN/STRAIN (Injury)	Injury/Illness	: Injury
State	: Indiana	Facility Name	: Bedford
IH Indicator	: No	ERGO Indicator	: Yes
OSHA Indicator	: No	Department/DROT	: 304011

Patient Statement : States I was lifting 2 layers of washers with another employee and I felt a pull in my lower back. The pain has gotten worse each day. I have pain into both legs, rt worse than lt.

Visit Code	: 2005-025-00103	Disposition	: Restriction Issued
Date of Visit In	: 1/25/05 6:45:00AM	Date of Visit Out	: 1/25/05 7:32:00AM
Revisit Required	: Yes	Revisit Date	: 1[illegible]
Office of Visit	: Bedford Medical Office	Recorded By	:
Primary Body Part	: BACK LOWER	Primary Diagnosis	: Strain/Sprain

Total No. of Visits for Case 2005-025-00061 : 1

Case No.	: 2005-026-00146	Case Type Name	: Occ - OSHA Record - Rest. Days Only
Employee's Name	:	Recorded By	: V
Inj/Ill Type	: TENOSYNOVITIS/TENDONITIS (Illness)	Injury/Illness	: Illness
State	: Indiana	Facility Name	: Bedford
IH Indicator	: No	ERGO Indicator	: No
OSHA Indicator	: No	Department/DROT	: 305022

Patient Statement : I HAVE PAIN IN MY RIGHT PALM AFTER REPEATED GRIPPING WITH BROKEN TIE STRAP CUTTER IN 305-2 CELL 1. I WAS GIVEN REPLACEMENT BUT IT WAS VERY TIGHT TOO. TODAY I CAN HARDLY GRIP THE CUTTER. I WAS GIVEN A NORMAL CUTTER TODAY.

Visit Code	: 2005-026-00239	Disposition	: Restriction Issued
Date of Visit In	: 1/26/05 9:12:00AM	Date of Visit Out	: 1/26/05 10:04:00AM
Revisit Required	: Yes	Revisit Date	: [illegible]
Office of Visit	: Bedford Medical Office	Recorded By	:
Primary Body Part	: HAND RIGHT	Primary Diagnosis	: Tendinitis CTD

Total No. of Visits for Case 2005-026-00146 : 1

Case No.	: 2005-026-00377	Case Type Name	: Occ - First aid
Employee's Name	:	Recorded By	:
Inj/Ill Type	: LACERATION	Injury/Illness	: Injury
State	: Indiana	Facility Name	: Bedford
IH Indicator	: No	ERGO Indicator	: No
OSHA Indicator	: No	Department/DROT	: 302033

Patient Statement : I cut my L index finger on a flange. I was wearing grey cloth gloves. Dept: 302-3, Job: wrap hoses.

Visit Code	: 2005-026-00630	Disposition	: Return To Work (working)
Date of Visit In	: 1/26/05 5:04:00PM	Date of Visit Out	: 1/26/05 5:19:00PM
Revisit Required	: No	Revisit Date	:
Office of Visit	: Bedford Medical Office	Recorded By	:
Primary Body Part	: FINGER INDEX LEFT	Primary Diagnosis	: Laceration

Total No. of Visits for Case 2005-026-00377 : 1

Case No. : 2005-026-00437 | Case Type Name : Occ - First aid
Employee's Name : | Recorded By :
Inj/Ill Type : SPRAIN/STRAIN (Illness) | Injury/Illness : Illness
State : Indiana | Facility Name : Bedford
IH Indicator : No | ERGO Indicator : No
OSHA Indicator : No | Department/DROT : 302033
Patient Statement : My R shoulder and R forearm are sore. I have been doing a job that makes my arm sore. Dept. 302-3, Job: pump, bracket, screw, screw gun.

Visit Code : 2005-026-00722 | Disposition : Return To Work (working)
Date of Visit In : 1/26/05 6:00:00PM | Date of Visit Out : 1/26/05 6:30:00PM
Revisit Required : Yes | Revisit Date : 1/27/05 [illegible]
Office of Visit : Bedford Medical Office | Recorded By :
Primary Body Part : SHOULDER RIGHT | Primary Diagnosis : Strain/Sprain CTD

Total No. of Visits for Case 2005-026-00437 : 1

Case No. : 2005-026-00450 | Case Type Name : Occ - First aid
Employee's Name | Recorded By
Inj/Ill Type : SPRAIN/STRAIN (Illness) | Injury/Illness : Illness
State : Indiana | Facility Name : Bedford
IH Indicator : No | ERGO Indicator : No
OSHA Indicator : No | Department/DROT : 302033
Patient Statement : I had tennis elbow in high school in 2001 and it started to flare-up yesterday. Do you have a band I can wear? Dept. 302-3, Cell: 3, Job: leak tester.

Visit Code : 2005-026-00742 | Disposition : Return To Work (working)
Date of Visit In : 1/26/05 6:37:00PM | Date of Visit Out : 1/26/05 7:15:00PM
Revisit Required : No | Revisit Date :
Office of Visit : Bedford Medical Office | Recorded By :
Primary Body Part : ELBOW LEFT | Primary Diagnosis : Strain/Sprain CTD

Total No. of Visits for Case 2005-026-00450 : 1

Case No. : 2005-027-00094 | Case Type Name : Occ - OSHA Record - Other
Employee's Name : | Recorded By :
Inj/Ill Type : CONTUSION | Injury/Illness : Injury
State : Indiana | Facility Name : Bedford
IH Indicator : No | ERGO Indicator : No
OSHA Indicator : No | Department/DROT : 348033
Patient Statement : Per security's med tx worksheet: Hit lt knee on a skid at 1800 348-3.

Visit Code : 2005-027-00133 | Disposition : Return To Work (working)
Date of Visit In : 1/26/05 9:30:00PM | Date of Visit Out : 1/26/05 9:35:00PM
Revisit Required : No | Revisit Date :
Office of Visit : Bedford Medical Office | Recorded By :
Primary Body Part : KNEE LEFT | Primary Diagnosis : Contusion/Bruise

Total No. of Visits for Case 2005-027-00094 : 1

Case No.	: 2005-031-00270	Case Type Name	: Occ - First aid
Employee's Name	:	Recorded By	
Inj/Ill Type	: SPRAIN/STRAIN (Illness)	Injury/Illness	: Illness
State	: Indiana	Facility Name	: Bedford
IH Indicator	: No	ERGO Indicator	: No
OSHA Indicator	: No	Department/DROT	: 302033

Patient Statement : PAIN BIL ELBOW AFTER SECURING PUMPS WITH SCREW GUN IN 302-3 CELL 2 FOR 2 HOURS. RIGHT IS WORSE THAN LEFT.

Visit Code	: 2005-031-00528	Disposition	: Return To Work (working)
Date of Visit In	: 1/31/05 3:40:00PM	Date of Visit Out	: 1/31/05 4:10:00PM
Revisit Required	: Yes	Revisit Date	: 2/2/05 12:00:00AM
Office of Visit	: Bedford Medical Office	Recorded By	
Primary Body Part	: ELBOW BILATERAL	Primary Diagnosis	: Strain/Sprain CTD

Total No. of Visits for Case 2005-031-00270 : 1

Total Visits for Report : 31

Mar 05

Case No. : 2005-048-00453
Employee's Name :
Inj/Ill Type : LACERATION
State : Indiana
IH Indicator : No
OSHA Indicator : No
Case Type Name : Occ - First aid
Recorded By :
Injury/Illness : Injury
Facility Name : Bedford
ERGO Indicator : No
Department/DROT : 302033
Patient Statement : I bumped my hand against a flange and got cut on lt index finger. I did not have gloves on. Dept 302-3, Job: harness wrap-flange.

Visit Code : 2005-048-00750
Date of Visit In : 2/17/05 5:31:00PM
Revisit Required : No
Office of Visit : Bedford Medical Office
Primary Body Part : FINGER INDEX LEFT
Disposition : Return To Work (working)
Date of Visit Out : 2/17/05 5:39:00PM
Revisit Date :
Recorded By :
Primary Diagnosis : Laceration

Total No. of Visits for Case 2005-048-00453 : 1

Case No. : 2005-049-00473
Employee's Name :
Inj/Ill Type : SPRAIN/STRAIN (Injury)
State : Indiana
IH Indicator : No
OSHA Indicator : No
Case Type Name : Occ - First aid
Recorded By :
Injury/Illness : Injury
Facility Name : Bedford
ERGO Indicator : No
Department/DROT : 316022
Patient Statement : I fell in plastics on 02/07 or 02/08, I can't remember and I didn't write it down or report it to anyone. I slipped in some oil was on the floor near machine 30. My L knee started hurting later in the week. Dept. 316-2

Visit Code : 2005-049-00809
Date of Visit In : 2/18/05 1:00:00PM
Revisit Required : Yes
Office of Visit : Bedford Medical Office
Primary Body Part : KNEE LEFT
Disposition : Return To Work (working)
Date of Visit Out : 2/18/05 1:35:00PM
Revisit Date : 2/21/05 12:00:00AM
Recorded By :
Primary Diagnosis : Strain/Sprain

Total No. of Visits for Case 2005-049-00473 : 1

Case No. : 2005-054-00139
Employee's Name :
Inj/Ill Type : SPRAIN/STRAIN (Illness)
State : Indiana
IH Indicator : No
OSHA Indicator : No
Case Type Name : Occ - First aid
Recorded By :
Injury/Illness : Illness
Facility Name : Bedford
ERGO Indicator : Yes
Department/DROT : 305022
Patient Statement : I HAVE PAIN LEFT SHOULDER BLADE AND RIGHT ELBOW/FOREARM AFTER DOING JOB 305-2 CELL 2 FOR 1 DAY. I HAVE TO REACH TOO FAR FOR PART AND THEN FLIP PART FREQUENTLY.

Visit Code : 2005-054-00219
Date of Visit In : 2/23/05 8:34:00AM
Revisit Required : Yes
Office of Visit : Bedford Medical Office
Primary Body Part : SCAPULA LEFT
Disposition : Return To Work (working)
Date of Visit Out : 2/23/05 9:16:00AM
Revisit Date : 3/2/05 12:00:00AM
Recorded By :
Primary Diagnosis : Strain/Sprain CTD

Total No. of Visits for Case 2005-054-00139 : 1

Case No.	: 2005-054-00148	Case Type Name	: Occ - First aid
Employee's Name	: I	Recorded By	:
Inj/Ill Type	: SYS/EFFECT GAS/FUME NON/RECORD	Injury/Illness	: Injury
State	: Indiana	Facility Name	: Bedford
IH Indicator	: No	ERGO Indicator	: No
OSHA Indicator	: No	Department/DROT	: 319022

Patient Statement : I HAD SUDDEN HEADACHE AFTER WORKING IN 319 ON G & L LINE FROM FUMES FROM NEW ARC MACHINE. FUMES ARE NOT VENTILATING OUT. I HAVE REPORTED THIS TO RA, D. HENRY, M. CARTER.

Visit Code	: 2005-054-00235	Disposition	: Return To Work (working)
Date of Visit In	: 2/23/05 8:52:00AM	Date of Visit Out	: 2/23/05 9:03:00AM
Revisit Required	: No	Revisit Date	:
Office of Visit	: Bedford Medical Office	Recorded By	:
Primary Body Part	: HEAD BILATERAL	Primary Diagnosis	: Headache

Total No. of Visits for Case 2005-054-00148 : 1

Case No.	: 2005-056-00150	Case Type Name	: Occ - First aid
Employee's Name	: (	Recorded By	:
Inj/Ill Type	: SPRAIN/STRAIN (Illness)	Injury/Illness	: Illness
State	: Indiana	Facility Name	: Bedford
IH Indicator	: No	ERGO Indicator	: No
OSHA Indicator	: No	Department/DROT	: 318022

Patient Statement : I HAVE BEEN SHOVING MANIFOLDS ALLDAY AND MY R WRIST IS HURTING. HAVE TO PUSH HARD TO PUSH MANIFOLD DOWN ONTO PUMP. DEPT. 318-2. RA AWARE OF PROBLEM.

Visit Code	: 2005-056-00310	Disposition	: Return To Work (working)
Date of Visit In	: 2/25/05 11:00:00AM	Date of Visit Out	: 2/25/05 11:15:00AM
Revisit Required	: No	Revisit Date	:
Office of Visit	: Bedford Medical Office	Recorded By	:
Primary Body Part	: WRIST RIGHT	Primary Diagnosis	: Strain/Sprain

Total No. of Visits for Case 2005-056-00150 : 1

Case No.	: 2005-059-00120	Case Type Name	: Occ - OSHA Record - Other
Employee's Name	:	Recorded By	:
Inj/Ill Type	: TENOSYNOVITIS/TENDONITIS (Illness)	Injury/Illness	: Illness
State	: Indiana	Facility Name	: Bedford
IH Indicator	: No	ERGO Indicator	: Yes
OSHA Indicator	: No	Department/DROT	: 302024

Patient Statement : States I am having pain in rt anterior shoulder from reaching back with rt arm on heat shrink 302 line 3. We went back to moving line 2 weeks ago. Pain started last week.

Visit Code	: 2005-059-00239	Disposition	: Return To Work (working)
Date of Visit In	: 2/28/05 9:55:00AM	Date of Visit Out	: 2/28/05 10:25:00AM
Revisit Required	: Yes	Revisit Date	: 3/3/05 12:00:00AM
Office of Visit	: Bedford Medical Office	Recorded By	:
Primary Body Part	: SHOULDER RIGHT	Primary Diagnosis	: Tendinitis

Total No. of Visits for Case 2005-059-00120 : 1

Total Visits for Report : 24

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Report Printed On: 03/07/2005

INJURY/ILLNESS DAILY LOG REPORT April 05

Report Parameters:

Office of Visit	: Bedford Medical Office	Case Type	: All
DROT	: All	Department	: All
Occ/Non Occ	: Occupational	First Time of Visit	: Yes
Region/Country/State	: North America,United States,Indiana	Facility	: Bedford
Date Range	: 04/01/2005 00:00 To 04/30/2005 23:59	Investigation Status	: All

Case No.	: 2005-091-00098	Case Type Name	: Occ - First aid
Employee's Name	:	Recorded By	:
Inj/Ill Type	: ABRASION	Injury/Illness	: Injury
State	: Indiana	Facility Name	: Bedford
IH Indicator	: No	ERGO Indicator	: No
OSHA Indicator	: No	Department/DROT	: 315022

Patient Statement : I HAVE ABRASIONS ACROSS MY RIGHT FOREARM AFTER SCRAPING IT ACROSS THE TOP OF CARDBOARD BOXES WHEN WORKING AS PACKER/STOCKER IN 315-2. NO PPE COVERS THE FOREARM.

Visit Code	: 2005-091-00142	Disposition	: Return To Work (working)
Date of Visit In	: 4/1/05 7:02:00AM	Date of Visit Out	: 4/1/05 7:09:00AM
Revisit Required	: No	Revisit Date	:
Office of Visit	: Bedford Medical Office	Recorded By	:
Primary Body Part	: ARM LOWER RIGHT	Primary Diagnosis	: Abrasion

Total No. of Visits for Case 2005-091-00098 : 1

Case No.	: 2005-091-00106	Case Type Name	: Occ - First aid
Employee's Name	:	Recorded By	:
Inj/Ill Type	: SPRAIN/STRAIN (Illness)	Injury/Illness	: Illness
State	: Indiana	Facility Name	: Bedford
IH Indicator	: No	ERGO Indicator	: Yes
OSHA Indicator	: No	Department/DROT	: 307022

Patient Statement : I HAVE BRUISE-TYPE PAIN IN RIGHT PALM AFTER REPETITIVELY PUSHING FLANGES IN 307 CELL 1. THE ARE HARD TO PUSH IN AND MY PALM FEELS BRUISED. I WEAR GLOVES BUT PALM PADDING.

Visit Code	: 2005-091-00155	Disposition	: Return To Work (working)
Date of Visit In	: 4/1/05 7:15:00AM	Date of Visit Out	: 4/1/05 7:25:00AM
Revisit Required	: Yes	Revisit Date	: 4/4/05 12:00:00AM
Office of Visit	: Bedford Medical Office	Recorded By	:
Primary Body Part	: HAND RIGHT	Primary Diagnosis	: Contusion/Bruise

Total No. of Visits for Case 2005-091-00106 : 1

Case No.	: 2005-094-00109	Case Type Name	: Occ - First aid
Employee's Name	:	Recorded By	:
Inj/Ill Type	: RESP.SYM./FUMES/VAPORS/DUST	Injury/Illness	: Illness
State	: Indiana	Facility Name	: Bedford
IH Indicator	: No	ERGO Indicator	: No
OSHA Indicator	: No	Department/DROT	: 316011

Patient Statement : States after midnight the grinder in plastics didn't work right and I was exposed to fine dust in the regrind room for about 15 min. I have coughed a little but my eyes are still irritated.

Visit Code	: 2005-094-00175	Disposition	: Return To Work (working)
Date of Visit In	: 4/4/05 6:35:00AM	Date of Visit Out	: 4/4/05 6:45:00AM
Revisit Required	: No	Revisit Date	:
Office of Visit	: Bedford Medical Office	Recorded By	:
Primary Body Part	: EYE BILATERAL	Primary Diagnosis	: Irritation/Inflammation

Total No. of Visits for Case 2005-094-00109 : 1

Report Printed On: 05/02/2005

Case No.	: 2005-116-00084	Case Type Name	: Occ - First aid
Employee's Name	:	Recorded By	:
Inj/Ill Type	: DERMATITIS CON/OTH ECZ - Illness	Injury/Illness	: Illness
State	: Indiana	Facility Name	: Bedford
IH Indicator	: No	ERGO Indicator	: No
OSHA Indicator	: No	Department/DROT	: 31700*

Patient Statement : States I think I am allergic to the new soap in the bathrooms, it is like a foam. In between my fingers the skin is red and itchy. When I use the pink soap started healing up.

Visit Code	: 2005-116-00158	Disposition	: Return To Work (working)
Date of Visit In	: 4/26/05 8:00:00AM	Date of Visit Out	: 4/26/05 8:05:00AM
Revisit Required	: No	Revisit Date	:
Office of Visit	: Bedford Medical Office	Recorded By	:
Primary Body Part	: HAND BILATERAL	Primary Diagnosis	: Dermatitis: Contact

Total No. of Visits for Case 2005-116-00084 : 1

Case No.	: 2005-117-00278	Case Type Name	: Occ - First aid
Employee's Name	:	Recorded By	
Inj/Ill Type	: SPRAIN/STRAIN (Illness)	Injury/Illness	: Illness
State	: Indiana	Facility Name	: Bedford
IH Indicator	: No	ERGO Indicator	: Yes
OSHA Indicator	: No	Department/DROT	: 30200*

Patient Statement : Would you look at my R elbow. It started hurting last night about supper time. I push harnesses. 2 people use to do the job; now I do the work alone; I think it is too much for my R elbow. Dept 302-3, Line: 3, Job: leak tester, Part; 4C2UAC.

Visit Code	: 2005-117-00545	Disposition	: Return To Work (working)
Date of Visit In	: 4/27/05 4:00:00PM	Date of Visit Out	: 4/27/05 4:25:00PM
Revisit Required	: Yes	Revisit Date	: 4/28/05 12:00:00AM
Office of Visit	: Bedford Medical Office	Recorded By	
Primary Body Part	: ELBOW RIGHT	Primary Diagnosis	: Strain/Sprain

Total No. of Visits for Case 2005-117-00278 : 1

Case No.	: 2005-118-00179	Case Type Name	: Occ - First aid
Employee's Name		Recorded By	
Inj/Ill Type	: TENOSYNOVITIS/TENDONITIS (Illness)	Injury/Illness	: Illness
State	: Indiana	Facility Name	: Bedford
IH Indicator	: No	ERGO Indicator	: No
OSHA Indicator	: No	Department/DROT	: 302024

Patient Statement : States I am having pain in my rt upper arm from straightening and bending my arm out to side when working in 302. It is not my shoulder. I am not reaching back at all it is just the movement of my arm.

Visit Code	: 2005-117-00223	Disposition	: Return To Work (working)
Date of Visit In	: 4/27/05 8:50:00AM	Date of Visit Out	: 4/27/05 9:05:00AM
Revisit Required	: Yes	Revisit Date	: 4/28/05 12:00:00AM
Office of Visit	: Bedford Medical Office	Recorded By	:
Primary Body Part	: ARM UPPER RIGHT	Primary Diagnosis	

Total No. of Visits for Case 2005-118-00179 : 1

May 05

Case No.	: 2005-132-00258	Case Type Name	: Occ - First aid
Employee's Name		Recorded By	:
Inj/Ill Type	: SPRAIN/STRAIN (Illness)	Injury/Illness	: Illness
State	: Indiana	Facility Name	: Bedford
IH Indicator	: No	ERGO Indicator	: No
OSHA Indicator	: No	Department/DROT	: 308033

Patient Statement : I have a pain in my R upper back. It started yesterday and I thought it would work itself out, but it hasn't. I have been moving tubs of flanges around and I think that has caused the pain. Dept. 308, Cell: 3, Job: stocker, Flanges 3F2U AA.

Visit Code	: 2005-132-00528	Disposition	: Return To Work (working)
Date of Visit In	: 5/12/05 4:49:00PM	Date of Visit Out	: 5/12/05 5:03:00PM
Revisit Required	: Yes	Revisit Date	: 5/13/05 12:00:00AM
Office of Visit	: Bedford Medical Office	Recorded By	:
Primary Body Part	: BACK UPPER	Primary Diagnosis	: Strain/Sprain

Total No. of Visits for Case 2005-132-00258 : 1

Case No.	: 2005-132-00275	Case Type Name	: Occ - First aid
Employee's Name		Recorded By	:
Inj/Ill Type	: LACERATION	Injury/Illness	: Injury
State	: Indiana	Facility Name	: Bedford
IH Indicator	: No	ERGO Indicator	: No
OSHA Indicator	: No	Department/DROT	: 367033

Patient Statement : I have a little cut on my R index finger. I cut it on the edge of a metal paper towel holder in the bathroom by stainless steel. They are exchanging the metal holders for plastic ones. I was not wearing gloves. Dept 367-3.

Visit Code	: 2005-132-00559	Disposition	: Return To Work (working)
Date of Visit In	: 5/12/05 5:40:00PM	Date of Visit Out	: 5/12/05 5:45:00PM
Revisit Required	: Yes	Revisit Date	: 5/13/05 12:00:00AM
Office of Visit	: Bedford Medical Office	Recorded By	:
Primary Body Part	: FINGER INDEX RIGHT	Primary Diagnosis	: Laceration

Total No. of Visits for Case 2005-132-00275 : 1

Case No.	: 2005-133-00277	Case Type Name	: Occ - First aid
Employee's Name	:	Recorded By	:
Inj/Ill Type	: LACERATION	Injury/Illness	: Injury
State	: Indiana	Facility Name	: Bedford
IH Indicator	: No	ERGO Indicator	: No
OSHA Indicator	: No	Department/DROT	: 302033

Patient Statement : I CUT MY LEFT MIDDLE FINGER ON A METAL BRACKET INSIDE A FLANGE WHEN WORKING 302-3 CELL 3. I ONLY HAD A GLOVE ON RIGHT HAND, CAN'T WEAR ONE ON LEFT AND DO THE JOB.

Visit Code	: 2005-133-00566	Disposition	: Return To Work (working)
Date of Visit In	: 5/13/05 5:25:00PM	Date of Visit Out	: 5/13/05 5:40:00PM
Revisit Required	: No	Revisit Date	:
Office of Visit	: Bedford Medical Office	Recorded By	
Primary Body Part	: FINGER MIDDLE LEFT	Primary Diagnosis	: Laceration

Total No. of Visits for Case 2005-133-00277 : 1

Case No.	: 2005-133-00279	Case Type Name	: Occ - First aid
Employee's Name	:	Recorded By	:
Inj/Ill Type	: LACERATION	Injury/Illness	: Injury
State	: Indiana	Facility Name	: Bedford
IH Indicator	: No	ERGO Indicator	: No
OSHA Indicator	: No	Department/DROT	: 302033

Patient Statement : I CUT KNUCKLE ON RIGHT INDEX FINGER ON METAL FLANGE WHEN PULLED IT OUT OF LEAK TESTER. I HAD GRAY GLOVES ON AND IT CUT THRU THE GLOVE.

Visit Code	: 2005-133-00569	Disposition	: Return To Work (working)
Date of Visit In	: 5/13/05 5:25:00PM	Date of Visit Out	: 5/13/05 5:35:00PM
Revisit Required	: No	Revisit Date	:
Office of Visit	: Bedford Medical Office	Recorded By	:
Primary Body Part	: FINGER INDEX RIGHT	Primary Diagnosis	: Laceration

Total No. of Visits for Case 2005-133-00279 : 1

Case No.	: 2005-136-00385	Case Type Name	: Occ - OSHA Record - Rest. Days Only
Employee's Name	:	Recorded By	:
Inj/Ill Type	: SPRAIN/STRAIN (Injury)	Injury/Illness	: Injury
State	: Indiana	Facility Name	: Bedford
IH Indicator	: No	ERGO Indicator	: No
OSHA Indicator	: No	Department/DROT	: 30802

Patient Statement : My L knee is swollen and hurts (dull ache) all the time. About a month ago I stepped down from a skid onto my L leg and twisted my lower thigh. Dept. 308-2, Cell: 3, QC

Visit Code	: 2005-136-00756	Disposition	: Restriction Issued
Date of Visit In	: 5/16/05 4:10:00PM	Date of Visit Out	: 5/16/05 5:10:00PM
Revisit Required	: Yes	Revisit Date	: 5/17/05 12:00:00AM
Office of Visit	: Bedford Medical Office	Recorded By	:
Primary Body Part	: KNEE LEFT	Primary Diagnosis	: Strain/Sprain

Total No. of Visits for Case 2005-136-00385 : 1

Case No.	: 2005-137-00060	Case Type Name	: Occ - First aid
Employee's Name	:	Recorded By	:
Inj/Ill Type	: SPRAIN/STRAIN (Illness)	Injury/Illness	: Illness
State	: Indiana	Facility Name	: Bedford
IH Indicator	: No	ERGO Indicator	: No
OSHA Indicator	: No	Department/DROT	: 307022

Patient Statement : States my lt thumb is hurting again from stretching out hand to grab parts. I went to 307 first of April. I do different jobs, but subscrew bothers it, holding lip/bottom of flange.

Visit Code	: 2005-137-00100	Disposition	: Return To Work (working)
Date of Visit In	: 5/17/05 7:03:00AM	Date of Visit Out	: 5/17/05 7:20:00AM
Revisit Required	: No	Revisit Date	:
Office of Visit	: Bedford Medical Office	Recorded By	:
Primary Body Part	: THUMB LEFT	Primary Diagnosis	: Strain/Sprain

Total No. of Visits for Case 2005-137-00060 : 1

Jun 05

Case No.	: 2005-164-00163	Case Type Name	: Occ - First aid
Employee's Name		Recorded By	:
Inj/Ill Type	: FOREIGN BODY	Injury/Illness	: Injury
State	: Indiana	Facility Name	: Bedford
IH Indicator	: No	ERGO Indicator	: No
OSHA Indicator	: No	Department/DROT	: 313022

Patient Statement : States I got a mtel splinter in my rt thumb while working on the Eagle. I work with stainless steel tubing and must have gotten a splinter from it. I was wearing the new gray gloves.

