COMPLETE

ENGINEERING CHANGE NOTICE

Page 1 of 2

1. ECN No 623518

Proj. ECN

2. ECN Category (mark one)	3. Originator's Name, Organization, MSIN, and Telephone No.	3a. USQ Required?	4. Date
Supplemental [] Direct Revision [x] Change ECN [] Temporary [] Standby [] Supersedure [] Cancel/Void []	C. C. Scaief III ISI/74430 S2-02 376-0491	[] Yes [X] No	1-22-96
	5. Project Title/No./Work Order No.	6. Bldg./Sys./Fac. No.	7. Approval Designator
	Flammable Gas/N2162	200-G	N/A
	8. Document Numbers Changed by this ECN (includes sheet no. and rev.)	9. Related ECN No(s).	10. Related PO No.
	WHC-SD-WM-ES-362, Rev 0	None	N/A

11a. Modification Work	11b. Work Package No.	11c. Modification Work Complete	11d. Restored to Original Condition (Temp. or Standby ECN only)
[] Yes (fill out Blk. 11b) [X] No (NA Blks. 11b, 11c, 11d)	N/A	N/A Cog. Engineer Signature & Date	N/A Cog. Engineer Signature & Date

12. Description of Change

This ECN revises the document to include recommendations and additional detail.

13a. Justification (mark one)

Criteria Change	[]	Design Improvement	[X]	Environmental	[]	Facility Deactivation	[]
As-Found	[]	Facilitate Const	[]	Const. Error/Omission	[]	Design Error/Omission	[]

13b. Justification Details

The change is necessary to direct resolution of ignition sources.

14. Distribution (include name, MSIN, and no. of copies)

See distribution sheet.

RELEASE STAMP

DATE: JAN 30 1996

STA: 4

HANFORD RELEASE

ID: 2

A-7900-013-2 (11/94) GEF095

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15. Design Verification Required	16. Cost Impact				17. Schedule Impact (days)	
	ENGINEERING		CONSTRUCTION			
[] Yes	Additional	[] $	Additional	[] $	Improvement	[]
[X] No	Savings	[] $	Savings	[] $	Delay	[]

18. Change Impact Review: Indicate the related documents (other than the engineering documents identified on Side 1) that will be affected by the change described in Block 12. Enter the affected document number in Block 19.

SDD/DD	[]	Seismic/Stress Analysis	[]	Tank Calibration Manual	[]
Functional Design Criteria	[]	Stress/Design Report	[]	Health Physics Procedure	[]
Operating Specification	[]	Interface Control Drawing	[]	Spares Multiple Unit Listing	[]
Criticality Specification	[]	Calibration Procedure	[]	Test Procedures/Specification	[]
Conceptual Design Report	[]	Installation Procedure	[]	Component Index	[]
Equipment Spec.	[]	Maintenance Procedure	[]	ASME Coded Item	[]
Const. Spec.	[]	Engineering Procedure	[]	Human Factor Consideration	[]
Procurement Spec.	[]	Operating Instruction	[]	Computer Software	[]
Vendor Information	[]	Operating Procedure	[]	Electric Circuit Schedule	[]
OM Manual	[]	Operational Safety Requirement	[]	ICRS Procedure	[]
FSAR/SAR	[]	IEFD Drawing	[]	Process Control Manual/Plan	[]
Safety Equipment List	[]	Cell Arrangement Drawing	[]	Process Flow Chart	[]
Radiation Work Permit	[]	Essential Material Specification	[]	Purchase Requisition	[]
Environmental Impact Statement	[]	Fac. Proc. Samp. Schedule	[]	Tickler File	[]
Environmental Report	[]	Inspection Plan	[]	None	[X]
Environmental Permit	[]	Inventory Adjustment Request	[]		[]

19. Other Affected Documents: (NOTE: Documents listed below will not be revised by this ECN.) Signatures below indicate that the signing organization has been notified of other affected documents listed below.

Document Number/Revision	Document Number/Revision	Document Number Revision

20. Approvals

Signature	Date	Signature	Date
OPERATIONS AND ENGINEERING		ARCHITECT-ENGINEER	
Cog. Eng. CC Scaief III — C.C. Scaief III	1-29-96	PE	
Cog. Mgr. TL Moore — J L Moore	1-29-96	QA	
QA		Safety	
Safety		Design	
Environ.		Environ.	
Other SH Rifaey		Other	
WTF RE Larson — R E Larson	1/25/96		
S. Rifaey — S. Rifaey	1/26/96		
		DEPARTMENT OF ENERGY	
		Signature or a Control Number that tracks the Approval Signature	
		ADDITIONAL	

TANK FARM POTENTIAL IGNITION SOURCES

C. C. Scaief III
Westinghouse Hanford Company, Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-87RL10930

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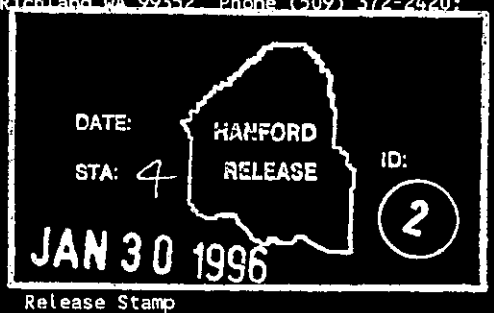
Key Words: flammable gas, ignition, tank, instrumentation

Abstract: This document identifies equipment, instrumentation, and sensors that are located in-tank as well as ex-tank in areas that may have communication paths with the tank vapor space. For each item, an attempt is made to identify the potential for ignition of flammable vapors using a graded approach. The scope includes all 177 underground storage tanks.



Release Approval — Date: 1/30/96

Release Stamp

Approved for Public Release

RECORD OF REVISION	(1) Document Number WHC-SD-WM-ES-362	Page 1 of 1

(2) Title
Tank Farm Potential Ignition Sources

CHANGE CONTROL RECORD

(3) Revision	(4) Description of Change - Replace, Add, and Delete Pages	Authorized for Release	
		(5) Cog. Engr.	(6) Cog. Mgr. Date
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1 RS	Revised per ECN 623518. This revision replaces Revision 0.	CC Scaief III CC Scaief III 1/9/96	TL Moore TL Moore 1/9/96

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1.0 INTRODUCTION

This report provides an assessment of the flammable gas ignition capability from both in-tank and ex-tank electrical equipment and instrumentation for all 177 underground waste storage tanks at the Hanford Nuclear Reservation. A previous study (WHC 1991a) provided a similar analysis for selected tanks. The methodology and calculations from this previous study are used extensively since much of the equipment is the same. Some new terms as well as a graded approach to the ignition potential have been added.

2.0 SUMMARY AND CONCLUSIONS

This assessment attempts to identify the ignition potential for electrical and other equipment in or in communication with the waste tanks. This information, coupled with the potential for the presence of flammable atmospheres can then be used to determine the risk, if any, associated with continued operation. For all identified equipment recommendations are made based on tank classification and work activities. Appendix A provides flow charts for determining the risk and ultimate resolution of unsafe conditions.

The high level detector and the pump pit leak detector employed in double shell tanks (DST) as well as some components associated with the ventilation systems were determined to have a High (see Section 3.0) capability for ignition. The high level detectors for DST flammable Watch List tanks and for Tank AW-104 have been disconnected. The high level detector in Tank AY-101 has been scheduled for disconnection. The camera system in Tank AN-107 also has a high capability for ignition, however, this tank has not been identified as having potential for generating significant flammable gas.

Both the rotary mode core sampler exhauster and the salt well pumping system have components with High capability for ignition. Designs are in progress to make these systems suitable for use in Hazardous areas. In addition, the waste tank main transfer pumps are considered to have a Medium capability for ignition. The remaining equipment has ignition capability ranging from Low to None.

