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Configuration Control during Maintenance of Safety Related Equipment

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ABSTRACT

Possibly the most important aspect of performing maintenance of safety related equipment is maintaining the component's original design basis. Assuring that the repaired item will perform the same safety function within the original performance and equipment qualification parameters is commonly referred to as configuration control. Maintaining configuration control of a technologically current well documented item is easy. Unfortunately, this does not describe most safety related items requiring maintenance within the global nuclear industry. Items such as motors, transformers, metal clad switchgear (low and medium voltage circuit breakers), refrigeration compressors, and electronic components (i.e. circuit boards, power supplies, regulators, etc.) which routinely require repair have been in service for twenty plus years. As a result, finding replacement parts and or material to repair the items to the original condition is becoming more and more difficult. An added difficulty is the lack of original technical documentation available on the item which is being repaired. The lack of technical documentation makes it difficult to identify replacement material and parts when the original part or material is not available. The lack of documentation also makes it difficult to test the repaired item to make sure that the original configuration has been maintained after the repair. The presentation will discuss the details of repairing various items including motors, metal clad switchgear, refrigeration compressors and power supplies and the controls which are necessary to maintain the configuration of the original item. The discussion will include the Quality Assurance and engineering necessary to identify and evaluate replacement material and parts necessary to perform repairs on safety related equipment when the original material or part is not available. Examples of repairs which required different parts or materials than the original to be used in the repair will be given. The examples will provide a summary of the identification of the new part/material, the tests/inspections necessary on the new part/material, the documentation necessary to justify its use in the safety related repair in accordance with the guidelines of EPRI NP-6406, the justification to show that the items original environmental/seismic qualification (IEEE Std. 323 and IEEE Std. 344) is still valid and the verification and acceptance of the final repair configuration via dedication in accordance with guidelines of EPRI NP-5652. The examples will include the situation where little to no original technical documentation was available and the process which is necessary to assure configuration control in these instances.

1 THE ISSUE

The majority of the safety related equipment in use within a nuclear power plant, independent of plant design or architect, is twenty plus years old. Considering that most equipment has a design life of twenty years on average this means that a lot of equipment will either need to be replaced or refurbished to meet overall plant life objectives. In the United States the plant life objective is forty years. However, more than 80% of the current nuclear plants within the United States are applying for license extension with the NRC for twenty additional years. As a result the design and implementation of a thorough equipment maintenance program is paramount to the life and profitability of today's nuclear power plant. For this discussion we will concentrate on safety related equipment maintenance

Complicating the maintenance issue is that the equipment is extremely old, outdated and in many cases obsolete. This requires the plant to perform maintenance on equipment without using original parts and or material to return the equipment to an as new condition at the end of the maintenance activity. This becomes and engineering challenge to demonstrate that the safety related configuration of the component is maintained with the use of new or different parts and or material. Will the new part or material alter how the component serves its safety function? Will the new part or material change the existing qualification of the original component as required by IEEE Std. 323 or 344? These questions and many others need to be addressed.

Examples of commonly maintained safety related equipment which fall in to this situation are:

- Motors
- Metal Clad Switchgear (low and medium voltage circuit breakers)
- Electronic Modules (i.e. power supplies)
- Printed Circuit Boards
- Refrigeration Compressors
- Transformers
- Pumps

The above is just a partial list of the more common safety related equipment types requiring routine maintenance.

2 THE PROCESS

Once it is determined that a component/system needs maintenance the following questions are normally raised:

1) Is the component/system still supported by the OEM?
2) Are replacement parts/material still available meeting the original requirements?
3) Is there sufficient technical information on the parts needed in the event direct replacements are not available and replacement parts need to be used?
4) Is there sufficient technical information (i.e. Instruction Manuals, Technical Manuals, drawings, bill of materials, etc.) available to perform the required maintenance and assure configuration control?

It is difficult enough to perform maintenance on a safety related component and assure that the configuration control has been maintained. However, in more and more instances the answers are coming back that the original parts are not available and that substitute parts need

to be used in order to perform the maintenance. Now assuring configuration control becomes even more difficult.