Visit Code	: 2005-164-00299	Disposition	: Return To Work (working)
Date of Visit In	: 6/13/05 10:03:00AM	Date of Visit Out	: 6/13/05 10:15:00AM
Revisit Required	: No	Revisit Date	:
Office of Visit	: Bedford Medical Office	Recorded By	:
Primary Body Part	: THUMB RIGHT	Primary Diagnosis	: Foreign Body, Skin

Total No. of Visits for Case 2005-164-00163 : 1

Case No.	: 2005-165-00088	Case Type Name	: Occ - First aid
Employee's Name	:	Recorded By	:
Inj/Ill Type	: SPRAIN/STRAIN (illness)	Injury/Illness	: Illness
State	: Indiana	Facility Name	: Bedford
IH Indicator	: No	ERGO Indicator	: Yes
OSHA Indicator	: No	Department/DROT	: 302022

Patient Statement : States my lt elbow has hurt for 3 weeks. Pain started after running gold-flange model which makes pushing harnesses tight. Dept 302 line 1.

Visit Code	: 2005-165-00154	Disposition	: Return To Work (working)
Date of Visit In	: 6/14/05 8:07:00AM	Date of Visit Out	: 6/14/05 8:20:00AM
Revisit Required	: No	Revisit Date	:
Office of Visit	: Bedford Medical Office	Recorded By	:
Primary Body Part	: ELBOW LEFT	Primary Diagnosis	: Strain/Sprain

Total No. of Visits for Case 2005-165-00088 : 1

Case No.	: 2005-166-00246	Case Type Name	: Occ - First aid
Employee's Name	:	Recorded By	:
Inj/Ill Type	: RESP/EFFECT GAS/FUME NON/RECD	Injury/Illness	: Injury
State	: Indiana	Facility Name	: Bedford
IH Indicator	: No	ERGO Indicator	: No
OSHA Indicator	: No	Department/DROT	: 316022

Patient Statement : DURING FIRE IN 316-2, EXPOSED TO FUMES FROM MELTING PLASTIC. I WORK IN 365-2. SYMPTOMS: COUGH, LIGHT HEADED, DRY MOUTH.

Visit Code	: 2005-166-00509	Disposition	: Return To Work (working)
Date of Visit In	: 6/15/05 1:40:00PM	Date of Visit Out	: 6/15/05 1:50:00PM
Revisit Required	: Yes	Revisit Date	: 6/16/05 12:00:00AM
Office of Visit	: Bedford Medical Office	Recorded By	: 1
Primary Body Part	: LUNG BILATERAL	Primary Diagnosis	: Respiratory Symptoms

Total No. of Visits for Case 2005-166-00246 : 1

Case No.	: 2005-166-00253	Case Type Name	: Occ - First aid
Employee's Name		Recorded By	:
Inj/Ill Type	: RESP/EFFECT GAS/FUME NON/RECD	Injury/Illness	: Injury
State	: Indiana	Facility Name	: Bedford
IH Indicator	: No	ERGO Indicator	: No
OSHA Indicator	: No	Department/DROT	: 316022

Patient Statement : I WAS EXPOSED TO FUMES FROM MELTING PLASTIC DURING A FIRE IN 316-2. I WORK IN 365-2. I HAD A COUGH AND DIZZY AFTER EXPOSURE.

Visit Code	: 2005-166-00524	Disposition	: Return To Work (working)
Date of Visit In	: 6/15/05 1:40:00PM	Date of Visit Out	: 6/15/05 1:50:00PM
Revisit Required	: Yes	Revisit Date	: 6/16/05 12:00:00AM
Office of Visit	: Bedford Medical Office	Recorded By	:
Primary Body Part	: LUNG BILATERAL	Primary Diagnosis	: Respiratory Symptoms

Total No. of Visits for Case 2005-166-00253 : 1

Case No.	: 2005-166-00288	Case Type Name	: Occ - First aid
Employee's Name	:	Recorded By	:
Inj/Ill Type	: SPRAIN/STRAIN (Illness)	Injury/Illness	: Illness
State	: Indiana	Facility Name	: Bedford
IH Indicator	: No	ERGO Indicator	: Yes
OSHA Indicator	: No	Department/DROT	: 302033

Patient Statement : States hands, wrists, thumbs hurting from taking harness out of flange when they don't pass leak test in 302-3. I do repair. This week we've done model 6C249H307AB. Increased # of rejects, 100+.

Visit Code	: 2005-166-00587	Disposition	: Return To Work (working)
Date of Visit In	: 6/15/05 4:28:00PM	Date of Visit Out	: 6/15/05 4:40:00PM
Revisit Required	: No	Revisit Date	:
Office of Visit	: Bedford Medical Office	Recorded By	:
Primary Body Part	: THUMB BILATERAL	Primary Diagnosis	: Strain/Sprain

Total No. of Visits for Case 2005-166-00288 : 1

Case No.	: 2005-167-00106	Case Type Name	: Occ - First aid
Employee's Name	:	Recorded By	:
Inj/Ill Type	: SPRAIN/STRAIN (Illness)	Injury/Illness	: Illness
State	: Indiana	Facility Name	: Bedford
IH Indicator	: No	ERGO Indicator	: Yes
OSHA Indicator	: No	Department/DROT	: 307033

Patient Statement : States I started having pain in rt upper back yesterday when doing my job building float rods in 307-3 cell 1. I force a rod down on the screw. About 100 out of 800 are really hard to push on.

Visit Code	: 2005-167-00162	Disposition	: Return To Work (working)
Date of Visit In	: 6/15/05 10:20:00PM	Date of Visit Out	: 6/15/05 10:45:00PM
Revisit Required	: No	Revisit Date	:
Office of Visit	: Bedford Medical Office	Recorded By	:
Primary Body Part	: THORACIC RIGHT	Primary Diagnosis	: Strain/Sprain

Total No. of Visits for Case 2005-167-00106 : 1

Aug 05

Case No.	: 2005-238-00177	Case Type Name	: Occ - First aid
Employee's Name	:	Recorded By	
Inj/Ill Type	: SPRAIN/STRAIN (Illness)	Injury/Illness	: Illness
State	: Indiana	Facility Name	: Bedford
IH Indicator	: No	ERGO Indicator	: No
OSHA Indicator	: No	Department/DROT	: 348022

Patient Statement : I HAVE STIFFNESS IN MY LOWER BACK AFTER TRYING TO HELP PUSH A SEMI OUT IF THE WAY THAT WAS IN THE DOCK AREA. I WORK IN 348-2 AS A TRUCK DRIVER. I WAS JUST TRYING TO HELP THE GUY.

Visit Code	: 2005-238-00364	Disposition	: Return To Work (working)
Date of Visit In	: 8/26/05 10:18:00AM	Date of Visit Out	: 8/26/05 10:38:00AM
Revisit Required	: Yes	Revisit Date	: 8/[illegible]
Office of Visit	: Bedford Medical Office	Recorded By	:
Primary Body Part	: BACK LOWER	Primary Diagnosis	: Strain/Sprain

Total No. of Visits for Case 2005-238-00177 : 1

Case No.	: 2005-241-00054	Case Type Name	: Occ - First aid
Employee's Name	:	Recorded By	:
Inj/Ill Type	: SPRAIN/STRAIN (Illness)	Injury/Illness	: Illness
State	: Indiana	Facility Name	: Bedford
IH Indicator	: No	ERGO Indicator	: Yes
OSHA Indicator	: No	Department/DROT	: 302022

Patient Statement : States Saturday I was on line 3 dept 302 pump build job and pulled my lt shoulder and hurt lt middle finger when reaching back for isolators, filters, pumps. Nonrotating job 1000 parts.

Visit Code	: 2005-241-00102	Disposition	: Return To Work (working)
Date of Visit In	: 8/29/05 7:15:00AM	Date of Visit Out	: 8/29/05 7:38:00AM
Revisit Required	: No	Revisit Date	:
Office of Visit	: Bedford Medical Office	Recorded By	:
Primary Body Part	: SHOULDER LEFT	Primary Diagnosis	: Strain/Sprain

Total No. of Visits for Case 2005-241-00054 : 1

Case No.	: 2005-241-00160	Case Type Name	: Occ - First aid
Employee's Name	:	Recorded By	
Inj/Ill Type	: CONTUSION	Injury/Illness	: Injury
State	: Indiana	Facility Name	: Bedford
IH Indicator	: No	ERGO Indicator	: No
OSHA Indicator	: No	Department/DROT	: 305022

Patient Statement : States I was putting hose on regulator with fixture. The hose was hard to get on so I pushed really hard on the fixture handle and smashed my rt middle finger between handle and base. Working repair.

Visit Code	: 2005-241-00346	Disposition	: Return To Work (working)
Date of Visit In	: 8/29/05 1:00:00PM	Date of Visit Out	: 8/29/05 1:14:00PM
Revisit Required	: No	Revisit Date	:
Office of Visit	: Bedford Medical Office	Recorded By	:
Primary Body Part	: FINGER MIDDLE RIGHT	Primary Diagnosis	: Contusion/Bruise

Total No. of Visits for Case 2005-241-00160 : 1

Sept 05

Case No.	: 2005-262-00309	Case Type Name	: Occ - First aid
Employee's Name	:	Recorded By	:
Inj/Ill Type	: SPRAIN/STRAIN (illness)	Injury/Illness	: Illness
State	: Indiana	Facility Name	: Bedford
IH Indicator	: No	ERGO Indicator	: Yes
OSHA Indicator	: No	Department/DROT	: 302033

Patient Statement : UPdated 09/20/05. My lower right arm has bothered me for about a year since working in dept 302 Line 1 where I had to force the tubes into the module. It has never went away. Anytime I have to forceful pushing it aggravates my lower right arm.

Visit Code	: 2005-262-00612	Disposition	: Return To Work (working)
Date of Visit In	: 9/19/05 6:30:00PM	Date of Visit Out	: 9/19/05 6:42:00PM
Revisit Required	: No	Revisit Date	:
Office of Visit	: Bedford Medical Office	Recorded By	:
Primary Body Part	: ELBOW RIGHT	Primary Diagnosis	: Strain/Sprain

Total No. of Visits for Case 2005-262-00309 : 1

Case No.	: 2005-263-00186	Case Type Name	: Occ - First aid
Employee's Name	:	Recorded By	:
Inj/Ill Type	: CALLOSITIES	Injury/Illness	: Illness
State	: Indiana	Facility Name	: Bedford
IH Indicator	: No	ERGO Indicator	: No
OSHA Indicator	: No	Department/DROT	: 318022

Patient Statement : My leftt thymb is sore and I need a bandaid. I keep hitting it with the screwgun while I batch build. I wear the grey cotton gloves. It is the cell in 318 screwdown job.

Visit Code	: 2005-263-00390	Disposition	: Return To Work (working)
Date of Visit In	: 9/20/05 7:32:00AM	Date of Visit Out	: 9/20/05 7:38:00AM
Revisit Required	: No	Revisit Date	:
Office of Visit	: Bedford Medical Office	Recorded By	:
Primary Body Part	: THUMB LEFT	Primary Diagnosis	: Abrasion

Total No. of Visits for Case 2005-263-00186 : 1

Case No.	: 2005-264-00162	Case Type Name	: Occ - First aid
Employee's Name	:	Recorded By	:
Inj/Ill Type	: ELECTRICAL SHOCK/OT.EXT.CAUSES	Injury/Illness	: Injury
State	: Indiana	Facility Name	: Bedford
IH Indicator	: No	ERGO Indicator	: No
OSHA Indicator	: No	Department/DROT	: 307022

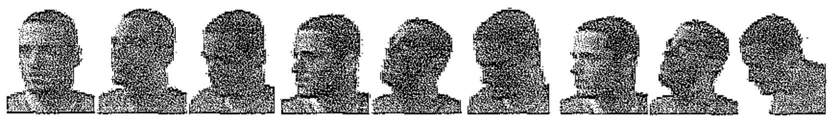
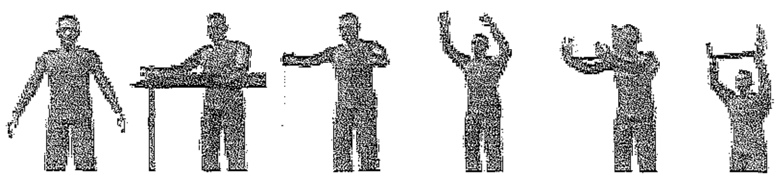
Patient Statement : I WAS SHOCKED ON MY RIGHT HAND WHEN I TOUCHED A FAN WITH RIGHT HAND WHEN HAD LEFT HAND ON PRESS IN 307-2 CELL 1. I FEEL OK.

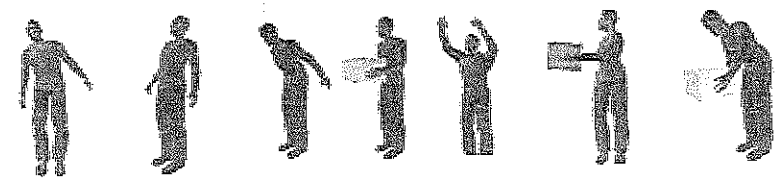
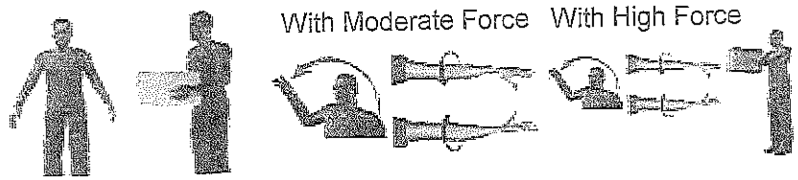
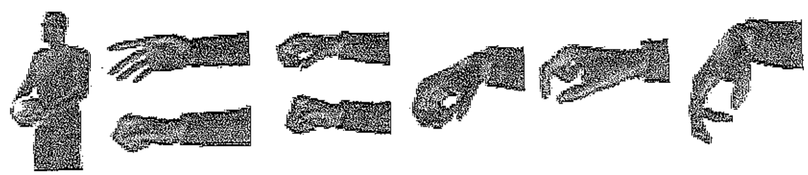
Visit Code	: 2005-264-00306	Disposition	: Return To Work (working)
Date of Visit In	: 9/21/05 10:55:00AM	Date of Visit Out	: 9/21/05 11:15:00AM
Revisit Required	: Yes	Revisit Date	: 9/22/05 12:00:00AM
Office of Visit	: Bedford Medical Office	Recorded By	:
Primary Body Part	: HAND RIGHT	Primary Diagnosis	: Electrical Shock

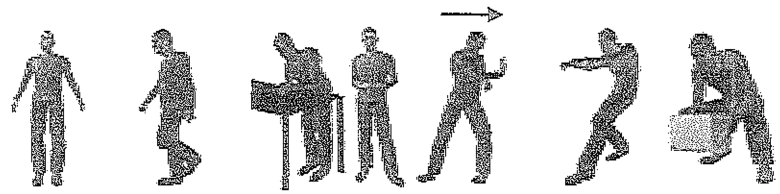
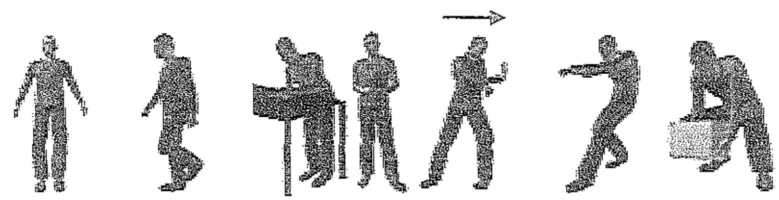
Total No. of Visits for Case 2005-264-00162 : 1

APPENDIX II. ERGONOMIC ANALYSIS

Rodgers / Kodak Muscle Fatigue Analysis Data Collection Sheet

Body Region	Effort Levels If the effort cannot be exerted by most people, enter Very High.			Scores		
	Light	Moderate	Heavy With Force or Weight	Effort Level	Effort Duration	Effort Frequency
Neck						
	Head turned partly to side, back or slightly forward.	Head turned to side; head fully back; head forward 20°.	Same as moderate but with force or weight; head stretched forward.			
Shoulders				Right Left	Right Left	Right Left
	Arms slightly away from sides; arms extended with some support.	Arms away from body; no support; working overhead	Exerting forces or holding weight with arms away from body or overhead.			

Back						
	Leaning to side or bending/arching back.	Bending forward; no load; lifting moderately heavy loads near body; working overhead.	Lifting or exerting force while twisting; high force or load while bending.			
		With Moderate Force	With High Force	Right	Right	Right
Arms/ Elbows				Left	Left	Left
	Arms away from body, no load; light forces lifting near body.	Rotating arms while exerting moderate force.	High forces exerted with rotation; lifting with arms extended.			
				Right	Right	Right
Wrists/ Hands/ Fingers				Left	Left	Left
	Light forces or weights handled close to body; straight wrists; comfortable power grips.	Grips with wide or narrow span; moderate risk angles, especially flexion; use of gloves with moderate force.	Pinch grips; strong wrist angles; slippery surfaces.			

Legs/ Knees				Right Left	Right Left	Right Left
	Standing, walking without bending or leaning; weight on both feet.	Bending forward, leaning on table; weight on one side; pivoting while exerting force.	Exerting high force while pulling or lifting; crouching while exerting force.			
Ankle/ Feet/ Toes				Right Left	Right Left	Right Left
	Standing, walking without bending or leaning; weight on both feet.	Bending forward, leaning on table; weight on one side; pivoting while exerting force.	Exerting high force while pulling or lifting; crouching while exerting force.			

Customize Report

Rotational Work Cell
Job Title: Support Tube to Reservoir
Job Description: PU screw set into tool - PU Assy, position wire (black) and seat screw - Snap support tubes into appropriate location - REL - - - -

Data Inputs

Effort		Duration	Frequency
Neck			
	Head turned partly to side, back or slightly forward	6-20 s	1-5 /min
Shoulders			
Right	Arms away from body, no support; working overhead	6-20 s	1-5 /min
Left	Arms away from body, no support; working overhead	6-20 s	1-5 /min
Back			
	Leaning to side or bending arching back	6-20 s	1-5 /min
Arms/Elbows			
Right	Rotating arms while exerting moderate force	6-20 s	1-5 /min
Left	Rotating arms while exerting moderate force	6-20 s	1-5 /min
Wrists/Hands/Fingers			
Right	Grips with wide or narrow span; moderate risk angles; use gloves with moderate forces	6-20 s	1-5 /min
Left	Grips with wide or narrow span; moderate risk angles; use gloves with moderate forces	6-20 s	1-5 /min
Legs/Knees			
Right	Standing, walking without bending or leaning; weight on both feet	0-6 s	0-1/ min
Left	Standing, walking without bending or leaning; weight on both feet	0-6 s	0-1/ min
Ankle/Feet/Toes			
Right	Standing, walking without bending or leaning; weight on both feet	0-6 s	0-1/ min
Left	Standing, walking without bending or leaning; weight on both feet	0-6 s	0-1/ min

Save These Inputs to an Excel File

Calculations

	Neck	Right Shoulder	Left Shoulder	Back	Right Arm	Left Arm
Priority	Low	Moderate	Moderate	Low	Moderate	Moderate

	Right Hand	Left Hand	Right Leg	Left Leg	Right Foot	Left Foot
Priority	Moderate	Moderate	Low	Low	Low	Low

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Reference

Chengalur, S.N., Rodgers, S.H., and Bernard, T.E. (2004). Kodak's Ergonomic Design for People at Work, 2nd Ed. John Wiley & Sons, Inc., Hoboken, New Jersey. pp 137-152.

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Customize Report

Rotational Work Cell
Job Title: Sub Screw and Wire Wrap
Job Description: PU Assy, place in fixt - Pos sub, pos wire (pink) - PU screw, set into tooling - Use tool to seat screw - Wrap wires as necessary - REL - - - -

Data Inputs

Effort		Duration	Frequency
Neck			
	Head turned partly to side, back or slightly forward	6-20 s	1-5 /min
Shoulders			
Right	Arms away from body, no support; working overhead	6-20 s	1-5 /min
Left	Arms slightly away from sides; arms extended with some support	6-20 s	1-5 /min
Back			
	Leaning to side or bending arching back	6-20 s	1-5 /min
Arms/Elbows			
Right	Rotating arms while exerting moderate force	6-20 s	1-5 /min
Left	Arms away from body, no load; light forces lifting near body	6-20 s	1-5 /min
Wrists/Hands/Fingers			
Right	Grips with wide or narrow span; moderate risk angles; use gloves with moderate forces	6-20 s	1-5 /min
Left	Light forces or weights handled close to body; straight wrists; comfortable power grips	6-20 s	1-5 /min
Legs/Knees			
Right	Standing, walking without bending or leaning; weight on both feet	0-6 s	0-1/ min
Left	Standing, walking without bending or leaning; weight on both feet	0-6 s	0-1/ min
Ankle/Feet/Toes			
Right	Standing, walking without bending or leaning; weight on both feet	0-6 s	0-1/ min
Left	Standing, walking without bending or leaning; weight on both feet	0-6 s	0-1/ min

Save These Inputs to an Excel File

Calculations

	Neck	Right Shoulder	Left Shoulder	Back	Right Arm	Left Arm
Priority	Low	Moderate	Low	Low	Moderate	Low

	Right Hand	Left Hand	Right Leg	Left Leg	Right Foot	Left Foot
Priority	Moderate	Low	Low	Low	Low	Low

Save This Report to an Excel File

Save This Report to a Word File

Reference

Chengalur, S.N., Rodgers, S.H., and Bernard, T.E. (2004). Kodak's Ergonomic Design for People at Work, 2nd Ed. John Wiley & Sons, Inc., Hoboken, New Jersey. pp 137-152.

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Customize Report

Rotational Work Cell
Job Title: Sub-Build
Job Description: PU card/case assy - PU float assy and pos to case, pos assy to fixt - PU contact, pos to fixt - PU back placte, route sub wire through, pos to fixt - DBP - RM Assy - aside to tote - REL - Restocking of subs @ heat shrink station as necessary - - - -

Data Inputs

Effort		Duration	Frequency
Neck			
	Head turned partly to side, back or slightly forward	6-20 s	1-5 /min
Shoulders			
Right	Arms slightly away from sides; arms extended with some support	6-20 s	1-5 /min
Left	Arms slightly away from sides; arms extended with some support	6-20 s	1-5 /min
Back			
	Leaning to side or bending arching back	6-20 s	1-5 /min
Arms/Elbows			
Right	Arms away from body, no load; light forces lifting near body	6-20 s	1-5 /min
Left	Arms away from body, no load; light forces lifting near body	6-20 s	1-5 /min
Wrists/Hands/Fingers			
Right	Light forces or weights handled close to body; straight wrists; comfortable power grips	6-20 s	1-5 /min
Left	Light forces or weights handled close to body; straight wrists; comfortable power grips	6-20 s	1-5 /min
Legs/Knees			
Right	Standing, walking without bending or leaning; weight on both feet	0-6 s	0-1/ min
Left	Standing, walking without bending or leaning; weight on both feet	0-6 s	0-1/ min
Ankle/Feet/Toes			
Right	Standing, walking without bending or leaning; weight on both feet	0-6 s	0-1/ min
Left	Standing, walking without bending or leaning; weight on both feet	0-6 s	0-1/ min

Save These Inputs to an Excel File

Calculations

	Neck	Right Shoulder	Left Shoulder	Back	Right Arm	Left Arm

Priority	Low	Low	Low	Low	Low	Low

	Right Hand	**Left Hand**	**Right Leg**	**Left Leg**	**Right Foot**	**Left Foot**
Priority	Low	Low	Low	Low	Low	Low

Save This Report to an Excel File

Save This Report to a Word File

Reference

Chengalur, S.N., Rodgers, S.H., and Bernard, T.E. (2004). Kodak's Ergonomic Design for People at Work, 2nd Ed. John Wiley & Sons, Inc., Hoboken, New Jersey. pp 137-152.

Printable Page

RULA

Data Collection Sheet

Posture Risk Factor Assessment for Group A
(upper arm, lower arm, and wrist)

Upper Arm Analysis	Ranges of Movement (check one only)	20 degrees of extension to 20 degrees of flexion	
		Extension greater than 20 degrees or 20 to 45 degrees of flexion	
		45 to 90 degrees of flexion	
		90 degees or more of flexion	
	Select any of the Following if True (check all that apply)	Condition 1: The upper arm is abducted	
		Condition 2: The shoulder is raised	
		Condition 3: The operator is leaning or the weight of the arm is supported	

Lower Arm Analysis	Ranges of Movement (check one only)	60 to 100 degrees of flexion	
		Less than 60 degrees or more than 100 degrees of flexion	
	Select if True	Condition 1: The lower arm is working across the midline of the body or out to the side	

Wrist Analysis	Ranges of Movement (check one only)	Neutral position (wrist neither flexed nor extended)	
		0 to 15 degrees in either flexion or extension	
		15 degrees or more in either flexion or extension	
	Select any of the Following if True (check all that apply)	Condition 1: The wrist is in either radial or ulnar deviation	
		Condition 2: The wrist is at or near the end of range of twist (near the end of pronation or supination range)	

Muscle Use and Repetitive Motion	Select if True	For the upper arm, lower arm, and wrist, the muscle use/body motion of the worker is mainly static (held for longer than one minute), or it is repetitive (repeated more than four times/minute)	

Force	Force or Load	No resistance or less than 4.4 lbs (2 kgs) of intermittent load or force	
		4.4 to 22 lbs (2 to 10 kgs) of intermittent load or force	
		4.4 to 22 lbs (2 to 10 kgs) of static or repeated load or force	
		22 lbs (10 kgs) or more of static load; or, 10 kg or more of repeated loads or forces; or, shock or forces with a rapid build-up	

Posture Risk Factor Assessment for Group B
(neck, trunk, and legs)

Neck Analysis	Ranges of Movement (check one only)	0 to 10 degrees of flexion	
		10 to 20 degrees of flexion	
		20 degrees or more of flexion	
		In extension	
	Select any of the Following if True (check all that apply)	Condition 1: The neck is twisted	
		Condition 2: The neck is in side-bending	

Trunk Analysis	Ranges of Motion (check one only)	Sitting and well supported with a hip-trunk angle of 90 degrees or more	
		0-20 degrees of trunk flexion from a standing position	
		20-60 degrees of trunk flexion from a standing position	
		60 degrees or more of trunk flexion from a standing position	
	Select any of the Following if True (check all that apply)	Condition 1: The trunk is twisting	
		Condition 2: The trunk is in side-bending	

Leg Analysis	Ranges of Motion (check one only)	The legs and feet are well supported with the worker seated and the weight evenly balanced	
		The worker is standing with the body weight evenly distributed over both feet with room for changes of position	
		The legs and feet are not supported while the worker is sitting or the weight is unevenly balanced when sitting or standing	

Muscle Use and Repetitive Motion	Select if True	For the neck, trunk, and legs, the muscle use/body motion of the worker is mainly static (held for longer than one minute), or it is repetitive (repeated more than four times/minute)	

Muscle Use and Repetitive Motion for the Neck, Trunk, and Legs	Force or Load	No resistance or less than 4.4 lbs (2 kgs) of intermittent load or force	
		4.4 to 22 lbs (2 to 10 kgs) of intermittent load or force	
		4.4 to 22 lbs (2 to 10 kgs) of static or repeated load or force	
		22 lbs (10 kgs) or more of static load; or, 10 kg or more of repeated loads or forces; or, shock or forces with a rapid build-up	

ergoweb

Customize Report

Rotational Work Cell
Job Title: Support Tube to Reservoir
Job Description: PU screw set into tool - PU Assy, position wire (black) and seat screw - Snap support tubes into appropriate location - REL - - - -

Data Inputs

Posture risk assessment for Group A

Upper Arm Analysis	**Ranges of movement**	Extension greater than 20 degrees or 20 to 45 degrees of flexion
	Conditions	Condition 1: The upper arm is abducted Condition 2: The shoulder is raised
Lower Arm Analysis	**Ranges of movement**	60 to 100 degrees of flexion
	Conditions	None selected
Wrist Analysis	**Ranges of movement**	0 to 15 degrees in either flexion or extension
	Conditions	Condition 1: The wrist is in either radial or ulnar deviation Condition 2: The wrist is at or near the end of range of twist (near the end of pronation or supination range)
Muscle Use and Repetitive Motion	For the upper arm, lower arm, and wrist, the muscle use/body motion of the worker is mainly static (held for longer than one minute), or it is repetitive (repeated more than four times/minute)	
Force	4.4 to 22 lbs (2 to 10 kgs) of intermittent load or force	

Posture risk assessment for Group B

Neck Analysis	**Ranges of movement**	0 to 10 degrees of flexion
	Conditions	None selected
Trunk Analysis	**Ranges of movement**	Sitting and well supported with a hip-trunk angle of 90 degrees or more
	Conditions	None selected
Leg Analysis	**Ranges of movement**	The legs and feet are well supported with the worker seated and the weight evenly balanced
Muscle Use and Repetitive Motion	None selected	
Force	No resistance or less than 4.4 lbs (2 kgs) of intermittent load or force	

Save These Inputs to an Excel File

Calculations

1 is an acceptable posture score. A score greater than 1 is associated with a posture with ergonomic risk. However, there is not a direct proportion between the magnitude of the score and the degree of ergonomic risk.

