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DROP TESTS RESULTS OF REVISED CLOSURE BOLT CONFIGURATION OF THE STANDARD WASTE BOX, STANDARD LARGE BOX-2, AND TEN DRUM OVERPACK PACKAGINGS

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ABSTRACT

The Transuranic (TRU) Disposition Project at Savannah River Site will require numerous transfers of radioactive materials within the site boundaries for sorting and repackaging. The three DOT Type A shipping packagings planned for this work have numerous bolts for securing the lids to the body of the packagings. In an effort to reduce operator time to open and close the packages during onsite transfers, thus reducing personnel exposure and costs, an evaluation was performed to analyze the effects of reducing the number of bolts required to secure the lid to the packaging body. The evaluation showed the reduction to one-third of the original number of bolts had no effect on the packagings' capability to sustain vibratory loads, shipping loads, internal pressure loads, and the loads resulting from a 4-ft drop. However, the loads caused by the 4-ft drop are difficult to estimate and the study recommended each of the packages be dropped to show the actual effects on the package closure. Even with reduced bolting, the packagings were still required to meet the 49 CFR 178.350 performance criteria for Type A packaging.

This paper will discuss the effects and results of the drop testing of the three packagings.

INTRODUCTION

Three DOT 7A Type A packagings will be used in Phase II TRU Disposition work to transfer radioactive materials on-site from E-Area to F- and H- Areas of the Savannah River Site (SRS). The packagings are the Standard Waste Box (SWB), Standard Large Box (SLB-2) and Ten Drum Overpack (TDOP). Each packaging will be loaded with radioactive materials from the E Area TRU storage facility, closed, and shipped to the F- or H- Areas for material sorting and repackaging. Closure procedures for all of the packagings require the installation of all bolts of the lid to prevent lid separation if the package is dropped.

The Phase II work will require numerous openings, closures, and transfers of materials over the life of the project. In order to minimize operators' time adjacent to these packages (according to ALARA principles) during packaging closures and openings, it is desirable to use fewer lid bolts for each packaging for on-site transfers. The packaging performance however is still required to meet the DOT 7A Type A criteria. An analysis using a reduced number of bolts was performed to evaluate the normal shipping load sealing capability and bolt stresses. The evaluation included a qualitative assessment of the packaging capability to retain integrity in a 4-ft drop with reduced numbers of bolts installed.

The analysis and evaluation concluded that the number of bolts could be reduced to one third the numbers of bolts with no adverse effects on packaging integrity and capability to sustain vibratory loads, shipping loads, loads due to internal pressure, and the loads resulting from a 4-ft drop. For the cylindrical TDOP packaging, every third bolt was installed. For the SLB-2 rectangular package and the SWB oblong package, three bolts along each direction were installed at the

corners and then every third bolt installed along the sides and ends.

Although the analysis showed that reducing the number of bolts to one-third would not impact the integrity of the package if dropped, it was recommended that drop testing be performed to validate this conclusion. The most challenging test drop orientation for all test packages was determined to be the center of gravity over top corner (CGTC).

During this testing, the suffix RB (Reduced Bolts) was added to the identifier of each packaging.

APPROACH

The approach for maintaining compliance with reduced bolting is to show the SWB-RB, SLB-2-RB, and TDOP-RB designs comply with the DOT 7A Type A performance specification from 49 CFR 178.350. The §178.350 specification invokes the following requirements from §173:

- .410, General design requirements.
- .412, Additional design requirements for Type A packages.
- .415, Authorized Type A packages, and
- .465, Type A packaging tests.

The reduced bolt configurations represent a relatively small design perturbation to the fully bolted units. Hence the existing compliance documentation for the fully bolted designs is applicable to the SWB-RB, SLB-2-RB, and TDOP-RB configurations as supplemented by the following items: 1) modified lid closure configuration, 2) pressure retention capability, 3) vibration capability, and 4) containment under the Type A package free drop test. The reduced bolt configuration was considered to have no affect on remaining 49 CFR, 7A Type A design and testing requirements of the fully bolted units.

