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EQUIPMENT DESIGN GUIDANCE DOCUMENT FOR FLAMMABLE GAS WASTE STORAGE TANK NEW EQUIPMENT

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Page 1 of 1

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| 1 | 1 | JW Lentsch | [signature] | 4/2/96 | S7-14 | | | | | | |
| 1 | 1 | GR Sawtelle | [signature] | 4/9/96 | A3-37 | (SAFETY) | | | | | |
| 1 | 1 | WW Jenkins | [signature] | 4/2/95 | S2-24 | | | | | | |
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# Equipment Design Guidance Document for Flammable Gas Waste Storage Tank New Equipment

**David B. Smet**
Westinghouse Hanford Company, Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-87RL10930

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Abstract: This document is intended to be used as guidance for design engineers who are involved in design of new equipment slated for use in Flammable Gas Waste Storage Tanks.

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A-6400-073 (10/95) GEF321

## TABLE OF CONTENTS

# EQUIPMENT DESIGN GUIDANCE DOCUMENT FOR FLAMMABLE GAS WASTE STORAGE TANK NEW EQUIPMENT

## 1.0 PURPOSE

The purpose of this document is to provide design guidance for all new equipment intended for application into those Hanford storage tanks in which flammable gas safety controls are required to be addressed as part of the equipment design.

These design criteria are to be used as guidance. The design of each specific piece of new equipment shall be required, as a minimum, to be reviewed by qualified Unreviewed Safety Question evaluators as an integral part of the final design approval. Further Safety Assessment may be also needed. This guidance is intended to be used in conjunction with the Operating Specifications Documents (OSD's) established for defining work controls in the waste storage tanks. The criteria set forth should be reviewed for applicability if the equipment will be required to operate in locations containing unacceptable concentrations of flammable gas.

## 2.0 SCOPE

This design guidance may be used for all new equipment introduced into Double Shell, Single Shell, Miscellaneous Underground Storage Tanks, and other waste storage containers that have flammable gas controls imposed upon them.

## 3.0 BACKGROUND

In November of 1990, a bill introduced by Representative Wyden of Oregon became Public Law 101-510, Section 3137 - "Safety Measures for Waste Tanks at Hanford Nuclear Reservation". Westinghouse Hanford Company's (WHC) response was to identify those tanks which "may have a serious potential for release of high-level waste due to uncontrolled increases in temperature or pressure....". These tanks became known as "Watch List" or Wyden Bill tanks. At that time watch lists were created for the safety issues of flammable gasses, ferrocyanide, organic salt, and high heat load.

In 1995 and 1996, both Pacific Northwest National Laboratory (PNNL) and WHC conducted independent reviews of tank surface level data for all 177 high level waste tanks in order to determine that all potential flammable gas tanks had been identified. The screening looked at changes in waste surface level as a function of changes in atmospheric pressure (Whitney, 1995), (Hopkins, 1995), (Hodgson, 1996). As a result of the review, additional tanks were identified as potential flammable gas concerns. To date, these tanks have not been officially added to the Wyden Bill list. WHC now requires all work within these tanks to utilize the same flammable gas controls. The Department of Energy (DOE) concurs with the additional controls.

Flammable gas has also been found trapped in equipment in several other non-watchlist tanks, e.g., during sampling activities. Further, a local flammable concentration (plume) is possible in some Hanford tanks. Gas plume burn calculations performed for double shell tank SY-101 (Heard, 1996), and extrapolated for single shell tanks, preliminarily indicate that a flammable gas burn on the order of 50 $ft^3$ is sufficient to rupture a HEPA filter and 600 $ft^3$ could result in dome collapse of a single shell tank . As a result, many Single and Double Shell Underground Storage Tanks are now subject to additional controls as a precautionary measure until more data can be gathered.

This evolution of events has raised issues with the design of equipment that may provide ignition sources near or in these tanks. The design for all new equipment shall be guided by the design criteria defined in this document.

## 4.0 WASTE TANK ACTIVITY BOUNDARIES

The following format is consistent with the OSD (OSD-T-151-00030, Rev. B17), (OSD-T-151-0007, Rev. H17), (OSD-T-151-0013, Rev. D10) approach, as well as other governing documents.

The activity boundaries are divided into two major areas: 1) Non Tank-Intrusive, and 2) Tank-Intrusive. Tank-Intrusive activities are subdivided into two physical boundaries; Dome Space-Intrusive, and Waste-Intrusive activities. Definitions of these areas are clearly described in the applicable OSD's. As a result of current safety assessment work for Rotary Mode Core Sampling and Saltwell Pumping, performed by Los Alamos National Laboratories, the boundaries are altered slightly from the definitions contained in the referenced OSD's and are as stated below.

Non Tank-Intrusive activities are bound by: 1) 36 opening diameters from any opening into the tank that is common to the in-tank environment, or to the contamination containment boundary (greenhouse), if less restrictive, and 2) the plane of that opening.

The Dome Space-Intrusive activities are bound by: 1) the plane of the top of the riser flange, and 2) all vapor space area down to the waste surface.

Waste-Intrusive activities are bound by: 1) the waste surface, and 2) the bottom of the waste. Additionally for waste intruding equipment, the waste intrusive boundary extends to any area within the equipment common to the waste environment (i.e. upper plenum of a drill string).

