



## **Safety Evaluation Report for the Tank Farms Fire Hazards Analysis**

### **Reviewers**

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## **Safety Evaluation Report for the Tank Farms Fire Hazards Analysis**

### **EXECUTIVE SUMMARY**

In accordance with U.S. Department of Energy (DOE), Office of River Protection (ORP) implementing directive ORP M 420.1-1, "ORP Fire Protection Program" (Reference 1), CH2M HILL Hanford Group, Inc. (CHG) developed and submitted with Reference 2 a "Tank Farms Fire Hazards Analysis," HNF-SD-WM-FHA-020, Revision 2 (Reference 3) for ORP approval. This revised Tank Farms Fire Hazards Analysis (FHA) evaluates the spectrum of fire and related hazards for the Tank Farms in relation to existing safeguards and fire protection program features. The conclusions of the analysis are that the fire risk associated with the Tank Farms is within acceptable limits, an adequate margin of fire safety exists, and fire protection defense-in-depth (DID) has been provided in accordance with applicable fire safety criteria.

As part of this analysis, a number of fire safety "equivalency" determinations were presented. CHG identified a limited number of conditions that do not literally meet the provisions of governing fire safety criteria. Nevertheless, on the basis of its fire protection program and compensating safeguards, the ORP review team concurs with the FHA that these conditions are deemed not to be safety significant and that a comparable level of safety has been achieved through the implementation of a multi-faceted fire safety program.

The FHA and equivalencies were reviewed in comparison with governing DOE fire safety criteria including ORP M 420.1-1 (Reference 1), DOE O 420.1 (Reference 4) and its Implementing Guide DOE G 440.1-5 (Reference 5), and the relevant sections of National Fire Protection Association (NFPA) Standard 801, "Fire Protection for Facilities Handling Radioactive Materials" (Reference 6).

The implementation plan to resolve the deficiencies documented in Section 19.2 of the FHA was reviewed and found to be acceptable.

Based on the review of the FHA (Reference 3), the ORP review team concluded that:

- The FHA and equivalencies were prepared in accordance with applicable DOE fire safety criteria.
- The FHA is comprehensive as measured by DOE and NFPA guidelines.
- The FHA is consistent with the conclusions of other relevant Authorization Basis analyses.
- The Tank Farms are governed by an acceptable fire safety program that features fire protection DID.
- An adequate margin of (fire) safety exists for the Tank Farms.
- The fire safety equivalencies are justified.

The ORP review team approves the Tank Farm FHA (Reference 3) and implementation plan and schedule as described and submitted by CHG.

**TABLE OF CONTENTS**

**EXECUTIVE SUMMARY ..... ii**

**TABLE OF CONTENTS ..... iii**

**1.0 PURPOSE OF REVIEW ..... 1**

**1.1 Review Criteria and Process..... 1**

**1.2 Review Process ..... 1**

**2.0 BACKGROUND..... 1**

**3.0 EVALUATION ..... 2**

**3.1 Fire Hazards Analysis..... 2**

**3.2 Fire Safety Equivalencies..... 4**

**4.0 CONCLUSIONS..... 5**

**5.0 REFERENCES ..... 6**

Enclosure – Reviewers and Qualifications

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## **Safety Evaluation Report for the Tank Farms Fire Hazards Analysis**

### **1.0 PURPOSE OF REVIEW**

The purpose of this review is to evaluate the acceptability of the CH2M HILL Hanford Group, Inc. (CHG) Tank Farm Fire Hazard Analysis (FHA) (Reference 3). Included in the document are evaluations by CHG of a number of fire safety “equivalencies.” This review, in addition to determining the acceptability of the FHA, will also determine if the equivalencies are in accordance with the protocol delineated in the U.S. Department of Energy (DOE) fire safety criteria.

