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WHC-SA-1976-FP

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Prepared for the U.S. Department of Energy
Office of Environmental Restoration and
Waste Management

Westinghouse
Hanford Company Richland, Washington

Hanford Operations and Engineering Contractor for the
U.S. Department of Energy under Contract DE-AC06-87RL10930

Conf-931160--35

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Date Published
November 1993

To be presented at
ANS 1993 Winter Meeting
San Francisco, California
November 14-19, 1993

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HANFORD SITE TANK 241-SY-101, DAMAGED EQUIPMENT REMOVAL

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ABSTRACT

Hanford Site Tank 241-SY-101 has a history of generating hydrogen-nitrous oxide gases. The gases are generated and trapped in the non-convective waste layer near the bottom of the 23-m- (75-ft-) diameter underground tank. Approximately every three months the pressure in the tank is relieved as the trapped gases are released through or around the surface crust into the tank dome. This process moves large amounts of liquid waste and crust material around in the tank. The moving waste displaced air lances and thermocouple assemblies (2-in. schedule-40 pipe) installed in four tank risers and permanently bent them to a maximum angle of 40 degrees. The bends were so severe that assemblies could not be removed from the tank using the originally designed hardware. Just after the tank releases the trapped gas, a 20-to-30-day work "window" opens.

An engineered system was developed and successfully used to remove the damaged tank hardware through the 10-cm- (4-in.-) diameter risers in which they were originally installed. Some phases of the removal operation required that equipment be designed for remote operation and total containment because of high radiation fields (up to 8 Rad/h). The equipment had to be electrically bonded because of the potential of hydrogen venting during the removal process. The equipment was designed to extract the assemblies slowly so that sparks or heat would not be generated as an ignition source for the

hydrogen. Sparks could occur if spray nozzles were sheared off the assemblies too quickly. Also, the removal process involved metal-to-metal contact when the assemblies were straightened by exerting large pressure loads against the bottom of the risers.

TANK DESCRIPTION

Tank 241-SY-101 contains a bottom layer of sludge 5.1 m (16.7 ft) thick with a 4.1-m- (13.3-ft-) layer of liquid on top of the sludge, topped by a crust with an estimated height of 1.1 m (3.5 ft). The tank is of double-wall construction, consisting of a 23-m- (75-ft-) diameter steel primary inner tank within a 24.4-m- (80-ft-) diameter steel secondary outer tank. The overall maximum height within the primary tank is 14.3 m (47 ft). The tank contains 10 risers extending approximately 2.7 m (9 ft) from the tank dome to grade level. The risers have the following diameters: 10 cm (4 in.), 15.2 cm (6 in.), 30.5 cm (12 in.), and 106.7 cm (42 in.). Three air lances and one thermocouple tree were installed in four of the 10-cm (4-in.) risers, one in each riser.

AIR LANCE AND THERMOCOUPLE CONDITION

The air lances and thermocouple tree were built from 2-in. schedule-40 pipe approximately 10 years ago. Pipe lengths were welded together approximately every 6.1 m (20 ft). The air lance welds were 100 percent penetration welds; the thermocouple welds were less than 100 percent penetration. The air lances also had spray nozzles installed at 1.5-m (5-ft) intervals on the section contacting the waste. All four assemblies were bent just below the riser dome interface by as much as 40 degrees (Figure 1). A coating of dried waste covered a section of the pipe including large-diameter waste-cake balls that adhered to the pipes just above the waste (Figure 2).

REMOVAL EQUIPMENT

The air lance and thermocouple tree removal hardware included a modified 37-ton commercial well-casing puller (Figure 3), a 20.2-m- (66-ft-) long receiver and receiver stand (Figure 4), containment tubes and boots, rigging, assembly cleaning equipment, load measuring equipment, a shielded glove box, and special retrieval equipment. Hardware was designed to be installed on the top of the tank dome risers for the removal process. The equipment kept the removal reaction force (compression loads) applied to the riser only. This method prevented damaging the riser-to-tank-dome-interface attachment weld, which is considered part of the tank containment. Also, equipment was designed to remove large deposits of hard waste material that was attached to each of the bent assemblies. The hot water spray system removed waste material before and during the pulling operation. All hardware was electrically bonded to the riser during the removal process because of the slight possibility of hydrogen venting during the removal operation.

