LL/ILW: Post-Qualification of Old Waste through Non-Destructive Extraction of Barrels from Cement Shields – 13535

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ABSTRACT

Currently there is a large number of radioactive waste drums entombed in cement shields at German nuclear power plants. These concrete containers used in the past for the waste are not approved for the final repository. Compliance with current acceptance criteria of the final repository has to be proven by qualification measures on the waste. To meet these criteria, a new declaration and new packing is necessary. A simple non-destructive extraction of about 2000 drums from their concrete shields is not possible. So different methods were tested to find a way of non-destructive extraction of old waste drums from cement shields and therefore reduce the final repository volume and final repository costs by using a container accepted and approved for Konrad. The main objective was to build a mobile system to offer this service to nuclear plant stations.

ITRODUCTION

We received the inquiry for making different Mock-Up trials to find a way for non-destructive extraction of waste drums from concrete shields.

The intent was to minimize volume and find a way of putting twelve waste drums in each Konrad container Type V instead of only three cement shielded drums. The concrete shielding is a 200l barrel fixed with grout and a weight round about 2.6 ton. The reinforced concrete form has a height of 1.55 m and a diameter of 1.06m. The use of these concrete shielded drums always makes handling difficult and consumes large quantities of valuable waste storage capacity.

DESCRIPTION

The first step was to produce three samples of concrete shielded drums. The intent was to create an exact copy of real concrete shields that can be used for the Mock-Up trials with the drilling process. Two concrete shields were produced with the Type IP-2 drum as the most common and one concrete shield was produced with the Type EB1 A200 drum. The barrels were filled with commercial gravel with a weight of round about 300 kg per drum.

Figure 1: different type of drums to produce the concrete shields

The next step was to entomb the drums in the concrete shields. For this the outer and inner lid has been removed and a concrete stone was placed in the middle of the bottom. With a lifting tool the drum was placed in the concrete shield. After loading, an expected eccentricity was determined.

Two different methods of filling were used. In the first case the concrete was produced with C25 and a reversing-drum mixer. To reach a better flow behavior 6 liter instead of 4 to 5 liter water were used. By poking in the four existing notches and so compacting the concrete, the drums placed themselves a bit and got coated with concrete. Afterwards the inner lid was insert and secured with the provided rebar after 2/3 of the concrete backfill height. The filling got finished and smoothed over the inner lid. The second method of filling was the same procedure as the first one only without poking in the notches. The cement curing process took more than 29 days.

Figure 2: concrete shields

To prepare the concrete shields for drilling, a horizontal standing area for the drill stand and drill machine was constructed. This includes a horizontal placement for the concrete shields with an intermediate restraint for the drill stand to shorten the lever. To collect the falling drill water and mud the ground was covered with foil. The concrete shield horizontal and plumb were checked to ensure proper alignment.

Figure 3: prepared concrete shield

Figure 4: first trial with diamond core bit

The first trial was made with a diamond core bit. The process was divided into two different steps. The bit had to have a size of 700 mm to be bigger than the drum and smaller than the concrete shield. In the first step, a 500 mm long bit was used to create a guidance channel for the 1400 mm long bit. After about 37 cm of drilling, the bit locked up and only got removed after several tries and the use of a 20 ton hydraulic shovel. The first trial was stopped. The inner lid was not really connected to the top of the drum as expected, the removing was easily done. A part of the drill core split near the cover of the drum (1 cm of concrete) and so locked up the bit.