Scoring for Group A body part

Body Part	Body Part Score	Posture Score A	Muscle	Force	Score C

107

Upper Arm	4				
Lower Arm	1	5	1	1	7
Wrist	3				
Wrist Twist	2				

Scoring for Group B body part

Body Part	Body Part Score	Posture Score B	Muscle	Force	Score D
Neck	1				
Trunk	1	1	0	0	1
Legs	1				

Grand Score

Score C	Score D	Grand Score
7	1	5

Conclusions

Based on the above data and criteria set forth by McAtamney and Corlett (1993), this Grand Score is classified as:

Action Level 3: further investigation and changes are required soon. The working posture is outside safe ranges, repetitive motion and/or static muscle contraction is required and significant force may be exerted.

Save This Report to an Excel File

Save This Report to a Word File

Reference

McAtamney, L., and Corlett, E.N., 1993, RULA: a survey method for the investigation of work-related upper limb disorders, *Applied Ergonomics*, 24(2), 91-99.

Printable Page

Customize Report

Rotational Work Cell
Job Title: Sub Screw and Wire Wrap
Job Description: PU Assy, place in fixt - Pos sub, pos wire (pink) - PU screw, set into tooling - Use tool to seat screw - Wrap wires as necessary - REL - - - -

Data Inputs

Posture risk assessment for Group A

Upper Arm Analysis	**Ranges of movement**	Extension greater than 20 degrees or 20 to 45 degrees of flexion
	Conditions	None selected
Lower Arm Analysis	**Ranges of movement**	60 to 100 degrees of flexion
	Conditions	Condition 1: The lower arm is working across the midline of the body or out to the side
Wrist Analysis	**Ranges of movement**	0 to 15 degrees in either flexion or extension
	Conditions	Condition 1: The wrist is in either radial or ulnar deviation Condition 2: The wrist is at or near the end of range of twist (near the end of pronation or supination range)
Muscle Use and Repetitive Motion	None selected	
Force	4.4 to 22 lbs (2 to 10 kgs) of intermittent load or force	

Posture risk assessment for Group B

Neck Analysis	**Ranges of movement**	0 to 10 degrees of flexion
	Conditions	None selected
Trunk Analysis	**Ranges of movement**	Sitting and well supported with a hip-trunk angle of 90 degrees or more
	Conditions	None selected
Leg Analysis	**Ranges of movement**	The legs and feet are well supported with the worker seated and the weight evenly balanced
Muscle Use and Repetitive Motion	None selected	
Force	No resistance or less than 4.4 lbs (2 kgs) of intermittent load or force	

Save These Inputs to an Excel File

Calculations

1 is an acceptable posture score. A score greater than 1 is associated with a posture with ergonomic risk. However, there is not a direct proportion between the magnitude of the score and the degree of ergonomic risk.

Scoring for Group A body part

Body Part	Body Part Score	Posture Score A	Muscle	Force	Score C
Upper	2	4	0	1	5

Arm	
Lower Arm	2
Wrist	3
Wrist Twist	2

Scoring for Group B body part

Body Part	Body Part Score	Posture Score B	Muscle	Force	Score D
Neck	1				
Trunk	1	1	0	0	1
Legs	1				

Grand Score

Score C	Score D	Grand Score
5	1	4

Conclusions

Based on the above data and criteria set forth by McAtamney and Corlett (1993), this Grand Score is classified as:

Action Level 2: further investigation is needed and changes may be required. The working posture is outside safe ranges or working postures are acceptable but characterized by repetitive motion, static muscle contraction or significant force.

Save This Report to an Excel File

Save This Report to a Word File

Reference

McAtamney, L., and Corlett, E.N., 1993, RULA: a survey method for the investigation of work-related upper limb disorders, *Applied Ergonomics*, 24(2), 91-99.

Printable Page

Customize Report

Rotational Work Cell
Job Title: Sub-Build
Job Description: PU card/case assy - PU float assy and pos to case, pos assy to fixt - PU contact, pos to fixt - PU back placte, route sub wire through, pos to fixt - DBP - RM Assy - aside to tote - REL - Restocking of subs @ heat shrink station as necessary - - - -

Data Inputs

Posture risk assessment for Group A

Upper Arm Analysis	**Ranges of movement**	20 degrees of extension to 20 degrees of flexion
	Conditions	None selected
Lower Arm Analysis	**Ranges of movement**	60 to 100 degrees of flexion
	Conditions	None selected
Wrist Analysis	**Ranges of movement**	0 to 15 degrees in either flexion or extension
	Conditions	None selected
Muscle Use and Repetitive Motion	None selected	
Force	No resistance or less than 4.4 lbs (2 kgs) of intermittent load or force	

Posture risk assessment for Group B

Neck Analysis	**Ranges of movement**	0 to 10 degrees of flexion
	Conditions	None selected
Trunk Analysis	**Ranges of movement**	Sitting and well supported with a hip-trunk angle of 90 degrees or more
	Conditions	None selected
Leg Analysis	**Ranges of movement**	The legs and feet are well supported with the worker seated and the weight evenly balanced
Muscle Use and Repetitive Motion	None selected	
Force	No resistance or less than 4.4 lbs (2 kgs) of intermittent load or force	

Save These Inputs to an Excel File

Calculations

1 is an acceptable posture score. A score greater than 1 is associated with a posture with ergonomic risk. However, there is not a direct proportion between the magnitude of the score and the degree of ergonomic risk.

Scoring for Group A body part

Body Part	Body Part Score	Posture Score A	Muscle	Force	Score C
Upper Arm	1				
Lower Arm	1	2	0	0	2
Wrist	2				

Wrist Twist	1

Scoring for Group B body part

Body Part	Body Part Score	Posture Score B	Muscle	Force	Score D
Neck	1				
Trunk	1	1	0	0	1
Legs	1				

Grand Score

Score C	Score D	Grand Score
2	1	2

Conclusions

Based on the above data and criteria set forth by McAtamney and Corlett (1993), this Grand Score is classified as:

Action Level 1: worker exposure to the measured risk factors is low and considered acceptable if not maintained or repeated over long periods.

Save This Report to an Excel File

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Reference

McAtamney, L., and Corlett, E.N., 1993, RULA: a survey method for the investigation of work-related upper limb disorders, *Applied Ergonomics*, 24(2), 91-99.

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APPENDIX III. PRODUCTION DATA

RANGER

Process Flow Chart

Project #: 2007 P150
Description: NA Ranger TMBS, MRFS Fuel Pump S
Part #: ▽ 7L54-9H307-A*/B*/C*
Part Name: TMBS, MRFS Fuel Pump Sender
Dept #: 307
Dept Name: Top Mount Bottom Sense
Veh Line/Mod Year: NA Ranger/2007
Company: Visteon/ETS
Contact/Phone: .
Core Team: .

Design/Mfg Resp:
Affected Supplier/Plant: Bedford
Other Areas Involved: 312, 316, 303, 313
Process: Manufacturing

Original Date: 9/21/2004
Last Rev: 1/26/06
Rev #: 10
Customer Eng Approval Date: ________
Customer QA Approval Date: ________
Supplier/Plant App Date: ________
Other Approval Date: ________
BP Rev Date/BP Rev: 20060103/F5
Drawing #: NFULE11332828

Sources of Variation (Incoming & Within)	Process Number & Process Name	Process Flow Chart	Class	Characteristics (Product & Process)
	910b - Assemble Regulator to Pocket			9210 Press Regulator to Pocket 9220 Secure Regulator with Clip 9230 Pocket Lubricated
	910c - Assemble Hoses to Regulator Dept: 305- Mtl Hdlng: Manual			910C Convolute hoses seated 910Q Hose Lubricated
	910d - Assemble ESD clip to regulator			9240 Press ESD clip to pocket
External Supplier Quality	00101 - Incoming Flange			GP-1 Incoming Material

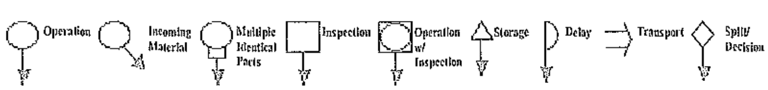
Operation · Incoming Material · Multiple Identical Parts · Inspection · Operation w/ Inspection · Storage · Delay · Transport · Split/ Decision

RANGER

Process Flow Chart

Project #: 2007 P150	Original Date: 9/21/2004
Description: NA Ranger TMBS, MRFS Fuel Pump S	Last Rev: 1/26/06
Part #: ▽7L54-9H307-A*/B*/C*	Rev #: 10
Part Name: TMBS, MRFS Fuel Pump Sender	Customer Eng Approval Date: ______
Dept #: 307	Customer QA Approval Date: ______
Dept Name: Top Mount Bottom Sense Design/Mfg Resp:	Supplier/Plant App Date: ______
Veh Line/Mod Year: NA Ranger/2007 Affected Supplier/Plant: Bedford	Other Approval Date: ______
Company: Visteon/ETS Other Areas Involved: 312, 316, 303, 313	BP Rev Date/BP Rev: 20060103/FS
Contact/Phone: Process: Manufacturing	Drawing #: NFULE11332828
Core Team:	

Sources of Variation (Incoming & Within)	Process Number & Process Name	Process Flow Chart	Class	Characteristics (Product & Process)
External Supplier Quality	**00102 - Incoming ROV**			GP-1 Incoming Material
External Supplier Quality	**00103 - Incoming FLVV**			GP-1 Incoming Material
Component size/hardness Component orientation Fixture stroke Flange part number	**00121 - Attach ROV, FLVV to Flange** Mtl Hdling: Pass to next operation			00121-1 ROV Secured to Flange 00121-2 FLVV Secured to Flange GP-5 Fixture Verification
Flange leak/permeability Cap leak/permeability Machine setup Component orientation	**00221 - He leak test** Mtl Hdling: Slide to next operation Caps removed/replaced as needed		VC	00221-1 Flange Leak Rate Tested GP-2 Test Mark Present GP-5 Fixture Verification GP-6 Data Collection



RANGER

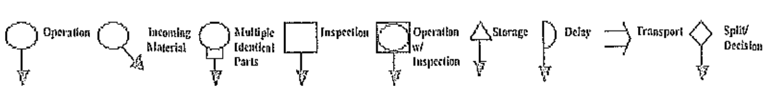
Process Flow Chart

Project #: 2007 P150
Description: NA Ranger TMBS, MRFS Fuel Pump S
Part #: ▽ 7L54-9H307-A*/B*/C*
Part Name: TMBS, MRFS Fuel Pump Sender
Dept #: 307
Dept Name: Top Mount Bottom Sense
Veh Line/Mod Year: NA Ranger/2007
Company: Visteon/FTS
Contact/Phone:
Core Team:

Design/Mfg Resp:
Affected Supplier/Plant: Bedford
Other Areas Involved: 312, 316, 303, 313
Process: Manufacturing

Original Date: 9/21/2004
Last Rev: 1/26/06
Rev #: 10
Customer Eng Approval Date:
Customer QA Approval Date:
Supplier/Plant App Date:
Other Approval Date:
BP Rev Date/BP Rev: 20060103/F5
Drawing #: NFULE11332828

Sources of Variation (Incoming & Within)	Process Number & Process Name	Process Flow Chart	Class	Characteristics (Product & Process)
Wire routing	**00401 - Incoming Sender Sub** Mtl Hdling: Slide/Batch from side oper Slider from Sender Sub Build station			GP-1 Incoming Material
Material length Shrinking temperature	**00402 - Incoming Shrink Wrap**			GP-1 Incoming Material
Positioning of shrink tube Time, temperature of heating	**00421 - Heat Shrink Sender to Flange** Mtl Hdling: Slide to next operation Slider to next station		VC	00421-1 Sender Wire Attached to Flange Wire 00421-2 Shrink Material Secured, No Exposed Metal
Length End-form	**00501 - Incoming Support Rods**			GP-1 Incoming Material



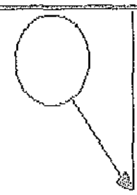
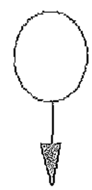
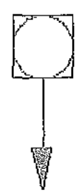
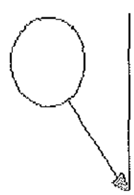
RANGER

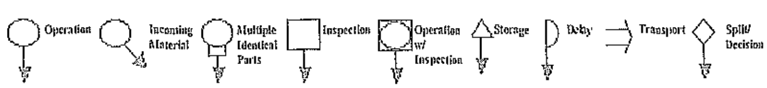
Process Flow Chart

Project #: 2007 P150
Description: NA Ranger TMBS, MRFS Fuel Pump S
Part #: v 7L54-9H307-A*/B*/C*
Part Name: TMBS, MRFS Fuel Pump Sender
Dept #: 307
Dept Name: Top Mount Bottom Sense
Veh Line/Mod Year: NA Ranger/2007
Company: Visteon/ETS
Contact/Phone:
Core Team:

Design/Mfg Resp:
Affected Supplier/Plant: Bedford
Other Areas Involved: 312, 316, 303, 313
Process: Manufacturing

Original Date: 9/21/2004
Last Rev: 1/26/06
Rev #: 10
Customer Eng Approval Date: ______
Customer QA Approval Date: ______
Supplier/Plant App Date: ______
Other Approval Date: ______
BP Rev Date/BP Rev: 20060103/F5
Drawing #: NFULE11332828

Sources of Variation (Incoming & Within)	Process Number & Process Name	Process Flow Chart	Class	Characteristics (Product & Process)
Hose Length Barbs	**00502 - Incoming Regulator Sub** Mtl Hdling: Batch from side operation			GP-1 Incoming Material
Tube onto which FPR is loaded FPR orientation Support rod orientation	**00521 - Support Rod Press onto Flange** Mtl Hdling: Pass to next operation Slider to next station		VC	00521-1 Regulator Assembly Attached to Tab Side Rod 00521-2 Support Rods Oriented Correctly 00521-3 Support Rods Secured to Flange GP-5 Fixture Verification
Component leak rate Flange angle Machine setup Fast-test seal	**00321 - FLVV/ROV Leak Test** Mtl Hdling: Pass to next operation Cap removed for testing and replaced before moving to next operation		VC	00321-1 FLVV and ROV leak Rate Measured GP-2 Test Mark Present GP-5 Fixture Verification GP-6 Data Collection
Length, gage, hardness	**00601 - Incoming Springs**			GP-1 Incoming Material



Fuel Delivery Assembly
BEDFORD PLANT
TIME STUDY

DATE: 6/6/2006

PART NO. : Static Work Cell

DONE BY: Scott Cramer

PART NAME: ----

OPERATION DESCRIPTION: Helium Leak Test

READINGS / 1000THS MIN

ELEMENT#	1ST	2ND	3RD	4TH
1	185	179		
2	193	146		
3	225	165		
4	220	202		
5	249	180		
6	192	217		
7	255	180		
8	229	210		
9	169	186		
10	222	174		
11	228	290		
12	220	274		
13	233	180		
14	255	183		
15	219	169		
16	231	229		
17	268	163		
18	262	193		
19	248	173		
20	231	214		
21	241	166		
22	218	245		
23	184	168		
24	243	215		
25	214	235		
TOTAL TIME	5.63400	4.93600	0.00000	0.00000
NO. READING	25	25	0	0
AVER. TIME	0.22536	0.19744	#DIV/0!	#DIV/0!
RATING FACTOR	85%	85%		
NORMAL TIME	0.19156	0.16782	#DIV/0!	#DIV/0!

INFREQUENT ELEMENTS

R	T	DESCRIPTION

SHIFT TIME:	480	MINUTES
PERS. BREAKS	-20	
WASH UPS	-10	
AREA CLEAN UP	-5	
LATE RETURN	-5	
TOTAL OPER. MIN.	440	

ALLOWED TIME	0.35938
SPECIAL ALLOW.	0
STANDARD TIME	0.35938
PCS PER 8 HOURS	**1,224**

ELEMENT		NORMAL TIME	PC./OCC	ALLOWED TIME
1	P/U Assy-RM Dust Caps if Applicable	0.19156	1	0.19156
2	RM Assy from test fixt-RM collar from Assy-place Assy to bin, P/U non-tested Assy fitted w/ dust caps, place collar on Assy place in fixture depress button to begin test	0.16782	1	0.16782

Fuel Delivery Assembly
BEDFORD PLANT
TIME STUDY

DATE: 6/6/2006 PART NO. : Static Work Cell

DONE BY: Scott Cramer

PART NAME: ---

OPERATION DESCRIPTION: Sub- Build

READINGS / 1000THS MIN

ELEMENT#	1ST	2ND	3RD	4TH
1	121	242		
2	114	211		
3	119	271		
4	100	335		
5	119	256		
6	125	281		
7	113	225		
8	120	293		
9	125	231		
10	104	277		
11	124	274		
12	95	239		
13	122	244		
14	119	265		
15	127	240		
16	118	333		
17	150	305		
18	147	301		
19	111	273		
20	120	293		
21	102	206		
22	109	256		
23	142	263		
24	113	259		
25	142	227		
TOTAL TIME	3.00100	6.60000	0.00000	0.00000
NO. READING	25	25		
AVER. TIME	0.12004	0.26400	#DIV/0!	#DIV/0!
RATING FACTOR	100%	100%		
NORMAL TIME	0.12004	0.26400	#DIV/0!	#DIV/0!

INFREQUENT ELEMENTS

R	T	DESCRIPTION

SHIFT TIME:	480	MINUTES
PERS. BREAKS	-20	
WASH UPS	-10	
AREA CLEAN UP	-5	
LATE RETURN	-5	
TOTAL OPER. MIN.	440	

ALLOWED TIME	0.38404
SPECIAL ALLOW.	0
STANDARD TIME	0.38404
PCS PER 8 HOURS	**1,146**

ELEMENT		NORMAL TIME	PC./OCC	ALLOWED TIME
1	P/U Card - P/U CASE-Place Card to Case, snap into place wrap wire and snap into place	0.12004	1	0.12004
2	P/U Float Assy- Place Float Assy into appropriate loc of case, set assy into fixt, P/U Back Plate, route wire through hole in Back Plate, depress button, m/c, remove assy from fixt-release to line or bin	0.26400	1	0.26400

NOTES:

Fuel Delivery Assembly
BEDFORD PLANT
TIME STUDY

DATE: 6/6/2006

PART NO. : Static Work Cell

DONE BY: Scott Cramer

PART NAME: ----

OPERATION DESCRIPTION: Heat Shrink

READINGS / 1000THS MIN

ELEMENT#	1ST	2ND	3RD	4TH
1	383			
2	416			
3	299			
4	318			
5	361			
6	258			
7	313			
8	313			
9	349			
10	294			
11	338			
12	301			
13	298			
14	315			
15	291			
16	309			
17	306			
18	285			
19	293			
20	299			
21	298			
22	301			
23	267			
24	296			
25	307			
TOTAL TIME	7.80800	0.00000	0.00000	0.00000
NO. READING	25			
AVER. TIME	0.31232	#DIV/0!	#DIV/0!	#DIV/0!
RATING FACTOR	88%			
NORMAL TIME	0.27484	#DIV/0!	#DIV/0!	#DIV/0!

INFREQUENT ELEMENTS

R	T	DESCRIPTION

SHIFT TIME:	480	MINUTES
PERS. BREAKS	-20	
WASH UPS	-10	
AREA CLEAN UP	-5	
LATE RETURN	-5	
TOTAL OPER. MIN.	440	

ALLOWED TIME	0.27484
SPECIAL ALLOW.	0
STANDARD TIME	0.27484
PCS PER 8 HOURS	**1,601**

ELEMENT		NORMAL TIME	PC./OCC	ALLOWED TIME
1	P/U Assy RM Dust Cap,- P/U shrink tube and place on appropriate wire (yellow), P/U Sub- Build and connect adaptor to wire on Flange Assy, Heat Shrink tube over connection, release to line	0.27484	1	0.27484

NOTES:

Fuel Delivery Assembly
BEDFORD PLANT
TIME STUDY

DATE: 6/6/2006 PART NO. : Static Work Cell

DONE BY: Scott Cramer

PART NAME: ----

OPERATION DESCRIPTION: FLVV Assembly and Test

READINGS / 1000THS MIN

ELEMENT#	1ST	2ND	3RD	M/C
1	415			124
2	449			123
3	464			139
4	433			134
5	431			128
6	431			134
7	434			123
8	535			120
9	523			125
10	463			
11	452			
12	466			
13	506			
14	493			
15	514			
16	424			
17	499			
18	452			
19	489			
20	477			
21	492			
22	474			
23	453			
24	465			
25	443			
TOTAL TIME	11.67700	0.00000	0.00000	1.15000
NO. READING	25			9
AVER. TIME	0.46708	#DIV/0!	#DIV/0!	0.12778
RATING FACTOR	100%			
NORMAL TIME	0.46708	#DIV/0!	#DIV/0!	0.00000

INFREQUENT ELEMENTS

R	T	DESCRIPTION

SHIFT TIME:	480	MINUTES
PERS. BREAKS	-20	
WASH UPS	-10	
AREA CLEAN UP	-5	
LATE RETURN	-5	
TOTAL OPER. MIN.	440	

ALLOWED TIME	0.46708
SPECIAL ALLOW.	0
STANDARD TIME	0.46708
PCS PER 8 HOURS	**942**

ELEMENT		NORMAL TIME	PC./OCC	ALLOWED TIME
1	P/U Flange Assy and place in fixt- P/U 2 straight tubes - P/U micro regulator and place on left tube below extrusion-place both tubes into fixture along with the micro regulator attached to one-depress buttons to test-wrap wires from the inside out around the right tube and release to line	0.46708	1	0.46708
4	Machine Cycle Time	0.12778	1	

NOTES:

Fuel Delivery Assembly
BEDFORD PLANT
TIME STUDY

DATE: 6/6/2006 PART NO. : Static Work Cell

DONE BY: Scott Cramer

PART NAME: ----

OPERATION DESCRIPTION: Pump Bracket Assy

READINGS / 1000THS MIN

ELEMENT#	1ST	2ND	3RD	4TH
1	343			
2	359			
3	352			
4	372			
5	336			
6	360			
7	388			
8	418			
9	414			
10	377			
11	397			
12	357			
13	392			
14	350			
15	363			
16	393			
17	375			
18	410			
19	352			
20	377			
21	316			
22	355			
23	314			
24	304			
25	343			
TOTAL TIME	9.11700	0.00000	0.00000	0.00000
NO. READING	25			
AVER. TIME	0.36468	#DIV/0!	#DIV/0!	#DIV/0!
RATING FACTOR	100%			
NORMAL TIME	0.36468	#DIV/0!	#DIV/0!	#DIV/0!

INFREQUENT ELEMENTS

R	T	DESCRIPTION

SHIFT TIME:	480	MINUTES
PERS. BREAKS	-20	
WASH UPS	-10	
AREA CLEAN UP	-5	
LATE RETURN	-5	
TOTAL OPER. MIN.	440	

ALLOWED TIME	0.36468
SPECIAL ALLOW.	0
STANDARD TIME	0.36468
PCS PER 8 HOURS	**1,207**

ELEMENT		NORMAL TIME	PC./OCC	ALLOWED TIME
1	P/U Pump-P/U Isolator, put isolator onto pump-P/U pump bracket , place pump inside bracket-P/U pump bracket bottom, place onto pump, place Pump Assy into Fixt,-P/U screw, place into head of drill, screw bottom bracket to pump bracket, RM from fixt,-P/U foot place on bottom bracket, release to line	0.36468	1	0.36468

NOTES:

Fuel Delivery Assembly
BEDFORD PLANT
TIME STUDY

DATE: 6/6/2006

PART NO. : Static Work Cell

DONE BY: Scott Cramer

PART NAME: ----

OPERATION DESCRIPTION: Filter and Conv. Hose to Pump

READINGS / 1000THS MIN

ELEMENT#	1ST	2ND	3RD	4TH
1	138	172		
2	166	171		
3	154	174		
4	168	135		
5	179	142		
6	199	135		
7	164	192		
8	122	136		
9	141	165		
10	137	176		
11	144	149		
12	157	154		
13	118	177		
14	141	166		
15	156	159		
16	112	174		
17	102	177		
18	138	139		
19	131	143		
20	111	157		
21	108	186		
22	107	172		
23	147	168		
24	125	143		
25	132	162		
TOTAL TIME	3.49700	4.02400	0.00000	0.00000
NO. READING	25	25	25	25
AVER. TIME	0.13988	0.16096	0.00000	0.00000
RATING FACTOR	120%	120%	100%	100%
NORMAL TIME	0.16786	0.19315	0.00000	0.00000

INFREQUENT ELEMENTS

R	T	DESCRIPTION

SHIFT TIME:	480	MINUTES
PERS. BREAKS	-20	
WASH UPS	-10	
AREA CLEAN UP	-5	
LATE RETURN	-5	
TOTAL OPER. MIN.	440	

ALLOWED TIME	0.36101
SPECIAL ALLOW.	0
STANDARD TIME	0.36101
PCS PER 8 HOURS	**1,219**

ELEMENT		NORMAL TIME	PC./OCC	ALLOWED TIME
1	P/U Pump Assy- P/U Foot, place on Bottom bracket-P/U Filter, pos. Filter on Pump Assy.-Pos. Pump Assy in Fixt.-Depress buttons	0.16786	1	0.16786
2	P/U Ring place in Fixt.-P/U Conv. Hose Place in Fixt-RM Pump Assy. from 1st Fixt. place in 2nd Fixt. activate lever-RM pump Assy from	0.19315	1	0.19315
3		0.00000	1	0.00000
4		0.00000	1	0.00000

NOTES:

Fuel Delivery Assembly
BEDFORD PLANT
TIME STUDY

DATE: 6/6/2006 PART NO. : Static Work Cell

DONE BY: Scott Cramer

PART NAME: ----

OPERATION DESCRIPTION: End Cap

READINGS / 1000THS MIN

ELEMENT#	1ST	2ND	3RD	4TH
1	142	90	125	
2	98	97	68	
3	88	114	73	
4	121	82	76	
5	106	132	103	
6	158	123	72	
7	112	100	77	
8	106	110	79	
9	126	103	74	
10	168	1333	67	
11	150	1115	67	
12	129	98	108	
13	142	109	132	
14	114	123	94	
15	144	125	81	
16	208	117	98	
17	147	124	114	
18	106	111	91	
19	86	112	83	
20	89	106	102	
21	117	103	82	
22	182	125	88	
23	128	119	73	
24	104	80	73	
25	84	103	77	
TOTAL TIME	3.15500	4.95400	2.17700	0.00000
NO. READING	25	25	25	
AVER. TIME	0.12620	0.19816	0.08708	#DIV/0!
RATING FACTOR	105%	100%	100%	
NORMAL TIME	0.13251	0.19816	0.08708	#DIV/0!

