# HANFORD'S SY-101 WASTE TRANSFER

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## ABSTRACT

The surface level in the 241-SY-101 (SY-101) waste storage tank at the U.S. Department of Energy Hanford Site has risen in recent years without waste addition. This resulted in the declaration of an unreviewed safety question and prompted actions to remediate the surface level rise which was caused by the formation of a thick floating crust which was trapping flammable gasses. The technique chosen to accomplish this was to dilute and transfer waste from SY-101 to an adjacent tank, 241-SY-102 (SY-102) and dilution of the remaining waste in the tank. The schedule to perform this transfer was very aggressive because the waste surface level was approaching the point where the tank becomes a single-walled rather than double-walled vessel. This is both an environmental concern and a safety concern.

In October 1998, a team was established to address these concerns. Parallel activities were initiated to provide interim relief from the level growth and permanently solve the level growth problem. By May of 1999, the system to provide interim relief, termed the mechanical mitigation arm (MMA), was deployed in SY-101 to break a hole in the crust and successfully provided interim relief from the crust level growth. Concurrently, work continued to plan, design, build, install, and operationally test a unique transfer and dilution system. This system installation was complete in September 1999. The first transfer of waste from SY-101 to SY-102 was completed in December 1999 and has been effective in improving the nuclear and environmental safety of this tank.

## INTRODUCTION

SY-101 contains approximately 3,800,000 L (1,000,000 gallons) of the most highly concentrated radioactive waste stored in the double-shell tanks at the Hanford Site. Degradation of organic complexants and radiolysis of water in the waste generate a flammable mixture of gases that includes hydrogen, nitrogen, nitrous oxide, and ammonia. Until 1993, the waste in SY-101 retained the gas and periodically released large volumes in sudden, buoyant displacement gas release events (BDGREs) approximately every 100 days. In July 1993, a mixer pump was installed in SY-101; it has prevented the periodic, large gas-release events by inducing a more nearly continuous release of gas.

Since September 1996, the waste-surface level in SY-101 had been rising in a manner inconsistent with previous behavior. This surface-level rise caused the U.S. Department of Energy, Richland Operations Office (DOE-RL) to declare an Unreviewed Safety Question (USQ) in February 1998. This is now called the Crust Level USQ because growth of the crust on the waste surface in this tank is causing the surface-level rise. As a result of this Crust Level

USQ, the River Protection Project (RPP) (formerly the Tank Waste Remediation System) established the SY Farm Project Team, which is responsible for developing and evaluating remediation options and executing the chosen option for remediating the surface-level rise for SY-101.

The development of the preferred remediation approach included a week long options evaluation seminar using Value Engineering methods with experts in all fields of waste management at the Hanford Site, National Laboratories, other DOE sites, private industry, and the academic community. The team developed the following options to halt the level increase:

1) MMA. This activity created a hole in the SY-101 crust surface to a) release part of the trapped gas and b) provide a temporary release point to prevent further buildup under and within the crust. This action has slowed the surface level rise. The MMA deployment was a near-term activity to buy time for a long-term solution. The MMA was successfully deployed two times, in May, 1999. The result was that the tank surface level decreased in May as shown in Figure 1; the first time this had occurred in years.

2) Transfer and dilution of waste from SY-101 to SY-102. This approach is the chosen, long-term solution to flammable gas buildup in SY-101. This activity is planned to transfer waste from SY-101 to SY-102 in batches where the waste will be treated in between transfers. The first batch transferred approximately 313,260 L (89,500 gallons) of SY-101 waste, mixed with approximately 337,120 L (82,700 gallons) of dilution water, to SY-102. Following the removal of this waste from SY-101, approximately 231,060 L (61,000 gallons) of water was added back to SY-101 [~98,485 L (26,000 gallons) added on the surface and ~132,575 L (35,000 gallons) added below the surface]. This "back-dilution" step which will be performed after each of the estimated three transfers, will remove the possibility of SY-101's physical and chemical makeup being able to produce gas release events. In addition, the transfer to SY-102 is composed such that it will not become another tank capable of gas release events.

Development and deployment of these two options in the timeframe allotted (approximately nine months) was a significant accomplishment toward improving the safety of what was once considered to be the most hazardous tank at the Hanford Site. Regulatory, technical, and logistical challenges were addressed. The following aspects of the project's development are unique.

1) Authorization basis development and implementation under contractor-level "prudent controls" as authorized by the Office of River Protection (French 1999). Hazard analysis of crust growth and waste transfers were performed and documented for the project. The hazards identified are generally similar to other tank transfers and are addressed by the safety analysis and safety controls for the tank farms. The hazards, safety analysis, and controls unique to the SY-101 transfer were also documented. Two hazards received specific additional analysis and safety controls: flammable gas deflagrations and toxicological exposures from a possible ammonia release. The control strategy based on contractor prudent controls uses the following hierarchy: (1) prevent the hazard from

occurring, (2) engineering design, (3) administrative controls, and (4) personal protective equipment.

2) Parallel path development of the authorization basis, design, design approval, procurement, fabrication, and in some cases installation. This included installation of a full mock-up facility with identical components.