## 5.0 EQUIPMENT DESIGN

The bases for the following design criteria are industrial standards derived from Code, Safety Assessment and Design documents (see Section 7.0), that govern Hydrogen Gas environment activities. Hydrogen gas is generated in Hanford's waste storage tanks and is of primary concern because of the extremely small amount of energy required for ignition. Safety class considerations for design are also addressed within the criteria.

### 5.1 NON TANK-INTRUSIVE ACTIVITY IGNITION SOURCE EQUIPMENT

For Non Tank-Intrusive ignition source equipment, Criteria 1 through 6 below apply.

## 5.2 DOME SPACE-INTRUSIVE ACTIVITY IGNITION SOURCE EQUIPMENT

For Dome Space-Intrusive ignition source equipment, Criteria 1 through 7 below apply.

**Note: For Dome-Intrusive activities, pending further characterization of the tanks, the engineer may choose to employ NFPA 70, Class 1, Division 1, Group B design when practicable, to reduce risk and to avoid future redesign should design requirements change. Criteria 1 through 7 below are minimum requirements guidance that include NFPA70, Class 1, Division 2, Group B design requirements.**

## 5.3 WASTE-INTRUSIVE ACTIVITY IGNITION SOURCE EQUIPMENT

For Waste-Intrusive ignition source equipment, Criteria 1, 2, 4, and 7 through 10 below apply.

DESIGN CRITERIA

Note: In order to determine the authorization basis for the design, an Unreviewed Safety Question Review/Evaluation, as a minimum, shall be performed for each design activity.

1. Mechanical tooling, equipment and materials (including lubricants, adhesives, gaskets, corrosion inhibitors, epoxies, etc.) shall be constructed of non-sparking semi-conductive material, or shall be rendered incapable of sparking, or shall have been analyzed and evaluated to not be capable of sparking under the applied conditions (Johnson, R.N. 1990). Materials containing exposed reactive metals e.g., aluminum, magnesium, zinc, titanium, shall not be used in order to prevent 'thermite reaction' potential (Raymond, R.E. 1996).

2. Exposed polymer materials shall be constructed of semi-conductive materials or shall employ semi-conductive exterior coatings with a resistive value no greater than $1 \times 10^6$ ohms over the full length of the component or, shall be rendered incapable of electrostatic charge buildup (NFPA 77 - 1993).

3. Electrical equipment shall be designed to be non-sparking under normal operation (as defined by NFPA 70, Class 1, Division 2, Group B criteria), or if normally sparking, the sparking component(s) shall be continuously isolated (pressurized) from the potentially flammable gas environment, or the design of the device enclosure shall be of sufficient strength (explosion-proof) to prevent propagation of a gas burn to the environment external to the enclosure ( NFPA 70 - 1993).

4. Heat generating device surface temperatures shall not exceed 80% of the autoignition temperature of the flammable gas[1]. Internal temperatures of heat

1 - This upper limit value will be lower if there are also organic salt flammability concerns associated with the tank, and will be addressed by the USQ Evaluation and/or Safety Assessment.

generating devices may exceed 80% of the autoignition temperature if the heat source is either isolated (pressurized) from the gas environment, or if the design of the device enclosure is of sufficient strength (explosion-proof) to prevent propagation of a gas burn to the environment external to the enclosure (NFPA 70 - 1993).

5. Shutdown is required of either 1) pressurized electrical and pressurized heat-generating equipment, upon loss of protective gas pressure or flow, or of 2) non-pressurized electrical equipment that is neither explosion-proof nor intrinsically safe, upon sensing of flammable gas concentrations at unacceptable levels. The shutdown control system shall also provide independent backup shutdown control should the primary shutdown control system fail ( NFPA 496 - 1993) (DOE Order 420.1).

6. Startup of 1) pressurized electrical equipment, or of 2) non-pressurized electrical, or heat-generating equipment that is neither explosion-proof nor intrinsically safe, shall only be allowed upon system sensing of pre-set safety limits e.g., adequate protective gas pressure established, or flammable gas concentrations at acceptable levels. If pressurized enclosures are utilized to isolate energized components, a minimum of four enclosure volumes shall be purged through the enclosure for energized components, and/or 10 volumes shall be purged for enclosed motors prior to startup of the system components (NFPA 70 - 1993) (NFPA 496 - 1993).

7. Metal components shall be constructed of an acceptable stainless steel series e.g., 304, 316, or 430, or a waste environment compatible equivalent. Materials containing exposed aluminum or other reactive materials, that generate flammable gas when contacting caustic waste material shall not be used (Farley, W.G. 1994). If materials other than stainless steel are used, the engineer should be able to defend the material(s) used through analysis or testing.

8. Electrical equipment shall be designed such that no single point failure of energized components can result in an arc or spark (as defined by NFPA 70, Class 1, Division 1, Group B criteria), or gas burn propagation to the environment external to the source enclosure (NFPA 70 - 1993), (DOE Order 420.1).

9. Shutdown of pressurized electrical and pressurized heat-generating equipment, upon loss of protective gas pressure or flow, shall be automatic by design. The shutdown control system shall also provide independent backup shutdown control should the primary shutdown control system fail. Consideration in design shall be given to prevention of common-mode failures of the primary and secondary shutdown control system (NFPA 496 - 1993), (DOE Order 420.1).

10. Startup of pressurized electrical or pressurized heat-generating equipment shall only be allowed upon system sensing of pre-set safety limits e.g., adequate protective gas pressure established. If pressurized enclosures are utilized to isolate energized components, a minimum of four enclosure volumes shall be purged through the enclosure for energized components, and/or 10 volumes shall be

purged for enclosed motors prior to controlled startup of the system components (NFPA 70 - 1993), (NFPA 496 - 1993).