If it is determined that the original replacement parts are not available for maintenance of the original component then the following options need to be explored:

1) Can equivalent parts be used and maintain the original safety function of the component?
2) If equivalent parts are not available can reconditioned parts be used?
3) Are newly reverse engineered and manufactured parts needed for the maintenance activity?
4) Will the replacement parts invalidate the component's qualification? Will requalification of the component be necessary due to the new parts?

Independent of the answer to questions one through three above an engineering justification will need to be performed on the new part used for the maintenance activity. An Item Equivalency Evaluation (IEE) will need to be generated in accordance with the guidelines of EPRI NP-6406 "Guidelines for the Technical Evaluation of Replacement Items in Nuclear Power Plants (NCIG-11)" comparing the critical characteristics of the original part to the newly proposed part. The IEE would need to address critical characteristics such as dimensions, weight, electrical performance, mechanical performance, material, as well as seismic and environmental characteristics. In many cases the critical characteristics would need to be determined by "Special Tests and Inspections" meeting the guidelines of Method 1 of EPRI NP-5652 "Guideline for Utilization of Commercial Grade Items in Nuclear Safety Related Applications (NCIG-07)".

3 EXAMPLES

A routine example of a maintenance action using different parts is the repair of a printed circuit board. Electrolytic capacitors are commonly replaced during the circuit board repair due to their finite life. The problem is that capacitor manufacturers constantly change their designs to meet the requirements of their biggest customers. In this day and age telecommunication and computer OEM's dominate a capacitor manufacturer's design which has significantly different requirements than an electronic module designed twenty plus years ago. As a result capacitors used in a repair today will be different than the original capacitors. Therefore a typical capacitor IEE must compare critical characteristics such as capacitance, working voltage, power, dimensions and lead type at a minimum.

Figure 1: PCB repair using trained technicians.

An added difficulty to repairing old PCB's is due to "matched components". Matched components being defined as components selected based on their individual tested parameters and the interaction of those parameters with another matched discrete component. In other words the original PCB manufacturer selected certain components based on their tested values and not just the published values to build a board. The tested values are within the published values but specific to a certain range that the original circuit board manufacturer needed. This makes repair of these matched component circuit boards difficult. In order to eliminate this problem computer software (PSPICE, Lab Bench, Lab View, etc.) is used to model the circuit prior to the repair to check for circuit theory problems. The repaired board is then fully tested to make sure the original safety function is maintained.

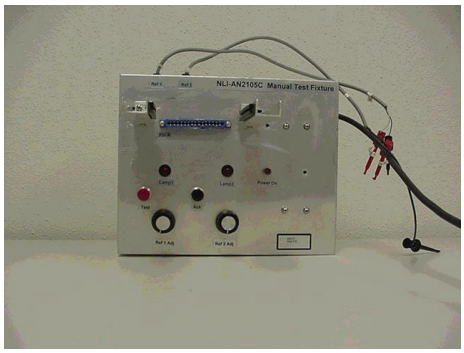

Figure 2: In many cases, in order to simulate the board's true safety function a test box as shown above is used to simulate the "host" that the board would normally be installed in.

A second example of a repair using parts different than the original is the maintenance of metal clad switchgear (low and medium voltage circuit breakers). The maintenance of metal clad switchgear involves the replacement of both electrical and mechanical components. The electrical components are normally switches or coils while the mechanical components are springs or arcing contacts. Many of the switches have become obsolete forcing the use of new switches. An IEE is prepared documenting the critical characteristic comparison of the new switch to the old switch. The IEE information is based on actual functional testing of the switch and would normally include dimensions, weight, contact resistance, contact rating and contact configuration. The switch is then seismically qualified in accordance with IEEE Std. 344-1975 and the original seismic requirements of the host breaker. This qualification allows the new switch to be installed in the new breaker without invalidating the original breaker qualification.

