Contract No. and Disclaimer:

DRAINING HAZARDOUS FLUIDS DURING BUILDING 221-1F DEACTIVATION AT THE SAVANNAH RIVER SITE (SRS)

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Several years ago, SRS completed a four year mission to decommission ~250 excess facilities. As part of that effort, SRS deactivated multiple facilities (e.g. Building 247-F, Naval Fuels Facility, and Building 211-F, Outside Facilities for F-Canyon) that contained extensive piping systems filled with hazardous material (e.g. nitric acid). Draining of hazardous materials from piping was successfully completed in all facilities without incident. In early 2009, the decommissioning program at SRS was restarted as a result of funding made available by the American Recovery & Reinvestment Act (ARRA). Under ARRA, draining of piping containing hazardous material was initiated in multiple facilities including Building 221-1F (or A-Line). This paper describes and reviews the draining of piping containing hazardous materials at A-Line, with emphasis on an incident involving the draining of nitric acid. The paper is intended to be a resource for engineers, planners, and project managers, who face similar draining challenges.

I. INTRODUCTION

In early 2009, the decommissioning program at SRS was restarted as a result of funding made available by the ARRA. Using the ARRA funding, SRS restarted deactivation of A-Line where deactivation included the draining of piping containing hazardous material (e.g. nitric acid). Removal of hazardous material from A-Line would prepare the facility for decommissioning (i.e. demolition), which would take the facility to its final end state.

II. BACKGROUND

Building 221-1F (also known as A-Line) is located adjacent to and southeast of F-Canyon in F-Area of the SRS. Previously, F-Canyon discharged uranyl nitrate solutions to A-Line, and A-Line converted the solutions to (depleted) uranium trioxide powder for long-term storage in drums elsewhere at SRS. A-Line has a footprint of approximately 12,500 square feet over three main floors and an extensive yard with multiple vessels and extensive piping systems.

FIGURE 1 – Building 221-1F, A-Line

A-Line was built in the early 50's and operated more or less continuously through the early 1990's when it was shutdown. A-Line then entered a period of surveillance and maintenance until approximately 2002, when it was initially deactivated concurrent with F-Canyon deactivation.

During the initial deactivation (Phase 1) from 2002 to 2005, typical deactivation activities were completed including the deinventory of chemicals and solutions and the flushing of piping and process vessels. Based on the Phase 1 deactivation, piping was believed to be flushed and drained. During subsequent deactivation initiated in 2006 (Phase II), SRS expected to encounter only minor quantities of fluid. For piping formerly containing nitric acid, SRS expected only mildly acidic fluids. The intent of the Phase II deactivation was to further reduce hazards in the facility. Phase II deactivation included the following example deactivation end points:

- Formal mechanical isolation of A-Line that included draining of piping and local air gapping of the piping
- Extensive equipment dismantlement and removal (further deinventory of piping and vessels that would result in a facility downgrade ("nuclear" reduced to "radiological" or "other industrial").

III. DISCUSSION

III.A. General Method for Draining Piping

SRS conducts all draining of hazardous fluids in accordance with written procedures (or "work packages"). As a first step in the preparation of work packages, Engineering develops a "drain index" as required by written draining guidelines. As part of the "drain index", the guidelines require Engineering to identify and/or define the following for each pipe to be drained:

- Pipe's location (pictures are required)
- Pipe's contents (e.g. 65% nitric acid)
- Pipe's size (e.g. 3" nominal) and materials of construction (304 stainless steel)
- Method to Drain (e.g. use "hot tap")[1]
- Method to Vent (e.g. open valve @ high point)
- Collection container
- Capping/sealing end of cut pipe

SRS Planning develops the work packages based on the engineering indexes. Past work packages contained instructions for draining each line, but left some details to the discretion of the experienced First Line Manager and deactivation worker. The work packages contained the following instructions/information, which were in addition to that contained in the engineering index:

- As reference, the manufacturer's instructions for the hot taps
- Use of pH paper to check pipe contents
- General chart for material compatibility

The following draining details were generally left to the discretion of the experienced First Line Manager and deactivation worker:

- Selection and use of containments (including components and materials of construction)[2]

Because system valves are typically not available at the desired draining location, SRS makes extensive use of hot taps to drain piping containing hazardous fluids. These hot taps are commercially available and have been used extensively and successfully at SRS as well at as other DOE sites. Users have reported successful use of the taps in a full range of application including concentrated nitric acid. The manufacturer offers the hot tap as a commercial product where the end user is responsible for ensuring material compatibility. Per the manufacturer, successful usage is expected provided you follow their operating procedures.

III.B. August 2009 Nitric Acid Release

Last August, SRS lost primary confinement associated with a nitric acid supply line that SRS was attempting to drain and then air gap. A hot tap was installed on the line several days prior to the release. A work bumped the drill bit, the drill bit was dislodged from the hot tap, and nitric acid spilled from the line. The spilled nitric acid contacted/ splashed several workers in the vicinity. All workers were wearing appropriate personal protective equipment (PPE); however, there are gaps at the edges of the face-shields and protective suits have seams. (For the most serious exposure, the acid penetrated the suit via the sleeve/glove interface.) End result, SRS transported three workers to a local hospital, where two were released and returned to work the same day. The third worker received skin grafts (temporary and permanent), and did not return to work for several days. Additionally, SRS transported four workers to SRS Medical as a precaution: all were released the same day. In total, the nitric acid exposures resulted in one recordable injury and four first aid cases.

Figure 2 shows the hot tap that failed. A yellow glovebag is draped over the nitric acid supply line. Just to the north and south of the glovebag are two tap: one acting as a vent and the other acting as a tap. The far tap, used as a drain, failed last August.

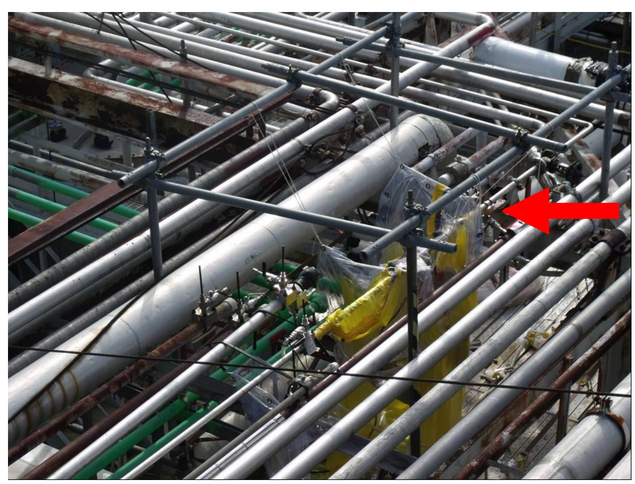

FIGURE 2 – Installed A-Line Hot Taps

[1] The guidelines establish a hierarchy of drain methods, where positive control is preferred. As a result, use of system valves or hot taps is generally specified. If the piping system is verified to hold minimal fluid, then drilling/cutting of piping or breaking of flanges is allowed with special approval.

[2] Containments include "leak collection rigs" under the drain point, "spill pallets" under the collection container, and glovebags around piping to be segmented and removed.

III.C. Investigation and Corrective Actions

SRS investigated the nitric acid spill, and generated approximately 40 corrective actions as a result of their investigation. One corrective action was to evaluate the tap's compatibility with concentrated nitric acid. SRS found that all components are compatible with the exception of the retaining ring and drill bit, which are both carbon steel. All other materials were found to be PTFE or 304 SS, both of these materials are highly resistant to nitric acid attack.

SRS also simulated exposures at various times and nitric acid concentrations, and found that the life of the carbon steel retaining ring was relatively short. SRS also found that with proper maintenance of the gland, the tap was leak free and the drill bit was tightly held even after a week's exposure to the most aggressive concentration of nitric acid.

SRS also recovered and inspected the actual drill bit that fell out of the tap back in August. Figure 3 shows the recovered drill bit after a week of exposure to concentrated nitric acid and approximately three months to the elements. Note the sharpness of the tip and the squareness of the slot.

FIGURE 3 – Recovered A-Line Hot Tap

Based on the laboratory simulations and the inspection of the recovered drill bit, SRS concluded that the drill bit failed for two reasons: (1) the retaining ring no longer provided its function either due to mechanical damage and/or corrosion, and (2) the drill bit was not adequately gripped by the gland. It took absence of both for the drill bit to fall out of the tap. Based on the laboratory simulation, SRS confirmed that if the gland is tightened and maintained in accordance with manufacturer's instructions (main thing is to torque the gland) the drill bit is tightly gripped by the gland, with no leakage for up to one week. Therefore, the tap can be used successfully with concentrated nitric acid.[3]

A final corrective action was to revise several procedures/guides in use by SRS's D&D organization and to generate a new procedure for use of the hot taps. These fixes were primarily geared to forcing and ensuring proper material and chemical evaluations during the preparation of engineering documentation and work packages, and to forcing proper usage of temporary components or tools such as the hot tap. Revised documentation includes the following:

- D&D work control procedure - Engineering is now a "subject matter expert" who is clearly responsible for material and chemical compatibility. Also, the revised procedure mandates review and approval of all work packages by Engineering.
- New hot tap procedure – SRS no longer provides the manufacturer's instructions in the work package as reference material. SRS now has a "use every time" procedure. The new procedure requires the following so as to preserve the retaining ring, and to maintain a tight grip on the drill bit:
  - Instructions no to use Teflon tape on the gland nut
  - Installation of a drill stop to prevent mechanical damage during drilling
  - Torquing the gland just prior to tapping
  - Torquing the gland again within 24 hours (due to creep)
  - Installing cap over the drill bit
- Guidelines for Engineering Indexes – Now more prescriptive than before. Requires sketch for all temporary rigs (e.g. leak collection rig, drain rig, vent rig, etc.) and systematic review of specified (or expected) components for material compatibility.
- Policy for Technical Reviews of D&D work packages – Reviewer must verify that (1) there is a documented material compatibility review in work packages and (2) work packages define and control tools and temporary equipment such the hot taps.

IV. Conclusions/Lessons Learned

There are three primary lessons learned associated with the August hot tap failure at SRS's A-Line. Those lessons learned are summarized as follows:

- Hot taps can be used with concentrated nitric acid, but the user needs to understand their

[3] Note that a cap, provided by the manufacturer, can be installed over the drill bit anytime after tapping.

limitations and plan accordingly. Within the hot taps, there are some carbon steel components that will corrode and eventually fail. So you need to maintain the gland gripping the drill bit and certainly install a cap within a short period after tapping.

- SRS's D&D organization uses many temporary systems like ventilation and pumps, and has a toolbox full of tools for segmenting components and handling those segmented components. These tools and temporary systems must be properly configured and controlled.
- Engineering has primary responsibility for material compatibility, and must have a program in place for systematically reviewing material compatibility (even for common D&D tools and temporary systems).

V. REFERENCES

1. John C. Musall, "Use of Stainless Steel Wet Tap for Draining Concentrated Nitric Acid at A-Line," SDD-2009-00116, 9/3/09.
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3. Eric Skidmore, "D&D Hot Tap Drain Rig Material Compatibility," SRNL-L7300-2009-00022, 12/7/09.