

**Engineering Analysis of
MRC-N-SS-W-AmBe Sealed Source
Special Form Equivalency**

**J. A. Tompkins
LANL/E/WM/OSR**

November, 1999

Los Alamos

NATIONAL LABORATORY

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Date: November 3, 1999
Refer to: OSRP:00-04

Leroy E. Leonard, PE
OSR Project Leader

Re: Special Form Character of MRC-N-SS-W-AmBe Sealed Sources

Problem:

The Monsanto Research Corporation (MRC) sealed source Model Number MRC-N-SS-W-AmBe is commonly encountered in Off-site Source Recovery Project actions. There is a lack of historical documentation to identify this model as DOT "Special Form", since these sealed sources predate any requirement for special form testing. The purpose of this memo is to compare relevant characteristics of the MRC-N-SS-W-AmBe sealed sources with the MRC 2720A series, for which Special Form documentation is available. Information for this comparison was obtained from the following sources:

- 1) A 1968 catalogue reference to MRC drawing: MRC-N-SS-W-AmBe
- 2) MRC request to US DOT for CoC on MRC Models 2720-A, B, and C series dated 10 December 1981
- 3) A telephone conversation with Edward Janzow, a former production line supervisor with MRC during the production of both model series.

Background:

The origin of the problem is rooted in the MRC decision to use a model number of the form MRC-N-SS-W-AmBe, which is very descriptive, but does not differentiate amongst the different capsule sizes and types. According to my telephone conversation with Ed Janzow (9/28/99), MRC recognized this problem and moved to convert all MRC-N-SS-W-AmBe capsule designs to the MRC 2720-A series. MRC then generated a new model number and drawing for each capsule design.

The characteristics compared for these sources were capsule dimensions, curie content, source material origins, capsule material, welding procedures, welder training, and welding equipment.

Analysis:

Model MRC-N-SS-W-AmBe and Model 2720-A series capsule dimensions were compared. Table 3 shows the results of the comparison as the net difference between the relevant capsules. This evaluation excludes MRC Models 2721-A and 2727-A, for which there is no equivalent series member in the MRC-N-SS-W-AmBe models. Tables 1 and 2 contain the relevant capsule dimensions for each source series. Table 3 contains the observed difference between dimensions reported in Tables 1 and 2. The first observation of Table 3 clearly suggests that the two series are effectively identical in physical dimensions. The first

measurable difference noted in Table 3 is the length of the inner capsule which is about 0.020 inches longer for all but one model of the MRC 2720-A series. The Model 2726-A inner capsule is 0.180 inches shorter than its MRC-N-SS-W-AmBe equivalent. This difference in the length of the inner capsule is not significant. The other difference is in the activity limits, which are higher for the MRC 2720-A series. The difference in maximum americium content of the two sets of capsules indicates that the MRC 2720-A capsules could be loaded with significantly higher amounts of Am-241, with the exception of the 2728-A capsule which was limited to 8.1 Ci.

According to Edward Jansow, former production line supervisor at MRC, the source of activity for these AmBe sealed sources was the AEC (later ERDA & DOE). Mr. Jansow stated that the following characteristics did not change:

- 1) origins of the Am-241
- 2) characteristics of the beryllium metal
- 3) capsule material origins (304 SS)
- 4) welding procedures, welder training, and welding equipment

In fact, according to Mr. Jansow, the MRC-N-SS-W-AmBe source fabrication methodologies were used to establish the minimum weld thickness for the Model 2720-A series (0.024 inches).

The stress analysis of the MRC 2720-A series was conservative and well documented. Worst case analysis scenarios use the minimum capsule wall and head thickness, minimum internal volume, and no retention of gas in the solid phase. The weld design provides a minimum safety factor of at least 4. The maximum stress occurs in the seal weld joining capsule plug to body, which was analyzed using the minimum weld penetration area. The shear stress limited internal pressure (P_S) of the inner and outer source capsule weld area, in general, is the most limiting of the design analysis requirements. The only exception is the 2728-A capsule which is limited by the shear stress in the capsule head (P_H).

