I. Title of USI Evaluation:

USI Evaluation for Replacement of Stand-by Pumps and Manifold Connection Hoses in the Target Service Bay FSS Water Mist System

II. Description of Proposed Activity (or discovered condition) (use attachments if necessary):

The Target Service Bay Fire Suppression System (FSS) is credited with detecting and suppressing fire in the Service Bay. Over the past several years, numerous leaks have been encountered in the system's stand-by pumps and manifold connection hoses. The manufacturer recommends replacement of both the standby pumps and manifold connection hoses with similar but not identical components. This USI Evaluation evaluates replacement of the following components in the Target Service Bay FSS:

- **Stand-by Pump Replacement** - replace the two *Haskel Milton Roy M Series* stand-by pumps with *Trojan Type J* gas driven mechanical piston-type stand-by pumps, and

- **Nitrogen Bottle Manifold Connection Hose Replacement** - replace the *Dunlop HIFLEX* hoses used to connect the nitrogen bottles to the nitrogen bottle manifold with new stainless steel braided flex hoses.

Mist System Overview

The Target Service Bay Fire Suppression System, referred to as the "water mist system" is a Credited Engineered Control credited with detecting and suppressing fire in the service bay. The system monitors the service bay atmosphere with a VESDA smoke detection system which actuates the water mist system upon detection of fire in the Service Bay. The water mist system utilizes a nitrogen bottle gas bank (see Figure 1) in conjunction with water stored in dedicated tanks (see Figure 2) to create a mist discharge through spay heads mounted in the Service Bay. The water mist is created by a Gas Driven Pump Unit (GPU).

The water mist system provides protection coverage for two zones of operations. Suppression Zone 1 covers the process/maintenance bay and Suppression Zone 2 covers the transfer bay. As stated in Section 5.2.6 of the FSAD-NF, the Target Service Bay FSS is credited for fire detection/suppression in Zone 1. Fire detection/suppression in Zone 2 is not a credited function.

The water mist system is comprised of two HI-FOG® GPUs (GPU-1 and GPU-2) manufactured by the Marioff Corporation. Figure 3 provides a photograph of GPU-2. Each GPU is fed by its own dedicated nitrogen gas bottle bank and dedicated water storage tanks (see Figures 1 and 2). The GPU uses a piston type pump propelled by the pressurized nitrogen to atomize the water into a mist.

A Stand-by pump (See Figures 3 and 4) is used to maintain GPU system standby pressure up to the actuation control valve at about 25 bar (360 psig)[1]. The Stand-by pump is a pneumatic pump powered by a dedicated nitrogen bottle (Figure 3).

[1] Technical Data Sheet TE6001, Gas driven Pump Unit GPU, Product GPU-6, September 18, 2003, Sheet 1 of 2

Figure 1. Target Service Bay Water Mist System Nitrogen Bottle Bank. Note the bottles are connected to a common manifold via manifold connection hoses.

Figure 2. Dedicated Water Tanks for Target Service Bay Mist System[1].

