Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

12-AMRP-0089

JUL 16 2012

Ms. J. A. Hedges, Program Manager
Nuclear Waste Program
State of Washington
Department of Ecology
3100 Port of Benton
Richland, Washington 99354

Dear Ms. Hedges:

231-Z-DR-11 MIXED WASTE CONTAINER ENGINEERING STRUCTURAL INTEGRITY ASSESSMENT, CHPRC-01811, REVISION 0

References:
(1) RL ltr. to J. A. Hedges, Ecology, from J. A. Dowell, "231-Z-DR-11 Mixed Waste Container Engineering Structural Integrity Assessment Plan, Revision 1," 12-AMRP-0055, dtd. June 6, 2012.

(2) Ecology ltr. to M. S. McCormick, RL, from J. B. Price, "Department of Ecology's (Ecology) Comments and Approval to Proceed on the CHPRC Engineering Assessment Proposal Box 231-Z-DR-11," 12-NWP-074, dtd. May 7, 2012.

(3) Ecology ltr. to M. S. McCormick, RL, and J. G. Lehew, CHPRC, "Immediate Action Required – Hand Delivered and Certified Mail Dangerous Waste Compliance Inspection at Operating Unit Group 6, Hanford Central Waste Complex Facility RCRA Site ID: WA 7890008967," 12-NWP-039, dtd. March 22, 2012.

This letter provides the Structural Integrity Assessment for Container 231-Z-DR-11 as requested by the State of Washington Department of Ecology (Ecology) (Reference 3). Ecology conditionally approved a plan for preparing the assessment pending confirmation that Ecology's comments were incorporated (Reference 2). The plan was revised and delivered to Ecology on June 7, 2012, (Reference 1). This started a 14 calendar day period to conduct the assessment. Field actives were completed on June 21, 2012. Per the plan, as approved by Ecology, the assessment report was to be delivered to Ecology 15 working days following completion of field activities.

The attached Structural Integrity Assessment was performed by an independent, qualified, professional engineer, (IQPE). The Structural Integrity Assessment concluded that Container 231-Z-DR-11 is structurally capable of being lifted, placed onto a transport trailer, transported and off-loaded to a new location. The IQPE-certified report details the basis for this conclusion and includes the information elements required by Ecology.

In Reference 3, Section 5.2, Ecology defined the information content of the Structural Integrity Assessment. One specific element was that:

> If the integrity of the container is determined to be satisfactory, then recommendations must be provided to Ecology for moving the mixed-waste container in accordance with Item 4 of the mitigation plan.

A "mitigation" plan is not specifically named in Reference 3. The "response" plan section contains a bullet Item 4 which requests that "if the container is confirmed by an integrity assessment to be sound, move container 231-Z-DR-11 to either a dangerous waste permitted containment building or an offsite approved dangerous waste permitted treatment facility.

Several options were evaluated for relocation of the container. Upon considering the regulatory requirements, Ecology's comments in the referenced letters, and budget, the following is the current strategy for managing the container. Place the container in an IP-1 bag and place both into an IP-1 box. This is a transportable configuration for later shipment to an offsite facility where the container can be size-reduced and placed in Waste Isolation Pilot Plant-compliant packages. Placement in the IP-1 bag/box configuration is expected to take about six months.

Container 231-Z-DR-11 can be managed in outside storage with the additional protections. This IP-1 box will be in a new location in the dangerous waste permitted Central Waste Complex Outside Storage Area, allowing for soil clean-up to commence.

Container 231-Z-DR-11 has not shown any sign of liquid run-off since the temporary enclosure was erected over this box on March 7, 2012. Daily monitoring has confirmed this observation. This container, once housed in the rugged weather-tight IP-1 container, will be in a safe, stable condition. It will also be ready for shipment, once funds are available for eventual offsite transport of this container.

If you have any questions, please contact me, or your staff may contact, Al Farabee, of my staff, on (509) 376-8089.

Sincerely,

Jonathan A. Dowell, Assistant Manager
for the River and Plateau

AMRP:MSC

Attachment

cc: See Page 3

cc w/attach:
G. Bohnee, NPT
L. Buck, Wanapum
D. A. Faulk, EPA
S. Harris, CTUIR
R. Jim, YN
S. L. Leckband, HAB
K. Niles, ODOE
J. B. Price, Ecology
D. Rowland, YN
Administrative Record (CWC)
Environmental Portal

cc w/o attach:
L. T. Blackford, CHPRC
A. E. Cawrse, CHPRC
L. M. Dittmer, CHPRC
M. N. Jaraysi, CHPRC
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CHPRC - 01811
Revision 0

231-Z-DR-11 MIXED WASTE CONTAINER ENGINEERING STRUCTURAL INTEGRITY ASSESSMENT

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788

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Approved for Public Release;
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231-Z-DR-11 MIXED WASTE CONTAINER ENGINEERING STRUCTURAL INTEGRITY ASSESSMENT

Document Type: RPT Program/Project: EPC

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CH2M HILL Plateau Remediation Company

Date Published
July 2012

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

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By Shauna E. Adams at 4:19 pm, Jul 03, 2012

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231-Z-DR-11 MIXED WASTE CONTAINER ENGINEERING STRUCTURAL INTEGRITY ASSESSMENT

Executive Summary

This structural integrity assessment report is in response to a State of Washington, Department of Ecology (Ecology), request in letter 12-NWP-039, dated March 22, 2012 (J. B. Price, Ecology, to M. S. McCormick, DOE-RL, "RE: Immediate Action Required – Hand Delivered and Certified Mail Dangerous Waste Compliance Inspection at Operating Unit Group 6, Hanford Central Waste Complex Facility RCRA Site ID: WA 7890008967"). An independent, qualified Professional Engineer (IQPE), Mr. Gary Wagenblast, was retained to perform this assessment. Mr. Wagenblast's resume is included in the report. An engineering structural assessment plan was developed and approved. During the execution of this structural integrity assessment, no field changes to the approved plan were made.

Based on the information available within the limits of the methods employed for this structural integrity assessment, the box 231-Z-DR-11 with its lifting fixture is structurally capable of being lifted, placed on a transport trailer, transported, and off-loaded at a new location.

Visual field inspections were made. Concrete weathering, staining, hairline cracks, and surface indentations were observed. Structural steel surface corrosion and missing welds were observed. Calculations were completed to quantify the strength of the burial box to resist transportation loads.

The weathering, stains, hairline cracks, and surface indentations on the concrete surfaces do not adversely affect the structural integrity of the burial box. The burial box has a reserve capacity of 9.5 times the transportation load requirement in the structural concrete components.

The surface corrosion of the structural steel channels, floor plate, and welds would reduce the structural steel capacity of the box. The burial box has a reserve capacity of 9.5 times the transportation load requirement in the structural steel components.

