REMOTE INSTALLATION OF A NEW RISER ON AN EXISTING WEST VALLEY SITE TANK

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ABSTRACT

A method of remotely installing new access ports, risers, on existing high level radioactive waste (HLW) tanks has been developed by Rockwell Hanford Operations (Rockwell) for use on two of the storage tanks at the West Valley Demonstration Project (WVDP), West Valley, NY. The equipment designed includes a semi-remote concrete coring machine and fully remotely operated machines for flame cutting, grinding, and welding.

INTRODUCTION

With passage of the West Valley Demonstration Project (WVDP) Act in October, 1980, Congress directed the U. S. Department of Energy (DOE) to undertake a high level radioactive waste management demonstration project at the West Valley site. Under the Act, the DOE is responsible for solidifying the high level waste (HLW) in a form suitable for transportation to a federal repository for permanent disposal. West Valley Nuclear Services Company, Inc. (WVNS), a wholly owned subsidiary of Westinghouse Electric Corp., is implementing the WVDP for the DOE.

The WVDP is located on a 1354 hectare site near the village of West Valley, 50 km south of Buffalo, New York. The site has been used for low level nuclear waste burial and HLW storage. It was the site for the first commercial nuclear fuel reprocessing facility in the world. Nuclear Fuel Services, Inc. (NFS), under a lease from the State of New York, managed the site from 1963 to 1982. The fuel reprocessing portion of the facility has not operated since 1972. From 1966 to 1972 when fuel was being reprocessed by NFS, high level liquid radioactive wastes were generated from both commercial nuclear reactor fuels and defense production reactor fuels. These wastes are presently stored on-site in underground tanks.

Due to the complex internal geometry of two tanks, a special array of pumps is required to mobilize the waste for removal. Each of the tanks has only one existing riser large enough to accommodate a mobilization pump, an insufficient number for waste removal. This paper addresses the task of installing new access risers at strategic locations on both of the tanks. Due to the high radiation field near Tank 8D-2, most of this task must be accomplished remotely. Although the radiation field around Tank 8D-1 is very low its new risers were installed first, with the same remotely operated equipment, to gain experience.

In support of the WVDP, Rockwell was requested to design, build, and demonstrate a system and method whereby new risers could be installed on the existing West Valley tanks. To support this fast-paced project, Rockwell enlisted the aid of other Hanford contractors including Westinghouse Hanford Company, J. A. Jones Construction Services Company, and UNC Nuclear Industries.

TANK DESCRIPTION

Tanks 8D-1 and 8D-2 are each encased within a separate reinforced concrete vault having a minimum thickness of 0.6 m. The carbon steel tanks are 21.3 m in diameter and 8.3 m deep. A 1.2 m crawl space separates the tank roof and the vault roof, and a 0.6 m annulus space separates the tank and vault walls.

The tank roof is fabricated from 0.011 m thick, high temperature boiler plate. It is partially supported by 0.2 m channel rafters skip welded, on edge, to the outside of the tank, on 0.38 m centers. The rafters are cross braced by 0.25 m "I" beam girders, located on 3 m centers (Fig. 1).

New access risers were required on the two waste tanks because of the complex internal geometry. A series of 45 0.2 m diameter pipes support the roof girders from a similar girder layout near the floor of the tank. The floor girders do not rest on the bottom of the tank, but are supported by series of support plates and stay bolts. The tank roof is further supported by six 1.22 m diameter pipes placed symmetrically at 4.9 m from the tank center. The vault roof is supported by 0.76 m diameter concrete columns which pass through the large diameter pipe columns.

The floor grid work makes the task of removing the sludge very difficult. Testing on a one-sixth scale model of the tank revealed seven new risers were required on Tank 8D-1 and eight on Tank 8D-2 to fully mobilize and remove the waste. Two of the risers on Tank 8D-1, near the ion exchange columns, were installed manually.