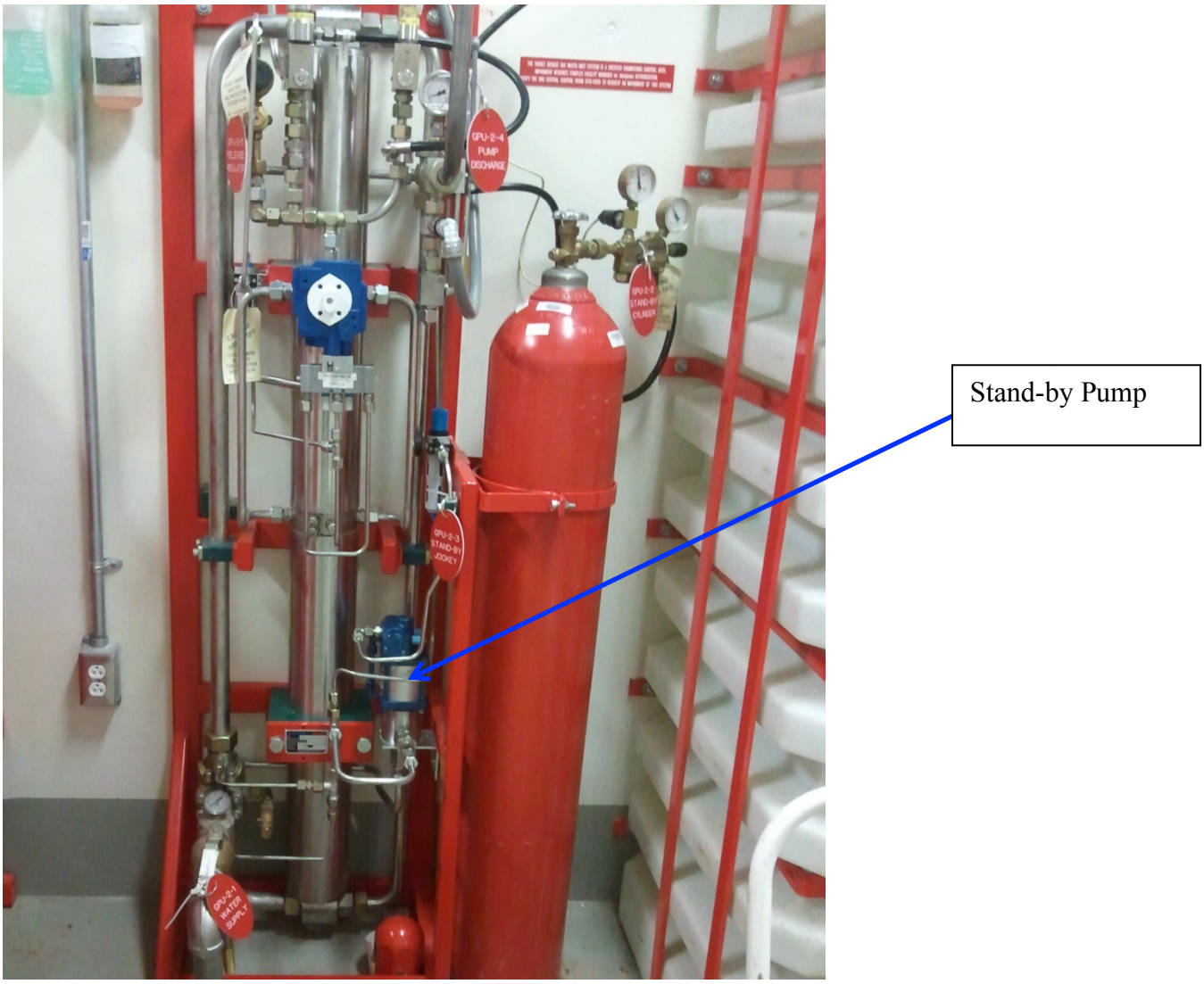

Figure 3. Target Service Bay Water Mist System GPU # 2.

Upon detecting smoke, the VESDA smoke detection system sends a signal to open the control valve which allows the standby pressure to create a flow of water through the control valve. The water flow induces a pressure drop that opens the hydraulically operated nitrogen cylinder primary valve that starts the main GPU and opens the pneumatic valves of the cylinder bank. A more detailed description of the system is provided in Marioff system manual[2].

As stated earlier, the system has experienced issues with gas leakage over the past several years.

[2] Marioff Hi-Fog Design Installation, Operations and Maintenance Manual, Document, MO/PES/02/DIOM/FM/98, Revision 1.3, November 2003.