The missing welds and the surface corrosion of the welds attaching the lid restraint guide angles to the top of the walls of the box would reduce the structural capacity of the lid restraint to be that of 5.75 times the transportation load requirement.

If a trailer is used to transport the box, the box must be placed on the trailer with a friction mat with the skid ramp of the box facing to the rear. The tie down design takes credit for friction mats placed between the trailer and the lifting fixture. To lift the fixture and the box, the lifting lugs must be reattached. Once on the trailer, the lifting lugs must be removed and the aft restraint cables and tie down hardware installed. This process is reversed at unloading. With these assumptions, the burial box is found to be stable against overturning during transport and the tie down rigging components are designed to safely resist the horizontal and vertical transport force requirements.

1.0 Purpose

The purpose of this engineering structural assessment is to examine burial box 231-Z-DR-11 and determine the viability of safely moving the burial box from its current location to a new location. This engineering structural assessment provides a technical opinion on the ability of the burial box to maintain its structural integrity during loading, transport, and unloading.

1.1. Background

Burial box 231-Z-DR-11 is a general purpose burial box constructed in the 1970s. According to the design drawing H-2-58526, the burial box was constructed for the PUREX complex. It was filled with general waste from the Plutonium Finishing Plant and placed in Trench 7 of burial ground 218-W-4C.

Figure 1. Photo Showing Burial Box Shoring and Excavation

The burial box was unearthed (retrieved) in 2008 from its former burial location, see Figure 1, and transported in April 2009 to the Central Waste Complex (CWC) (reference work document 2X-08-03783) and has been located at the CWC outside storage area since that date. The burial box was stored outside, above ground, and uncovered from April 2009 until March 2012. The burial box, once filled with waste, was designed to be dragged only (not to be lifted). In order to lift the burial box onto a transport trailer, a lifting fixture, H-2-833036, was designed and fabricated in 2009.

In the burial grounds, the burial box was dragged onto the lifting fixture, see Figure 2 and Figure 5, and then, by lifting the fixture, the burial box was lifted onto a transport trailer, see Figure 3, and moved to the CWC storage yard. The burial box is now resting on the lifting

fixture, which sits on a flat gravel pad which slopes down slightly toward the southwest. The burial box is currently stored outside, above ground, and protected from weather by a field-constructed plastic tarp and scaffold cover installed in March 2012, see Figure 4.

Figure 2. Photo Showing Burial Box Being Prepared to be Dragged onto the Lifting Fixture

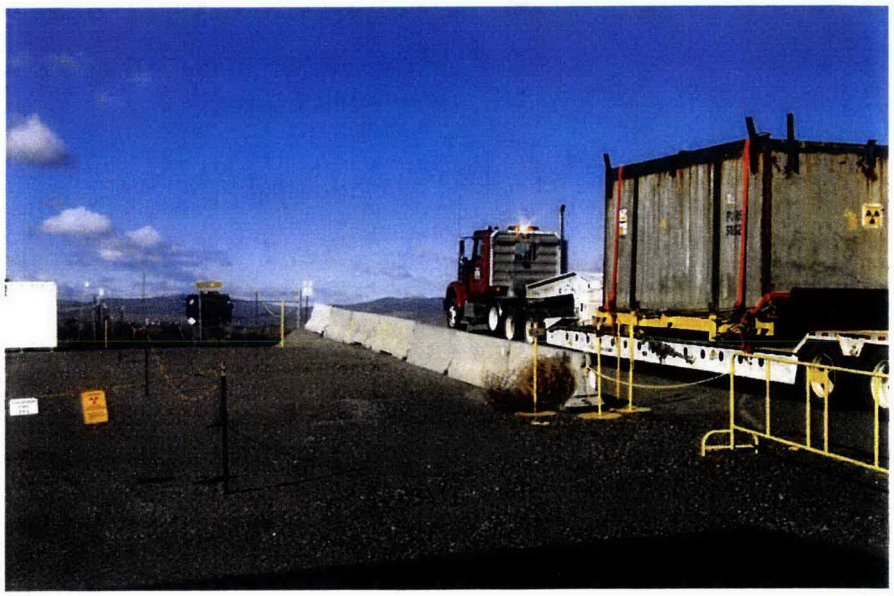

Figure 3. Photo Showing Burial Box on Transport Trailer with Tie Downs

Figure 4. Photo Showing Burial Box at Current Location with Weather Cover

The burial box weight is 40,400 pounds empty and 79,500 pounds filled. With the 2,900 pound weight of the lifting fixture, the total lifted weight of the burial box is 82,400 pounds. These are the actual, as measured weights of the burial box and lifting fixture; they were recorded when the box was lifted and moved in 2009. Other weights were considered in the design and testing phases to achieve a conservative and safe operation. In the design of the spacing of the beams in the lifting fixture (prior to knowing the actual weights) a design weight of 104,000 pounds was used (1.25 times the weight of 83,300 pounds which was painted on the outside of the box). In the design of the tie-downs, a design weight of 97,140 pounds was used (83,300 pounds for the box, 2,840 pounds for the lifting fixture, 1,000 pounds for rigging, and 10,000 pounds for uncertainty). In the load testing of the lifting fixture, a test weight of 125,000 pounds was used (1.25 times the 100,000 pound rated lifting fixture capacity, which is a nominal increase over the actual weight of the loaded box plus lifting fixture plus rigging). For the purpose of this structural assessment, the design weight of 89,500 pounds was used (79,500 pounds for the box plus 10,000 pounds for uncertainty).

Table 1. Summary of Weights and Design Loads

	Actual Weight	Lifting Fixture Design	Lifting Fixture Load Test	Tie-Down Design	Structural Assessment Loads
Empty Box	40,400 lbs				
Filled Box	79,500 lbs	104,000 lbs	125,000 lbs	83,300 lbs	79,500 lbs
Lifting Fixture	2,900 lbs			2,840 lbs	
Design Weight	82,400 lbs			97,140 lbs	89,500 lbs
Rated Capacity of Lifting Fixture	100,000 lbs				

1.2. Actions Required of the Department of Energy Richland Office (RL) and CHPRC by the Washington State Department of Ecology

In the letter dated March 22, 2012, Ecology issued a letter to RL and CHPRC, requiring a structural integrity evaluation of the mixed-waste burial box 231-Z-DR-11 be performed by an independent, qualified, professional engineer, licensed in the state of Washington. All records, photos, and field notes developed during the structural integrity assessment are to be a part of the report. The report is to describe any field changes required. The report is to include conclusions regarding the structural integrity of the burial box. If the structural integrity of the burial box is deemed compromised, the report is to provide recommendations to assure mixed waste within the burial box is properly contained. If the integrity of the burial box is determined satisfactory, then recommendations are to be provided for moving the burial box.