INFREQUENT ELEMENTS

R	T	DESCRIPTION

SHIFT TIME:	480	MINUTES
PERS. BREAKS	-20	
WASH UPS	-10	
AREA CLEAN UP	-5	
LATE RETURN	-5	
TOTAL OPER. MIN.	440	

ALLOWED TIME	0.41775
SPECIAL ALLOW.	0
STANDARD TIME	0.41775
PCS PER 8 HOURS	**1,053**

ELEMENT		NORMAL TIME	PC./OCC	ALLOWED TIME
1	P/U Flange Assy- P/U 2 springs, place onto tubes, 1 each tube, P/U Filter Pump Assy and place at the end of tubes	0.13251	1	0.13251
2	Set Assy into fixt-P/U end cap for tube, place in fixt-activate lever	0.19816	1	0.19816
3	Check test occurs, snap dump tube into place using second smaller lever remove from fixt- release to line	0.08708	1	0.08708

NOTES:

Fuel Delivery Assembly
BEDFORD PLANT
TIME STUDY

DATE: 6/6/2006 PART NO. : Static Work Cell

DONE BY: Scott Cramer

PART NAME: ----

OPERATION DESCRIPTION: Conv. Hose to Flange

READINGS / 1000THS MIN

ELEMENT#	1ST	2ND	3RD	4TH
1	309			
2	276			
3	289			
4	303			
5	282			
6	290			
7	331			
8	369			
9	342			
10	322			
11	301			
12	315			
13	327			
14	351			
15	327			
16	343			
17	325			
18	306			
19	296			
20	340			
21	295			
22	294			
23	292			
24	303			
25	323			
TOTAL TIME	7.85100	0.00000	0.00000	0.00000
NO. READING	25			
AVER. TIME	0.31404	#DIV/0!	#DIV/0!	#DIV/0!
RATING FACTOR	95%			
NORMAL TIME	0.29834	#DIV/0!	#DIV/0!	#DIV/0!

INFREQUENT ELEMENTS

R	T	DESCRIPTION

SHIFT TIME:	480	MINUTES
PERS. BREAKS	-20	
WASH UPS	-10	
AREA CLEAN UP	-5	
LATE RETURN	-5	
TOTAL OPER. MIN.	440	

ALLOWED TIME	0.29834
SPECIAL ALLOW.	0
STANDARD TIME	0.29834
PCS PER 8 HOURS	**1,475**

ELEMENT		NORMAL TIME	PC./OCC	ALLOWED TIME
1	P/U Flange Assy dip end of conv. tube in lubricant, place in fixt. activate lever, place foot pad @ bottom of filter/pump assy, RM 2 dust caps release from fixt.- release to line	0.29834	1	0.29834

NOTES:

Fuel Delivery Assembly
BEDFORD PLANT
TIME STUDY

DATE: 6/6/2006 PART NO. : Static Work Cell

DONE BY: Scott Cramer

PART NAME: ---

OPERATION DESCRIPTION: 2nd Conv. Hose to Flange

READINGS / 1000THS MIN

ELEMENT#	1ST	2ND	3RD	4TH
1	389	343	357	
2	314	337	403	
3	421	390	378	
4	414	320	326	
5	413	523	379	
6	382	442	335	
7	444	434	369	
8	377	335	360	
9	360	349	349	
10	403	336	407	
11	382	365	333	
12	435	344	340	
13	377	400	304	
14	437	411	323	
15	399	431	426	
16	462	367	358	
17	383	409	320	
18	395	526	333	
19	440	411	449	
20	468	389	316	
21	445	436	321	
22	404	348	413	
23	351	400	435	
24	383	317	385	
25	434	406	352	
TOTAL TIME	28.95200	0.00000	0.00000	0.00000
NO. READING	75	25	25	
AVER. TIME	0.38603	0.00000	0.00000	#DIV/0!
RATING FACTOR	101%	100%	100%	
NORMAL TIME	0.39146	0.00000	0.00000	#DIV/0!
Original pc/occ	95 3	110 3	110 3	

INFREQUENT ELEMENTS

R	T	DESCRIPTION

SHIFT TIME:	480	MINUTES
PERS. BREAKS	-20	
WASH UPS	-10	
AREA CLEAN UP	-5	
LATE RETURN	-5	
TOTAL OPER. MIN.	440	

ALLOWED TIME	0.39146
SPECIAL ALLOW.	0
STANDARD TIME	0.39146
PCS PER 8 HOURS	**1,124**

ELEMENT		NORMAL TIME	PC./OCC	ALLOWED TIME
1	P/U Flange Assy- dip conv. hose into lubricant-place hose into fixture, clamp hose-activate lever-wrap wires, attach two snap connectors, one to pump, one to micro regulator-release lever-release clamp, ensure that Sub-Build wire is double clipped-release to line	0.39146	1	0.39146
1		0.00000	1	0.00000
1		0.00000	1	0.00000
		#DIV/0!	1	0.00000

NOTES:

Fuel Delivery Assembly
BEDFORD PLANT
TIME STUDY

DATE: 6/6/2006 PART NO. : Static Work Cell

DONE BY: Scott Cramer

PART NAME: ----

OPERATION DESCRIPTION: Pressure Test Subsrew

READINGS / 1000THS MIN

ELEMENT#	1ST	2ND	3RD	4TH
1	198	354		
2	238	379		
3	146	603		
4	147	500		
5	209	316		
6	138	394		
7	55	330		
8	126	335		
9	210	279		
10	266	331		
11	207	481		
12	197	319		
13	180	347		
14	191	361		
15	189	338		
16	124	323		
17	144	336		
18	131	302		
19	258	338		
20	157	324		
21	151	332		
22	219	272		
23	173	320		
24	204	334		
25	260	312		
TOTAL TIME	4.51800	8.86000	0.00000	0.00000
NO. READING	25	25		
AVER. TIME	0.18072	0.35440	#DIV/0!	#DIV/0!
RATING FACTOR	82%	77%		
NORMAL TIME	0.14819	0.27289	#DIV/0!	#DIV/0!

INFREQUENT ELEMENTS

R	T	DESCRIPTION

SHIFT TIME:	480	MINUTES
PERS. BREAKS	-20	
WASH UPS	-10	
AREA CLEAN UP	-5	
LATE RETURN	-5	
TOTAL OPER. MIN.	440	

ALLOWED TIME	0.42108
SPECIAL ALLOW.	0
STANDARD TIME	0.42108
PCS PER 8 HOURS	**1,045**

ELEMENT		NORMAL TIME	PC./OCC	ALLOWED TIME
1	P/U Flange Assy-P/U Dust Cap and place on flanges-set Assy into fixt-test	0.14819	1	0.14819
2	Arrange Sub-Build and wire (pink) into appropriate location-P/U screw and place into head of drill, Screw sub-Build and wire (pink) remove from fixt-P/U 2 Dust Caps and place on flanges- release to line	0.27289	1	0.27289

NOTES:

Fuel Delivery Assembly
BEDFORD PLANT
TIME STUDY

DATE: 6/6/2006 PART NO. : Static Work Cell

DONE BY: Scott Cramer

PART NAME: ---

OPERATION DESCRIPTION: Check Plate

READINGS / 1000THS MIN

ELEMENT#	1ST	2ND	3RD	4TH
1	472			
2	489			
3	336			
4	471			
5	478			
6	337			
7	442			
8	334			
9	341			
10	464			
11	348			
12	377			
13	321			
14	375			
15	360			
16	352			
17	344			
18	394			
19	340			
20	353			
21	348			
22	315			
23	340			
24	326			
25	346			
TOTAL TIME	9.40300	0.00000	0.00000	0.00000
NO. READING	25			
AVER. TIME	0.37612	#DIV/0!	#DIV/0!	#DIV/0!
RATING FACTOR	111%			
NORMAL TIME	0.41825	#DIV/0!	#DIV/0!	#DIV/0!

INFREQUENT ELEMENTS

R	T	DESCRIPTION

SHIFT TIME:	480	MINUTES
PERS. BREAKS	-20	
WASH UPS	-10	
AREA CLEAN UP	-5	
LATE RETURN	-5	
TOTAL OPER. MIN.	440	

ALLOWED TIME	0.41825
SPECIAL ALLOW.	0
STANDARD TIME	0.41825
PCS PER 8 HOURS	**1,052**

ELEMENT		NORMAL TIME	PC./OCC	ALLOWED TIME
1	P/U Flange Assy- Place in fixt.-depress buttons-check float positioning- check float range of motion-wait for test to complete- RM from fixt.-peel printed label, place ontop of Flange Assy- release to line	0.41825	1	0.41825

NOTES:

WINDSHIELD WASHER RESERVIOR
BEDFORD PLANT
TIME STUDY

DATE: 5/8/2006 PART NO. : 7L54 9H307 CF

DONE BY: Jamison Reynolds

PART NAME: Ranger

OPERATION DESCRIPTION: Flange Assy/Float Rod

READINGS / 1000THS MIN

ELEMENT#	1ST	2ND	3RD	4TH
1	162	127	500	
2	154	104		
3	159	115		
4	174	119		
5	181	93		
6	174	102		
7	165	96		
8	160	115		
9	144	118		
10	182	104		
11	170	119		
12	169	109		
13	169	112		
14	166	106		
15	163	92		
16	167	120		
17	175	109		
18	183	117		
19		99		
20		115		
21		117		
22		128		
23		111		
24		119		
25		116		
TOTAL TIME	3.01700	2.78200	0.50000	0.00000
NO. READING	18	25	1	1
AVER. TIME	0.16761	0.11128	0.50000	0.00000
RATING FACTOR	115%	115%	100%	100%
NORMAL TIME	0.19275	0.12797	0.50000	0.00000

INFREQUENT ELEMENTS

R	T	DESCRIPTION

SHIFT TIME:	480	MINUTES
PERS. BREAKS	-20	
WASH UPS	-10	
AREA CLEAN UP	-5	
LATE RETURN	-5	
TOTAL OPER. MIN.	440	

ALLOWED TIME	0.34072
SPECIAL ALLOW.	0
STANDARD TIME	0.34072
PCS PER 8 HOURS	**1,291**

ELEMENT		NORMAL TIME	PC./OCC	ALLOWED TIME
1	PU flange - dip to lub - pos to fixt - PU FLVV - pos to fixt - PU roll over valve - pos to fixt - pull lever to seat both to flange - RM assy - PU dust cap - pos to flange - push to seat	0.19275	1	0.19275
2	PU float rod - PU flat float - pos flat float to float rod - PU pal nut - pos to tool - use tool to secure pal nut to float rod - aisde assy - REL	0.12797	1	0.12797
3	travel time and restock	0.50000	25	0.02000
4		0.00000	1	0.00000

WINDSHIELD WASHER RESERVIOR
BEDFORD PLANT
TIME STUDY

DATE: 5/8/2006 PART NO. : 7L54 9H307 CF

DONE BY: Jamison Reynolds

PART NAME: Ranger

OPERATION DESCRIPTION: Regulator Assy and ESD Clip

READINGS / 1000THS MIN

ELEMENT#	1ST	2ND	3RD	4TH
1		122	590	
2	252	133		
3	266	125		
4	252	98		
5	250	79		
6	242	86		
7	252	77		
8	252	98		
9	248	92		
10	250	73		
11	283	118		
12	265	86		
13	271	78		
14	256	84		
15	280	89		
16	281	75		
17	288	78		
18	248	65		
19	282	102		
20	245	128		
21	242	85		
22	250	94		
23	262	101		
24				
25				
TOTAL TIME	5.71700	2.16600	0.59000	0.00000
NO. READING	22	23	1	25
AVER. TIME	0.25986	0.09417	0.59000	0.00000
RATING FACTOR	115%	115%	100%	100%
NORMAL TIME	0.29884	0.10830	0.59000	0.00000

INFREQUENT ELEMENTS

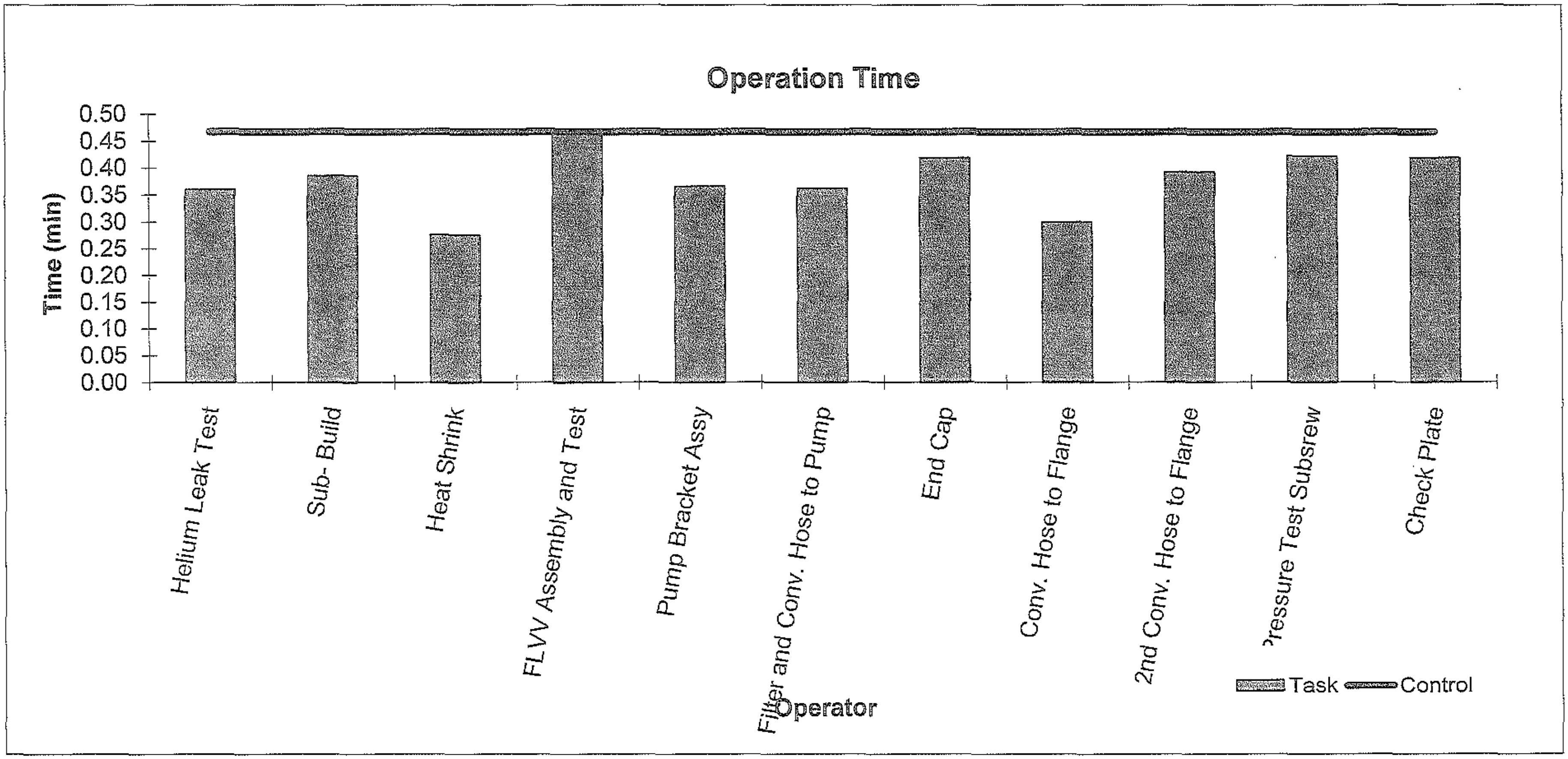
R	T	DESCRIPTION

SHIFT TIME:	480	MINUTES
PERS. BREAKS	-20	
WASH UPS	-10	
AREA CLEAN UP	-5	
LATE RETURN	-5	
TOTAL OPER. MIN.	440	

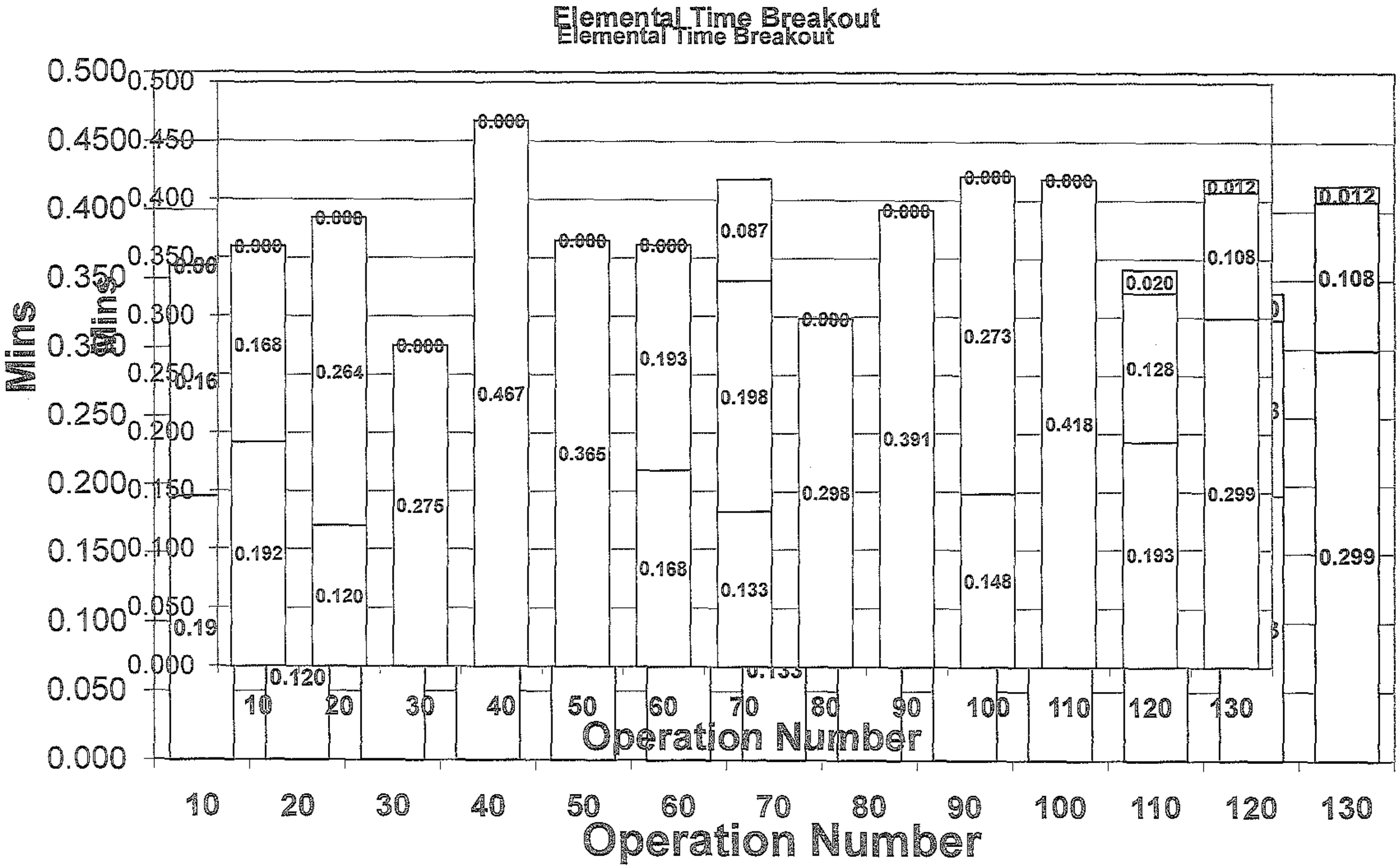
ALLOWED TIME	0.41894
SPECIAL ALLOW.	0
STANDARD TIME	0.41894
PCS PER 8 HOURS	**1,050**

ELEMENT		NORMAL TIME	PC./OCC	ALLOWED TIME
1	PU reg - PU housing - PU clip - assy and pos to fixt - PU(2) hoses - dip to lub - pos to fixt - press DPB - m/c - RM assy - aside to container - REL	0.29884	1	0.29884
2	PU reg assy - pos to fixt - PU ESD clip - pos to fixt - pull lever to seat - RM assy - aside to container - REL	0.10830	1	0.10830
3	travel time and restock	0.59000	50	0.01180
4		0.00000	1	0.00000

NOTES:

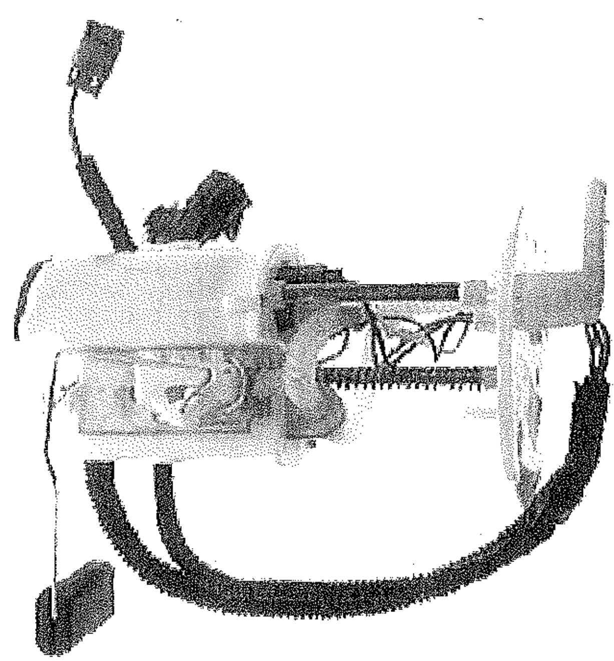


Operation Time
Time (min)
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Helium Leak Test
Sub- Build
Heat Shrink
FLVV Assembly and Test
Pump Bracket Assy
Filter and Conv. Hose to Pump
End Cap
Conv. Hose to Flange
2nd Conv. Hose to Flange
Pressure Test Subsrew
Check Plate
Operator
Task
Control


Elemental Time Breakout
Mins
0.500
0.450
0.400
0.350
0.300
0.250
0.200
0.150
0.100
0.050
0.000
0.000
0.168
0.192
0.000
0.264
0.120
0.000
0.275
0.000
0.467
0.000
0.365
0.000
0.193
0.168
0.087
0.198
0.133
0.000
0.298
0.000
0.391
0.000
0.273
0.148
0.000
0.418
0.020
0.128
0.193
0.012
0.108
0.299
10
20
30
40
50
60
70
80
90
100
110
120
130
Operation Number

307-1

308-3



DEPARTMENT

BEDFORD PLANT

WORK STANDARD SUMMARY

Part Number:	**Rotational**	Part Name:	%%%%%%
Revision Date:	8/28/2006	Previous Date:	%%%%%%
Authorization:	Time Study	Prepared by:	Scott Cramer
Line Bal. to:	**918** Pcs/shift.		

	No. of Operators:	Rate per 8 Hrs.
Plastics	6.45	918
Regulator Assy	0.72	918
Buss Wire	0.09	918
Filter	0.33	918
Support Tube	0.83	918
Module Assy	8.96	3043
Final Assembly	13.59	918
Total Assy	30.95	918

	Oper. Min.	Inh. Min.	Relief Min.	Repair Min.	Total Std. Min.	Total Std. Hrs.
Plastics	2.15	0.00	0.28	0.04	2.47	**0.0412**
Regulator Assy	0.34	0.00	0.03	0.01	0.38	**0.0064**
Buss Wire	0.10	0.00	0.00	0.00	0.10	**0.0017**
Filter	0.30	0.00	0.01	0.01	0.32	**0.0054**
Support Tube	0.26	0.00	0.04	0.01	0.30	**0.0050**
Module Assy	1.21	0.15	0.12	0.02	1.50	**0.0251**
Final Assembly	6.46	1.08	0.59	0.13	8.26	**0.1377**
Total Assy	10.82567	1.23029	1.07578	0.21651	13.34826	**0.22247**

Previous CWS: Hrs/pc

Variance: -0.13770 Hrs/pc

Concurrence:

RES ADV: ______________________ Date: ________

AREA ENG: ______________________ Date: ________

AREA MGR: ______________________ Date: ________

FUEL DELIVERY MODULE
BEDFORD PLANT
TIME STUDY

DATE: 8/28/2006 PART NO. : Rotational

DONE BY: Scott Cramer

PART NAME: %%%%%%

OPERATION DESCRIPTION: Regulator Assy

READINGS / 1000THS MIN

ELEMENT#	1ST	2ND	3RD	4TH	5th	6th
1	127	127				
2	190	135				
3	175	198				
4	167	110				
5	191	126				
6	194	113				
7	228	171				
8	285	144				
9	230	130				
10	201	146				
11	195	166				
12	217	145				
13	200	142				
14	182	137				
15	201	172				
16	202	128				
17	196	119				
18	216	150				
19	196	123				
20	214	129				
21	189	211				
22	178	148				
23		161				
24						
25						
TOTAL TIME	4.37400	3.32100	0.00000	0.00000	0.00000	0.00000
NO. READING	22	23	0	0	0	0
AVER. TIME	0.19882	0.14439	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
RATING FACTOR	100%	100%	100%	100%	100%	100%
NORMAL TIME	0.19882	0.14439	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

INFREQUENT ELEMENTS

R	T	DESCRIPTION

SHIFT TIME:	480	MINUTES
PERS. BREAKS	-20	
WASH UPS	-10	
AREA CLEAN UP	-5	
LATE RETURN	-5	
TOTAL OPER. MIN.	440	

ALLOWED TIME	0.34321
SPECIAL ALLOW.	0
STANDARD TIME	0.34321
PCS PER 8 HOURS	**1,282**

ELEMENT		NORMAL TIME	PC./OCC	ALLOWED TIME
1	PU Valve, Spring, and stop Valve, Assemble and place into fixt - PU regulator pocket, lubricate, place over valce asssembly to insert press	0.19882	1	0.19882
2	PU regulator pocket place into fixt - PU micro regulator, seat into pocket - PU pin place into fixt depress button M/C - RM - REL	0.14439	1	0.14439
3		#DIV/0!	1	
4		#DIV/0!	1	
5		#DIV/0!	1	
6		#DIV/0!	1	

NOTES:

FUEL DELIVERY MODULE
BEDFORD PLANT
TIME STUDY

DATE: 8/28/2006 PART NO. : Rotational

DONE BY: Scott Cramer

PART NAME: %%%%%%

OPERATION DESCRIPTION: Regulator Testing

READINGS / 1000THS MIN

ELEMENT#	1ST	2ND	3RD	4TH	5th	6th
1			163			
2			160			
3			203			
4			152			
5			194			
6			168			
7			181			
8			202			
9			155			
10			164			
11			185			
12			184			
13			152			
14			156			
15			203			
16			163			
17			166			
18						
19						
20						
21						
22						
23						
24						
25						
TOTAL TIME	0.00000	0.00000	2.95100	0.00000	0.00000	0.00000
NO. READING	0	0	17	0	0	0
AVER. TIME	#DIV/0!	#DIV/0!	0.17359	#DIV/0!	#DIV/0!	#DIV/0!
RATING FACTOR	100%	100%	100%	100%	100%	100%
NORMAL TIME	#DIV/0!	#DIV/0!	0.17359	#DIV/0!	#DIV/0!	#DIV/0!

