1. Update the following information in TRUPACT-II SAR tables 5.4-12, 5.4-13 and 5.4-15 based upon the results of SCA-CAL-0005 (ADAMS Accession No. ML21279A188) to demonstrate compliance with the applicable regulatory limits in 10 CFR Part 71:
   a. calculated dose rate (mrem/hr)
   b. tally error
   c. allowable activity (par/s) and
   d. allowable activity (Ci)

   Response:

   Table 5.4-16 in Section 5.4.5 of the TRUPACT-II Safety Analysis Report reports a maximum 0.8% increase for the NCT 2-meter dose rate for axial gaps of 1/2 inch at both ends of the sidewall lead column. For simplicity and conservatism, it is proposed to alternatively increase the activity limit administrative margin defined in Section 5.5.10 by 1% (from 10% to 11%) to account for the maximum lead gap in lieu of updating Tables 5.4-12, 5.4-13, and 5.4-15 for the SC-30G2, SC-30G3, and SC-55G2, respectively. Accordingly, Step 10 in Section 5.5.10 is revised to say:

   10. For all payloads except the SC-30G2, SC-30G3, and SC-55G2, ensure that the combined sum of the sum of fractions for the gamma and the neutron source term is less than or equal to 0.90. For the SC-30G2, SC-30G3, and SC-55G2 payloads, ensure that the combined sum of the sum of fractions for the gamma and the neutron source term is less than or equal to 0.89.

2. Update the following information in TRUPACT-II SAR tables 5.5-16, 5.5-18 and 5.5-22 based upon the results of SCA-CAL-0005 (ADAMS Accession No. ML21279A188) to demonstrate compliance with the applicable regulatory limits in 10 CFR Part 71:
   a. calculated dose rate (mrem/hr)
   b. tally error and
   c. allowable activity (γ/s)

   Response:

   See response to No. 1, above. As for response No. 1, there is no need to revise Tables 5.5-16, 5.5-18, and 5.5-22 for the SC-30G2, SC-30G3, and SC-55G2, respectively, since the revised administrative margin for these containers is 11%, and is included in the determination of acceptable activity in Step 10 of Section 5.5.10 of the TRUPACT-II Safety Analysis Report.

3. Is the gamma scan performed on an assembled container or only on individual components?

Response:

With reference to Figure 1, Figure 2, and Figure 3 for the SC-30G2, SC-30G3, and SC-55G2 shielded containers, respectively, the gamma scan process is performed on the container body without the base lead or outer base plates installed, and without the prototypic lid installed.

To simulate the presence of these components for ALARA purposes, a test base is used that has lead and steel plates of similar thicknesses and diameters as specified in the fabrication drawings, less sufficient sliding clearances to fit within the container body base for gamma scan testing. Similarly, the test lid is a prototypic lid, but also includes a center hole to allow access for the gamma scan test's radioactive source and a slightly reduced step diameter for sufficient clearance with the unfinished upper flange.

Upon successful completion of gamma scan testing, the base lead and steel plates are machined and installed in the body assembly and the filer shield plug and lid lead plate is machined and installed in the lid assembly.

