DESIGN AND TESTING OF SPEC 7A CONTAINERS FOR
PACKAGING RADIOACTIVE WASTE

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I. INTRODUCTION

A Specification 7A Type A primary container which can also function as an overpack was designed and tested for use in the disposal and/or retrievable storage of radioactive waste, specifically transuranic (TRU) waste. This container represents our final design and testing efforts of what we consider a superior Type A steel container for use in packaging radioactive waste. As will be covered in this report, other containers have serious drawbacks that have prevented LLNL from adopting their design..

The Lawrence Livermore National Laboratory (LLNL) is currently using a Type A wooden container 4'x7' which is rated at 1140 Kg gross weight for buried radioactive waste.⁽¹⁾ However, this container is limited in its application due to: (1) Net weight restriction of 900 Kg of waste, (2) Does not meet the Transuranic Waste storage criteria for 20 year retrievability requirement, (3) Container is fabricated using combustible material, and (4) The porous nature of wood, even when sealed by a silicone-based paint, does not afford adequate containment for tritium contaminated waste.

For approximately three years, work has been done on designing and testing Spec 7A containers that will withstand the test conditions as stated in Title 49, "Transportation," of the Code of Federal Regulations (CFR), Paragraph 173.398, "Special Tests." The Standards state that Type A packaging must be so designed and constructed that, if it were subject to certain environmental and test conditions,

- o There would not be any release of radioactive material from the package.
- o The effectiveness of the package would not be substantially reduced.

- o There would not be any mixture of gases or vapors in the package which could, through any credible increase of pressure or an explosion, significantly reduce the effectiveness of the package.

The prescribed tests are:

- o COMPRESSION: For packages of not more than 10,000 pounds gross weight, the package shall withstand a compressive load equal to five times the weight of the package applied for a period of 24 hours (173.398(b)3v).
- o FREE DROP: The package must withstand a free drop through a distance of 4 feet onto a flat, essentially unyielding horizontal surface, striking the surface in a position for which maximum damage is expected (173.398(b)3ii).
- o PENETRATION: The exposed surface of the package which is expected to be most vulnerable to puncture shall withstand the impact of the hemispherical end of a vertical steel cylinder, 1.25 inches in diameter and weighing 13 pounds, falling from a height of 40 inches (173.398(b)iv).
- o VIBRATION: The container must withstand any vibration normally incident to transportation (173.398(b)2iv).

Environmental conditions are considered in the tests: heat (direct sunlight at ambient temperature of 130°F in still air), cold (ambient temperature of -40°F in still air and shade) and reduced pressure (ambient pressure of 0.5 atm).

Previous designs of steel Type A containers are shown in Figures 1 through 8. However, each of these containers was unsatisfactory for one or a combination of the following reasons:

1. Container failed at least one of the DOT test conditions: Figure 3 (TX-3), Figure 7 (B-88).
2. Closure of container required welding which presented a fire hazard: Figures 2 (TX), 3 (TX-1), and 6 (Sand Box).
3. Weight or size of empty container was difficult to maneuver: Figures 1 (BB), 2 (TX), 3 (TX-1), and 4 (TX-2).
4. Cost of container was prohibitive for general use: Figures 1 (BB), 2 (TX), 3 (TX-1), and 4 (TX-2).
5. Shape of container did not lend itself to stacking or maximum usefulness of burial or storage space: Figures 1 (BB), 2 (TX), and 4 (TX-2).
6. Special handling equipment is required: Figure 6 (Sand box).

Because of these failures or inadequacies, we continued to work on new designs which would eliminate these problems. This effort represents two years of designing and destructively testing containers that would satisfactorily meet the above stated criteria. These efforts are manifested in the final container: The TX-4 (Figure 8).

Note: BB is the Bennett Bucket (Figure 1).

II. CONTAINER CONSTRUCTION

The TX-4 is a mild steel box with outer dimensions of 4'x4'x7'; the construction design is shown in Figure 8. The dimensions on this container are of the standard size used at LLNL for shipment to the Nevada Test Site (NTS) for retrievable storage. However, other sizes are currently being considered in conformance to the criteria

established by the WIPP program.⁽¹⁾ These sizes and volumes are listed in Table I.

TABLE I. ALTERNATIVE TX-4 CONTAINERS FOR THE WASTE
ISOLATION PILOT PLANT (WIPP) PROGRAM

<u>Length</u>	<u>Width</u>	<u>Height</u>	<u>Volume (m³)</u>
74.5"	50.5"	38.5"	2.37
68"	54"	38.5"	2.32
88"	54"	54"	4.21

The TX-4 was fabricated by Livermore Truck and Trailer Body Company according to criteria supplied by LLNL. The container is fabricated from 14 gauge steel sheet supported by an external framework of 4" x 1-1/2" square tubing (the container corners are reinforced with 3" angle stock skip welded). Four, 3" steel channels support the container which allows standard forklift access.