## 6.0 ALTERNATIVE APPROACHES

Use of standard industrial practices as defined above, provide sufficient precaution to achieve design that is as spark-free as is required for the activity and location. It is not the intent of this document to require formal risk assessment to show compliance with acceptable accident frequencies. The guidance contained herein has been established by industry, both nuclear and non-nuclear, to provide acceptably low risk equipment application into this type of hazardous location. Additionally, because of the high consequences of an accident in a waste storage tank at Hanford, conservatism has been built into this design guidance that is in harmony with current safety and risk assessment analyses. Alternative approaches using administrative and engineered layers of safety control, also known as 'defense in depth', can be utilized as long as they can be technically defended through the same review and approval process.

# 7.0 SOURCE REFERENCES

ANSI/ISA-RP 12.6 - *"Installation of Intrinsically Safe Systems for Hazardous (Classified) Locations"*, 1987 Edition.

Characterization Equipment Engineering, November 16, 1995 - *"Meeting Minutes - Discussion with NFPA Code Consultant Peter Schram"*. Westinghouse Hanford Company, Richland, Washington - Attached as Appendix A.

Department of Energy Order 420.1 - *"Facility Safety"*.

*"Equipment Rating and Automatic Shut-Down Requirements"* - WHC-SD-WM-SAD-035, Appendix B, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Farley, W.G., 1994 - *"Safety Assessment for Installation and Operation of Thermocouple Trees in Ferrocyanide Tanks"*. WHC-SD-WM-SAD-014, Rev. 3, Westinghouse Hanford Company, Richland Washington.

Heard, F. J., January 1996 - *"Waste Tank 241-SY-101 Dome Air Space and Ventilation System Response To A Flammable Gas Plume Burn"*, WHC-SD-WM-ER-515, Rev. 0 Westinghouse Hanford Company, Richland, Washington.

Hodgson, K. M., March 1996 - *"Evaluation of Hanford Tanks for Trapped Gas"*, WHC-SD-WM-ER-526, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

Hopkins, J. D., August 1994 - *"Criteria for Flammable Gas Watchlist Tanks"*, WHC-EP-0702, Westinghouse Hanford Company, Richland, Washington.

Hopkins, J. D., December 1995 - *"Methodology for Flammable Gas Evaluation"*, WHC-SD-WM-TI-724, Westinghouse Hanford Company, Richland, Washington.

Huckfeldt, R. A. - *"Electrical Hazard Classification Study for the Flammable Gas Watchlist Tanks"*, WHC-SD-WM-HC-017, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Johnson, R. N., 1990 - *"Selection of Spark Resistant Tool Materials for Use in 101-SY"*. WHC Internal Memo, R.N. Johnson to R.E. Bauer, Westinghouse Hanford Company, Richland, Washington - Contained in WHC-SD-WM-DA-077, *"Gas Monitor System Sample Probe Design Support Analyses"*, K.L.Pearce, November 9, 1992.

LA-UR-92-3196 , Appendix AA, Latest Revision - *"Hazards Classifications for the In-Tank Equipment Requirements"*.

NFPA 70 - *"National Electric Code, Articles 500 - Hazardous (Classified) Locations and 501 - Class I Locations"* - 1993 Edition.

NFPA 77 - *"Recommended Practice on Static Electricity"* - 1993 Edition.

NFPA 496 - *"Standard for Purged and Pressurized Enclosures for Electrical Equipment"* - 1993 Edition.

NFPA 497A - *"Recommended Practice for Classification of Class I Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas"* - 1992 Edition.

NFPA 497M - *"Classification of Gases, Vapors, and Dusts for Electrical Equipment in Hazardous (Classified) Locations"* - 1991 Edition.

*"Non Reactor Facility Safety Analysis Manual"* - WHC-CM-4-46, Section, 7.0, Rev. 4 Westinghouse Hanford Company, Richland, Washington.

*"Operating Specifications for Double Shell Waste Storage Tanks"* - OSD-T-151-00013, Rev. D10

*"Operating Specifications for Flammable Gas Watchlist Waste Storage Tanks"* - OSD-T-151-00030, Rev. B17.

*"Operating Specifications for Single Shell Waste Storage Tanks"* - OSD-T-151-0007, Rev. H17

Raymond, R. E., 1996 - *"Actions in Response to Spark Reported During Work on Tank 241-U-109"*, WHC Internal Memo 9650352 R.E. Raymond to Steven Burnam. Westinghouse Hanford Company, Richland, Washington - Attached as Appendix B.

*"Safety Basis for Activities in Single Shell Waste Storage Tanks"* - WHC-SD-WM-SARR 004, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

*"Safety Basis for Activities in Double Shell Waste Storage Tanks"* - WHC-SD-WM-SARR 002, Rev. 1, Westinghouse Hanford Company, Richland, Washington

Sidpara, A.B., 1995 - *"Risk Acceptance Criteria for Tank Farm Operation"*, Department of Energy Memo 95-TOP-063 A.B. Sidpara to President, Westinghouse Hanford Company, Richland, Washington - Attached as Appendix C.

Underwriter's Laboratory (UL) 1203-94 - *"Explosion-Proof and Dust-Ignition Proof Electrical Equipment for Use in Hazardous (Classified) Locations"*.