The assemblies were straightened during the removal operation using the bottom of the riser as a pivot point. The carbon steel assemblies were taken slightly beyond the yield point to straighten them enough to be pulled through the riser. The rebending operation caused very little damage to the bottom of the riser.

Modifications to the well-casing pullers used on the radioactive storage tank included changing the top and bottom plates to provide enough room for the containment equipment and to allow the slip bowl on the top plate to float. Movement of the slip bowl was needed to relieve some of the side loading caused by the bent pipe as it passed through the puller assembly. The containment used on the equipment can be seen in Figure 3. The lower containment consisted of sealed telescoping clear plastic tubes between the top and bottom plate. The upper containment was a flexible plastic tube to allow for misalignment between the puller and receiver. Once the shielded glove box was placed over the pulling equipment, all removal operations were completed remotely. Glove box ports were available for nonstandard procedures if problems were encountered.

SPECIAL RETRIEVAL TOOLS

Special retrieval tools consisted of commercial pipe internal mandrels that were modified so they could be maneuvered around large angles to retrieve broken pipes. The thermocouple tree broke at two weld joints because of less than 100 percent penetration. When the pipe broke, angles estimated at up to approximately 40 degrees had to be accommodated to latch the retrieval tools. The first break occurred inside the lower section of the riser. The broken pipe was jammed against the riser wall at an approximately 20-degree angle. Access to the broken pipe was limited through a 10-cm- (4-in.-) diameter riser. A commercial mandrel used in the well-drilling industry was modified, then attached to a specially designed swivel joint and mounted on the end of a high-strength extension rod (Figure 5). This apparatus was used to grapple the broken pipe end. The second break was at a section of pipe located just below the bottom of the riser. Two sections of pipe were being held together by a small section of the metal wall. This break could be seen using an in-tank camera. The grapple for this retrieval consisted of a split block attached to a 16-mm (5/8-in.) cable. The split block concept had been used to retrieve pipes sections in wells and it was recommended by an offsite consultant. This concept was modified by adding lead-in components and special wire ties to assist in positioning the split blocks. These modifications allowed the split blocks to be installed through the internal diameter of the top section of the broken pipe and go around the 40-degree angle at the break then into the internal diameter of the lower section of pipe. The grapple and 5.2-m- (17-ft-) long cable was guided into position using a tapered guide designed to maneuver a 40-degree bend without catching on the broken ends of the pipe. Fiber optic cameras were used before each broken-pipe retrieval operation to determine if obstructions were present inside the thermocouple assembly.

TEST PROGRAM

A preliminary test program was completed in parallel to designing the removal equipment. As the individual test results became available, they were used to improve the design. The preliminary tests were used to determine the required removal loads and the feasibility of using commercially available casing pulling equipment. The latter part of the preliminary test phase also verified fit-up and operation of removal equipment and containment components. The removal loads were determined by forcing a simulated bent assembly through a full-scale riser mockup. The removal-load testing also included shearing off nozzles (1/8-in. pipe plugs), simulating those installed on the air lances. In addition, methods for removing the material caked on the lances were tested. The final checkout and qualification testing of the removal equipment was completed before releasing the equipment to Tank Farm Operations for field use.

The results of removal-load tests at the mockup facility indicated a force of between 6,000 and 12,000 pounds would be required to remove the bent sections of pipe, depending on the amount of resistance encountered from the waste material. Actual removal loads encountered in the field was a maximum of 14,000 pounds force. The waste resisted the movement of the air lance or thermocouples more than expected.

CONCLUSIONS

The air lance and thermocouple tree removal was successfully completed in the field on Tank 241-SY-101. The assembly removal operation was completed basically in several phases: site preparation, cutting off the assembly tops, waste-cake ball removal, assembly pulling, and packaging the assemblies in receivers for disposal. The air lances were removed without problems. However, during removal, a thermocouple tree assembly broke at two welded areas. The less-than-full-penetration welds connecting the sections of the assembly broke near the bottom of the riser. Special retrieval equipment was then developed on a fast-track process and adapted to the removal equipment. The special retrieval equipment was remotely latched onto the broken assemblies to allow the removal operation to be completed.

