AIR MONITORING REQUIREMENTS AND ALARM RESPONSE PROCEDURES IN REPROCESSING PLANTS

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INTRODUCTION

During the design stage for any plant handling radioactive materials a study is carried out to identify potential release mechanisms whereby activity may become suspended in air breathed by plant operators. The designers are then required to ensure that all reasonable precautions are taken to minimise this hazard from airborne contamination and to ensure that under routine conditions defined minimum standards are attained. However, because it is not possible completely to eliminate the hazard at the design stage it is necessary prior to the operation of the plant to assess the potential for an airborne contamination hazard and where appropriate to make provision for its measurement. Where the hazard is significant and may be subject to temporal variation it is necessary to provide alarmed airborne contamination monitors to warn personnel of a deterioration in conditions, following which precautionary measures must be undertaken to minimise the potential dose uptake to workers.

A comprehensive air monitoring programme will need to consider the requirement to sample for alpha and/or beta particulate activity, volatile species activity (eg iodine) and radioactive gas (eg tritium or krypton). This paper reviews the philosophy and requirements of the air monitoring programme for the reprocessing plant at BNFL's Sellafield site (formerly known as Windscale and Calder Works), with particular emphasis on particulate activity sampling systems.

AIRBORNE CONTAMINATION MONITORING SYSTEMS

Non-Alarmed Sampling

In many plants or plant areas there is no significant potential for the generation of abnormal levels of airborne contamination although some degree of contact with active materials is envisaged. In such locations, which will normally be remote from the major operating or cell areas and may include locations such as trace active workshops etc, it is acceptable to use simple non-alarmed samplers to give retrospective confirmatory information on long term trends of airborne contamination levels.

Alarmed Monitoring Systems

An alarmed airborne contamination monitor is programmed to give an audible and visual warning at a pre-determined level of integrated exposure, in the area from which the air is being sampled. In response to these local alarm signals operators are required to move away from the vicinity of the alarm, where appropriate donning respiratory protection, and to report to defined locations within the plant in order to permit standard follow-up procedures (involving checking affected individuals for personal contamination and checking the validity of the alarm) to be initiated.

In a large plant it is not practicable to provide alarmed air monitoring instruments adequately to sample the breathing air at every potentially occupied location within the plant. A degree of judgement is therefore necessary in the siting of air monitors and past experience has enabled guidelines to be developed for this task.

The major factors affecting the siting of airborne contamination monitors are:-

(1) The potential magnitude of an incident and the potential for release of airborne contamination.

(2) The presence of a potential air-flow or leakage path between a source of activity and the occupied plant area.

(3) The occupancy factor for the affected area.

Having identified those areas of the plant which require the presence of an alarmed monitor, the precise locations are determined principally by ventilation patterns, although it is acknowledged that in many cases local airflow is dependent on many factors and may be subject to considerable variation.

Whilst many fixed locations can be identified for air monitors there are in many cases temporary localised hazards, eg during specific maintenance operations, for which it is inappropriate to provide installed air monitoring instrumentation. For such operations it is practice to provide portable alarmed air monitors.

Building Evacuation Alarm

Consideration of potential hazard situationsin major process buildings has shown that for a minority of abnormal events the local response procedure described above may not afford adequate protection to personnel. On these occasions it is judged necessary to evacuate all persons from the plant or a large section of the building. In particular, the following situations give rise to such a requirement:

(a) A release of airborne activity which spreads significantly through the building (despite the normal ventilation arrangements which are designed to prevent this) will give rise to a hazard in plant areas where direct arisings of airborne activity are improbable. Such areas are often unprotected by local airborne contamination alarms.

(b) In the event of a widespread release of activity the movement of personnel out of the area of a succession of local alarms could result in a prolonged movements within the building.

(c) In the event of an exceptionally high level of local airborne activity the degree of protection afforded by locally available respiratory protection equipment may be inadequate.

In addition it is possible that future plant ventilation systems will contain a partial recirculation of building air. In such systems it would be necessary to initiate a building evacuation if significant airborne contamination were detected in the recirculatory feed to plant areas. It should be noted that there is a similar requirement to the need to detect airborne activity in the plenum air intake of a plant, due to a release from a nearby building. However, in this latter case, whilst it is necessary to alert building occupants to the need to wear respiratory protection, a decision to evacuate the building needs more careful analysis, noting that such action may move workers closer to the source of activity.

From the above discussion it follows that the criteria for initiation of a building evacuation alarm may be detailed as follows:

(a) A spread of airborne activity through a significant area of the plant.

(b) Local detection of exceptionally high levels of airborne contamination.

or (c) The detection of significant activity in a building ventilation recirculatory air feed.