The regional distributor and installer of Marioff equipment, *ORR Protection Systems*, headquartered in Louisville, Kentucky, was hired to trouble shoot the system. *ORR Protection Systems* identified leaks in the Standby-Pumps and in multiple manifold connection hoses connecting the nitrogen gas bottles to the nitrogen bottle manifold. The Standby Pumps were leaking through seals and the hoses were leaking through the outer jackets (linings). *ORR Protection Systems* recommended replacement of both the Stand-by Pumps and the manifold connection hoses with improved components.

Replacement Stand-by Pumps

The original Stand-by Pumps used in the system, were *Haskel Milton Roy M Series* gas driven mechanical piston-type pumps.

ORR Protection Systems communicated that Marioff has discontinued use of the Haskel Milton Roy M Series Stand-by pumps. The *Haskel* pumps have been found to be prone to leakage due to internal corrosion problems. Consistent with Marioff Product Information Note DOC00024603 (Dated June 27, 2008), ORR Fire Protection recommended replacement of the *Haskel Milton Roy M Series* Stand-by Pumps with *Trojan Type J* Stand-by Pumps (see Figure 4). Marioff Product Information Note DOC0002460 indicates that Marioff transitioned to use of the *Trojan Type J* Stand-by Pumps in 2008 and made a retrofit kit available for changing the Stand-by Pumps in installed GPU units.

The data sheet for the Trojan Type J Stand-by pump lists the following specifications:

Ratio 1:11
Output/Cycle: 19 cc
Max Free Flow: 5 liters/minute
Max Output Pressure w air supply @ 7bar: 73 bar

The nameplate on the pump indicates:

Air: Hydraulic Ratio: 11:1
Air Pressure: 1.3 bar min and 8 bar max
Type: J

The *Trojan* pump offers stainless steel wetted internal components, which the *Haskel* pump lacked, to prevent internal corrosion. The Trojan pump offers greater durability and overall reliability.

3 Product Information Note DOC0002460, Trojan *Stand-by Pumps Taken Into Use*, HI-FOG Water Mist Fire Protection, Marioff Corporation, PIN 006/2008June 27, 2008.

Figure 4. Replacement Trojan Type J Stand-by Pump and Adjacent Nitrogen Cylinder(GPU #2)

Replacement Manifold Connection Hoses

Manifold connection hoses are used to connect nitrogen gas bottles to the nitrogen gas manifold as shown in Figure 5. In the operational system configuration, all gas bottle valves are fully opened such that the manifold is maintained in a pressurized state via the manifold connection hoses. Any leak in the system bleeds down the system pressure, ultimately actuating a low pressure alarm to

the operator. Leaks in the previous bottle to manifold hoses caused significant system down time.

Due to difficulties in obtaining needed hoses from *ORR Protection Systems*, an experienced manufacturer of high-pressure hose assemblies[4] was contracted to fabricate replacement hoses appropriate for connecting the nitrogen gas bottles to the mist system manifold. Details of the new hose specifications and design have been approved by ORNL Fire Protection[5].

The Water Mist system uses nitrogen gas cylinders and those cylinders have pressure ratings. All cylinders are stamped with a 2400 psig working pressure. Furthermore, they are also stamped with a "+" that means they can be over-filled by 10%. The replacement hoses have a 3700 psig working pressure and are tested to 2860 psig. Therefore, the hose pressure ratings supersede the cylinder limitations. An example of the Hydrostatic Test Certification for the hoses is provided in Attachment 1.

Figure 5. Nitrogen Gas Bottles Connected to Nitrogen Gas Manifold.
Manifold connection[2]

The planned modifications enhance overall performance of the fire suppression systems by increasing system reliability and availability. The ability of the system to continue to meet the requirements of NFPA-750 will be unaffected.

Current Mist System Status

The Target Service Bay FSS (water mist system) is presently considered inoperable. Requirements

[4] SNS Drawing, *Target Service Bay Mist Fire Protection System Braided Fire Protection Hose*, 108030700-M8U-8700-A037, Revision 0.
[5] *Request For Fire Protection Engineering Approval*, Replacement/Repair of Target Service Bay Water Mist System Hoses and Components, Reference Number 8700-2014-003, June 2014.

for Operability/Compensatory Measures as stated in the ASE Section 3.7.2 have been enacted and will remain in force until the FSS is returned to operability.