The lid is constructed from 14 gauge steel continuously welded on a framework of 2" structural steel channel. The lid's perimeter channel has a 1/4" x 1-1/2" neoprene gasket set inside which forms a seal against the boxed tubing on the box's open lip. This interlocking channel/square tubing configuration forms a very rigid, positive closure which gives a great deal of structural strength to the lid/box interface. Two, 2" structural channels function as strongbacks and run across the lid to provide additional support to the steel sheet. Twenty-four, 5" Grade 5 bolts are used to seal the lid to the container.

A ter-polymer sealant used to seal the lid to the container is a flexible emulsion-type blend of inorganic materials and acrylic polymers. This adhesive was chosen for its strength, superior adhesive properties, flexibility (elongation to 525%), and resistance to extremes of weathering and corrosives. When the lid is sealed in this manner, the container's resistance to rigid-shock damage is greatly enhanced.

The completed TX-4 container has a net weight of 380 Kg. In lots of 25 containers, the cost of the TX-4 is \$990.

III. TEST CONDITIONS OF THE TX-4

The materials loaded into the TX-4 were chosen so as to reach the desired gross weight, completely fill the volume of the container, and in the event of failure, simulate the spilling of contaminated waste. Free-standing liquids are not allowed in any radioactive waste container, so water was not used in any of the test simulations. A combination of Drysorb (packaged in bags) and 40 mesh loose sand was used to achieve the 7,000 pound gross weight loading.

The pressure, compression, free-drop and penetration tests (in that order) were run on the TX-4; these tests were carried out at the Toxic Waste Control Department's facility at LLNL.

III.1 Reduced Pressure Test

According to 49CFR 173.398(b)2iii, the container is to be subjected to a reduced atmosphere pressure of 0.5 atmosphere (absolute). Since this test required equipment that is not readily available such as an environmental vacuum chamber larger than the TX-4, an alternate, equivalent test was conducted to simulate this condition.

The following rationale was used in devising this test: If a container is sealed in an environment where the pressure equals one atmosphere and then the pressure outside the container is reduced to 0.5 atm (as required by Title 49CFR), then the pressure differential is 7.3 psia with the inside being at a greater pressure relative to the outside. Effectively, the inside of the container has been pressurized by reducing the pressure that surrounds the outside of the package.

We tested the TX-4 by pressurizing the inside of the package using nitrogen gas and then holding the pressure at 7.3 psig for 5 minutes to observe a pressure drop. Thus, the TX-4 was subjected to the same pressure differential as if we had reduced the outside environmental pressure to 0.5 atm. Figures 9 and 10 show the TX-4 under this pressure and the pressure indicator after five minutes. The TX-4 did bulge under this pressure but showed no signs of leaking.

This test is very difficult to pass for most containers which do not employ a continuous, positive closure such as a piano hinge or continuous weld. We attribute the success of this test to the closure design. Steel channel is welded to the lid which firmly fits over the TX-4's square tubing around the container's perimeter.

III.2 Compression Test

For the compression test, a 660 pound metal plate was first placed on the lid of the loaded TX-4. The purpose of the plate was to contribute to a part of the total compressive weight (five times the total gross weight) and to distribute the

weight uniformly across the lid of the package. The balance of the weight was made up by a large concrete block and three steel armor plates. The weights used for the compression test are shown in Table II.

TABLE II. WEIGHTS USED FOR COMPRESSION TEST

<u>Item</u>	<u>Weight (lbs.)</u>
TX-4 Loaded to 7,000 Pounds Gross Weight (840 Pounds Empty Weight	
Metal Plate	660
Concrete Block	28,480
Armor Plates	<u>5,960</u>
TOTAL	35,100

Figure 11 shows the TX-4 with the weights in place. The test lasted 24 hours with no distortion or visible change being observed for the duration of the test.

III.3 Free-Drop Test

The free-drop test was performed outside our Solid Waste Facility using a boom crane. The loaded 7,000 pound TX-4 was elevated to a height of 4 feet and then released by means of a quick-release shackle. The container was elevated in a position so that when dropped the impact would be on the lid's corner. (The top corner of the TX-4 is considered its most vulnerable point). A metal plate was used as the surface that the TX-4 was dropped on (See Figure 12). This metal plate satisfied the condition that the package strike a flat, essentially unyielding surface.

The TX-4 is shown in Figure 12 just after it had been released from its 4 foot position. Figure 13 shows the package immediately after impact. Figure 14 is a closeup photograph of the damage incurred after the test. As is seen from this photograph, a minimum amount of damage occurred, with no release of its contents.

III.4 Penetration Test

For the penetration test a steel rod was fabricated to meet the specifications set forth in 49CFR 173.398 (1.25 inch diameter and weighing 13 pounds). The apparatus for releasing the rod was a length of pipe drilled for the insertion of a pin at several different positions. This pipe was then attached to a stand on which it was elevated vertically above the surface of the TX-4. The rod was placed in the pipe with the hemispherical end pointed down and held in place by the pin. The pin was quickly removed by pulling the attached wire, so the rod struck the surface of the package. The apparatus for performing the test is shown in place, with the steel rod after impact on the lid of the container (dropped from 40 inches). On impact the rod produced a slight indentation. As expected, the damage was negligible.