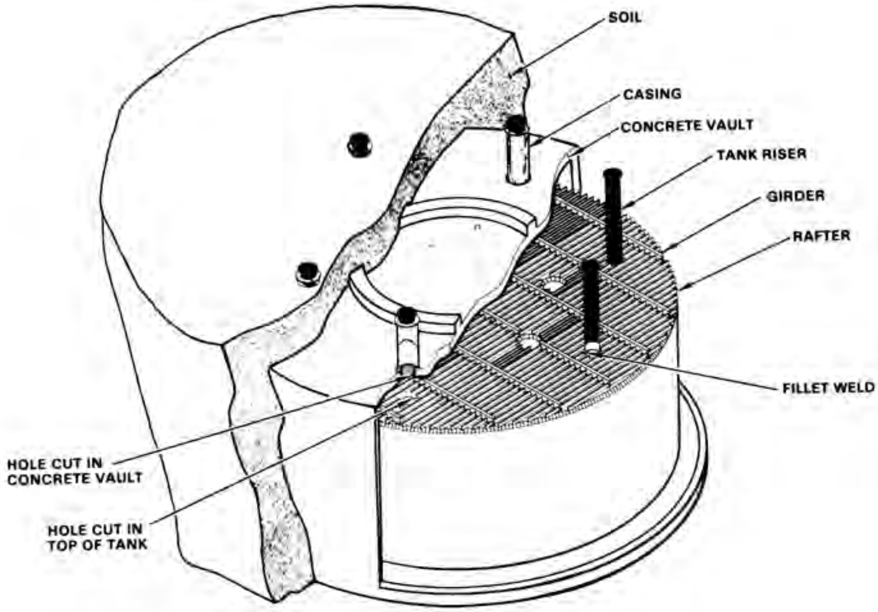

Fig. 1. West Valley High Level Waste Tank With New Risers in Place

RISER INSTALLATION

Installing a new 0.71 m diameter riser on either of the existing tanks involves a number of steps, most of which are performed remotely. First, the riser is located, and the site is excavated using conventional construction methods. Next, the concrete vault is cored to gain access to the tank roof. Sections of the two interfering rafters are then removed and the roof plate prepared for welding. The new riser is then positioned onto the tank roof and welded in place. The final step is to make the circular cut in the tank roof, at the bottom of the riser, to gain direct access to the tank interior.

Pilot Hole

Since there is no contamination present in the soil and the radiation level is very low, the riser site is located and excavated using conventional methods. A construction caisson is positioned on the vault to prevent the overburden walls from collapsing, and the area within is cleared of debris.

Next, a 0.1 m diameter hole is cored through the vault at the proposed riser centerline. This task is also performed with conventional tooling. However, the coring machine and the concrete plug are removed simultaneously with an overhead crane, only after all personnel are clear, since direct radiation exposure from the tank to the surface now exists.

The pilot hole in the vault serves three purposes. It is used to locate and mark the riser centerline relative to the tank rafters. It serves as an access port to check for vault contamination and verify the expected radiation level and lastly, it is used to hold and lift the 0.76 m diameter concrete core.

After the pilot hole is drilled a marking fixture is inserted which marks the tank top directly beneath the pilot hole. A small video camera is then used to determine how close the pilot hole is to being centered between two rafters. If the hole is more than .013 m off-center then a new pilot hole is drilled with its position being adjusted as required.

Casing Installation

The primary purpose of the casing is to transfer most of the riser loads away from the tank roof and distribute them over the vault roof. During the installation process, the casing also serves as a support structure for the concrete coring machine. (Fig. 2)

The casing is positioned on the vault and centered on the pilot hole. A number of large diameter anchor bolts are used to secure the casing bearing plate to the vault roof, to resist the torque and thrust of the coring machine.

Concrete Coring

A 0.76 m diameter hole is cut in the vault by concrete coring equipment expressly designed for this purpose. It includes the coring machine, a hydraulic powerpack unit, and a portable operating station. The coring machine is positioned on the casing and secured by six taper pins driven into

