NUCLEAR SAFETY DIRECTORATE - BUSINESS MANAGEMENT SYSTEM		
TECHNICAL ASSESSMENT GUIDE **VENTILATION**		**T/AST/022** ISSUE 001
Approved By: *R P Pape*	R P Pape	Issue Date: 28/06/00
Open Government Status: Fully Open		Review Date: 28/06/03

1. Purpose and scope

1.1 This assessment guide covers the principles for ventilation of the designated radioactive areas within the buildings on nuclear licensed sites, from the point where air is drawn into the building, to where it is discharged to atmosphere after appropriate conditioning, filtration and monitoring.

1.2 This TAG contains *guidance* to advise and inform NSD inspectors in the exercise of their professional regulatory judgement. Comments on this guide, and suggestions for future revisions, should be recorded on the appropriate registry file.

2. SAPs addressed

2.1 Any ventilation system provided in the interests of safety should meet the Key Engineering Principles. In addition there are a number of general plant Principles which the system should meet. These are listed below. These general Principles do not specify any standards or criteria which should be followed, however, the licensee should clearly state the standards used and the performance targets.

2.2 The Principles relating to ventilation are: P239 to P242.

2.3 These Principles should be considered as goal setting and the safety case should demonstrate how each component of the Principles have been achieved. These general plant principles do not place quantitative requirements on a licensee but the safety case for a particular facility should clearly identify how the facility meets the above Principles. In general the Principles are based on "best" practice but it may still be possible to implement improvements that reduce the risks to as low as reasonably practicable.

3. Relationship to licence and other relevant legislation

3.1 There are no licence conditions dealing explicitly with ventilation, although LC34: ‘Leakage and escape of radioactive material and radioactive waste' will be applicable in some circumstances.

3.2 There are no regulations dealing with ventilation systems from a nuclear safety point of view. For many years the industry code of practice was AECP 1054[1]. This code of practice is no longer maintained as the sole ventilation code within the British Nuclear Industry, however, it remains as useful guidance. Some operators have developed their own version of this code (such as BNFL with NF 0166/1). It is also understood that IAEA are planning to produce more guidance of this subject in 2001. Within a safety case there should be emphasis on what the Licensee regards as current best practice (note too the comments in **para. 4.6**).

4. Advice to assessors

Ventilation systems are provided to control the spread of nuclear matter within the plant and its escape to the environment, in normal operation and fault conditions. Ventilation systems are an important part of the "containment strategy" as they allow normal access into potentially contaminated areas by maintaining airborne contamination below prescribed levels. In many facilities such access would not be possible without well designed and operated ventilation systems.

4.1 Ventilation systems are important in limiting the spread of radioactive contamination. To this end, the plant may be divided into zones separated by barriers. Each zone is ventilated so that there is a pressure gradient between adjacent zones, the aim being to ensure that any movement of airborne radioactive contamination is from the zone with the lowest to that with the highest potential for contamination.

4.2 The ventilation system includes any equipment such as filters or other gas cleaning facilities which may be provided to mitigate the consequences of radioactive release. The system also includes many mechanical/electrical/ control and instrumentation items, the reliability of which has a direct bearing on the risk to workers and others.

4.3 Where equipment forming part of the ventilation system serves as part of a safety system the general principles applicable to engineering and safety systems should also be applied.

4.4 The potential for a fire can have a major impact on the design of the ventilation and containment system, influencing for example the position, number and type of fire dampers. In addition to the principles in this section, other impacts of fire may need to be considered, and reference should be made to Protection Against Fire (P141 to P143).

4.5 The principles in this section apply generally unless the wording makes it clear that limited application was intended or unless it can be shown that the total amount of nuclear matter concerned is sufficiently small or is in such a chemical or physical form as to make it unnecessary to apply any one or more of the principles.

4.6 Guidance has been prepared by a number of different organisations on the design of ventilation systems [1 to 4]. The Inspectorate has not approved such guidance but its use may give the assessor some confidence that the licensee is making use of existing industry practice and standards. The assessor will need to be satisfied that the licensee is applying such guidance correctly and that adequate consideration has been given to reducing risks to as low as reasonably practicable .

4.7 Ventilation systems are generally provided in conjunction with other containment to ensure the adequate segregation of nuclear materials and the general environment, workers and others. The contribution a ventilation system makes to the overall containment strategy may however vary between existing and new plants. Improvements in engineering techniques and the characteristics of the process may result in the requirements of the ventilation system being changed.

4.8 Ventilation systems by necessity have mechanical/electrical components such as motors, fans, filters and control systems which have to meet the necessary standards of redundancy and diversity to ensure continued safe operation. These, along with the segregation of essential services (e.g. electrical supplies), should be considered during the assessment of the safety case.

4.9 The safety case should contain a clear statement on the duty of the ventilation system including for example its role in reducing air contamination levels, any general duty in providing a satisfactory working environment as regards temperature and humidity, and as part of the overall containment system . Such differing duties may result in conflicts in the requirements for the ventilation system which will have to be justified. The safety case should clearly identify what happens in fault situations, for example when a glove fails in a glovebox an additional flow of air is required to prevent backflow of radioactive material into the working environment.