#### **1.1 Review Criteria and Process**

The principal review criteria utilized in reviewing the FHA is from:

- ORP M 420.1-1, “ORP Fire Protection Program” (Reference 1)
- DOE O 420.1, “Facility Safety” (Reference 4)
- DOE G 440.1-5, “Implementation Guide for Use With DOE Order 420.1, Fire Safety Program” (Reference 5)
- National Fire Protection Association (NFPA) Standard 801, “Fire Protection for Facilities Handling Radioactive Material” (Reference 6)
- NFPA Standard 101, “Life Safety Code” (Reference 7)

#### **1.2 Review Process**

The review was performed by the DOE Office of River Protection (ORP) Tank Farm Engineering Division. It involved comparing the contents of the Tank Farm FHA with the above-referenced criteria to determine if the criteria were met. The reviewer list and qualifications are identified in Enclosure 1.

### **2.0 BACKGROUND**

Paragraph 5.2.g of ORP M 420.1-1 (Reference 1) requires site operating contractors to “Perform FHA of facilities in accordance with DOE O 420.1 and DOE G 440.1-5, as supplemented by this manual.” Section 6.7.2 of Reference 1 delineates specific expectations regarding the scope and content of completed FHA. Reference 1 also describes a process for identifying and obtaining approval of fire safety “equivalencies.” An equivalency is a condition that deviates from the literal wording of a fire protection code or standard, yet achieves a comparable level of safety. To be accepted, an equivalency must be reviewed and approved by the DOE Authority Having Jurisdiction (AHJ) for fire safety. The AHJ for the Tank Farms is the ORP Manager.

In accordance with these requirements, CHG submitted (Reference 8) with Revision 1 of Reference 3 (FHA) attached with a number of equivalencies. The initial review of this submittal resulted in the conclusions that CHG had not addressed all of the essential elements of a comprehensive FHA, as required by DOE. Additionally, the analysis was inconsistent with other Authorization Basis (AB) documents and did not completely describe available safeguards. As a result of the above ORP letter "Return for Rework of Fire Hazards Analysis (FHA) for Tank Farms" (Reference 9) was issued to CHG. In response, CHG has submitted a revised FHA and corresponding equivalencies (Reference 9). The subject CHG submittal (Reference 2) with Revision 2 of reference 3 attached has addressed the above concerns with the Revision 1 FHA.

The FHA (Reference 3) concludes that the fire protection program for the site is acceptable and that an adequate margin of fire safety exists. The contractor also represents the equivalencies as being justified and recommends their approval.

### **3.0 EVALUATION**

#### **3.1 Fire Hazards Analysis**

The FHA encompasses a number of facilities including the tanks, support buildings (such as the evaporators), pipelines and associated equipment (such as valve pits), and ancillary buildings (such as the control, compressor and change buildings). Each of these facilities and their corresponding fire hazards are described in detail in accordance with the DOE fire protection guidelines. The corresponding operational characteristics are described separately in the FHA as are the available fire protection features.

Fire and related hazards associated with the Tank Farm facilities are both delineated in the FHA and described elsewhere in corresponding AB documents and related studies. They include a spectrum of common hazards, such as conventional ignition of ordinary combustible materials, through various scenarios associated with the ignition of off gases related to stored waste, among other accidents. For each of the hazards, CHG (or their predecessors in referenced studies) have evaluated the risk associated with credible (and beyond credible) events. The analyses have been conducted by a diverse group of qualified and experienced fire protection engineers, accident analysts, and supporting experts. Resulting from these analyses, and consistent with Integrated Safety Management principles, appropriate safeguards have been implemented with the intention of minimizing the occurrence of an ignition or limiting the consequences of a fire or related event, if one should occur. In addition to a range of specific fire prevention and protection features that are described below, fire safety is achieved through design and operational safeguards, such as tank ventilation systems and equipment inspection, testing and maintenance programs. No single safeguard is relied upon to assure an adequate margin of safety.

The fire protection program that has been implemented by CHG for the Tank Farms is multi-faceted. It includes, among other attributes, a range of fire prevention measures, such as combustible material and ignition source controls. It also manifests both passive fire safety features (such as fire barriers within buildings and combustible-free zones around facilities) and active fire protection systems for facilities (principally fire suppression and detection systems).

The program encompasses the training of employees in hazard recognition, fire prevention, and emergency response. It includes a number of fire protection engineering related activities such as routine fire safety assessments of all facilities, the review of planned modifications to assure conformance to fire applicable standards, and the development of hazards analyses for work activities. All are intended to minimize the risk from fire and related events.