3.0 TERMS AND METHODOLOGY

This assessment identifies equipment, instrumentation, and sensors that are located in-tank as well as ex-tank in areas that may have communication paths with the tank vapor space. For each item, an attempt is made to identify the potential for ignition of flammable vapors using a graded approach. This ignition potential is based on the generation of sparks (with sufficient energy) or high surface temperature by the examined equipment in the presence of hydrogen in its most easily ignitable concentration. The ignition potential does not establish the overall risk since hydrogen may or may not be present.

In addition to identifying the potential for ignition in the presence of flammable atmospheres, recommendations for redesign or limits of operation are included for each type of equipment. In some cases additional information is required to make this determination. These recommendations are based on the tank classification and work activity status. The tank

classifications (WHC 1995c) are based on the tank's potential for achieving a percentage of the Lower Flammable Limit (LFL) as follows:

Potential LFL	Level	Controls, and Monitoring
PLFL $\geq$ 25%	A	Work controls and continuous monitoring required.
PLFL $<$ 25%	B	Work controls and monitoring during Waste Intrusive work.

These potential LFLs are based on both steady state gas generation as well as the capability for an Episodic Gas Release (EGR). Work activities that are Waste Intrusive (WHC 1995e) place additional recommendations on some equipment. Section 4.0 includes a recommendation for each type of equipment based on the above levels and work activity. The recommendations may or may not be easily achieved depending on the degree of difficulty associated with shutdown or replacement of the equipment. When this occurs, additional assessments are necessary in order to determine the appropriate action. Appendix A contains logic flow diagrams detailing the process of evaluating the risk posed by ignition sources based on the above potential flammability categories and the performance of Waste Intrusive work.

It is important to note that this assessment does not examine the installed equipment for compliance with the National Electrical Code (NEC) for Hazardous (Classified) locations (NFPA 1993). The criteria for NEC compliance within a location that has been determined to be Class I, Division 1 or Division 2 are most stringent. Some equipment installed within the last few years has been designed for code compliance and is so noted in the assessment. Most equipment installations occurring prior to concerns regarding flammable vapors or within areas previously assumed to be free of such vapors may not meet the requirements of the NEC for Division 1 or Division 2 locations.

Requirements for Division 1 locations for wiring methods include rigid metal conduit, explosion proof conduit fittings, and conduit seals. Electrical equipment must be in explosion proof enclosures or must be continuously purged with air. Alternately, equipment that is approved as "intrinsically safe" (UL 1988) does not require special enclosures. Intrinsically safe circuits have insufficient energy to ignite the flammable mixture. The intrinsically safe designation includes the consideration of double fault conditions as well as opening, shorting, and grounding of field wiring. See WHC 1991a for a more complete discussion.

Requirements for Division 2 locations are less stringent. Explosion proof enclosures are not required for "nonincendive" circuits. Nonincendive is similar to intrinsically safe except that consideration of fault conditions are excluded, however, opening, shorting, and grounding of field wiring must be considered. Some relays, switches, and other contact type devices which use low energy can be considered nonincendive even though they generate sparks during normal operation. Induction motors can be used in Division 2 locations provided any associated resistance devices, switching mechanisms, or sliding contacts are approved for

Division 1 locations. Wiring methods for Division 2 locations include threaded metal conduit or Type MI cable with approved termination fittings. Conduit seals are required in some instances. It is important to note that even though equipment that may be suitable for Division 2 locations is employed, the wiring methods used for installation must also comply with the NEC.

For purposes of this assessment the following five graded levels of ignition capability are defined:

Ignition Capability	Description
None	Meets the requirements of the NEC for Class I, Division 1, Group B locations and is approved for use by UL, FM, or by WHC formal design verification.
Very Low	Analysis indicates multiple failures would probably be required to generate sufficient energy for ignition. This equipment may meet requirements for intrinsically safe (Class I, Division 1, Group B) but is untested and not formally approved for such use.
Low	Analysis indicates at least a single failure would probably be required and involves low energy and low voltages. Would probably meet the requirements for nonincendive (Class I, Division 2, group B).
Moderate	Would probably require at least a single failure but has significant energy. May meet requirements for nonincendive (Class I, Division 2) but field wiring may present an additional ignition potential.
High	Produces a spark of sufficient energy or high temperature under normal operating conditions that includes opening, shorting, and grounding of field wiring. Would not meet requirements for nonincendive (Class I, Division 2, Group B).

The NEC provides a code for electrical construction but does not address operational considerations. As such, there may be other methods for achieving the required degree of safety. One such method, suggested by Peter Schram (Schram 1995) is to monitor for the presence of flammable gas and automatically disconnect electrical circuits in the event its presence is detected. This practice is reportedly employed in the mining and petrochemical industries. Using this technique, it is expected that levels of Low to Very Low ignition capability could be achieved provided response time is sufficient to shut down the equipment before a flammable atmosphere is achieved at the equipment location.

To date, Tank Waste Remediation System (TWRS) Industrial Health and Safety has not classified any tanks or associated areas as Class I, Division 1. The vapor space of Tank SY-101 has been classified as Class I, Division 2. TWRS Safety has, however, recommended that new designs for flammable gas watch list tanks comply as closely as practical to the NEC requirements for Class I, Division 2. These recommendations are contained in WHC-SD-WM-HC-014 (draft).

4.0 DISCUSSION

The appendix provides a table listing instruments, sensors, and electrical equipment for each of the 177 underground storage tanks. A distinction is made between in-tank and ex-tank equipment. The ex-tank equipment has been included when its atmosphere is thought to be in communication with the tank vapor space. This list is thought to contain all standard common types of equipment but may not contain equipment deployed for limited use or for special purposes. In addition to equipment installed on a tank-by-tank basis, other equipment such as ventilation systems is associated with a farm or group of tanks. The table uses shading to indicate equipment in the Moderate or High capability level.

4.1 IN-TANK EQUIPMENT

In-Tank Temperature Sensors

In-tank temperature sensors are either thermocouples (TC) or Resistance Temperature Detectors (RTD). The measuring circuits for TCs and RTDs generally use voltages and currents well below those required for ignition of hydrogen should the field wiring open or short. It is therefore concluded that these devices have very low capability for ignition. Although there are several temperature tree basic designs as well as variations in use, all are thought to enclose the temperature element within a pipe. As such they are isolated from the tank waste and vapor space and should pose no hazard.

Recommendations: Because the temperature sensors pose no hazard, no changes or restrictions are recommended for any tank classification or work status.

Enraf Level Gauge

The Enraf 854 Automatic Tank Gauge (ATG) is designed and approved by Factory Mutual (FM) for use in Class I, Division 1, Groups B (H_2), C, and D locations. The parts of the gauge exposed to the tank vapor (displacer, wire, and drum) contain no electrical components and are isolated from the electronics housing. The drum torque is magnetically coupled to the motor in the electronics housing. It therefore has no capability for ignition on the tank vapor side. The electronics and motor housing is approved as explosion proof when installed in accordance with the NEC for Hazardous locations (conduit seals, etc.). Enraf gauges on the flammable gas tanks were installed in this manner. This area is in free air and would not be considered Hazardous except possibly when the riser is open.

Recommendations: Because the Enraf level gauge poses no hazard, no changes or restrictions are recommended for any tank classification or work status.

Food Instrument Company (FIC) Level Gauge

The FIC gauge uses electrical conductivity for detecting the waste level, however, the sensing circuit has current limiting resistors and is analyzed in WHC 1991a. The gauges have very low capability for ignition.

Recommendations: Because the FIC level gauge poses a very low hazard, no changes or restrictions are recommended for any tank classification or work status.

Manual Tape

Some tanks have metal tapes that are used for electrical sensing of the level. They are periodically used in conjunction with a portable ohm meter to manually sense the level. This technique has been analyzed in WHC 1991a and has very low capability for ignition.

Recommendations: Because the manual tape poses a very low hazard, no changes or restrictions are recommended for any tank classification or work status.

