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OPERATOR DRIVEN RELIABILITY

There are many very technical initiatives employed in order to improve the reliability of plant equipment. Most when implemented correctly are very successful and achieve significant results. One of the most effective methods to improve the reliability of plant equipment is also the one that is least technical in nature, which is the utilization of the floor operator. In order for the floor operator to become an effective tool in improving the reliability of equipment he/she must be able to do the same thing that the predictive maintenance technology such as vibration analysis, thermography, oil analysis, etc. is capable of, that is predict failures before they occur through the early identification of work. To develop operators with this capability there are two critical prerequisites, one the correct training, and two a reliability driven process for the early identification of work.

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Most would agree that the primary function of the floor operator in a refinery is to safely operate and monitor the equipment in his/her area of responsibility. Over the years with the development of computer systems such as Data Acquisition Systems (DAS) and other systems that analyze and trend data the utilization of the floor operator to monitor the equipment has become envisioned as less important. Typically analyses of the work requests generated by floor operators will show they are reactive or corrective in nature and occur after there has been a functional failure or significant degradation in the performance of the equipment. Although this evolution is to some small degree a result of the dependence on computer systems these systems are not the root causes of this transition.

In order for the floor operator to become an effective tool in improving the reliability of equipment he/she must be able to do the same thing that the predictive maintenance technology such as vibration analysis, thermography, oil analysis, etc. is capable of, that is predict failures before they occur through the early identification of work. To develop operators with this capability there are two critical prerequisites, one the correct training, and two a reliability driven process for the early identification of work.

In many cases the training that is provided to operators is limited to the mechanics of performing his job, i.e. the steps that should be followed to start a pump, what valves to open in what sequence and their physical location, where the start switch and breakers are located, how to do a cursory inspection of the pump once it is running, etc. Although training on the mechanics is important training should not stop there. In order to support the safe and reliable operation of the equipment the operator should have a basic understanding of the equipment he/she is operating. The root cause of unreliable equipment can be attributed to one or more of the following, improper design or application, poor maintenance practices, or faulty operation. In most cases improper design or application and poor maintenance practices are relatively easy to identify based on the failure mode of the equipment. Faulty operation of the equipment can be the result of production driven mandates, operating equipment outside its design parameters or by lack of proper training and a system of accountability for the operators responsible for the equipment. In a refinery or most other process type industries faulty operation of the equipment is not limited to a specific piece of equipment but also to the process that the equipment is utilized in. Changes in the upstream or downstream process can have negative impacts on the reliability of a specific piece of equipment. This requires that the operator not only be trained on the mechanics of the operation of the equipment, the basic theory on how the equipment works but also on the details of the process that the equipment operates in. When an operator is given sufficient training he/she will have the tools they require to operate the equipment within its design parameters. Most equipment will deliver reliable operations when it is properly maintained and operated within its design parameters.

The training of operators on the basic theory of the equipment they operate has an additional benefit in that they can identify issues with the equipment at very early stages of failure and in many cases correct the problem before failure or significant degradation in the performance of the equipment occurs. An example of this would be a centrifugal pump that has a flow rate less than normal. If the operator that is responsible for this pump had an understanding of how centrifugal pumps work he/she would be able to perform basic troubleshooting of the pump to determine if the cause was process related or a mechanical issue with the pump. If the issue is process related the operator could take the required steps to correct the process issue before the pump becomes damaged. If the operator determines that the issue is with the pump internals a work request could be written providing important information to the maintenance organization. This would enable maintenance to properly plan the work ensuring that the required parts and materials are on site, and through joint prioritization schedule the work with the minimum impact on production. Also since the work was identified early it is likely that the repair of the pump will require less time and less parts and materials that if the pump was allowed to continue in operation.

Providing operators with this type of training requires a significant investment of both time and money but also provides a significant return on that investment. At the Sinclair Wyoming Refinery operator training has been identified as a major contributor to their reactive culture. Prior to the implementation or work management processes in maintenance and operations almost all work was performed on an emergency or extremely urgent basis. Some of that work was a direct result of improper operation of the equipment that could be attributed to the lack of well trained operators. Sinclair faces some unique obstacles in achieving a well trained operator work force due to the geographical location of the facility and the available labor pool on which they can draw. Although Sinclair has not addressed the development of a more comprehensive training program they have taken steps in that direction. They have assigned positions for a trainer on each of the unit operating crews, and are adding operations personnel to over staff the department in order to provide personnel to fill in positions in order to provide training.

In summary having a well trained operations group drives equipment reliability through the operation of plant equipment within its design parameters and providing the early identification of issues with equipment prior to functional failure.

The second prerequisite to achieving operator driven equipment reliability is a work process that supports the early identification of work. There are some key elements that all work identification processes must have;

- Equipment Hierarchy
- Critical Equipment List
- Operator Routes, Rounds and Checklists
- Quality Work Requests
- Job Repair Tagging
- Work Request Prioritization System
- Work Request Approval System
- Formal PM/PdM System

Although a good equipment hierarchy to the correct level and formal PM/PdM systems are required in order to maintain equipment to a level that provides reliable service they are not typically operator driven but rather engineering and maintenance functions and will not be addressed in this paper. Of the remaining elements two that are important to achieving operator driven reliability, the Critical Equipment List, and Operator Routes, Rounds and Checklists. The others support improved equipment reliability by providing support to the maintenance organization of the facility.