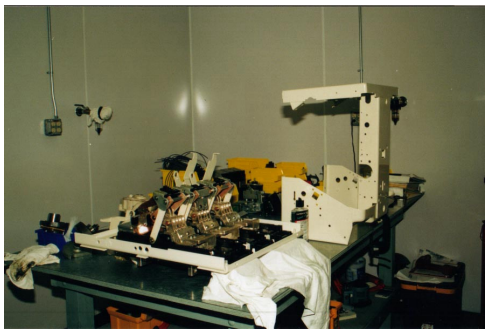

Figure 3: Maintenance of GE AK-75 Series Breaker

The switch is then installed in the breaker as part of the maintenance activity. The breaker's safety function is then fully verified and accepted by test.

Another example of using different parts during the maintenance of metal clad switchgear is the use of replated arcing contact fingers. Many of the old medium voltage circuit breaker parts are no longer available as new, therefore used silver replated parts are commonly used during the maintenance activity. As before an IEE is prepared documenting the critical characteristics between the original part and the replated part. The IEE compares critical characteristics such as dimensions, weight, material, resistance, conductivity and silver plating thickness. In addition to the IEE justification, Quality Assurance control is needed during the silver plating procedure to assure proper adhesion and uniformity during the plating process. Even before the plating can begin non-destructive examination must be performed to show that the arcing contact has acceptable structural integrity.

The replated arcing contact is then installed in the breaker during the maintenance activity and the breaker is fully functionally tested for its safety function.

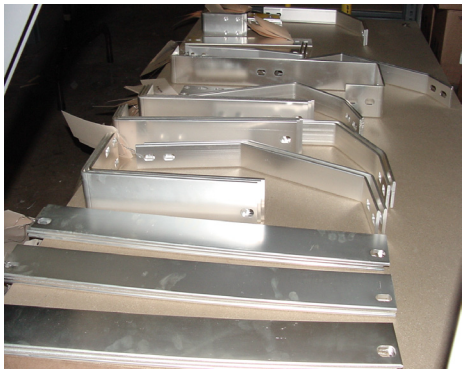

Figure 4: The above picture shows silver plated parts used for metal clad switchgear maintenance.

A final example would be the maintenance of a refrigeration compressor. This example includes the use of new parts due to obsolescence but also a change in the rod journal bearing size due to excessive wear requiring machining and larger bearings. As part of the maintenance a pilot valve needed to be changed with a new different valve since the original valve was obsolete. An IEE was prepared documenting the comparison of the valves critical characteristics based on functional testing of the valves and the valve was seismically qualified in accordance with IEEE Std. 344-1975 and the original compressor's requirements.

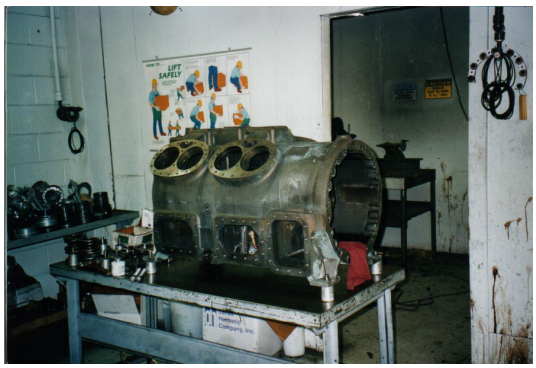

Figure 5: Refrigeration Compressor Maintenance

The next step was to prepare the justification for using larger rod journal bearings. An engineering calculation was prepared documenting the acceptability of the original seismic qualification and addressing the operability of the compressor. The machining was controlled under a nuclear specific quality assurance program and the new larger bearings were installed. The final configuration was fully functional tested and cycled for 72 hours as a burn in to justify that the compressor could perform the original safety function with the above stated changes.

Figure 6: Dedication of Compressor Parts

4 CONCLUSION

Once it is determined that the new part meets the form, fit and function of the original part it can be used in the maintenance activity. Subsequent to the maintenance the component would be fully tested to ensure that the maintenance and new parts did not change the configuration of the component. This would assure that the component would still perform its safety function as originally designed.