High Level Detector

The high level detector uses the same electronic circuitry as the leak detector (Section 5.2.5 of WHC 1991a). This device has a high capability for ignition as discussed in the reference. A spark would occur if moisture or condensation shorted the probe contacts or if the field wiring shorted. This would also occur in a high level event. WHC 1991a reports that this probe was disconnected in Tanks AN-103, -104, and -105 (Watch List). The detector for Tank AW-101 (subsequently added to the Watch List) and Tank AW-104, has also been disconnected.

Recommendations: Level A: Because the high level detector is located within the dome space and it has a high capability for ignition, it should either be disconnected or replaced with an intrinsically safe unit.

Level B: For Waste Intrusive work, identify in the work package.

Standard Hydrogen Monitoring System (SHMS)

The SHMS (H-2-87275) was designed for use in tanks with flammable atmospheres and has been approved by a formal design verification process for such use. It therefore has no capability for ignition.

Recommendations: Because the SHMS poses no hazard, no changes or restrictions are recommended for any tank classification or work status.

Pressure Transmitter

All Double Shell and some Single Shell Tanks (SST) have differential pressure transmitters for monitoring of the tank vapor pressure relative to atmosphere. All DSTs with the exception of AP Farm use pneumatic pressure transmitters. These devices are intrinsically safe since they use no electrical power and therefore have no capability for ignition. The transmitters at AP Farm are electronic, however, the electronics are not in direct contact with the process vapor. It is possible that a failure of the electronics could produce a spark. These devices are considered to have a low capability for ignition. The pressure transmitters for AP Farm are coupled to the tank vapor space via a 1/2 inch copper tube that is purged with instrument air. It is unlikely that even if the dome space achieved the LFL for short periods of time that the pressure transmitter sense lines would also reach LFL. In addition, this would have to be coupled with a failure of the isolating diaphragm and the electronics to produce a spark in contact with the ignitable vapor.

Recommendations: Because the pneumatic pressure transmitter poses no hazard, no changes or restrictions are recommended for any tank classification or work status.

Because the electronic transmitter has a low capability for ignition and the location and configuration make the presence of flammable vapor very unlikely, no changes or restrictions are recommended for any tank classification or work status.

Camera

Several of the tanks have remote viewing capability using a video camera with pan/tilt capability and lighting. The systems that have been installed with the exception of AN-107 are designed for use in Class I, Division 1 locations (gas purging) and therefore have no capability for ignition. The system in AN-107 does not have purging for the camera and associated pan/tilt motors and it does not use explosion proof rated lights. The lights use a sealed beam unit and the maximum external temperature is not expected to exceed 550 °F. The pan/tilt dc motors which have brushes are considered incendive devices. The camera system in AN-107 is therefore considered to have a high capability for ignition.

Recommendations: If Tank AN-107 becomes a Level A tank, the camera system should be replaced with equipment qualified for use in a Hazardous environment.

Level B: For Waste Intrusive work, the equipment should be identified in the work package.

Mixer Pump

Both AN-107 and SY-101 have mixer pumps installed. The SY-101 mixer pump was analyzed by formal design verification and has been determined to have no capability for ignition. Additional investigation is required for AN-107.

Recommendations: For Level A additional examination of the pump is required.

4.2 EX-TANK EQUIPMENT

Transfer Pumps

Most DSTs have transfer pump motors located in the central pump pit. Although SSTs also have transfer pumps, they are no longer used. The motor for these pumps is a three-phase induction type and is discussed in WHC 1991a. When operating as designed they do not spark or generate high temperatures, however, there are failure modes that would provide sufficient energy for ignition. In addition, there is uncertainty regarding the use of thermal over load switches within the motor housing. A three phase induction motor can may be used in a Class I, Division 2 location provided no starter circuits or overload circuits are used (unless in explosion proof enclosures or are intrinsically safe). As discussed previously, the wiring must also meet certain requirements. When used without the overload switch, the pumps have a low to moderate capability for ignition.

Recommendations: Level A: The pump starter circuits should be examined to determine whether a thermal overload contact (within the motor housing) is used to shutdown the motor. If it is, it should be removed from the circuit (provided overload heaters are used in the starter relay) or the switch contact should be made intrinsically safe using an isolating relay. Alternately the pump should not be used. No additional changes or work restrictions are recommended.

Level B: For Waste Intrusive work the equipment should be identified in the work package.

Pump Pit Leak Detector

The leak detection probe and associated electronics have been analyzed by WHC 1991a and like the high level detector it has a high capability for ignition. As shown in the table, all DST central pump pits have a leak detector. The leak detectors in SST pump pits have been disconnected and isolated according to Waste Tank Farm Plant Engineering. The leak detector in the Tank SY-101 pump pit has been modified to an intrinsically safe design.

Recommendations: Level A: The leak detectors should either be deactivated or modified by replacing the induction relay with a unit designed to make the remote (within the pit) contacts intrinsically safe.

Level B: For Waste Intrusive work, identify in the work package.

Salt Well Pumping System

The Department of Energy (DOE) has directed that salt well pumping of tanks with PLFL < 25% (Level B) shall have continuous monitoring with automatic shutdown on detection of

hydrogen. In addition, salt well pumping systems for use on Level A tanks will be designed for use in Class I, Division 2, Group B locations.

The salt well pumping system utilizes a jet pump and associated controls. The jet pump is powered by a three phase 480 volt induction motor. The motor has a bimetallic thermal over temperature switch mounted in contact with the stator windings, however, its use is optional as it must be wired in series with the starter holding coil. The elementary diagrams do not indicate the use of this overload switch. Overload protection is, however, included within the motor starter circuitry (located remotely). The motor therefore poses a low to moderate ignition capability.

Recommendations: Level A: The motor should either not use the thermal overload circuit or the circuit should be made intrinsically safe.

Level B: For Waste Intrusive work, the equipment should be identified in the work package.

The jumper assembly contains two valve position limit switches and two pressure switches. These are electromechanical and are used to switch currents to 120 VAC inductive loads - relays and a solenoid valve. These devices and their associated circuits are considered incendive and have a high capability for ignition. See WHC 1991a, Section 5.2.7.

Recommendations: Level A: These devices should be made intrinsically safe by installing intrinsically safe repeater relays.

Level B: For Waste Intrusive work the equipment should be identified in the work package.

A pressure transducer is also used on some of the jumpers. It uses a 10 volt excitation and has a millivolt output. Maximum excitation current is six ma. This device is considered non incendive and has a low capability for ignition.

Recommendations: No changes or restrictions for any tank classification or work status.

A Brooks Instrument Model 7485 magnetic flowmeter with the Complete Remote Electronics (CRE) option is used on the jumper assembly. The flow transmitter and the CRE are FM approved and CSA certified for use in Class I, Division 2, Groups A, B, C, and D locations. It therefore has a low capability for ignition.

Recommendations: No changes or restrictions for any tank classification or work status.

Each pit contains a leak detector which has been determined to have a high capability for ignition.

Recommendations: Same as the pump pit leak detector above.

Some pits have heat trace and strip heaters for freeze protection. Chromalox heat traces are rated for Class I, Division 2 use, however, each installation would have to be examined individually for the presence and type of heat trace material used. In general this would probably be considered to have a low capability for ignition. The strip heaters would presumably have a locally mounted thermostat for on/off control. The thermostat has a high capability for ignition.

Recommendations: Level A: The heaters and heat trace should not be used if controlling thermostats with electromechanical switches are located within the pits. Alternately, the controlling circuits should be redesigned and modified to be safe.

Level B: For Waste Intrusive work the equipment should be identified in the work package.

Tank Farm Primary Ventilation Systems

All double shell tanks and selected single shell tanks have ventilation systems for cooling and contamination control. The system for SY Farm has recently been replaced with a new system that has been reviewed against the requirements for Class I, Division 2, Group B as outlined in WHC 1995a.