Summary:

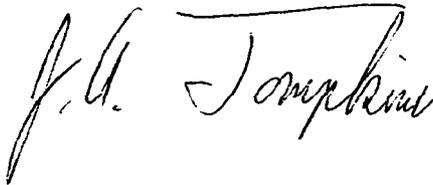
- 1) The MRC 2720-A series sources are very well documented with respect to the ANSI N5.10-1968 characterization methodology, Special Form testing (49 CFR173.469) methodology, and detailed engineering stress analysis. This "Special Form" testing documentation for Model 2720-A capsules is on file with the U.S. DOT and the OSR Project Office at LANL, TA-46, Building 234.
- 2) MRC 2720-A series capsule construction is effectively identical to the MRC-N-SS-W-AmBe construction, with the exception of the dimensions of the inner capsules. A 0.020-inch shorter inner capsule was used in most of the MRC-N-SS-W-AmBe capsules as compared to the 2720-A capsules, making the MRC-N-SS-W-AmBe sources slightly stiffer structurally, although not significantly so. One 2720-A series inner capsule (2726-A) was 0.180 inch shorter than its MRC-N-SS-W-AmBe counterpart, however, this difference is not structurally significant.
- 3) The americium loading in the 2720-A series capsules is higher than in the MRC-N-SS-W-AmBe capsules with the exception of the 2728-A, which limited the curie content to 8.1 Ci. The corresponding MRC-N-SS-W-AmBe capsule was loaded to a maximum of 50 Ci.

Significant Observations:

- 1) The difference in inner capsule length is not a significant factor in evaluating either the ANSI or the Special Form equivalency, as this difference would not significantly change the mechanical strength of the MRC-N-SS-W-AmBe source capsules weld penetration or the plug thickness, which is the controlling limitation.
- 2) MRC-N-SS-W-AmBe capsules loaded with more activity than the corresponding 2720-A series capsules are not documented in terms of Special Form equivalency.
- 3) All MRC-N-SS-W-AmBe capsules, except the 1.5-inch OD capsules (2728-A) containing more than 8.1 Ci Am-241, will be treated as Special Form. Those MR-N-SS-W-AmBe capsules 1.5 inch in OD, containing more the 8.1 Ci Am-241, will be treated as normal form material for purposes of the US DOT.

Therefore, from this review we conclude that within the limitations specified in item (3) above, MRC-N-SS-W-AmBe source capsules are equivalent to special form capsules specified for the MRC 2720-A series capsules.

J.A. Tompkins, CHP
OSR Project Engineer



Attachment: As Stated

Cy: OSRP File

Table 1. MRC-N-SS-W-AmBe Capsule Dimensions

| Activity Max. (Ci) | Inner ID (in) | Inner OD (in) | Inner wall thick (in) | Inner lgth (in) | Outer ID (in) | Outer OD (in) | Outer wall thick (in) | Outer lgth (in) |
|-----------------------|------------------|------------------|--------------------------|--------------------|------------------|------------------|--------------------------|--------------------|
| 0.2 | 0.312 | 0.402 | 0.045 | 0.48 | 0.407 | 0.50 | 0.047 | 0.70 |
| 1.0 | 0.562 | 0.652 | 0.045 | 0.65 | 0.657 | 0.75 | 0.047 | 0.87 |
| 3 | 0.812 | 0.902 | 0.045 | 0.9 | 0.907 | 1.00 | 0.047 | 1.12 |
| 6 | 0.812 | 0.902 | 0.045 | 1.28 | 0.907 | 1.00 | 0.047 | 1.50 |
| 10 | 0.812 | 0.902 | 0.045 | 1.78 | 0.907 | 1.00 | 0.047 | 2.00 |
| 50 | 1.25 | 1.37 | 0.060 | 3.28 | 1.375 | 1.50 | 0.063 | 3.50 |

Table 2. MRC 2720 A Series Capsule Dimensions

| Model | Activity* Max. (Ci) | Inner ID (in) | Inner OD (in) | Inner wall thick (in) | Inner lgth (in) | Outer ID (in) | Outer OD (in) | Outer wall thick (in) | Outer lgth (in) |
|--------|------------------------|------------------|------------------|--------------------------|--------------------|------------------|------------------|--------------------------|--------------------|
| 2722 A | 1.0 | 0.312 | 0.402 | 0.045 | 0.500 | 0.407 | 0.500 | 0.047 | 0.700 |
| 2723 A | 3.0 | 0.562 | 0.652 | 0.045 | 0.670 | 0.657 | 0.750 | 0.047 | 0.870 |
| 2724 A | 5.0 | 0.812 | 0.902 | 0.045 | 0.920 | 0.907 | 1.000 | 0.047 | 1.120 |
| 2725 A | 8.5 | 0.812 | 0.902 | 0.045 | 1.300 | 0.907 | 1.000 | 0.047 | 1.500 |
| 2726 A | 12.0 | 0.812 | 0.902 | 0.045 | 1.600 | 0.907 | 1.000 | 0.047 | 2.000 |
| 2728 A | 8.1 | 1.250 | 1.370 | 0.060 | 3.300 | 1.375 | 1.500 | 0.063 | 3.500 |