Figure 1. Air Lance Bent at Approximately 40 Degrees Due to Movement of Radioactive Tank Waste.

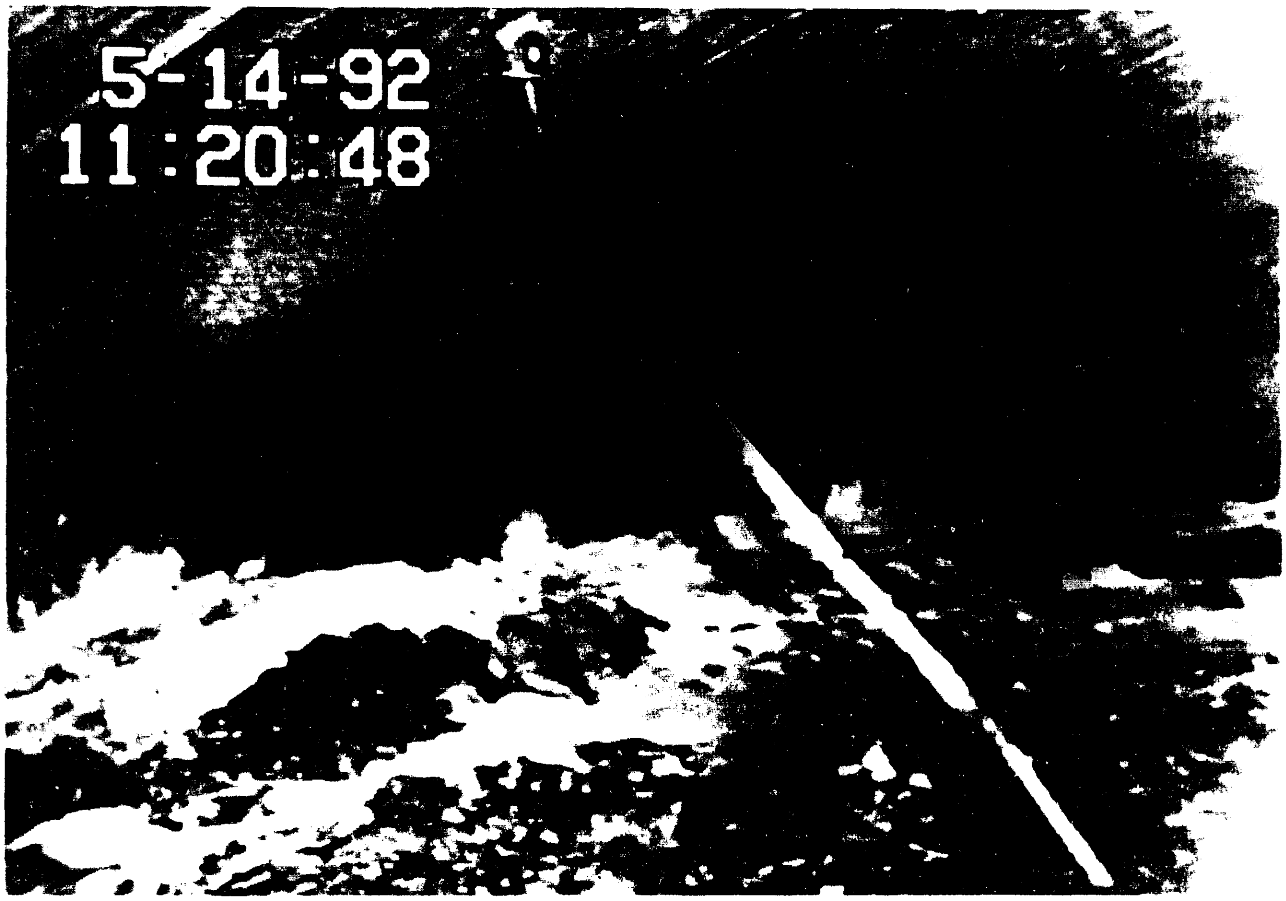

Figure 2. Tank Waste Material Dried on Air Lance, Including Large-Diameter Cake Ball.