INFREQUENT ELEMENTS

R	T	DESCRIPTION

SHIFT TIME:	480	MINUTES
PERS. BREAKS	-20	
WASH UPS	-10	
AREA CLEAN UP	-5	
LATE RETURN	-5	
TOTAL OPER. MIN.	440	

ALLOWED TIME	0.17359
SPECIAL ALLOW.	0
STANDARD TIME	0.17359
PCS PER 8 HOURS	**2,535**

ELEMENT		NORMAL TIME	PC./OCC	ALLOWED TIME
1		#DIV/0!	1	
2		#DIV/0!	1	
3	Unload tested assy from Tester - REL to tote - Unload heat stake fixt - Place assy into tester - DBP	0.17359	1	0.17359
4		#DIV/0!	1	
5		#DIV/0!	1	
6		#DIV/0!	1	

FUEL DELIVERY MODULE
BEDFORD PLANT
TIME STUDY

DATE: 8/28/2006 PART NO. : Rotational

DONE BY: Scott Cramer

PART NAME: %%%%%%

OPERATION DESCRIPTION: Rod Press

READINGS / 1000THS MIN

ELEMENT#	1ST	2ND	3RD	4TH	5th	6th
1	823	175				
2	1195	193				
3	1902	228				
4	1770	197				
5		199				
6		198				
7		233				
8		243				
9		220				
10		212				
11		196				
12		145				
13		218				
14		211				
15		178				
16		187				
17		205				
18		229				
19		183				
20		174				
21		186				
22		203				
23		185				
24		198				
25		197				
TOTAL TIME	5.69000	4.99300	0.00000	0.00000	0.00000	0.00000
NO. READING	4	25	0	0	0	0
AVER. TIME	1.42250	0.19972	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
RATING FACTOR	110%	105%	100%	100%	100%	100%
NORMAL TIME	1.56475	0.20971	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

INFREQUENT ELEMENTS

R	T	DESCRIPTION

SHIFT TIME:	480	MINUTES
PERS. BREAKS	-20	
WASH UPS	-10	
AREA CLEAN UP	-5	
LATE RETURN	-5	
TOTAL OPER. MIN.	440	

ALLOWED TIME	0.27230
SPECIAL ALLOW.	0
STANDARD TIME	0.27230
PCS PER 8 HOURS	**1,616**

ELEMENT		NORMAL TIME	PC./OCC	ALLOWED TIME
1	PU Retainer, Guide, Tube, Spring - Assy in Peg Board	1.56475	25	0.06259
2	PU Flange, place into fixt. - PU Rod Assy place into fixt - Pu Rod place into fixt - DBP - RM - REL	0.20971	1	0.20971
3		#DIV/0!	1	
4		#DIV/0!	1	
5		#DIV/0!	1	
6		#DIV/0!	1	

FUEL DELIVERY MODULE
BEDFORD PLANT
TIME STUDY

DATE: 8/28/2006 PART NO. : Rotational

DONE BY: Scott Cramer

PART NAME: %%%%%%

OPERATION DESCRIPTION: Leak Test

READINGS / 1000THS MIN

ELEMENT#	1ST	2ND	3RD	4TH	5th	6th
1	90	131	148			
2	96	92	156			
3	126	93	162			
4	90	141	135			
5	132	89	181			
6	96	103	157			
7	126	66	166			
8	105	64	131			
9	110	96	211			
10	114	98	143			
11	85	131	172			
12	91	200	123			
13	105	159	188			
14	108	131	151			
15	85	142	147			
16	78	101	150			
17	73	108	163			
18	125	133	199			
19	77	81	163			
20	110	114	190			
21	83	129	161			
22	102	102	173			
23	87	89	199			
24	95	110	174			
25	97	93	180			
TOTAL TIME	2.48600	2.79600	4.12500	0.00000	0.00000	0.00000
NO. READING	25	25	25	0	0	0
AVER. TIME	0.09944	0.11184	0.16500	#DIV/0!	#DIV/0!	#DIV/0!
RATING FACTOR	100%	100%	110%	100%	100%	100%
NORMAL TIME	0.09944	0.11184	0.18150	#DIV/0!	#DIV/0!	#DIV/0!

INFREQUENT ELEMENTS

R	T	DESCRIPTION

SHIFT TIME:	480	MINUTES
PERS. BREAKS	-20	
WASH UPS	-10	
AREA CLEAN UP	-5	
LATE RETURN	-5	
TOTAL OPER. MIN.	440	

ALLOWED TIME	0.39278
SPECIAL ALLOW.	0
STANDARD TIME	0.39278
PCS PER 8 HOURS	**1,120**

ELEMENT		NORMAL TIME	PC./OCC	ALLOWED TIME
1	PU flange assy - PU dust caps (2) place on flanges	0.09944	1	0.09944
2	M/C	0.11184	1	0.11184
3	Unload flange - Load new flange - DBP	0.18150	1	0.18150
4		#DIV/0!	1	
5		#DIV/0!	1	
6		#DIV/0!	1	

FUEL DELIVERY MODULE
BEDFORD PLANT
TIME STUDY

DATE: 8/28/2006 PART NO. : Rotational

DONE BY: Scott Cramer

PART NAME: %%%%%%

OPERATION DESCRIPTION: Conv Hose/Regulator Assy to flange

READINGS / 1000THS MIN

ELEMENT#	1ST	2ND	3RD	4TH	5th	6th
1	103	246				
2	192	269				
3	140	201				
4	120	235				
5	109	223				
6	152	251				
7	86	258				
8	119	246				
9	139	218				
10	151	210				
11	107	271				
12	134	209				
13	143	233				
14	158	185				
15	141	205				
16	113	239				
17	1525	217				
18	154	210				
19	104	234				
20	117	266				
21	173	213				
22	168	242				
23	139	239				
24	156	256				
25						
TOTAL TIME	4.64300	5.57600	0.00000	0.00000	0.00000	0.00000
NO. READING	24	24	0	0	0	0
AVER. TIME	0.19346	0.23233	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
RATING FACTOR	100%	100%	100%	100%	100%	100%
NORMAL TIME	0.19346	0.23233	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

INFREQUENT ELEMENTS

R	T	DESCRIPTION

SHIFT TIME:	480	MINUTES
PERS. BREAKS	-20	
WASH UPS	-10	
AREA CLEAN UP	-5	
LATE RETURN	-5	
TOTAL OPER. MIN.	440	

ALLOWED TIME	0.42579
SPECIAL ALLOW.	0
STANDARD TIME	0.42579
PCS PER 8 HOURS	**1,033**

ELEMENT		NORMAL TIME	PC./OCC	ALLOWED TIME
1	PU conv hose (2) dip both ends itno lubricate, set into fixt, clamp	0.19346	1	0.19346
2	PU Regulator, place into fixt. - PU flange, place into fixt - activate lever - RM - REL	0.23233	1	0.23233
3		#DIV/0!	1	
4		#DIV/0!	1	
5		#DIV/0!	1	
6		#DIV/0!	1	

FUEL DELIVERY MODULE
BEDFORD PLANT
TIME STUDY

DATE: 8/28/2006 PART NO. : Rotational

DONE BY: Scott Cramer

PART NAME: %%%%%%

OPERATION DESCRIPTION: Reservoir Flange Assy

READINGS / 1000THS MIN

ELEMENT#	1ST	2ND	3RD	4TH	5th	6th
1	111	210				
2	148	242				
3	108	217				
4	125	229				
5	107	267				
6	126	237				
7	115	252				
8	127	243				
9	98	212				
10	104	245				
11	111	223				
12	124	235				
13	121	245				
14	114	248				
15	119	248				
16	135	226				
17	122	241				
18	118	267				
19	145	217				
20	143	240				
21	115	252				
22	136	220				
23	138	235				
24	113	234				
25	107	223				
TOTAL TIME	3.03000	5.90800	0.00000	0.00000	0.00000	0.00000
NO. READING	25	25	0	0	0	0
AVER. TIME	0.12120	0.23632	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
RATING FACTOR	105%	100%	100%	100%	100%	100%
NORMAL TIME	0.12726	0.23632	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

INFREQUENT ELEMENTS

R	T	DESCRIPTION

SHIFT TIME:	480	MINUTES
PERS. BREAKS	-20	
WASH UPS	-10	
AREA CLEAN UP	-5	
LATE RETURN	-5	
TOTAL OPER. MIN.	440	

ALLOWED TIME	0.36358
SPECIAL ALLOW.	0
STANDARD TIME	0.36358
PCS PER 8 HOURS	**1,210**

ELEMENT		NORMAL TIME	PC./OCC	ALLOWED TIME
1	Pu crimp place into fixt and set using button - PU conv hose lubricate both ends place into fixt and clamp into place	0.12726	1	0.12726
2	PU reservoir - PU filter, snap filter into place on reservoir and set into fixt - PU flange assy. place into fixt. - activate lever - RM - REL	0.23632	1	0.23632
3		#DIV/0!	1	
4		#DIV/0!	1	
5		#DIV/0!	1	
6		#DIV/0!	1	

FUEL DELIVERY MODULE
BEDFORD PLANT
TIME STUDY

DATE: 8/28/2006 PART NO. : Rotational

DONE BY: Scott Cramer

PART NAME: %%%%%%

OPERATION DESCRIPTION: Regulator to the Reservoir

READINGS / 1000THS MIN

ELEMENT#	1ST	2ND	3RD	4TH	5th	6th
1	369	102				
2	262	94				
3	342	142				
4	342	100				
5	353	98				
6	258	108				
7	237	103				
8	380	123				
9	211	89				
10	239	134				
11	272	107				
12	227	93				
13	214	114				
14	249	116				
15	282	121				
16	324	154				
17	265	108				
18	259	101				
19	269	88				
20	226	127				
21	274	106				
22	239	153				
23	302	85				
24	251	83				
25	265	92				
TOTAL TIME	6.91100	2.74100	0.00000	0.00000	0.00000	0.00000
NO. READING	25	25	0	0	0	0
AVER. TIME	0.27644	0.10964	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
RATING FACTOR	100%	100%	100%	100%	100%	100%
NORMAL TIME	0.27644	0.10964	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

INFREQUENT ELEMENTS

R	T	DESCRIPTION

SHIFT TIME:	480	MINUTES
PERS. BREAKS	-20	
WASH UPS	-10	
AREA CLEAN UP	-5	
LATE RETURN	-5	
TOTAL OPER. MIN.	440	

ALLOWED TIME	0.38608
SPECIAL ALLOW.	0
STANDARD TIME	0.38608
PCS PER 8 HOURS	**1,140**

ELEMENT		NORMAL TIME	PC./OCC	ALLOWED TIME
1	PU screw set into tool - PU Assy, place into fixt - Position Regulator - Using tool seat screw - PU 2nd scrw place in tool and seat screw	0.27644	1	0.27644
2	Route wires, snap plug into reservoir - RM - REL	0.10964	1	0.10964
3		#DIV/0!	1	
4		#DIV/0!	1	
5		#DIV/0!	1	
6		#DIV/0!	1	

FUEL DELIVERY MODULE
BEDFORD PLANT
TIME STUDY

DATE: 8/28/2006 PART NO. : Rotational

DONE BY: Scott Cramer

PART NAME: %%%%%%

OPERATION DESCRIPTION: Support Tube to Reservoir

READINGS / 1000THS MIN

ELEMENT#	1ST	2ND	3RD	4TH	5th	6th
1	190	235				
2	163	183				
3	256	196				
4	263	194				
5	221	267				
6	230	191				
7	235	222				
8	178	234				
9	199	232				
10	224	179				
11	267	202				
12	216	187				
13	188	198				
14	223	204				
15	173	204				
16	174	164				
17	242	194				
18	192	172				
19	237	229				
20	296	232				
21	231	244				
22	230	176				
23	191	151				
24	227	247				
25	213	181				
TOTAL TIME	5.45900	5.11800	0.00000	0.00000	0.00000	0.00000
NO. READING	25	25	0	0	0	0
AVER. TIME	0.21836	0.20472	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
RATING FACTOR	100%	100%	100%	100%	100%	100%
NORMAL TIME	0.21836	0.20472	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

INFREQUENT ELEMENTS

R	T	DESCRIPTION

SHIFT TIME:	480	MINUTES
PERS. BREAKS	-20	
WASH UPS	-10	
AREA CLEAN UP	-5	
LATE RETURN	-5	
TOTAL OPER. MIN.	440	

ALLOWED TIME	0.42308
SPECIAL ALLOW.	0
STANDARD TIME	0.42308
PCS PER 8 HOURS	**1,040**

ELEMENT		NORMAL TIME	PC./OCC	ALLOWED TIME
1	PU screw set into tool - PU Assy, position wire (black) and seat screw	0.21836	1	0.21836
2	Snap support tubes into appropriate location - REL	0.20472	1	0.20472
3		#DIV/0!	1	
4		#DIV/0!	1	
5		#DIV/0!	1	
6		#DIV/0!	1	

FUEL DELIVERY MODULE
BEDFORD PLANT
TIME STUDY

DATE: 8/28/2006 PART NO. : Rotational

DONE BY: Scott Cramer

PART NAME: %%%%%%

OPERATION DESCRIPTION: Heat Shrink

READINGS / 1000THS MIN

ELEMENT#	1ST	2ND	3RD	4TH	5th	6th
1	373					
2	371					
3	480					
4	339					
5	350					
6	351					
7	352					
8	325					
9	324					
10	366					
11	356					
12	343					
13	362					
14	343					
15	341					
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
TOTAL TIME	5.37600	0.00000	0.00000	0.00000	0.00000	0.00000
NO. READING	15	0	0	0	0	0
AVER. TIME	0.35840	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
RATING FACTOR	90%	100%	100%	100%	100%	100%
NORMAL TIME	0.32256	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

INFREQUENT ELEMENTS

R	T	DESCRIPTION

SHIFT TIME:	480	MINUTES
PERS. BREAKS	-20	
WASH UPS	-10	
AREA CLEAN UP	-5	
LATE RETURN	-5	
TOTAL OPER. MIN.	440	

ALLOWED TIME	0.32256
SPECIAL ALLOW.	0
STANDARD TIME	0.32256
PCS PER 8 HOURS	**1,364**

ELEMENT		NORMAL TIME	PC./OCC	ALLOWED TIME
1	PU Sub assy - PU Heat shrink tube, pos over sub wire - PU Flange assy - Connect wires (yellow) - Place over heat source as necessary -	0.32256	1	0.32256
2		#DIV/0!	1	
3		#DIV/0!	1	
4		#DIV/0!	1	
5		#DIV/0!	1	
6		#DIV/0!	1	

FUEL DELIVERY MODULE
BEDFORD PLANT
TIME STUDY

DATE: 8/28/2006 PART NO. : Rotational

DONE BY: Scott Cramer

PART NAME: %%%%%

OPERATION DESCRIPTION: Sub Screw and Wire Wrap

READINGS / 1000THS MIN

ELEMENT#	1ST	2ND	3RD	4TH	5th	6th
1	244	206				
2	250	207				
3	271	152				
4	223	194				
5	252	150				
6	252	269				
7	276	217				
8	289	225				
9	241	224				
10	222	274				
11	267	290				
12	270	301				
13	240	203				
14	272	222				
15	252	214				
16	279	227				
17	231	234				
18	207	281				
19	209	235				
20	241	238				
21	234	245				
22	227	254				
23	203	304				
24	271	267				
25	217	205				
TOTAL TIME	6.14000	5.83800	0.00000	0.00000	0.00000	0.00000
NO. READING	25	25	0	0	0	0
AVER. TIME	0.24560	0.23352	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
RATING FACTOR	100%	100%	100%	100%	100%	100%
NORMAL TIME	0.24560	0.23352	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

INFREQUENT ELEMENTS

R	T	DESCRIPTION

SHIFT TIME:	480	MINUTES
PERS. BREAKS	-20	
WASH UPS	-10	
AREA CLEAN UP	-5	
LATE RETURN	-5	
TOTAL OPER. MIN.	440	

ALLOWED TIME	0.47912
SPECIAL ALLOW.	0
STANDARD TIME	0.47912
PCS PER 8 HOURS	**918**

ELEMENT		NORMAL TIME	PC./OCC	ALLOWED TIME
1	PU Assy, place in fixt - Pos sub, pos wire (pink) - PU screw, set into tooling - Use tool to seat screw	0.24560	1	0.24560
2	Wrap wires as necessary - REL	0.23352	1	0.23352
3		#DIV/0!	1	
4		#DIV/0!	1	
5		#DIV/0!	1	
6		#DIV/0!	1	

FUEL DELIVERY MODULE
BEDFORD PLANT
TIME STUDY

DATE: 8/28/2006

PART NO. : Rotational

DONE BY: Scott Cramer

PART NAME: %%%%%%

OPERATION DESCRIPTION: Assy Leak Test

READINGS / 1000THS MIN

ELEMENT#	1ST	2ND	3RD	4TH	5th	6th
1	25	291				
2	62	302				
3	28	323				
4	57	310				
5	63	301				
6	74	358				
7	65	296				
8	78	251				
9	83	285				
10	43	257				
11	106	253				
12	100	241				
13	57	252				
14	65	239				
15	71	232				
16	63	264				
17	70	225				
18	52	252				
19	62	236				
20	63	267				
21	112	223				
22	74	321				
23	51	266				
24	84	256				
25	82	244				
TOTAL TIME	1.69000	6.74700	0.00000	0.00000	0.00000	0.00000
NO. READING	25	25	0	0	0	0
AVER. TIME	0.06760	0.26988	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
RATING FACTOR	105%	105%	100%	100%	100%	100%
NORMAL TIME	0.07098	0.28337	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

INFREQUENT ELEMENTS

R	T	DESCRIPTION

SHIFT TIME:	480	MINUTES
PERS. BREAKS	-20	
WASH UPS	-10	
AREA CLEAN UP	-5	
LATE RETURN	-5	
TOTAL OPER. MIN.	440	

ALLOWED TIME	0.35435
SPECIAL ALLOW.	0
STANDARD TIME	0.35435
PCS PER 8 HOURS	**1,242**

ELEMENT		NORMAL TIME	PC./OCC	ALLOWED TIME
1	PU Assy, attach testing adaptor - BP - M/C	0.07098	1	0.07098
2	RM Testere - PU dust caps (2) place on exposed flanges - connect conv hose to reservoir - REL	0.28337	1	0.28337
3		#DIV/0!	1	
4		#DIV/0!	1	
5		#DIV/0!	1	
6		#DIV/0!	1	

FUEL DELIVERY MODULE
BEDFORD PLANT
TIME STUDY

DATE: 8/28/2006

PART NO. : Rotational

DONE BY: Scott Cramer

PART NAME: %%%%%%

OPERATION DESCRIPTION: Check Plate

READINGS / 1000THS MIN

ELEMENT#	1ST	2ND	3RD	4TH	5th	6th
1	293					
2	270					
3	270					
4	254					
5	308					
6	305					
7	267					
8	311					
9	271					
10	275					
11	250					
12	200					
13	193					
14	221					
15	291					
16	258					
17	230					
18	253					
19	187					
20	278					
21	300					
22	212					
23	234					
24	221					
25	232					
TOTAL TIME	6.38400	0.00000	0.00000	0.00000	0.00000	0.00000
NO. READING	25	0	0	0	0	0
AVER. TIME	0.25536	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
RATING FACTOR	115%	100%	100%	100%	100%	100%
NORMAL TIME	0.29366	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

INFREQUENT ELEMENTS

R	T	DESCRIPTION

SHIFT TIME:	480	MINUTES
PERS. BREAKS	-20	
WASH UPS	-10	
AREA CLEAN UP	-5	
LATE RETURN	-5	
TOTAL OPER. MIN.	440	

ALLOWED TIME	0.29366
SPECIAL ALLOW.	0
STANDARD TIME	0.29366
PCS PER 8 HOURS	**1,498**

ELEMENT		NORMAL TIME	PC./OCC	ALLOWED TIME
1	PU Assy, pos to fixt - DBP - check and adjust float as required - raise float to check high resistance - RM Assy - Place label on flange -	0.29366	1	0.29366
2		#DIV/0!	1	
3		#DIV/0!	1	
4		#DIV/0!	1	
5		#DIV/0!	1	
6		#DIV/0!	1	

FUEL DELIVERY MODULE
BEDFORD PLANT
TIME STUDY

DATE: 8/28/2006 PART NO.: Rotational

DONE BY: Scott Cramer

PART NAME: %%%%%%

OPERATION DESCRIPTION: Sub-Build

READINGS / 1000THS MIN

ELEMENT#	1ST	2ND	3RD	4TH	5th	6th
1	269	837				
2	304					
3	251					
4	313					
5	334					
6	330					
7	340					
8	302					
9	287					
10	290					
11	298					
12	352					
13	301					
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
TOTAL TIME	3.97100	0.83700	0.00000	0.00000	0.00000	0.00000
NO. READING	13	1	0	0	0	0
AVER. TIME	0.30546	0.83700	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
RATING FACTOR	100%	100%	100%	100%	100%	100%
NORMAL TIME	0.30546	0.83700	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

INFREQUENT ELEMENTS

R	T	DESCRIPTION

SHIFT TIME:	480	MINUTES
PERS. BREAKS	-20	
WASH UPS	-10	
AREA CLEAN UP	-5	
LATE RETURN	-5	
TOTAL OPER. MIN.	440	

ALLOWED TIME	0.31662
SPECIAL ALLOW.	0
STANDARD TIME	0.31662
PCS PER 8 HOURS	**1,390**

ELEMENT		NORMAL TIME	PC./OCC	ALLOWED TIME
1	PU card/case assy - PU float assy and pos to case, pos assy to fixt - PU contact, pos to fixt - PU back placte, route sub wire through, pos	0.30546	1	0.30546
2	Restocking of subs @ heat shrink station as necessary	0.83700	75	0.01116
3		#DIV/0!	1	
4		#DIV/0!	1	
5		#DIV/0!	1	
6		#DIV/0!	1	

FUEL DELIVERY MODULE
BEDFORD PLANT
TIME STUDY

DATE: 8/28/2006 PART NO. : Rotational

DONE BY: Scott Cramer

PART NAME: %%%%%%

OPERATION DESCRIPTION: Card to case/Float Rod Assy

READINGS / 1000THS MIN

ELEMENT#	1ST	2ND	3RD	4TH	5th	6th
1	128	120				
2	101	150				
3	124	131				
4	104	89				
5	111	119				
6	114	151				
7	116	99				
8	118	132				
9	108	106				
10	136	113				
11	116	119				
12	108	95				
13	120	104				
14	115	117				
15	114	81				
16	112	1158				
17	105	94				
18	118	100				
19	114	123				
20	124	108				
21	112	96				
22	113	114				
23	116	100				
24	123	123				
25	123	111				
TOTAL TIME	2.89300	3.85300	0.00000	0.00000	0.00000	0.00000
NO. READING	25	25	0	0	0	0
AVER. TIME	0.11572	0.15412	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
RATING FACTOR	100%	100%	100%	100%	100%	100%
NORMAL TIME	0.11572	0.15412	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

INFREQUENT ELEMENTS

R	T	DESCRIPTION

SHIFT TIME:	480	MINUTES
PERS. BREAKS	-20	
WASH UPS	-10	
AREA CLEAN UP	-5	
LATE RETURN	-5	
TOTAL OPER. MIN.	440	

ALLOWED TIME	0.26984
SPECIAL ALLOW.	0
STANDARD TIME	0.26984
PCS PER 8 HOURS	**1,631**

ELEMENT		NORMAL TIME	PC./OCC	ALLOWED TIME
1	PU Rod, Float, slide rod through float - PU nut, place in tooling - depress rod into tooling secure float - RM - REL	0.11572	1	0.11572
2	PU Card - PU Case - Route wire through case as required - snap card into place - secure wire - REL	0.15412	1	0.15412
3		#DIV/0!	1	
4		#DIV/0!	1	
5		#DIV/0!	1	
6		#DIV/0!	1	

APPENDIX IV. SIMULATION DATA

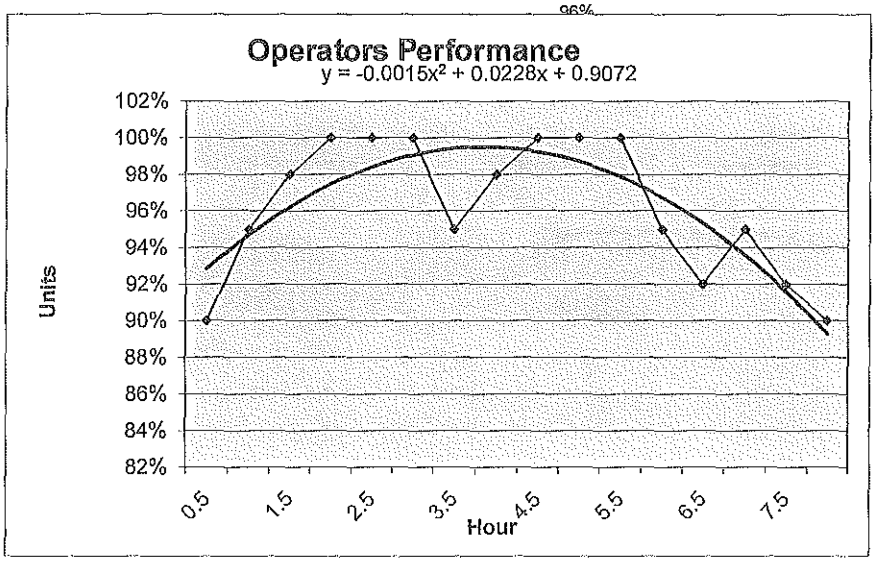
FLVV Assembly and Test
Non- Rotational Cell

Performance Ratings	
Peak	*Low*
100%	90%

	Operation Rate	Line Rate	15	20	25
0.46709	**942**	942	32.11364	42.81818182	53.52272727
	Parts not needed	0			
	Inherit Delay(min)	-0.01			

0.46708 Constraint Operation 100%

Hour	Basic Min	Production (Units)	Duration Worked (min)	Performance Rating	Parts Required	Performance to Parts Required
0.5	0.519	58	30	90%	64.2	90%
1	0.492	61	30	95%	64.2	95%
1.5	0.477	63	30	98%	64.2	98%
2	0.467	64	30	100%	64.2	100%
2.5	0.467	64	30	100%	64.2	100%
3	0.467	32	15	100%	32.1	100%
3.5	0.492	61	30	95%	64.2	95%
4	0.477	63	30	98%	64.2	98%
4.5	0.467	54	25	100%	53.5	100%
5	0.467	64	30	100%	64.2	100%
5.5	0.467	64	30	100%	64.2	100%
6	0.492	61	30	95%	64.2	95%
6.5	0.508	59	30	92%	64.2	92%
7	0.492	31	15	95%	32.1	95%
7.5	0.508	59	30	92%	64.2	92%
8	0.519	48	25	90%	53.5	90%
	Total	**906**	**440**	96%	**942**	