2.0 Scope

The scope of the engineering structural assessment is to provide qualitative and quantitative data related to the structural ability of the burial box to be lifted, loaded onto a transport trailer, transported, and unloaded off the trailer at the new location. Criteria that will be used in this determination are a combination of quantitative values (strength of materials, reaction to gravity and transport loads, compliance with applicable codes and standards) and qualitative observations (assessment of the influence of rust, observations of any concrete cracks or defects, observation of as-built conditions).

Qualitative assessment of whether or not the moisture is coming from the contents of the box, from rain/snow water infiltrating and escaping the box, or from rain/snow water washing down the exterior of the box is NOT a part of the engineering structural assessment.

Details related to "containment/contamination control" during the lift and move is not a part of this structural assessment. Details related to "containment/contamination control" during the lift and move will be a part of the work package that directs the actual move.

3.0 Burial Box Description and Construction Features

The dimensions of the box are 10 feet 10 inches wide, 19 feet 0 inches long (22 feet 9 inches including the skid plate), and 10 feet 0 inches high (8 feet 0 inches wall height plus the lid thickness plus the lid lifting bail).

The burial box was constructed of reinforced concrete wall panels framed with carbon steel channels (H-2-58526) welded together at the four corners of each wall panel. The wall panels were poured flat on a formed surface on the ground and when the concrete had cured, the wall panels were tipped up into place. The wall panel carbon steel frame channels were welded to each other at the outside of each of the four corners of the burial box with a 2 inch long, one-quarter inch thick, structural fillet weld at the top, bottom, and center of the wall height. In addition, a small (size is undocumented) fillet weld was made between the structural welds to act as a continuous seal weld. The wall panel carbon steel frame channels were welded around

the outside and inside perimeter of the base of the walls onto a one-half inch thick carbon steel plate comprising the bottom of the burial box. On the outside of the box, an intermittent one-quarter inch thick fillet weld two inches long, spaced 8 inches center to center was used. On the inside of the box, a continuous one-quarter inch thick fillet weld was used. The burial box is partially lined with an 11 gage carbon steel sheet continuously welded to the floor plate and extending 22 inches up the four walls of the burial box. The top edge of the liner is welded to steel inserts in the concrete walls with an intermittent one-eighth inch thick fillet weld one inch long, spaced 12 inches center to center and was sealed to the concrete walls with caulking.

Welding and welder qualifications for all welds throughout the burial box were performed using specification HW-4926-S, developed by and for the period Hanford contractor and approved for use by the Atomic Energy Commission. The welding specification included provisions for qualification of welders, specification of weld filler material, welding processes, fabrication requirements, weld quality requirements, inspection requirements, and weld defect repair requirements. The welder qualification and welding, as specified, are acceptable.

The reinforced concrete walls (the ends and the sides) were designed with vertical structural reinforcement bars at the inside face of the walls, horizontal non-structural (crack mitigating temperature steel) bars at the inside face of the walls, and non-structural bars at the outside face of the walls to help maintain position of the channel frame during the concrete pour. Based on the position of the structural reinforcing bars, the walls are designed to resist soil loads during burial. The top of the walls are restrained from inward movement by the welding to the base plate at the bottom of the wall and by bearing on the burial box lid at the top of the wall. The reinforced concrete walls are designed to resist the soil load in bending by spanning between the base plate and the lid. The walls are not designed to resist internal pressures although the walls will have some limited capacity due to the tensile strength of the concrete. The burial box is designed to be dragged only, not lifted, after loading. The empty box was to be lifted only with the lid in place.

The construction of the lid restraint guide/bearing angles differs from the design drawing. On the design drawing H-2-58526 there are 3 styles of guide/bearing angles of varying angle length and protrusion above the top of the box to help remotely guide the lid into place. During the visual inspection (see section 8), it was noted that the style and number of guides differed from the design drawing and that some of the welds were missing or broken. The result is that there are three structurally viable guides on the front end of the box, three on the rear end of the box, five on the right side, and two on the left side.

In 2009, an assessment of the General Purpose Burial Box was made for compliance with IP-1 (CFR 49-173) container requirements. A draft copy of the documentation for this IP-1 container certification was reviewed. The draft certification document includes a description of the container, the materials of construction, construction details, and a compliance statement for the applicable requirements found in 49 CFR 173.24, 49 CFR 173.24a, 49 CFR 173.410, and 49 CFR 173.411. The draft compliance document states that with the container being constructed of reinforced concrete and welded steel, the vibration or vibration resonance from Normal Conditions of Transport would not cause a leak path or release of contents. The IQPE is in agreement with this statement relating to vibration and vibration resonance. The issue of

whether the burial box meets or does not meet IP-1 criteria, or whether the box is required to meet IP-1 criteria, is not a part of this assessment.

The design and fabrication of the burial box was compared to ACI and AISC code requirements and is found to be in compliance.

4.0 Lifting Fixture Description and Construction Features

As mentioned above, the burial box, once filled with waste, was designed to be dragged only (not to be lifted). In order to lift the burial box onto a transport trailer, a lifting fixture, H-2-833036, was designed and fabricated in 2009, see Figure 5. In the burial grounds, the burial box was dragged onto the lifting fixture and then, by lifting the fixture, the burial box was lifted onto a transport trailer and moved to the Central Waste Complex storage yard.