Lid closure for the reduced bolting configuration is shown in Attachment 1. Closure instructions were written based on these bolting configurations. Pressure retention under a reduced external atmosphere of 25 kPa (§173.412(f)), and vibration capability (§173.410(f)) were shown by analysis to be satisfactory for each container design. The remainder of this paper discusses the drop testing to show compliance to the §173.465(c) requirements.

Each packaging was dropped from a height of 4-ft to confirm the initial analysis. Crusher-run material (a road paving material consisting of small rocks, gravel, and sand) was used to simulate the packaging contents. The sand particles in the crusher-run provided particles small enough to indicate a leak from the packaging. The maximum gross weights of each packaging were:

- SWB-RB – 4,000 lb
- SLB-2-RB – 10,500 lb
- TDOP-RB – 6,700 lb

The SWB-RB and SLB-2-RB packagings were dropped in the orientation center of gravity over top corner. The TDOP-RB packaging was dropped center of gravity over top edge. The angles of the packages from the vertical were approximately:

- SLB-2-RB – 60.5 degrees
- SWB-RB- 62.4 degrees
- TDOP-RB – 43.6 degrees

The packagings were dropped onto an essentially flat, unyielding surface. The drop pad consisted of a 6-in thick steel plate with dimensions approximately 8-ft x 12-ft. The weight of the plate was approximately 25500 lbs. The plate was set on a grout bed approximately 1 to 1 ½ inches thick. The grout cured for 10 days. The grout bed provided solid contact of the plate and concrete building foundation. The drop pad was centered over a footing in the concrete foundation. The footing is approximately 3-ft x 3-ft x 3-ft. The drop pad is shown in Fig. 1. The criteria for a successful drop were:

- No lid separation from the body resulting in loss of gasket compression
- No visible leakage of the crusher-run contents

Standard Waste Box – SWB-RB

The first package dropped was the SWB-RB#1. The packaging was loaded with crusher-run to maximum gross weight (4000 lb) and dropped CGTC from a height of 4 ft. Upon impact, the top lid buckled in the area where two bolt holes were left open near the impact point, and the test contents leaked from the package. Another bolt hole without a bolt near the impact area also leaked particles.

After this initial drop, the test plan was re-evaluated and the bolt installation sequence was revised for all packagings. For the cylindrical TDOP-RB packaging, every other bolt was installed. For the SLB-2-RB package and the SWB-RB package, two bolts along each direction was installed at each corner and then every other bolt was installed along the sides and ends (to the extent possible). The final bolting sequences for all packagings are shown in Attachment 1.

The SWB-RB#2 (second SWB packaging) with the revised bolt installation was retested. The drop angle was approximately 63 degrees (See Fig. 2). The SWB-RB#2 leaked contents and buckled in the same manner as SWB-RB#1 at impact. The lid buckled at the first vacant bolt holes after the two installed bolts on the corner (impact point). (See Fig. 3 and Fig. 4)

Ten Drum Overpack

The TDOP-RB was loaded with crusher-run and dropped on the top edge at an angle of approximately 43 degrees (Fig. 5). The package weighed a total of 6650 lb. There was no evidence of content leakage or separation of the lid from the body at impact.

Two cap screw heads holding the top lid sheared at impact. The screw nearest the impact point sheared at the cap head. The second cap screw failed with the threaded shank of the screw pulling from the cap head. There was no evidence of separation of the TDOP lid from the top flange of the body. See Fig. 6 and Fig. 7. The particles on the pad shown in Fig. 6 are paint flakes and rust particles from the packaging. There was no crusher-run material on the drop pad.

Standard Large Box – 2

The SLB-2-RB was loaded with crusher-run to a gross weight of 10,700 lb and dropped at an angle of approximately 60 degrees (See Fig. 8). There was no evidence of content leakage. The top corner point of impact was deformed and the flanged lip was torn, however, there was no separation of the lid from the packaging. Fig. 9 shows the impact point and the slight side distortion resulting from the drop. Similar distortion was evident on the top lid and end surfaces adjacent to the impact corner.

CONCLUSIONS

The SWB-RB did not meet the criteria with either of the revised bolt configurations. Both of the dropped packagings had lid and body separation and contents leakage when dropped. The SLB-2-RB and the TDOP-RB met the acceptance criteria with the revised bolt pattern pictured in Attachment 1. Additionally the two units were shown by analysis to meet the applicable pressure retention and vibration requirements of 49 CFR and therefore when used with the reduced bolting closure instructions, meet the 49 CFR 178.350 7A Type A requirements[1].

