AMP 219 FUSES NOT SUBJECT TO ENVIRONMENTAL QUALIFICATION REQUIREMENTS (VERSION 2017)

**Programme Description**

The purpose of the AMP described herein is to provide reasonable assurance that the intended functions of fuses are maintained consistent with the current licensing basis through the intended period of operation.

Fuses are installed in motor control center cubicles, control panels, or distribution panels to protect connected loads under fault or overload conditions. From these diverse applications it can be seen that fuses are an important component in nuclear plant electrical systems, and they must function properly to ensure safe plant operation.

When a fuse is located in an environment protected from heat, moisture and caustic fumes, and the fuse is applied in a circuit with an ampacity no greater than the fuse's nominal breaking capacity, the fuse should not open unless it is subject to an overcurrent condition. However, fuses are often installed in cubicles that contain heat-generating equipment, such as transformers, resistors, and coil-energized relays. These components elevate the cubicle temperature and can cause premature ageing of the fuse. Exposure to long-term, elevated temperatures might potentially affect the rated breaking capacity and the response time (warm-up time, interrupting ability) of the fuse.

Operating experience [1-4] has shown that fuses experience a number of age-related failures. The major concern is that the fuse opens spuriously with loss of the safety related function as result.

Since they are not subject to the environmental qualification requirements, an AMP is required to manage the ageing effects. This AMP ensures that fuses will perform their intended function for the intended period of operation.

**Evaluation and Technical Basis**

1. ***Scope of the ageing management programme based on understanding ageing:***

This AMP manages fuses, within the scope according to national regulatory requirements, considered susceptible to the following degradation mechanisms and stressors: elevated temperature, thermal cycling, electrical transients (electrical cycling, power quality, inrush current).

These degradation mechanisms lead to characteristic changes (electrical resistance, time response) and possibly to loss of electrical function.

1. ***Preventive actions to minimize and control ageing degradation:***

Lifetime of fuses is related to the operating current or operating cycles. Degradation of equipment can be limited by choosing the adapted rated current.

1. ***Detection of ageing effects:***

Testing of the fuses is limited to resistance testing and time response [2-4]. The resistance test is used during manufacture to determine if the fuse is acceptable. A specific resistance value is associated with an acceptable fuse in new condition. These resistance values can change with degradation of the fuse element and may be useful as an indicator of ageing degradation in service.

A population of aged fuses (taken from the installation) is tested on a periodical basis according to national regulations. During those tests, cycling tests are performed (corresponding with a period of X years of operation depending on the period that the fuses will be used in the future) from 0 to 90% of the rated current and check that the fuse doesn’t open spuriously.

After the cycling test an overcurrent test can be performed to control if the fuse opens at the correct time for a given current.

Not all fuses are tested. A representative population (defined by the NPP) is used. If negative OPEX is detected, the population is extended.

1. ***Monitoring and trending of ageing effects:***

The rate of failures can be trended to detect on which fuses type failures are the most common/frequent. A failure rate of less than 2/1000 fuses can be seen as acceptable.

1. ***Mitigating ageing effects:***

Fuses that are operated continuously at less than approximately 60 % of their rated current could potentially have an unlimited life. During the choice of fuses, one could take this into account.

For information: The worst case operating conditions would be in an application for which the fuse is repeatedly cycled from zero current to 90 % or more of the rated current. This would expose the fuse element to potentially severe mechanical stress due to expansion and contraction.

1. ***Acceptance criteria:***

The acceptance criteria for each test are defined by the specific type of test performed and the specific type of fuses tested. Information about the appropriate values is given by the manufacturer.

For the resistance measurement test, conservative resistance values are used. This corresponds to high resistance values.

1. ***Corrective actions:***

An engineering evaluation is performed and corrective actions are taken when the test acceptance criteria are not met in order to ensure that the intended functions of the fuse can be maintained consistent with the current licensing basis.

Such an evaluation is to consider the significance of the test results, the operability of the component, the potential root causes for not meeting the test acceptance criteria, and the likelihood of recurrence.

X-rays are also used in failure evaluations to provide information on the root cause of the fuse opening [3-4]. These can be compared to X-rays during manufacturing, which are used to verify fuse element integrity and to ensure that no excess solder is inadvertently deposited on the fuse element. This would change the fuse performance properties.

1. ***Operating experience feedback and feedback of research and development results:***

This AMP addresses the industry-wide generic experience. Relevant plant-specific operating experience is considered in the development of the plant AMP to ensure the AMP is adequate for the plant. The plant implements a feedback process to periodically evaluate plant and industry-wide operating experience and research and development (R&D) results, and, as necessary, either modifies the plant AMP or takes additional actions (e.g. develop a new plant-specific AMP) to ensure the continued effectiveness of the ageing management.

1. Data given in [2] show a number of operating experiences, and more specifically that fuse failures can often go undetected until the system or component is called upon to operate.
2. The operating experience [3-4] shows that there was no spurious failure of fuses during the cycle test. On a few fuses the resistance was higher than the average resistance. This could be an indication that the fuse has aged and could trip prematurely. During the overcurrent trip test there was a difference in response time between fuses. This difference was acceptable for the manufacturer.

At the time when this AMP was produced, no relevant R&D was identified.

1. ***Quality management:***

Site quality assurance procedures, review and approval processes, and administrative controls are implemented in accordance with the different national regulatory requirements (e.g., 10 CFR 50, Appendix B [5]).

References

1. UNITED STATES NUCLEAR REGULATORY COMMISSION, Fuse Holders, NUREG 1801 Rev.2 Chapter XI.E5, USNRC, December 2010.
2. UNITED STATES NUCLEAR REGULATORY COMMISSION, Ageing Assessment of Safety-Related Fuses Used in Low- and Medium-Voltage Applications in Nuclear Power Plants, NUREG-1760, USNRC, May 31, 2002.
3. Centrale Nucléaire de Tihange : Vieillissement accéléré sur fusibles basse tension de type aM et aLC.
4. Kerncentrale Doel, Electrabel: Onderzoek omtrent ontijdig aangesproken LS smeltveiligheden Ferraz type CP 500 V ALC.
5. UNITED STATES NUCLEAR REGULATORY COMMISSION, 10 CFR Part 50, Appendix B, Quality Assurance Criteria for Nuclear Power Plants, Office of the Federal Register, National Archives and Records Administration, USNRC, 2015.