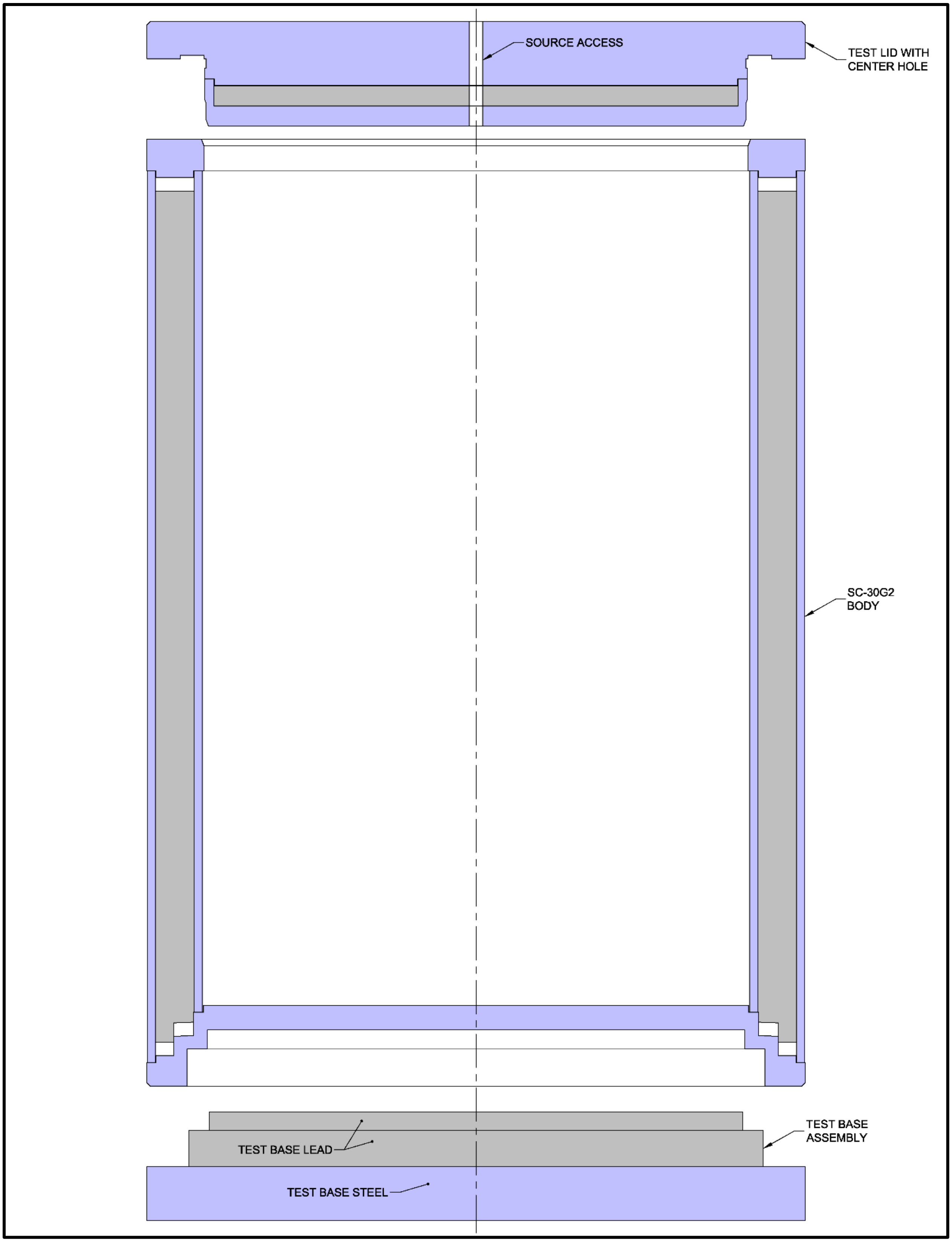

Figure 1 – SC-30G2 Gamma Scan Test Assembly Exploded View

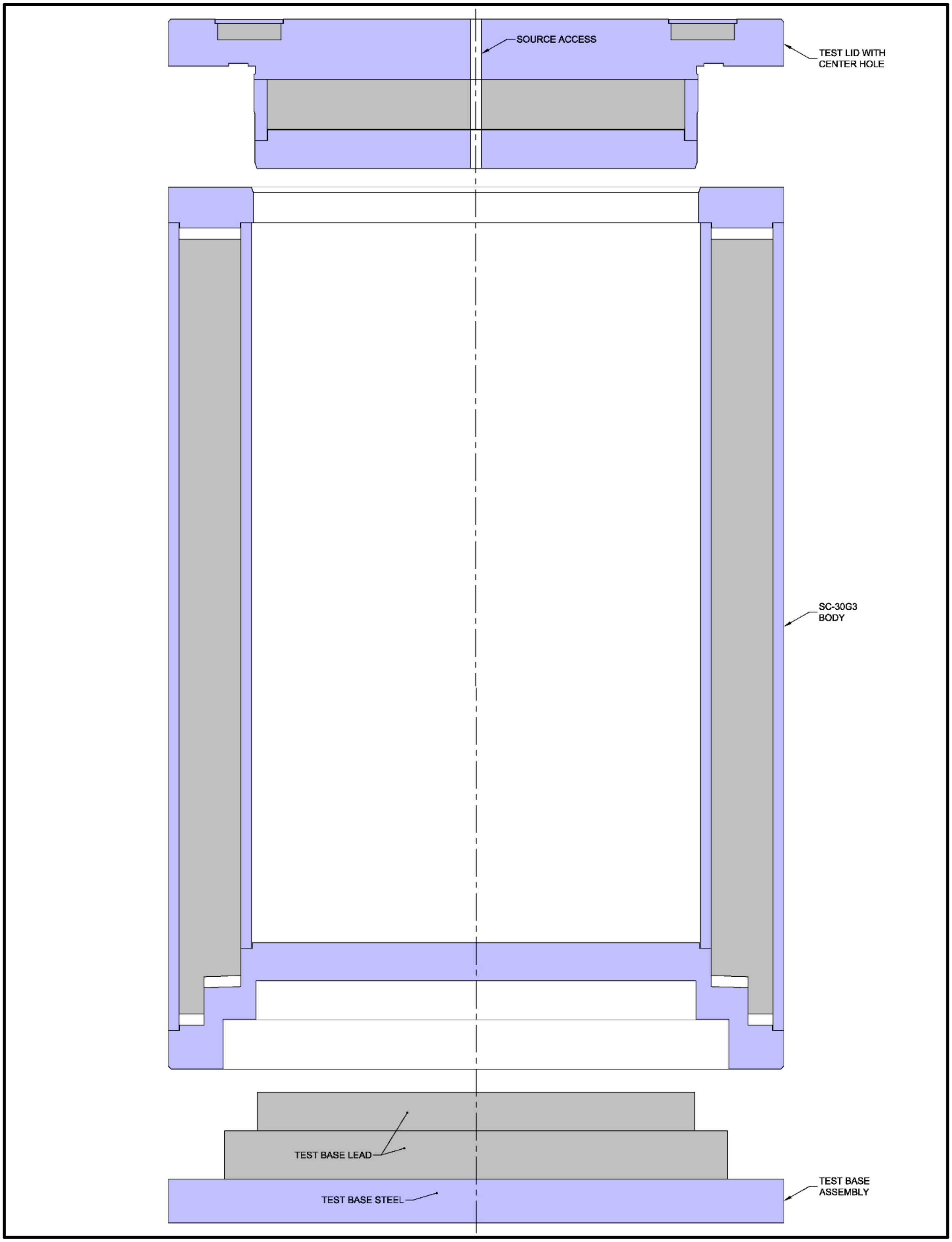

Figure 2 – SC-30G3 Gamma Scan Test Assembly Exploded View

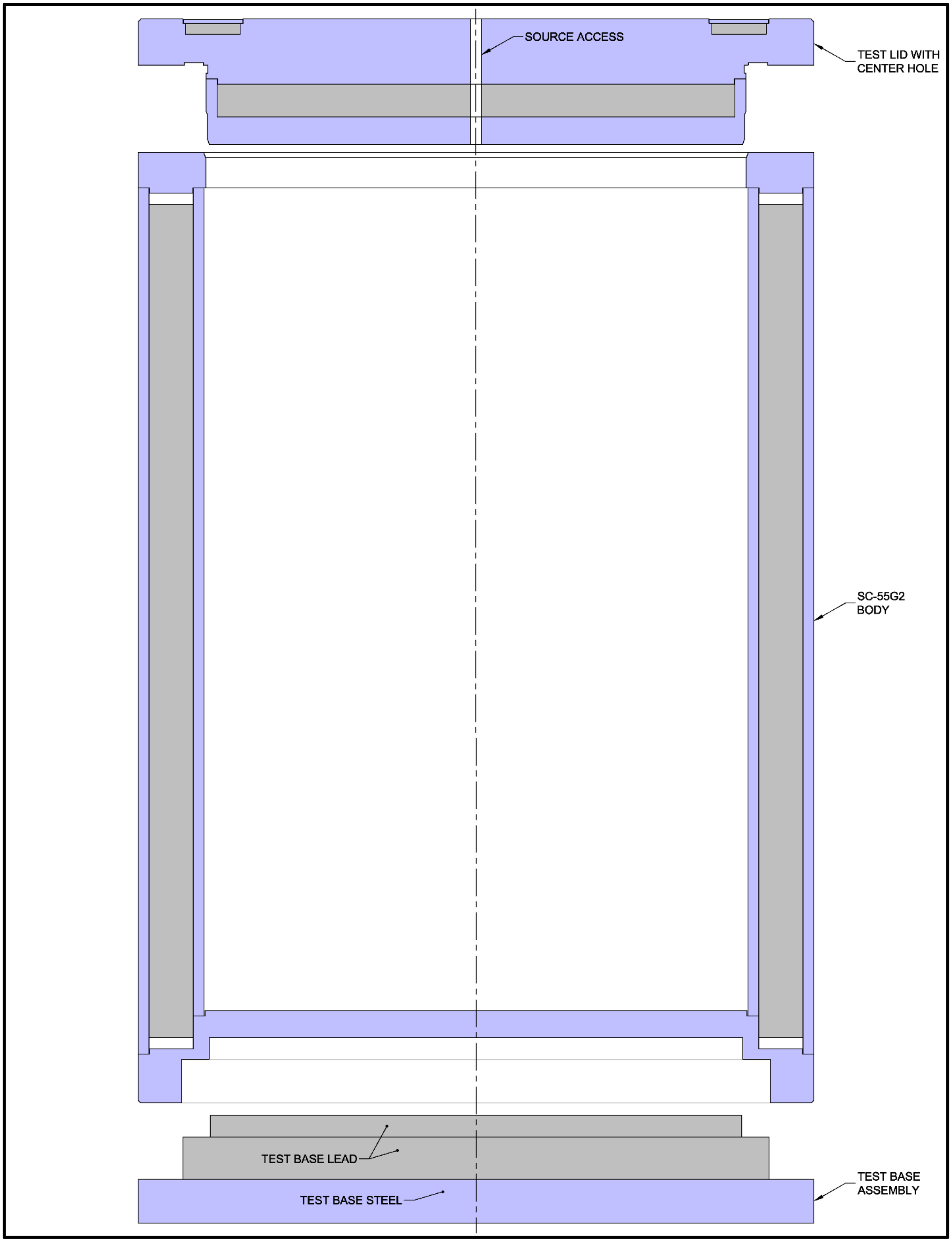

Figure 3 – SC-55G2 Gamma Scan Test Assembly Exploded View

4. Explain how the gamma scan will be used to measure the thickness of the lead shield in the corners of the shielded container. If the gamma scan is not used, explain how you ensure that the thickness of the lead in the corners of the shielded container are within the values shown in the licensing drawings.