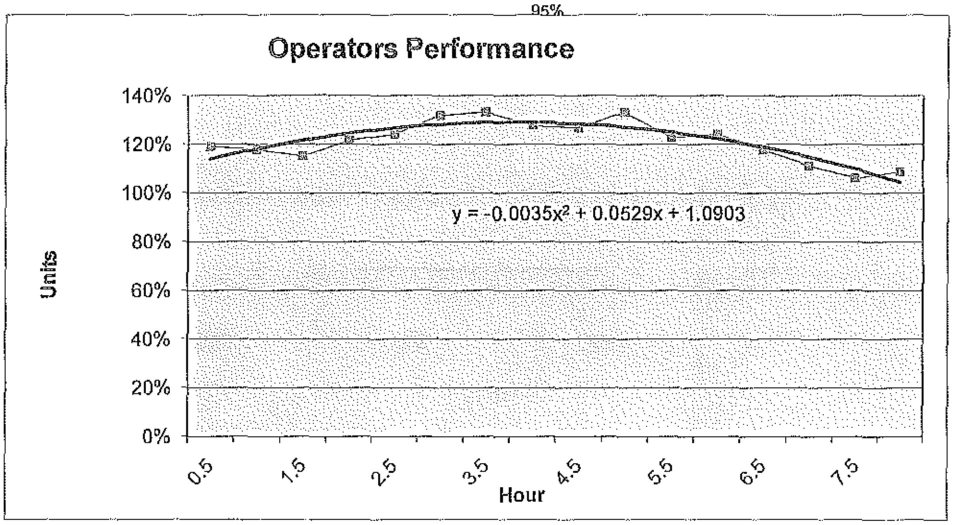
Pump Bracket Assy
Non- Rotational Cell

Performance Ratings	
Peak	Low
104%	83%

	Operation Rate	Line Rate	15	20	25	30
0.36468	1207	942	32.11364	42.81818182	53.52272727	64.22727
	Parts not needed	265				
	Inherit Delay(min)	96.46				

0.46708 Constraint Operation 100%

Hour	Basic Min	Production (Units)	Duration Worked (min)	Performance Rating	Parts Required	Performance to Parts Required
0.5	0.392	77	30	93%	64.2	119%
1	0.396	76	30	92%	64.2	118%
1.5	0.405	74	30	90%	64.2	115%
2	0.384	78	30	95%	64.2	122%
2.5	0.376	80	30	97%	64.2	124%
3	0.354	42	15	103%	32.1	132%
3.5	0.351	86	30	104%	64.2	133%
4	0.365	82	30	100%	64.2	128%
4.5	0.368	68	25	99%	53.5	127%
5	0.351	86	30	104%	64.2	133%
5.5	0.380	79	30	96%	64.2	123%
6	0.376	80	30	97%	64.2	124%
6.5	0.396	76	30	92%	64.2	118%
7	0.419	36	15	87%	32.1	111%
7.5	0.439	68	30	83%	64.2	106%
8	0.429	58	25	85%	53.5	109%
	Total	1144	440		942	
				95%		

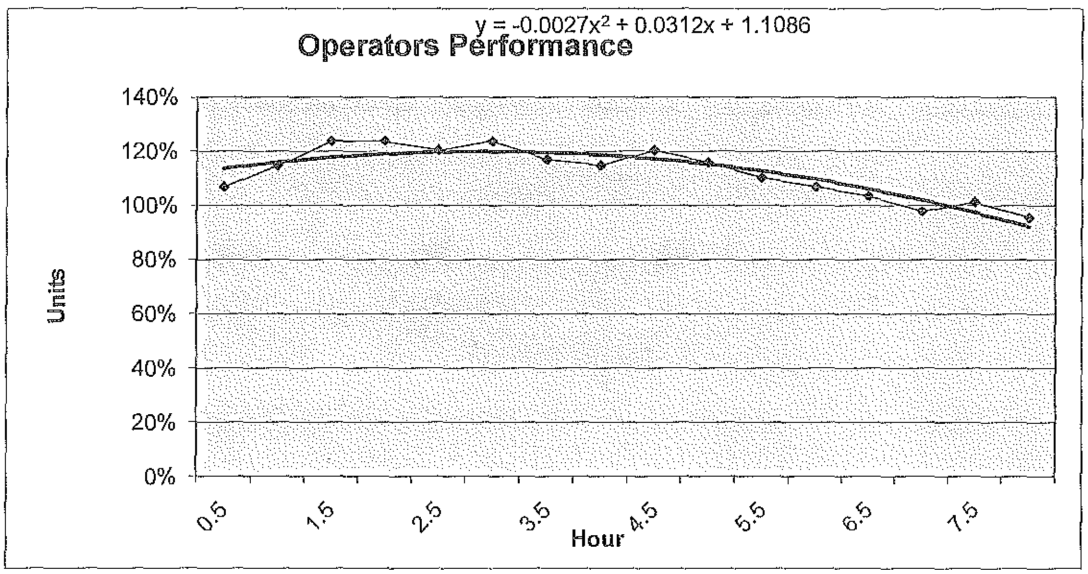


Conv Hose/Regulator Assy to Flange
Rotational Cell

Performance Ratings			Operation Rate	Line Rate	15	20	25	30
		0.42579	**1033**	918	31.29545	41.72727273	52.15909	62.59091
Peak	*Low*		Parts not needed	115				
110%	85%		Inherit Delay(min)	48.98				

0.47912 Constraint Operation 100%

Hour	Basic Min	Production (Units)	Duration Worked (min)	Performance Rating	Parts Required	Performance to Parts Required
0.5	0.448	67	30	95%	62.6	107%
1	0.417	72	30	102%	62.6	115%
1.5	0.387	78	30	110%	62.6	124%
2	0.387	78	30	110%	62.6	124%
2.5	0.398	75	30	107%	62.6	120%
3	0.387	39	15	110%	31.3	124%
3.5	0.409	73	30	104%	62.6	117%
4	0.417	72	30	102%	62.6	115%
4.5	0.398	63	25	107%	52.2	120%
5	0.413	73	30	103%	62.6	116%
5.5	0.434	69	30	98%	62.6	110%
6	0.448	67	30	95%	62.6	107%
6.5	0.463	65	30	92%	62.6	104%
7	0.489	31	15	87%	31.3	98%
7.5	0.473	63	30	90%	62.6	101%
8	0.501	50	25	85%	52.2	96%
Total		1033	440			
				100%		

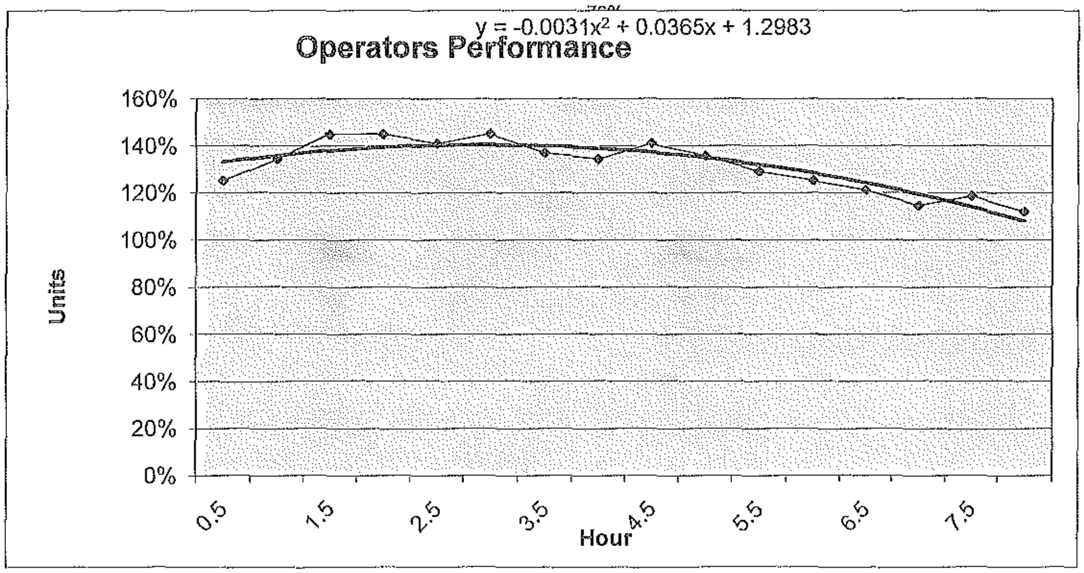


Reservoir Flange Assembly
Rotational Cell

Performance Ratings			Operation Rate	Line Rate	15	20	25	30
		0.36358	**1210**	918	31.29545	41.72727273	52.15909	62.59091
Peak	*Low*		Parts not needed	292				
110%	85%		Inherit Delay(min)	106.11				

0.47912 Constraint Operation 100%

Hour	Basic Min	Production (Units)	Duration Worked (min)	Performance Rating	Parts Required	Performance to Parts Required
0.5	0.383	78	30	95%	62.6	125%
1	0.356	84	30	102%	62.6	134%
1.5	0.331	91	30	110%	62.6	145%
2	0.331	91	30	110%	62.6	145%
2.5	0.340	88	30	107%	62.6	141%
3	0.331	45	15	110%	31.3	145%
3.5	0.350	86	30	104%	62.6	137%
4	0.356	84	30	102%	62.6	134%
4.5	0.340	74	25	107%	52.2	141%
5	0.353	85	30	103%	62.6	136%
5.5	0.371	81	30	98%	62.6	129%
6	0.383	78	30	95%	62.6	125%
6.5	0.395	76	30	92%	62.6	121%
7	0.418	36	15	87%	31.3	115%
7.5	0.404	74	30	90%	62.6	119%
8	0.428	58	25	85%	52.2	112%
Total		1210	440			
				100%		



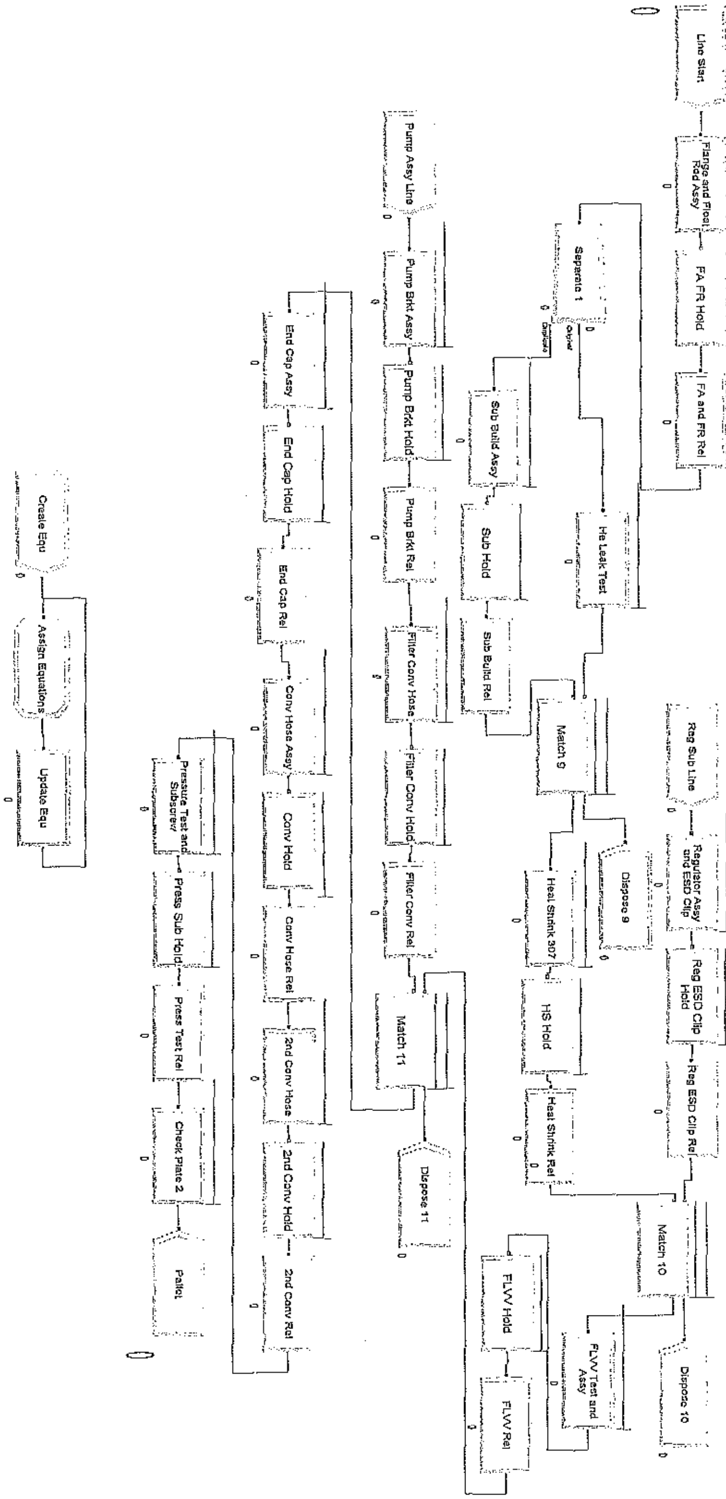
Rotational	Non-rotational	Non Equations				
Regulator Testing Equ	Reg Assy and ESD Clip equ	0.4671/((-0.0029*((TNOW)/60)**2)+0.0282*((TNOW)/60)+1.1298)	-0.0029	0.282	1.1298	
Rod Press Equ	FLVV Assy and Test equ	0.4671/((-0.0016*((TNOW)/60)**2)+0.0237*((TNOW)/60)+0.9065)	0.0016	0.237	0.9065	
						applied Reg Assy and ESD Clip to
Leak Test Equ	Helium Leak test equ	0.4671/((-0.0033*((TNOW)/60)**2)+0.0462*((TNOW)/60)+1.1604)	-0.0033	0.462	1.1604	both Reg test and assy
Conv Hose Reg Assy Equ	Pump Brckt Assy equ	0.4671/((-0.0035*((TNOW)/60)**2)+0.0529*((TNOW)/60)+1.0903)	-0.0035	0.529	1.0903	
Reservoir Flange Assy Equ	Conv Hose to Flange equ	0.4671/((-0.0033*((TNOW)/60)**2)+0.0485*((TNOW)/60)+1.384)	-0.0033	0.0485	1.384	
Regulator to Reservoir Equ	2nd Conv Hose to Flange equ	0.4671/((-0.0026*((TNOW)/60)**2)+0.042*((TNOW)/60)+1.0028)	-0.0026	0.042	0.0028	
Support Tube Equ	End Cap Equ	0.4671/((-0.0003*((TNOW)/60)**2)+0.0003*((TNOW)/60)+1.0537)	-0.0003	0.0003	1.0537	
Float Rod Card 2 Case Equ	Flange Float Rod equ	0.4671/((-0.0041*((TNOW)/60)**2)+0.0542*((TNOW)/60)+1.2288)	-0.0041	0.0542	1.2288	
Sub Build Equ	Sub Build equ	0.4671/((-0.0017*((TNOW)/60)**2)+0.0267*((TNOW)/60)+1.0502)	-0.0017	0.0267	1.052	
Heat Shrink Equ	Heat Shrink equ	0.4671/((-0.0066*((TNOW)/60)**2)+0.084*((TNOW)/60)+1.6334)	-0.0066	0.084	1.6334	
Subscrew W Wrap Equ	Pressure Test Subscrew equ	0.4671/((-0.0015*((TNOW)/60)**2)+0.0113*((TNOW)/60)+1.1199)	-0.0015	0.0113	1.1199	
Assy Leak Test Equ	Filter and Conv Hose equ	0.4671/((-0.0023*((TNOW)/60)**2)+0.0272*((TNOW)/60)+1.2187)	-0.0023	0.0272	1.2187	
Check Plate Equ	Check Plate equ	0.4671/((-0.0015*((TNOW)/60)**2)+0.0137*((TNOW)/60)+1.1485)	-0.0015	0.0137	1.1485	
Regulator Assy Equ	Reg Assy and ESD Clip equ	0.4671/((-0.0029*((TNOW)/60)**2)+0.0282*((TNOW)/60)+1.1298)	-0.0029	0.0282	1.1298	

Non-rotational	Rotational	Rotational Equations			
Reg Assy and ESD Clip equ	Regulator Testing Equ	(0.4793)/((-0.0066*((TNOW)/60)**2)+0.0765*((TNOW)/60)+2.7193)	-0.0066	0.0765	2.7193
FLVV Assy and Test equ	Rod Press Equ	(0.4793)/((-0.0042*((TNOW)/60)**2)+0.0488*((TNOW)/60)+1.7335)	-0.0042	0.0488	1.7355
Helium Leak test equ	Leak Test Equ	(0.4793)/((-0.0029*((TNOW)/60)**2)+0.0338*((TNOW)/60)+1.2018)	-0.0029	0.0338	1.2018
Pump Brckt Assy equ	Conv Hose Reg Assy Equ	(0.4793)/((-0.0027*((TNOW)/60)**2)+0.0312*((TNOW)/60)+1.1086)	-0.0027	0.0312	1.1086
Conv Hose to Flange equ	Reservoir Flange Assy Equ	(0.4793)/((-0.0031*((TNOW)/60)**2)+0.0365*((TNOW)/60)+1.2983)	-0.0031	0.0365	1.2983
2nd Conv Hose to Flange equ	Regulator to Reservoir Equ	(0.4793)/((-0.0029*((TNOW)/60)**2)+0.0344*((TNOW)/60)+1.2226)	-0.0029	0.0344	1.226
End Cap Equ	Support Tube Equ	(0.4793)/((-0.0027*((TNOW)/60)**2)+0.0314*((TNOW)/60)+1.1157)	-0.0027	0.0314	1.1157
Flange Float Rod equ	Float Rod Card 2 Case Equ	(0.4793)/((-0.004*((TNOW)/60)**2)+0.0512*((TNOW)/60)+1.7172)	-0.004	0.0512	1.7172
Sub Build equ	Sub Build Equ	(0.4793)/((-0.0036*((TNOW)/60)**2)+0.0419*((TNOW)/60)+1.4909)	-0.0036	0.0419	1.4909
Heat Shrink equ	Heat Shrink Equ	(0.4793)/((-0.0035*((TNOW)/60)**2)+0.412*((TNOW)/60)+1.4634)	-0.0035	0.412	1.4634
Pressure Test Subscrew equ	Subscrew W Wrap Equ	(0.4793)/((-0.0024*((TNOW)/60)**2)+0.0277*((TNOW)/60)+0.9852)	-0.0024	0.0277	0.9852
Filter and Conv Hose equ	Assy Leak Test Equ	(0.4793)/((-0.0032*((TNOW)/60)**2)+0.0375*((TNOW)/60)+1.3321)	-0.0032	0.0375	1.3327
Check Plate equ	Check Plate Equ	(0.4793)/((-0.0039*((TNOW)/60)**2)+0.0452*((TNOW)/60)+1.6074)	-0.0039	0.0452	1.6074

RULA Results Comparison

Used to assign the cross performance when changing from Rot --> Non and Non-->Rot

30803					30701				
Rotational	Score C	Score D	Grand Score	Action Level	Non-rotational	Score C	Score D	Grand Scoı	Action Level
Regulator Testing Equ	4	1	3	2	Regulator Assy and ESD Clip	4	1	3	2
Rod Press Equ	4	2	3	2	FLVV Assembly and Test	2	1	2	1
Leak Test Equ	3	2	3	2	Helium Leak Test	[illegible]	2	4	2
Conv Hose Reg Assy Equ	[illegible]	1	4	2	Pump Bracket Assy	4	1	3	2
Reservoir Flange Assy Equ	[illegible]	2	4	2	Conv. Hose to Flange	[illegible]	1	4	2
Regulator to Reservoir Equ	[illegible]	1	4	2	2nd Conv. Hose to Flange	[illegible]	1	4	2
Support Tube Equ	[illegible]	1	[illegible]	[illegible]	End Cap	[illegible]	1	4	2
Float Rod Card 2 Case Equ	3	1	3	2	Flange Assy/Float Rod	3	1	3	2
Float Rod Card to Case									
Sub Build Equ	2	1	2	1	Sub- Build	2	1	2	1
Heat Shrink Equ	2	1	2	1	Heat Shrink	2	1	2	1
Subscrew W Wrap Equ	5	1	4	2	Pressure Test Subscrew	[illegible]	1	4	2
Assy Leak Test Equ	3	1	3	2	Filter and Conv. Hose to Pump	3	1	3	2
Check Plate Equ	2	2	2	1	Check Plate	3	1	3	2
Regulator Assy Equ	4	1	3	2	Regulator Assy and ESD Clip	4	1	3	2


Line Start
Flange and Float Rod Assy
FA FR Hold
FA and FR Rel
Separate 1
Original
Duplicate
He Leak Test
Sub Build Assy
Sub Hold
Sub Build Rel
Match 9
Dispose 9
Heat Shrink 307
HS Hold
Heat Shrink Rel
Reg Sub Line
Regulator Assy and ESD Clip
Reg ESD Clip Hold
Reg ESD Clip Rel
Match 10
Dispose 10
FLVV Test and Assy
FLVV Hold
FLVV Rel
Pump Assy Line
Pump Brkt Assy
Pump Brkt Hold
Pump Brkt Rel
Filter Conv Hose
Filter Conv Hold
Filter Conv Rel
Match 11
Dispose 11
End Cap Assy
End Cap Hold
End Cap Rel
Conv Hose Assy
Conv Hold
Conv Hose Rel
2nd Conv Hose
2nd Conv Hold
2nd Conv Rel
Pressure Test and Subscrew
Press Sub Hold
Press Test Rel
Check Plate 2
Pallet
Create Equ
Assign Equations
Update Equ

Replications: 65 Time Units: Minutes

Key Performance Indicators

System	Average
Number Out	3,584

Non-Rotational
Simulation
Results

Replications: 65 Time Units: Minutes

Entity

Time

VA Time

	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Entity 1	0.8863	0.00	0.8863	0.8863	0.00	1.1580
Entity 2	0.4117	0.00	0.4117	0.4117	0.3898	0.4876
Entity 3	2.7601	0.00	2.7601	2.7601	2.6821	2.9639

NVA Time

	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Entity 1	0.00	0.00	0.00	0.00	0.00	0.00
Entity 2	0.00	0.00	0.00	0.00	0.00	0.00
Entity 3	0.00	0.00	0.00	0.00	0.00	0.00

Wait Time

	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Entity 1	0.02529389	0.00	0.02529389	0.02529389	0.00	0.4134
Entity 2	0.6170	0.00	0.6170	0.6170	0.00	0.9659
Entity 3	0.6574	0.00	0.6574	0.6574	0.03015874	1.0483

Transfer Time

	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Entity 1	0.00	0.00	0.00	0.00	0.00	0.00
Entity 2	0.00	0.00	0.00	0.00	0.00	0.00
Entity 3	0.00	0.00	0.00	0.00	0.00	0.00

Other Time

	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Entity 1	0.00	0.00	0.00	0.00	0.00	0.00
Entity 2	0.00	0.00	0.00	0.00	0.00	0.00
Entity 3	0.00	0.00	0.00	0.00	0.00	0.00

Total Time

	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Entity 1	0.9116	0.00	0.9116	0.9116	0.00	1.4678
Entity 2	1.0287	0.00	1.0287	1.0287	0.4134	1.4535
Entity 3	3.4174	0.00	3.4174	3.4174	2.9106	4.0122

Other

Replications: 65 Time Units: Minutes

Process

Time per Entity

VA Time Per Entity	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
2nd Conv Hose	0.4150	0.00	0.4150	0.4150	0.3984	0.4651
2nd Conv Rel	0.00	0.00	0.00	0.00	0.00	0.00
Check Plate 2	0.4080	0.00	0.4080	0.4080	0.3959	0.4468
Conv Hose Assy	0.3100	0.00	0.3100	0.3100	0.2990	0.3371
Conv Hose Rel	0.00	0.00	0.00	0.00	0.00	0.00
End Cap Assy	0.4509	0.00	0.4509	0.4509	0.4433	0.4674
End Cap Rel	0.00	0.00	0.00	0.00	0.00	0.00
FA and FR Rel	0.00	0.00	0.00	0.00	0.00	0.00
Filter Conv Hose	0.3713	0.00	0.3713	0.3713	0.3596	0.4058
Filter Conv Rel	0.00	0.00	0.00	0.00	0.00	0.00
Flange and Float Rod Assy	0.3486	0.00	0.3486	0.3486	0.00	0.3932
FLVV Rel	0.00	0.00	0.00	0.00	0.00	0.00
FLVV Test and Assy	0.3798	0.00	0.3798	0.3798	0.3620	0.4284
He Leak Test	0.3683	0.00	0.3683	0.3683	0.00	0.4025
Heat Shrink 307	0.2613	0.00	0.2613	0.2613	0.00	0.3068
Heat Shrink Rel	0.00	0.00	0.00	0.00	0.00	0.00
Press Test Rel	0.00	0.00	0.00	0.00	0.00	0.00
Pressure Test and Subscrew	0.4251	0.00	0.4251	0.4251	0.4093	0.4751
Pump Brkt Assy	0.3798	0.00	0.3798	0.3798	0.3620	0.4284
Pump Brkt Rel	0.00	0.00	0.00	0.00	0.00	0.00
Reg ESD Clip Rel	0.00	0.00	0.00	0.00	0.00	0.00
Regulator Assy and ESD Clip	0.4117	0.00	0.4117	0.4117	0.3898	0.4876
Sub Build Assy	0.4145	0.00	0.4145	0.4145	0.00	0.4448
Sub Build Rel	0.00	0.00	0.00	0.00	0.00	0.00
Update Equ	1.0000	0.00	1.0000	1.0000	1.0000	1.0000

Replications: 65 Time Units: Minutes

Process

Time per Entity

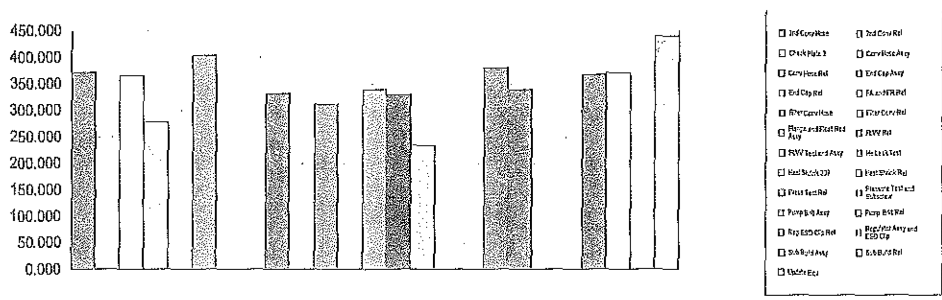
Wait Time Per Entity	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
2nd Conv Hose	0.00	0.00	0.00	0.00	0.00	0.00
Check Plate 2	0.00	0.00	0.00	0.00	0.00	0.00
Conv Hose Assy	0.00	0.00	0.00	0.00	0.00	0.00
End Cap Assy	0.00	0.00	0.00	0.00	0.00	0.00
Filter Conv Hose	0.00	0.00	0.00	0.00	0.00	0.00
Flange and Float Rod Assy	0.00	0.00	0.00	0.00	0.00	0.00
FLVV Test and Assy	0.00	0.00	0.00	0.00	0.00	0.00
He Leak Test	0.00	0.00	0.00	0.00	0.00	0.00
Heat Shrink 307	0.00	0.00	0.00	0.00	0.00	0.00
Pressure Test and Subscrew	0.00	0.00	0.00	0.00	0.00	0.00
Pump Brkt Assy	0.02190232	0.00	0.02190232	0.02190232	0.00	0.3803
Regulator Assy and ESD Clip	0.04586756	0.00	0.04586756	0.04586756	0.00	0.9659
Sub Build Assy	0.00000701	0.00	0.00000701	0.00000701	0.00	0.00628070