The other farm ventilation systems typically have components such as fan motors and blowers, motor operated dampers, pressure and flow instrumentation, pressure switches, heaters, and temperature sensors. The only components located in the air stream are the blower, temperature sensors, and heaters. Differential pressure gauges and switches are coupled via sensing lines to the air steam. The actual type of instruments used and their location would have to be examined for each system. An examination of the drawings for AN Farm revealed that the differential pressure switches are manufactured by Dwyer (Series 43000) and are located on a rack a few feet from the duct and are coupled via 1/4" copper lines and fittings. The pressure switches control 120 VAC circuits and these switch contacts are considered to have a high capability for ignition. At least one side of the differential pressure is isolated via the diaphragm used to activate the switch, however, it is unclear whether both sides are isolated. The diaphragm sensing of the pressure is static and therefore requires no vapor flow . This means that there would always be some diffusion time required before any flammable vapor could reach the diaphragm. It may not be credible that an LFL mixture could be obtained at the diaphragm by this process.

Recommendations: Level A: The pressure switches require additional analysis.

Level B: For Waste Intrusive work, the equipment should be identified in the work package.

Only one motor operated damper is used and it is controlled by a single phase 115 VAC motor. An examination of the drawings reveals that the motor is located outside the duct in a weatherproof enclosure. The motor has a high capability for ignition.

Recommendations: Although the damper motor has components capable of sparking, it is located outside the ventilation duct. No changes or restrictions are recommended for any tank level or work status.

Requirements for fans used for handling potentially flammable vapors are provided in Air Movement and Controls Association (AMCA) Standard 99-0401-86. The requirements dictate the use of non ferrous materials and isolation of bearings and drive components from the air stream. With the exception of SY Farm, the fans used in tank farm ventilation systems are not designed to meet the AMCA standard. As such, fans are considered to have a medium capability for ignition.

Recommendations: Level A: Additional examination of the nature of construction, the location of bearings, and the potential for LFL in the air steam is required.

Level B: For Waste Intrusive work, the equipment should be identified in the work package.

The temperature sensors have a very low capability for ignition as discussed previously.

Recommendations: No changes or restrictions for any tank classification or work status.

AY, AZ and SX Farms use steam heaters which will never reach 80% (774 °F) of the autoignition temperature (968 °F) of hydrogen. The remaining farms use an electric heater. The heaters are Indeeco horizontal flow, finned flange slip in type. The elements are U-bent and composed of high grade resistance wire in a copper plated steel sheath. Two types of thermal cut outs are employed. An automatic reset disk type is located in the heater flange on the leaving air side. A bulb temperature sensing type with contactor is also used. It appears from the Vendor Information (VI) data that the contactor for the bulb type is located in the NEMA 4 enclosure adjacent to the heaters. The back wall of the enclosure is exposed to the duct and the heating elements penetrate the enclosure wall.

It is unclear whether the heater sheath is adequately sealed from vapor intrusion and whether the wiring exiting the sheath (within the NEMA enclosure) is sealed. It is also not clear whether the element penetrations are sealed at the flange. The thermal cut outs have a high capability for ignition. No data could be found on the operating surface temperature of the sheath or on the resistance wire temperature. It must be assumed that these elements have a medium to high capability for ignition.

Recommendations: Level A: The heater circuits and the heating elements within the ventilation systems for Tank Farms AN, AP, and AW need additional examination to determine the expected surface temperature of the heater element. The heater over temperature circuits also need to be examined in more detail.

Level B: For Waste Intrusive work, the equipment should be identified in the work package.

Exhaust Monitoring Systems

The active primary ventilation systems are continuously monitored for radiation using particulate collection systems coupled with radiation detectors. Some systems monitor for beta and gamma emissions only while others additionally monitor for alpha particles. The systems vary somewhat in design but typically consist of sample probes within the exhaust duct for collection, sample flow monitoring, and continuous air monitors (CAM) for sample collection and detection. Both a record sample stream (collection filter only) and a monitor sample stream are employed. The system uses vacuum pumps for drawing the sample streams from the exhaust stack. Flow monitoring and totalizing use rotometers and a Rockwell MR-9 gas meter and pose no ignition hazard. The sample streams are exhausted to atmosphere external to the monitoring cabinet. Pressure switches are used to sense sample pump failure.

The pressure switches typically control 115 VAC for annunciation and as such have a high capability for ignition, however, the switch contacts are probably not in the sample stream as they are generally separated by an actuating diaphragm.

Recommendations: Level A: The pressure switches require additional analysis.

Level B: For Waste Intrusive work, the equipment should be identified in the work package.

The vacuum pump motor is typically an Eberline model RAP-1 and is powered by a single phase 115 VAC motor which has a high capability for ignition as discussed in Section 5.2.6 of WHC 1991. The motor, however, is not exposed to the sample stream. It would only become an ignition source if the instrumentation cabinet should become filled with an ignitible vapor. The vacuum pump is a carbon vane type and its ignition capability is unknown.

Recommendations: Level A: Additional information regarding the spark capability of a carbon vane vacuum pump is required.

Level B: For Waste Intrusive work, the equipment should be identified in the work package.

The radiation monitors are Eberline beta/gamma CAMs. The detector is a gas proportional type and the gas detection chamber is isolated from the sample stream by an aluminized mylar cover. In the event the mylar were to rupture, the sample stream would be exposed to the high voltage wire element. An additional failure of the wire would be required to achieve sparking. This arrangement is considered to have a low capability for ignition.

Recommendations: No changes or restrictions are recommended for any tank classification or work status.

Rotary Mode Core Sampler Exhauster

The Rotary Mode Core Sampler Exhauster is described in the System Design Description (WHC 1995b). The exhauster is presently being reviewed by others for its ignition capability. The system design changes required to bring it into compliance with Class I, Division 2 are also being investigated. The following items have been determined to be out of compliance with Division 2.

Pressure and Differential Pressure Gauges
Electric Heater
Relative Humidity Instrument
Fan Motor and Blower
Continuous Air Monitor

Some of this equipment causes the system to have a high capability for ignition.

Recommendations: This system is presently being redesigned by Characterization Equipment Design in an attempt to meet Class I, Division 1, Group B requirements. Provided this occurs, the system should be acceptable for all tank levels and work status.

5.0 REFERENCES

WHC 1991, *Hydrogen Ignition Capability of Tank Farm Instrumentation and Electrical Equipment*, WHC-SD-WM-ES-176, Westinghouse Hanford Company, Richland Washington.

WHC 1992, *Tank Farms Pumping Equipment List*, WHC-SD-WM-RPT-025, Westinghouse Hanford Company, Richland Washington.

WHC 1995a, *Safety Review and Evaluation - SY Farm Exhauster*, TF-94-0330, Westinghouse Hanford Company, Richland Washington.

WHC 1995b, *System Design Description for the Rotary Mode Core Sampling Exhauster*, WHC-SD-WM-SDD-035, Westinghouse Hanford Company, Richland Washington.

WHC 1995c, *Methodology for Flammable Gas Evaluation*, WHC-SD-WM-TI-724, Westinghouse Hanford Company, Richland Washington.

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WHC 1995e, *Operating Specifications for the 241-AN, AP, AW, AY, AZ, and SY Tank Farms*, OSD-T-151-00007, Westinghouse Hanford Company, Richland Washington.

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Schram 1995, *Consultation Meeting at Hanford*, Peter J. Schram, formerly Chief Electrical Engineer for NFPA.