* Depends on packing factor (pf), which is the fraction of the theoretical density achieved by compression of the source material in the source shell. Maximum activity is allowed for pf of 0.5.

Source is of the tube and plug design. Minimum weld thicknesses are 0.024" (2722-A - 2726-A) & 0.033" (2728-A).

Material 304 SS. Earliest drawings 9/5/69. Last Drawing Revision in set 8-28-75.

Table 3. Net Dimensional Difference, Models MRC 2720-A minus Models MRC-N-SS-W-AmBe

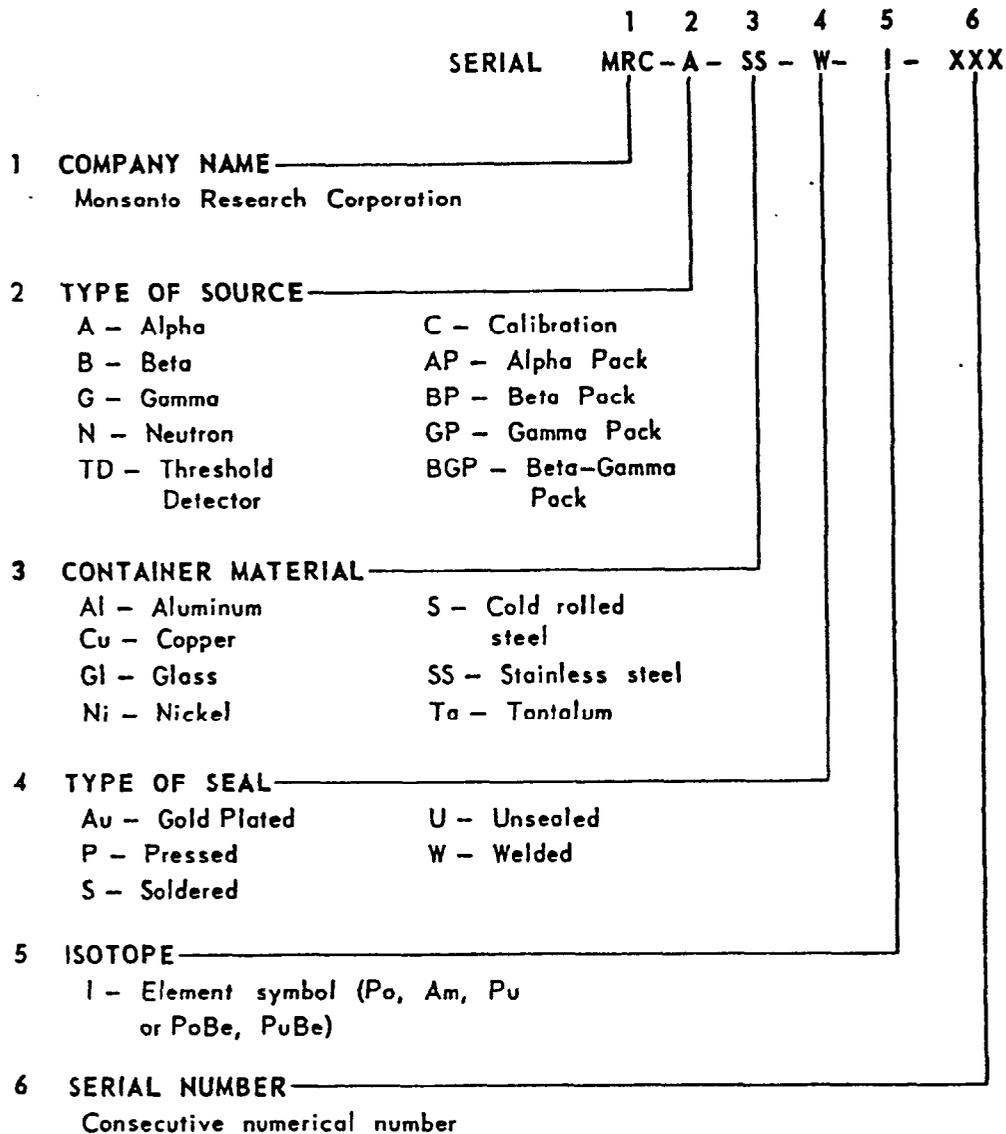
| Model | Activity* Max. (Ci) | Inner ID (in) | Inner OD (in) | Inner wall thick (in) | Inner lgth (in) | Outer ID (in) | Outer OD (in) | Outer wall thick (in) | Outer lgth (in) |
|--------|------------------------|------------------|------------------|--------------------------|--------------------|------------------|------------------|--------------------------|--------------------|
| 2722 A | 0.8 | 0.000 | 0.000 | 0.000 | 0.020 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2723 A | 2.0 | 0.000 | 0.000 | 0.000 | 0.020 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2724 A | 2.0 | 0.000 | 0.000 | 0.000 | 0.020 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2725 A | 2.5 | 0.000 | 0.000 | 0.000 | 0.020 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2726 A | 2.0 | 0.000 | 0.000 | 0.000 | -0.180 | 0.000 | 0.000 | 0.000 | 0.000 |
| 2728 A | -41.9 | 0.000 | 0.000 | 0.000 | 0.020 | 0.000 | 0.000 | 0.000 | 0.000 |