Underwriter's Laboratory (UL) 913-88 - *"Intrinsically Safe Apparatus for Use in Hazardous Locations"*.

Underwriter's Laboratory (UL) 844 - *"Use of Lighting Fixtures in Hazardous Locations"*.

Whitney, P., October 1995 - *"Screening the Hanford Tanks for Trapped Gas"*, PNL-10821, Pacific Northwest National Laboratory, Richland, Washington.

# APPENDIX A

## MEETING MINUTES - DISCUSSION WITH NFPA CODE CONSULTANT PETER SCHRAM

# MEETING MINUTES

SUBJECT: DISCUSSION WITH NFPA CODE CONSULTANT PETER SCHRAM

| TO: Distribution | BUILDING 2704HV/G134 |
|---|---|
| FROM: Characterization Equipment Engineering | CHAIRMAN R. E. Raymond |

| DEPARTMENT-OPERATION-COMPONENT | AREA | SHIFT | DATE OF MEETING | NUMBER ATTENDING |
|---|---|---|---|---|
| Characterization Equipment Engineering | 200E | Day | November 7, 1995 | |

**ATTENDEES:**

| | |
|---|---|
| Rick Raymond | Jack Lentsch |
| Don Board | Dennis Hamilton |
| Greg McDonald | Rick Huckfeldt |
| Fred Schmorde | Det Wegener |
| Judy Burton | Andy Cockrell |
| John Lee | Dave Smet |
| Bob White | Gus Myers |
| Ralph Elwell | Jeff Smalley |
| Andy Mousel | Jim Criddle |
| Jim Robinson | Eric Waldo |
| Troy Farris | Peter Schram |
| Jim Bussell | |

On November 7, 1995 from 10:00am to 12:30pm, the subject meeting was held. These are the minutes of that meeting. The distribution list were the attendees at that meeting:

I. Peter Schram Comments:

1. The NEC, because it is a construction code, does not recognize the detection of Flammable Gas. However, Operating codes (such as OSHA) do make allowance for detection as a safety precaution for operation. An example is a "hot work" procedure. National Fire Protection Association (NFPA) code 70E for example gives you instructions on how to work on energized circuits. There are similar rules in OSHA to allow operation and maintenance.

2. It is a common practice to allow compensatory measures to demonstrate equivalent safety in special cases. This is allowable by the NEC code in section 90-4, paragraph 2.

3. NEC was not written for bubbles in solid materials (the situation in the tank waste). The Mine Safety Hazards Association (MSHA) for underground mining operations and OSHA for tunneling operations do recognize gas detection as part of protection and is written for situations where bubble are found in solids.

4. If the tank dome space can (under normal operating conditions) not get above 25% LFL then the dome space should be unclassified. If 25-50% then Class 1, Division 2; if >50% then Class 1, Division 1.

5. There are many cases where people over-classify their systems for cautious reasons (cost, risk, consequences, lack of knowledge).

6. A type X purge has automatic interlocks. The problem with detectors is the response time versus how quick is the rate of increase of flammable mixture. The other problem is detector locations.

A-3000-480 (10/94) GEF011

MEETING MINUTES (Continued) Page 2 of 2

7. Purging is an acceptable method per the code in lieu of explosion proof equipment.

II. **Peter Schram Recommendations:**

1. The waste volume should be classified as Class 1, Division 1, Group B and that volumes in direct connection with the waste volume also be classified as Class 1, Division 1, Group B and that any equipment used in those locations shall meet the requirements of Class 1, Division 1, Group B locations per the code.

   Basis: This is a conservative recommendation based on observations of flammable gases in drill strings in tanks BY-110 and S-107.

2. If the tank vapor space does not normally exceed 25% of LFL at any location in the space then that space is unclassified. If under abnormal conditions the vapor space can reach or exceed 100% LFL then it should be classified at least as Division 2.

**Rick Huckfeldt Action:**

To prepare a letter stating that, temporarily, if provision is made, by procedure, for purge and sample using trained operators prior to operation of equipment inside the drill string then, the volume of the drill string can be unclassified. Concurrence on letter will be provided by Peter Schram.

**Greg McDonald Comment:**

You should prepare such a letter (to be prepared by Rick Huckfeldt) then submit this to the Hanford Electrical Code Board (HECB) for their blessing. You would probably get their blessing.

Questions:

1. Bob White: How do you interpret the words may have flammable vapors "under normal conditions". What if we have >100% a few minutes a year?

   **Answer from Peter Schram:** The code committee has been wrestling with these questions for years. The committee has tried to set guidelines for the fraction of the time that the space might contain flammable material. This was rejected in preference to engineering judgements. In article 505 there are some words on this: in summary, normal conditions include when operating within plant parameters and includes occasional releases. Spills are not normal operations. In NFPA code 479A there is guidance on this.

   Further comment from Peter Schram on the use of the term "may have" flammable gas. Basements of homes that have natural gas lines in them are not classified. Why: because if you have a leak then electrical gear rarely is the ignition source. Therefore classification is not applied even though in an industrial situation such as space it might be classified.