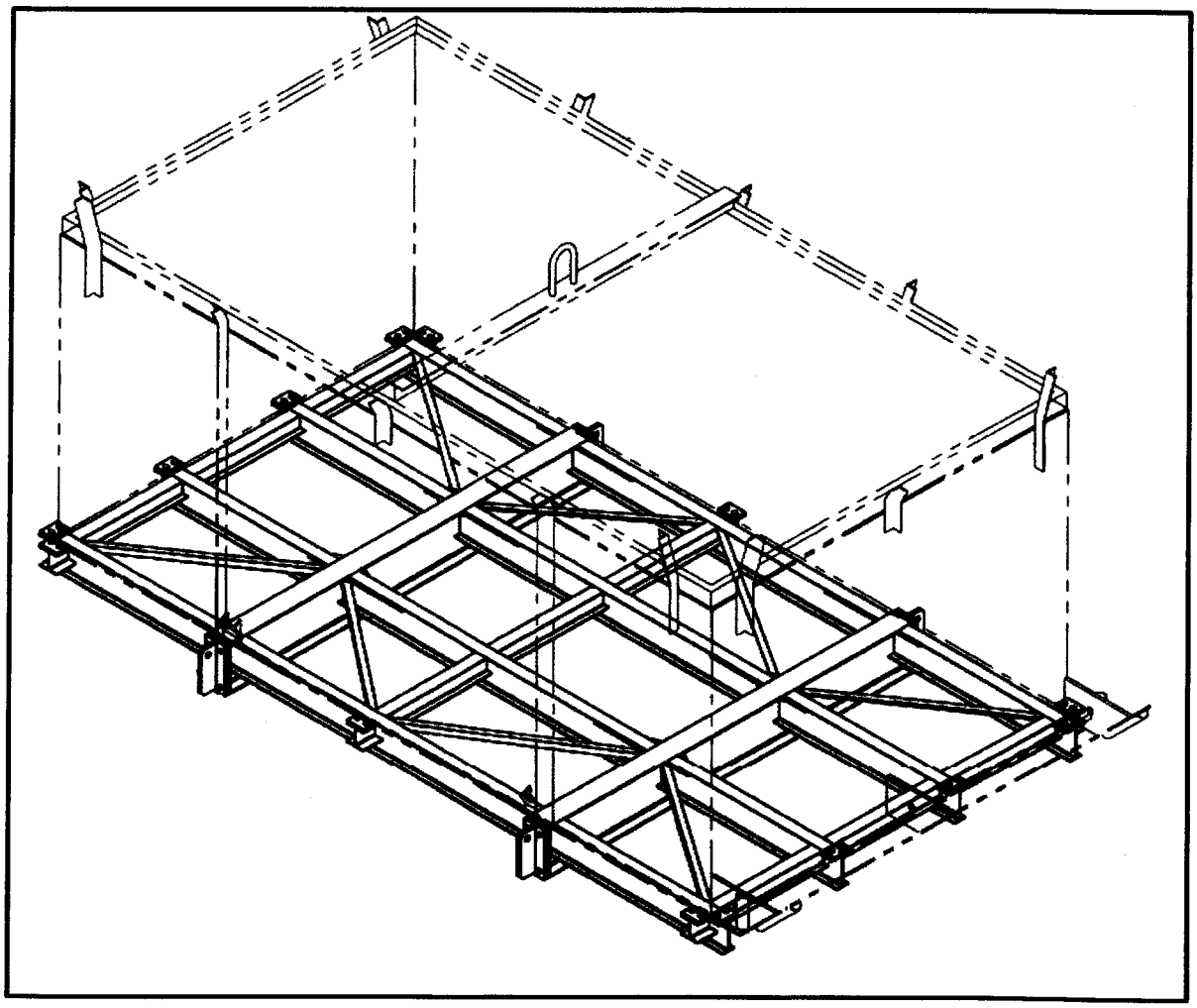

Figure 5. Lifting Fixture

The lifting fixture has two main functions.

- First is to provide support for the one-half inch thick steel plate comprising the bottom of the burial box when the box is not setting on a flat surface. The bottom plate, spanning the width of the box, does not have sufficient strength to safely withstand the assumed uniformly distributed pressure from the contents. The evaluation of the bottom plate is found in HNF-FMP-08-36263-R0 pages 12 through 19. The lifting fixture is designed of beams supporting the bottom plate such that the bottom plate, with shorter spans, can safely withstand the uniformly distributed floor load from the contents. Functioning as supports for the floor plate during normal storage operations, the design of the support beams is governed by normal building code allowable stresses found in the AISC. To account for the uncertainty in the distribution of the weight of the contents, the gross weight of the burial box, including the contents, was increased by 25 percent, (a load factor of 1.25) for the design of the lifting fixture. This 25 percent increase was used only for the strength and stiffness design of the lifting fixture beams. This 25 percent increase was not considered in threated load capacity. The rated load capacity was conservatively established at 100,000 pounds which was a nominal increase over the actual weight of the burial box , contents, lifting frame, and rigging.

- Second is to lift the burial box. The components of the lifting fixture required to lift the burial box are governed by the ASME BTH-1, Design of Below-The-Hook Lifting Devices.
  These components are the two main W16x36 (16 inches deep and 36 pounds per foot of length) lifting beams and the Lifting Lugs. The other support beams are not substantially loaded during lifting operations. The stiffness of the burial box concrete walls is much greater than the stiffness of the steel beams.

  The calculation for the stiffness of the burial box versus the steel beams is:

  Height of burial box walls:
  h.wall = 8 ft = 96 in

  Thickness of burial box walls:
  t.wall = 4 in

  Moment of inertia of burial box walls:
  $I.box = (2\ walls) * t.wall * (h.wall)^3 / 12 = 2 * 4 * 96^3 / 12 = 589{,}824\ in^4$

  Modulus of Elasticity for burial box:
  $E.box = 33 * (150\ pcf)^{1.5} * (\sqrt{3000}\ psi) = 3{,}300{,}000\ psi$

  Stiffness of burial box:
  $E.box * I.box = 3.3E6 * 0.589E6 = 1.94E12\ \#\ in^2$

  Stiffness of steel beams:

Moment of Inertia of four W10x12 steel beams:
$I.w12 = 4 * 53.8\ in^4 = 215.2\ in^4$

Modulus of Elasticity of steel:
$E.s = 29{,}000{,}000$ psi

Stiffness of steel beams:
$E.s * I.w12 = 29E6 * 215.2 = 6.24E9\ \#\ in^2$

Relative stiffness:
$EI.box / EI.w12 = 1.94E12 / 6.25E9 = 310$

The concrete burial box is 310 times as stiff as the four steel beams. The concrete box will not deflect during lifting and will not apply load to the steel beams. The only steel members that are loaded during the lifting operation are the W16x36 beams.

In 2009, when it was decided to unearth the box and move it to above ground storage, a lifting fixture was required. The design of the burial box is documented on drawing H-2-833036. Calculations are documented in HNF-FMP-08-36263-R0. The FMP documents three iterations of the design. The design that was fabricated and used was designed on pages 77 through 101 using W16x36, W10x12, and W6x9 beams with flange stiffeners.

The design of the lifting fixture was made using criteria from ASME BTH-1, Design of Below-The-Hook Lifting Devices for all lifting fixture components. This is appropriate for the main W16x36 beams and the lifting lugs. The ASME BTH-1 criteria are conservative for all other components. The AISC code, which allows higher stresses, is appropriate for these other components.

Restraints against motion forward on the trailer and motion laterally on the trailer are provided by bearing blocks bolted to the top of the lifting fixture. Restraints against motion aft on the trailer are provided by cables running through the skid structure on the burial box and attached to the lifting lugs on the lifting fixture. These calculations were documented in HNF-FMP-08-36263-R0C. Tie downs for the burial box/lifting fixture combination are discussed below.

The lifting fixture was load tested for lifting 125,000 pounds which is 125 percent of the rated load of 100,000 pounds. This is in compliance with ASME-BTH-1. The load test is documented in the critical lift plan 2X-08-03783, see Section 6 below.

Welding and welder qualifications for all welds throughout the lifting fixture were performed using AWS D14.1 with an option to use ASME Section IX for welder qualification. When the box was constructed, all welds were visually inspected. All lifting welds were additionally magnetic particle inspected before and after load testing. All this was in conformance with the ASME-BTH-1 criteria. The welder qualification and welding as specified are acceptable.