   <u>Response</u>:

   The current gamma scan process only evaluates shielding "efficacy" over the axial span of the payload cavity, a decision based on the deep overlap of the sidewall lead beyond the payload cavity preventing a significant increase in measured dose rate at the container's surface. Shielding efficacy is determined by a combination of container geometry, materials, and distance between the source and detector.

   With reference to Figure 4, grid locations aligned with the payload cavity are scanned with the source axially aligned with the detector; the reject count rate (RCR; i.e., acceptance criterion) is based on a flat-block calibration measurement. The axial grid locations for the straight-shot measurements are as follows: 1.5 – 30.0 for the SC-30G2 and SC-30G3, and 1.5 – 36.0 for the SC-55G2.

Figure 4 – Example SC-30G3 Gamma Scan Test Configuration

For axial grid locations below and above the payload cavity, however, the gamma scan procedure will be revised to include measurements for shielding efficacy using the following steps:

a. Establish a source position above the bottom of the payload cavity that allows angled dose rate measurements beyond the payload cavity, including measuring for the presence of axial gaps in the sidewall lead. Figure 5, Figure 6, and Figure 7 for the SC-30G2, SC-30G3, and SC-55G2, respectively, show the detector in its lowest and highest grid positions for detecting the presence of axial gaps at the ends of the sidewall lead column. The detector in the three figures is assumed to have a relatively standard, 2-inch diameter scintillator face.

b. Create MCNP models of the prototypic gamma scan test configurations for the SC-30G2, SC-30G3, and SC-55G2 designs with minimum material conditions, i.e., minimum steel shell and sidewall lead thicknesses, including the presence of a 1/2-inch axial gap at both ends of the sidewall lead column. The model will include a test base and lid, as described in the previous response; both are reusable for gamma scan testing all units of that size.

c. Run the three MCNP models for a unit source strength of ^{60}Co and ^{192}Ir (the two most commonly used radionuclides for gamma scan testing) for a straight-through-the-wall baseline case, then for the “slant-shot” grid rows below and above the payload cavity. For example, with reference to Figure 5 for the SC-30G2, the below and above grid locations are -1.5, -3.0, 31.5, and 33.0. An RCR adjustment factor can be applied to these slant-shot grid rows by calculating the ratio of the slant-shot unit dose rate with the straight-through unit dose rate for each grid row.

Section 8.1.5 of the HalfPACT Safety Analysis Report will be revised to summarize the above process for slant-shot gamma scan testing beyond the payload cavities for the SC-30G2, SC-30G3, and SC-55G2 containers.