2. Can induction motors be used in the vapor space?

   **Answer:** Code 501-508B, Class 1, Division 2, paragraph 2, spaces, induction motors shall be permitted.

A-3000-480 (10/94) GEF011

# APPENDIX B

## WHC INTERNAL MEMO - ACTIONS IN RESPONSE TO SPARK REPORTED DURING WORK ON TANK 241-U-109

Westinghouse
Hanford Company

P.O. Box 1970 Richland, WA 99352

January 23, 1996 9650352

Mr. Steven Burnam, Program Director
Waste Characterization Project
U.S. Department of Energy
Richland Field Office
Richland, Washington 99352

Dear Mr. Burnam:

ACTIONS IN RESPONSE TO SPARK REPORTED DURING WORK ON TANK 241-U-109 SPARKS.009

Reference: WHC Occurrence Report, RL-WHC-TANKFARM-1996-0009 "Mechanical Spark Experienced When Disconnecting Quill Rod From The Drill String at 241-U-109," RL-WHC-TANKFARM-1996-0009, dated January 19, 1996.

In the referenced occurrence report, Westinghouse Hanford Company (WHC) notified the Department of Energy, Richland Field Office (RL), of an event that occurred on January 17, 1996, when a spark was observed while in the process of removing drill string from Tank 241-U-109. The occurrence report and associated Critique Report identified several corrective actions. In addition to these corrective actions, WHC has performed certain other actions in response to this event. The purpose of this letter is to 1) document these additional actions, and 2) inform RL of the intent to continue with sampling activities.

The actions taken are as follows:

1. WHC has identified the most likely source or cause of the spark(s) observed on the evening of January 17, 1996, while removing drill rod sections from Tank 241-U-109. WHC has had this identification of the spark reviewed by an independent, credible expert. Please see attachment 1 for more details.

2. WHC has verified that all parts of the system which could come in contact with the tank vapor space in accordance with footnotes 1, 2, or 3 to section 30.2.A (Hydrogen/Flammable Gas Tank) of OSD-T-151-00030 (Operation Specification for Watch List Tanks) have not been assembled or operated using any compound that makes sparking more likely. See attachment 2 for more details.

Mr. Steven T. Burnam
Page 2

9650352

3. WHC has completed training of all personnel that can affect the quality of work performed in the field on the corrective actions from the occurrence report and the critique. There were no additional actions resulting from items 1 and 2 above (see attachments 1 and 2). WHC has a system in place that requires the same training for any personnel not currently on-Site before they are assigned work in the field.

WHC intends to commence with core sampling operations immediately. Other actions associated with this event are still in progress, but their completion has not been tied to the resumption of core sampling operations.

Should you have questions or wish further information, please contact Mr. Richard E. Raymond on 373-3647.

Sincerely,

L. F. Ermold

L. F. Ermold, Director
Characterization Sampling and Analysis
Tank Waste Remediation System

lrm

Attachments (2)

RL - P. R. Hernandez
R. R. McNulty
J. C. Peschong
R. E. Gerton
A. H. Wirkkala (w/o attachment)

BEST AVAILABLE COPY

EXTERNAL LETTER
9650352

ATTACHMENT 1

ASSESSMENT OF CAUSE OF SPARK OBSERVED
WHILE REMOVING DRILL STRING
FROM TANK 241-U-109
ON
JANUARY 17, 1996

Consisting of 2 Pages

Attachment 1 9650352

# CAUSES OF SPARKS AND EVALUATION OF THE SPARK AT TANK 241-U-109

## INTRODUCTION

An engineering evaluation has been conducted to determine the cause of the spark at Tank 241-U-109. The possible causes of sparks, and an evaluation of their applicability to this situation are summarized below.

### 1. Electrical Charges due to Piezoelectric effects

To cause a piezoelectric effect a material such as quartz is needed. The components present in the vicinity of the observed spark include: the carbon steel quill rod adapter, carbon steel drill string and anti-seize compound. Carbon steel does not exhibit piezoelectric properties. The anti-seize compound may contain powders of silica based materials (such as mica). The amount and size of these particles should not result in a spark of the magnitude observed. Based on the above information it is very unlikely that the observed spark resulted from this effect. To completely eliminate this effect from further consideration anti-seize compound without silica based materials should be used.

### 2. Electrical Charges due to electrostatic charge imbalance

To eliminate the possibility of spark generation due to electrostatic charge imbalance, all the wiring for bonding and grounding the equipment was checked on graveyard shift 1/17/95 and found to be correct per the procedure, and the resistance between the quill rod and the drill rod was found to be approximately one ohm. This same wiring was confirmed on day shift 1/17/95, which indicates that static electrical discharge did not cause the spark. Another indication that the spark wasn't electrical in nature, was that the spark was observed by two personnel to fly out laterally in the direction of the quill rod movement rather than jumping between the two rods as would happen if the spark was due to an electrical potential difference. Based on the above information it can be concluded that the observed spark did not result from electrostatic charge imbalance.

### 3. Electrical Charges due to interruption of a highly inductive electrical circuit

The truck electrical wiring was checked for voltage leakage problems to ground on both graveyard shift and again on day shift. No electrical wiring problems were found. With the quill rod adapter grounded through the drill rig, and the drill string grounded through the foot clamp and no source of electrical potential between the quill rod adapter and the footclamp, there is no driving force for an electric current to flow between the drill string and the quill rod adapter. The above indicates that the cause of the spark was not due to an electrical short somewhere on the truck. If an electrical short had been present, it should have drained direct to the ground via the grounding wiring.

### 4. Friction Sparking

Friction sparking occurs when an impact causes the ejection of hot, glowing or burning debris. The probability of producing a burning spark decreases with increasing oxidation resistance of the material.[1] The quill rod and drill rod are both carbon steel. Informal tests were performed on 1/17/95 to determine how feasible it was to cause sparking with the drill rod. The initial test consisted of randomly striking the ends of two sections of drill rod without any pipe compound on them forcefully together in various configurations. While sparking was observed, the magnitude was less than the observed spark and the color was yellowish rather than the blue white of the observed spark. Therefore, while friction sparking is a plausible cause of the observed spark it does not completely explain the observed event.