The design and fabrication of the lifting fixture, being governed by ASME-BTH-1 criteria for all components, is found to be in compliance with the AISC code requirements. It is concluded that the lifting fixture is safe for lifting and transporting the burial box.

5.0 Tie Down Analysis Review

HNF-40138 was released in February 2009 providing documentation for the tie downs for the 231-Z-DR-11 burial box/lifting fixture to the transport trailer. The document considered the lifting fixture structure was designed for the horizontal loads from the burial box during transport. The tie down analysis provided the requirements to secure the lifting fixture to the transport trailer for horizontal loads and provided the requirements to secure the burial box/lifting fixture combination to the transport trailer for vertical transport loads.

The tie down design/analysis, HNF-40138, takes credit for friction mats placed between the trailer and the lifting fixture and for a maximum transport speed of 20 miles per hour within the 200 West Area where the roads are relatively flat. The box must be placed on the trailer with the skid ramp facing to the rear. To lift the fixture/box, the lifting lugs must be reattached. Once on the trailer, the lifting lugs must be removed and the aft restraint cables and tie down hardware installed. This process is reversed at unloading.

With these assumptions, the burial box is found to be stable against overturning during transport and the tie down rigging components are designed to safely resist the horizontal and vertical transport force requirements.

The tie downs are found to be in compliance with the requirements found in 49 CFR 393.102.

6.0 Critical Lift Plan Review

The Critical Lift Plan (Ref 2X-08-03783) for loading the burial box onto the transport trailer for shipment was reviewed. The lift fixture was properly tested and welds examined. The burial box/lift fixture was properly restrained and tied down (see Section 5).

The burial box is found to be safely lifted onto the transport trailer.

7.0 Evaluate Burial Box for Transport Loads

The burial box will be evaluated for its ability to withstand the loads associated with transport.

7.1. Design Requirements

From HNF-40138, the 49 CFR 393.102 requirements for tie-down of packages using breaking strength of tie-down assemblies is:

- 0.8 g deceleration in the forward direction
- 0.5 g acceleration in the rearward direction

- 0.5 g acceleration in the lateral direction.

From HNF-40138, the 49 CFR 393.102 requirements for tie-down of packages using working strength of tie-down assemblies is:

- 0.435 g deceleration in the forward direction
- 0.5 g acceleration in the rearward direction
- 0.25 g acceleration in the lateral direction.

7.2. Design Analysis

For the purposes of this evaluation, the capacity of the burial box to withstand transport loads will be derived from the building codes for structural concrete and for structural welding. For both of these, the capacity is a working capacity having a safety margin of approximately 2 or 3 against breaking strength. Actual breaking strengths for the concrete and welded steel burial box are very difficult to determine. Therefore, the building code capacity will be used and compared to the design requirements for tie-down loads for packages using working strength of assemblies.

7.3. Design Input

- The concrete burial box is secured longitudinally and laterally to the lifting fixture drawing H-2-833036.
- The burial box with lifting fixture is secured to the transport vehicle according to the tie-down analysis HNF-40138.
- The weight of the filled burial box as measured when lifted in 2009 is 79,500 pounds.
- The weight of the empty burial box without lid according to design drawing H-2-58526 is 13.2 tons or 26,400 pounds.
- The weight of the burial box lid according to design drawing H-2-58526 is 7 tons or 14,000 pounds.
- The concrete strength is 3,000 psi according to drawing H-2-58526.
- Welding electrode strength is 60,000 psi according to HWS-4962-S, referenced on H-2-58526.

7.4. Design Assumptions

- The waste make-up is not known and is assumed to be generally evenly distributed throughout the burial box.
- For the tie-down design, HNF-40138, 10,000 pounds was added to the gross weight of the filled box.
- The box was buried in relatively dry soil conditions from the 1970's to 2009 when it was exhumed and relocated to the CWC storage yard.

7.5. Design Load Factors

From HNF-40138, the 49 CFR 393.102 requirements for tie-down of packages using working strength of tie-down assemblies is:

- 0.435 g deceleration in the forward direction
- 0.5 g acceleration in the rearward direction
- 0.25 g acceleration in the lateral direction.

7.6. Design Forces

The weight of the burial box:
W.box = 79,500 pounds

Uncertainty weight:
W.uncer = 10,000 pounds

Transportation design weight:
W.des = W.box + W.uncer = 89,500 pounds

Transportation Longitudinal Forward Load:
F.long = W.des * 0.435 g = 38,932 pounds

Transportation Longitudinal Rearward Load:
F.rear = W.des * 0.5 g = 44,750 pounds

Transportation Lateral Load:
F.lat = W.des * 0.25 g = 22,375 pounds

The weight of the burial box lid:
W.lid = 14,000 pounds

Transportation Longitudinal Forward Load:
F.long.lid = W.lid * 0.435 g = 6,090 pounds

Transportation Longitudinal Rearward Load:
F.rear.lid= W.lid * 0.5 g = 7,000 pounds

Transportation Lateral Load:
F.lat.lid = W.lid * 0.25 g = 3,500 pounds.

7.7. Burial Box Capacity

Check the weld capacity between the wall and the base plate: The weld is shown on drawing H-2-58526, detail 3, as an intermittent one-quarter inch thick fillet weld two inches long spaced every 8 inches center to center. This weld occurs between the wall channel and the base plate on both the inside and outside of the wall. Allowable weld stress is taken from AISC Table J2.5 as 0.3 * weld metal tensile strength.

Side Wall length is:
L.wall = 19 ft = 228 in

End Wall length is:
L.wall.end = 10 ft + 7.5 in = 127.5 in

The longitudinal weld area is:
A.weld.long = 0.25" * 0.707 * (8"+2")/8" * L.wall = 50.37 sq in

The lateral weld area is:
A.weld.lat = 0.25" * 0.707 * (8"+2")/8" * L.wall.end = 28.17 sq in

Weld capacity for forward/rearward motion is:
F.cap.weld.long = A.weld.long * 0.3 * 60,000 psi = 906,700 pounds

OK > F.rear = 44,750 pounds

RESERVE CAPACITY = 906.7/44.75 -1 = 19.26 times the transportation requirement

Weld capacity for lateral motion is:
F.cap.weld.lat = A.weld.lat * 0.3 * 60,000 psi = 507,050 pounds

OK > F.lat = 22,375 pounds

RESERVE CAPACITY = 507.05/22.37 -1 = 21.7 times the transportation requirement.

Check the concrete walls as shear walls: The walls are shown on drawing H-2-58526 as being 4 inches thick. Shear strength of concrete is taken as 10 * √fc' from ACI 318 11.10.3. Strength reduction factor is taken as 0.75 per ACI 318 11.9.3.1. Live load factor is taken as 1.6 per ACI 318 9.2.1.