Critical Equipment List

Most refineries have identified the critical equipment in their plant and processes, but what has been the criteria used to identify that equipment. In many if not most cases the criteria is related on how critical the equipment is to supporting operation of the plant or process at full capacity. If this is the basis for determining how critical the equipment is what is the applied use of the critical equipment list. In this case the critical equipment list is most often utilized to assist in the prioritization of work. Considering that the daily operation of the refinery is based on many changing variables, such as the specifications of the feedstock, the desired products and their specifications, various equipment availability, storage capacity for intermediate products or feedstock, etc. it becomes very difficult to accurately determine the criticality of some specific equipment to plant or processes at any given point in the future. Although a critical equipment list does offer some insight into determining how important work on a given piece of equipment maybe there other more effective ways that this can be determined. The personnel that are responsible for the operation and maintenance of the equipment are the most effective way to determine the importance of any work that has to be performed since they know the current status of all the variables that the specific piece of equipment and the work that is required will impact at any given point in time.

If the use of a critical equipment list is not the best method to prioritize work why is it important and how should it be utilized? Critical equipment lists are a significant tool in improving the reliability of station equipment if the criteria for their development are based on not only how critical is the equipment to the plant and process operation but also how often the equipment should be monitored by the operator. The development of the critical equipment list should be a collaborative effort that involves knowledgeable personnel from operations, maintenance, reliability and process engineering, and maintenance.

Typically there are three frequencies, at which equipment should be monitored, once per hour, once per shift, and once per day. This would dictate that there should be three levels of critical equipment that relate to these frequencies. Without argument there are some vital process parameters that require much more frequent monitoring than once per hour, most often parameters such as these are continuously monitored and visual and audio alarm points. Although critical equipment lists establish a frequency at which equipment should be monitored for equipment reliability they do not determine what parameters of the equipment should be monitored.

Once the critical equipment list has been developed the next step in the process is to determine what parameters should be monitored. This step in the process is typically an engineering/maintenance function and requires that the various failure modes for each piece of equipment be determined. Each failure mode is then evaluated to determine what operating parameters would provide data that could be used to diagnose the condition of the equipment and trend its condition over time in order to predict failure. In some cases this evaluation may indicate there is a need to install additional instrumentation on some equipment in order to provide this capability.

The next step is to determine what the range of each parameter should be under normal operating conditions. In some cases there maybe multiple ranges based on operating or ambient conditions, such as heat exchanger inlet/outlet temperatures which can vary based on ambient air temperatures, humidity, etc. This data is then used to develop detailed operator routes, rounds and equipment check sheets. The equipment check sheets should provide the operator a means to record each parameter and indicate what the range of that parameter should be under the specific operating conditions that exist. It is imperative that all equipment data that is to be used to diagnose equipment be recorded on the check sheet including data that may be acquired from a computerized data acquisition system.

The work identification process would define the operator's role as to perform the monitoring of the equipment and the recording of the required data at the frequencies defined by the process. It addition it should also require the generation of a work request if any monitored parameter is outside the indicated range. If operators are properly trained and understand the operation of the equipment as discussed earlier they will have the capability to perform some minor troubleshooting of the equipment when and out of range parameter is discovered. This knowledge and capability should enable the operator to correct the issue if it is not actually equipment related and reduce the origination of nuisance work requests by the operators.

In order to achieve equipment reliability through the use of detailed operator routes, rounds and check lists it is required that a effective reliability organization exists to analyze and trend the data collected by the operators.

The design and implementation of work management practices at the Sinclair Wyoming Refinery has addressed all of fundamental elements of an effective work identification process. A critical equipment list with three levels has been developed for each of the operating units. Sinclair is in the process of developing detailed operating routes, rounds and check sheets. As you can imagine this is a long process and is relatively labor intensive and requires a good portion of the facilities engineering resources. The analysis of the utilization of the data is to be addressed in the development and implementation of the pro-active maintenance processes at the facility.

In summary in order to utilize the operators to drive equipment reliability there are several fundamental things that must exist;

- Operator training not only on the mechanics and process related functions of their job but also on the equipment which they are operate.
- Critical equipment lists that are based on equipment reliability.
- Detailed operator routes, rounds and check sheets that indicate what parameters are to be monitored and what the expected range is for each parameter.
- Process that requires the generation of a work request when any equipment parameter is out of range.
- An effective reliability engineering organization that is properly staffed to analyze and trend equipment data in order to predict failure.

Although this has been a brief discussion on what is required to achieve an effective operations organization that actively contributes to improved reliability of plant equipment it is evident that it requires a rather large investment in both time and money by management. It should also be evident when given the proper training and tools that the operator can provide a significant impact on the reliability of plant equipment.