Fire protection features for the Tank Farm complex is diverse. Features include individual (fire) water distribution systems with hydrants generally positioned to permit ready access by the Hanford Fire Department (HFD [Refer to Section 3.2 of this SER for the exceptions]). The capacity of these systems is sufficient to suppress any credible fire as confirmed by water flow tests and is suitably redundant to avoid interruption as a result of a single component failure.

Select buildings are equipped with fixed automatic fire suppression systems, fire detection, alarm, and signaling systems. These systems are, generally, designed, installed and maintained in accordance with the governing NFPA codes and standards and DOE guidelines (deviations from established standards have been identified and justified). The fire protection systems are provided to correspond with and mitigate distinct fire hazards associated with these facilities. Protection is provided commensurate with the identified hazards. Supplementing the fixed systems is manual fire fighting equipment, principally portable fire extinguishers of appropriate type, and readily accessible to those trained in their use.

Structures, interior finish and equipment components are of fire resistant or noncombustible construction, where necessary. Transient combustible materials are subjected to a program of controls that minimize their accumulation. Ignition sources, such as energized electrical equipment, smoking materials, cutting torches, etc. are also controlled in such a manner as to minimize the potential for ignition and the development of uncontrolled fires.

To assure that employees are capable of evacuating any building in the event of a fire, adequate emergency egress capabilities have been provided. This includes remote and redundant paths of travel to exits, along with exit signage and emergency lighting, as needed. The provisions for emergency egress generally conform to the requirements of Title 29 Code of Federal Regulations (CFR) Part 1910.38 "Means of Egress" (Reference 10) and NFPA Standard 101 "Life Safety Code" (Reference 7). A limited number of variances have been identified to these requirements, but the conditions will not adversely affect employee safety (Refer to the discussion in Section 3.2 of this SER on the fire safety equivalencies).

While the safeguards identified above are intended to prevent or control a fire, the HFD is relied upon to extinguish fires at the Tank Farms and to mitigate the consequences of a range of related events, such as responding to a medical emergency and hazardous material incident. The HFD is a professional emergency response force with a full complement of mobile fire apparatus, a complete inventory of fire fighting and related equipment, and a sufficient staff of trained emergency response professionals. It is equipped, positioned, and trained to respond in a timely and effective manner to these occurrences. The capabilities of the HFD are confirmed through regular instruction and onsite drills, the ongoing development of the Baseline Needs Assessment and periodic evaluations to the requirements of NFPA standards related to emergency response.

Based on the above fire protection program and related engineering and administrative safeguards, the identified fire hazards and associated risk are acceptable. These safeguards represent fire protection defense-in-depth as required by the above-referenced fire safety criteria. An adequate fire safety margin exists.

### **3.2 Fire Safety Equivalencies**

As defined in the Implementation Guide (Reference 5), an “equivalency” is a determination by the DOE AHJ that a code or standard has been met by alternate means. The DOE AHJ for the Tank Farms is the ORP Manager.

CHG identified three conditions for which equivalency determinations were made:

- The property loss potential associated with a waste storage tank headspace explosion may exceed the \$150 million limit imposed by DOE.
- The Building 2704-HV second floor exit capacity is less than that required by the Life Safety Code (Reference 7).
- The spacing of fire hydrants in a limited area exceeds that stipulated in ORP M 420.1-1 (Reference 1).

To establish that an equivalent level of safety exists to compensate for these conditions, the contractor described safeguards that are in place and being maintained. For the property loss potential associated with a headspace explosion, these included both administrative controls and engineered safeguards that minimize the potential for an explosion, as described in Section 3.1 above. For 2704-HV, the nominal exit deficiency was compared to the actual occupancy of the second floor and with existing fire safety features to demonstrate that, in the unlikely event that a fire occurred, second floor occupants could safely evacuate in a timely manner. Regarding the spacing of fire hydrants, CHG described the capabilities of the HFD to compensate for hydrant placement.