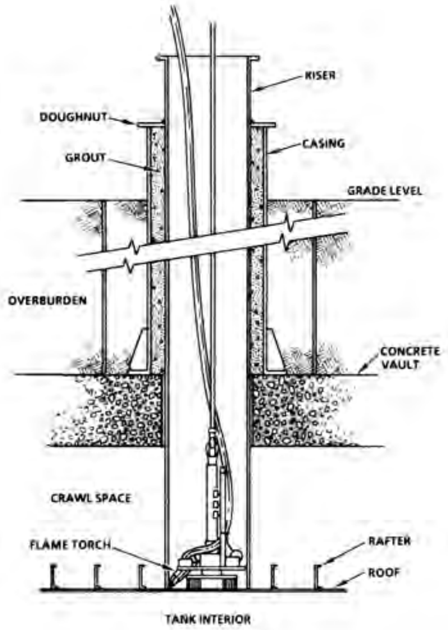

Fig. 2. Installation Elevation Shown With Roof Penetration in Process

matching holes in the casing. The coring machine utilizes a pair of hydraulic cylinders, a hydraulic motor and a gear reducer to rotate and load the coring bit. The coring bit is of conventional design, using synthetic diamond impregnated segments. The coring machine has been designed with a clear centerline to accommodate a lifting rod which extends from the crane hook through both the coring machine and the vault pilot hole. On the underside of the vault, a set of three hardened steel fingers are flared outward and locked into position from the surface, to prevent the core from falling onto the tank roof. By preloading the crane cable to the weight of the concrete core, positive control of the core is maintained during and after the cutting operation. The tensioned lifting rod also serves as a stable axle for the coring machine.

Rafter Cutting

Since the channel rafters are welded to the exterior of the tank roof, the interfering sections have to be removed. Rafter removal must be accomplished without breaching containment, and therefore, is performed in two steps. First, as much as safely possible is cut away with an oxygen-acetylene torch. The remainder of the rafter section, primarily the lower flange of the channel, is removed in a subsequent grinding operation.

Earlier in the riser installation operation, a great effort was made to insure the riser centerline fell between two rafters. Now, with the centerline midway between rafters, it is apparent only two rafter sections, of equal length, have to be removed to clear the new riser. This minimizes any structural weakening of the tank.

The rafter cutting machine is an extensively modified commercial unit normally used for cutting and welding in two planes. It has been made semi-automatic and carries a flame torch along a preset path. The torch is held parallel to the roof at all times to avoid damaging the roof plate. The rafter cutter is remotely operated and monitored by a closed circuit television (CCTV) camera that moves with the torch.

Since the rafter cutter is about 1 m long and the access hole is 0.76 m in diameter, a special entry technique is required. First, the rafter cutter is rigged to hang vertically, making it possible to pass through the hole in the vault roof. Taking advantage of the crawl space between the tank and the vault, the drive head is remotely driven to the center of the rail, shifting the center of gravity and causing the unit to rotate to the horizontal position. It is then maneuvered onto a rafter for the cutting operation.

When the cut is completed, the rafter cutter is moved to the other rafter and the cutting sequence is repeated. The rafter cutter is removed by reversing the insertion technique, and the two cut-outs are retrieved by an electromagnet.

Roof Grinding

The rafter cutting technique described earlier insures that the vault remains uncontaminated, but the lower rafter flanges still interfere with the new riser. The flange sections in the vicinity of the new riser location are removed by grinding.

A turntable mounted pneumatic grinder is used to remove the lower rafter flanges and prepare the roof plate for welding on a nominal 0.71 m diameter circle. The operator has complete, remote control of the grinder position in the vertical and horizontal (rotational) directions. A CCTV camera that rotates with the turntable and an overhead camera are used to monitor this operation.

All fragile and consumable items are mounted on the upper rotating part of the turntable which can be retrieved separately from the stationary clamping magnets and centerpost. This design philosophy allows replacement of a worn grinding wheel or a failed component without losing the original centerline of the grinding circle. The grinding operation continues until a uniform circle of bright metal can be seen on the closed circuit television monitor.

Riser Welding

By changing the tooling, the grinding turntable is converted into a Gas Metal Arc Welding (GMAW) welding turntable. The weld head incorporates independent cam followers to track any out-of-roundness in the riser or irregularities in the tank roof, thus maintaining the proper torch-to-joint angle and distance. A miniature wire feeder is mounted directly on the turntable to minimize the feed distance.

Since the tank roofs at West Valley are sloped and the design criteria calls for a vertical riser, it is necessary to bevel and contour the base of the riser to fit the condition of the tank found at each riser location. To accomplish this, the riser is first positioned on the tank top and held vertical and then the turntable is lowered through the riser onto the tank. With the weld head engaged but not operating, the turntable is rotated one revolution. The lower cam follower tracks the roof contour while the upper follower leaves a mark on the inside wall of the riser near the base. The mark is used as a reference to handwork the riser base as required.