In 2012, *ORR Protection Systems,* an authorized distributor and installer for Marioff, replaced the Haskel Stand-by Pumps with Trojan Type J Standby Pumps and also replaced the manifold connection hoses connecting the nitrogen gas bottles to the nitrogen gas manifold. The system was not and has not been returned to service pending review and approvals (including USI Evaluation) and testing.

During the review process it was discovered that the wrong hoses (Marioff Product A20035) were used. Hoses and specification sheets were provided for steel braided hoses designed for the lower pressure application of connecting the spray head assembly body to the water distribution pipework[6] . As stated earlier, the system was not and has not been returned to service.

The replacement hoses will be installed by the Target Systems Team in accordance with ORNL SBMS and SNS work control procedures. The entire Target Service Bay Fire Suppression System (water mist system) will undergo full annual testing by ORNL Fire Protection to ensure proper operability and compliance with NFPA-750[7].

III. Does the proposed activity or discovered condition affect information presented in the FSAD-NF or FSAD-PF, e.g. regarding equipment, administrative controls, or safety analyses. If so specify the applicable FSAD and relevant sections.

No. The FSAD-NF discusses the role of the GPU #1 and GPU #2, but does not specify details such as what types of pumps or hoses are involved. The proposed modification does not affect the role of the GPUs as described in the FSAD. The proposed change does not affect information presented in the FSAD and no FSAD revisions would be necessary to accommodate the proposed change.

The FSAD-NF addresses the FSS in the Target Service Bay in the following Sections:

3.3.10.3 *Fire Protection Systems*

4.3.12 *Fire Detection and Suppression System Event Scenario Summary*

5.2.6 *Fire Suppression System Inside The Target Service Bay*

IV. Does the proposed activity or discovered condition affect any of the requirements of the ASE. If so, list the affected sections

No. The ASE addresses the FSS in the Target Service Bay in Section 3.7, *Fire Suppression System Inside Target Service Bay*. The ASE provides operability requirements, compensatory measures and surveillance requirements; but does not address details regarding the types of pumps or hoses involved. The proposed change does not affect any information presented in the ASE.

Furthermore, the ASE requires the mist system to be operable when mercury is loaded in the circulation loop unless the steel shielding designed to cover the mercury loop is installed (ASE, Section 3.7). By procedures, the respective steel shielding designed to cover the mercury loop has always been and should

[6] Marioff Technical Data Sheet TA2005, Oct 13, 2008.

[7] NFPA-750, *Standard on Water Mist Fire Protection Systems,* National Fire Protection Association, 2010 Edition.

always be installed when mercury is in the circulation loop. Per SNS Operations Procedures Manual, SNS OPM- 7.T-5.2, Filling, Startup and Operation of the Mercury Loop, has a prerequisite that the shielding is in place (refer to Step 3.16). In addition, Group Internal Operating Procedure, TS-IOP-014 Target Change Out – Removal and Installation, has requirements for installation of shielding (refer to Step 5.63) and has sign offs that the system is ready (refer to Step 5.64). Therefore, the ASE requirement for FSS operability has been and continues to be met, and the proposed activity does not affect any of the requirements of the ASE.

V. USI Evaluation Criteria:

1. Could the change significantly increase the probability of occurrence of an accident previously evaluated in the FSADs? Yes __ No_x_

   Justification: The proposed change has no affect on the probability of occurrence of any accident evaluated in the FSAD. Changes to the FSS, a mitigative system, do not have the potential to affect accident occurrence probability

2. Could the change significantly increase the consequences of an accident previously evaluated in the FSADs? Yes__ No _x_

   Justification: The proposed change does not increase the consequence of any accident evaluated in the FSADs. The FSS in the Service Bay is credited for mitigating postulated fires in the Service Bay. The unmitigated consequences of such accidents are not impacted. Since the proposed change does not negatively affect the functionality or reliability of the FSS, mitigated accident consequences are not affected.

