WHC-SA-2924-FP
CONF-9501119--1

Remote Controlled Tool Systems for Nuclear Sites Have Subsea Applications

R. J. Kuhta

Date Published
October 1995

To Be Presented at:
Underwater Intervention Conference
January 5, 1995

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

Remote Controlled Tool Systems for Nuclear Sites Have Subsea Applications

Bill Bath
Chuck Yemington
Sonsub Environmental Services
1640 West Sam Houston Parkway North
Houston, Texas 77043

Bob Kuhta
Westinghouse Hanford Company
P.O. Box 1970
Richland, Washington 99352

ABSTRACT

Remotely operated underwater tool systems designed to operate in Nuclear Fuel Storage Basins can be applied to deep water, subsea oilfield applications. Spent nuclear fuel rods are stored underwater in large indoor swimming pool-like facilities where the water cover shields the workers from the radiation. This paper describes three specialized tooling systems that were designed and built by Sonsub for work at the Department of Energy's Hanford site. The Door Seal Tool removed an existing seal system, cleaned a 20 ft. tall, carbon steel, underwater hatch and installed a new stainless steel gasket surface with underwater epoxy. The Concrete Sampling Tool was built to take core samples from the vertical, concrete walls of the basins. The tool has three hydraulic drills with proprietary hollow core drill bits to cut and retrieve the concrete samples. The Rack Saw remotely attached itself to a structure, cut a variety of steel shapes and pipes, and retained the cut pieces for retrieval. All of these systems are remotely operated with onboard video cameras and debris collection systems. The methods and equipment proven in this application are available to refurbish sealing surfaces and to drill or sample concrete in offshore oil field applications.

INTRODUCTION

The Department of Energy's Hanford Site near Richland, Washington has been part of the United State's nuclear development program since the early days of World War II. Plutonium produced at Hanford was sent to Los Alamos to build the first nuclear bomb that was tested at the now famous Trinity Site in New Mexico. A byproduct of this work is the spent nuclear fuel that is stored at the site. This material is stored underwater in indoor swimming pool-like storage facilities called Basins. The 105-K East Basin at Hanford, which was built in 1951, is typical of these facilities. The K East Basin is a water filled, unlined concrete pool inside a large industrial building. The K East pool contains the largest inventory of spent fuel in the DOE complex. Many of the spent fuel containers in the pool are damaged or corroded and subsequent release of radioactive materials into the pool water precludes divers working in the basin. The basin pool is approximately 20 feet deep, 70 feet wide and 130 feet long. The water level is maintained at about 17 feet. The spent fuel and is stored in cans and racks on the pool floor. The water covering the spent fuel provides protection from radioactive fuel rods but there is no protection from the tiny particles and corrosion products that float in the water and collect at the waterline on the pool walls. Due to Westinghouse regulated exposure limits, the time that a person may be in the basin is only about 40 hours per year. Therefore, the hazardous environment, underwater operations and federal regulations acting together make remote intervention a safer and more cost effective solution. In addition, all work in the basins has to meet the requirements of Nuclear Containment Facility quality standards.

DOORWAYS IN THE BASINS

The K basins have a discharge chute on one side of the pool that was used to receive and package the spent nuclear fuel before it is moved to the main pool area by an overhead crane. This discharge chute was designed with an construction joint spanning the full width of the concrete floor. Recent safety analysis revealed that a seismic event could cause this joint to open and allow loss of contaminated water to the environment as well as causing a drop in the water level above the stored fuel. Spent nuclear fuel is no longer being produced in any Department of Energy facility so the discharge chute is not currently in use. Therefore, the basin operators decided that the discharge chute should be sealed off from the main pool.