After preparing the base, the riser and the turntable are re-positioned on the tank. The riser-to-roof joint is inspected for cleanliness and joint fit-up before initiating the automated weld sequence. The completed internal fillet weld is visually inspected with the turntable camera. To further verify the integrity of the weld, the riser is pneumatically pressure-tested using a shielded leak test fixture supported by the overhead crane.

After the weld has passed inspection, a vertical preload is applied to the riser through the shielded test fixture. Since all radiation leak paths are blocked, the upper riser welds can be safely completed and inspected manually. The "doughnut", the main load transfer member of the installation, is welded to the riser while the preload is maintained (Fig.2). This design approach effectively diverts riser flange loads away from the tank roof and distributes them over the vault roof. When the welding is completed, the riser flange can safely support the weight of either the test fixture or the permanent shield plug. The mobilization pumps are supported by a bridge structure that spans the tank.

Roof Penetration

Penetrating the tank roof, the final step in the riser installation procedure, allows direct access to the tank interior. Since contamination is now a possibility, this portion of the installation procedure must be approached in a slightly different manner.

From this point on, all steps necessary to make the roof penetration take place within a containment tent. A crane is used to position the containment tent, a prefabricated, double chamber structure. The riser shield plug is removed from the riser through the roof of the tent, and tank ventilation airflow is increased.

Another turntable, similar to the one used for grinding and welding, is used to cut through the tank roof with an oxygen-acetylene torch. Since this turntable could be contaminated after initial use, it is dedicated to the roof cutting operation. This "hot" turntable is kept isolated from the environment unless smears prove it is not contaminated.

The torch is positioned to cut through the roof at the foot of the weld or about a 0.013 m from the inner surface of the riser. This gives the maximum possible pass-through diameter of slightly over 0.66 m, easily accommodating the 0.61 m diameter mobilization pump. The ignitor electrode, connected to an automotive-type ignition coil, is positioned slightly below and very close to the torch tip to insure the torch will ignite before explosive quantities of unburnt gases can accumulate at the base of the closed riser.

After the roof cut is completed, the contaminated cutout is brought to the surface using the turntable electromagnets. While still within the containment tent, the cutout is bagged and boxed for disposal according to standard industry practices. The turntable is also bagged and removed from the tent, and the shield plug is reinstalled in the riser. The containment tent and other equipment are then removed to the next riser site.

Design Changes

Early in the conceptual phase of the project, the plan was to use an ultra high pressure (241 MPa) water jet to make a tapered circular cut in the concrete vault. A trailer mounted water jet system was borrowed from UNC Nuclear Industries to test the feasibility of this approach on a 0.69 m thick concrete block. With three intensifiers on line, the water jet was unable to cut through the lower course of re-bar. The jet simply deflected to the side of the bar. The manufacturer said a fourth intensifier, not immediately available, would give the jet enough energy to cut the lower re-bar. However, there was no way to stop the jet from cutting into the tank after cutting through the vault at West Valley. Since this presented an unacceptable risk to containment, all development work on the water jet was abandoned in favor of the concrete coring machine described earlier.

Also early in the conceptual phase, an industrial robot, held in an inverted position, to perform the rafter cutting, riser welding, and roof cutting operations was considered. Extremely long lead times and limited flexibility of available robots, combined to eliminate this approach from further consideration.

EQUIPMENT TESTING AT HANFORD SITE

Tank Mock-up

In order to adequately test the equipment and operating procedures before starting work on the tanks, a full scale mock-up of a section of the tank was constructed according to the original drawings. The mock-up, installed in a pit in the 305 building at the Hanford Site, consisted of 1.2x1.2 m rafter sections representing the tank roof and a 1.2x2.4x.6 m thick block of aged concrete taken from a wall in the 201R building, an abandoned building site at Hanford. The block was positioned on a stand above the roof sections to simulate the crawl space between the concrete vault and the tank. Full length 1.0 m and 0.71 m diameter pipes were used to represent the casing and the riser.