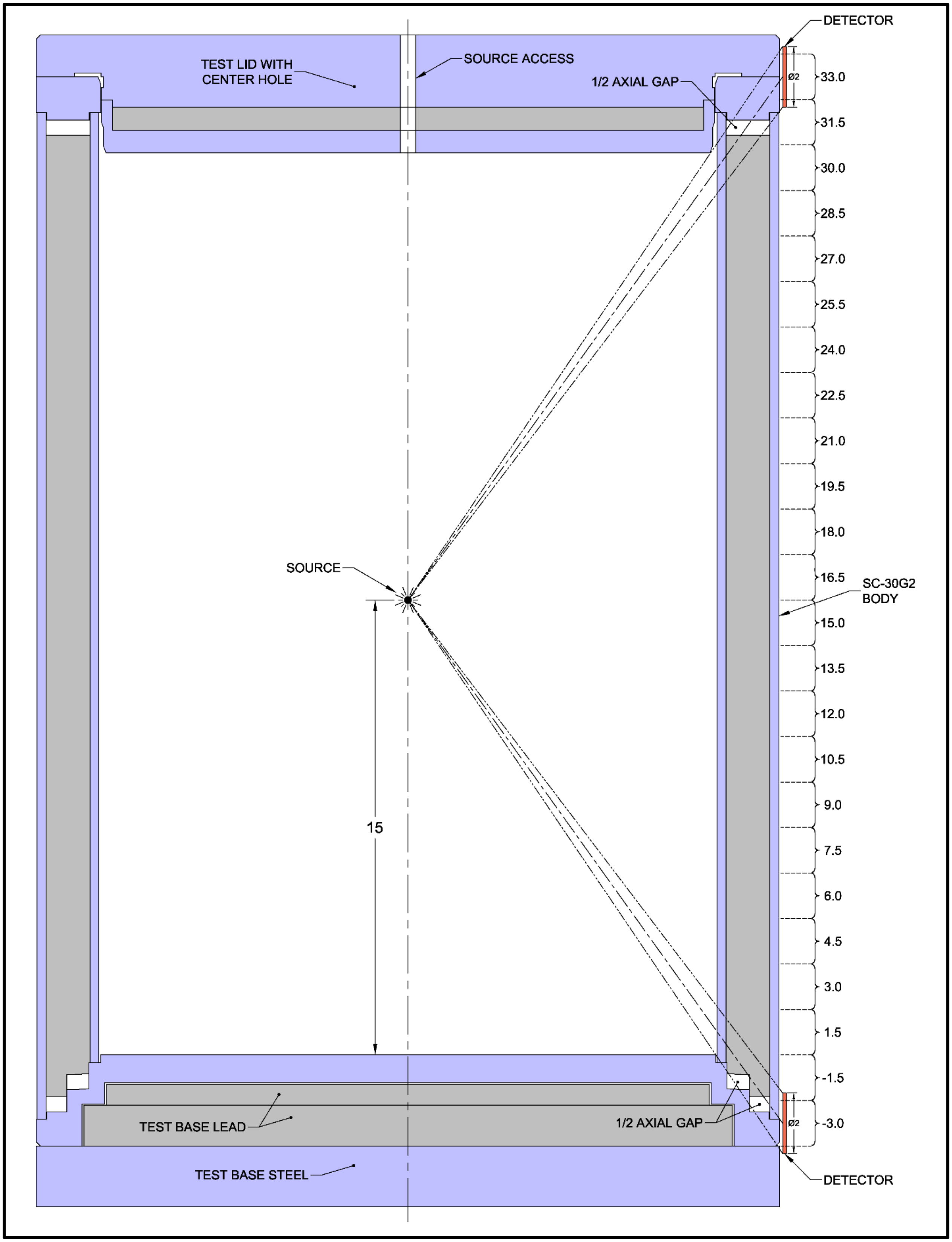

Figure 5 – SC-30G2 Gamma Scan Grid Layout Beyond the Payload Cavity

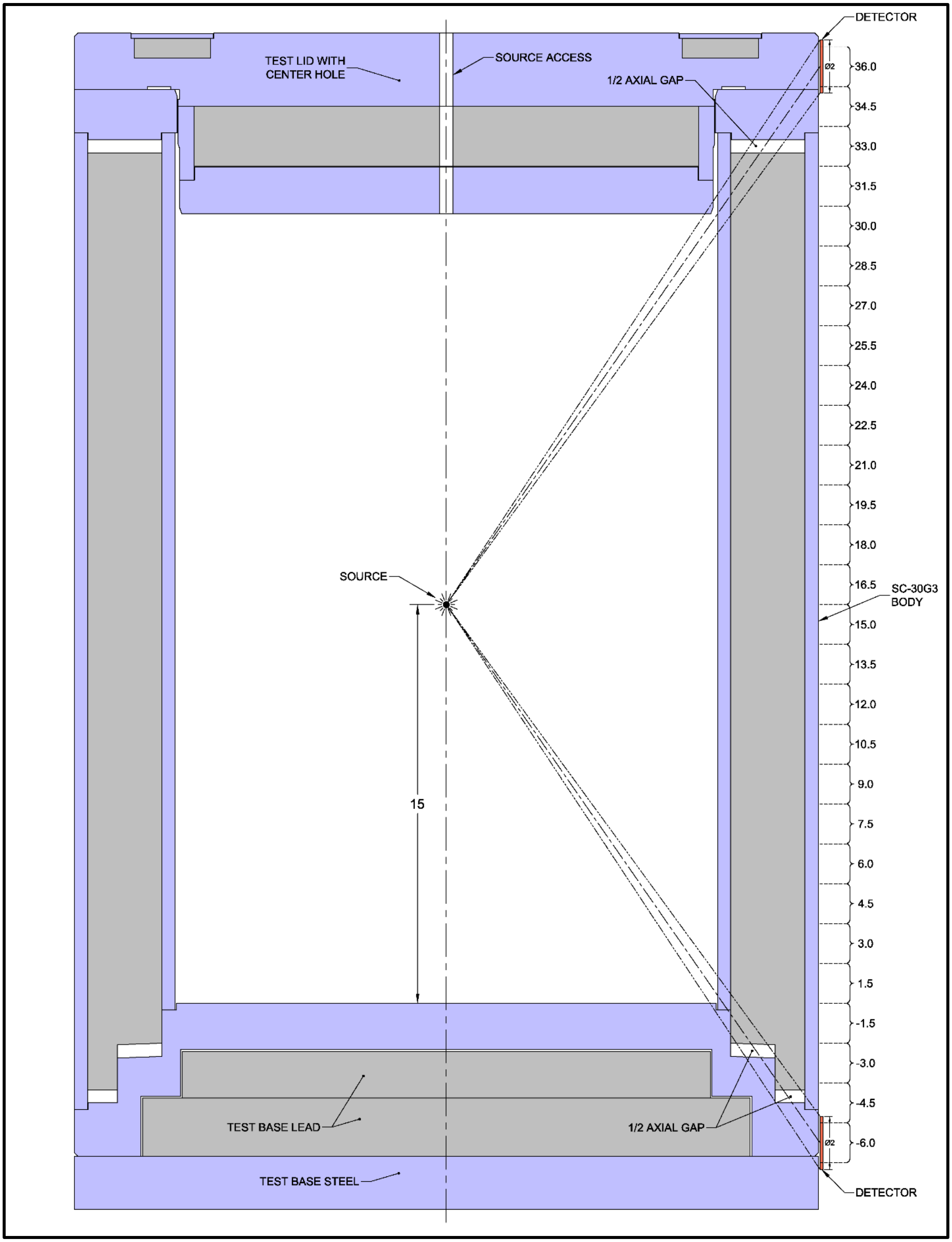

Figure 6 – SC-30G3 Gamma Scan Grid Layout Beyond the Payload Cavity

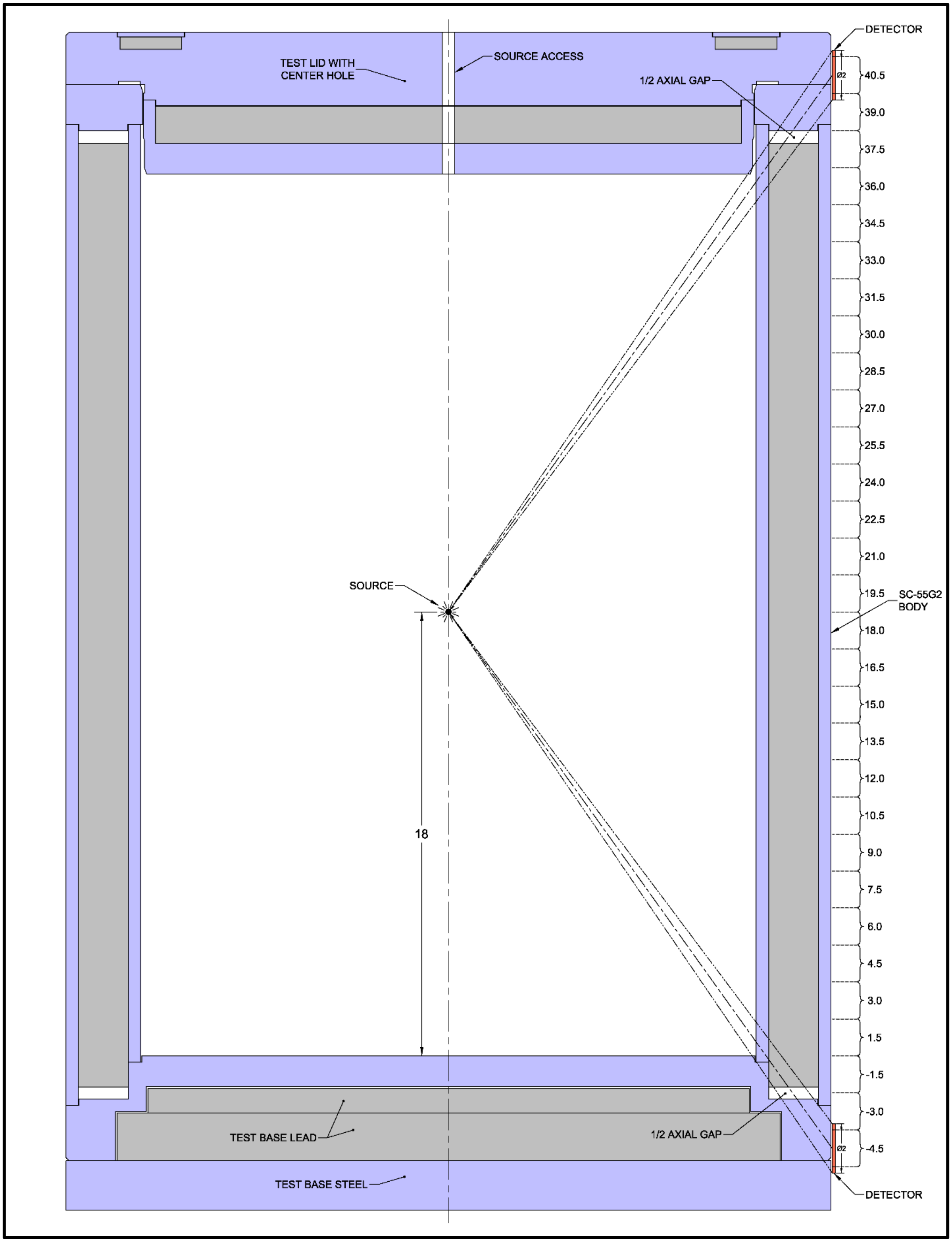

Figure 7 – SC-55G2 Gamma Scan Grid Layout Beyond the Payload Cavity

5. Provide the maximum amount of the proposed content that can be shipped a single shielded container and per shipment considering the applicable regulatory limits in 10 CFR Part 71. Also, provide the calculation as part of your response.

