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The research of environmental qualification for non-metallic part in safety-related active mechanical equipment in NPP

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1. Introduction

The environmental qualification(EQ) is to ensure that equipment will operate on demand to meet system performance requirements during normal and abnormal service conditions. There are five safety functions such as maintaining the reactor coolant pressure boundary, achieving and maintaining a safe shutdown of the reactor, preventing or mitigating radiation exposure, non-safety-related equipment that affect safety-related equipment perform its safety function and post-accident monitoring in the environmental conditions (normal operating conditions, transient conditions and design basis accident conditions).

Typical environmental qualification(EQ) equipment is electrical equipment selected by 10CFR50.49, Regulatory Guide 1.89, and IEEE Std. 323 standard means mechanical equipments like pumps and valves are not contained the in the EQ program.

Recently, Korean regulator(KINS) pointed out that there is no clear/related requirements to verify environmental qualification of nonmetallic components like gasket, packing, seal and O-Ring. They brought out a regulatory issue to establish detailed methods for environmental verification of non-metallic parts in mechanical equipment. The issue is referred by NUREG 0800(SRP 3.11, NRC Guidelines for Safety-related Electrical and Mechanical Equipment).

In this paper, I'd like to introduce the environmental qualification of nonmetallic components issue and discuss the difference between qualification of electrical components and qualification of non-metallic parts in mechanical equipment.

2. Methods and Results

2.1. Non-metallic components

General non-metallic components in mechanical equipment are seals, gaskets, packing materials, diaphragm and lubricating fluids in the mechanical components such as pumps and valves that are vulnerable to high temperature or high radiation.

Among the various NPP types in the world, the PHWR has the requirement of nonmetallic components environmental qualification by the Canadian Standard Association (CSA) because Canadian EQ standard does not limit EQ equipments as 'electrical'.

Figure 1 show the pictures of typical non-metallic components.


O-Ring


gasket


packing


diaphragm

Figure 1. typical non-metallic components.

2.2 Status of nonmetallic components environmental qualification

While some new constructing NPP classified non-metallic components in mechanical equipment as environmental qualification requirement in accordance with NUREG-0800 SRP 3.11 (2007 edition), some operating NPP has no environmental qualification requirement for the non-metallic components in mechanical equipment. Some operating NPP is maintaining active mechanical equipment in safety and safety related systems by periodic inspection, maintenance and replacement according to the manufacturer's recommended manual to guarantee the ability of non-metallic parts such as valve diaphragms, O-rings for sealing equipment, gaskets, etc., which are essential for the performance.

Recently, the US Nuclear Regulatory Commission (NRC) published issue 172 (Resolution of Generic Safety Issues) mentioning that that sub-components such as seal, gasket, and packing for mechanical equipment cannot be suitably qualified because the absence of environmental qualification program or the regulation like 10CFR 50.49 applied to electrical equipment. The U.S. NRC recommended to refer ASME QME-1 (American Society

of Mechanical Engineers, Qualification of Active Mechanical Equipment) to setup the environmental qualification program of non-metallic components. ASME QME-1 Appendix QR-B provides non-mandatory requirements to qualify non-metallic components in mechanical equipment.

Figure 2 shows the scope of environmental qualification program by NRC issue.

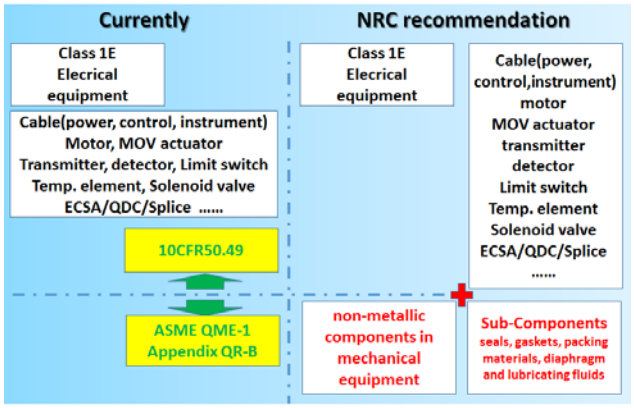

Figure 2. the scope of environmental qualification program

2.3 Consideration for qualification by ASME QME-1(Appendix QR-B)

Environmental qualification(EQ) for electrical equipment by 10CFR50.49 and qualification for non-metallic components in mechanical equipment by ASME QME-1 Appendix QR-B is quite different.

Figure 3 shows ASME QME-1 Appendix QR-B standard.

Figure 2. ASME QME-1 Appendix QR-B standard

The most important difference compared to 10CFR50.49 / IEEE Std 323 method is qualification parameters. In QME-1 Appendix QR-B, the internal process fluid parameters such as process fluid media type and chemistry, process temperature, process pressure, process relative humidity and process radiation should be included in the qualification parameters. The other differences are as follows,

- Qualification by analysis(only) is possible
- The component(part) should be assembled or simulated fixture during type test
- Test margin is not suggested
- Classification as harsh/mild is not needed

3. Conclusions

Non-mandatory Appendix QR-B of ASME QME-1(KEPIC MF) standard is recommended by U.S. NRC to qualify non-metallic components in mechanical equipment.

The environmental qualification scope is asked to broaden including sub-components such as seals, gaskets, packing materials, diaphragm and lubricating fluids in the safety-related active mechanical equipment.

Electrical equipment qualification by 10CFR50.49 and non-metallic components qualification by ASME QME-1 Appendix QR-B is different, mainly the internal process fluid parameters should be included in the qualification parameters

In order to qualify non-metallic components, it is necessary to add up the method by the ASME QME-1 Appendix QR-B onto 10CFR50.49 / IEEE Std 323 qualification method.

The method is in developing by the Central Research Institute project to provide the suitable procedure and methodology that reflects the ASME QME-1 QR-B standard.

REFERENCES

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