RISER CONSTRUCTION AT WEST VALLEY

Rockwell's agreement with WVNS was to make the first two riser installations on Tank 8D-1. The first, designated M-6, served as the final acceptance test of the equipment, and the second installation, M-7, was to train the West Valley operators on the equipment. They completed the remaining three remotely installed risers on 8D-1 and will perform all eight installations on Tank 8D-2. The riser installations on Tank 8D-1, with a radiation level of less than 2.58×10^{-6} C/kg/hr (10 mR/hr), were completed before commencing work on Tank 8D-2, with a field of 0.10 C/kg/hr (400 R/hr) near the tank top, thus giving the operators the maximum possible experience with the equipment before starting work on the hot tank.

The original plan was to complete the M-6 riser and then start work on M-7. To streamline the construction, in an attempt to complete all of the riser installations on both tanks before the onset of winter in New York state, West Valley engineering decided to break up the operating procedure into stand-alone sections. For example, after completing the coring operation on M-6 and M-7, a crew took the coring machine and cored M-2, M-3, and M-8 while rafter cutting and roof grinding were taking place at M-6 and M-7. Delays in delivery of the new risers demonstrated the wisdom of this approach.

Operations

West Valley Operations had completed the pilot hole and casing installation operations on Tank 8D-1 prior to arrival of Rockwell personnel on site. Both the acceptance test and training installations began with the large diameter coring operations.

Both the M-6 and M-7 coring operations proceeded in the normal manner. Although the vault re-bar was somewhat larger than in the block used for the mock-up, cutting times were comparable. The M-6 coring operation took just under nine hours and M-7 was completed in 10 hours.

Rafter cutting also proceeded without serious problems. Handling the rafter cutter with the boom crane was more tedious than with the bridge crane used at the Hanford Site. As expected, no contamination was found on any of the cut-outs.

At West Valley, both solid core and hollow core grinding wheels were available. In an effort to reduce the grinding time, both were used. The solid core was used to grind away the bulk of the rafter flanges because of its greater durability and the hollow core was used on the roof plate since it tended to wear more evenly. This approach reduced the grinding time from 24 to about 17 hours on M-6.

Since the humidity at West Valley is nearly triple that at the Hanford Site, a severe problem with water accumulation within the grinder motor was encountered after several hours of operation. Water traps in the air lines plus periodic dismantling and cleaning of the grinder motor reduced, but did not eliminate this problem. Wet air reduces the grinder power which increases the grinding time; the M-2 riser required 26 hours to grind.

The expected slope of the roof of Tank 8D-1 was about 0.018 radians. The actual slopes, as measured by calibrated inclinometers on the grinding turntable, were 0.013 rad at M-6 and 0.031 rad at M-7. The riser base contouring, described earlier, accommodated this, as well as the irregular surface encountered on M-6.

The remote welding of both M-6 and M-7 proceeded without problems. The M-6 weld, however, failed the pneumatic leak test. Close-up inspection of the weld with two different CCTV systems showed the weld bead had been laid on the low side of the joint, leaving incomplete fusion of the riser base in three areas. The torch was realigned, and a second pass was made above the first. The weld then passed the leak test. This experience proved that remote recovery from a misplaced or incomplete weld was possible.

The cutting operation, which took place within a containment tent since contamination was now a possibility, showed a problem with incomplete cutting on both the M-6 and M-7 installations. On M-6, the incomplete cut was at the start/stop position and M-7 had two regions totaling .06-.08 m in length that were not cut. A second pass over the affected areas freed the roof plate in both cases. The possible causes of incomplete cutting are that the tank ventilation system disturbed the flame pattern, or dirt and rust on the underside of the roof plate reflected the flame back into the tip, or both.

SUMMARY

A method of remotely installing new risers on the existing high level waste tanks at West Valley was successively demonstrated on-site during FY-1986. The West Valley Operations group have since completed all of the new riser installations on Tank 8D-1 and have begun work on Tank 8D-2.

The West Valley Remote Riser Installation Project was accomplished in 18 months. The conceptual design of the equipment began in March, 1985, and the roof penetration on the second installation was completed on August 26, 1986, thus fulfilling Rockwell's commitment to WVNS. The construction of the first two risers on Tank 8D-1 took approximately three months, from June 9, through August 26, 1986. The equipment designed by Rockwell, with the invaluable assistance of P. A. Titzler, Westinghouse Hanford Company , includes remotely operated machines for concrete coring, flame cutting, grinding, and welding. The total cost of this program was just under $1.25 million.

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