III.5 Vibration Test

Type A containers are transported by LLNL trucks or common carriers to the Nevada Test Site (NTS) for burial. When the containers arrive and are ready to be unloaded and transferred to the burial pit or retrievable storage area, they are inspected for evidence of damage incident to transportation. Because of the TX-4's construction and our testing of other containers⁽¹⁾ built less soundly yet easily passing this test, we did not test this package for vibration. Our experience is that shipping any reasonably built container, even loaded to as much as 25,000 pounds, will easily survive this vibration test.

III.6 Environmental Conditions

A temperature differential of 170°F , as specified in the requirements (-40°F to 130°F) could cause some container materials to change configuration sufficiently to breach the integrity of the container, releasing radioactive material to the environment. However, the TX-4 is constructed of 14 gauge steel, reinforced with boxed tubing which is more than adequate to maintain its integrity under these environmental test conditions.

The thermal expansion coefficient for steel is approximately 7×10^{-5} inches per inch per degree Fahrenheit. This factor represents the maximum measured expansion. Therefore, for the largest side of the container (84 inches) the thermal expansion would be:

$$(7 \times 10^{-5} \text{ in./in. } ^{\circ}\text{F}) (84 \text{ in.}) (170^{\circ}\text{F}) = 0.1 \text{ inches}$$

Considering the flexibility of sheet metal and the survival of the box to the destructive tests already covered in this report, the integrity of the TX-4 to this temperature differential would be maintained and virtually unaffected by these temperature extremes.

IV. DISCUSSION OF OTHER WASTE CONTAINER DESIGNS

As mentioned earlier in this report, several containers of numerous designs have been used and tested, but all had drawbacks which made them unacceptable for general use. This section will briefly describe our experience with these containers.

IV.1 Bennett Bucket (See Figure 1)

The Bennett Bucket was designed and used by LLNL for many years as a Type A container rated at a gross loading of 6,000 pounds. We stopped using this cylindrical container for the following reasons:

- a) It is a very large and awkward container which usually made its maneuverability difficult.
- b) Large cylindrical containers do not meet the size requirements for the Waste Isolation Pilot Plant.⁽²⁾⁽⁴⁾
- c) Fabrication cost is high (approximately \$1,500 per container).
- d) Cylindrical containers do not efficiently use available storage or disposal space.
- e) The Bennett Bucket cannot be stacked safely.

IV.2 TX Container (See Figure 2)

This container was designed and used by LLNL because it more efficiently used the space available for packaging. The containers were exceptionally strong, with a 4'x4'x7' container weighing over 2,000 pounds net weight. The following problems were experienced with the TX container:

- a) Fabrication cost is high (approximately \$2,300 per container).
- b) Difficult to maneuver because of its weight.

- c) Did not utilize space efficiently because of the outside steel support structure.
- d) Presented a fire hazard during closure because of the welded lid design.
- e) Cannot be stacked safely because of the external support structure.

IV.3 TX-1 Container (See Figure 3)

This container was designed to eliminate the outside steel structure allowing efficient storage space usage. However, the steel supports were simply reversed and placed inside which caused problems with waste packaging operations. All of the problems mentioned with the TX container, except for stackability, was present with the TX-1.

IV.4 TX-2 Container (See Figure 4)

The TX-2 was designed and used by LLNL to eliminate the fire safety concerns of welding the lid on the container with radioactive waste in close proximity to the welded area. We reverted back to the outside structural supports because more problems were caused with them being inside than were solved with the stackability problem mentioned in IV.2. Another improvement was obtained with the TX-2 in that forklift access could be made from the side or from the end. However, the drawbacks of the cost, weight and maneuverability were still problems. In addition, the sealing of the TX-2 was labor intense because of the 80 bolts used in its closure.

IV.5 TX-3 Container (See Figure 5)

The TX-3 was a radical departure from our previous thinking and was designed jointly by LLNL and Livermore Truck and Trailer Company. The construction is very similar to the TX-4 in that 14 gauge steel and boxed tubing were used. A piano-type hinge was used as the lid closure mechanism. Four steel rods were driven through the hinges once the lid was on. The total time for closure took approximately five minutes and did not require any welding. The container (4'x4'x7') was relatively light-weight (approximately 800 pounds), cost-effective (\$1,000), could easily be stacked, used packaging space efficiently, and was easy to maneuver. However, the lid closure was not effective in that the hinges were inherently weak and folded over on the Drop Test which broke the lid seal. We tested this container at 7,000 pounds gross weight. All tests were passed except for the pressure test and the drop test (See Figure 16 for damage caused by the latter test). We also dropped this container at 4 feet on its bottom corner which resulted in a minimum amount of damage (see Figure 17) and no breach of containment. After close examination of the internal and external damage caused by the drop test to the closure/lid structure, the presently designed TX-4 was fabricated.