The longitudinal shear wall area is:
A.wall.long = 4" * L.wall * 2 = 1,824 sq in

The lateral shear wall area is:
A.wall.lat = 4" * L.wall.end * 2 = 1,020 sq in

Shear wall capacity for forward/rearward motion is:
F.cap.wall.long = A.wall.long * 10 * √3000 psi * 0.75 = 749,300 pounds

OK > F.rear = 1.6 * 44,750 pounds = 71,600 pounds

RESERVE CAPACITY = 749.3/71.6 -1 = 9.5 times the transportation requirement

Shear wall capacity for lateral motion is:
F.cap.wall.lat = A.wall.lat * 10 * √3000 psi * 0.75 = 419,000 pounds

OK > F.lat = 1.6 * 22,375 pounds = 35,800 pounds

RESERVE CAPACITY = 419.0/35.8 -1 =10.7 times the transportation requirement.

7.8. Burial Box Lid Restraint Capacity

Check the weld capacity between the guide/bearing angles and the top of the wall: The weld is shown on drawing H-2-58526, detail 5 and 6, as an all-around one-quarter inch thick fillet weld between the L3x3x3/8 guide angle and the C4x5.4 along the top of the wall. Allowable weld stress is taken from AISC Table J2.5 as 0.3 * weld metal tensile strength.

The weld area for each guide angle is:
A.guide = 0.25" * 0.707 * (3"+3"+1.58"+1.58") = 1.62 sq in

Weld capacity is:
F.cap = A.guide * 0.3 * 60,000 psi = 29,160 pounds per guide

RESERVE CAPACITY for Forward Restraint is:
3 * 29.16/6.09 -1 =13.36 times the transportation requirement

RESERVE CAPACITY for Rearward Restraint is:
3 * 29.16/7.0 -1 =11.5 times the transportation requirement

RESERVE CAPACITY for Lateral Restraint is:
2 * 29.16/3.5 -1 = 15.66 times the transportation requirement

7.9. As-Designed Analysis Conclusion

When manufactured, the H-2-58526 burial box had ample capacity to resist transportation loads. The burial box had a minimum reserve capacity of 9.5 times the transportation load requirement in the structural concrete components and a reserve capacity of 19 times the transportation requirements in the structural steel and weld components. The burial box lid restraints had a minimum reserve capacity of 11.5 times the transportation load requirement.

8.0 Visual Inspection

The field work comprised two visual inspection walk-downs of the burial box 231-Z-DE-11. Physical touching, sampling, or stressing of the contaminated burial box or lifting fixture by integrity assessment personnel was not permitted. No monitoring devices were used or were necessary to determine the structural integrity of the box. The interior of the burial box was not inspected.

An initial field walk-down was conducted with Sean Fargo, Charles Kronvall, Richard Steen, and Gary Wagenblast in attendance. Charles Kronvall and Richard Steen, having dosimetry and

current radiation training, were escorted into the radiation protection area for a close (within approximately five feet) visual inspection of all four sides of the burial box. Sean Fargo and Gary Wagenblast were restricted to viewing the burial box from outside of the radiation protection area and were able to view only the front (skid) end and the two long sides of the burial box from approximately thirty feet away.

A follow-on field walk-down was conducted with Sean Fargo, Richard Steen, and Gary Wagenblast in attendance, see Figure 6. Dosimetry was provided and all were escorted into the radiation protection area for a close as safely possible (within approximately five feet) visual inspection of all four sides of the burial box. This second field walk-down, performed on June 21, 2012 constituted the cessation of field activities for this assessment report. As stated in the approved Engineering Structural Integrity Assessment Plan, the conclusion of field activities then began the 15 work day clock for submittal of this structural integrity assessment to Ecology.

Figure 6. Photo Showing Burial Box Visual Inspection by IQPE

The burial box has visible rust of the carbon steel surfaces and welds, see Figure 7. It appears that the rust is surface corrosion. The depth of corrosion could not be determined by visual inspection. The steel channels at the base of the walls and the exterior welds between the walls and the floor plate (components relied on for transport load transfer) have lesser corrosion than other steel members. The welds are still visible and identifiable.

Figure 7. Photo Showing Burial Box Steel Surface Corrosion

During the June 21 walk-down it was noticed that the number and style of lid restraint guides differed from the design drawing and that some of the welds were missing or broken.

- On the front of the box, the number and style of guides matched the H-2-58526 design drawing, one Detail 5 guide and two Detail 6 guides. All welds had surface corrosion but were still visible and identifiable.
- On the back of the box, the number and style of guides matched the H-2-58526 design drawing, three Detail 5 guides. All welds had surface corrosion but were still visible and identifiable.
- On the left side of the box, the design drawing called for two Detail 5 guides and one Detail 2 guide. Actually wherever the drawing called for a Detail 5 guide, a Detail 2 guide was installed, and wherever the drawing called for a Detail 2 guide, a Detail 5 guide was installed. Additionally, on the left-front Detail 2 guide, the weld at the top of the guide was missing, see Figure 8. It appears that the weld was never made. On the left-rear Detail 2 guide, the weld at the bottom of the guide was missing, see Figure 9. It appears that the weld was never made. All other welds had surface corrosion but were still visible and identifiable.

Figure 8. Photo Showing Missing Weld

Figure 9. Photo Showing Missing Weld

- On the right side of the box, the design drawing called for two Detail 5 guides, two Detail 6 guides, and one Detail 2 guide. Actually wherever the drawing called for a Detail 5 guide, a Detail 2 guide was installed, and wherever the drawing called for a Detail 2 guide, a Detail 5 guide was installed. Additionally, on the right-rear Detail 2 guide, the weld at the bottom of the guide was missing, see Figure 10. It appears that the weld was never made. All other welds had surface corrosion but were still visible and identifiable.

Figure 10. Photo Showing Missing Weld

The concrete surfaces have visible surface indentations from forming, see Figure 11. The walls were likely poured flat on the ground or on a concrete floor slab and when the concrete was cured, the walls tipped up into place. It appears that the floor slab was lined with a plastic sheet and folds in the plastic sheet left indentations in the hardened concrete.