The second trial was extracting the drums by using diamond saw technology. The first two cuts were made to separate the head and base of the concrete shield. I It was simple to determined how to conduct these cuts without damaging the drum. Cut 1 was 26 cm above the bottom edge of the concrete shield. Because of the concrete stone on the bottom of the concrete shield damage to the drum was not possible. The bottom part had a weight of about 441 kg. The cut-off had about 3 cm tolerance to the first ring of the drum. The second cut was approximately 3 cm under the lower armoring stick of the inner lid of the concrete shield, easy to see in the open space from outside. The head of the concrete shield had a weight of about 293 kg. Between cut and drum was more than 5 cm space. The next two cuts with the diamond saw were made for splitting the outside in two different parts. The cuts were only 12 cm deep and ended in the armor less slots. By placing steel wedges in the saw cuts, a gap was formed that followed the inner form of the drum. The effect of the wedges was limited and the use of a hydraulic splitter after using a core drill was necessary. The core drill had a diameter of 50 mm and was done by hand. The use of the hydraulic splitter took place in two diagonal spots on the concrete shield. As a result the upper part could be removed from the base.

Figure 5: cuts to separate the outside

Figure 6: use of the hydraulic splitter

Figure 7: concrete shield without upper part

After removing one half part of the concrete shield the drum was still stuck in the other part. The smooth coated drum surface had no bond to the concrete.

The fifth cut was made to half the half-shell concrete again. The last concrete section was removed by using wedges. Since now no more concrete was more available as a support, the wedges were used along the hoops and the drum was removed from the last part.

Figure 8: removed third part

Figure 9: freed drum

The order of cuts, tools and change of position of the concrete shield were necessary to optimize the result. Six different cuts around the concrete shield with the diamond saw were done. The concrete coat of the shield was separated into two quarter parts and four eight parts. All cuts were about 20 cm deep and split the armoring. The concrete body around the drum is still closed. Then two cuts in the concrete shield were done. The head and bottom part got removed with a diamond wire saw in the same position. Before the first cut all preparations for the second cut were made. Only the wire saw had to change position. The concrete shield was only moved one time during the whole process. After removing the head and bottom, the drum can be evaluated and measured. A damaged drum could be stabilized with polyurethane foam or similar by an injection. The cuts on the sides generated smaller segments. These segments got removed by using different wedges. Because of the big counterweight the wedges had no effect on the drum.

Figure 10: different cuts in the third trial

Figure 11: first wedged part

As expected the separation happened between the concrete shielding and the grout. The thickness of the grout up to the barrel skin was approx. 22mm at the weakest place and really solid. Removing the drum from the last concrete segment was possible without problems because of the circumferential gap between drum and cement. The removal was possible with the use of eyebolt instead of the lid screws.

Figure 12: freed drum with concrete

DISCUSSION

In the first trial, the real position of the drum was not known with certainty. The surface geometry of the drum causes four weak points: lid, upper and 2 drum hoops. After blocking the first time with the 500 mm bit a second blocking with the longer bit would have guided to a loss of the drum. Therefore, a different solution was necessary.

With the second method the drum was extracted from the concrete shield without any damage. As expected there was little binding between drum and concrete. Only the barrel hoops were stuck in the concrete. By using a hydraulic splitter and wedges, the concrete shield was removed from the drum. With the last concrete part the wedges on the drum hoops were driven tangential with light hammer beating. The use of wedges did not damage the drum or drum hoops. The trial was considered successful. The blocking of the concrete with the drum hoops in combination with damaged or rusted drum as a worst case is with this method still in discussion. Through filling the drums with humid material, restricted corrosions ability could be assumed. A permanent moisture penetration through outside was excluded. The alkalinity of the concrete would prevent damage of the drum.

CONCLUSION

A non-destructive extraction of drums out of concrete shields is possible. After different trials the best way is to saw first the vertical cuts and afterwards the ones for the head and bottom. The decision of the order of cuts and work steps as well as the position of the concrete shield were made to produce less difficulty and stress for the workforce. Till separation the head and bottom the guarding concrete shield is protecting. Afterwards, evaluation of the damage can be made and the dose for employees can be measured. For damaged drums, the described process can be used and the drum can be over packed. The non-destructive extraction of these radioactive wastes allows post-qualification and conditioning meeting the acceptance criteria of the final repository. A new declaration and new packing can easily done using this method. The post-qualification waste is possible and waste storage can be increased. With the mobile system developed the non-destructive extraction of old waste drums from their cement shields can be conducted at all nuclear plant stations.