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[1] P. Voigtsberger, Bundesarbeitsblatt, p. 191-198 (1955)



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5. Thermite "Flash"

A thermite "flash" is strongly exothermic reaction of a more reactive metal with an oxide, such as aluminum with iron oxide. A typical example is when aluminum rubs against rusty steel. A subsequent light impact can be sufficient to cause a thermite flash involving the reaction.[2]

$$3\ Fe_3O_4 + 8\ Al \rightarrow 9\ Fe + 4\ Al_2O_3 + heat$$

Several different types of anti-seize compound have been used during core drilling. One of these compounds, Bostik NEVER SEEZ Catalog No. NSBT-8, contains elemental copper and aluminum, among other constituents and possibly was the type of pipe compound used on the U-109 drill rod. Informal tests were performed on 1/17/95 to determine how feasible it was to cause sparking with the drill rod and this anti-seize compound to determine if this could have been the spark source. The test consisted of randomly striking the ends of two sections of drill rod with anti-seize compound on them, forcefully together in various configurations. With the use of this compound, sparking was seen to markedly increase, and in one instance a spark over an inch long flew out, similar to what was reported on 1/16/96 at U-109. Based on this information it can be concluded that use of an anti-seize compound that contains aluminum powders, is the most probable cause of the observed spark.

6. Compressive Heating of Gas

Compressive heating of gas to ignition temperatures, as in a diesel engine, is not applicable with the geometries being considered here.

Due to the geometry of the sampling system at the location of the spark at Tank 241-U-109, this is not a possible mechanism.

Some Important Considerations:

1) Nearly any material, including hard rubber, can be made to ignite flammable gases if the impacting conditions and material combinations are appropriate or adequately severe.[3]

2) Proper selection of materials and conditions can virtually eliminate ignition sources, although material selection above may be insufficient.

CONCLUSION:

The spark at Tank 241-U-109 could have been caused by friction sparking, but is most likely due to a thermite flash resulting from the pipe anti-seize compound used on the drill string threads.

Prepared by: [signature] Date: 1/23/96

Reviewed by: [signature] Date: 1/23/96

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[2]D. H. Desy, et al., Methane Ignition by Frictional Impact Between Aluminum Alloys and Rusted Steel, BUMINES-RI-8005 (January 1975)

[3]Power Engineering, Vol. 59, pp. 79-80 (February 1955)

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EXTERNAL LETTER
9650352

ATTACHMENT 2

VERIFICATION OF USE OF SPARK PROMOTING
COMPOUNDS AT THE BOUNDARY
USED TO DEMONSTRATE COMPLIANCE
WITH
OSD-0030

Consisting of 4 Pages

Attachment 2 9650352

VERIFICATION OF USE OF SPARK PROMOTING
COMPOUNDS AT THE BOUNDARY
USED TO DEMONSTRATE COMPLIANCE
WITH
OSD-0030

Materials used during core sampling activities which could come in contact with the tank vapor space could be of concern if they will interact with the waste or vapors to increase the potential for flammable gas ignition events. These materials fall into two categories; 1) fluids or consumable materials, and 2) metallic or structural components. These are discussed separately below. The items involved are listed, along with the potential for increased flammable gas ignition events due to the presence of the material or an "unapproved" substitute, and any applicable controls to ensure proper materials are used.

1. <u>Fluids or Consumable Materials</u>

A) Dow Corning 111 Valve Lubricant and Sealant Compound - This is a silicone based lubricant used on the o-ring in the sampler piston and threads on the seal at bottom of sampler. This material is not flammable and will not cause any flammable gas sparking concerns. Should the wrong material be used, there would likely be sampler operability or possibly sample contamination problems, but the chance of a spark is remote. Gritty type materials would not accidently be used in place of the silicone material. The correct material to use is spelled out on the drawing for fabricating the samplers. All material used at the shop for fabricating the samplers is put on the Bill of Materials (BOM) and approved by Quality Control (QC) prior to use.

B) *Loctite 404 - This is an organic material with small amounts of titanium dioxide and silica. It is used for installation of the ball detents on sampler quadralatch, and for installation of the sampler cap. This material is placed on the threads of the items and is not exposed to the waste, except for very small quantities which may be present outside the threads. Due to the location and use, should an incorrect loctite compound be used, there would be negligible impact expected on flammable gas safety. The correct material to use is spelled out on the drawing for fabricating the samplers. All material used at the shop for fabricating the samplers is put on the BOM and approved by QC prior to use.

C) WD-40 - This is a common organic household lubricant. It is used occasionally for lubricating the grapple fingers, the RLU and miscellaneous items associated with the grapple and RLU retrieval mechanisms. This is a flammable material with about 80% volatiles which evaporate shortly after spraying. The remainder is a petroleum based oil. The amount of spray used is small. The material can be present inside the drill string in small quantities on the RLU or grapple, but is not a spark enhancing agent. The presence of excessive amounts of

Page 1 of 4

*Loctite is a trademark of Loctite Corporation

Attachment 2 9650352

WD-40 should show up in the Combustible Gas Meter (CGM) readings taken of the drill string. There are no specific controls in place to restrict the use of penetrating oils to WD-40. Similar compounds should have similar results. Since the material should not come in contact with the sample matrix, and monitoring should detect excessive levels of the spray oil, there are no safety requirements necessitating controls on the type of penetrating oil used.

