

LIFETIME™ Equipment Monitoring System Engineering Asset Management

Background

Westinghouse developed the LIFETIME™ Equipment Monitoring System to address the nuclear industry's long-standing need for a means to continuously monitor the temperature and radiation environment of components located throughout nuclear plants.

Description

Every equipment LIFETIME monitor is comprised of a package of several optional devices, each of which measures different ranges of environmental parameters. Because inclusion of each type of device in the monitor is optional, plants can select the precise environmental parameters to be monitored according to specific needs and budgetary constraints.

To evaluate component degradation, it is necessary to know the exposure temperature and its variation over time. The integrating thermal monitors (ITMs) provide the necessary information as concisely as possible. The ITMs consist of glass, solid-state track recorders that contain latent fission fragment tracks introduced into the material during manufacture. The ITMs go through a thermal annealing process while installed in a plant, and after removal they are again exposed to the fission source. At this point, the ITMs contain both annealed and unannealed latent tracks.

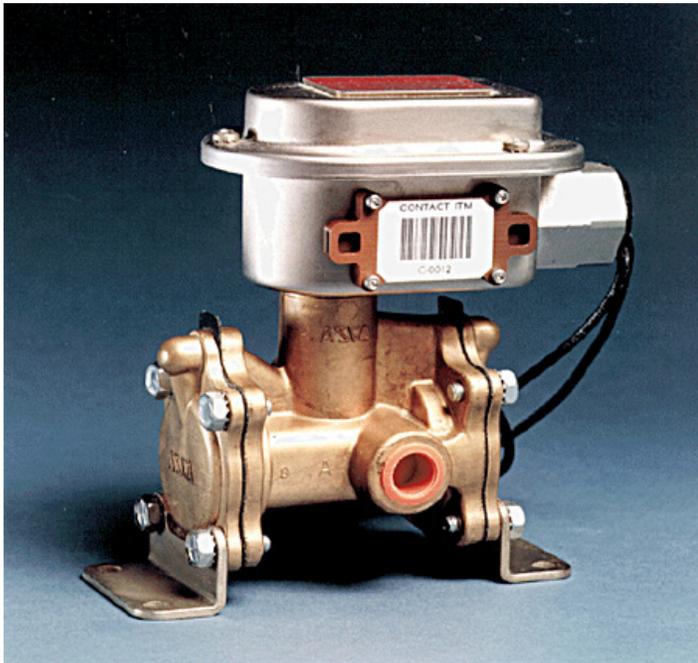


Equipment LIFETIME monitor

D/D_0 (annealed track diameter divided by unannealed track diameter), the known time of exposure, the effective exposure temperature and activation energy can be determined from the calibration data. This effective exposure temperature is termed the “Arrhenius equivalent” temperature.

The Arrhenius equivalent temperature permits an evaluation of component integrity. The degradation mechanisms that limit the life of equipment are usually treated as having a temperature dependence that conforms to the Arrhenius model. This model has been used in equipment qualification to extrapolate the results of short-time thermal exposure at high temperatures to obtain expected aging effects due to long-time exposures at lower temperatures.

Westinghouse offers a variety of passive radiation measurement devices for inclusion in the equipment LIFETIME monitor. Each device can take measurements in harsh environments over long periods. The radiation types measured include gamma ray doses (high and low range), post-accident beta particle doses, and fast and thermal neutron fluences. Each of these measurement types is accurate to within ± 10 percent.



CITM attached to solenoid valve

The contact integrating thermal monitor (CITM) is a small, lightweight, passive temperature monitor that uses ITMs to provide an Arrhenius equivalent temperature as a function of activation energy. The CITM can be attached directly to monitored equipment to measure surface temperature or placed inside active relay cabinets or motor control centers to monitor internal temperatures.

Benefits

- Extend the qualified life of safety-related electrical equipment by improving initial assumptions regarding service environment, resulting in significant savings in equipment replacement costs over the life of the plant
- Conduct long-term temperature surveys of the plant and containment building to confirm that operation is within analyzed limits; take measurements at many more locations and at lower installations and operating cost than with alternative instrumentation
- Assess potential age-related degradation of major, high-cost components, including cabling, which can provide tremendous value when used for license renewal
- Justify plant restart following accidental exposure to higher-than-normal radiation levels; permit an accurate evaluation of actual service conditions, which may expedite restart and help avoid unnecessary component replacement

The Westinghouse equipment LIFETIME monitor system offers nuclear plants a cost-effective way to obtain data that would otherwise be unavailable or prohibitively expensive, for purposes of reducing operation and management costs, resolving regulatory issues and supporting plant license renewal.

Experience

Westinghouse has over 30 years of experience in the areas of equipment qualification, radiation analysis and nuclear power plant monitoring. The first equipment LIFETIME monitors were installed in a pressurized water reactor (PWR) plant in October 1989. The first monitors in a boiling water reactor (BWR) plant were installed in March 1990, and the first monitors in a CANada Deuterium Uranium (CANDU) plant were installed in June 2003. Equipment LIFETIME monitors have also been provided to the Electric Power Research Institute to monitor the radiation and thermal environment experienced by the equipment and cable samples in the Natural Aging Program (RP1707-13). This program involves nine nuclear power plants (six PWR and three BWR).

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