A.5 Filtration

This addendum provides further guidance for clauses 5.2.2 and 5.5.3 of NVF/DG001:

5.2.2 HEPA FILTRATION - TYPE TESTING

The intent of this clause is to ensure suitable filters are purchased for use.

In the 1980's the Containment and Ventilation Treatment Working Party (CVTWP) led a research programme that developed circular filters. The Filter Development and Standards Working Party (a sub committee) led the development programme, undertaken at Harwell in Oxfordshire. The programme included a 'Hot Dynamic Test Rig' to examine the behaviour of HEPA filters under operational conditions. Up until then, filters were supplied with a manufacturer's certificate of the DF – tested under ideal conditions at the factory. Subsequently, each filter for use in the nuclear industry was TYPE TESTED, as part of a TYPE APPROVAL process.

The function of Type Approval is to define what the supplier must produce in terms of delivery and performance. It typically covers dimensions and strength of materials, so that a filter will fit the housing and perform as expected during its whole life without breaking, but also covers labelling and packaging etc. Each specific form of filter was Type tested, and if passed, a license number issued valid for five years. This increased confidence in the manufacturer's certificate issued with the filter.

Time moved on and test rigs were dismantled. Type testing provided the initial proving of "untried filter types" (e.g. Circular filters) and the many years of filter operation since has operationally proven these. The nuclear industry is still using filters of the same basic design as were Type Approved although the five-year Type Test validity has expired.

It is possible for filter designs to change with time, due to the adoption of new materials and adhesives, even if they appear identical. There is no major reported evidence of performance degradation to date, although there is anecdotal evidence of a few instances of early performance deterioration and failures, where untested materials have been used.

The manufacturer's certificate is once again the basis for acceptance of filters as adequate. The end-user may wish to check with the manufacturer on the materials content and obtain some form of guarantee or advice, especially with regard to ageing effects.

Section 5.2 has not been revised to remove Type Testing even though it is no longer available.

5.5.3 IN-SITU FILTER PERFORMANCE TESTING

This clause is concerned with demonstrating that claimed filter performance of the installed system is achieved in practice. Performance testing of HEPA filters has been discussed extensively in published papers, and the merits (and limitations) of the various methods have been compared [ref.1,2,3]. Further detail and comparison is not intended here - rather an appreciation of what can actually be determined from the results of HEPA filter testing.

There are several major methods of HEPA filter testing in use:

DOP (mono-dispersed bench test or poly-dispersed field test)

NaCl (British Standard BS3928)

Paraffin (Din 24-184)

Uranine (AFNOR - NFX 44001)

Condensation Nuclei

Laser particle counting

The results of testing the same filter by different methods do not necessarily give the same efficiency rating. Thus, **the efficiency of a filter should be quoted against the method used to test it.**

The test challenge used in the methods is an attempt to represent the aerosols that the filter will be required to deal with. It is unlikely that the aerosol, and its size distribution, from one plant will be the same as another, and yet the same test challenge aerosol is used. Additionally, filter installations are designed for incident conditions on their associated plant, and the normal arisings may be orders of magnitude less in terms of concentration. The efficiency test is based upon a particular test challenge and cannot accurately determine the performance of the filters when an incident occurs (with potentially significant differences in temperature, pressure, moisture content, etc.).

For an actual installation, the ability to accurately measure an efficiency, with an in-situ test method and apparatus, will be determined by the ability to obtain representative samples of the aerosol in the gas before and after the filters. Thus, the tests carried out are nearer to a method of comparing one installed filter with another, than an absolute measurement of efficiency [ref.1].

The laboratory testing of filters shows decontamination factors (DF) of above 10^5, whereas the claimed performance within the aerial effluent flow sheet of a plant may be 10^2, 10^3 or 10^4 per stage. The achieved DF should be greater than the required DF to ensure the Safety Case requirement is exceeded by an appropriate margin. There are also other reasons for this lower claimed performance e.g. the fault condition requires the claimed DF to be different to that of the in-situ test condition, or there may be a risk of filter deteriation as a result of another low frequency fault event. However, the safety margin is such that on-site tests may be better directed to identifying leakage that could compromise the safety margin, rather than trying to prove a particular DF.

The testing of HEPA filters in-situ is a way of determining that the filters on an installation are in good condition efficiency-wise, and will be able to perform to the standards that HEPA filters have been shown to achieve in the past. **The tests are less an absolute determination of DF and more of a measure of confidence in the installation.**

ADDITIONAL ADVICE - FILTER AGEING

Some HEPA filters have remained in use well beyond their intended life (20, 30 or even more years). These are often justified on the basis of a successful in-situ DOP test. However, this does not give an indication of filter strength – evidence [ref.4] shows that even in dry air, embrittlement can occur, and with other potential changes, HEPA filters have a limited life.

In-situ testing gives no indication of the condition of the filter in relation to strength etc. and cannot determine the filter condition with respect to ageing.

For filters that directly affect safety or environmental protection, and that could be subjected to a pressure pulse, **it is good practice to assess the filter condition five years after installation**. The assessment should look at life limiting factors, such as exposure to damp or corrosive conditions, or unstable flow. The assessment may extend the life of the filter for a further period. In any case, filters should be changed after ten years from installation, unless there are ALARP reasons for not doing so (for example if the ventilation system will soon be decommissioned).

References

1. “Testing and Monitoring of Off-gas Cleanup Systems at Nuclear Facilities”, International Atomic Energy Agency, Technical Report Series No. 243, Vienna (1984). (ISBN:92-0-125284-6)

2. "Air Cleaning in Accident Conditions", A Report to CSNI by NEA, Group of Experts, 1984 P77-79.

3. “Design and Operation of Off-gas and Ventilation Systems in facilities handling Low and Intermediate Level Radioactive Waste”, International Atomic Energy Agency, Technical Report Series No. 292, IAEA, Vienna.

4. “Maximum HEPA filter life”, W Bergman, Lawrence Livermore Laboratory, UCRL-AR-134141, 1999.