D) Mean Streak Marking Stick - This is a white "grease pencil" used for marking numbers on the drill string sections. It contains small amounts of glycol ether solvents. The writing on the drill string would pose a negligible flammabilty hazard during operation. The drill rod could rub against the inside of a tank riser and theroetically cause a spark from the metal to metal contact. The presence of the writing material on the outside of the drill rod did not show any increased sparking potential when rudimentary tests were done striking and rubbing drill rod sections together that contained this material on the side. Further testing is not deemed warranted on this material. No controls are in place to ensure just this type of marking pencil is used, nor are any believed warranted at this time.

E) CIMSTAR QUAL STAR Undyed 042 - This is a thin preservative film which is present on new drill string as it comes from the manufacturer. Much of this is wiped off to permit writing on the drill string, and the insides are usually cleaned also, but there will likely be some residue. The material is made up primarily of mineral oil and other organic compounds. The Material Safety Data Sheet (MSDS) for the material indicates NA for flash point and lower explosive limit/upper explosive limit (LEL/UEL). No unusual fire or explosion hazards are listed. There will not be any cross contamination problems with the sample matrix and residual preservative on the drill string. No controls are in place to ensure just this type of preservative is used, nor are any believed warranted at this time. If shown necessary in the future, cleaning requirements would be developed for the drill string prior to use rather than specifying a given preservative.

F) Pipe Joint compounds - A number of pipe joint compounds may have been used within the past year for lubrication of the drill rod joints. Pipe joint compounds which may have been used for core sampling drill rod include:

-LA-CO T-O-T Pipe Joint Compound
-BOSTIK NEVER-SEEZ Pipe Compound with Teflon, Catalog # NPBT-8
-BOSTIK NEVER-SEEZ Anti Sieze and Lubricating Compound, Catalog # NSBT-8
-BOSTIK NEVER-SEEZ NICKEL NSN Pipe Compound (MSDS attached)
-BOSTIK NEVER-SEEZ NI/NUC GRADE Anti Sieze Compound (MSDS attached)
-TERAND ANTI-SEIZE COMPOUND
-MISTY ANTI-SEIZE COMPOUND
-PERMATEX ANTI-SEIZE LUBRICANT, part no. 133K
-FEL PRO HI-TEMP NICKEL-EASE anti seize lubricant, part no. 51285
-LA-CO Slic-Tite Paste Heavy Duty Thread Sealing Compound

Attachment 2 9650352

The first compound listed is the material recommended to use in the future. It has been used in the past without sparking noted, and is claimed by the manufacturer to be safe for use on natural gas pipelines. The second and third ones are the materials suspected of being used on U-109, with the second being the most likely. The third compound listed is the one which showed evidence of enhanced sparking in the preliminary tests done on 1/18/96. The procedures for core sampling have been or will be revised to require the use of LA-CO T-O-T only. Procedures which haven't been changed yet have been suspended until changed. A change will be made to the drawings for the core sampling equipment to show LA-CO T-O-T as the only acceptable pipe joint thread compound.

Some or all of the above compounds will be tested for spark enhancement potential. If testing shows no sparking problems, procedures, and drawings will be revised to list the additional acceptable materials.

G) Soapy water - This is used for flange gasket removal on the tank risers and for decontamination. It will have no impact on spark enhancement. No controls are in place on it's use, nor are any believed warranted at this time. There are general controls in place for tank farm activities concerning chemicals to use for decontamination, but these are present for corrosion control, not to minimize flammable gas ignition.

H) Lithium Bromide solution - This is a 0.3M aqueous solution used for hydrostatic head fluid for truck #1, and for flushing the bit for trucks #2, #3, and #4, wherever water would be required. The solution used is analyzed by the laboratory and an analysis provided prior to use. It will have no impact on spark enhancement.

2. Metallic or Structural Components

Listed below are the type of material and grades used for various sampler components which come in contact with the waste.

| | | |
|---|---|---|
| -Drill rod | - | ASTM A513 (AISI 1035), TYPE 5 ELECTRIC RESISTANCE WELDED CARBON AND ALLOY STEEL MECHANICAL TUBING, MANDREL DRAWN |
| -Core barrel | - | Same as for drill rod |
| -Drill bit | - | N/A, proprietary material, subject of other testing |
| -Quill rod adapter | - | ASTM A53, GR B, CARBON STEEL |
| -Universal Sampler | | |
| -body | - | ASTM A269 or A276 304 SST |
| -ball valve | - | Same as body |
| -cap | - | ANY GRADE ALUMINUM |
| -piston | - | ASTM A276 304 SST |
| -trip wires | - | NYLON (TYPE II) COATED AISI TYPE 302/304 SST, MIL W3420B WIRE |
| -quadralatch | - | AISI 8620-322 (ANNEALED) CARBON STEEL |

Attachment 2 9650352

The drill rod and core barrel material are ordered to manufacturers specification with QC personnel checking the material upon receipt. These are the only drill rods or core barrels available in tank farms for core sampling, so there is no chance of using material other than as listed. There are several different designs of drill rod or core barrels available, but they are made of the same material. Use of the wrong drill rod or core barrel could cause operational problems, but these wouldn't affect the flammable gas ignition potential.