The successful testing of the SLB-2-RB and TDOP-RB allowed these two packagings to be used for onsite transfers of radioactive materials under specific conditions[2]. The conditions consist of:

- Each SLB-2-RB and TDOP-RB is procured as DOT 7A Type A packaging with regulatory documents
- The packagings are specifically identified as SLB-2-RB and TDOP-RB to be used for onsite transfers only
- Packagings must be used with supplemental closure instructions
- The reduced bolt configurations are for use only on the TRU Repack/Remediation Operations and not to be used for newly generated waste

REFERENCES

1. May, C. G., *Results for the 4-ft Drop Tests of the Standard Waste Box, Standard Large Box-2, and the Ten Drum Over Pack*, SRNL-TR-2009-00420, Savannah River National Laboratory, October 30, 2009.

2. Oppermann, Erich K., *TDOP-RB and SLB-2-RB Regulatory Compliance Summary*, M-TRT-E-00003, Savannah River Nuclear Solutions, Rev 0, December 10, 2009.

DISCLAIMER

FIGURES

Figure 1. Drop Pad

Figure 2. SWB-RB#2 in position for drop

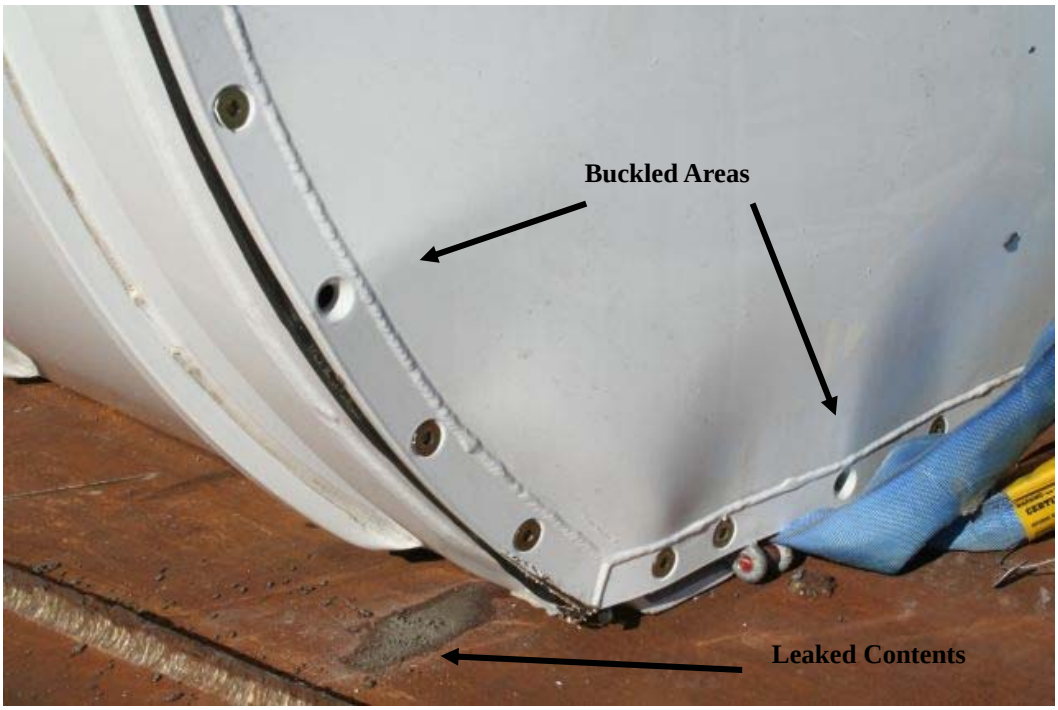


Figure 3. Buckled areas and leaked contents (SWB-RB#2)

