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DOE 6430.1A COMPLIANCE CHECKLIST FOR THE ROTARY
MODE CORE SAMPLING EXHAUSTER FLAMMABLE GAS
INTERLOCK

OCT 03 1995

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1	1	Cog. Eng. JD Robinson	<i>JD Robinson</i>	09/29/95	57-12				
1	1	Cog. Mgr. DW Hamilton	<i>DW Hamilton</i>	9/29/95	57-12				
1	1	QA ML McElroy	<i>M. L. McElroy</i>	10/3/95	57-07				
1	1	Safety NJ Milliken	<i>NJ Milliken</i>	10/3/95	H4-65				
1	1	Safety RJ Van Vleet	<i>RJ Van Vleet</i>	10/3/95	H4-64				
1	1	Field Engineer EJ Waldo	<i>EJ Waldo</i>		57-12				

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6. Author

Name: JD Robinson

James D. Robinson
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7. Abstract

This document examines the Safety Class I criteria in DOE 6430.1a and determines applicability to the rotary mode core sampling exhauster flammable gas interlock.

8. RELEASE STAMP

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**DOE 6430.1a COMPLIANCE CHECKLIST
FOR THE
ROTARY MODE CORE SAMPLING EXHAUSTER
FLAMMABLE GAS INTERLOCK**

**WESTINGHOUSE HANFORD COMPANY
SEPTEMBER 1995**

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DOE 6430.1a Compliance Checklist
For The
Rotary Mode Core Sampling Exhauster
Flammable Gas Interlock

1.0 Introduction

This document provides a Safety Class I compliance checklist for the rotary mode core sampling (RMCS) exhauster flammable gas interlock. Two assumptions regarding the interlock are necessary to prepare this checklist. First, the interlock is a portable component, taken into and removed from, a facility. Second, the design basis accident (DBA) which the interlock is to prevent (not survive) is a deflagration in a single shell flammable gas watchlist tank.

The document is developed from safety class criteria contained within DOE Order 6430.1a. To do this, the contents of each division were reviewed. From this review it was determined that two Sections (1300-3 and 1660-99.0) were applicable to the interlock.

The checklist is developed by first considering the general discussion of Safety Class Criteria contained in Section 1300-3. Each paragraph in that section is examined for applicability to this design; if it is found not to be applicable, the basis for that determination is noted. If the requirements of the paragraph are applicable to the flammable gas interlock, a consideration of how those requirements are addressed by the interlock design follows.

From the general safety class requirements of Section 1300-3 the check list moves to the more specific requirements of Section 1660-99.0, "Nonreactor Nuclear Facilities." Again, the same format as above is applied; each paragraph is addressed for applicability, followed by a discussion. This document begins with a description of the interlock.

2.0 Design Description

The interlock is intended to be a stand alone component used in conjunction with the RMCS exhauster. It meets the criteria found in Reference 1. It is expected to be employed only when RMCS exhausters are used on flammable gas tanks. The interlock terminates electrical power to the RMCS exhauster when hydrogen concentration in the exhaust stream exceeds 6250 parts per million (ppm). The basis for selecting 6250 ppm may be found in Reference 2. Electrical power to the exhauster is also terminated when the rate-of-rise of hydrogen concentration exceeds a predetermined value; the value to be provided by the Safety Analysis group.

The RMCS exhauster has four components that are not classified for use in potentially flammable atmospheres; the heater, the alpha and beta continuous air monitors (CAMs), and the fan/motor assembly. When electrically energized

each of these represent a potential ignition source in a flammable airstream. De-energizing them will eliminate the potential ignition sources.

There is an interface between the core sampling truck and the exhauster. When the power is lost to the exhauster a normally closed relay opens. This signals the truck internal controller that the exhauster has shut down. A pre-programmed shut down sequence then begins; the result being that shutting down the exhauster will shut down the complete RMCS system.

The interlock consists of five primary components; a spool piece to obtain gas samples from the exhaust stream, two identical pump/detector/electronic packages, and two identical power shut off contactors. It is powered by a source external to the exhauster. If power is lost to the interlock, or if flow within either sample loops falls below a preset level, the interlock will shut down the exhauster.

The flexible duct from the waste tank is attached to the spool piece which bolts directly to the exhauster heater. The ventilation stream passes through the spool piece and into the exhauster. Within the spool piece are two transverse sample locations. Exhaust stream samples are drawn from each location by separate vacuum pumps. Each vacuum pump, detector cell and electronics package is contained within a separate weather proof enclosure. Both sample streams are then pumped to separate hydrogen detector cells.