IV.6 Sand Box (See Figure 6)

The Sand Box was designed by Sandia National Laboratories in Albuquerque. It involved several innovative design concepts that were claimed to make this container ideal for the WIPP, such as ease of handling, maneuverability, light weight, inexpensive, etc. We purchased a number of these containers from Sandia's suggested manufacturer (Powell Steel) who had been working closely with Laboratory personnel. We then proceeded to do some limited testing on this container at its rated 6,000 pound gross load.

In general, we found this "Type A" container to be poorly designed and ineffective in its operational use. In our opinion, the welding operation required for lid closure represents a severe fire hazard and is very time-intensive.

Figure 18 is a detail of how the lid seats on the edge of the container. The folded edge of the container is supposed to form a flat face for the lid. This, in fact, does not happen because of the light gauge of the sheet metal and tight fold that is required to make this bend. The actual bend formed is similar to a rolled tube and forms a very poor seating surface for the lid. In addition, the lid is constructed of light sheet metal which is very flimsy, even with the corrugations. When the lid is placed on the container, gaps between the container seat and lid would occur which required a heavy plate being placed on top to hold the lid flush with the container.

In actual use, the Sand Box was very difficult to move because of its non-standard lifting straps. Despite the information given to us by Sandia on the availability of a pin mechanism that hooks onto a Hyster Forklift carriage, we could not locate any supplier of this equipment, including Hyster.

The Sand Box also presented problems in loading. Because there are no structural supports in this container and it is constructed out of 12 gauge steel, the box would distort from its rectangular shape when loaded with waste so that the rectangular lid would not line up with the container's seating surface. Since the original rectangular shape of the box was lost with its loading, the lid either overhung or fell short of lining up with the box itself. Gaps of 2 inches between the edge of the container and the lid were common which made welding the lid on impossible.

The cost of the Sand Box was another factor that we found not to be accurate. In lots of 25, our cost was approximately \$1,000 each from the suggested manufacturer--presumably this was due to the special work required for the corrugation pressings.

Finally, the Sand Box distorts under the compression loading of 30,000 pounds at its rated gross weight of 6,000 pounds (see Figure 19). It should be noted that the design specified by Sandia calls for fabrication using 18 gauge steel. All of our "Sand" boxes were fabricated with 12 gauge steel in an effort to strengthen these containers. However, the additional strength offered by the heavier steel was not sufficient to overcome the poor design. We did not perform a drop test on this container because of a general lack of interest due to the many operational problems caused by the design of this container.

IV.7 B-88 Container (See Figure 7)

The B-88 container is manufactured by Container Products Corporation located in Wilmington, North Carolina. The B-88 is advertised as a Type A container meeting the test requirements as stated in Title 49 when loaded to 6,000 pounds. We purchased two of these containers which had external dimensions of 48.5"H x 47"W x 92"L and cost approximately \$800 each, F.O.B. California. These containers appear to be very similar to standard Demster dumpsters used for municipal waste except for their proprietary "Safe-T-Loc" closure mechanism. It is our opinion that the design and workmanship on these containers were poor which resulted in a sloppy closing mechanism for both containers that we purchased. The positive locking mechanism that the manufacturer claimed was achieved by the "Safe-T-Loc" did very little to secure the lid to the container.

One B-88 was loaded to 6,000 pounds and a strong silicone adhesive was applied in a continuous bead to the gasket supplied

with the containers (the manufacturer does not mention using any adhesive for sealing). Even with the use of this adhesive, we were unable to obtain the desired pressure because of leaks. Further, during this pressure test two "Safe-T-Locs" catastrophically popped off and were later found several feet away from the container.

We then proceeded to test the B-88 with a compression weight of 30,000 pounds. The container withstood this test as far as the container's integrity is concerned. The only damage that occurred was to the three members that support the container to allow forklift access. These structures were crushed.

We used the other B-88 container to perform the drop test with it loaded to a gross weight of 6,000 pounds. The lid was sealed with the silicone adhesive in addition to the manufacturer's supplied materials, i.e., gasket and "Safe-T-Locs." Figure 20 shows the damage incurred immediately after the 4 foot corner drop. The B-88 did not pass this test.

Table III summarizes the testing of all of these containers and the TX-4.

TABLE III
SUMMARY OF RESULTS OF VARIOUS TYPE A CONTAINERS

<u>Container</u>	<u>Pressure Test</u>	<u>Compress. Test</u>	<u>Drop Test</u>	<u>Absence of Fire Hazard</u>	<u>Easy to Maneuver</u>	<u>Standard Equipment</u>	<u>Standard Size</u>	<u>Gross Weight (lbs.)</u>	<u>Net Weight (lbs.)</u>	<u>Cost</u>	<u>Type "A"</u>
Ben. Buc. (Fig. 1)	Yes	Yes	Yes	Yes	No	Yes	No	7000	1400	\$1500	Yes
TX (Fig. 2)	Yes	Yes	Yes	No	No	Yes	Yes	7000	2100	\$2200	Yes
TX-1 (Fig. 3)	Yes	Yes	Yes	No	No	Yes	Yes	7000	2100	\$2200	Yes
TX-2 (Fig. 4)	Yes	Yes	Yes	Yes	No	Yes	Yes	7000	2200	\$2400	Yes
TX-3 (Fig. 5)	No	Yes	No	Yes	Yes	Yes	Yes	7000	800	\$1000	No
TX-4 (Fig. 8)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	7000	840	\$975	Yes
Sand Bx (Fig. 6)	Yes	No	--	No	No	No	Yes	6000	800	\$1000	--
B-88 (Fig. 7)	No	Yes	No	Yes	Yes	Yes	Yes	6000	800	\$800	No