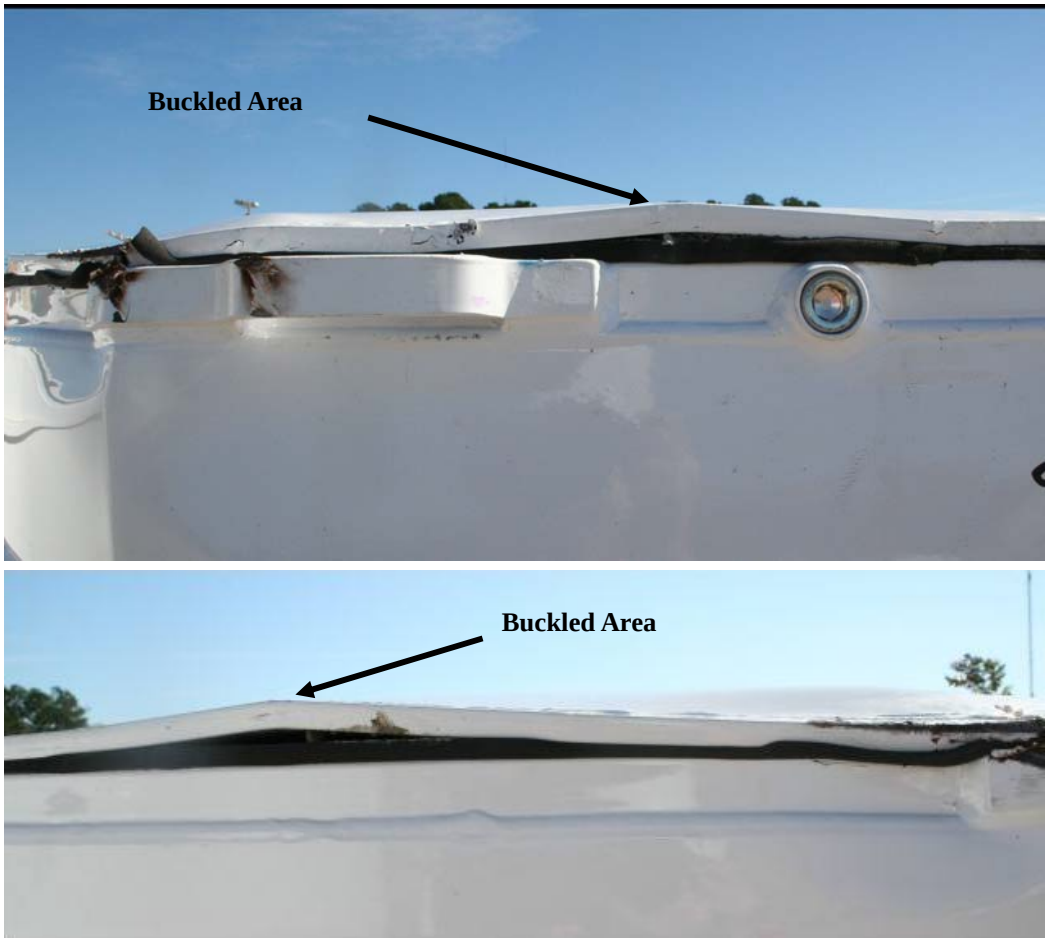


Figure 4. Lid separation (Buckled areas). Top – separation along straight edge of packaging. Bottom – separation along curved edge of packaging (SWB-RB#2)

Figure 5. TDOP-RB in position prior to 4-ft drop height. Approximately 43 degrees angle.