3) Procurement of engineered equipment (design and build) in less than five months. Several pieces comprised the offsite design and build contracts. The transfer assembly included a water supply skid, 45.7-meter (150-ft) hose-in-hose transfer line, drop leg, pre-fabricated pump pit, valve manifold, and the pump itself. All these pieces were built and tested at different vendors. (See Figure 2 for an aerial view of the installed equipment.)

4) Installation and readiness review activities on an expedited basis.

## EQUIPMENT DETAILS

The first transfer campaign pumped approximately 337,260 L (89,500) gallons of waste from SY-101 to SY-102. Ultimately, at least 1,133,640 L (300,000 gallons) will be transferred from SY-101 to close the USQ. Several alternatives were investigated for the transfer system. An abbreviated list of alternatives is shown below. The final alternative, an innovative hose-in-hose aboveground transfer, was chosen as the best approach based on the constraints involved.

1. Below-ground transfer tying into existing lines from a 107-cm (42-inch) riser in SY-101 to the SY-102 pump pit.
2. Below-ground transfer from the SY-101 pump pit to the SY-102 pump pit.
3. Aboveground transfer from a 107-cm (42-inch) riser in SY-101 to a 107-cm (42-inch) riser in SY-102.

The constraints involved included assuring operability of the existing mixer pump in SY-101, availability of viable underground lines, space constraints above and below ground, and regulatory (e.g., authorization basis, environmental) constraints.

The equipment was developed under specification and designed and built by the vendors. As a natural outcome of the design and construction approach, the development of the transfer system was split into subsystems as listed below:

1. Pre-fabricated pump pit (all stainless steel) for installation on a 107-cm (42-inch) riser (first time installation of a new "above-ground" pit on a tank.)
2. Transfer pump and variable frequency drive (first-time use of a canned rotor pump in Hanford waste tanks).
3. Piping manifold.
4. Dilution water supply system.
5. Aboveground hose assembly.
6. SY-102 transfer pit on a 107-cm (42-inch) riser and discharge leg into SY-102.
7. Instrumentation and control system.

The system is required to transfer SY-101 waste at 1.83 m/s (6 ft/s) to avoid solids settling within the aboveground hose assembly. The waste must be diluted at the pump suction between the ratios of 0.5:1 (water: waste) to 2:1 for discharge into SY-102 to prevent gas release events from occurring in another tank. The system must operate at SY-101 tank temperatures of approximately 52 °C (125 °F) to reduce chemical reactions associated with temperature differences when the waste and dilution water are mixed. This includes that the dilution water supply be heated. Concerns about undetected dilution, leakage, back-pressure, off-gassing, and siphoning were addressed through the design of controls or passive engineering systems. For example, the discharge leg into the receiver tank, SY-102, contains a specially-designed siphon break to reduce ammonia off-gassing while precluding siphoning from the higher elevation SY-101 tank.

The subsystems were designed, built, tested, and installed in the seven-month period between March1999 (when the Project was authorized funding by DOE) and September 1999. The equipment was tested in the field during October, and November and readiness review activities concluded in December. The following is a summary of the events leading up to, and of the actual transfer and back-dilution evolution:

- At ~1430, 12/17 DOE signed the Readiness Review letter, giving the contractor the authorization to proceed with the transfer.
- At 0630, 12/ 18 the Transfer Pump was started which began sending diluted (~1:1) waste from tank 241-SY-101 (SY-101) to SY-102. [The waste level in SY-101 was ~ 1,095 cm (431 inches) before the transfer, and the waste level in SY-102 was ~740 cm (291 inches).]
- At 0545, 12/19 the transfer was COMPLETED. Included in the transfer was ~337,120 L (89,500 gallons) of SY-101 waste, mixed with ~ 313,260 L (82,700 gallons) of dilution water, for a total of ~652,276 L(172,200 gallons) of material pumped into SY-102. [The waste level in SY-101 after the transfer was ~993-cm (391 inches), ~102-cm (40 inch) drop, and the waste level in SY-102 was ~897 cm (353 inches), ~132 cm (52 inch) increase.]
- At 1824, 12/19 back dilution above the surface of SY-101 (through the vent line on the top of the transfer pump flange) was commenced.
- At 0432, 12/20 back dilution above the surface of SY-101 was completed. Approximately 98,485 L (26,000 gallons) of water was added to the surface of SY-101.
- At 0445, 12/20 back dilution below the surface of SY-101 (through the dilution line that discharges at the bottom, or suction area, of the transfer pump) was commenced.
- At ~1530, 12/20 back dilution below the surface of SY-101 was completed. Approximately 132,576 L (35,000 gallons) of water was added to the tank, below the surface of SY-101. This completed the actions identified for this transfer.
- During the transfer:
  - The SY-101 Hydrogen level remained relatively stable at ~500 Parts Per Million (PPM) [Typically this is at ~50PPM]
  - The SY-101 Ammonia level peaked at ~270 PPM [Typically this is at ~50PPM]
  - The SY-101 Nitrous Oxide peaked at ~280 PPM [Typically this is at ~20PPM]
  - The SY-102 Ammonia peaked at ~2000 PPM [Typically this is at ~250 PPM]
  - The Ammonia detected at the SY Farm Stack (From Tanks SY-101, 102, and 103) peaked at ~700 PPM (Typically this is at ~250 PPM)