V. CONCLUSION

For a variety of reasons, the containers that have or currently are being used for packaging radioactive waste have drawbacks which has motivated LLNL to investigate, design and destructively test different Type A containers. The result of this work is manifested in the TX-4. It is comparatively lightweight, which increases the net payload, and the simplicity of the design and ease in handling have proved to be timesaving. The TX-4 is readily available, relatively inexpensive and

practical to use. It easily meets Type A packaging specifications with a gross payload of 7,000 pounds. Although no tests were performed at a higher weight, we feel that the TX-4 could pass the tests at higher gross weights if the need arises.

REFERENCES

1. R. S. Roberts, P. E. Barry, "Design and Testing of Wood Containers for Radioactive Waste," UCRL-53136, March, 1981.
2. TRU Waste Certification Compliance Requirements for Newly-Generated Contact-Handled Wastes for Shipment to the WIPP, WIPP-DOE-114, UC-70, October, 1981.
3. Quality Assurance Measures for Certification of TRU Waste for Shipment to the WIPP, WIPP-DOE-120, April, 1982.
4. Management of Transuranic Contaminated Material, DOE Order 5820.1, September, 1982.

NOTES

UNLESS OTHERWISE SPECIFIED

- DIMENSIONING AND TOLERANCING PER ASME Y14.5-1994.
- ADDITIONAL AND FORM TOLERANCES APPLY TO ALL DIMENSIONS.
- SURFACE TEXTURE PER ASME Y14.3-1994.
- 100% ON STOCK.
- PARTS SHOWN IN TWO VIEWS. IF ONE VIEW IS SHOWN, THE OTHER VIEW IS IMPLICIT. THE PART SHALL BE MANUFACTURED TO THE DIMENSIONS SHOWN. THE PART SHALL BE MANUFACTURED TO THE DIMENSIONS SHOWN. THE PART SHALL BE MANUFACTURED TO THE DIMENSIONS SHOWN.
- WEIGHT = 11.40 POUNDS, INCLUDING .015 IN. ALLOWABLE GROSS WEIGHT = 10.00 POUNDS.
- PARTS CONTAINING (1) 100% AND (2) 100% SHALL BE MANUFACTURED TO THE DIMENSIONS SHOWN. THE PART SHALL BE MANUFACTURED TO THE DIMENSIONS SHOWN. THE PART SHALL BE MANUFACTURED TO THE DIMENSIONS SHOWN.
- DIMENSIONS ARE IN INCHES AND DECIMALS THEREOF. FRACTIONS SHALL BE SHOWN AS DECIMALS. DIMENSIONS SHALL BE SHOWN TO THE RIGHT OF THE DIMENSION LINE. DIMENSIONS SHALL BE SHOWN TO THE RIGHT OF THE DIMENSION LINE. DIMENSIONS SHALL BE SHOWN TO THE RIGHT OF THE DIMENSION LINE.

SEE NOTE 5

REV	DATE	DESCRIPTION	BY	CHKD	APP'D
1	10/1/94	INITIAL DESIGN	J. W. CONTE		
2	10/1/94	REVISION 1	J. W. CONTE		
3	10/1/94	REVISION 2	J. W. CONTE		
4	10/1/94	REVISION 3	J. W. CONTE		
5	10/1/94	REVISION 4	J. W. CONTE		
6	10/1/94	REVISION 5	J. W. CONTE		
7	10/1/94	REVISION 6	J. W. CONTE		
8	10/1/94	REVISION 7	J. W. CONTE		
9	10/1/94	REVISION 8	J. W. CONTE		
10	10/1/94	REVISION 9	J. W. CONTE		
11	10/1/94	REVISION 10	J. W. CONTE		
12	10/1/94	REVISION 11	J. W. CONTE		
13	10/1/94	REVISION 12	J. W. CONTE		
14	10/1/94	REVISION 13	J. W. CONTE		
15	10/1/94	REVISION 14	J. W. CONTE		
16	10/1/94	REVISION 15	J. W. CONTE		
17	10/1/94	REVISION 16	J. W. CONTE		
18	10/1/94	REVISION 17	J. W. CONTE		
19	10/1/94	REVISION 18	J. W. CONTE		
20	10/1/94	REVISION 19	J. W. CONTE		
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22	10/1/94	REVISION 21	J. W. CONTE		
23	10/1/94	REVISION 22	J. W. CONTE		
24	10/1/94	REVISION 23	J. W. CONTE		
25	10/1/94	REVISION 24	J. W. CONTE		
26	10/1/94	REVISION 25	J. W. CONTE		
27	10/1/94	REVISION 26	J. W. CONTE		
28	10/1/94	REVISION 27	J. W. CONTE		
29	10/1/94	REVISION 28	J. W. CONTE		
30	10/1/94	REVISION 29	J. W. CONTE		
31	10/1/94	REVISION 30	J. W. CONTE		
32	10/1/94	REVISION 31	J. W. CONTE		
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36	10/1/94	REVISION 35	J. W. CONTE		
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43	10/1/94	REVISION 42	J. W. CONTE		
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54	10/1/94	REVISION 53	J. W. CONTE		
55	10/1/94	REVISION 54	J. W. CONTE		
56	10/1/94	REVISION 55	J. W. CONTE		
57	10/1/94	REVISION 56	J. W. CONTE		
58	10/1/94	REVISION 57	J. W. CONTE		
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60	10/1/94	REVISION 59	J. W. CONTE		
61	10/1/94	REVISION 60	J. W. CONTE		
62	10/1/94	REVISION 61	J. W. CONTE		
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65	10/1/94	REVISION 64	J. W. CONTE		
66	10/1/94	REVISION 65	J. W. CONTE		
67	10/1/94	REVISION 66	J. W. CONTE		
68	10/1/94	REVISION 67	J. W. CONTE		
69	10/1/94	REVISION 68	J. W. CONTE		
70	10/1/94	REVISION 69	J. W. CONTE		
71	10/1/94	REVISION 70	J. W. CONTE		
72	10/1/94	REVISION 71	J. W. CONTE		
73	10/1/94	REVISION 72	J. W. CONTE		
74	10/1/94	REVISION 73	J. W. CONTE		
75	10/1/94	REVISION 74	J. W. CONTE		
76	10/1/94	REVISION 75	J. W. CONTE		
77	10/1/94	REVISION 76	J. W. CONTE		
78	10/1/94	REVISION 77	J. W. CONTE		
79	10/1/94	REVISION 78	J. W. CONTE		
80	10/1/94	REVISION 79	J. W. CONTE		
81	10/1/94	REVISION 80	J. W. CONTE		
82	10/1/94	REVISION 81	J. W. CONTE		
83	10/1/94	REVISION 82	J. W. CONTE		
84	10/1/94	REVISION 83	J. W. CONTE		
85	10/1/94	REVISION 84	J. W. CONTE		
86	10/1/94	REVISION 85	J. W. CONTE		
87	10/1/94	REVISION 86	J. W. CONTE		
88	10/1/94	REVISION 87	J. W. CONTE		
89	10/1/94	REVISION 88	J. W. CONTE		
90	10/1/94	REVISION 89	J. W. CONTE		
91	10/1/94	REVISION 90	J. W. CONTE		
92	10/1/94	REVISION 91	J. W. CONTE		
93	10/1/94	REVISION 92	J. W. CONTE		
94	10/1/94	REVISION 93	J. W. CONTE		
95	10/1/94	REVISION 94	J. W. CONTE		
96	10/1/94	REVISION 95	J. W. CONTE		
97	10/1/94	REVISION 96	J. W. CONTE		
98	10/1/94	REVISION 97	J. W. CONTE		
99	10/1/94	REVISION 98	J. W. CONTE		
100	10/1/94	REVISION 99	J. W. CONTE		
101	10/1/94	REVISION 100	J. W. CONTE		

Figure 1. Design of Bennett Bucket, a cylindrical steel waste container.

NOTES ASSEMBLY ORDER

1. DISASSEMBLE PARTS (1) WITH ASSIGNED
2. DISASSEMBLE PARTS (2) WITH ASSIGNED
3. DISASSEMBLE PARTS (3) WITH ASSIGNED
4. DISASSEMBLE PARTS (4) WITH ASSIGNED
5. DISASSEMBLE PARTS (5) WITH ASSIGNED
6. DISASSEMBLE PARTS (6) WITH ASSIGNED
7. DISASSEMBLE PARTS (7) WITH ASSIGNED
8. DISASSEMBLE PARTS (8) WITH ASSIGNED
9. DISASSEMBLE PARTS (9) WITH ASSIGNED
10. DISASSEMBLE PARTS (10) WITH ASSIGNED
11. DISASSEMBLE PARTS (11) WITH ASSIGNED

1	DISASSEMBLE PARTS (1) WITH ASSIGNED	2	
2	DISASSEMBLE PARTS (2) WITH ASSIGNED	3	
3	DISASSEMBLE PARTS (3) WITH ASSIGNED	4	
4	DISASSEMBLE PARTS (4) WITH ASSIGNED	5	
5	DISASSEMBLE PARTS (5) WITH ASSIGNED	6	
6	DISASSEMBLE PARTS (6) WITH ASSIGNED	7	
7	DISASSEMBLE PARTS (7) WITH ASSIGNED	8	
8	DISASSEMBLE PARTS (8) WITH ASSIGNED	9	
9	DISASSEMBLE PARTS (9) WITH ASSIGNED	10	
10	DISASSEMBLE PARTS (10) WITH ASSIGNED	11	
11	DISASSEMBLE PARTS (11) WITH ASSIGNED	12	

Figure 3. TX-1 waste container showing interior welded steel structure.