3.0 Section 1300-3, Safety Class Criteria

This section provides the general criteria for safety class facility components, systems and structures.

Paragraph 3.1: General. This paragraph outlines the general requirements for safety class items. It states that the standards of design, fabrication, testing, quality, and installation must be commensurate with the potential consequences of failing to prevent the design basis accident.

Application: This document will demonstrate that the flammable gas interlock meets the general requirements of this paragraph.

Paragraph 3.2: Safety Class Items. This paragraph defines safety class items. The paragraph also states that safety class items should be subject to appropriately higher-quality design, fabrication, and test standards. It also states that safety class items shall comply with DOE 6430.1a, Section 1040, Quality Assurance.

Application: The function of the flammable gas interlock has undergone a safety class evaluation as outlined in Chapter 9 (Safety Classification of Structures, Systems, and Components) of WHC-CM-4-46, *Safety Analysis Manual*. It was determined that

its failure could adversely effect the safety and health of the public. The interlock is a safety class item as defined by paragraph 3.2.

Paragraph 3.3: This paragraph outlines the design attributes that will insure that a single failure does not result in the loss of capability of a safety class component to accomplish its required safety function. A single failure is defined as:

"An occurrence that results in the loss of capability of a component to perform its intended safety function. Systems are considered to be designed against an assumed single failure if neither (1) a single failure of any active component (assuming passive components function properly) nor, (2) a single failure of any passive component (assuming active components function properly) results in a loss of the system's capability to perform its safety function".

The paragraph also states that to protect against single failure the design shall include appropriate redundancy and shall consider diversity to minimize the possibility of common-mode failures of redundant items.

Application: This paragraph is applicable. The interlock is a redundant design; two identical, separate pump/sensor/electronic assemblies are used. Common-mode failures are addressed by field calibration of each assembly prior to installation on a tank and operator checks when in use.

The interlock fails in the "alarmed" mode. Typical failure points would include the electronic packages, vacuum pumps, or a loss of electrical power. A failure of any one of these components would result in a shut down of the interlock, the exhauster and eventually the core sampling truck.

Paragraph 3.4: This paragraph identifies equipment environmental considerations. It is further divided into three subsections.

Subsection 3.4.1: General. This subsection states that safety class items shall be designed to be compatible with the environmental conditions associated with operation, maintenance and testing. It further states that the environmental capability shall be demonstrated by appropriate testing, analysis, operating experience, or other methods that can be supported by auditable documentation. A combination of the above methods may also be used.

Application: This paragraph is applicable to the interlock. The interlock design uses components with known operational histories. For example, the detection cells are used in the standard hydrogen monitoring systems (SHMS) applications and equipment enclosures have many similar applications on the Hanford Site.

Subsection 3.4.2: Environmental Qualification of Equipment. This subsection states that equipment shall have environmental qualification to demonstrate performance capability under DBA conditions.

Application: This paragraph does not apply to the interlock. There is no DBA which it has to survive. The interlock function is to prevent a DBA, not provide warning after. The interlock is internally qualified for the tank headspace vapors and externally qualified for the tank farm ambient environment.

Subsection 3.4.3: Equipment Operability Qualification. This subsection discusses testing and analysis to be performed on the safety class item for design basis earthquake (DBE) qualification.

Application: This paragraph does not apply to the interlock. As portable equipment the RMCS exhaustor does not have a DBE. The interlock, when used, is fixed to the exhaustor. There is no DBE for the interlock. Seismic qualification is not applicable to a temporary piece of equipment (the exhaustor, rotary mode core sampling truck, etc.). Functionally, the interlock would not be required following a seismic event.

Paragraph 3.5: Maintenance. This paragraph states the general criteria for maintenance of safety class items. It states that design shall provide for routine maintenance, repair, or replacement of the item. The design shall also include features to minimize self contamination.

Application: This paragraph is applicable to the interlock. The interlock enclosure is located outside of the contaminated airstream. Contaminated air passes through ultra high efficiency filters prior to the monitoring instruments. The airstream is then returned to the exhaustor. This arrangement is typical of the SHMS installations used throughout tank farms. During maintenance it is intended to replace an entire pump/monitor/electronic enclosure rather than repair in-situ. Calibration of hydrogen cells can be accomplished without opening the enclosure.

Paragraph 3.6: Testing. This paragraph states that the design shall include provisions for testing.