The discharge chute is connected to the main pool by two doorways. These doorways are 38 inches wide and 20 feet tall. The doorways were originally fitted with steel doors mounted on hinges. The hinges are attached to a carbon steel doorframe that is embedded in the concrete wall. The steel doorframe had an inflatable rubber gasket held in place by a steel retaining bar. After 40 years underwater, the door hinges were inoperable and the rubber seals were deteriorated and no longer usable. To replace the doors, Westinghouse Hanford engineers fabricated new steel isolation barriers. The isolation barriers were designed to be lowered into place by the existing overhead hoist and held in place by turnbuckles and strongback braces. The barriers are fitted with an elastomeric seal to prevent water leakage around the barrier edges. To achieve a good seal between the barrier and the doorframe, the existing inflatable seal and retaining bars on the doorframe needed to be replaced with a smooth, stainless steel seal surface.

The work on the door frames was complicated by the fact that the fuel canister storage racks on the pool floor extended to within a few inches of the door openings. In order to provide space to work on the doorways and to install the new barriers, the fuel canisters near the doors had to be moved and the existing racks had to be cut away. Moving the canisters is a normal operation for the basin operators but no equipment existed for cutting away the racks. The fuel racks are fabricated from 6″ channel, 2″ angle, and 1 1/2″ pipe carbon steel material. The racks provided a grid of 10.4″ by 19.7″ openings for storing pairs of fuel canisters. Any work near the floor of the basin was further complicated by the large amount of sediment and corrosion products produced by the steel racks and the spent nuclear fuel. This debris is easily disturbed and remains suspended in the water for several days before settling back to the basin floor. This debris must be captured and removed immediately to avoid complete loss of video capability.

RACK SAW

The Rack Saw was purpose built by Sonsub to meet the specific requirements of the fuel rack materials and configuration. The Rack Saw, shown in Figure 2, is fitted with a pair of hydraulically driven abrasive wheel saws. These saws, which are a mirror image of each other, are mounted on either side of the Rack Saw frame. The mirror image mounting arrangement provides the ability to cut within 2″ of existing braces on both sides of the rack. In addition, each saw has the ability to cut through a steel rack section made up of a 6″ steel channel (placed with the web in the vertical position) with a 1 ½″ angle section welded to the top leg of the channel. The combination of channels, angles, flat bars and pipes that make up the fuel racks required the use of an 18″ abrasive blade and a hydraulically actuated feed system. The Rack Saw is remotely operated from the remote control console. Video cameras mounted on the Rack Saw provide visual feedback to the operator during cutting operations. The video cameras were also used to confirm alignment of the Rack Saw during installation. Steel shrouds around the saw blades were connected to a water filter vacuum system during the cutting operation to reduce degradation of visibility.

Vacuumed water from the saw blade shrouds was passed through a roughing filter and a fine filter before being returned to the basin. The filter elements collected the radioactive sediment so they had to be kept submerged to reduce the radiation hazard. Special long reach tools were devised to remove and replace the filter elements without removing them from the water.

DOOR SEAL TOOL

The Door Seal Tool is made up of a support frame, a movable platen, a variable speed trolley and a group of purpose built tools. The platen is mounted to the support frame on four linear bearings. Platen movement is accomplished by eight hydraulic cylinder units. Each hydraulic cylinder unit is made up of two hydraulic cylinders mounted back to back such that three fixed positions can be provided in addition to an infinite number of intermediate positions. The platen provides a track for the tool trolley The trolley is connected to an endless chain drive powered by a variable speed electric motor mounted at the top of the tool frame.

The tool trolley provides the ability to move the individual tools around the track while the platen cylinders move the tools perpendicular to the doorframe. Sonsub designed a purpose built tool for each of the successive operations that are necessary to complete the work. The tools include:

o Seal Cutter

- o Bolt Cutter
- o Outside Bar Breaker
- o Paint Stripper
- o Wire Brush
- o Epoxy Applicator

The Door Seal Tool was carried into the basin using a combination of wheeled trolleys and the existing overhead trolley hoists. The stainless steel seal surface for both doors was positioned on the Tool prior to entering the basin. The Tool entered the basin in a horizontal orientation suspended from two rail mounted trolley hoists. In this position, the Tool is approximately 4 ft. wide, 2 ft. high, and 20 ft. long. The Tool was maneuvered over the discharge chute and the bottom end of the Tool was lowered into the water until it hung vertically from the single trolley hoist at the top. The Tool was then maneuvered into the doorway where it was manually positioned against the doorway's seal retainer flat bars.