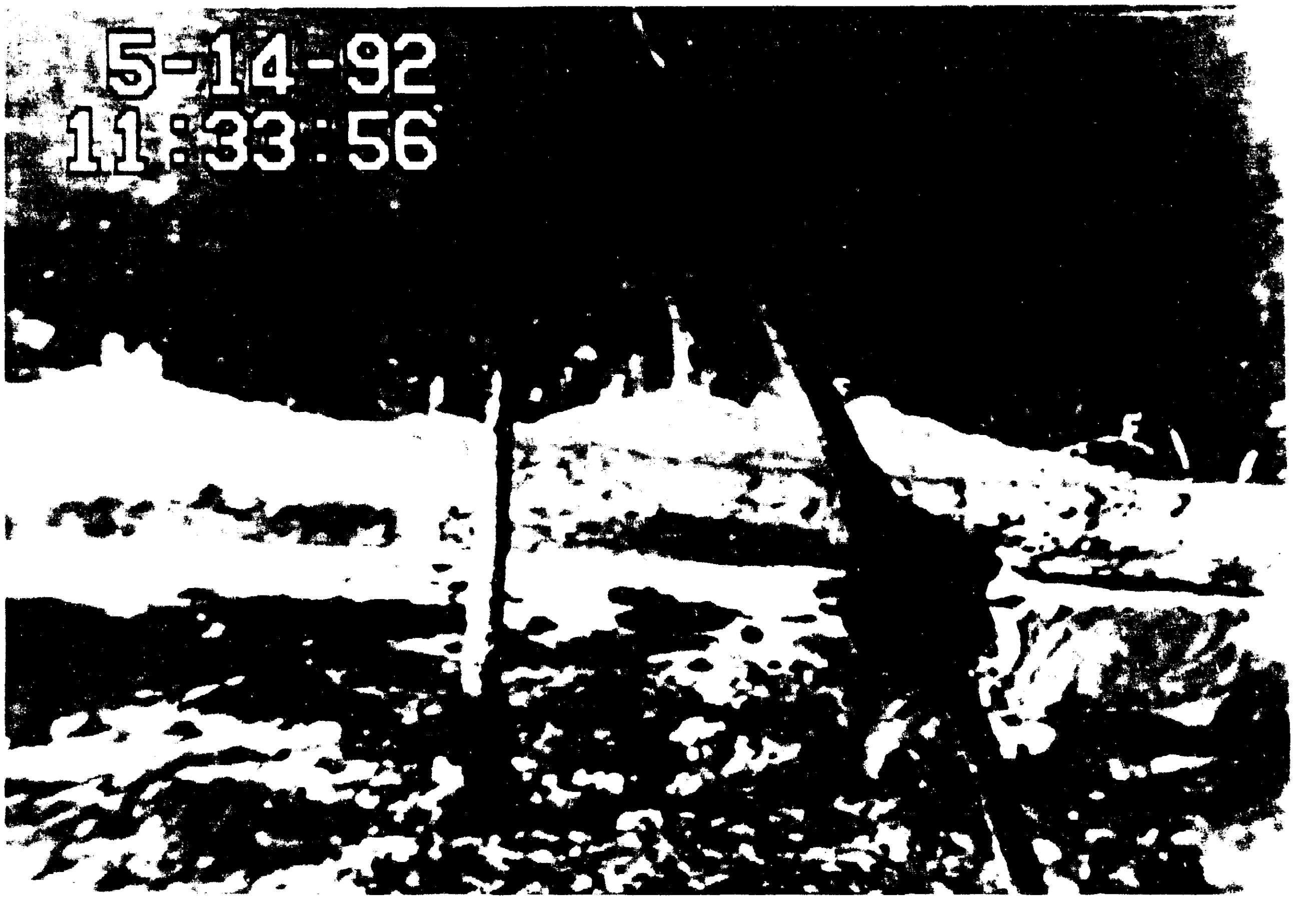

Figure 3. Modified Commercial Casing Puller Designed for Removing In-Tank Hardware.