* Model 2720-A series capsules are 0.020 inches longer in the inner capsule than MRC-N-SS-W-AmBe capsules, with the exception of the Model 2726-A, which is 0.180 inches shorter.

* Americium activities in the 2720-A series capsule are 0.8 to 2.0 Ci greater with the exception of the 2728-A, which is rated at 8.1 Ci as opposed to the largest of the MRC-N-SS-W-AmBe capsules which was rated at 10 to 50 Ci.

MONSANTO RESEARCH CORPORATION MODEL AND SERIAL NUMBERS

All MRC sources are numbered to identify the company, type of source, container material, type of seal, contained isotope, and serial number. MRC's identification numbers are made up of six characters:

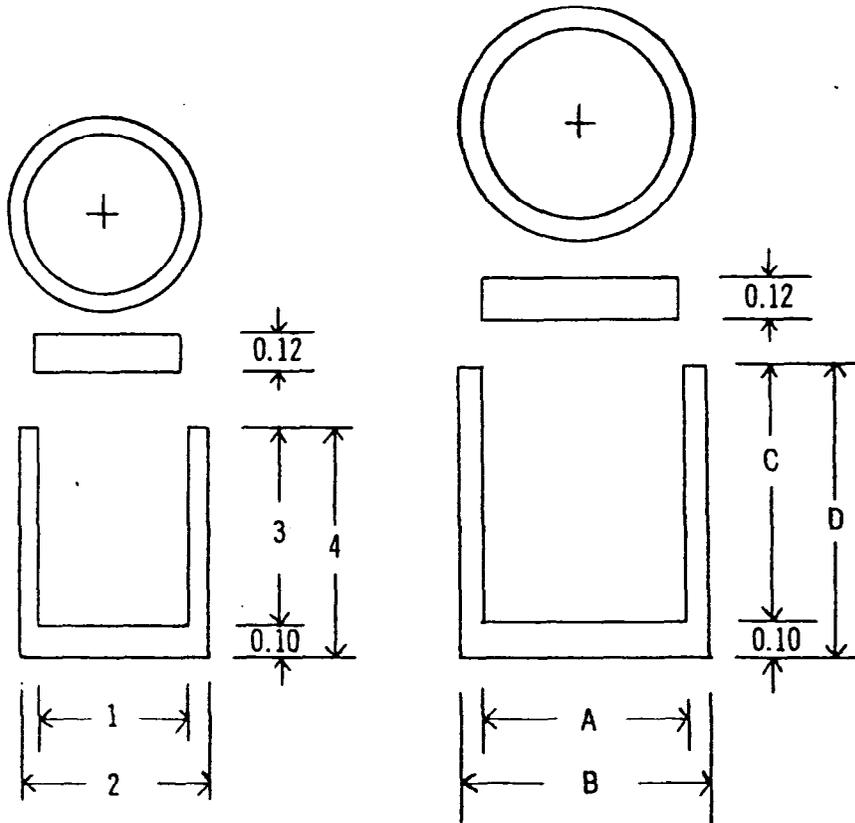


EXAMPLE: MRC-N-SS-W-AmBe-401 designates a Monsanto Research Corporation neutron source, encapsulated in stainless steel, welded, with an americium-beryllium matrix, serial number 401.