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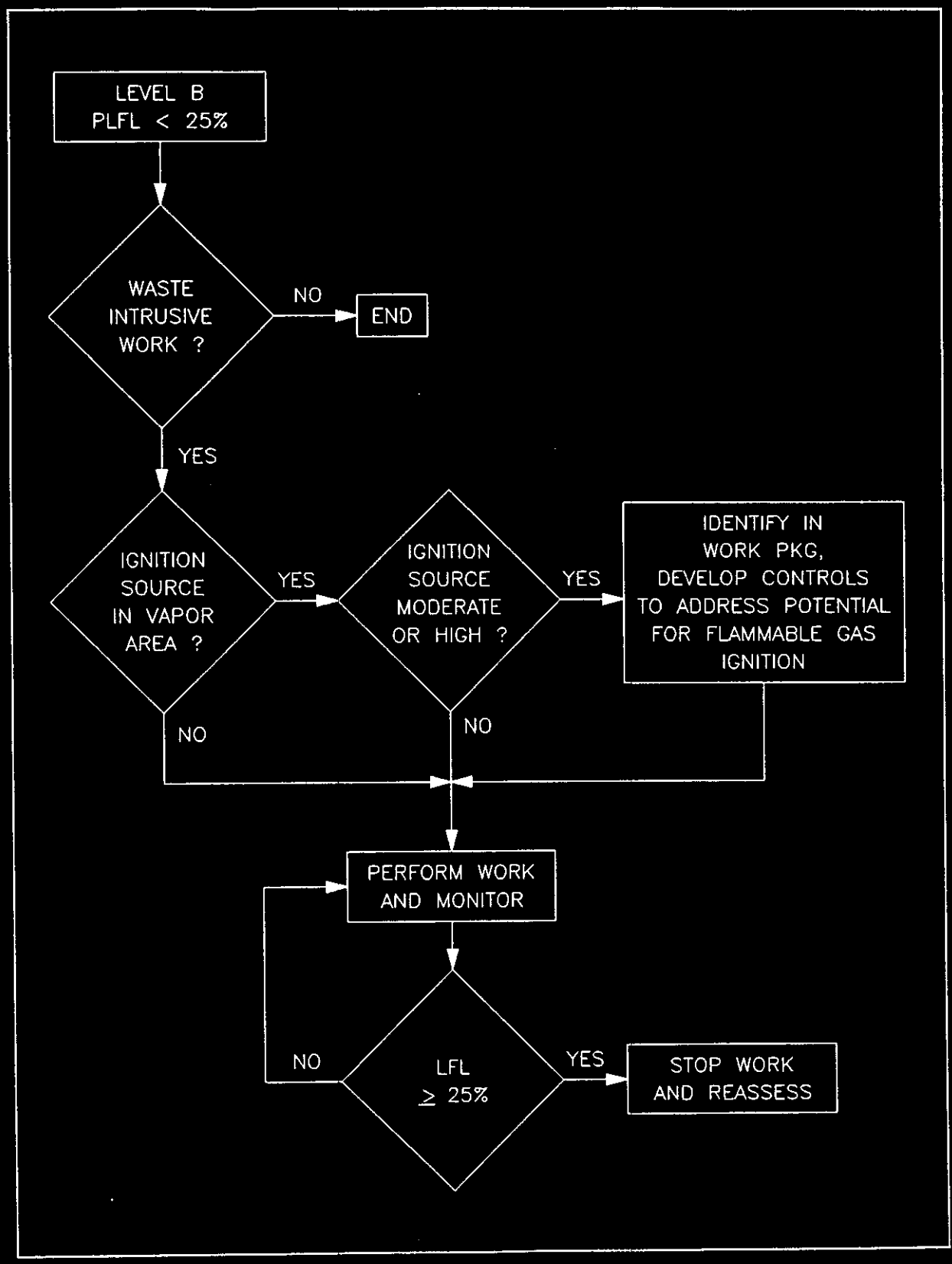
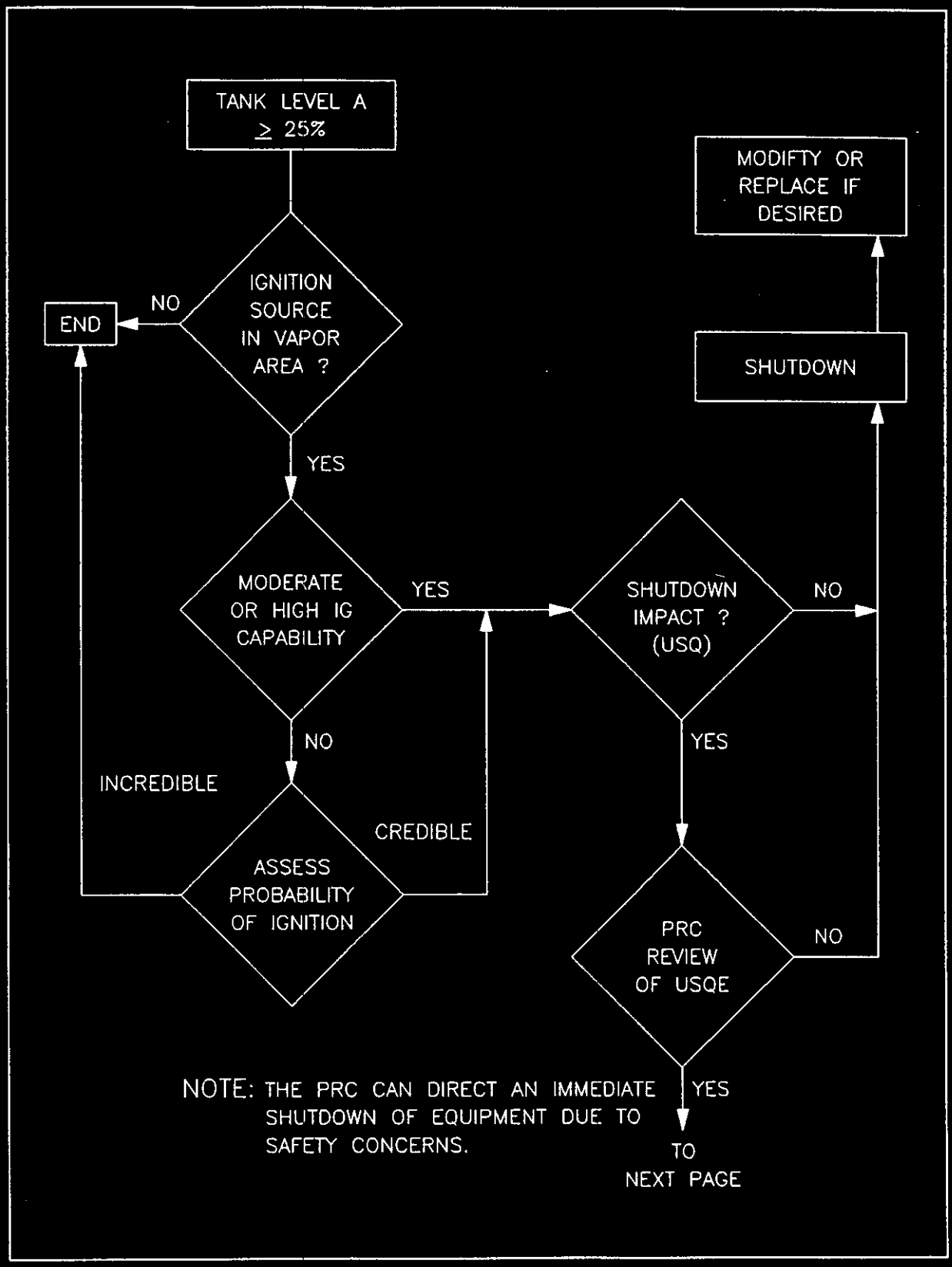
6.0 APPENDICES

