U.S. ATOMIC ENERGY COMMISSION

REGULATORY GUIDE

DIRECTORATE OF REGULATORY STANDARDS

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REGULATORY GUIDE 3.7

MONITORING OF COMBUSTIBLE GASES AND VAPORS IN PLUTONIUM PROCESSING AND FUEL FABRICATION PLANTS

A. INTRODUCTION

Each applicant for a license to possess and use special nuclear material in a plutonium processing and fuel fabrication plant as defined in § 70.4(r) of 10 CFR Part 70, "Special Nuclear Material," must fulfill the provisions of § 70.23, "Requirements for the Approval of Applications." Subparagraphs § 70.23(a)(3) and (4) require that the applicant's proposed equipment and facilities and proposed procedures be adequate to protect health and to minimize danger to life or property. Where combustible gases and solvents are used within the confinement barriers of a plutonium processing and fuel fabrication plant, measures are needed to protect against the possibility of the formation of flammable mixtures with these gases and vapors. The presence of such a flammable mixture within the multiple confinement barriers of the plant could result in a fire or explosion which might breach one or more of the confinement barriers and allow radioactive material to be dispersed within regions of the plant and possibly the environs. This regulatory guide describes an acceptable program for complying with the Commission's regulations with regard to protecting against the possibility of the formation of flammable mixtures with combustible gases and vapors.

B. DISCUSSION

Within a plutonium processing and fuel fabrication plant, a postulated fire or explosion is an accident that can furnish sufficient energy for the release and dispersal of radioactive material from the confinement barriers to the regions occupied by working personnel and, depending upon the severity of the accident, to the environs. Therefore, conditions that can lead to these hazardous events must be precluded. One such event is the uncontrolled or undetected formation of a flammable mixture of a combustible gas or vapor and an oxidant followed by its deflagration or detonation.

Combustible gases and vapors and their limits of flammability in various oxidizing atmospheres have been studied by the Bureau of Mines.[1,2] Flammability has been found to be a function of the type of combustible gas, oxidant concentration, temperature, humidity, vessel characteristics, and direction of flame propagation, among other things. Within the confinement barriers of a plutonium processing and fuel fabrication plant, flammable mixtures must be precluded, and therefore the maximum allowable concentration of any combustible gas or vapor in a mixture should always be below the lower limit of flammability as given for that particular mixture.

Some common sources of combustible gases and vapors that have led to fires and explosions within confinement barriers have been (1) solvents or coolants used in chemical processing, surface finishing, or equipment maintenance, (2) reducing atmospheres used in conversion and sintering furnaces, and (3) decomposition products formed during waste incineration and chemical processing. Measures have been developed to prevent the recurrence of flammability conditions and have been based on one or more of the following concepts: (1) prohibiting or restricting the use of the combustible material, (2) inert gas purging within the confinement barriers where combustible gases or vapors are expected, thus reducing or eliminating the oxidant content, or increasing the air flow within these confinement barriers, thus diluting the combustible concentration below the lower limit for flammability, and (3) establishing other procedural changes based upon the results of the accident investigation.

[1] Bureau of Mines Bulletin 503, "Limits of Flammability of Gases and Vapors," H. F. Coward and G. W. Jones.

[2] Bureau of Mines Bulletin 627, "Flammability Characteristics of Combustible Gases and Vapors," M. G. Zabetakis.

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While this arrangement has for the most part been effective in preventing the recurrence of fires and explosions for specific processes within an individual facility, such procedures usually have been initiated and/or emphasized only after an accident and may suffer with time from relaxation of vigilance, process modifications, and the formation of unexpected combustible products. The monitoring and alarm system for combustible gases and vapors discussed in this regulatory guide is expected to contribute to the safe operation of the plant in many ways, especially in the following aspects: (1) an initial fire or explosion accident is unlikely to happen since an alarm will indicate when the flammable limit is being approached, (2) the need for administrative involvement should be minimal since the system can provide continuous automatic surveillance, and (3) unexpected combustible products will have a high probability of being detected.

C. REGULATORY POSITION

1. All processes and plant operations carried out in or associated with the confinement barriers of a plutonium processing and fuel fabrication plant should be evaluated as potential sources of combustible solvents, gases, or vapors.

2. Where sources of combustible solvents, gases, or vapors can be identified or postulated under normal or abnormal conditions, the formation of a flammable or explosive mixture within the confinement barriers should be precluded by establishing suitable process parameters and plant operating procedures.

3. Assurance that the established processing and operating procedures are maintaining safe conditions should be provided by suitable continuous monitoring systems appropriately placed within those confinement barriers that were identified in C.1. above. These systems should give an audible and visual local alarm indication to operating personnel when the prescribed safe limits for combustible gas and vapor mixtures have been achieved or exceeded.

4. The procedure for remedial action to be taken in the event of an alarm signal should be established.

5. The absence of an evident ignition source within those confinement barriers postulated to contain combustible gases, solvents, or vapors does not relieve the requirement for a monitoring and alarm system.

6. The monitoring and alarm system itself should not introduce an ignition source and should not affect the confinement integrity.

7. The monitoring and alarm system should be designed for in-place calibration and testing.