- NOTES: 1. Make all closures by inert gas welding
 2. Solid bottoms may be replaced by welded plugs
 3. Ni, Ta, Steel may be substituted
 4. Add 0.20 to length of outer containers if thread is desired
 5. Leak test by pressurizing to 100 psi in helium and immersing in liquid.
 6. All steel, Ni and Ta containers withstand 10,000 psi.
 7. Lengths and diameters may be altered without changing other specifications

INNER CONTAINER

OUTER CONTAINER



| CURIE RANGE | DIMENSIONS | | | | | | | |
|-------------|------------|-------|------|------|-------|------|------|------|
| | PART NO. | | | | | | | |
| | 1 | 2 | 3 | 4 | A | B | C | D |
| 0-0.2 | 0.312 | 0.402 | 0.38 | 0.48 | 0.407 | 0.50 | 0.60 | 0.70 |
| 0.2-1.0 | 0.562 | 0.652 | 0.55 | 0.65 | 0.657 | 0.75 | 0.77 | 0.87 |
| 1-3 | 0.812 | 0.902 | 0.78 | 0.90 | 0.907 | 1.00 | 1.02 | 1.12 |
| 3-6 | 0.812 | 0.902 | 1.18 | 1.28 | 0.907 | 1.00 | 1.40 | 1.50 |
| 6-10 | 0.812 | 0.902 | 1.68 | 1.78 | 0.907 | 1.00 | 1.90 | 2.00 |
| 10-50 | 1.25 | 1.37 | 3.18 | 3.28 | 1.375 | 1.50 | 3.40 | 3.50 |

MATERIAL - 304 STAINLESS STEEL
 OTHER METALS ON REQUEST

Am Be
 SOURCE CONTAINER
 MODEL MRC-N-SS-W-Am Be

Monsanto

ENGINEERED PRODUCTS

MONSANTO RESEARCH CORPORATION

Dayton Laboratory
1515 Nicholas Road
P. O. Box 8, Station B
Dayton, Ohio 45407
Phones: (513) 268-6769
(513) 268-3411
Telegraph: TWX 810-459-1681

10 December 1981

Mr. Richard Rawl
U.S. Department of Transportation
Office of Hazardous Materials
Washington, D. C. 20590

Dear Mr. Rawl:

Monsanto Research Corporation requests that IAEA Certificate of Competent Authority, Special Form Radioactive Material Encapsulation Certificate Number USA/0043/S (Revision 2) be amended to include the information provided with this letter.

This revision includes a "C" series to be added to our present "A" and "B" series of the MRC 2720 standard neutron sources.

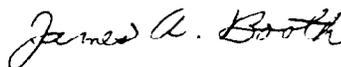
This complete revision is a result of our on-going program to review source models and up date them when appropriate.

The capsules are intended for general neutron source applications.

The maximum isotope content and the minimum Quality control inspections are listed in the accompanying Sealed Sources Containing By-Product Material, MRC Model 2720 Series Neutron Sources.

Should you require additional information or if we can offer further assistance, please contact us immediately.