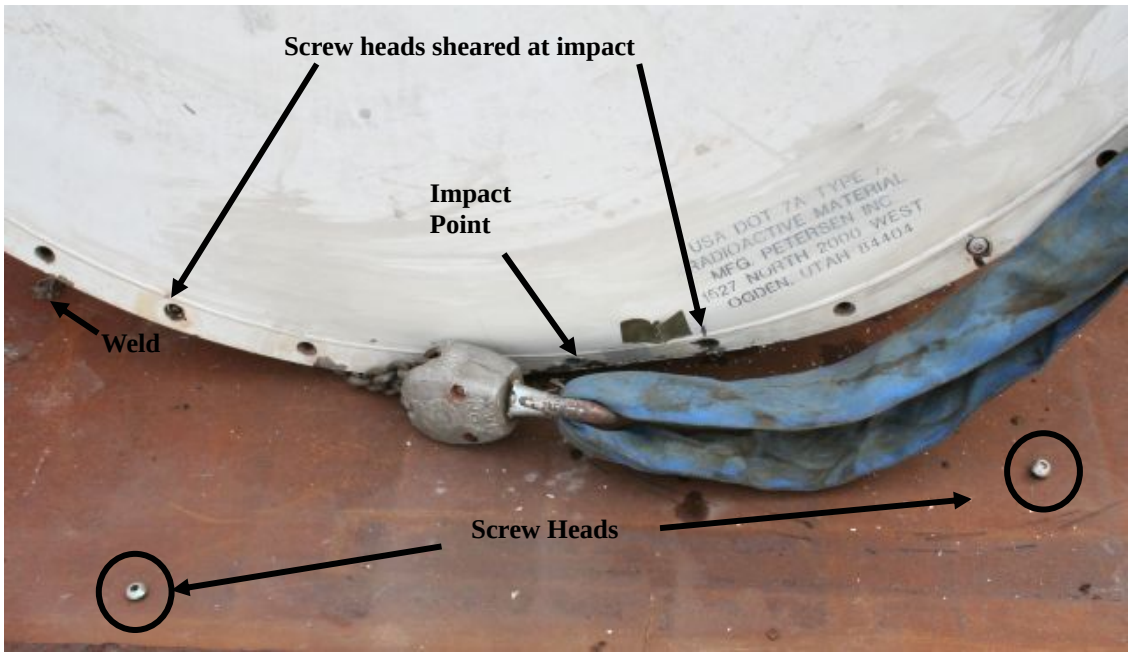


Figure 6. Sheared screw heads at impact. Particles on drop pad are paint flakes and not contents (TDOP-RB)

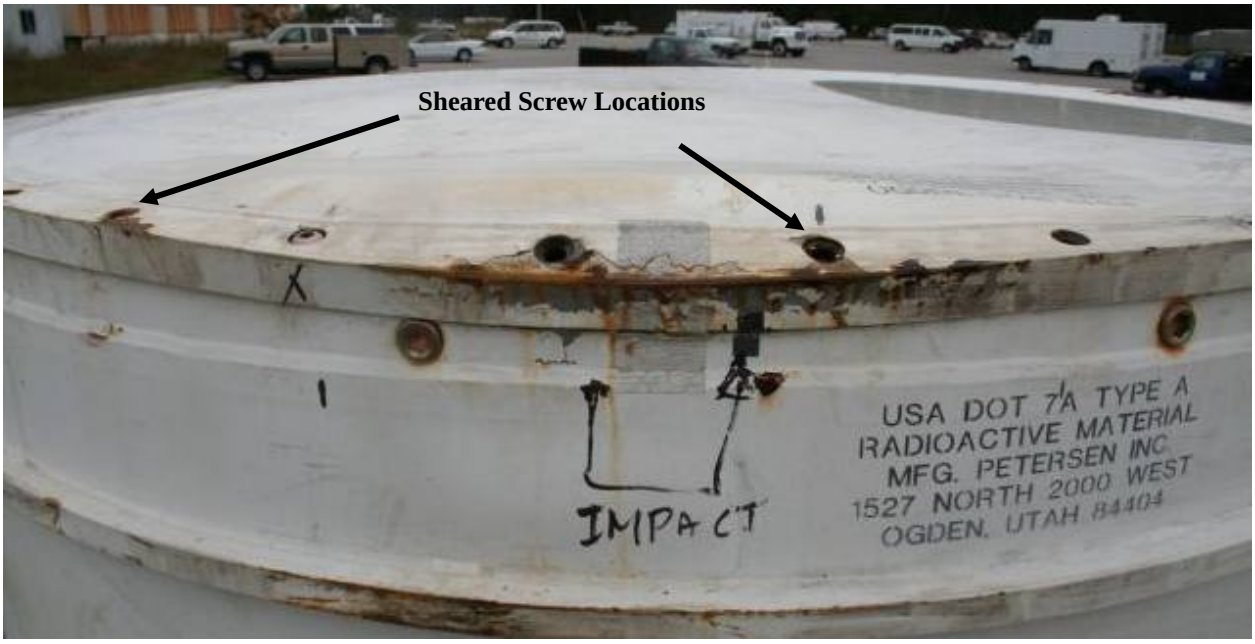


Figure 7. TDOP impact area (TDOP-RB)