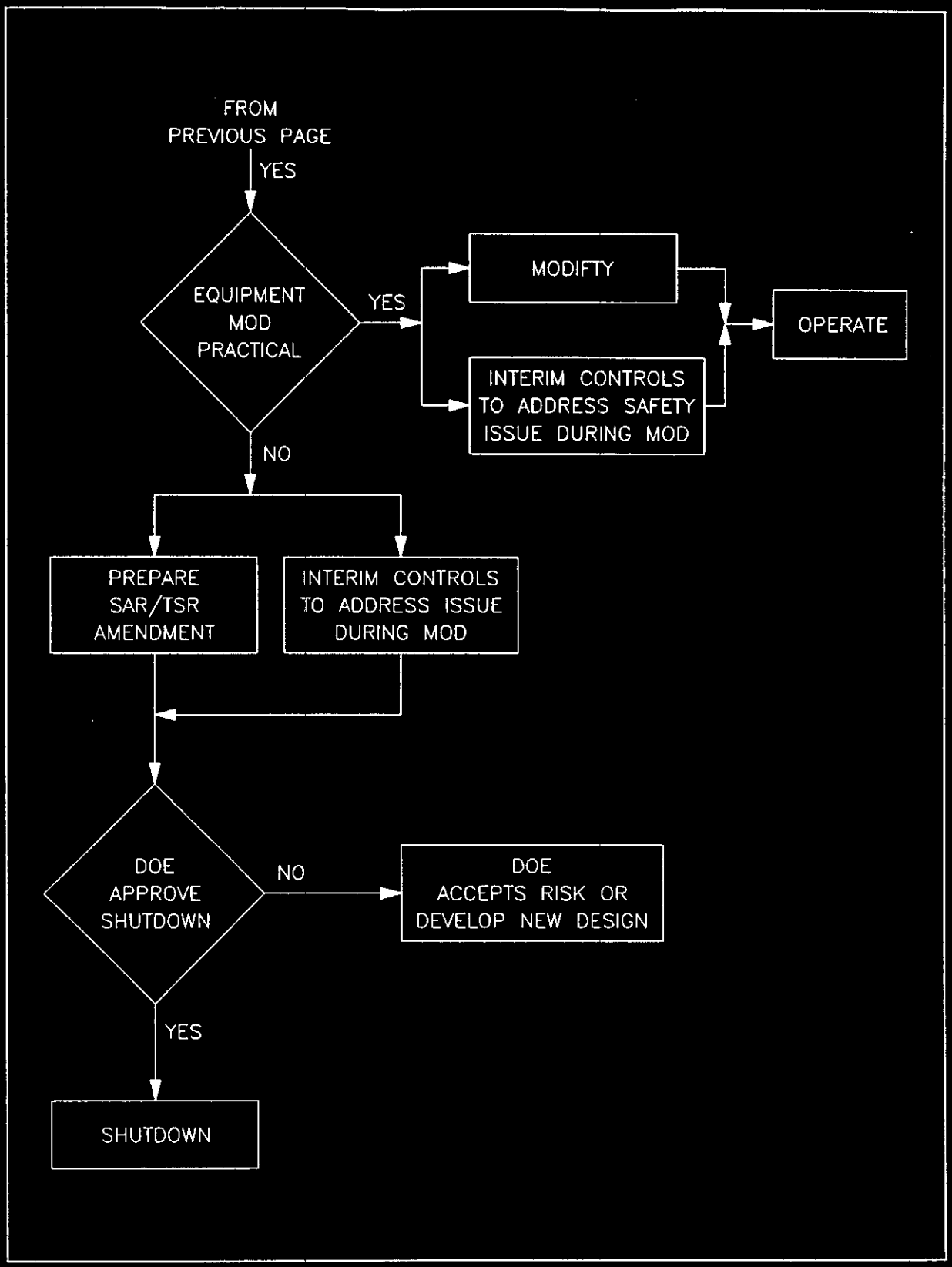
6.1 APPENDIX A: LOGIC DIAGRAMS

Flow charts are provided for both Level A and Level B tanks. Level B is on Page A-2. The logic basically requires that any source with moderate or high ignition capability within a vapor area be identified in the work package. The chart for Level A tanks begins on Page A-3. Those items that have been identified as having a moderate or high ignition capability are considered for shutdown. This simply means placing the equipment in a state that would preclude generating a spark or high temperature. Since shutting down the equipment may mean a change to the Authorization Basis, the change must be reviewed for a possible Unreviewed Safety Question (USQ). If the answer to the USQ is no, the equipment can be shutdown provided there are no adverse operational impacts.

If the answer to the USQ is yes, the Plant Review Committee (PRC) makes a final determination. If they uphold the yes answer to the USQ evaluation, then the change (shutdown) would result in a change to the Authorization Basis. The PRC may elect to direct an immediate shutdown due to safety concerns. At this point (Page A-4) the equipment may be modified (made to operate safely) if practical and if it can be accomplished in a timely manner. If not, a change to the SAR/TSR is prepared and submitted to DOE for approval. This could then result in shutdown or acceptance of the risk.


LEVEL B
PLFL < 25%
WASTE
INTRUSIVE
WORK ?
NO
END
YES
IGNITION
SOURCE
IN VAPOR
AREA ?
YES
IGNITION
SOURCE
MODERATE
OR HIGH ?
YES
IDENTIFY IN
WORK PKG,
DEVELOP CONTROLS
TO ADDRESS POTENTIAL
FOR FLAMMABLE GAS
IGNITION
NO
NO
PERFORM WORK
AND MONITOR
LFL
≥ 25%
NO
YES
STOP WORK
AND REASSESS


TANK LEVEL A ≥ 25%
IGNITION SOURCE IN VAPOR AREA ?
NO
END
YES
MODERATE OR HIGH IG CAPABILITY
YES
SHUTDOWN IMPACT ? (USQ)
NO
MODIFTY OR REPLACE IF DESIRED
SHUTDOWN
NO
INCREDIBLE
CREDIBLE
ASSESS PROBABILITY OF IGNITION
YES
PRC REVIEW OF USQE
NO
YES
NOTE: THE PRC CAN DIRECT AN IMMEDIATE SHUTDOWN OF EQUIPMENT DUE TO SAFETY CONCERNS.
TO NEXT PAGE


FROM
PREVIOUS PAGE
YES
EQUIPMENT
MOD
PRACTICAL
YES
MODIFTY
INTERIM CONTROLS
TO ADDRESS SAFETY
ISSUE DURING MOD
OPERATE
NO
PREPARE
SAR/TSR
AMENDMENT
INTERIM CONTROLS
TO ADDRESS ISSUE
DURING MOD
DOE
APPROVE
SHUTDOWN
NO
DOE
ACCEPTS RISK OR
DEVELOP NEW DESIGN
YES
SHUTDOWN

6.2 APPENDIX B: TABLE OF POTENTIAL IGNITION SOURCES

IGNITION CAPABILITY FOR TANK INSTRUMENTS, SENSORS, AND ELECTRICAL EQUIPMENT

TANK, BLDG, OR FARM	ROW NUM	IN-TANK SENSORS, INSTRUMENTS, AND ELECTRICAL EQUIPMENT															EX-TANK SENSORS, INSTRUMENTS, AND ELECTRICAL EQUIPMENT							
		WASTE AND VAPOR SPACE TEMPERATURE SENSORS						LEVEL				SHMS	PDT	CAMERA	MIXER PUMP		PUMP (XFR)	PPIT LDK	SALT WELL PUMP SYSTEM	TANK VENT SYSTEM	CORE SAMPLER VENT SYS	EXHAUST MONITOR SYSTEM		
		TC STL A	TC STL B	TC NEW B	RTD TVP	TC MIT	MISC WAST	ENRAF	FIC	MAN TAPE	HL DET													
COLUMN		C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W		