NOTES: WASTE CONTAINER SPECIFICATIONS

1. DIMENSIONS AND TOLERANCING PER ANSI-ASME Y14.5.
2. POSITIONAL AND FORM TOLERANCING PER Y14.5.
3. SURFACE TEXTURE PER ANSI-ASME Y14.3.
4. SURFACE FINISH.
5. REMOVE BURRS AND SHARP EDGES .05 MAX.
6. STEEL, MAX. WEIGHT 1000 LB. WHERE INDICATED.
7. STEEL, MAX. 1/2" THICK CHARACTERS WHERE INDICATED.
8. DISPOSAL CONTAINER TO BE SHIPPED ASSEMBLED.

1	SCREW 1/2" BLACK & N. CAP NUTS	2
2	W/ PLATING PLATE, 1/2" X 1/2"	25
3	1/2" X 1/2" PLATE	
4	LOCK WRENCH IN LINE WITH HOLE	25
5	W/ PLATE, 1/2" X 1/2"	
6	W/ PLATE, 1/2" X 1/2"	
7	W/ PLATE, 1/2" X 1/2"	
8	W/ PLATE, 1/2" X 1/2"	
9	W/ PLATE, 1/2" X 1/2"	
10	W/ PLATE, 1/2" X 1/2"	
11	W/ PLATE, 1/2" X 1/2"	
12	W/ PLATE, 1/2" X 1/2"	
13	W/ PLATE, 1/2" X 1/2"	
14	W/ PLATE, 1/2" X 1/2"	
15	W/ PLATE, 1/2" X 1/2"	
16	W/ PLATE, 1/2" X 1/2"	
17	W/ PLATE, 1/2" X 1/2"	
18	W/ PLATE, 1/2" X 1/2"	
19	W/ PLATE, 1/2" X 1/2"	
20	W/ PLATE, 1/2" X 1/2"	
21	W/ PLATE, 1/2" X 1/2"	
22	W/ PLATE, 1/2" X 1/2"	
23	W/ PLATE, 1/2" X 1/2"	
24	W/ PLATE, 1/2" X 1/2"	
25	W/ PLATE, 1/2" X 1/2"	
26	W/ PLATE, 1/2" X 1/2"	
27	W/ PLATE, 1/2" X 1/2"	
28	W/ PLATE, 1/2" X 1/2"	
29	W/ PLATE, 1/2" X 1/2"	
30	W/ PLATE, 1/2" X 1/2"	
31	W/ PLATE, 1/2" X 1/2"	
32	W/ PLATE, 1/2" X 1/2"	
33	W/ PLATE, 1/2" X 1/2"	
34	W/ PLATE, 1/2" X 1/2"	
35	W/ PLATE, 1/2" X 1/2"	
36	W/ PLATE, 1/2" X 1/2"	
37	W/ PLATE, 1/2" X 1/2"	
38	W/ PLATE, 1/2" X 1/2"	
39	W/ PLATE, 1/2" X 1/2"	
40	W/ PLATE, 1/2" X 1/2"	
41	W/ PLATE, 1/2" X 1/2"	
42	W/ PLATE, 1/2" X 1/2"	
43	W/ PLATE, 1/2" X 1/2"	
44	W/ PLATE, 1/2" X 1/2"	
45	W/ PLATE, 1/2" X 1/2"	
46	W/ PLATE, 1/2" X 1/2"	
47	W/ PLATE, 1/2" X 1/2"	
48	W/ PLATE, 1/2" X 1/2"	
49	W/ PLATE, 1/2" X 1/2"	
50	W/ PLATE, 1/2" X 1/2"	
51	W/ PLATE, 1/2" X 1/2"	
52	W/ PLATE, 1/2" X 1/2"	
53	W/ PLATE, 1/2" X 1/2"	
54	W/ PLATE, 1/2" X 1/2"	
55	W/ PLATE, 1/2" X 1/2"	
56	W/ PLATE, 1/2" X 1/2"	
57	W/ PLATE, 1/2" X 1/2"	
58	W/ PLATE, 1/2" X 1/2"	
59	W/ PLATE, 1/2" X 1/2"	
60	W/ PLATE, 1/2" X 1/2"	
61	W/ PLATE, 1/2" X 1/2"	
62	W/ PLATE, 1/2" X 1/2"	
63	W/ PLATE, 1/2" X 1/2"	
64	W/ PLATE, 1/2" X 1/2"	
65	W/ PLATE, 1/2" X 1/2"	
66	W/ PLATE, 1/2" X 1/2"	
67	W/ PLATE, 1/2" X 1/2"	
68	W/ PLATE, 1/2" X 1/2"	
69	W/ PLATE, 1/2" X 1/2"	
70	W/ PLATE, 1/2" X 1/2"	
71	W/ PLATE, 1/2" X 1/2"	
72	W/ PLATE, 1/2" X 1/2"	
73	W/ PLATE, 1/2" X 1/2"	
74	W/ PLATE, 1/2" X 1/2"	
75	W/ PLATE, 1/2" X 1/2"	
76	W/ PLATE, 1/2" X 1/2"	
77	W/ PLATE, 1/2" X 1/2"	
78	W/ PLATE, 1/2" X 1/2"	
79	W/ PLATE, 1/2" X 1/2"	
80	W/ PLATE, 1/2" X 1/2"	
81	W/ PLATE, 1/2" X 1/2"	
82	W/ PLATE, 1/2" X 1/2"	
83	W/ PLATE, 1/2" X 1/2"	
84	W/ PLATE, 1/2" X 1/2"	
85	W/ PLATE, 1/2" X 1/2"	
86	W/ PLATE, 1/2" X 1/2"	
87	W/ PLATE, 1/2" X 1/2"	
88	W/ PLATE, 1/2" X 1/2"	
89	W/ PLATE, 1/2" X 1/2"	
90	W/ PLATE, 1/2" X 1/2"	
91	W/ PLATE, 1/2" X 1/2"	
92	W/ PLATE, 1/2" X 1/2"	
93	W/ PLATE, 1/2" X 1/2"	
94	W/ PLATE, 1/2" X 1/2"	
95	W/ PLATE, 1/2" X 1/2"	
96	W/ PLATE, 1/2" X 1/2"	
97	W/ PLATE, 1/2" X 1/2"	
98	W/ PLATE, 1/2" X 1/2"	
99	W/ PLATE, 1/2" X 1/2"	
100	W/ PLATE, 1/2" X 1/2"	