Replications: 65 Time Units: Minutes

Process

Accumulated Time

Accum VA Time	Average	Half Width	Minimum Average	Maximum Average
2nd Conv Hose	371.82	0.00	371.82	371.82
2nd Conv Rel	0.00	0.00	0.00	0.00
Check Plate 2	365.54	0.00	365.54	365.54
Conv Hose Assy	277.78	0.00	277.78	277.78
Conv Hose Rel	0.00	0.00	0.00	0.00
End Cap Assy	403.98	0.00	403.98	403.98
End Cap Rel	0.00	0.00	0.00	0.00
FA and FR Rel	0.00	0.00	0.00	0.00
Filter Conv Hose	332.68	0.00	332.68	332.68
Filter Conv Rel	0.00	0.00	0.00	0.00
Flange and Float Rod Assy	312.39	0.00	312.39	312.39
FLVV Rel	0.00	0.00	0.00	0.00
FLVV Test and Assy	340.30	0.00	340.30	340.30
He Leak Test	330.00	0.00	330.00	330.00
Heat Shrink 307	234.16	0.00	234.16	234.16
Heat Shrink Rel	0.00	0.00	0.00	0.00
Press Test Rel	0.00	0.00	0.00	0.00
Pressure Test and Subscrew	380.86	0.00	380.86	380.86
Pump Brkt Assy	340.34	0.00	340.34	340.34
Pump Brkt Rel	0.00	0.00	0.00	0.00
Reg ESD Clip Rel	0.00	0.00	0.00	0.00
Regulator Assy and ESD Clip	368.84	0.00	368.84	368.84
Sub Build Assy	371.43	0.00	371.43	371.43
Sub Build Rel	0.00	0.00	0.00	0.00
Update Equ	440.00	0.00	440.00	440.00



Replications: 65 Time Units: Minutes

Queue

Time

Waiting Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
2nd Conv Hold.Queue	0.00001530	0.00	0.00001530	0.00001530	0.00	0.00499026
2nd Conv Hose.Queue	0.00	0.00	0.00	0.00	0.00	0.00
Check Plate 2.Queue	0.00	0.00	0.00	0.00	0.00	0.00
Conv Hold.Queue	0.00	0.00	0.00	0.00	0.00	0.00
Conv Hose Assy.Queue	0.00	0.00	0.00	0.00	0.00	0.00
End Cap Assy.Queue	0.00	0.00	0.00	0.00	0.00	0.00
End Cap Hold.Queue	0.00	0.00	0.00	0.00	0.00	0.00
FA FR Hold.Queue	0.00	0.00	0.00	0.00	0.00	0.00
Filter Conv Hold.Queue	0.0960	0.00	0.0960	0.0960	0.00	0.2365
Filter Conv Hose.Queue	0.00	0.00	0.00	0.00	0.00	0.00
Flange and Float Rod Assy.Queue	0.00	0.00	0.00	0.00	0.00	0.00
FLVV Hold.Queue	0.00	0.00	0.00	0.00	0.00	0.00
FLVV Test and Assy.Queue	0.00	0.00	0.00	0.00	0.00	0.00
He Leak Test.Queue	0.00	0.00	0.00	0.00	0.00	0.00
Heat Shrink 307.Queue	0.00	0.00	0.00	0.00	0.00	0.00
HS Hold.Queue	0.00190529	0.00	0.00190529	0.00190529	0.00	0.1804
Match 10.Queue1	0.5363	0.00	0.5363	0.5363	0.00	0.6969
Match 10.Queue2	0.00210416	0.00	0.00210416	0.00210416	0.00	0.4134
Match 11.Queue1	0.00	0.00	0.00	0.00	0.00	0.00
Match 11.Queue2	0.4841	0.00	0.4841	0.4841	0.03015874	0.7256
Match 9.Queue1	0.04641247	0.00	0.04641247	0.04641247	0.00	0.0915
Match 9.Queue2	0.00	0.00	0.00	0.00	0.00	0.00
Press Sub Hold.Queue	0.00	0.00	0.00	0.00	0.00	0.00
Pressure Test and Subscrew.Queue	0.00	0.00	0.00	0.00	0.00	0.00
Pump Brkt Assy.Queue	0.02190232	0.00	0.02190232	0.02190232	0.00	0.3803
Pump Brkt Hold.Queue	0.05536173	0.00	0.05536173	0.05536173	0.00	0.1524
Reg ESD Clip Hold.Queue	0.03491821	0.00	0.03491821	0.03491821	0.00	0.3977
Regulator Assy and ESD Clip.Queue	0.04586756	0.00	0.04586756	0.04586756	0.00	0.9659
Sub Build Assy.Queue	0.00000701	0.00	0.00000701	0.00000701	0.00	0.00628070
Sub Hold.Queue	0.00015885	0.00	0.00015885	0.00015885	0.00	0.05902974

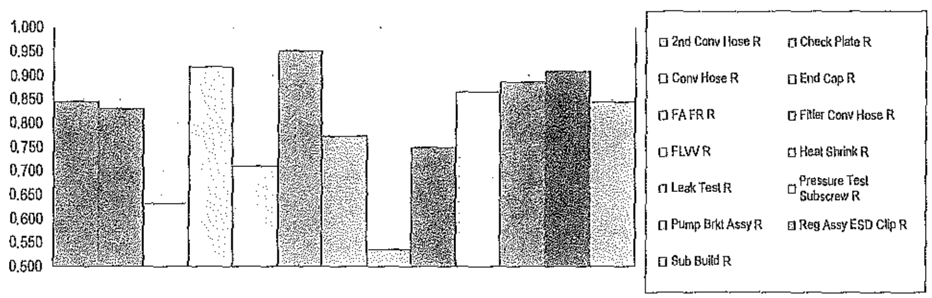
Other

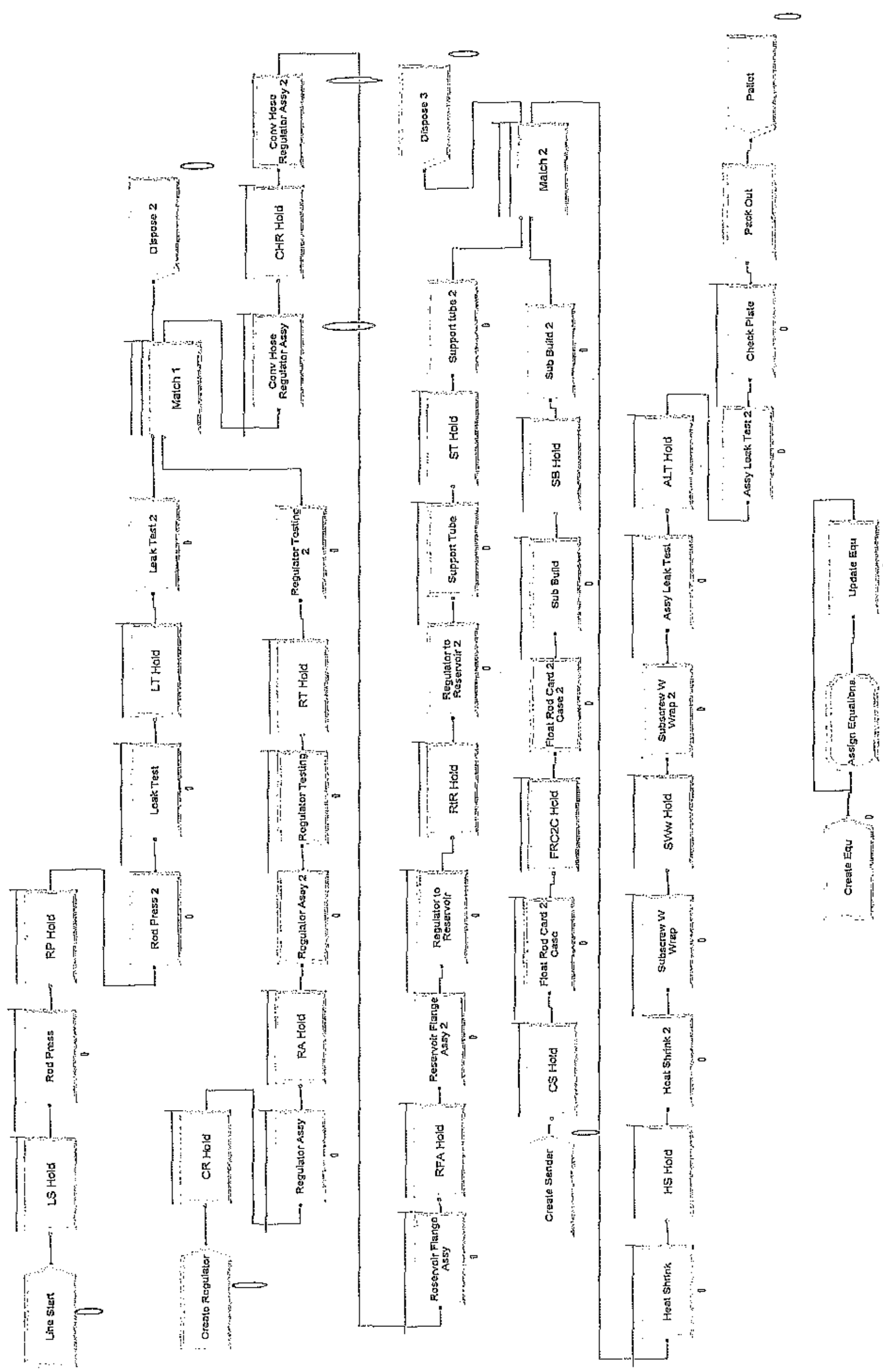
Replications: 65 Time Units: Minutes

Resource

Usage

Scheduled Utilization	Average	Half Width	Minimum Average	Maximum Average
2nd Conv Hose R	0.8451	0.00	0.8451	0.8451
Check Plate R	0.8308	0.00	0.8308	0.8308
Conv Hose R	0.6313	0.00	0.6313	0.6313
End Cap R	0.9181	0.00	0.9181	0.9181
FA FR R	0.7100	0.00	0.7100	0.7100
Fitler Conv Hose R	0.9517	0.00	0.9517	0.9517
FLVV R	0.7734	0.00	0.7734	0.7734
Heat Shrink R	0.5361	0.00	0.5361	0.5361
Leak Test R	0.7500	0.00	0.7500	0.7500
Pressure Test Subscrew R	0.8656	0.00	0.8656	0.8656
Pump Brkt Assy R	0.8862	0.00	0.8862	0.8862
Reg Assy ESD Clip R	0.9094	0.00	0.9094	0.9094
Sub Build R	0.8445	0.00	0.8445	0.8445




Line Start
LS Hold
Rod Press
RP Hold
Rod Press 2
Leak Test
LT Hold
Leak Test 2
Match 1
Dispose 2
Create Regulator
CR Hold
Regulator Assy
RA Hold
Regulator Assy 2
Regulator Testing
RT Hold
Regulator Testing 2
Conv Hose Regulator Assy
CHR Hold
Conv Hose Regulator Assy 2
Reservoir Flange Assy
RFA Hold
Reservoir Flange Assy 2
Regulator to Reservoir
RtR Hold
Regulator to Reservoir 2
Support Tube
ST Hold
Support tube 2
Dispose 3
Match 2
Create Sender
CS Hold
Float Rod Card 2 Case
FRC2C Hold
Float Rod Card 2 Case 2
Sub Build
SB Hold
Sub Build 2
Heat Shrink
HS Hold
Heat Shrink 2
Subscrew W Wrap
SWw Hold
Subscrew W Wrap 2
Assy Leak Test
ALT Hold
Assy Leak Test 2
Check Plate
Pack Out
Pallet
Create Equ
Assign Equations
Update Equ

Rotational Cell

Replications: 65 Time Units: Minutes

Key Performance Indicators

System

	Average
Number Out	2,688

Rotational Simulation Results

Rotational Cell

Replications: 65 Time Units: Minutes

Entity

Time

VA Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Entity 1	0.6518	0.00	0.6518	0.6518	0.00	0.7455
Entity 2	2.0743	0.00	2.0743	2.0743	1.9847	2.3687
Entity 3	1.9991	0.00	1.9991	1.9991	1.9128	2.2833

NVA Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Entity 1	0.00	0.00	0.00	0.00	0.00	0.00
Entity 2	0.00	0.00	0.00	0.00	0.00	0.00
Entity 3	0.00	0.00	0.00	0.00	0.00	0.00

Wait Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Entity 1	0.3599	0.00	0.3599	0.3599	0.00	5.4768
Entity 2	0.5777	0.00	0.5777	0.5777	0.00	6.0164
Entity 3	2.1304	0.00	2.1304	2.1304	1.5465	7.9164

Transfer Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Entity 1	0.00	0.00	0.00	0.00	0.00	0.00
Entity 2	0.00	0.00	0.00	0.00	0.00	0.00
Entity 3	0.00	0.00	0.00	0.00	0.00	0.00

Other Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Entity 1	0.00	0.00	0.00	0.00	0.00	0.00
Entity 2	0.00	0.00	0.00	0.00	0.00	0.00
Entity 3	0.00	0.00	0.00	0.00	0.00	0.00

Total Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Entity 1	1.0117	0.00	1.0117	1.0117	0.5247	6.2223
Entity 2	2.6521	0.00	2.6521	2.6521	2.1240	8.3852
Entity 3	4.1295	0.00	4.1295	4.1295	3.4845	10.1998

Other

Rotational Cell

Replications: 65 Time Units: Minutes

Process

Time per Entity

VA Time Per Entity	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Assy Leak Test	0.3476	0.00	0.3476	0.3476	0.3324	0.3984
Assy Leak Test 2	0.00	0.00	0.00	0.00	0.00	0.00
Check Plate	0.2886	0.00	0.2886	0.2886	0.2757	0.3322
Conv Hose Regulator Assy	0.4183	0.00	0.4183	0.4183	0.3998	0.4795
Conv Hose Regulator Assy 2	0.00	0.00	0.00	0.00	0.00	0.00
Float Rod Card 2 Case	0.2650	0.00	0.2650	0.2650	0.2548	0.2946
Float Rod Card 2 Case 2	0.00	0.00	0.00	0.00	0.00	0.00
Heat Shrink	0.3161	0.00	0.3161	0.3161	0.3025	0.3607
Heat Shrink 2	0.00	0.00	0.00	0.00	0.00	0.00
Leak Test	0.3849	0.00	0.3849	0.3849	0.00	0.4402
Leak Test 2	0.00	0.00	0.00	0.00	0.00	0.00
Regulator Assy	0.3363	0.00	0.3363	0.3363	0.3219	0.3828
Regulator Assy 2	0.00	0.00	0.00	0.00	0.00	0.00
Regulator Testing	0.1704	0.00	0.1704	0.1704	0.1630	0.1951
Regulator Testing 2	0.00	0.00	0.00	0.00	0.00	0.00
Regulator to Reservoir	0.3778	0.00	0.3778	0.3778	0.3618	0.4292
Regulator to Reservoir 2	0.00	0.00	0.00	0.00	0.00	0.00
Reservoir Flange Assy	0.3561	0.00	0.3561	0.3561	0.3410	0.4058
Reservoir Flange Assy 2	0.00	0.00	0.00	0.00	0.00	0.00
Rod Press	0.2669	0.00	0.2669	0.2669	0.00	0.3053
Rod Press 2	0.00	0.00	0.00	0.00	0.00	0.00
Sub Build	0.3107	0.00	0.3107	0.3107	0.2972	0.3551
Sub Build 2	0.00	0.00	0.00	0.00	0.00	0.00
Subscrew W Wrap	0.4711	0.00	0.4711	0.4711	0.4500	0.5424
Subscrew W Wrap 2	0.00	0.00	0.00	0.00	0.00	0.00
Support Tube	0.4154	0.00	0.4154	0.4154	0.3971	0.4762
Support tube 2	0.00	0.00	0.00	0.00	0.00	0.00
Update Equ	1.0000	0.00	1.0000	1.0000	1.0000	1.0000

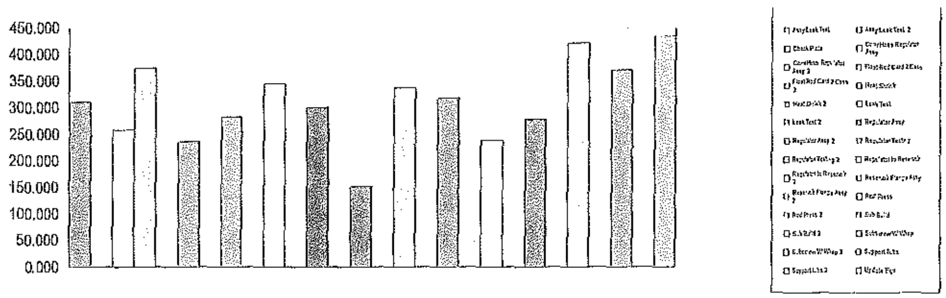
Rotational Cell

Replications: 65 Time Units: Minutes

Process

Accumulated Time

Accum VA Time	Average	Half Width	Minimum Average	Maximum Average
Assy Leak Test	311.42	0.00	311.42	311.42
Assy Leak Test 2	0.00	0.00	0.00	0.00
Check Plate	258.61	0.00	258.61	258.61
Conv Hose Regulator Assy	374.83	0.00	374.83	374.83
Conv Hose Regulator Assy 2	0.00	0.00	0.00	0.00
Float Rod Card 2 Case	237.43	0.00	237.43	237.43
Float Rod Card 2 Case 2	0.00	0.00	0.00	0.00
Heat Shrink	283.20	0.00	283.20	283.20
Heat Shrink 2	0.00	0.00	0.00	0.00
Leak Test	344.83	0.00	344.83	344.83
Leak Test 2	0.00	0.00	0.00	0.00
Regulator Assy	301.30	0.00	301.30	301.30
Regulator Assy 2	0.00	0.00	0.00	0.00
Regulator Testing	152.71	0.00	152.71	152.71
Regulator Testing 2	0.00	0.00	0.00	0.00
Regulator to Reservoir	338.47	0.00	338.47	338.47
Regulator to Reservoir 2	0.00	0.00	0.00	0.00
Reservoir Flange Assy	319.10	0.00	319.10	319.10
Reservoir Flange Assy 2	0.00	0.00	0.00	0.00
Rod Press	239.15	0.00	239.15	239.15
Rod Press 2	0.00	0.00	0.00	0.00
Sub Build	278.39	0.00	278.39	278.39
Sub Build 2	0.00	0.00	0.00	0.00
Subscrew W Wrap	422.15	0.00	422.15	422.15
Subscrew W Wrap 2	0.00	0.00	0.00	0.00
Support Tube	372.18	0.00	372.18	372.18
Support tube 2	0.00	0.00	0.00	0.00
Update Equ	436.00	0.00	436.00	436.00



Rotational Cell

Replications: 65 Time Units: Minutes

Queue

Time

Waiting Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
ALT Hold.Queue	0.00	0.00	0.00	0.00	0.00	0.00
Assy Leak Test.Queue	0.00	0.00	0.00	0.00	0.00	0.00
Check Plate.Queue	0.00	0.00	0.00	0.00	0.00	0.00
CHR Hold.Queue	0.00976391	0.00	0.00976391	0.00976391	0.00	0.06036507
Conv Hose Regulator Assy.Queue	0.00	0.00	0.00	0.00	0.00	0.00
CR Hold.Queue	0.3094	0.00	0.3094	0.3094	0.00	5.1434
CS Hold.Queue	0.3941	0.00	0.3941	0.3941	0.00	5.6824
Float Rod Card 2 Case.Queue	0.00	0.00	0.00	0.00	0.00	0.00
FRC2C Hold.Queue	0.06100981	0.00	0.06100981	0.06100981	0.00	0.2453
Heat Shrink.Queue	0.00	0.00	0.00	0.00	0.00	0.00
HS Hold.Queue	0.05400622	0.00	0.05400622	0.05400622	0.00	0.1809
Leak Test.Queue	0.00	0.00	0.00	0.00	0.00	0.00
LS Hold.Queue	0.3094	0.00	0.3094	0.3094	0.00	5.1434
LT Hold.Queue	0.01554412	0.00	0.01554412	0.01554412	0.00	0.0997
Match 1.Queue1	0.00058565	0.00	0.00058565	0.00058565	0.00	0.5247
Match 1.Queue2	0.05377195	0.00	0.05377195	0.05377195	0.00	0.1506
Match 2.Queue1	0.00	0.00	0.00	0.00	0.00	0.00
Match 2.Queue2	1.5534	0.00	1.5534	1.5534	1.4054	1.6959
RA Hold.Queue	0.02259386	0.00	0.02259386	0.02259386	0.00	0.1563
Regulator Assy.Queue	0.00	0.00	0.00	0.00	0.00	0.00
Regulator Testing.Queue	0.00	0.00	0.00	0.00	0.00	0.00
Regulator to Reservoir.Queue	0.00	0.00	0.00	0.00	0.00	0.00
Reservoir Flange Assy.Queue	0.00	0.00	0.00	0.00	0.00	0.00
RFA Hold.Queue	0.02256733	0.00	0.02256733	0.02256733	0.00	0.1349
Rod Press.Queue	0.00	0.00	0.00	0.00	0.00	0.00
RP Hold.Queue	0.03441071	0.00	0.03441071	0.03441071	0.00	0.2338
RT Hold.Queue	0.1192	0.00	0.1192	0.1192	0.00	0.3447
RtR Hold.Queue	0.02386021	0.00	0.02386021	0.02386021	0.00	0.1115
SB Hold.Queue	0.06788745	0.00	0.06788745	0.06788745	0.00	0.1848
ST Hold.Queue	0.01661286	0.00	0.01661286	0.01661286	0.00	0.06532871
Sub Build.Queue	0.00	0.00	0.00	0.00	0.00	0.00
Subscrew W Wrap.Queue	0.00	0.00	0.00	0.00	0.00	0.00
Support Tube.Queue	0.00	0.00	0.00	0.00	0.00	0.00
SWw Hold.Queue	0.00	0.00	0.00	0.00	0.00	0.00

Other

Rotational Cell

Replications: 65 Time Units: Minutes

Resource

Usage

Number Scheduled	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Assy Leak Test R	1.0000	0.00	1.0000	1.0000	1.0000	1.0000
Check Plate R	1.0000	0.00	1.0000	1.0000	1.0000	1.0000
Conv Hose Reg Assy R	1.0000	0.00	1.0000	1.0000	1.0000	1.0000
Float Rod Card 2 Case R	1.0000	0.00	1.0000	1.0000	1.0000	1.0000
Heat Shrink R	1.0000	0.00	1.0000	1.0000	1.0000	1.0000
Leak Test R	1.0000	0.00	1.0000	1.0000	1.0000	1.0000
Reg Assy R	1.0000	0.00	1.0000	1.0000	1.0000	1.0000
Reg Testing R	1.0000	0.00	1.0000	1.0000	1.0000	1.0000
Reg to Res R	1.0000	0.00	1.0000	1.0000	1.0000	1.0000
Res Flange Assy R	1.0000	0.00	1.0000	1.0000	1.0000	1.0000
Rod Press R	1.0000	0.00	1.0000	1.0000	1.0000	1.0000
Sub Build R	1.0000	0.00	1.0000	1.0000	1.0000	1.0000
Subscrew W Wrap R	1.0000	0.00	1.0000	1.0000	1.0000	1.0000
Support Tube R	1.0000	0.00	1.0000	1.0000	1.0000	1.0000

Rotational Cell X

Replications: 65 Time Units: Minutes

Key Performance Indicators

System	Average
Number Out	3,584

3Ø7-1 to Rotational
Sim Results

Rotational Cell X

Replications: 65 Time Units: Minutes

Entity

Time

VA Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Entity 1	0.7695	0.00	0.7695	0.7695	0.00	1.0108
Entity 2	0.1701	0.00	0.1701	0.1701	0.1630	0.1931
Entity 3	2.6689	0.00	2.6689	2.6689	2.5579	3.0333

NVA Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Entity 1	0.00	0.00	0.00	0.00	0.00	0.00
Entity 2	0.00	0.00	0.00	0.00	0.00	0.00
Entity 3	0.00	0.00	0.00	0.00	0.00	0.00

Wait Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Entity 1	0.6539	0.00	0.6539	0.6539	0.00	7.0774
Entity 2	1.3947	0.00	1.3947	1.3947	0.00	7.6499
Entity 3	1.2956	0.00	1.2956	1.2956	0.00	7.8188

Transfer Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Entity 1	0.00	0.00	0.00	0.00	0.00	0.00
Entity 2	0.00	0.00	0.00	0.00	0.00	0.00
Entity 3	0.00	0.00	0.00	0.00	0.00	0.00

Other Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Entity 1	0.00	0.00	0.00	0.00	0.00	0.00
Entity 2	0.00	0.00	0.00	0.00	0.00	0.00
Entity 3	0.00	0.00	0.00	0.00	0.00	0.00

Total Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Entity 1	1.4234	0.00	1.4234	1.4234	0.00	8.0882
Entity 2	1.5647	0.00	1.5647	1.5647	0.1763	7.8430
Entity 3	3.9645	0.00	3.9645	3.9645	2.7659	10.8521

Other

Rotational Cell X

Replications: 65 Time Units: Minutes

Process

Time per Entity

Wait Time Per Entity	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
2nd Conv Hose	0.00	0.00	0.00	0.00	0.00	0.00
Check Plate 2	0.00	0.00	0.00	0.00	0.00	0.00
Conv Hose Assy	0.00	0.00	0.00	0.00	0.00	0.00
End Cap Assy	0.00	0.00	0.00	0.00	0.00	0.00
Filter Conv Hose	0.00	0.00	0.00	0.00	0.00	0.00
Flange and Float Rod Assy	0.00	0.00	0.00	0.00	0.00	0.00
FLVV Test and Assy	0.00	0.00	0.00	0.00	0.00	0.00
He Leak Test	0.00	0.00	0.00	0.00	0.00	0.00
Heat Shrink 307	0.00	0.00	0.00	0.00	0.00	0.00
Pressure Test and Subscrew	0.00	0.00	0.00	0.00	0.00	0.00
Pump Brkt Assy	0.8267	0.00	0.8267	0.8267	0.00	7.3081
Regulator Assy and ESD Clip	0.6113	0.00	0.6113	0.6113	0.00	6.7739
Sub Build Assy	0.5089	0.00	0.5089	0.5089	0.00	6.4841