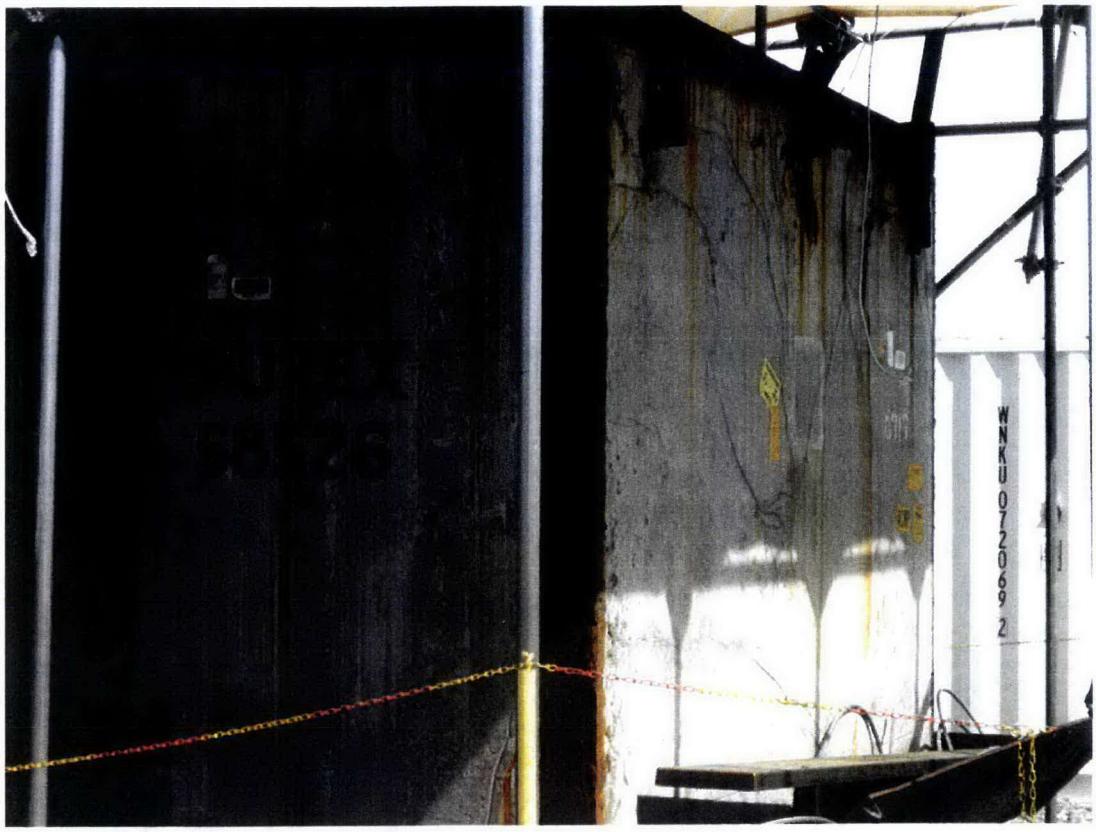

Figure 11. Photo Showing Concrete Surfaces

The concrete surfaces have nonstructural hairline shrinkage cracks, see Figure 11. Nonstructural hairline cracks routinely occur and are expected in concrete walls. These hairline cracks result during the drying and curing process.

The concrete surfaces show signs of weathering and staining, see Figure 11. This is expected. The box had been buried for approximately forty years. The box however was not directly exposed to the soil. The top and the sides of the box were protected from direct contact with the soil. Shoring consisting of railroad ties and plywood was placed on top and on the sides of the box prior to the soil overburden being backfilled around the box.

Field notes and electronic copy of all photos taken as a part of this structural integrity assessment are included as Attachment 2.

9.0 Conclusions and Recommendations

When manufactured, the H-2-58526 burial box had ample capacity to resist transportation loads. The burial box had a minimum reserve capacity of 9.5 times the transportation load requirement in the structural concrete components, a reserve capacity of 19 times the transportation

requirements in the structural steel and weld components, and a reserve capacity of 11.5 times the transportation requirements lid restraints.

The surface indentations in the concrete surfaces do not adversely affect the structural integrity of the burial box. The hairline cracks in the concrete surfaces do not adversely affect the structural integrity of the burial box. The weathering and stains cracks on the concrete surfaces do not adversely affect the structural integrity of the burial box. In the opinion of the IQPE, the current condition of the burial box continues to maintain its reserve capacity of 9.5 times the transportation load requirement in the structural concrete components.

The apparent surface corrosion of the structural steel channels, floor plate, and welds would reduce the structural steel capacity of the box. The structural steel components and welds relied on during transport loading conditions have a designed reserve capacity of 19 times the transportation requirement (see Section 7.7). It is the conclusion of the structural integrity inspection that the reserve capacity in the structural steel components and welds would be reduced by no more than one-half as a result of the surface corrosion. This would reduce the reserve capacity of the structural steel components to be that of 19/2=9.5 times the transportation load requirement, roughly equivalent to the reserve strength of the structural concrete components.

It is the conclusion of the structural integrity inspection that the overall reserve capacity of the structural components of the burial box has not been diminished by the surface corrosion of the structural steel. The reserve capacity of the concrete and steel components are now roughly equivalent and approximately 9.5 times the transport load requirements.

The missing welds and the apparent surface corrosion of the welds attaching the lid restraint guide angles to the top of the walls of the box would reduce the structural capacity of the lid restraint. It is the conclusion of the structural integrity inspection that the reserve capacity in these welds would be reduced by no more than one-half as a result of the surface corrosion. This would reduce the reserve capacity of the lid restraint to be that of 11.5/2=5.75 times the transportation load requirement.

The tie down design/analysis, HNF-40138, takes credit for friction mats placed between the trailer and the lifting fixture and for a maximum transport speed of 20 miles per hour within the 200 West Area where the roads are relatively flat. The box must be placed on the trailer with the skid ramp facing to the rear. To lift the fixture/box, the lifting lugs must be reattached. Once on the trailer, the lifting lugs must be removed and the aft restraint cables and tie down hardware installed. This process is reversed at unloading. With these assumptions, the burial box is found to be stable against overturning during transport and the tie down rigging components are designed to safely resist the horizontal and vertical transport force requirements.

There are no new field changes required as a result of this structural integrity assessment required for the transport of the burial box.

10.0 Certification

I, Gary R, Wagenblast P.E., certify, based on the information available to me within the limits of the methods employed for this structural integrity assessment, that the box 231-Z-DR-11 with its lifting fixture is structurally capable of being lifted, placed on a transport trailer, transported, and off-loaded at a new location.

Signed: G. R. Wagenblast, P.E. Verified: S.A. Fargo, PE

Date: 6/29/2012 Date: 6/29/2012

GARY R. WAGENBLAST STATE OF WASHINGTON 22269 REGISTERED PROFESSIONAL ENGINEER

SEAN A. FARGO STATE OF WASHINGTON 15769 REGISTERED PROFESSIONAL ENGINEER

EXPIRES 2/01/2014

P. E. Stamp

11.0 References

Documents Reviewed:

- Drawings:
  - H-2-58526 Rev. 7, General Purpose Burial Box
  - H-2-833036, SWSD General Purpose Burial Box Lifting Fixture
- Work Document 2X-08-03783, Critical Lift Plan, Load/Unload Concrete Box for Shipment
- HNF-FMP-08-36263-R0, SWSD General Purpose Burial Box Lifting Fixture
- HNF-FMP-08-36263-R0C, SWSD General Purpose Burial Box Lifting Fixture
- HNF-40138, Rev 0, Tie down Analysis of Concrete Waste Box 231-Z-DR-11 to HO-64-05716.