Figure 8. SLB-2-RB in CGOC position at drop height of 4-ft

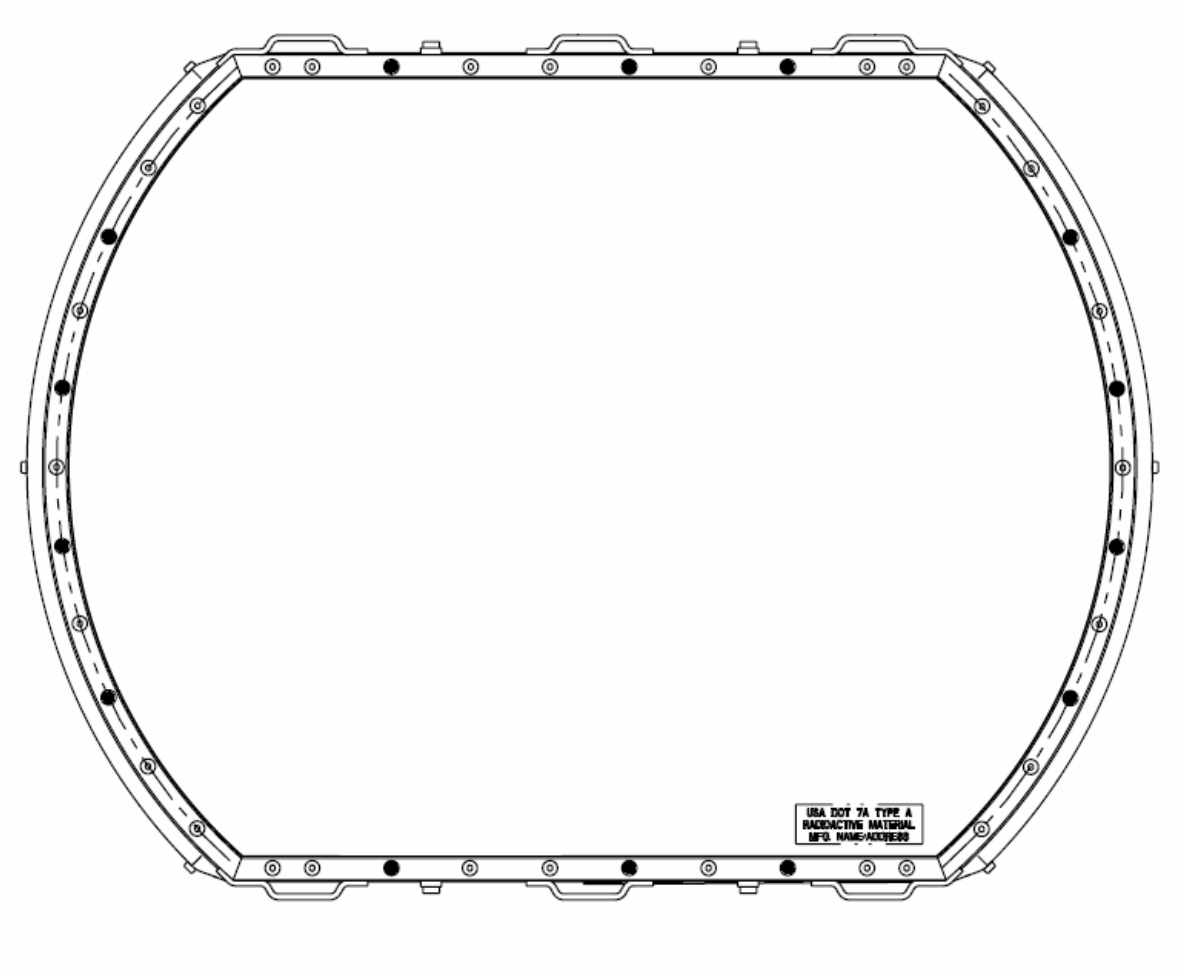
Figure 9. Left – Top corner impact point and side distortion. Right – Top corner impact point (SLB-2-RB)