Rotational Cell X

Replications: 65 Time Units: Minutes

Process

Time per Entity

Total Time Per Entity	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
2nd Conv Hose	0.3770	0.00	0.3770	0.3770	0.3618	0.4261
2nd Conv Rel	0.00	0.00	0.00	0.00	0.00	0.00
Check Plate 2	0.2879	0.00	0.2879	0.2879	0.2757	0.3286
Conv Hose Assy	0.3554	0.00	0.3554	0.3554	0.3410	0.4023
Conv Hose Rel	0.00	0.00	0.00	0.00	0.00	0.00
End Cap Assy	0.4144	0.00	0.4144	0.4144	0.3971	0.4712
End Cap Rel	0.00	0.00	0.00	0.00	0.00	0.00
FA and FR Rel	0.00	0.00	0.00	0.00	0.00	0.00
Filter Conv Hose	0.3466	0.00	0.3466	0.3466	0.3324	0.3925
Filter Conv Rel	0.00	0.00	0.00	0.00	0.00	0.00
Flange and Float Rod Assy	0.2641	0.00	0.2641	0.2641	0.00	0.2898
FLVV Rel	0.00	0.00	0.00	0.00	0.00	0.00
FLVV Test and Assy	0.2667	0.00	0.2667	0.2667	0.2556	0.3030
He Leak Test	0.3838	0.00	0.3838	0.3838	0.00	0.4319
Heat Shrink 307	0.3149	0.00	0.3149	0.3149	0.00	0.3565
Heat Shrink Rel	0.00	0.00	0.00	0.00	0.00	0.00
Press Test Rel	0.00	0.00	0.00	0.00	0.00	0.00
Pressure Test and Subscrew	0.4700	0.00	0.4700	0.4700	0.4500	0.5374
Pump Brkt Assy	1.2441	0.00	1.2441	1.2441	0.4044	7.7832
Pump Brkt Rel	0.00	0.00	0.00	0.00	0.00	0.00
Reg ESD Clip Rel	0.00	0.00	0.00	0.00	0.00	0.00
Regulator Assy and ESD Clip	0.7813	0.00	0.7813	0.7813	0.1630	6.9670
Sub Build Assy	0.8185	0.00	0.8185	0.8185	0.00	6.8355
Sub Build Rel	0.00	0.00	0.00	0.00	0.00	0.00
Update Equ	1.0000	0.00	1.0000	1.0000	1.0000	1.0000

Accumulated Time

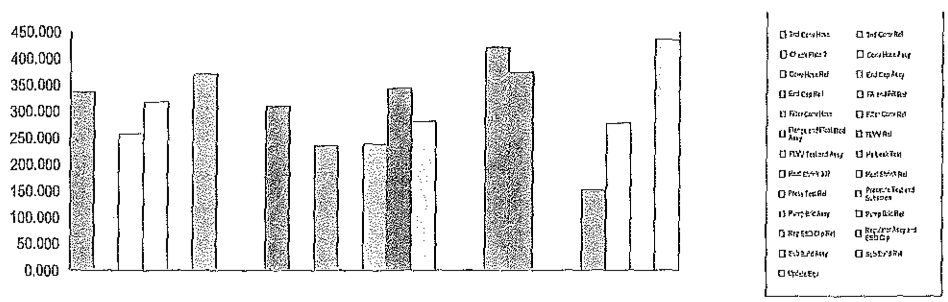
Rotational Cell X

Replications: 65 Time Units: Minutes

Process

Accumulated Time

Accum VA Time	Average	Half Width	Minimum Average	Maximum Average
2nd Conv Hose	337.82	0.00	337.82	337.82
2nd Conv Rel	0.00	0.00	0.00	0.00
Check Plate 2	257.98	0.00	257.98	257.98
Conv Hose Assy	318.48	0.00	318.48	318.48
Conv Hose Rel	0.00	0.00	0.00	0.00
End Cap Assy	371.30	0.00	371.30	371.30
End Cap Rel	0.00	0.00	0.00	0.00
FA and FR Rel	0.00	0.00	0.00	0.00
Filter Conv Hose	310.58	0.00	310.58	310.58
Filter Conv Rel	0.00	0.00	0.00	0.00
Flange and Float Rod Assy	236.61	0.00	236.61	236.61
FLVV Rel	0.00	0.00	0.00	0.00
FLVV Test and Assy	238.98	0.00	238.98	238.98
He Leak Test	343.86	0.00	343.86	343.86
Heat Shrink 307	282.14	0.00	282.14	282.14
Heat Shrink Rel	0.00	0.00	0.00	0.00
Press Test Rel	0.00	0.00	0.00	0.00
Pressure Test and Subscrew	421.16	0.00	421.16	421.16
Pump Brkt Assy	374.00	0.00	374.00	374.00
Pump Brkt Rel	0.00	0.00	0.00	0.00
Reg ESD Clip Rel	0.00	0.00	0.00	0.00
Regulator Assy and ESD Clip	152.37	0.00	152.37	152.37
Sub Build Assy	277.43	0.00	277.43	277.43
Sub Build Rel	0.00	0.00	0.00	0.00
Update Equ	436.00	0.00	436.00	436.00



Rotational Cell X

Replications: 65 Time Units: Minutes

Queue

Time

Waiting Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
2nd Conv Hold.Queue	0.05124267	0.00	0.05124267	0.05124267	0.00	0.1104
2nd Conv Hose.Queue	0.00	0.00	0.00	0.00	0.00	0.00
Check Plate 2.Queue	0.00	0.00	0.00	0.00	0.00	0.00
Conv Hold.Queue	0.05856298	0.00	0.05856298	0.05856298	0.00	0.1335
Conv Hose Assy.Queue	0.00	0.00	0.00	0.00	0.00	0.00
End Cap Assy.Queue	0.00	0.00	0.00	0.00	0.00	0.00
End Cap Hold.Queue	0.02694665	0.00	0.02694665	0.02694665	0.00	0.06455011
FA FR Hold.Queue	0.00	0.00	0.00	0.00	0.00	0.00
Filter Conv Hold.Queue	0.1256	0.00	0.1256	0.1256	0.00	0.4474
Filter Conv Hose.Queue	0.00	0.00	0.00	0.00	0.00	0.00
Flange and Float Rod Assy.Queue	0.00	0.00	0.00	0.00	0.00	0.00
FLVV Hold.Queue	0.0911	0.00	0.0911	0.0911	0.00	0.2320
FLVV Test and Assy.Queue	0.00	0.00	0.00	0.00	0.00	0.00
He Leak Test.Queue	0.00	0.00	0.00	0.00	0.00	0.00
Heat Shrink 307.Queue	0.00	0.00	0.00	0.00	0.00	0.00
HS Hold.Queue	0.06166419	0.00	0.06166419	0.06166419	0.00	0.1785
Match 10.Queue1	0.5918	0.00	0.5918	0.5918	0.00	0.8289
Match 10.Queue2	0.00019672	0.00	0.00019672	0.00019672	0.00	0.1763
Match 11.Queue1	0.00037880	0.00	0.00037880	0.00037880	0.00	0.3394
Match 11.Queue2	0.1507	0.00	0.1507	0.1507	0.00	0.4892
Match 9.Queue1	0.5401	0.00	0.5401	0.5401	0.00	6.5864
Match 9.Queue2	0.04561623	0.00	0.04561623	0.04561623	0.00	0.07733477
Press Sub Hold.Queue	0.00	0.00	0.00	0.00	0.00	0.00
Pressure Test and Subscrew.Queue	0.00	0.00	0.00	0.00	0.00	0.00
Pump Brkt Assy.Queue	0.8267	0.00	0.8267	0.8267	0.00	7.3081
Pump Brkt Hold.Queue	0.05585573	0.00	0.05585573	0.05585573	0.00	0.3170
Reg ESD Clip Hold.Queue	0.1916	0.00	0.1916	0.1916	0.00	0.3411
Regulator Assy and ESD Clip.Queue	0.6113	0.00	0.6113	0.6113	0.00	6.7739
Sub Build Assy.Queue	0.5089	0.00	0.5089	0.5089	0.00	6.4841
Sub Hold.Queue	0.05979560	0.00	0.05979560	0.05979560	0.00	0.1828

Other

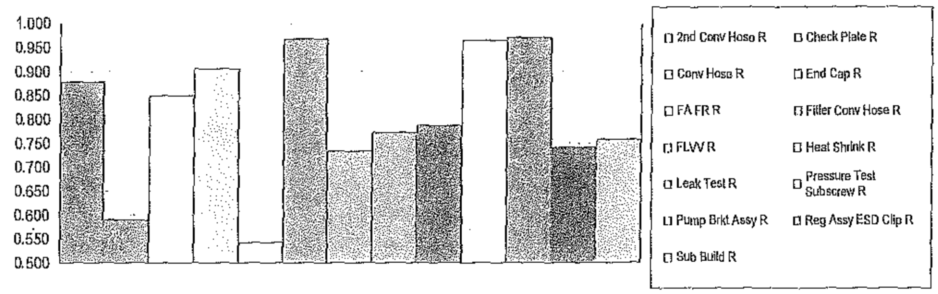
Rotational Cell X

Replications: 65 Time Units: Minutes

Resource

Usage

Scheduled Utilization	Average	Half Width	Minimum Average	Maximum Average
2nd Conv Hose R	0.8791	0.00	0.8791	0.8791
Check Plate R	0.5910	0.00	0.5910	0.5910
Conv Hose R	0.8498	0.00	0.8498	0.8498
End Cap R	0.9059	0.00	0.9059	0.9059
FA FR R	0.5421	0.00	0.5421	0.5421
Fitler Conv Hose R	0.9693	0.00	0.9693	0.9693
FLVV R	0.7344	0.00	0.7344	0.7344
Heat Shrink R	0.7729	0.00	0.7729	0.7729
Leak Test R	0.7878	0.00	0.7878	0.7878
Pressure Test Subscrew R	0.9648	0.00	0.9648	0.9648
Pump Brkt Assy R	0.9715	0.00	0.9715	0.9715
Reg Assy ESD Clip R	0.7424	0.00	0.7424	0.7424
Sub Build R	0.7583	0.00	0.7583	0.7583



Rotational Cell to Non Rotational Cell

Replications: 65 Time Units: Minutes

Key Performance Indicators

System	Average
Number Out	2,688

308-3 to Non-Rotational
only 16 pages

Rotational Cell to Non Rotational Cell

Replications: 65 Time Units: Minutes

Entity

Time

VA Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Entity 1	0.8519	0.00	0.8519	0.8519	0.00	0.9198
Entity 2	2.3856	0.00	2.3856	2.3856	2.2953	2.6568
Entity 3	2.2370	0.00	2.2370	2.2370	2.1533	2.5028

NVA Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Entity 1	0.00	0.00	0.00	0.00	0.00	0.00
Entity 2	0.00	0.00	0.00	0.00	0.00	0.00
Entity 3	0.00	0.00	0.00	0.00	0.00	0.00

Wait Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Entity 1	3.8428	0.00	3.8428	3.8428	0.00	6.9540
Entity 2	3.8668	0.00	3.8668	3.8668	0.00	6.8742
Entity 3	5.4868	0.00	5.4868	5.4868	1.6759	8.6964

Transfer Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Entity 1	0.00	0.00	0.00	0.00	0.00	0.00
Entity 2	0.00	0.00	0.00	0.00	0.00	0.00
Entity 3	0.00	0.00	0.00	0.00	0.00	0.00

Other Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Entity 1	0.00	0.00	0.00	0.00	0.00	0.00
Entity 2	0.00	0.00	0.00	0.00	0.00	0.00
Entity 3	0.00	0.00	0.00	0.00	0.00	0.00

Total Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Entity 1	4.6947	0.00	4.6947	4.6947	0.8269	7.8738
Entity 2	6.2524	0.00	6.2524	6.2524	2.5008	9.5310
Entity 3	7.7238	0.00	7.7238	7.7238	3.9913	11.1991

Other

Rotational Cell to Non Rotational Cell

Replications: 65 Time Units: Minutes

Process

Time per Entity

VA Time Per Entity	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Assy Leak Test	0.3725	0.00	0.3725	0.3725	0.3596	0.4135
Assy Leak Test 2	0.00	0.00	0.00	0.00	0.00	0.00
Check Plate	0.4092	0.00	0.4092	0.4092	0.3959	0.4532
Conv Hose Regulator Assy	0.3804	0.00	0.3804	0.3804	0.3620	0.4284
Conv Hose Regulator Assy 2	0.00	0.00	0.00	0.00	0.00	0.00
Float Rod Card 2 Case	0.3503	0.00	0.3503	0.3503	0.3318	0.4030
Float Rod Card 2 Case 2	0.00	0.00	0.00	0.00	0.00	0.00
Heat Shrink	0.2631	0.00	0.2631	0.2631	0.2458	0.3191
Heat Shrink 2	0.00	0.00	0.00	0.00	0.00	0.00
Leak Test	0.3691	0.00	0.3691	0.3691	0.00	0.4098
Leak Test 2	0.00	0.00	0.00	0.00	0.00	0.00
Regulator Assy	0.4139	0.00	0.4139	0.4139	0.3898	0.4998
Regulator Assy 2	0.00	0.00	0.00	0.00	0.00	0.00
Regulator Testing	0.4140	0.00	0.4140	0.4140	0.3898	0.4998
Regulator Testing 2	0.00	0.00	0.00	0.00	0.00	0.00
Regulator to Reservoir	0.4153	0.00	0.4153	0.4153	0.3984	0.4651
Regulator to Reservoir 2	0.00	0.00	0.00	0.00	0.00	0.00
Reservoir Flange Assy	0.3105	0.00	0.3105	0.3105	0.2990	0.3371
Reservoir Flange Assy 2	0.00	0.00	0.00	0.00	0.00	0.00
Rod Press	0.4828	0.00	0.4828	0.4828	0.00	0.5153
Rod Press 2	0.00	0.00	0.00	0.00	0.00	0.00
Sub Build	0.4153	0.00	0.4153	0.4153	0.4044	0.4448
Sub Build 2	0.00	0.00	0.00	0.00	0.00	0.00
Subscrew W Wrap	0.4267	0.00	0.4267	0.4267	0.4093	0.4824
Subscrew W Wrap 2	0.00	0.00	0.00	0.00	0.00	0.00
Support Tube	0.4515	0.00	0.4515	0.4515	0.4433	0.4693
Support tube 2	0.00	0.00	0.00	0.00	0.00	0.00
Update Equ	1.0000	0.00	1.0000	1.0000	1.0000	1.0000

Rotational Cell to Non Rotational Cell

Replications: 65 Time Units: Minutes

Process

Time per Entity

Wait Time Per Entity	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Assy Leak Test	0.00	0.00	0.00	0.00	0.00	0.00
Check Plate	0.00	0.00	0.00	0.00	0.00	0.00
Conv Hose Regulator Assy	0.00	0.00	0.00	0.00	0.00	0.00
Float Rod Card 2 Case	0.00	0.00	0.00	0.00	0.00	0.00
Heat Shrink	0.00	0.00	0.00	0.00	0.00	0.00
Leak Test	0.00	0.00	0.00	0.00	0.00	0.00
Regulator Assy	0.00	0.00	0.00	0.00	0.00	0.00
Regulator Testing	0.00	0.00	0.00	0.00	0.00	0.00
Regulator to Reservoir	0.00	0.00	0.00	0.00	0.00	0.00
Reservoir Flange Assy	0.00	0.00	0.00	0.00	0.00	0.00
Rod Press	0.00	0.00	0.00	0.00	0.00	0.00
Sub Build	0.00	0.00	0.00	0.00	0.00	0.00
Subscrew W Wrap	0.00	0.00	0.00	0.00	0.00	0.00
Support Tube	0.00	0.00	0.00	0.00	0.00	0.00

Rotational Cell to Non Rotational Cell

Replications: 65 Time Units: Minutes

Process

Time per Entity

Total Time Per Entity	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
Assy Leak Test	0.3725	0.00	0.3725	0.3725	0.3596	0.4135
Assy Leak Test 2	0.00	0.00	0.00	0.00	0.00	0.00
Check Plate	0.4092	0.00	0.4092	0.4092	0.3959	0.4532
Conv Hose Regulator Assy ·	0.3804	0.00	0.3804	0.3804	0.3620	0.4284
Conv Hose Regulator Assy 2	0.00	0.00	0.00	0.00	0.00	0.00
Float Rod Card 2 Case	0.3503	0.00	0.3503	0.3503	0.3318	0.4030
Float Rod Card 2 Case 2	0.00	0.00	0.00	0.00	0.00	0.00
Heat Shrink	0.2631	0.00	0.2631	0.2631	0.2458	0.3191
Heat Shrink 2	0.00	0.00	0.00	0.00	0.00	0.00
Leak Test	0.3691	0.00	0.3691	0.3691	0.00	0.4098
Leak Test 2	0.00	0.00	0.00	0.00	0.00	0.00
Regulator Assy	0.4139	0.00	0.4139	0.4139	0.3898	0.4998
Regulator Assy 2	0.00	0.00	0.00	0.00	0.00	0.00
Regulator Testing	0.4140	0.00	0.4140	0.4140	0.3898	0.4998
Regulator Testing 2	0.00	0.00	0.00	0.00	0.00	0.00
Regulator to Reservoir	0.4153	0.00	0.4153	0.4153	0.3984	0.4651
Regulator to Reservoir 2	0.00	0.00	0.00	0.00	0.00	0.00
Reservoir Flange Assy	0.3105	0.00	0.3105	0.3105	0.2990	0.3371
Reservoir Flange Assy 2	0.00	0.00	0.00	0.00	0.00	0.00
Rod Press	0.4828	0.00	0.4828	0.4828	0.00	0.5153
Rod Press 2	0.00	0.00	0.00	0.00	0.00	0.00
Sub Build	0.4153	0.00	0.4153	0.4153	0.4044	0.4448
Sub Build 2	0.00	0.00	0.00	0.00	0.00	0.00
Subscrew W Wrap	0.4267	0.00	0.4267	0.4267	0.4093	0.4824
Subscrew W Wrap 2	0.00	0.00	0.00	0.00	0.00	0.00
Support Tube	0.4515	0.00	0.4515	0.4515	0.4433	0.4693
Support tube 2	0.00	0.00	0.00	0.00	0.00	0.00
Update Equ	1.0000	0.00	1.0000	1.0000	1.0000	1.0000

Accumulated Time

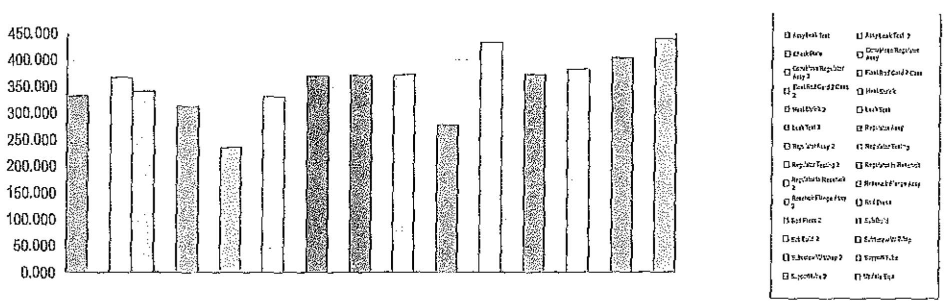
Rotational Cell to Non Rotational Cell

Replications: 65 Time Units: Minutes

Process

Accumulated Time

Accum VA Time	Average	Half Width	Minimum Average	Maximum Average
Assy Leak Test	333.76	0.00	333.76	333.76
Assy Leak Test 2	0.00	0.00	0.00	0.00
Check Plate	366.67	0.00	366.67	366.67
Conv Hose Regulator Assy	340.84	0.00	340.84	340.84
Conv Hose Regulator Assy 2	0.00	0.00	0.00	0.00
Float Rod Card 2 Case	313.85	0.00	313.85	313.85
Float Rod Card 2 Case 2	0.00	0.00	0.00	0.00
Heat Shrink	235.73	0.00	235.73	235.73
Heat Shrink 2	0.00	0.00	0.00	0.00
Leak Test	330.75	0.00	330.75	330.75
Leak Test 2	0.00	0.00	0.00	0.00
Regulator Assy	370.88	0.00	370.88	370.88
Regulator Assy 2	0.00	0.00	0.00	0.00
Regulator Testing	370.97	0.00	370.97	370.97
Regulator Testing 2	0.00	0.00	0.00	0.00
Regulator to Reservoir	372.09	0.00	372.09	372.09
Regulator to Reservoir 2	0.00	0.00	0.00	0.00
Reservoir Flange Assy	278.20	0.00	278.20	278.20
Reservoir Flange Assy 2	0.00	0.00	0.00	0.00
Rod Press	432.55	0.00	432.55	432.55
Rod Press 2	0.00	0.00	0.00	0.00
Sub Build	372.09	0.00	372.09	372.09
Sub Build 2	0.00	0.00	0.00	0.00
Subscrew W Wrap	382.30	0.00	382.30	382.30
Subscrew W Wrap 2	0.00	0.00	0.00	0.00
Support Tube	404.51	0.00	404.51	404.51
Support tube 2	0.00	0.00	0.00	0.00
Update Equ	440.00	0.00	440.00	440.00



Rotational Cell to Non Rotational Cell

Replications: 65 Time Units: Minutes

Queue

Time

Waiting Time	Average	Half Width	Minimum Average	Maximum Average	Minimum Value	Maximum Value
ALT Hold.Queue	0.00	0.00	0.00	0.00	0.00	0.00
Assy Leak Test.Queue	0.00	0.00	0.00	0.00	0.00	0.00
Check Plate.Queue	0.00	0.00	0.00	0.00	0.00	0.00
CHR Hold.Queue	0.00	0.00	0.00	0.00	0.00	0.00
Conv Hose Regulator Assy.Queue	0.00	0.00	0.00	0.00	0.00	0.00
CR Hold.Queue	3.6261	0.00	3.6261	3.6261	0.00	6.7574
CS Hold.Queue	3.6163	0.00	3.6163	3.6163	0.00	6.7845
Float Rod Card 2 Case.Queue	0.00	0.00	0.00	0.00	0.00	0.00
FRC2C Hold.Queue	0.1322	0.00	0.1322	0.1322	0.00	0.1405
Heat Shrink.Queue	0.00	0.00	0.00	0.00	0.00	0.00
HS Hold.Queue	0.00	0.00	0.00	0.00	0.00	0.00
Leak Test.Queue	0.00	0.00	0.00	0.00	0.00	0.00
LS Hold.Queue	3.8419	0.00	3.8419	3.8419	0.00	6.9540
LT Hold.Queue	0.00	0.00	0.00	0.00	0.00	0.00
Match 1.Queue1	0.00092285	0.00	0.00092285	0.00092285	0.00	0.8269
Match 1.Queue2	0.1028	0.00	0.1028	0.1028	0.00	0.1079
Match 2.Queue1	0.00	0.00	0.00	0.00	0.00	0.00
Match 2.Queue2	1.6704	0.00	1.6704	1.6704	1.6322	1.8428
RA Hold.Queue	0.06881145	0.00	0.06881145	0.06881145	0.00	0.1015
Regulator Assy.Queue	0.00	0.00	0.00	0.00	0.00	0.00
Regulator Testing.Queue	0.00	0.00	0.00	0.00	0.00	0.00
Regulator to Reservoir.Queue	0.00	0.00	0.00	0.00	0.00	0.00
Reservoir Flange Assy.Queue	0.00	0.00	0.00	0.00	0.00	0.00
RFA Hold.Queue	0.00	0.00	0.00	0.00	0.00	0.00
Rod Press.Queue	0.00	0.00	0.00	0.00	0.00	0.00
RP Hold.Queue	0.00	0.00	0.00	0.00	0.00	0.00
RT Hold.Queue	0.06899142	0.00	0.06899142	0.06899142	0.00	0.1016
RtR Hold.Queue	0.00	0.00	0.00	0.00	0.00	0.00
SB Hold.Queue	0.06783212	0.00	0.06783212	0.06783212	0.00	0.1206
ST Hold.Queue	0.00	0.00	0.00	0.00	0.00	0.00
Sub Build.Queue	0.00	0.00	0.00	0.00	0.00	0.00
Subscrew W Wrap.Queue	0.00	0.00	0.00	0.00	0.00	0.00
Support Tube.Queue	0.00	0.00	0.00	0.00	0.00	0.00
SWw Hold.Queue	0.00	0.00	0.00	0.00	0.00	0.00

Other

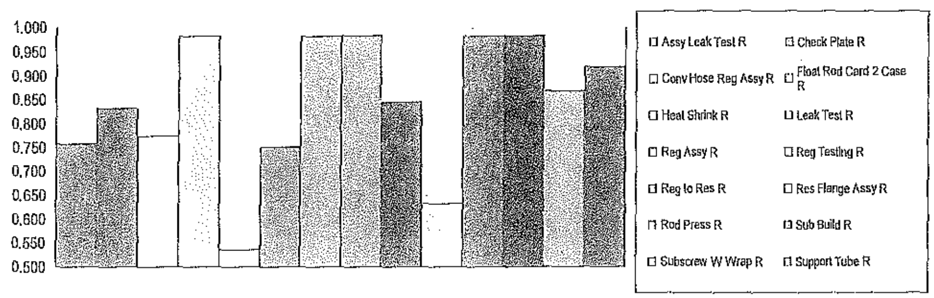
Rotational Cell to Non Rotational Cell

Replications: 65 Time Units: Minutes

Resource

Usage

Scheduled Utilization	Average	Half Width	Minimum Average	Maximum Average
Assy Leak Test R	0.7585	0.00	0.7585	0.7585
Check Plate R	0.8333	0.00	0.8333	0.8333
Conv Hose Reg Assy R	0.7746	0.00	0.7746	0.7746
Float Rod Card 2 Case R	0.9825	0.00	0.9825	0.9825
Heat Shrink R	0.5357	0.00	0.5357	0.5357
Leak Test R	0.7517	0.00	0.7517	0.7517
Reg Assy R	0.9830	0.00	0.9830	0.9830
Reg Testing R	0.9836	0.00	0.9836	0.9836
Reg to Res R	0.8456	0.00	0.8456	0.8456
Res Flange Assy R	0.6323	0.00	0.6323	0.6323
Rod Press R	0.9831	0.00	0.9831	0.9831
Sub Build R	0.9838	0.00	0.9838	0.9838
Subscrew W Wrap R	0.8689	0.00	0.8689	0.8689
Support Tube R	0.9193	0.00	0.9193	0.9193



VITA

The author grew up in Union, Kentucky where he attended public schools and was continually reinforced of the values of higher education. After graduating from Larry A. Ryle in 1999, the author attended the University Of Louisville, Speed School of Engineering. He received his Bachelor's Degree in Industrial Engineering in 2005. While studying at U of L, the author participated in activities outside of school such as volunteering and holding leadership offices with the international fraternal organization of Pi Kappa Alpha, intramural sports as well as the educational co-op program. This provided him with work place experience in the realms of fulfillment center process standardization, ecommerce, logistics, and research and development.

After graduating he went to work in Bedford, Indiana to take a position as an Industrial Engineer with Visteon Corporation, LLC. He furthered his experience by applying the techniques and knowledge learned during his education. He spent two years at the plant where he was involved with work center design, the ergonomics committee, work standard development, performance analysis, budget creation and earning a Certification of a Green Belt in Six Sigma . The Plant fell onto economically challenging times and was forced to close. This provided the author the opportunity to move back to the Northern Kentucky area and continue work in the automotive industry. Transitioning into a position in a company headquarters allowed Scott the opportunity to be responsible for seventeen facilities' production efficiency, expanding from just the one plant in Indiana. During his time at Toyota Boshoku America, the author has been viewed as a leader among his team and has been recognized in the Toyota Production System (TPS), as well as becoming a Certified Trainer in TPS.

At this point in his career, the author has been working on his thesis to complete his Master's degree in Industrial Engineering. He is looking forward to continue his career as leader and an innovator in the industry.