Figure 4. Top and side view of TX-2 steel waste container. This design allows forklift access from both side and end.

Figure 5. TX-3 steel waste container, showing piano hinged closure mechanism.

Figure 6. Design and detail of 12 gauge steel "Sand Box" waste container.

NO.	QTY	DESCRIPTION
1	1	1/2" TUBING, 3/4" X 3/4" STEEL
2	1	1/2" TUBING, 3/4" X 3/4" STEEL
3	1	1/2" CHANNEL, 3/4" X 3/4" STEEL
4	1	1/2" ANGLE, 3/4" X 3/4" STEEL
5	1	1/2" 16GA. STEEL LINING, 7'-7 1/2" X 4'-7 1/2"
6	1	1/2" 16GA. STEEL LINING, 7'-4 1/2" X 4'-5 1/2"
7	1	1/2" 16GA. STEEL LINING, 4'-4 1/2" X 4'-5 1/2"
8	1	1/2" 16GA. STEEL LINING, 7'-4 1/2" X 4'-5 1/2"
9	1	1/2" 16GA. STEEL LINING, 7'-4 1/2" X 4'-5 1/2"
10	1	1/2" FLAT BAR, 3/4" X 7' X 3/4" TH. W/ 2" BEND.
11	1	1/2" FLAT BAR, 3/4" X 7' X 3/4" TH. W/ 2" BEND.

NO.	DESCRIPTION	DATE
1	DETAIL, PHOTO	
University of California LAWRENCE LIVERMORE LABORATORY PLANT ENGINEERING		
BUILDING G-2 HAZARDOUS WASTE CONTAINER T.W. CONTROL		
DESIGNED BY	LARSEN	DATE 8-2-82
CHECKED BY		DATE
APPROVED BY	PLM	DATE 8-2-82
ISSUED FOR CONSTRUCTION		DATE
BY		DATE
CHECKED BY		DATE
<div style="border: 1px solid black; padding: 5px; display: inline-block;">M-1</div>		
PLM82-612-004C		

Figure 7. Design and photo of B-BB steel waste container illustrating "Safe-T-Loc" closure mechanism.

Figure 8. Complete design, detail, and photo of TX-4 steel waste container.

Figure 9. TX-4 during 5 minute pressure test shows slight bulging at 7.3 psig.

Figure 10. Pressure gauges at 7.3 psig after 5 minute pressure test.

Figure 11. TX-4 container loaded to 7,000 pounds with 35,100 pounds of weights in place for compression test.

Figure 12. TX-4 container loaded to 7,000 pounds shown mid-air in 4 foot free-drop test.

Figure 13. TX-4 container loaded to 7,000 pounds lying on its side immediately after impact on steel plate showing no release of contents.

Figure 14. Damage incurred to TX-4 container after 4 foot free-drop test.

Figure 15. 13 pound steel rod immediately after 40 inch drop shows slight indentation on TX-4 container with no breach of containment.

Figure 16. TX-3 piano-hinged container being raised after 4 foot free-drop showing damage and breach of containment.

Figure 17. TX-3 piano-hinged container after drop test on bottom corner showing minimal damage.

Figure 19. "Sand Box" container undergoing 30,000 pound compression test shows distortion on upper right portion.

Figure 20. B-88 container loaded to 6,000 pounds showing failure of "Safe-T-Loc" closure mechanism and breach of containment immediately after 4 foot corner drop test.