3. Could the change significantly increase the probability of occurrence of a malfunction of equipment important to safety previously evaluated in the FSADs?

   Yes__ No _x_

   Justification: The proposed change does not significantly increase the probability of occurrence of a malfunction of the FSS. Replacement of the pumps and hoses with the new manufacture's recommended components will increase the system reliability and availability by reducing system downtime due to leaks. Prior to service, the system will undergo full annual testing by ORNL Fire Protection to ensure proper operability and compliance with NFPA-750.

4. Could the change significantly increase the consequences of a malfunction of equipment important to safety previously evaluated in the FSADs?

   Yes__ No _x_
   Justification: The replacement stand by pumps and manifold connection hoses are similar to the original components and serve identical functions within the system. The consequences of a malfunction of the FSS are unaffected by the proposed change.

5. Could the change create the possibility of a different type of accident than any previously evaluated in the FSADs that would have potentially significant safety consequences? Yes__ No _x_
   Justification: The proposed upgrade of the systems' stand by pumps and manifold connection hoses will not create the possibility of any new accident. The replacement components are similar to the original components and serve the identical functions within the system.

6. Could the change increase the possibility of a different type of malfunction of equipment important to safety than any previously evaluated in the FSADs?

   Yes__ No _x_
   Justification: No. The replacement stand by pumps and manifold connection hoses are similar to the original components and serve the identical functions within the system. The proposed change to upgrade the system's pumps and hoses will improve system reliability and availability by using superior components and will not create a different type of malfunction of the FSS.

VI. USI Determination: A USI is determined to exist if the answer to any of the 6 questions above (Section V) is "Yes." If the answer to all 6 questions is "No", then no USI exists.

a. Does the proposed activity (or discovered condition) constitute a USI?

__ Yes – DOE approval required prior to implementing

_x_ No – Proposed activity may be implemented with appropriate internal review.

Qualified Preparer, David Freeman, SNS Safety Specialist — Date: 7/3/2014

Qualified Reviewer, Mike Harrington — Date: 7/2/2014

Patrick Thornton, SNS Fire Protection Engineer — Date: 7/3/14

Reviewer, Steven Trotter, Environmental Engineer — Date: 7/3/2014

Mike Baumgartner, Mechanical Systems and Operations Group Leader — Date: 7/7/14

Approvals:

Signature of SNS Operations Manager or Designee — Date: 10 July 2014

Attachment 1.

Credited Engineering Control Compliance and Test Report

Date: 4·3·14

Work Order Number: 1362128

Test Report

Initial Test: ✓ Re Test:

System Tested: REPLACEMENT MIST FIRE PROTECTION HOSES

Section Tested: HF3455-TA-12MM-24 NO. 1, 2, 3, 4

Piping Material: 316 STAINLESS STEEL & 304 STAINLESS STEEL

Acceptance Criteria: HOLD TEST PRESSURE FOR 10 MINUTES WITH NO LEAKS

Type of Test: PNEUMATIC UNDER WATER Test Medium: NITROGEN

Test Duration: 10 MIN Test Pressure: 2860 PSI - 2901.4

Test Start Time: 1:46p Test Finish Time: 1:56p

Acceptance Criteria Met Yes/No: YES

Test Performed By: Brian Smalley (RESEARCH MECHANIC) DATE: 4·3·14

Test Accepted By: [signature] (TASK LEADER) DATE: 4-3-14

Credited Engineering Control Compliance

Brief description of CEC change or modification: Pressure Circled is final test pressure @ 10 minute interval in P.S.I

Operations Lead Up Date ACE / OE Tracker Date:

Group Leader Concur CEC Compliance / Date: