STARTUP AND TESTING OF CRITICAL EQUIPMENT FOR CLOSURE OF HIGH LEVEL WASTE STORAGE TANKS AT HANFORD

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ABSTRACT

The Hanford Site has 149 single-shell tanks and 28 double-shell tanks that store high-level chemical and radioactive waste. In order to decommission and close these tanks, the waste contained in the tanks will have to be retrieved and processed into stable long-term waste forms. This paper describes the startup and testing activities for the infrastructure upgrades and specific retrieval equipment required to retrieve and process the tank waste.

Specific upgrades to the tank farm infrastructure include: installing new transfer piping and valves, refurbishing and modifying transfer pits, installing new leak detection systems, installing new tank ventilation systems, and installing a central control system (the Master Pump Shutdown System (MPSS)). A summary of these upgrades is also provided in this paper. Because of the scale of the upgrades, the design, procurement, fabrication, and installation activities must take place on parallel paths. This necessitates a systematic and integrated approach to start-up and testing prior to turnover of the equipment to Operations.

The processes of initiating the testing program during the design phase of a project through the final operational acceptance testing are discussed in this paper. Specific activities presented in this paper include: Test Plans, Operational Acceptance Checklists, Factory Acceptance Tests, Construction Acceptance Tests, Operational Acceptance Tests, and Test Result Reports. The integration and involvement of the various departments associated with the upgrades and modifications (i.e., Project, Construction, Operations, Engineering, and Startup) are also discussed.

HANFORD SITE TANK FARMS

The Hanford Site, located along the Columbia River in Southeastern Washington State, is a Department of Energy (DOE) facility. During World War II and the Cold War, the primary mission of the Hanford Site was to support the production of weapons grade nuclear materials. The facilities and processes used to develop and refine the weapons grade nuclear materials operated for over 40 years. During this time, high-level chemical and radioactive waste was generated as a by-product of the refining processes. A majority of this waste is stored in large underground tanks. The Hanford Site has 149 single-shell tanks and 28 double-shell underground tanks used for waste storage. These tanks are arranged in sub-groups called Tank Farms. An example of some of Hanford's tank farms is provided in Figure 1.

Hanford Site

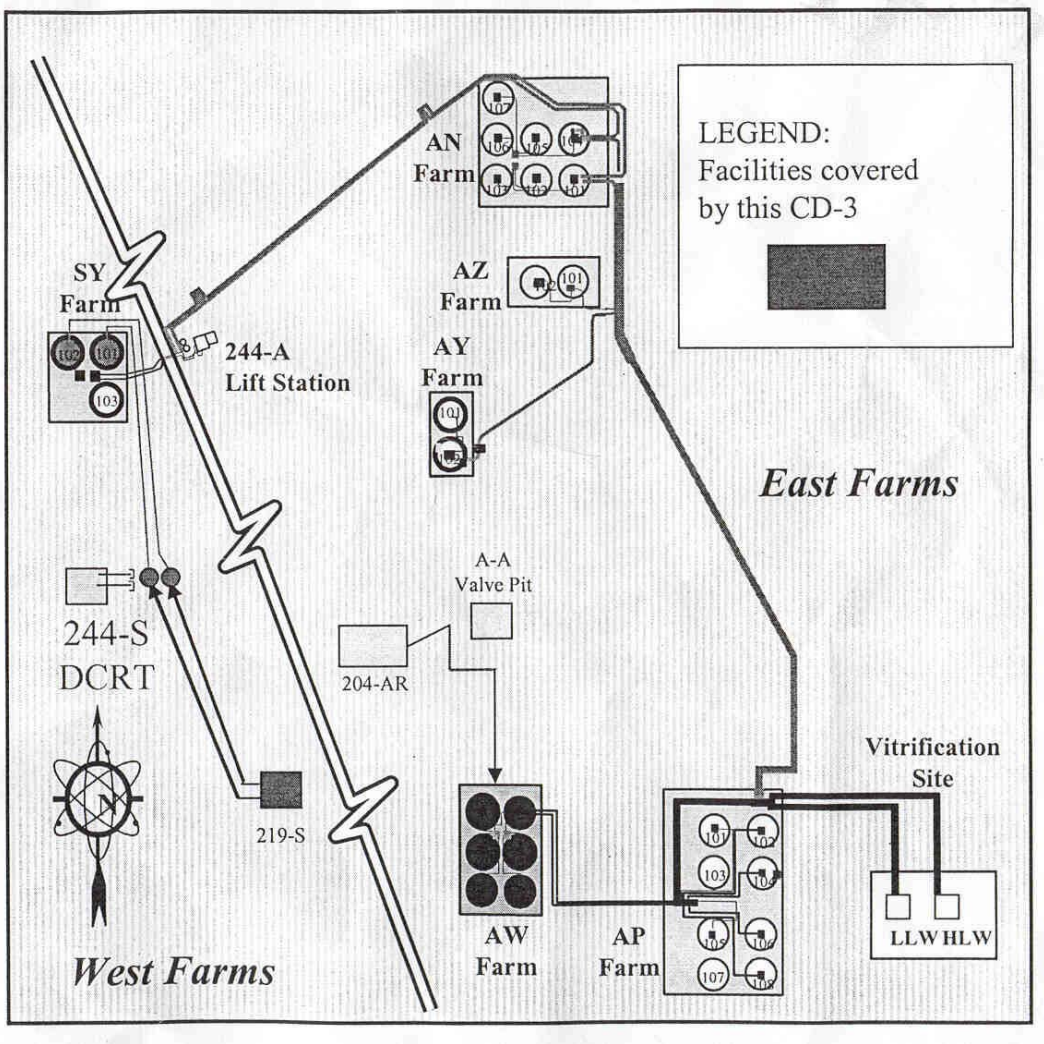

Fig. 1 Example of tank farms

The waste contained in the tanks can be transferred between tanks and between tank farms through a network of above and below ground pipe-in-pipe pipelines. Examples of some of Hanford's pipeline networks are shown in Figure 1.

Access to the underground tanks is achieved through tank risers and pits. Typically, the pits and risers are used for waste transfers (in and out of the tanks), to monitor and inspect the tanks, and to ventilate the tanks. A typical single shell tank layout is provided in Figure 2.

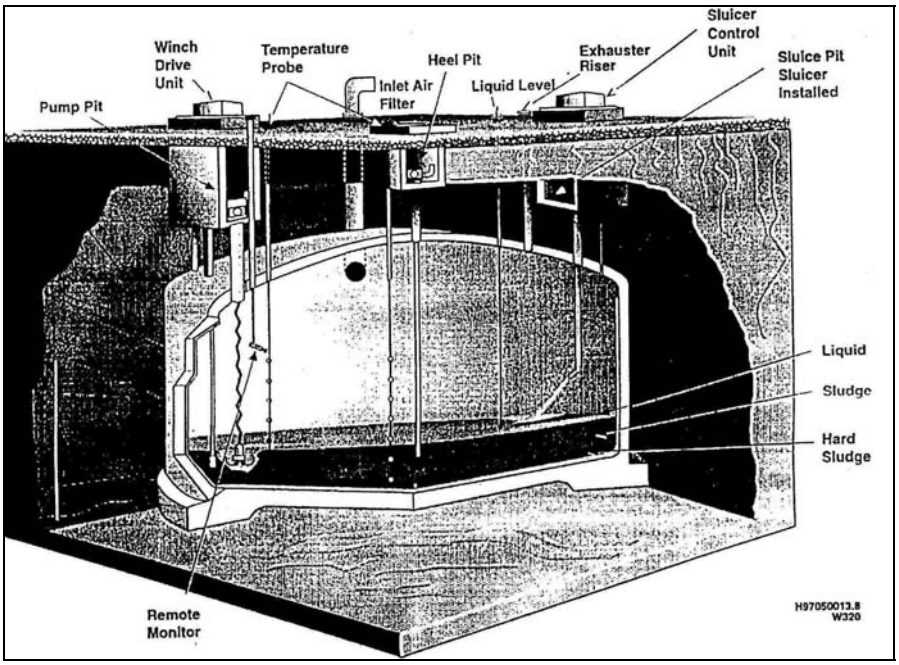

Fig. 2 Typical Hanford single shell tank

Today, the mission of the Hanford Site is environmental restoration and protection of the Columbia River (Hanford Reach) ecosystem. A primary aspect of this mission is to decommission and close the underground waste tanks. The waste contained in the underground tanks will be retrieved and processed into stable long-term waste forms.

TANK RETRIEVAL PROJECTS

Upgrades to the tank farm infrastructure were required to enable the closure of the tanks and to transfer the waste to long-term processing. Long-term processing will be in the form of glass vitrification (see Figure 1 for planned vitrification site). Due to the extent of the upgrades required, the upgrades were broken into sub-projects. These sub-projects include projects dedicated to tank farm infrastructure upgrades, and others that actually retrieve waste from the tanks. Projects involving tank farm upgrades include Projects W-314, E-525, and Project W-211. Projects involved in the temporary installation of retrieval equipment and the retrieval of waste are generally referred to as "Closure" projects. Closure projects are currently retrieving and transferring waste from single-shell tanks to double-shell tanks.

As an example of the complexity and scope of the projects currently being undertaken at Hanford, aspects of Project W-314 will be summarized. Project W-314 has been upgrading tank farm systems for approximately 7 years. Project W-314 is approximately 80% complete with its defined work scope and is expected to be finished in 2005. Upgrades performed by Project W-314 involve all aspects of tank farm operation and infrastructure. These upgrades include; installing new transfer piping and valves, refurbishing and modifying transfer pits, installing new leak detection systems, installing new tank ventilation systems, and installing a central control system (the MPSS).

Twenty seven tank access pits in seven tank farms were upgraded by Project W-314. Typical pit upgrades included repairing the pit containment and applying a new protective coating to the pit walls and floor. Valves and pipe jumpers were also installed in selected pits. Examples of the pits before and after refurbishing are provided in Figs. 3 and 4.

Before

After

Fig. 3 Transfer Pit Before and After Restorations and Upgrades

Before

After

Fig. 4, Tank Pump Pit Before and After Restorations and Upgrades

Project W-314 has also placed approximately 10,000 feet of new pipeline. The installed pipelines have pipe-in-pipe configurations for environmental protection purposes. In order to detect possible breaches in the primary pipe, leak detectors monitor the encasement section of the pipe-in-pipe. In addition, the encasement pipes drain into pits where additional leak detectors are present. Both the pit and encasement leak detectors interface with the new MPSS.

The MPSS is a central system for monitoring and control of waste transfers involved in the decommissioning of the single shell tanks. The MPSS will allow Tank Farm Operations to set-up and direct waste transfers using an automated control system. In addition, the MPSS monitors the input signals from the leak detectors installed in the transfer pits and encasement segments of the pipe-in-pipe pipelines. This automated and centralized system provides a safe and quick response in the event of a breach in the primary waste transfer containment.

In addition to the infrastructure and control upgrades outlined above, Project W-314 also installed new ventilation systems at two tank farms. These tank farms are scheduled to be primary staging areas to receive and send the waste to the long term processing facility. The ventilation systems are used to keep flammable gas (a by-product of the stored waste) from accumulating to unsafe levels. The ventilation systems also exchange the warm air in the tank vapor space and provide cooling for the tanks.

START-UP OF CRITICAL SYSTEMS

As outlined in the above section, multiple projects are currently upgrading tank farm systems at the Hanford site. These projects have long durations and involve many aspects of tank farms systems. Because of the scale of the upgrades, the design, procurement, fabrication, and installation activities of these projects must take place on parallel paths. Thus, careful configuration control must be maintained between Operations and the Projects Organizations to ensure only equipment ready for operation is placed into service.

In the past, the individual Projects were responsible for startup and turnover activities associated with their work. Although procedures were in place to govern the startup activities, there were inconsistencies in the methods and manner in which individual projects used these procedures. In addition, because multiple projects have been working on the tank farms over an extended period of time, there became a need for a "global" look at the work being performed. To address this need, a Startup and Testing Program was developed and implemented.

The Startup and Testing organization at CH2M HILL Hanford Group, Inc. is responsible for three primary functions. These functions are:

- Startup and Testing
- Readiness
- Turnover.

Startup And Testing

Startup and Testing is the process of testing new or modified structures, systems, and components (SSCs) which are important to environmental protection and health and safety of personnel. The Startup and Testing Program ensures that all SSCs are capable of fully meeting their design requirements prior to turnover to Operations. It also ensures that the testing performed to validate this capability is documented

in a manner that fully supports CH2M HILL Hanford Group's readiness activities consistent with graded approach considerations.

A key tool in the Startup and Testing Program is the development of a comprehensive Test Plan for each project. Implementing the use of test plans ensures that new and modified SSCs are fabricated, constructed and tested in accordance with the approved design. By meeting specified acceptance criteria, these SSCs are capable of fully performing their design functions to meet project/modification performance requirements. Test plans are developed concurrently with the design so that the scope and responsibility for testing activities are identified and documented early in the project life cycle.

A graded approach for testing activities is systematically determined during development of the test plan and, once approved, ensures the appropriate level of testing review and documentation is applied. Test plans provide a mechanism for ensuring the testing are appropriately identified, performed in a logical sequence, and documented, thereby establishing confidence to support "achieving readiness" associated with the new or modified SSC.

As part of the natural sequence of fabrication, installation, and operation, there are different types and levels of testing that are performed on the equipment to ensure proper form, fit, and function. These tests are identified within the Test Plan.

- Factory Acceptance Testing (FAT). This is testing performed by the manufacturer at their facility to ensure that the supplied equipment meets their standards of quality and the design parameters specified in the purchase contract Some FATs may also be done after the equipment is received and installed. These on-site FATs are performed at the vendor's direction. Examples of FATs include: pump flow testing, 24-hour motor runs, and Programmable Logic Controller software validation. During detailed design, the Startup and Testing Organization supports Engineering in the development of the requirements for FATs by providing appropriate input during the preparation of procurement specifications.

- Construction Acceptance Testing (CAT). This is testing performed by the Construction Organization to ensure that the construction activities were properly performed in accordance with industry practices, codes and standards, and the quality requirements of the contract. These tests ensure the electrical and mechanical integrity of the new or modified SSCs, and that all equipment was properly installed. Examples of CATs include: visual inspections, pressure tests, piping leak tests, vessel cleaning and inspections, electrical insulation and continuity tests, pipe flushing and cleaning, equipment alignment, motor bumps, and verification of component functionality. During detailed design, the Startup and Testing Organization supports Engineering in the development of the requirements for CATs by providing appropriate input during the preparation of construction specifications.

- Operational Acceptance Testing (OAT). OATs are performed after construction is completed on SSCs and are generally performed by the Operations Organization with support from the Startup and Testing Organization. Operational acceptance testing verifies: operational modes, equipment performance in accordance with requirements, interfaces between systems and instrumentation, and that Programmable Logic Controllers operate properly. OATs may include system tests and may involve integrated testing of multiple systems. The identification of the test requirements and the level of testing (component, system, or integrated) is identified in the Test Plan.

- Post-Modification Testing (PMT). Not all changes made to equipment and systems warrant a full testing program. PMTs are used to ensure that equipment with minor modifications will perform

its design function and that no other equipment was affected by the modification in a manner that would inhibit its ability to perform its design function.