4.10 The licensees may use one of a number of approaches to the design of a ventilation system dependent on the duty. A clear statement should be made on the standards and any design codes being used. This relates not only to the design philosophy of the system but also to the sizing, the materials of construction, the radiological protection standards, the explosion standards, the mechanical/electrical equipment and the control systems. The actual environmental discharge requirements are a matter for the Authorising Departments (currently the EA and SEPA) and any liaison should be conducted under the Memoranda of Understanding.

4.11 In the assessment of ventilation systems many factors have to be considered, the majority of which have their own specific standards and codes. The level of sophistication for each area will be determined by each factor's effect on safety and the risk such a factor poses to workers and others. The hazard and risk assessment prepared to justify the safety of the facility should clearly identify the particular operating conditions being maintained by the ventilation system in both design and accident situations.

4.12 Some of the factors which may arise in the assessment are

1) the use of appropriate standards and codes of practice for all parts of the ventilation systems. Where computer codes are part of the safety arguments these must be verified and validated ; different licensees may use different codes of practice, standards and criteria and the assessor will have to be satisfied that they are acceptable for each application. A review of the particular code of practice or standard may be all that is necessary to give the confidence that suitable provisions have been made, but a check on the accurate interpretation and implementation may also be necessary.

2) the system must be sized to ensure the required airflow and depressions are achieved and maintained in normal and accident situations. Each parameter must be justified to ensure that back-contamination does not occur through openings such as doors, engineered flowpaths or glovebox openings. Entrainment of any material being processed must be considered to ensure adequate precautions are taken to prevent deposition of solids in the ventilation ducts.

3) the in-leakage through uncontrolled openings should be minimised as this may reduce the efficiency of the ventilation systems. Some facilities may have a very high requirement for the minimisation of such leakages.

4) the pressure gradient should be from clean areas through to those with potentially the most highly contaminated conditions and the flow through openings between areas should be sized to prevent back contamination.

5) the air flow should be such that the design radiological protection

conditions for each section of the plant is maintained: such conditions will be specified in that part of the safety case dealing with radiological protection. The ventilation system must be designed to ensure the appropriate radiological protection criteria are met and the different areas maintain their radiological classification; there should be clear statements as to how this is achieved.

6) the materials of construction must be compatible with the materials being processed, any requirements for decontamination, and any materials generated following fault conditions.

7) as with other equipment acceptable construction and installation codes and practices must be followed.

8) sufficient and adequate consideration must be given to the maintenance, testing and inspection requirements of the total system.

9) filters must be suitable for their duty and compatible with the process fluids. Due consideration must be given to the installation, testing and changing of all filters with particular emphasis on a safe change procedure to protect the operator and on filter management prior to disposal. The by-passing of filters is a common problem and a suitable testing programme must be in place to ensure the performance criteria are met.

10) the level of redundancy and diversity required in the component parts of the ventilation system should be identified. Of particular importance is the ability of the system to resist internal and external hazards, fire being accepted as a major threat to a ventilation system.

11) inlet air filters should be considered if there is a need to provide protection in the event of a release from an adjacent building, or if there is a fault scenario involving back-flow from a building.

12) cylindrical rather than cuboid HEPA filters may be preferred for new plants to reduce by-passing and waste volumes. These will also be consistent with safe change philosophies.

13) back-flow (flow-reversal) of gases exhausted from one part of a plant may affect safety of another if exhaust fans discharge into common ducts or stacks both in normal and accident situations. In such circumstances consideration should be given to the provision of dedicated exhaust paths.

14) the problems of liquor droplets and the deposition of hygroscopic solids can result in rapid blockage of filters and damage to the mechanical and electrical equipment. This may determine the need for some form of clean up equipment. Similarly, debris being transported within the ventilation system may require the provision of electrostatic precipitators or spark arrestors

15) discharge limits to the environment are a matter for the Authorising Departments (currently the Environment Agency) but close liaison and consultation is necessary under the Memorandum of Understanding.

4.13 Ventilation systems should be instrumented and monitored to ensure the appropriate volume flowrates and depressions are obtained and maintained. This matters equally to those areas where there is direct operator contact (e.g. gloveboxes) and the important gas cleaning facilities such as filters, cyclones and scrubbers. The efficient operation of such devices will contribute to maintaining doses and risks to workers and others to as low a level as is reasonably achievable.

4.14 Existing nuclear ventilation systems should be assessed periodically to confirm fitness for purpose. It is unlikely that anyone other than an engineer experienced in nuclear ventilation system design or commissioning could undertake such an assessment. The assessment should consider current running parameters, system deterioration and any plant modifications having the potential to change ventilation flows, typically structural modifications could do this. The requirement for, extent of, and periodicity of such assessments must be commensurate with the safety significance of the ventilation system and should be defined by those experienced engineers for inclusion in the safety case.

References

1. AECP 1054 - March 1993, AEA Technology Code of Practice, Ventilation of Radioactive Areas.

2. IAEA, Design and Operation of Off-gas Cleaning Systems at High Level Liquid Waste Conditioning Facilities, Technical Report Series No. 291 (1988).

3. IAEA, Design and Operation of Off-gas Cleaning and Ventilation Systems in Facilities Handling Low and Intermediate Level Radioactive Material, Technical Report Series No. 292 (1988).

4. OECD-NEA, The Safety of the Nuclear Fuel Cycle, 1993.