From ORP’s perspective, the \$150 million loss potential limit is intended as a “trigger” to prompt the installation of additional fire protection (fire barriers and/or automatic fire suppression) to limit loss below this amount. This is based on the premise that a fire will occur. At the Tank Farms, multiple safeguards are provided to prevent an explosion from occurring in the first place. This approach is considered acceptable and preferable because it minimizes the potential for any loss and it reflects the fact that the installation of conventional fire suppression systems and barriers are impractical, costly, and potentially ineffective.

With regard to Building 2704-HV, actual human habitation of the second floor is significantly less than the calculated exit capacity. Emergency egress consists of redundant and remote paths of travel that are provided with emergency lighting and illuminated exit signs. The employees are intimately familiar with the means available to escape from a fire and are fully capable of doing so in an effective manner. Fire prevention measures are in place, such as controls on combustibles and ignition sources. Fire protection features have been provided commensurate with the hazard. Based on the identified hazards a fire is likely to be small initially and detected

in its formative stages. The HFD is fully capable of suppressing a fire before it spreads. Under these circumstances, a timely evacuation of all second floor personnel is expected.

The adverse safety consequence of the noted hydrant placement is that access to the hydrants by the HFD will be delayed briefly and that additional lengths of fire hose will be necessary to reach fire-affected areas. However, the HFD is well trained in hose evolutions, it is provided with sufficient hose on each pumper to compensate for the extra distance, and it is staffed by knowledgeable and experienced emergency responders. The added time that will be necessary to compensate for this condition is deemed minimal and insignificant from a safety perspective.

Based on the compensating safeguards provided, the ORP review team concluded that an equivalent level of safety has been achieved for the above-noted conditions.

Reference 2 contains an implementation plan to resolve the four (4) deficiencies listed in Section 19.2 of the FHA. The review team finds that the implementation plan and schedule is acceptable.

#### **4.0 CONCLUSIONS**

The FHA and equivalencies were reviewed in comparison with governing DOE fire safety criteria including ORP M 420.1-1, DOE O 420.1 and its Implementing Guide, and the relevant sections of NFPA Standard 801, "Fire Protection for Facilities Handling Radioactive Materials," and NFPA Standard 101, "Life Safety Code." Based on the review of this documentation, the ORP review team concludes that:

- The FHA and equivalencies were prepared in accordance with applicable DOE fire safety criteria.
- The FHA is comprehensive as measured by DOE and NFPA guidelines.
- The FHA is consistent with the conclusions of other relevant AB analyses.
- The Tank Farms are governed by an acceptable fire safety program that features fire protection defense-in-depth.
- An adequate margin of (fire) safety exists for the Tank Farms.
- The fire safety equivalencies are justified.

Based on the above, the ORP review team approves the Tank Farm FHA (Reference 3) without modifications.

The ORP review team also reviewed the implementation plan and schedule to resolve the four deficiencies listed in Section 19.2 of the FHA and finds it acceptable. CHG is directed to complete the implementation plan as described in Reference 2.

## **5.0 REFERENCES**

1. ORP M 420.1-1, "ORP Fire Protection Program."
2. CHG letter from E. S. Aromi to R. J. Schepens, ORP, "," CHG-, dated .
3. HNF-SD-WM-FHA-020, "Tank Farm Fire Hazards Analysis," Revision 2.
4. DOE O 420.1, "Facility Safety."
5. DOE G 440.1-5, "Implementation Guide for Use With DOE Order 420.1, Fire Safety Program."
6. NFPA Standard 801, "Fire Protection for Facilities Handling Radioactive Material."
7. NFPA Standard 101, "Life Safety Code."
8. CHG letter from J. C. Fulton to S. L. Johnson, ORP, "Transmittal of CH2M HILL Hanford Group, Inc. Fire Hazards Analysis," CHG-0107151, dated December 27, 2001.
9. ORP letter from H. L. Boston to E. S. Aromi, CHG, "Return for Rework of Fire Hazards Analysis (FHA) for Tank Farms," 02-SHD-008, dated February 13, 2002.
10. 29 CFR 1910.38, Subpart E, "Means of Egress."