Sincerely,



James A. Booth
Manager
Engineering Design and Development

JAB:bo

Enclosures: see attached sheet

Changes To MRC Model 2720 Series Neutron Sources

| <u>Page Number</u> | <u>Change</u> |
|--------------------|---|
| 1 | Added Model 2729-C |
| 4 | Added Model 2729-C and related information |
| 11 | Added information on Model 2729-C |
| 12 | Added "/in ² " previously omitted |
| 13 | Added "/in ² " previously omitted Added information on Model 2729-C |
| 20 | Added "(atm)" previously omitted in section 5.3 |
| 44 | Revised calculations of Model 2726-A to reflect ".027" minimum weld penetration |
| 48 | Corrected analysis and reduced maximum curie content from 6 curie to 5.45 curies. |
| 52 | Corrected analysis of outer capsule and reduced maximum curies from 10 curies to 8.1 curies. |
| 62 | Corrected $(t_w)_s$ and $(t_b)_s$. |
| 66 | Corrected (I.L.) p. from .542 to .541. |
| 70 | Corrected $(t_h)_s$, $(t_b)_s$, and (I.L.)p. |
| 72 | Revised maximum curies from 10 curies to 9.4 curies for .5 packing fraction. |
| 74 | Corrected (I.D.)s from .812 to .817 |
| 78 | Corrected $(t_w)_s$ from .005 to .055. |
| 87 | Changed O.L. from .495 to .500. Added tolerance on t_b . |
| 95 | Changed $(t_b)_s$ from .085 to .095. |
| 96 | Revised P_H (BOT) from .03317 to .04144. |
| 102 | Changed (I.L.)p from .900 to .825. |
| 104 | Revised maximum curie loadings. |
| 106 | Changed (I.L.)p from 1.39 to 1.325 |
| 107 | Revised maximum curie content. |

SEALED SOURCES CONTAINING BY-PRODUCT MATERIAL
MRC Model 2720 Series Neutron Sources

A. Identification

The Model 2720 series consists of 8 sources in each of three classes. Each source, and variations, can be identified by a drawing consistent with the enclosed "Identification Key & Cross-Index (MRC Dwg. No. 2720-AA00). The basic capsules in each class are designated and tabulated below:

| <u>2720-A Class</u> | <u>2720-B Class</u> | <u>2720-C Class</u> | |
|---------------------|---------------------|---------------------|---|
| 2721-A | 2721-B | 2721-C | ← |
| 2722-A | 2722-B | 2722-C | ← |
| 2723-A | 2723-B | 2723-C | ← |
| 2724-A | 2724-B | 2724-C | ← |
| 2725-A | 2725-B | 2725-C | ← |
| 2726-A | 2726-B | 2726-C | ← |
| 2727-A | 2727-B | 2727-C | ← |
| 2728-A | 2728-B | 2728-C | ← |

Besides the basic capsules in the B and C classes there may be several variations to each model. Various provisions may be made to facilitate handling, including threaded holes or studs along with increased length to accommodate the handling feature without change to the basic capsule integrity. The drawing, MRC A2720-AA00, indicates how the capsule variations may be identified.

B. Proposed Use

General Neutron Source Applications

- C. Isotope: Americium-241 or Plutonium-238
 Chemical Form of Isotope: Oxide
 Physical Form of Isotope: Powder

Denotes Drawing Size
 Denotes Engineered Products Dwg.
 Denotes Standard Capsule
 Denotes Source Series
 Basic Dimensions Code

B 2 7 2 3 - A D 0 0

Denotes thread size on AB to AE and BB to BE dwgs. [00 implies 1/4-20 x 1/4"
 other than 00 implies non-
 1/4-20 threads]
 Denotes modification number, AX & BX series only

A implies no threaded holes or studs, basic dimensions
 B implies threaded hole one end, .250 length increase over basic dimensions
 C implies threaded holes both ends, .500 length increase over basic dimensions
 D implies threaded stud, 1/4" long, one end
 E implies threaded stud, 1/4" long, each end
 X implies modifications other than threaded holes & studs

A implies tube & plug type construction, (original version of source)
 B implies improved version having machined - in bottom (model - B)
 C implies improved version having machined-in bottom (model - C)

| CROSS - INDEX | | | DRAWING NO. | | Date of Dwg. No. Change |
|---------------|----------------|-------------------------|-------------|------------|-------------------------|
| DRAWING NO. | | Date of Dwg. No. Change | Previous | Current | |
| Previous | Current | | A2766-AA00 | A2723-BX00 | |
| A2722-AA01 | A2722-BA00 | 4-16-74 | | | |
| A2723-AA01 | A2723-BA00 | 4-16-74 | | | |
| A2724-AA01 | A2724-BA00 | 4-16-74 | | | |
| A2725-AA01 | A2725-BB00 | 4-16-74 | | | |
| A2725-AA02 | A2725-BA00 | 4-16-74 | | | |
| A2727-AA01 | Obsolete, | 4-8-74 | | | |
| | Use A2727-BA00 | | | | |
| A2727-AA02 | A2727-BA00 | 4-16-74 | | | |
| A2727-AA03 | A2727-BX00 | 4-15-74 | | | |

△ 5-481 Added Model C
 △ 5-1-74 Added New Drawing

N.R. 2/29/74
N.R. 2/29/74

MONSIEUR RESEARCH CORPORATION

IDENTIFICATION KEY
 &
 CROSS-INDEX

N.R. 4-1974
238 4-1974
M.F. 4-19-74
ARKA 4-22-74

SCALE: DWG. NO. **A2720-AA00**

Target: The target for production of neutrons may be beryllium, lithium, boron or fluorine

Chemical Form of target:

Be: Metal

Li: Metal, hydroxide or hydride

B : Metal

F : Calcium Fluoride

Physical Form of target: powder

Method: A physical mixture of the isotope and target is compressed into the inner capsule and the end cap is welded into place.