Once in position in the doorway, hydraulically actuated clamping "legs" were activated to lock the Door Tool in place. The Tool platen was then extended horizontally to provide a work space for the tools and a precision track for the tool carrier. The tool carrier was alternately fitted with a variety of tools to accomplish the following tasks:

- o Cut and remove old rubber gaskets
- o Remove old metal gasket retainers
- o Remove epoxy paint and corrosion
- o Install stainless sealing surface
- o Capture cuttings in filter system

After each doorway was cleaned and the epoxy applied, the platen was closed to press the new stainless steel seal surface against the doorframe. The epoxy was then allowed to cure before the Door Seal Tool was moved to the next doorway.

Cleaning the doorframe surface produced a large amount of debris that could not be allowed to escape from the cleaning tool housing. Degradation of the visibility due to the rust particles dislodged from the carbon steel door frame was the primary concern for the underwater video cameras. In addition, contaminated debris dislodged above the water line could not be allowed to escape into the air in the basin. In order to prevent escape of cleaning debris, the cleaning tool housing was continuously scavenged by a vacuum filter system. The filter system included both a water filter and an air filter. Scavenged water passes through a submerged bag filter before being discharged directly back into the basin water. Scavenged air passes through a coalescer and a desiccant filter before being discharged through a nuclear grade HEPA filter.

BASIN WALLS

Another task that the basin operators wanted to perform was to take core samples from the concrete pool walls in the area of the water surface. Since the contaminated particles tend to collect in the "Bathtub Ring" at the water surface, this area is ~~signification~~ Significant to any effort involving people working in the basin. The Westinghouse

Hanford engineers determined that core samples 1 inch in diameter and 2 inches deep were needed to correctly determine the penetration of radioactive contamination into the porous concrete surface. This work was complicated by the basin configuration that completely covered the pool surface with a steel walkway leaving only a 1 1/2" wide slot access to the area to be sampled. In addition, some of the samples had to be taken in air while others were at or below the waterline and in either case, the drill cuttings could not be allowed to escape into the pool water

CONCRETE SAMPLING TOOL

The concrete sampling tool is divided into two systems that operate above and below the walkway. The surface system is a selfsteering transport that follows the 1 1/2" slot in the walkway grating. The transport is fitted with an hoist that suspends the submerged work system below the grating. The surface transport is remotely operated to carry the work system to the sampling site and to position the work system vertically at the waterline. The work system has three identical drilling units enclosed in a lexan housing. The housing is connected to the remote air and water filter system so that no drill cuttings are allowed to escape into the basin water. Each drilling unit has independent speed and feed controls as well as a rocker control. Each drill motor is fitted with a proprietary, hollow center drill bit that cuts a circular slot around the sample. The circular slot provides clearance around the drill bit so that after the drill is sufficiently deep in the concrete, the rocker cylinder can break off the concrete sample. The sample is retained in the drill bit until the drilling unit is returned to the surface.

A further condition required for this work is that the drill can not be allowed to touch or damage any of the rebar in the concrete. Since the exact spacing of the rebar can not be determined from the plans, a rebar sensor is incorporated into the drilling unit work system. The rebar sensor is fixed mounted to the work system such that as the surface transport travels along the slot, the sensor is moved along the concrete pool wall. Vertical movement of the sensor is provided by the transport hoist. The sensor is capable of determining the location and the depth of any rebar with its range.

CONCLUSION

The technology demonstrated by the three systems described here is directly applicable to subsea oilfield work. The Door Seal Tool illustrates multistep precision seal surface preparation that can be applied to underwater valves or piping offshore. The Concrete Sampling Tool can be used to drill holes or to take samples from existing concrete structures. This work can be done with no danger of damage or exposure of the rebar. Insitu samples of new construction concrete can easily be taken for Quality Assurance purposes with the Concrete Sampling Tool. The Rack Saw design can be configured to fit a wide variety of structural members such as installation appurtenances on steel jacks. These machines have demonstrated how readily available materials and "off the shelf" components can be rapidly assembled to do complex remote intervention tasks.