Application: This paragraph is applicable to the interlock. The interlock is initially calibrated in a laboratory setting. The calibration is field verified after installation on a tank and before use. The design also allows in-place (without disconnect from the exhaustor) calibration checking and functional testing.

4.0 Section 1660-99 Special Facilities

1660-99.0 Nonreactor Nuclear Facilities - General

1660-99.0.1 Safety Class (Emergency) Electrical Systems

This paragraph identifies the basic approach (IEEE 308) and the need for emergency power for those items that perform a safety function. It also states that the design should be provided with suitable redundancy and separation to insure adequate capability exists with the addition of a single failure. IEEE 379 and IEEE 384 are to be used for redundancy and separation criteria. It also states that the connection of non safety class loads to safety class buses shall be minimized. The equipment shall also meet the environmental qualifications of Section 1330-3.4. Again there is a requirement for demonstration of functionality after a DBE. The capability to periodically test the system is required.

Application: This paragraph presents no different requirements than those of Section 1300-3. The paragraph is applicable to the interlock with the same exceptions as noted earlier; i.e., the interlock has no DBE. As the interlock will also indicate an alarm condition (shut down exhaustor) on loss of electric power, an uninterrupted power supply (UPS) is not required.

1660-99.0.2 Protection System and Instrumentation and Controls

This paragraph defines protection systems and instrumentation and controls and the automatic actions they must take to ensure specific design limits are not exceeded as a result of anticipated operational occurrences. These systems should also provide audible and visual indication of system status. The paragraph also requires automatic protective actions to be provided with a manually initiated backup.

Application: This paragraph adds two new requirements to those presented in Section 1300-3; manual back up for the automatic protective action and audible and visual indications of system status.

The interlock has a manual back up for the automatic exhauster shutdown. Output from the hydrogen detector cell is sent to the data logger already in place on the exhauster. The data logger will continuously record hydrogen levels (in ppm) in the exhaust stream. If the shutdown level (6250 ppm) is reached and the interlock does not terminate exhauster operations, the exhauster general alarm beacon will go on and operators will manually shut the exhauster down.

The interlock has a power status indicator light for each sampling pump/detector cell assembly. The light will remain on while the interlock is operational. If the interlock becomes inoperable, the exhauster will shutdown which activates an audible alarm on the core sampling truck just before RMCS system shutdown.

1660-99.0.3 Qualification

This paragraph states that protection systems and safety class instrumentation and control equipment shall be qualified to the requirements of Section 1300-3.4.

Application: Discussion of Section 1300-3.4 is presented above.

1660-99.0.4 Separation and Physical Separation

This paragraph states that safety class systems shall be physically protected or separated to prevent a common external event or failure of one channel from causing a failure in the redundant channel.

Application: This is applicable to the exhauster but it adds no new requirements to those of paragraph 1300-3.3.

1660-99.0.5 Test and Calibration

This paragraph states that the design shall include provisions for testing.

Application: This is applicable to the exhauster but it adds no new requirements to those of paragraph 1300-3.6.

1660-99.0.6 Power Sources

This paragraph states that an analysis shall be made to determine power requirements for a safe shutdown of the process. It also states that a safety class electric power system shall be provided unless adequate system performance, including safe shutdown, can be demonstrated when only conventional power sources are used.

Application: The safe shutdown in this instance is deenergizing the exhauster if hydrogen concentration in the exhaust stream exceeds 6250 ppm. The interlock is designed so that a power outage will also shutdown the exhauster. No analysis is needed to determine power requirements for a safe shutdown (the system is deenergized).

5.0 References

1. WHC-SD-WM-FDC-045, Rev. 0, Functional Design Criteria, Flammable Gas Detection and Shutdown System, J. E. Dunks, Westinghouse Hanford Company, Richland, Washington.
2. WHC-SD-WM-TI-691, Rev. 0, Strategy for Resolution of the Flammable Gas Safety Issue, G. D. Johnson, Westinghouse Hanford Company, Richland, Washington.
3. WHC-CM-4-46, Safety Analysis Manual, Section 9.0, Rev. 0, Safety Classification of Systems, Components and Structures, Westinghouse Hanford Company, Richland, Washington.
4. Institute of Electrical and Electronics Engineers, 345 East 47th Street, New York, New York 10017. The following:
 1. IEEE 308, Standard Criteria for Class 1E Power System for Nuclear Power Generating Stations.
 2. IEEE 379, Standard Application of the Single Failure Criterion to Nuclear Power Generating Station Class 1E Systems.
 3. IEEE 384, Standard Criteria for Independence of Class 1E Equipment and Circuits.