<u>Response</u>:

The maximum activity per shipment is provided in Section 5.5 of the TRUPACT-II Safety Analysis Report; the tables therein list activity limits based on a per package (payload) basis. More specifically, Section 5.5.10 of the TRUPACT-II Safety Analysis Report lists the applicable steps that are followed to ensure the shielded container payloads are in compliance with 10 CFR Part 71. Three examples of calculating the allowable activity are provided in Section 5.5.10.1 for various container types and concentrated/distributed sources (note the table references in Section 5.5.10.1 are incorrect and will be updated). The final step of Section 5.5.10 is to ensure that the combined sum of fractions for the gamma and the neutron source term is less than or equal to 0.90 for a package (with the exception of the SC-30G2, SC-30G3, and SC-55G2 containers where the combined sum of fractions for the gamma and the neutron source term is less than or equal to 0.89). As explained below, this sum of fractions of 0.90 (or 0.89, as appropriate) represents the maximum allowable activity for both a single container a well as the package. For a shipment, up to three packages meeting the activity limits specified in Section 5.5 are allowed on a trailer.

One SC-30G3 can be shipped in a HalfPACT package; therefore, the activity limit for the package/container is determined using Tables 5.5-18 and 5.5-19 for gamma and neutron wastes, respectively, where the combined sum of fractions for the gamma and the neutron source term is less than or equal to 0.89.

Similarly, one SC-55G2 can be shipped in a HalfPACT package; therefore, the activity limit for the package/container is determined using Tables 5.5-22 and 5.5-23 for gamma and neutron wastes, respectively, where the combined sum of fractions for the gamma and the neutron source term is less than or equal to 0.89.

For the SC-30G2, where there are two containers per HalfPACT, the theoretical maximum activity limit for a shielded container is equal to the package activity limit, assuming one of the shielded containers in the HalfPACT package is empty. In reality, containers certified for shipment would never approach these limits due to other limiting factors, mainly the CH-TRAMPAC payload container surface dose rate requirement not exceeding 200 mrem/hr. The activity limit for the package/container is determined using Tables 5.5-16 and 5.5-17 for gamma and neutron wastes, respectively, where the combined sum of fractions for the gamma and the neutron source term is less than or equal to 0.89.

Finally, for the SC-55G1, where there are two containers per HalfPACT, the theoretical maximum activity limit for a shielded container is again equal to the package activity limit, assuming one of the shielded containers in the HalfPACT package is empty. As previously stated, containers certified for shipment would never approach these limits due to other limiting factors, mainly the CH-TRAMPAC payload container surface dose rate requirement not exceeding 200 mrem/hr. The activity limit for the package/container is determined using Tables 5.5-20 and 5.5-21 for gamma and neutron wastes, respectively, where the combined sum of fractions for the gamma and the neutron source term is less than or equal to 0.90.

As an example calculation, assume a HalfPACT package payload consists of an SC-30G3 containing waste debris contaminated with 0.01 Ci of ^{252}Cf and a 1.0-cm diameter by 1.5-cm long metal capsule containing 20 Ci of ^{60}Co. Following the 10-step process delineated in Section 5.5.10 yields the following results:

1. The neutron radionuclide is ^{252}Cf with a total activity of 0.005 Ci, and the gamma radionuclide is ^{60}Co with a total activity of 20 Ci.
2. The neutron debris is distributed, but will be treated as concentrated to avoid having to show it meets the requirement of Case B. The gamma source is concentrated.
3. N/A; not a distributed gamma source, so source density is not applicable.
4. See Table 1 for a list of all discrete gamma energies and intensities.
5. See Table 1; the gamma source strength (γ/s) is determined as the product of the source activity (Ci), Intensity (%), and conversion factor (3.7E+10 γ/s/Ci). Thus, for the 1.173237 MeV gamma energy, the source strength is (20 Ci) × (9.9974E+01% / 100) × (3.7E+10 γ/s/Ci) = 7.3981E+11 γ/s.
6. See Table 1; the allowable fraction is the ratio of the source strength to the allowable activity for each discrete gamma energy. The source strength is log-log interpolated from the allowable activities found in Table 5.5-18 for a concentrated gamma source. Thus, for the 1.173237 MeV gamma energy, the log-log interpolated allowable activity is 3.2487E+12 γ/s, and the corresponding allowable fraction is (7.3981E+11 γ/s) / (3.2487E+12 γ/s) = 2.28E-01.
7. See Table 1; the neutron source spectrum for ^{252}Cf is found in Section 5.2.2.
8. See Table 1; the neutron source strength (n/s) is determined as the product of the source activity (Ci) and source strength (n/s/g) divided by the specific activity for ^{252}Cf (536 Ci/g). Thus, for the 0.5 MeV neutron energy, the source strength is (0.01 Ci) × (1.8000E+11 n/s/g) / (536 Ci/g) = 3.3582E+06 n/s.
9. See Table 1; the allowable fraction is the ratio of the source strength to the allowable activity for each discrete neutron energy. The source strength is log-log interpolated from the allowable activities found in Table 5.5-19 for a concentrated neutron source. Thus, for the 0.5 MeV neutron energy, the log-log interpolated allowable activity is 3.7900E+08 n/s, and the corresponding allowable fraction is (3.3582E+06 n/s) / (3.7900E+08 n/s) = 8.86E-03.
10. See Table 1; the combined sum of the sum of fractions for the gamma and neutron source terms, 0.854, is less than or equal to 0.89; thus, the HalfPACT package is authorized for transport.

