AMP 226 FANS USED IN I&C AND POWER ELECTRONICS CABINETS   
(VERSION 2021)

# Programme Description

The purpose of the AMP described herein is to provide reasonable assurance that the intended functions of fans installed in cabinets housing I&C or power electronics are maintained consistent with the current licensing basis through the intended period of operation.

Fans are installed in cabinets in order to evacuate the heat produced by electronic equipment. As operating temperature is a major stressor in electronic components, it needs to remain bounded to minimize ageing and thus premature failures (see AMP218). While ambient temperature and humidity in rooms are controlled by HVAC systems, temperature inside cabinets is lowered by circulating air from the bottom to the top. The function of the fans is to accelerate the natural convection produced by the dissipated heat.

There are two main types of fans: fixed speed and variable speed fans. The former are generally AC powered and work continuously. The latter type usually have a control unit with a sensor which continuously measures the temperature of the extracted air and adjusts the speed accordingly.

AC fans are usually physically bigger than DC fans and have metallic blades, while DC fans are mainly polymeric (e.g., PBT or ABS).

Regarding the mounting, there are two categories: enclosure mounted (top/bottom/front/rear mounted) or rackmount. Rackmount type are arrangements of two or more small DC fans inside a housing.

### Evaluation and Technical Basis

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

This AMP applies to fans installed in I&C and power electronics cabinets for the ventilation of electronic equipment.

Components subject to ageing are windings, bearings, blades and the electronic modules of control units. Assuming that fans are exposed to indoor controlled air, Table 1 summarizes degradation mechanisms and ageing effects relevant to these components.

|  |  |  |
| --- | --- | --- |
| **Component** | **Degradation mechanisms** | **Ageing effects** |
| Bearing | Grease dry-out | Bearing failure |
| Vibratory loading (self-induced) |
| Wear |
| Winding | Ohmic heating | Winding failure |
| Vibratory loading (self-induced) |
| Control unit | Ohmic heating | Degradation of electronic components |
| Calibration drift |
| Blades | Elevated temperature | Polymer degradation |

Table 1: Degradation mechanisms and ageing effects

As control units are electronic equipment, they are already covered by AMP218, therefore their subcomponents are not detailed in this AMP.

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

This is a condition monitoring program, and no actions are taken as part of this programme to prevent or mitigate ageing degradation. However, as a basic measure, normal environmental conditions are respected, and cabinet’s air filters are cleaned/replaced periodically to minimize ageing degradation due to temperature and dirt, respectively.

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

This AMP focuses on the demands for the visual inspections and the surveillance test programme.

Periodic visual inspections and cleaning are performed, consisting of:

* With the fan running, look for abnormal noise or vibrations (no measurement is required).
* Using an anemometer, measure the airflow speed and compare it with baseline measurements or reference values in vendor’s manual.
* Once stopped, clean blades and air filter (if any).
* Look for possible cracked/broken blades.
* Check that the shaft moves smoothly to detect possible damage in bearings.

Simple electrical tests are also performed at regular intervals, as follows:

* In fixed speed fans, winding insulation resistance is measured.
* In variable speed fans a test is carried out which consists of measuring output voltage of control unit at different temperatures, then measuring the frequency (i.e., speed) of the fan, if available, and comparing both values with those given by the manufacturer.

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

Trending actions are included as part of this AMP. Test results are managed and trended (e.g., insulation resistance and fan speed as a function of temperature) so that they can be utilized for quantitative trend monitoring.

Failure rate can also be monitored to detect in which type of fan the failures are more frequent.

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

This programme is a condition monitoring programme. This programme has no specific operations, maintenance, and repair aspects except the replacement before the end of the expected lifetime of the fan.

1. ***Acceptance criteria:***

The physical parameters mentioned in attribute 3 are to be within the predicted acceptance criteria.

For periodic visual inspections, according to the observed defects, two categories are possible: satisfactory and non-satisfactory.

Acceptance criteria for insulation resistance are defined by codes and standards according to voltage category [1].

Regarding control units testing, information about the appropriate values is given by the manufacturer. The testing results are compared with previous results to identify a possible degradation trend.

1. ***Corrective actions:***

Corrective actions are taken when unacceptable conditions are found, considering the age of the components as well as the severity of the anomaly. Corrective actions may include:

* For enclosure mount type: replacement of bearings or the entire defective fan.
* For rackmount type: replacement of a single fan, the control unit or the complete rackmount unit.

In case of cabinets provided with maintenance-free fans, they may be replaced after a certain period, usually five to ten years, depending on the environmental conditions [2] and with no need of previous inspection. For monitored fans, run-to-failure approach is also acceptable.

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.

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 [3]).

References

1. INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, IEEE Recommended Practice for Testing Insulation Resistance of Electric Machinery, IEEE 43-2013, December 2013.
2. ELECTRIC POWER RESEARCH INSTITUTE, “EPRI Preventive Maintenance Basis Database (PMBD)”, Inverter template, ID 3002005428, Palo Alto, CA, June 2015.
3. 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.