The engineering of a building evacuation system makes use of selected local airborne activity monitoring units provided in accordance with the guidelines listed in the previous section. Signals from appropriate units are taken to a central logic system which on fulfilment of defined criteria triggers the evacuation alarm. The following criteria are used to determine which local monitors are linked to the building evacuation system:

(a) Areas adjacent to the major activity processing cells etc where there is a low probability of a release of high potential magnitude.

(b) Major link corridors within the plant which although having a low probability of direct arisings of activity may become channels for the transfer of activity though the building.

(c) Areas which are environmentally segregated from the remainder of the plant and which have only a very small potential for activity arisings may be provided with alarmed monitoring units which are <u>not</u> connected into the building evacuation logic system.

Additionally the building evacuation system will be triggered by the detection of activity in a ventilation recirculatory air feed.

AN INTEGRATED BUILDING AIRBORNE CONTAMINATION MONITORING SYSTEM

The differing requirements of a plant air monitoring programme may therefore be met by integrating three types of monitoring unit into a combined sampling programme:

(a) Air sampling and activity detection units with local alarm facilities, also connected to the logic system of the building evacuation alarm. These units would be situated in areas where there is the potential for a large release of activity or areas which could be affected by the spread of activity through the building.

(b) Air sampling and activity detection units with local alarm facilities only, to be situated in areas where a potential for airborne activity exists but where the only significant source of activity is local.

(c) Non-alarmed sampling, used to give confirmatory information on long term trends of airborne contamination levels, situated in plant areas where there is no significant potential for the generation of abnormal levels of contamination.

It is advantageous to display the status of all alarmed monitors in a central location in or adjacent to the plant. In such a system it is possible to generate at this central control a notification of an increase in contamination level on any monitor at a level below that set for local alarm, and hence investigate abnormal increases in contamination level on any monitor at a level below that set for local alarm, and hence investigate abnormal increases in contamination levels before alarm action becomes necessary. Additionally, to assist in this pre-alarm identification of abnormal contamination levels and also to ensure that data is available for post-event analysis it is of value to make available a continuous recording of any detected airborne contamination levels which are in excess of the normal background levels recorded in the building. For a large monitoring system, computer-based information storage and display systems are being developed which also permit graphic displays of the status of all radiometric instrumentation within the plant.

The air monitoring alarm system discussed above represents a three tier alarm response as follows:

(a) investigation level.

(b) local area evacuation (around a given local area alarm).

(c) building evacuation.

A rationale for setting the alarm levels has been developed based on plant experience over a large number of years. The most important factor is to set alarm levels as low as practicable without generating a significant incidence of false alarms which would create a lack of confidence with the alarm system and an unacceptable interference with the operation of the plant. The action levels must also, of course, be compatible with the regime for operator dose uptake control, although it is recognised that the relationship between activity concentration at the monitoring unit and that breathed by an operator may be extremely variable and is not generally subject to precise analysis. However, on the basis of past plant experience the alarm settings used on current plants, expressed in terms of integrated exposure (Derived Airborne Concentration x Hours), are as follows:

(a) investigation level - 1 DAC hour

(b) local area evacuation - 8 DAC hours

(c) building evacuation -100 DAC hours (locally) or 8 DAC hours (widespread)

The successful implementation of an alarm system based on the above principles is dependent upon the availability of instrumentation compatible with the required alarm levels. In those areas of the reprocessing plant where any arising of airborne activity would contain a significant beta-emitter component an alarm system based on beta-in-air detection units may be installed to comply with these principles. However, in plutonium processing facilities the alarm system must be comprised of plutonium-in-air monitoring units. These alarm units are subject to interference from natural radon/thoron daughter products which give rise to spurious signals in the alarm channel of the alpha spectrometry detection instrumentation, and the current generation of technology does not permit reliable alarm signals to be generated at levels less than about 8 DAC hours, and in many cases the alarm levels may be significantly higher. This constraint on available instrumentation, and a recognition of differences in plant layout between plutonium plants and most other facilities whereby the former principally consist of suites of cells linked to access corridors and operating faces, has led to an evacuation philosophy for plutonium plants based on the detection of airborne activity in link corridors and operating areas.

In large reprocessing facilities the plant may be divided into sub-units, separated by effective air locks and provided with largely independent ventilation systems. Such sub-units may be defined as independant areas for the purpose of plant evacuation.

SUMMARY AND CONCLUSIONS

Plant design must ensure that all practicable measures are taken to minimise the potential release of airborne activity into areas which could give rise to hazard to operators. Nevertheless, the provision of an air monitoring and building evacuation alarm system must be based on the acceptance of an appropriate degree of potential hazard, and in such cases the system must be capable of warning personnel against all significant incidents of airborne contamination, including those release mechanisms which may not have been identified in a prior hazard analysis.

The required air monitoring programme can best be met with an integrated system of local monitoring units comprising of both alarmed and non-alarmed units, and with the alarmed units operating in three tier mode - ie investigation level, local evacuation alarm and an associated building evacuation system.