All the remaining items are fabricated in the shops. The correct material to use is spelled out on the fabrication drawings. All material used at the shop for fabricating these items is put on the BOM and approved by QC prior to use. The universal samplers are cleaned with hexane prior to shipment from the shop to remove traces of machining oil or other contaminants.

One item to point out is the aluminum cap on the sampler. This would dissolve if exposed to the caustic wastes in the Hanford waste tanks, and generate hydrogen. A drawing change has been made to fabricate this cap from steel to eliminate this potential concern. At this time, samplers with the aluminum cap are still in use, but will likely be discontinued when the current supply is depleted.

# APPENDIX C

## DEPARTMENT OF ENERGY MEMO - RISK ACCEPTANCE CRITERIA FOR TANK FARM OPERATIONS

04/04/96 12:37 ☎509 3765396 SA&E 002
06/02/95 12:17 ☎509 376 2002 TWRS 001

Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

Risk acceptance

JUN 14 1995

95-TOP-063

President
Westinghouse Hanford Company
Richland, Washington

Dear Sir:

RISK ACCEPTANCE CRITERIA FOR TANK FARM OPERATION

Reference: WHC-CM-4-46, "Nonreactor Facility Safety Analysis Manual," Rev 4, March 31, 1995

Westinghouse Hanford Company (WHC) is directed to apply the risk acceptance criteria contained in the enclosure to this letter to all safety analysis for the tank farms and the 242-A Evaporator. Any changes to this criteria will require, at a minimum, concurrence and approval of the changes from my office.

Risk acceptance criteria for the evaluation of the acceptability of accidents at Hanford is contained in the referenced document. The Department of Energy (DOE) has approved application of the criteria taken from earlier revisions of this document for tank farm operation. This was done in the approval of the Evaporator Facility and Above-Ground Transfer Safety Analysis Reports. However, WHC subsequently revised this document in a non-conservative direction. This was done without knowledge or authorization from DOE. By definition, this would constitute an unreviewed safety question when applied to new accidents, as DOE would be asked to assume a greater risk than it has previously accepted for new accidents.

As pertains to tank farm operation, I have concluded that this change is unacceptable.

Therefore, WHC is directed to cease all application of the criteria contained in the updated referenced document for the evaluation of any accidents contained in any safety documents pertaining to any system or equipment in the Hanford Tank Farms, new tank farms, connection systems for the farms, or to the 242-A Evaporator facility. All safety documents pertaining to any system or equipment in the Hanford tank farms, new tank farms, connection systems for the farms or to the evaporator facility will use the criteria enclosed. This includes documents under preparation.

The risk acceptance criteria shown in the enclosure to this letter shall be used for all safety analysis, pending further analysis and concurrence in the revision of this criteria by DOE.

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06/02/95 12:17 ☎509 376 2002 TWRS 002

JUN 14 1995

WHC
95-TOP-003

-2-

If you have any questions, please contact Mr. Greg Morgan of my staff on (509) 373-2346.

Sincerely,

Ami B. Sidpara, Director
Tank Operations Division

Enclosure

cc w\encl:
R. Raymond, WHC
J. Lee, WHC
R. Schlosser, WHC
G. Franz, WHC
J. Badden, WHC
D. Busche, WHC
G. Jones, MACTEC

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04/04/96 12:36 ☎509 3765396 SA&E ☒004
03/02/95 12:18 ☎509 376 2002 TWRS ☒003

# Enclosure

## Tank Farm Risk Acceptance Criteria

Radiological Criteria

| Range of Annual Frequency | Effective Dose Equivalent (REM) |
|---|---|
| **On-Site Guidelines** | |
| 1.0 E-01 to 1.0 E-02 * | 1- 5 |
| 1.0 E-02 to 1.0 E-04 * | 5- 25 |
| 1.0 E-04 to 1.0 E-06 * | 25- 100 |
| **Off-Site Guidelines** | |
| 1.0 E+00 to 1.0 E-02 * | .01- .5 |
| 1.0 E-02 to 1.0 E-04 * | .5- 4 |
| 1.0 E-04 to 1.0 E-06 * | 4- 25 |

* Note: If a specific single point frequency is used, the guidelines are to be applied as curves. However, if a qualitative frequency ranking is used, the corresponding consequence limit (in REM) shall be used equal to the <u>lowest</u> REM limit for that frequency range.

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Toxicological Criteria

| Range of Annual Frequency | On-Site Guidelines | Off-Site Guidelines |
|---|---|---|
| 1.0 E-02 to 1.0 E+00 | ≤ ERPG-1 | ≤ PEL-TWA |
| 1.0 E-04 to 1.0 E-02 | ≤ ERPG-2 | ≤ ERPG-1 |
| 1.0 E-06 to 1.0 E-04 | ≤ ERPG-3 | ≤ ERPG-2 |

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# DISTRIBUTION SHEET

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| ME McKinney | S2-48 | X | | | |
| WC Miller | A2-34 | X | | | |
| CM Monasmith | E6-27 | X | | | |
| TL Moore | H6-11 | X | | | |
| RJ Nicklas | R1-43 | X | | | |
| EM Nordquist | S2-48 | X | | | |
| PL Owens | T4-01 | X | | | |
| JC Peschong | S7-53 | X | | | |
| DC Pfluger | H5-52 | X | | | |

EDT-608346

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| AM Umek | S7-81 | X |
| JE Van Beek | S2-48 | X |
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| JR White | H5-09 | X |
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