ATTACHMENT 1

SWB-RB #2

◎ Bolt Installed

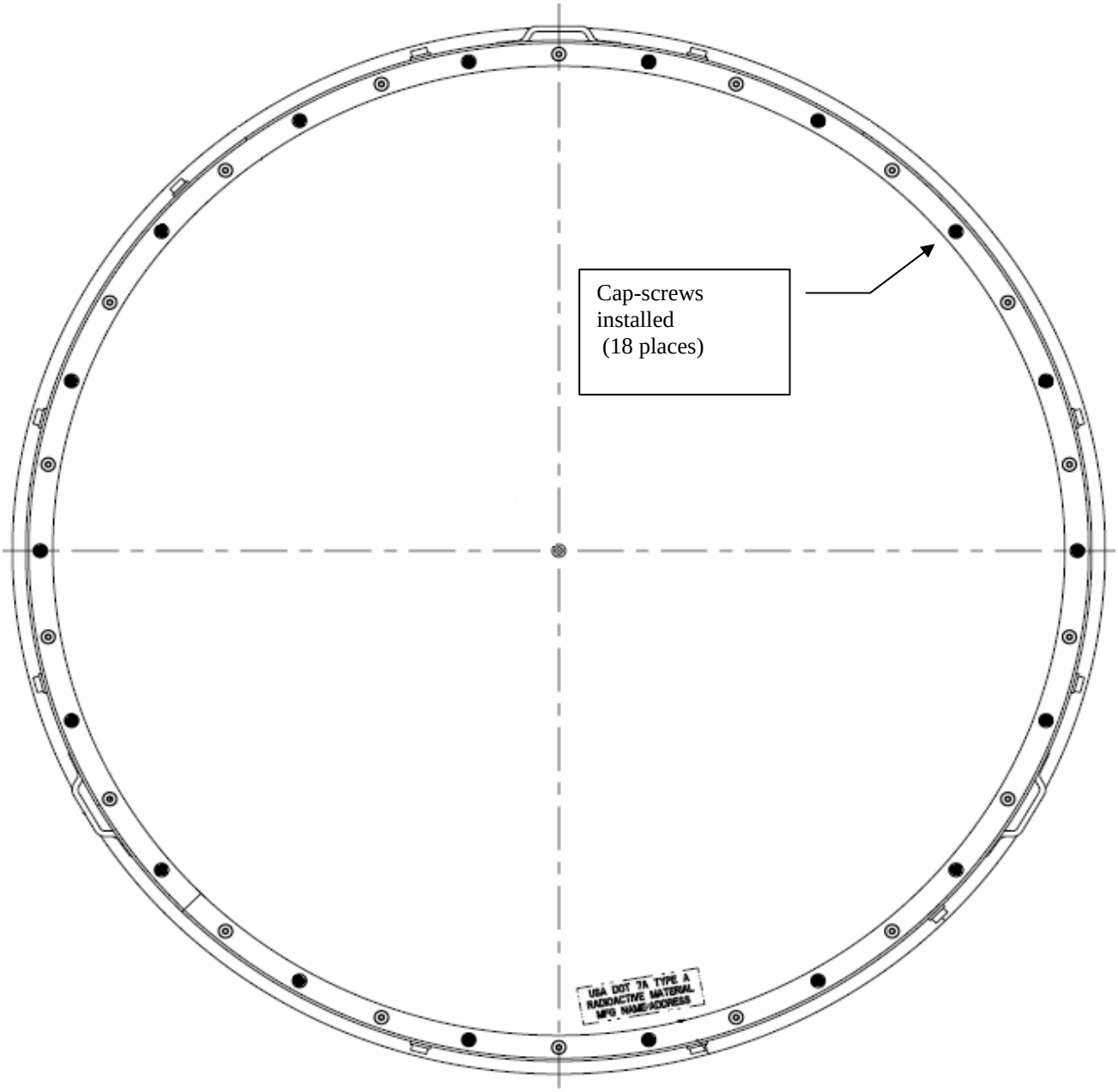
● Bolt Missing



TDOP-RB

Cap Screws Installed

Cap Screws Missing



SLB-2-RB

◎ Bolt Installed

● Bolt Missing