Table 1 – Acceptable Activity Example for an SC-30G3 with ^{252}Cf and ^{60}Co

Gamma Energy (MeV)	Intensity (%)	Source Strength (γ/s)	Allowable Activity (γ/s)	Allowable Fraction	Comment
0.0434	1.4800E-02	0.0000E+00	0.0000E+00	0.00E+00	^{252}Cf; ignored: Energy < 0.15 MeV
0.1002	1.3000E-02	0.0000E+00	0.0000E+00	0.00E+00	^{252}Cf; ignored: Energy < 0.15 MeV
0.1545	5.0400E-04	0.0000E+00	1.7011E+24	0.00E+00	^{252}Cf; ignored: Intensity < 0.1%
0.34693	7.6000E-03	0.0000E+00	7.0957E+17	0.00E+00	^{60}Co; ignored: Intensity < 0.1%
0.82628	7.6000E-03	0.0000E+00	3.7353E+13	0.00E+00	^{60}Co; ignored: Intensity < 0.1%
1.173237	9.9974E+01	7.3981E+11	3.2487E+12	2.28E-01	^{60}Co
1.332501	9.9986E+01	7.3990E+11	1.7274E+12	4.28E-01	^{60}Co
2.15877	1.1100E-03	0.0000E+00	3.8681E+11	0.00E+00	^{60}Co; ignored: Intensity < 0.1%
2.505	2.0000E-06	0.0000E+00	2.8477E+11	0.00E+00	^{60}Co; ignored: Intensity < 0.1%
Total Gamma				6.56E-01	DCF has no effect due to screening
Neutron Energy (MeV)	**Source Strength (n/s/g)**	**Source Strength (n/s)**	**Allowable Activity (n/s)**	**Allowable Fraction**	**Comment**
0.5	1.8000E+11	3.3582E+06	3.7900E+08	8.86E-03	^{252}Cf
1	2.7100E+11	5.0560E+06	2.5500E+08	1.98E-02	^{252}Cf
2	5.3600E+11	1.0000E+07	1.8600E+08	5.38E-02	^{252}Cf
3	4.1000E+11	7.6493E+06	1.7652E+08	4.33E-02	^{252}Cf
4	2.7300E+11	5.0933E+06	1.7735E+08	2.87E-02	^{252}Cf
6	2.6600E+11	4.9627E+06	1.7076E+08	2.91E-02	^{252}Cf
8	8.5300E+10	1.5914E+06	1.5993E+08	9.95E-03	^{252}Cf
10	2.4400E+10	4.5522E+05	1.5200E+08	2.99E-03	^{252}Cf
15	8.3600E+09	1.5597E+05	1.0900E+08	1.43E-03	^{252}Cf
Total Neutron				1.98E-01	DCF is not applicable to neutrons
Total Gamma & Neutron				8.54E-01	Authorized for Transport, F ≤ 0.89

6. During the phone call last week, the applicant mentioned that they performed a calculation assuming a 1/2 -in. gap of the lead shield. Using the 1/2 -in. gap of the lead shield, provide the allowable activity calculation using the applicable 10 CFR Part 71 dose\dose rate limit.

   Response:

   The evaluation for the effect of axial sidewall lead gaps of up to 1/2 inch is provided in Section 5.4.5 of the TRUPACT-II Safety Analysis Report and in calculation SCA-CAL-0005 (ADAMS Accession No. ML21279A188). Allowable activity calculations that account for the calculated dose rate increases from Section 5.4.5 are discussed in the above responses.

PLANNED PATH FORWARD:

Based on the questions/responses above, our expected path forward (pending concurrence) includes revising the documents to be resubmitted to address the following:

- TRUPACT-II SAR Section 5.5.10, Step 10, as noted above.
- HalfPACT SAR drawings 163-010, 163.011, and 163-013 to include discussion regarding potential gaps at the ends of the lead annulus as analyzed in SCA-CAL-0005.
- Section 8.1.5 of the HalfPACT SAR to include similar discussion of the gamma scan process for the SC-30G2, SC-30G3, and SC-55G2, as described above in the Question 4 response.