NOTES

C. TC STL A: Style A, welded, unsheathed, not replaceable Type J thermocouples (TC).

D. TC STL B: Style B, sheathed, replaceable Type J and some Type E TCs.

E. TC NEW B: Same as B but Type K, built since 1990.

F. RTD TVP: Includes vapor port and uses RTD sensors.

G. TC MIT: Each MIT has 22 Type K sensors, except SY-101 Riser 17C has one failed sensor.

H. MISC WAST: Includes air lift circulator sensors, LOW sensors, and other misc waste sensors.

I. ENRAF: Enraf level gauge.

J. FIC: Food Instrument Company reel type conductivity gauge.

K. MAN TAPE: Manual metal measuring tape with portable conductivity meter.

L. HL DET: Tank high level sensing probe - conductivity.

M. SHMS: Standard Hydrogen Monitoring System.

N. PDT: Differential pressure transmitter.

O. CAMERA: Video camera and lights for continuous viewing.

P. MIXER PUMP: Mixer pump (within waste) for waste mixing via central pump pit.

R. PUMP (XFR): Transfer pump (in pump pit).

S. PPIT LDK: Pump pit leak detector - conductivity.

T. SALT WELL PUMP SYSTEM: pump and associated instrumentation for salt well pumping.

U. TANK VENT SYSTEM: Primary tank active ventilation system.

V. CORE SAMPLER VENT SYS: Rotary core sampling truck ventilation system (portable).

W. EXHAUST MONITOR SYSTEM: Particulate radiation monitoring for tank active ventilation.

Ignition Capability: N=None VL=Very Low L=Low M=Moderate H=High
OS = Out of Service or Disconnected
Shaded areas indicate moderate to high ignition capability.

TANK, BLDG, OR FARM	ROW NUM	IN-TANK SENSORS, INSTRUMENTS, AND ELECTRICAL EQUIPMENT															EX-TANK SENSORS, INSTRUMENTS, AND ELECTRICAL EQUIPMENT							
		WASTE AND VAPOR SPACE TEMPERATURE SENSORS						LEVEL				SHMS	PDT	CAMERA	MIXER PUMP		PUMP (XFR)	PPIT LDK	SALT WELL PUMP SYSTEM	TANK VENT SYSTEM	CORE SAMPLER VENT SYS	EXHAUST MONITOR SYSTEM		
		TC STL A	TC STL B	TC NEW B	RTD TVP	TC MIT	MISC WAST	ENRAF	FIC	MAN TAPE	HL DET														
COLUMN		C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W			
A FARM																									
A-101	6	VL						N				N													
A-102	7	VL							VL																
A-103	8	VL							VL																
A-104	9						VL			VL										OS					
A-105	10						VL			VL										OS					
A-106	11	VL							VL											OS					
AN FARM	12																			H					
AN-101	13	VL							VL		H		N				M	H							
AN-102	14	VL							VL		H		N				M	H							
AN-103	15	VL						N			H,OS	N	N	N			M	H							
AN-104	16	VL						N			H,OS	N	N	N			M	H							
AN-105	17	VL						N			H,OS	N	N	N			M	H							
AN-106	18	VL							VL		H		N				M	H							
AN-107	19	VL							VL		H		N	N	TBD			H							
AP FARM	20																			H					
AP-101	21	VL							VL	VL	H		L				M	H							
AP-102	22	VL							VL	VL	H		L				M	H							
AP-103	23	VL							VL	VL	H		L				M	H							
AP-104	24	VL							VL	VL	H		L				M	H							
AP-105	25	VL							VL	VL	H		L				M	H							
AP-106	26	VL							VL	VL	H		L				M	H							
AP-107	27	VL							VL	VL	H		L				M	H							
AP-108	28	VL							VL	VL	H		L				M	H							
AW FARM	29																			H					
AW-101	30	VL				VL		N		VL	H,OS	N	N	N			M	H							
AW-102	31	VL							VL	VL	H		N				M	H							
AW-103	32	VL							VL	VL	H		N				M	H							
AW-104	33	VL							VL	VL	H,OS		N				M	H							
AW-105	34	VL							VL	VL	H		N				M	H							
AW-106	35	VL							VL	VL	H		N				M	H							
AX FARM	36																								
AX-101	37	VL						N				N													
AX-102	38	VL								VL															

Ignition Capability: N=None VL=Very Low L=Low M=Moderate H=High
OS = Out of Service or Disconnected
Shaded areas indicate moderate to high ignition capability.

TANK, BLDG, OR FARM	ROW NUM	IN-TANK SENSORS, INSTRUMENTS, AND ELECTRICAL EQUIPMENT															EX-TANK SENSORS, INSTRUMENTS, AND ELECTRICAL EQUIPMENT							
		WASTE AND VAPOR SPACE TEMPERATURE SENSORS						LEVEL				SHMS	PDT	CAMERA	MIXER PUMP		PUMP (XFR)	PPIT LDK	SALT WELL PUMP SYSTEM	TANK VENT SYSTEM	CORE SAMPLER VENT SYS	EXHAUST MONITOR SYSTEM		
		TC STL A	TC STL B	TC NEW B	RTD TVP	TC MIT	MISC WAST	ENRAF	FIC	MAN TAPE	HL DET													
COLUMN		C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W		
AX-103	39	VL						N				N												
AX-104	40	VL								VL														
AY FARM	41																			H				
AY-101	42		VL				VL	N		VL	H		N				M	H						
AY-102	43		VL				VL		VL	VL	H		N				M	H						
AZ FARM	44																			H				
AZ-101	45		VL				VL	N		VL	H		N				M	H						
AZ-102	46		VL				VL		VL	VL	H		N				M	H						
B FARM	47																							
B-101	48								VL															
B-102	49							N																
B-103	50								VL															
B-104	51									VL														
B-105	52									VL														
B-106	53								VL															
B-107	54									VL														
B-108	55								VL															
B-109	56									VL														
B-110	57									VL														
B-111	58								VL															
B-112	59							N																
B-201	60									VL														
B-202	61									VL														
B-203	62									VL														
B-204	63									VL														
BX FARM	64																							
BX-101	65	VL								VL														
BX-102	66	VL								VL														
BX-103	67	VL																						
BX-104	68								VL															
BX-105	69	VL							VL															
BX-106	70	VL		VL				N																
BX-107	71	VL							VL															
BX-108	72	VL								VL														

Ignition Capability: N=None VL=Very Low L=Low M=Moderate H=High
OS = Out of Service or Disconnected
Shaded areas indicate moderate to high ignition capability.

TANK, BLDG, OR FARM	ROW NUM	IN-TANK SENSORS, INSTRUMENTS, AND ELECTRICAL EQUIPMENT															EX-TANK SENSORS, INSTRUMENTS, AND ELECTRICAL EQUIPMENT							
		WASTE AND VAPOR SPACE TEMPERATURE SENSORS						LEVEL				SHMS	PDT	CAMERA	MIXER PUMP		PUMP (XFR)	PPIT LDK	SALT WELL PUMP SYSTEM	TANK VENT SYSTEM	CORE SAMPLER VENT SYS	EXHAUST MONITOR SYSTEM		
		TC STL A	TC STL B	TC NEW B	RTD TVP	TC MIT	MISC WAST	ENRAF	FIC	MAN TAPE	HL DET													
COLUMN		C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W		
BX-109	73	VL						N																
BX-110	74	VL							VL															
BX-111	75	VL								VL														
BX-112	76	6							VL															
BY FARM	77																							
BY-101	78	VL		VL						VL														
BY-102	79									VL														
BY-103	80	VL			VL					VL														
BY-104	81		VL	VL						VL														
BY-105	82	VL	VL							VL														
BY-106	83		VL							VL														
BY-107	84	VL			VL					VL														
BY-108	85	VL			VL					VL														
BY-109	86								VL															
BY-110	87		VL	VL						VL														
BY-111	88			VL			VL			VL														
BY-112	89			VL			VL			VL														
C FARM	90																							
C-101	91	VL								VL														
C-102	92	VL							VL															
C-103	93		VL					N		VL														
C-104	94	VL							VL															
C-105	95		VL						VL											H				
C-106	96	VL	VL					N	VL											H				
C-107	97		VL					N																
C-108	98			VL						VL														
C-109	99	VL		VL						VL														
C-110	100	VL								VL														
C-111	101	VL			VL					VL														
C-112	102	VL		VL						VL														
C-201	103	VL								VL														
C-202	104	VL								VL														
C-203	105	VL								VL														
C-204	106									VL														

Ignition Capability: N=None VL=Very Low L=Low M=Moderate H=High
OS = Out of Service or Disconnected
Shaded areas indicate moderate to high ignition capability.