**ENCLOSURE TO ATTACHMENT  
02-TED-**

**REVIEWERS AND QUALIFICATIONS**

## **Reviewers**

**Dennis J. Kubicki, P.E.**

**Stephen H. Pfaff**

**Chris Sorensen**

## **Reviewer Qualifications**

**Team Member Name:** Dennis J. Kubicki, P.E.

**Title and Organization:** Senior Fire Protection Engineer, U.S. Department of Energy (DOE) Headquarters' (HQ) Office of Corporate Safety Assurance  
Seconded to the Office of River Protection (ORP)

**Area Assigned:** Fire Safety

**Education and Technical Qualifications and Experience:**

- B.S. Degree in Fire Protection and Safety Engineering from Illinois Institute of Technology
- Master's Degree in Business Administration from the University of Maryland
- Master's Degree in Safety from the University of Southern California.
- Registered professional engineer in the state of Delaware.

**Summary of Experience:**

Mr. Kubicki has held a number of fire protection engineering positions since graduation, including those with; Insurance Services Office of Maryland, the Maryland State Fire Marshal's Office, the U.S. General Services Administration, NASA, and the U.S. Nuclear Regulatory Commission. Throughout his career he has performed an extensive array of fire safety assessments. He has been with DOE since 1990 where he has been responsible for developing fire protection policy and standards, performing oversight of (DOE) contractor fire safety programs, implementing fire safety research, developing training courses, and providing fire protection technical assistance to other Departmental entities.

Mr. Kubicki has authored a number of articles on diverse fire safety topics and was editor of DOE's fire protection newsletter "DOE-Nuts." From its inception until the summer of 2000, he was Chairman of the DOE Fire Safety Committee. Dennis is currently a member of the National Fire Protection Association's technical committee for fire safety for nuclear facilities.

**Team Member Name:** Stephen H. Pfaff  
**Title and Organization:** Facility Representative, ORP  
**Area Assigned:** Tank Farm Operations

**Summary of Education and Technical Qualifications:**

- Sixteen years experience in the naval nuclear and DOE non-reactor nuclear fields
- B.S. in business administration and naval science, Oregon State University
- Qualified as prospective chief engineer for the D2G nuclear propulsion plant
- Qualified as facility representative at Rocky Flats and Hanford
- Office of Assistant Manager for Environmental, Safety, Health and Quality-Qualified assessment team member and NQA-1 lead auditor

**Summary of Experience:**

- Team member, three Vital Safety System assessments at Hanford Tank Farms in support of the DOE implementation plan for Defense Nuclear Facilities Safety Board Recommendation 2000-2
- Team member, two construction quality assurance assessments of the tank farms construction contractor
- Team member, Integrated Safety Management (ISM) Phase II Assessment of Tank Farm Contractor (TFC)
- Team leader, ORP line management readiness review prior to Phase II Assessment of TFC's ISM system
- Team leader, corrective action management assessment of the TFC
- Team member, DOE readiness assessment for restart of the Hanford Plutonium Finishing Plant laboratory and waste management activities
- Team leader, conduct of operations assessment of TFC

**Team Member Name:** Chris Sorensen

**Title and Organization:** General Engineer, Tank Farm Engineering Team, ORP

**Area Assigned:** Tank Farms Engineering

**Summary of Education and Technical Qualifications:**

- B.S. in Engineering, University of Washington
- Qualified Nuclear Shift Test Engineer on S5W Reactor Plants, Puget Sound Naval Shipyard
- Qualified as U.S. Nuclear Regulatory Commission (NRC) Resident Inspector and Senior Resident Inspector
- Qualified in Nuclear Safety Systems, Technical Qualification Program for DOE Technical Personnel
- Twenty-three years experience in various naval, commercial, and DOE nuclear facilities

**Summary of Experience:**

- Responsible for Startup/Restart Program and ISM System for the ORP.
- Site Safety Representative at Hanford for DOE HQ.
- DOE Project Engineer for Fast Flux Test Facility.
- NRC Senior Resident Inspector at Columbia Generating Station, dealing with inspection and enforcement of facility license and design basis.
- NRC Resident Inspector at Columbia Generating Station.
- NRC Project Inspector for Palo Verde Nuclear Generating Station.
- Nuclear Shift Test Engineer for reactor plants on various submarines at Puget Sound Naval Shipyard.
- Assistant Shift Test Engineer for reactor plants on various submarines at Puget Sound Naval Shipyard.