The unique equipment designed and utilized for this transfer, worked flawlessly. The work on this project has resulted in both news stories and in an editorial opinion: ***"That's a great accomplishment that adds to the growing recent momentum at Hanford in which missed deadlines and bureaucratic malaise are being replaced with timely progress and aggressive leadership."*** (Tri-City Herald, 1999)

**References:**

French, R. T., *Contract No. DE-AC06-96RL13200 – Submittal of Updated Unreviewed Safety Question (USQ) Evaluation and Supplemental Controls for Tank 241-SY- 101*, 99-TSD-051, 04/27/1999, U.S. Department of Energy, Office of River Protection, Richland, Washington.

Tri-City Herald (no author named), December 27, 1999, Volume 97, Issue 361, pg A-6, "Tank Waste Transfer Adds Momentum," Tri-City Herald Newspaper, Kennewick, Washington.

**Figure 1. Program Schedule Overlaying Crust Growth Curve.**

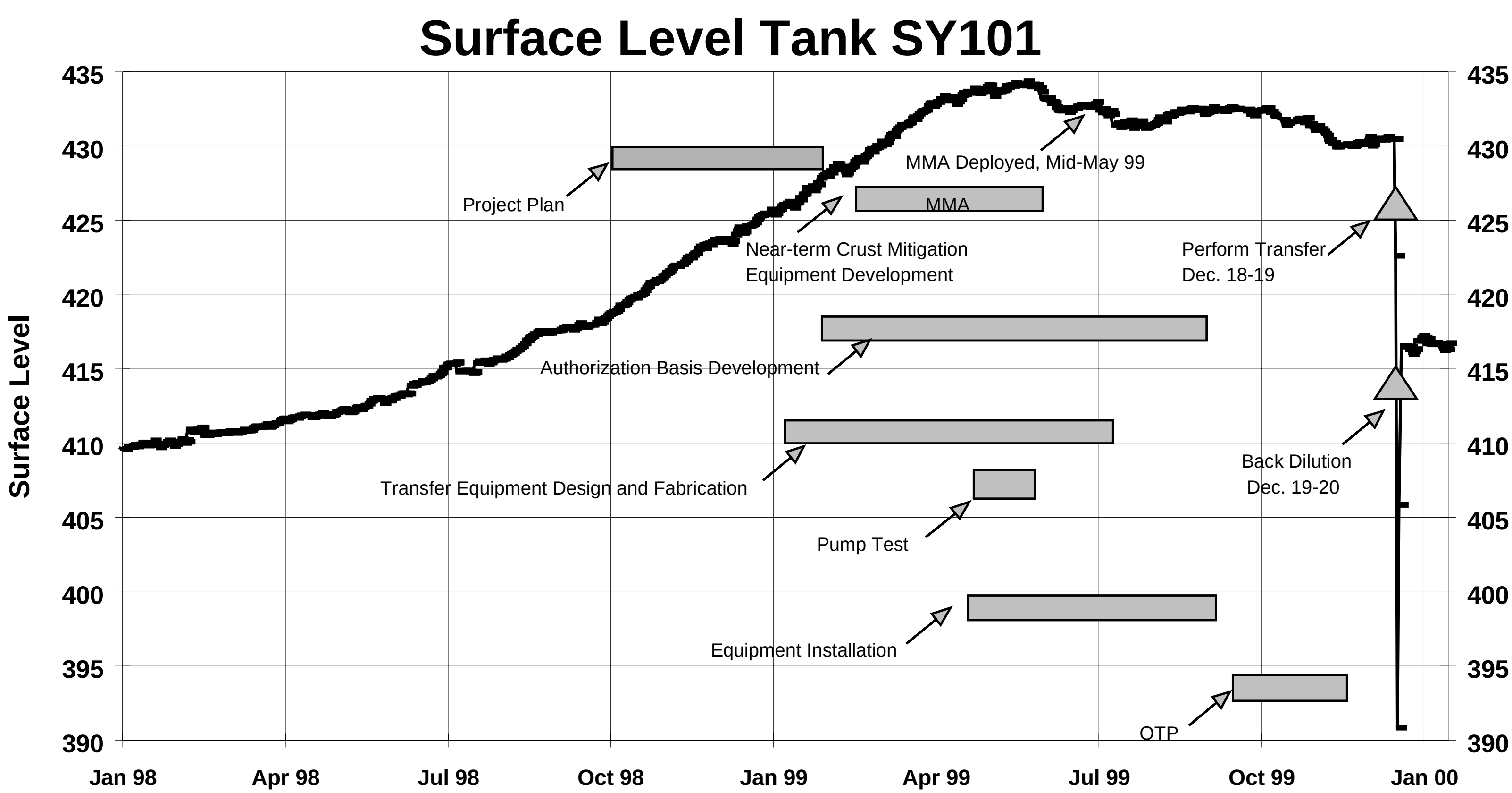

**Figure 2. Aerial Photo of SY-101/SY-102 Transfer Equipment.**