TANK, BLDG, OR FARM	ROW NUM	IN-TANK SENSORS, INSTRUMENTS, AND ELECTRICAL EQUIPMENT															EX-TANK SENSORS, INSTRUMENTS, AND ELECTRICAL EQUIPMENT							
		WASTE AND VAPOR SPACE TEMPERATURE SENSORS						LEVEL				SHMS	PDT	CAMERA	MIXER PUMP		PUMP (XFR)	PPIT LDK	SALT WELL PUMP SYSTEM	TANK VENT SYSTEM	CORE SAMPLER VENT SYS	EXHAUST MONITOR SYSTEM		
		TC STL A	TC STL B	TC NEW B	RTD TVP	TC MIT	MISC WAST	ENRAF	FIC	MAN TAPE	HL DET													
COLUMN		C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W		
S FARM	107																							
S-101	108		VL					N																
S-102	109		VL					N				N												
S-103	110		VL					N																
S-104	111	VL							VL	VL														
S-105	112	VL						N																
S-106	113	VL						N		VL														
S-107	114		VL					N																
S-108	115	VL						N		VL														
S-109	116	VL						N																
S-110	117		VL					N																
S-111	118	VL						N				N												
S-112	119	VL						N				N												
SX FARM	120																							
SX-101	121		VL					N				N								H				
SX-102	122		VL					N				N								H				
SX-103	123		VL					N				N								H				
SX-104	124		VL					N				N								H				
SX-105	125		VL					N				N								H				
SX-106	126		VL					N				N								H				
SX-107	127	VL								VL										H				
SX-108	128	VL								VL										H				
SX-109	129	VL								VL		N								H				
SX-110	130	VL								VL										H				
SX-111	131	VL								VL										H				
SX-112	132	VL								VL										H				
SX-113	133	VL								VL														
SX-114	134	VL								VL										H				
SX-115	135									VL														
SY FARM	136																			N				
SY-101	137					VL		N	VL	VL		N		N	N			N						
SY-102	138	VL						N		VL							M,OS	H						
SY-103	139	VL				VL		N		VL		N		N			M	H						
T FARM	140																							

Ignition Capability: N=None VL=Very Low L=Low M=Moderate H=High
OS = Out of Service or Disconnected
Shaded areas indicate moderate to high ignition capability.

TANK, BLDG, OR FARM	ROW NUM	IN-TANK SENSORS, INSTRUMENTS, AND ELECTRICAL EQUIPMENT															EX-TANK SENSORS, INSTRUMENTS, AND ELECTRICAL EQUIPMENT							
		WASTE AND VAPOR SPACE TEMPERATURE SENSORS						LEVEL				SHMS	PDT	CAMERA	MIXER PUMP		PUMP (XFR)	PPIT LDK	SALT WELL PUMP SYSTEM	TANK VENT SYSTEM	CORE SAMPLER VENT SYS	EXHAUST MONITOR SYSTEM		
		TC STL A	TC STL B	TC NEW B	RTD TVP	TC MIT	MISC WAST	ENRAF	FIC	MAN TAPE	HL DET													
COLUMN		C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W		
T-101	141	VL						N																
T-102	142							N																
T-103	143							N																
T-104	144	VL								VL														
T-105	145							N																
T-106	146	VL						N																
T-107	147	VL			VL			N																
T-108	148	VL						N																
T-109	149	VL						N																
T-110	150	VL						N				N												
T-111	151	VL						N																
T-112	152	VL						N																
T-201	153	VL								VL														
T-202	154	VL								VL														
T-203	155	VL								VL														
T-204	156	VL								VL														
TX FARM	157																							
TX-101	158								VL															
TX-102	159	VL								VL														
TX-103	160	VL							VL															
TX-104	161	VL							VL															
TX-105	162		VL							VL														
TX-106	163	VL							VL	VL														
TX-107	164	VL							VL															
TX-108	165	VL							VL	VL														
TX-109	166	VL							VL	VL														
TX-110	167									VL														
TX-111	168	VL							VL	VL														
TX-112	169	VL								VL														
TX-113	170	VL								VL														
TX-114	171									VL														
TX-115	172	VL								VL														
TX-116	173									VL														
TX-117	174								VL	VL														
TX-118	175	VL		VL					VL															

Ignition Capability: N=None VL=Very Low L=Low M=Moderate H=High
OS = Out of Service or Disconnected
Shaded areas indicate moderate to high ignition capability.

TANK, BLDG, OR FARM	ROW NUM	IN-TANK SENSORS, INSTRUMENTS, AND ELECTRICAL EQUIPMENT															EX-TANK SENSORS, INSTRUMENTS, AND ELECTRICAL EQUIPMENT							
		WASTE AND VAPOR SPACE TEMPERATURE SENSORS						LEVEL				SHMS	PDT	CAMERA	MIXER PUMP		PUMP (XFR)	PPIT LDK	SALT WELL PUMP SYSTEM	TANK VENT SYSTEM	CORE SAMPLER VENT SYS	EXHAUST MONITOR SYSTEM		
		TC STL A	TC STL B	TC NEW B	RTD TVP	TC MIT	MISC WAST	ENRAF	FIC	MAN TAPE	HL DET													
COLUMN		C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W		
TY FARM	176																							
TY-101	177	VL			VL			N																
TY-102	178	VL						N																
TY-103	179	VL			VL				VL															
TY-104	180	VL			VL			N																
TY-105	181	VL								VL														
TY-106	182	VL								VL														
U FARM	183																							
U-101	184	VL								VL														
U-102	185	VL							VL	VL														
U-103	186	VL						N				N												
U-104	187									VL														
U-105	188	VL						N				N												
U-106	189	VL						N																
U-107	190	VL						N				N												
U-108	191	VL						N				N												
U-109	192	VL						N				N												
U-110	193	VL							VL															
U-111	194	VL							VL															
U-112	195	VL								VL														
U-201	196	VL								VL														
U-202	197	VL								VL														
U-203	198	VL								VL														
U-204	199	VL								VL														

Ignition Capability: N=None VL=Very Low L=Low M=Moderate H=High
OS = Out of Service or Disconnected
Shaded areas indicate moderate to high ignition capability.

DISTRIBUTION SHEET

To: Distribution

From: Instrument Systems Integration

Date: January 30, 1996

Project Title/Work Order:

Ignition Sources

EDT No.:

ECN No.: 623518

Name	MSIN	With Document	ECN	EDT
D. B. Engelman	R1-49	X		
G. R. Franz	S7-81	X		
J. K. Hamilton	R1-90	X		
G. A. Hanson	S7-16	X		
R. A. Huckfelt	R3-01	X		
W. W. Jenkins	S2-24	X		
G. D. Johnson	S7-14	X		
E. J. Lipke	S7-14	X		
W. C. Miller	R1-30	X		
T. L. Moore	R2-76	X		
C. M. Monasmith	E6-27	X		
J. G. Propson	R2-36	X		
R. E. Raymond	S7-12	X		
S. H. Rifaey	T4-07	X		
C. C. Scaief III	S2-02	X	X	
J. S. Schofield	S7-12	X		
J. D. Thomson	H6-35	X		
R. E. Raymond	S7-12	X		
A. M. Umek	S7-81	X		
J. H. Wicks	R2-50	X		
Central Files (Original + 3) A3-88	~~L8-04~~	X	X	