Applicable codes:

- American Concrete Institute ACI-318, Building Code Requirements for Structural Concrete
- American Institute of Steel Construction, Manual of Steel Construction
- American Society of Mechanical Engineers, ASME-BTH-1, Design of Below the Hook Lifting Devices
- Code of Federal Regulations:
  - CFR 49-393.102, Protection Against Shifting and Falling Cargo
  - CFR 49-173.24, General Requirements for Packages
  - CFR 49-173.410, General Design Requirements
  - CFR 49-173.411, Industrial Packaging.

- Welding Codes:
  - American Welding Society (AWS) D14.1, "Specification for Welding of Industrial Cranes and Other Material Handling Equipment". Used for the design of the Lifting Fixture
  - HW-4926-S: "Standard Specification for Welding Carbon Steels". Used for the design of the Burial Box.

Attachment 1 IQPE-GARY R. WAGENBLAST Resume

Information and the credentials for Mr. Wagenblast are included. Mr. Wagenblast's credentials were presented to ECOLOGY on April 4, 2012, and verbally accepted by ECOLOGY on April 11. 2012.

GARY R. WAGENBLAST, P.E.

1808 Hunt Avenue, 509-946-4791 home
Richland, WA 99354

EDUCATION

1973 B.S. Civil Engineering, Washington State University, Pullman, WA

PROFESSIONAL REGISTRATIONS

Registered Professional Engineer in Civil Engineering, Washington, 1984.

EXPERIENCE

Mr. Wagenblast has 39 years experience in civil and structural engineering. He is currently semi-retired. He previously held a position as a Principal Design Engineer in the Fluor Federal Services Civil/Structural/Environmental Engineering Group. He is well versed in the design criteria for nuclear and non-nuclear steel, wood, and reinforced concrete structures. He has been responsible for the structural qualification of many buildings, structures, systems, and components to the latest US Department of Energy design criteria. Mr. Wagenblast was responsible for the structural linear and non-linear seismic and extreme wind evaluation of the existing 325 laboratory building and the existing 234-5Z plutonium processing building qualifying the facilities to current DOE criteria. He was also responsible for the soil-structure interaction seismic evaluation for proposed buried radioactive-liquid-waste tanks at Hanford and for surface facilities at the Yucca Mountain, Nevada site.

Structural Design and Evaluation

- Lead engineer for the design, fabrication, and installation of reinforced concrete and structural steel structures to provide increased safeguards and security of special nuclear materials at the canister storage facility grounds.

- Lead engineer for the design, fabrication, and installation of structural steel submerged particulate containment tanks installed in the Hanford K basins.

- Lead engineer for the preliminary seismic soil-structure-interaction evaluation of the waste handling at the Yucca Mountain, Nevada site.

- Lead civil/structural engineer for reinforced concrete and steel design for field assignment at British Petroleum Oil refinery in Ohio.

- Lead engineer for the seismic soil-structure-interaction design of an 83 feet diameter, 54 feet high, buried reinforced concrete tank for radioactive-liquid waste. The design evaluation included the development of simplified computer modeling and evaluation methods which reduced significantly the manpower and computer time to complete the evaluation.

- Performed linear and approximate non-linear evaluation of the reinforced concrete B-Plant canyon, B-Plant stack, AR vault, and AR stack. Evaluations included seismic capacity, extreme wind capacity, dead and live load capacity, and the development of internal floor response spectra for subsequent evaluation of equipment.

- Performed linear and approximate non-linear seismic and extreme wind evaluation of the structural steel frame 325 laboratory building qualifying this facility to current DOE criteria.

- Directed the activities of consultants in the linear and non-linear dynamic evaluation efforts for the qualification of the structural steel braced frame 234-5Z building to current DOE criteria. The evaluation accounted for stiffness and structural capacity of reinforced concrete walls not originally intended to resist lateral loads.

- Evaluated and designed upgrades for the structural stability of glove boxes, hoods, and filters in the 234-5Z laboratory to current DOE criteria in support of PFP restart.

- Performed design and analyses in support of general plant maintenance including floor load limit evaluation, hoist and trolley load limits, soil retaining walls, small building specification, foundation design, new intra-area road design, area grading and drainage.

- Performed structural design and analysis of steel, wood, and reinforced concrete containers used for transport and shallow trench burial of solid radioactive waste.

- Directed the program to evaluate distortions in the N-Reactor core for the purpose of determining the source of high forces required to refuel the reactor. A FORTRAN computer program was developed to predict contact conditions between the fuel elements and the distorted tubes and to select fuel elements to preclude the contact conditions. The program resulted in the recommendation of specific fuel elements that could be charged in the distorted pressure tubes.

SELECTED PUBLICATIONS

C. K. Wong, M.D. Stine, G. R. Wagenblast, S. K. Farnworth, "Soil Structure Interaction Analysis of Buried Tank Subjected to Vertical Excitation". Fifth DOE Natural Phenomena Hazards Mitigation Symposium - 1995, Denver, Colorado.

G. R. Wagenblast and M.D. Northey, "Use of Personal Computers in Performing a Linear Modal Analysis of a Large Finite-Element Model". Seismic Engineering, American Society of Mechanical Engineers, ASME publication PVP-Volume 220, pp.97-100, June 1991.

B. V. Winkel and G. R. Wagenblast, "Nonlinear Seismic Analysis of a Thick-Walled Concrete Canyon Structure". Second DOE Natural Phenomena Hazards Mitigation Conference - 1989, Knoxville, Tennessee. pp.135-141.

SECURITY CLEARANCE

Mr. Wagenblast currently holds a work approval security clearance appropriate for non-classified Hanford work scope. He had held a DOE Q security clearance prior to the general security reductions at the Hanford site.

EMPLOYMENT HISTORY

TRS Staffing Solutions, contracted to Fluor Federal Services	2-2006 to present
Fluor Federal Services, Principal Design Engineer	10-96 to 2-2006
ICF Kaiser Hanford,	1-95 to 10-96
Westinghouse Hanford Company	4-80 to 1-95
Rockwell Hanford Company	2-77 to 4-80
J.C. Lemons Co.	9-76 to 1-77
Northern Industrial Contractors	7-76 to 9-76
Wright-Schuchart-Harbor	4-74 to 6-76

Attachment 2 Field Notes and Photos (electronic file)

Electronic files of all photos are transmitted by separate electronic media.

FIELD NOTES
June 21, 2012
G.R. Wagenblast

Long guides / lid restraints

LF - welds broken
at top
OK at BOT
LR - welds never made
at BOT
OK at TOP
RR - weld missing @ BOT
OK @ TOP
RF - OK

Short guides / Lid RESTR

LS - Front & Back Missing - Midlock
BACK - 3 OK
RS - 3 OK
FRONT - 3 OK

Attachment 3

Computer Disk

Box 231-Z-DR-11 Photographs