Modernizing Operations Management in the Nuclear Energy Industry

About this paper

Increased global demand for energy has suddenly boosted demand for nuclear reactors worldwide. The industry needs to modernize manufacturing processes to meet new productivity and regulatory demands.

This paper is of interest to Engineering, Operations, Quality Assurance, Records Management and Integrated Safety Analysis departments with initiatives to achieve greater productivity through improved process control that meets the latest requirements from regulatory agencies.

Improving efficiency and process control reduces risk on big manufacturing projects by controlling an important variable that can cause potential delays and cost overruns. Lessons learned from leading companies pave the way for the next generation of operations management systems that will enable the nuclear energy industry to meet the demand ahead.

Best practices in reducing process variance are introduced in this paper around a methodology encompassing four functions: (1) Planning, (2) Guiding, (3) Monitoring, and (4) Correcting. These procedures encompass not only the requirements, but also the spirit of process and quality control behind the requirements found in standards from ISO, NRC and ASME.

Introduction

Global demand for green energy has created increased demand for a new generation of nuclear reactors worldwide. Current plans for new nuclear power plants include at least 15 in the United States and at least 30 more worldwide over the next eight to ten years.

The sudden high demand is a new challenge for the industry. The number of nuclear power plants worldwide had not increased significantly over the last 20 years. The accelerated resurgence in the industry means that it is also time to dust off the old manufacturing processes and revisit them in light of new productivity and regulatory requirements. Processes for design, fabrication, and construction must be more efficient and fail-safe to meet the newer requirements from regulatory agencies, utility companies and consumers. Each new facility built will cost on average $6-8 billion and take up to 9 years to complete.

Managing risk for these projects implies minimizing potential delays and cost overruns in construction that could arise due to suspect quality or lack of compliance. Much of this risk needs to be managed in the supply chain of manufacturers of components for the nuclear power plants. Many of the components need to be produced with "nuclear grade" quality and the suppliers in this industry must be ready to tackle the same quality and compliance management concerns of their customers and the Nuclear Regulatory Commission (NRC). Components must be delivered with the required pedigree.

Regulatory requirements in this industry include NRC requirements for Quality Assurance 10 CFR 50 Appendix B; Reporting of Defects and Noncompliance 10 CFR 21; and ASME standards for Nuclear Quality Assurance NQA-1-1994.

Manufacturers have tackled these requirements in the past with pallets and pallets of paperwork, labor intensive validation processes, and a variety of disconnected systems and spreadsheets. Many of these old processes require double validation because manual procedures are prone to error. The increased demand for reactor production necessitates improvements in manufacturing productivity.

Some leading companies in the nuclear industry and similar regulated industries like Aerospace and Defense have been able to achieve great productivity improvement by implementing new systems that help streamline procedures between Engineering, Manufacturing, Quality, and Production Control departments. Lessons learned from these leading companies pave the way for the next generation of operations management systems that will enable the nuclear energy industry to meet the demand ahead. Some of these new best practices are discussed in this paper.

Supporting the New Generation Nuclear Reactors with New Generation Processes

It is understandable that over the years traditional procedures in this heavily regulated industry have been focused on regulatory compliance and documentation, often at the expense of productivity initiatives. Nevertheless, in these high demand times, a new generation of processes is required to address the need to increase productivity while maintaining and improving regulatory compliance.

W. Edwards Deming often stated that the secret to improving quality is "reduction in variation." A methodology for process control to reduce variation requires the following ingredients: (1) Planning, (2) Guiding, (3) Monitoring, and (4) Correcting. This methodology embraces quality assurance during the entire manufacturing process flow starting early in the design of the process instead of being relegated to a verification step at the end.

The goal of these processes is to achieve greater productivity through improved process control. These procedures encompass not only the requirements, but also the spirit behind the requirements in ISO, NRC and ASME regulations. The spirit that process control and quality assurance throughout the process will yield consistent quality results at the end.

Planning Quality into the Manufacturing Process

This first step is to provide the shop floor with the information and instructions they need to successfully build a high quality part. Consider how much information and technical specifications go into a single part and this becomes a very large manual process and often prone to errors. In fact, NRC audit findings single out that due to this manual process and paper driven library, that work orders are released using the incorrect specifications because a simple change was not incorporated into the work orders. This is very serious infraction and expensive to correct.

By establishing an electronic knowledge center with revision control including work instructions, visuals aids, drawings, inspection procedures, test procedures and other various supporting documents you can ensure that the shop floor is receiving the correct information to perform the task and satisfy the NRC and NUPIC auditors that appropriate controls are in place.

In current systems, the work instructions can contain illustrations, 3D models, drawings, and videos. The requirements for data collection can be overlaid on top of graphical illustrations including information about the process, parts and tools used. Process planners can force through the system certain critical work sequences and inspection points. If flagged, the system can prevent the mechanic from moving forward to the next step until mandatory steps are performed. These types of automated checks eliminate the need for some of the additional signatures that were required before.

Guiding Process Execution at the Shop Floor

The work instructions spell out the critical steps in the manufacturing process for the mechanic and indicate requirements for certification and data collection. However, in manual paper-based procedures, additional validation points and audits are required to ensure that employees follow the prescribed process. Someone has to review each page and make sure that all signatures and data were signed properly by certified employees.

Employees can forget to capture some critical data while performing the job and the paper is prone to loss or damage by everyday accidents like coffee or grease spills. Recoveries from these incidents are expensive and can cause rework.

Modern online procedures can automate this process and step the mechanic through the work instructions. The system keeps track of employee certifications and makes sure the employee

cannot close the work step until all data requirements are collected. This eliminates the additional manual validation step.