- The Startup and Testing Organization reviews minor engineering changes and identifies those that require modifications to existing plant SSCs. These changes are screened for application of the graded approach. Changes with modifications which screen "low" will become the responsibility of Engineering to perform the required post-modification testing.

A Joint Test Group (made up of executive level personnel) and a Joint Test Working Group (made up of director/manager level personnel) have also been commissioned. These groups perform in-line reviews of various test documents based on a graded approach. These groups ensure constant application of program standards and provide management input to improve the in-field reliability and effectiveness of the test documents.

Readiness

Following completion of testing, the Startup and Testing program provides for the achievement of readiness required prior to safe startup or restart of a facility or activity. To achieve proper readiness, the scope of the activity must be well defined and understood to ensure all required readiness actions are accomplished. The scope of the facility or activity must define the physical and administrative boundaries and must ensure evidence of readiness is generated and complied with during the process.

- Achieving Readiness: Readiness achievement is required prior to the performance of a readiness review. The activity scope must be well defined and understood to ensure all required readiness actions are accomplished. The scope must define the physical and administrative boundaries of the readiness activities and it must also ensure evidence of readiness is generated and complied with during the process. The scope may be defined through schedules and documentation (e.g., facility readiness plan, compliance planning matrix, operational acceptance checklist, etc.), and must define the duration and expectations for satisfactory completion.

- Readiness Reviews: When achievement of readiness has been accomplished, formal readiness reviews will be conducted. Readiness reviews are not intended to be a management tool to achieve readiness. The purpose of a readiness review is to confirm a nuclear facility's "state of readiness" for safe startup or restart. Readiness reviews verify the following:

    - It is safe to start/restart the facility,
    - The facility and/or programmatic activity is physically ready to startup/restart,
    - The facility meets approved design requirements,
    - The facility can be operated safely, within the boundaries of the authorization basis,
    - The facility will be operated, maintained, and supported by trained and competent personnel,
    - The facility can be operated with no undue risk to employees, the public, or the environment,
    - The necessary infrastructure (procedures, staffing, compliance with DOE Orders, rules, and other requirements, etc.) is in place,
    - Management, operations, and support staff are prepared to manage, operate, and maintain the facility that is about to startup/restart.

The types of formal readiness reviews performed by both CH2M HILL Hanford Group, Inc. and the Department of Energy, Office of River Protections (DOE-ORP) include:

- Operational readiness review
- Level 1 readiness assessment (most complex readiness assessment)
- Level 2 readiness assessment
- Level 3 readiness assessment (least complex readiness assessment).

Turnover

Turnover represents the activities, functions, and documentation required to ensure an orderly turnover of SSCs from Construction to Startup and Testing and, finally, to Operations. Although sometimes the turnover activities are over-shadowed by the testing activities, they are key to ensuring Operations and Engineering have all the adequate support material to successfully operate and maintain proper configuration control of the modified systems. Support activities may include:

- Ensuring updates to equipment lists are performed
- Ensuring adequate spare parts were identified, ordered, and received
- Ensuring facility drawings were updated to reflect the new or modified systems
- Coordinating the support activities of Operations personnel with those of the Training & Procedures organization to ensure maintenance and operating procedures are developed, along with training materials.

SUMMARY

To enable the closure of the underground tanks and the transfer of the high level chemical and radioactive nuclear waste to long-term processing, it was determined that upgrades to the tank farm infrastructure at the Hanford Site were required. To support these activities, multiple projects involving all aspects of tank farm operation have been implemented.

To support the successful turnover of the updated and modified SSCs to Operations, a comprehensive Start-up and Testing program has been established. The Startup and Testing organization at CH2M HILL Hanford Group, Inc. is responsible for the three primary functions. These functions are:

- Startup and testing
- Readiness
- Turnover

The Startup and Testing Program ensures that all SSCs are capable of fully meeting their design requirements prior to turnover to Operations. It also ensures that the testing performed to validate this capability is documented in a manner that fully supports CH2M HILL Hanford Group's readiness activities consistent with graded approach considerations.