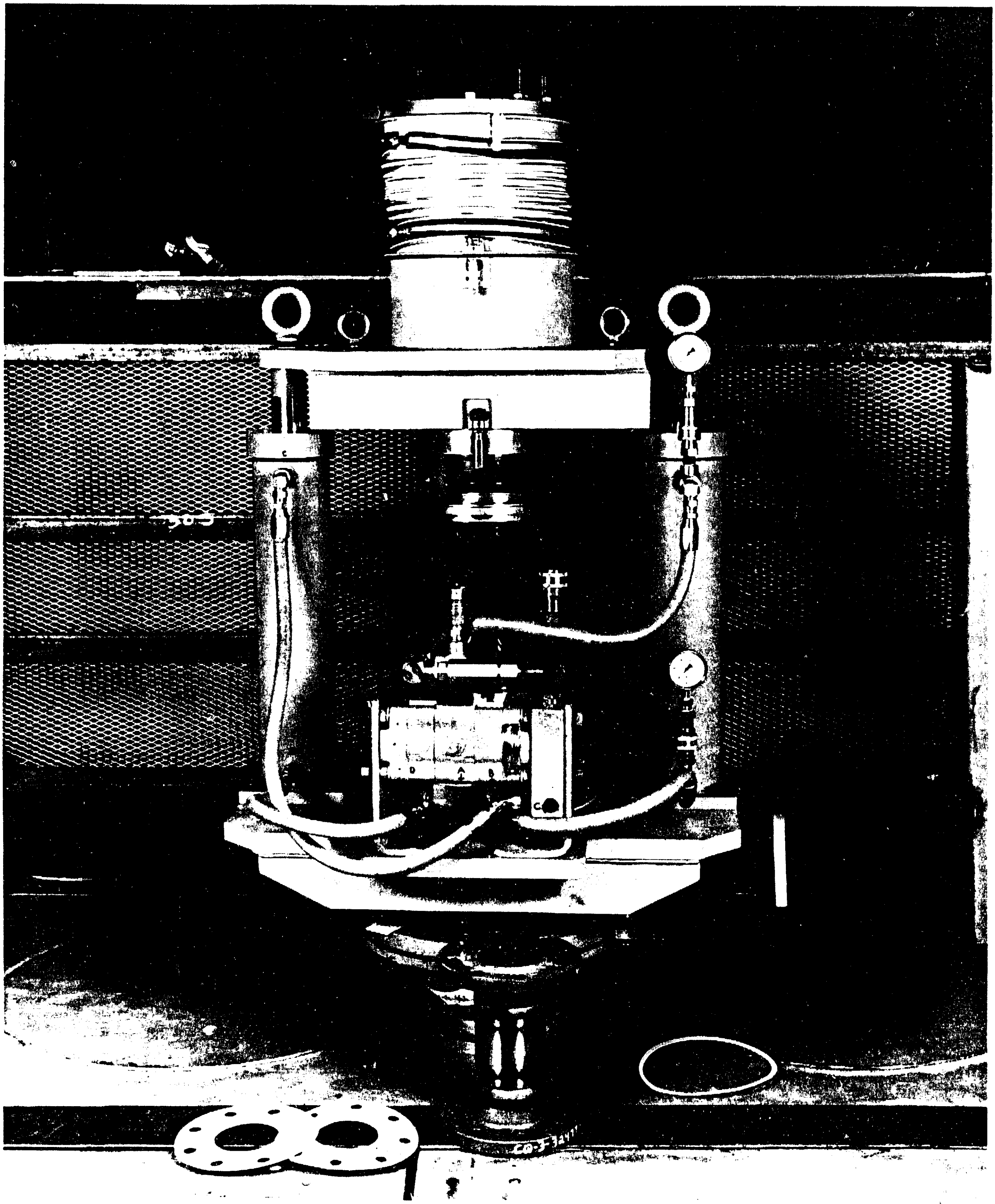

Figure 4. Field Operations Installing a 66-ft-long Receiver into the S
Shielded Glovebox Containing the Pulling Equipment is Shown Below the S

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