When evaluating new systems it is important to keep in mind that the goal is to streamline procedures and provide new productivity tools, otherwise it is possible to end up with a "paper on glass" system that duplicates the old paper-based procedures. Instead, it is possible with new systems to facilitate the manufacturing process and eliminate wasteful steps. Technicians can now sign on to jobs and follow clear online work instructions that walk them through data collection requirements and takes them straight to relevant bookmarked information without any time wasted searching through thick procedure books. Inspectors are automatically alerted at the callboard when jobs are ready for inspection, and engineers are automatically notified when their expertise or approval is required on the shop floor.

Monitoring Process Execution in Real-Time

There are several types of "monitoring" required to keep the manufacturing process under control. These include (a) control charts, (b) real-time alerts, (c) dashboards, and (d) device history record.

Control charts are the first thing to come to mind when thinking about process control. Automated systems can be configured to monitor data collected during the manufacturing process and trigger real-time alerts when a product is out of tolerance or a process appears to be out-of-control. These alerts can be automatically routed to appropriate personnel via email so they can be notified at home if necessary.

Supervisors can monitor performance dashboards to identify problem areas that require extra attention. Real-time visibility of issues and constraints means that supervisors can jump on a situation right away and minimize the impact to the overall schedule.

Historical records are required for regulatory compliance with NRC requirements for Quality Assurance 10 CFR 50 Appendix B; Reporting of Defects and Noncompliance 10 CFR 21; and ASME standards for Nuclear Quality Assurance NQA-1-1994.clear grade components including methods for Supplier Quality Assurance to guarantee acceptability of parts and assemblies for shipment to point of use. Component certification records must also rollup into reports for higher nuclear products providing a complete electronic library of each manufacturing step, part genealogy, inspection and test reports, and discrepancy disposition.

Historical records should also be available and easily queried online for root-cause analysis purposes.

Correcting Issues during Process Execution

When issues arise during inspection in the manufacturing process, discrepancies must be documented and routed for disposition, root-cause analysis and corrective action. In traditional processes, a paper document is generated and walked to every person that has to

approve it. In a modern system, approvals can be done online and in parallel if appropriate. The cycle time to respond to issues on the shop floor can be greatly reduced.

In an online system, it is easy to insert disposition instructions into the original Work Order or into a supplemental Work Order. Defects and nonconformance are tracked to each component manufactured and the history is inherited into the higher level assembly. An automated corrective action system can ensure that no issues fall throuh the crack without proper root-cause analysis and verification of results.

Case Study - Lessons from the Naval Nuclear Propulsion Program

The nuclear energy industry can look at achievements in the Naval Reactor Program for examples of these types of process improvements. The discipline imbedded in the design, manufacturing and quality practices in the Navy nuclear program have served them well and are worth a look when evaluating solutions for the resurging commercial nuclear industry.

Nuclear reactors have operated at sea for the U.S. Navy surface and submarine fleet with over 138 million miles of safe operation. Since the introduction of the Nautilus in the late 1950's, nuclear power has been a critical element of Navy response in times of foreign threat or disaster.

After 40 years of using paper-based manufacturing and quality processes that leveraged highly trained technicians to control, verify and over check critical features, in 1996 a new strategy was developed to support the emerging young workforce population of supplier employees with automation and software solutions to guide execution and control critical operations.

Paper processes were estimated to add 40 percent of overhead cost to each unit produced proving vulnerable to human error and lacking adequate repeatability with a new workforce. The Navy realized that production cycle time could be reduced at least 10 percent and product quality could be maintained and improved long term by replacing paper processes with automated systems and knowledge centers. The Navy moved to start re-engineering processes through cycle time reduction reviews and streamlining of requirements.

Results of current efforts by Navy suppliers and customers have helped to substantially improve shipbuilding performance. On August 28, 2008 the Navy announced that the newest nuclear-powered attack submarine was delivered eight months ahead of schedule. The new technologies and process innovations are starting to pay big dividends already.

Summary

The high demand for energy world-wide is fueling demand for a new generation of nuclear reactors and demand for higher manufacturing productivity in the industry. Processes for design, fabrication, and construction of nuclear reactors must be more efficient and fail-safe to meet the newer requirements from regulatory agencies, utility companies and consumers.

To reduce risk and variability, manufacturers and suppliers need to implement operations process management improvements in (1) planning, (2) guiding, (3) monitoring, and (4) correcting procedures. New procedures must embrace quality assurance during the entire manufacturing process flow starting early in the design of the process instead of being relegated to a verification step at the end.

The goal of these processes is to achieve greater productivity through improved process control which is the spirit behind the requirements in ISO, NRC and ASME regulations.

A new breed of technology solutions is available to help implement the best practices discussed in this paper. Industry leaders have started the journey of process improvement but much opportunity is still ahead for this industry. The kinds of initiatives outlined in this white paper have had significant impact on companies' productivity and bottom line.

About iBASEt

iBASEt is a leader in software for Manufacturing Engineering, Operations Management, Manufacturing Execution Systems (MES), Quality Assurance, and Maintenance, Repair and Overhaul (MRO) for complex discrete industries including Aerospace, Defense, Nuclear, Electronics, and Medical Devices. iBASEt's Solumina® software streamlines and integrates processes between manufacturing support departments and the supply chain.

Solumina has been used in manufacturing of aerospace and nuclear grade products since 1998, including fabrication and certification of reactor components for the Navy. Customers include industry leaders like DoE, BWXT, Honeywell, Pratt & Whitney, Sikorsky, Northrop Grumman, Parker Hannifin, Lockheed Martin, BAE Systems, and United Space Alliance.

For more information on the Solumina Operations Process Management software suite visit www.solumina.com.