MAXIMUM CURIE CONTENT

The following table lists the maximum content for each capsule in each class of the Model 2720 Series when they are loaded to each of the three maximum packing fractions. Other packing fractions may be used with corresponding changes in maximum curie content.

| <u>CAPSULE</u> | <u>MAXIMUM CURIE CONTENT WITH 0.5 P.F.</u> | <u>MAXIMUM CURIE CONTENT WITH 0.68 P.F.</u> | <u>MAXIMUM CURIE CONTENT WITH 0.8 P.F.</u> |
|----------------|--|---|--|
| 2721 A | 0.3 | 0.2 | 0.14 |
| 2722 A | 1. | 0.7 | 0.4 |
| 2723 A | 3. | 2. | 1.2 |
| 2724 A | 5. | 3.5 | 2. |
| 2725 A | 8.5 | 5.5 | 3.5 |
| 2726 A | 12. | 8.5 | 5. |
| 2727 A | 6. | not useable | not useable |
| 2728 A | 10. | not useable | not useable |
| 2721 B | 0.4 | 0.25 | 0.16 |
| 2722 B | 1.4 | .90 | 0.56 |
| 2723 B | 2.9 | 1.8 | 1.1 |
| 2724 B | 6. | 4. | 2.5 |
| 2725 B | 10. | 6.5 | 4. |
| 2726 B | 16. | 10. | 6. |
| 2727 B | 47. | 30. | 18. |
| 2728 B | 75. | 45. | 30. |

| <u>CAPSULE</u> | <u>MAXIMUM CURIE CONTENT WITH 0.5 P.F.</u> | <u>MAXIMUM CURIE CONTENT WITH 0.68 P.F.</u> | <u>MAXIMUM CURIE CONTENT WITH 0.8 P.F.</u> |
|----------------|--|---|--|
| 2721 C | 0.3 | 0.19 | 0.12 |
| 2722 C | 1.3 | 0.84 | 0.52 |
| 2723 C | 2.35 | 1.50 | 0.94 |
| 2724 C | 5.6 | 3.6 | 2.2 |
| 2725 C | 11.4 | 7.3 | 4.5 |
| 2726 C | 17.7 | 11.2 | 7.0 |
| 2727 C | 48.0 | 30.5 | 19.0 |
| 2728 C | 78 | 50 | 31 |

D. Construction

Model 2720 Series Neutron sources are doubly encapsulated in 304 stainless steel. A drawing of each source in each class is enclosed. The drawings are consistent with the identification key mentioned in Section A above. Closure welds are made by Tungsten-Inert-Gas (TIG) welding.

J E. Prototype Tests

Integrity of the Model 2720 Series Neutron sources was established by prototype testing and engineering design analysis. Three capsules (2722-A, 2724-A and 2728A) were selected for prototype testing to qualify the entire Model 2720 Series. The qualification testing was then supplemented by a rigorous engineering design analysis to confirm that all the sources meet "special form" criteria.

All three passed ANSI testing procedures required for classification of 64525. This classification greatly exceeds the 22222 classification which are the performance requirements for typical use of general neutron sources stated by ANSI N5.10-1968. Appendix A contains the description and results of the ANSI prototype testing and "special form" design analysis.

Design analysis calculations assumes that each source capsule (and each variation) meets "special form" criteria at the end of 10 years after continuous operation at an assumed temperature of 400°F during this period. The calculations (Appendix B), show that each source meets "special form" criteria. The calculations also indicate consistent conservative design which supplements the prototype testing to qualify the Class A capsules of the Model 2720 series. The design analysis of the Class B series shows that this class has an even higher integrity than the Class A capsules.

F. QUALITY CONTROL

All hardware is examined for dimensional fit and finish. Completed inner and outer capsules are helium bubble tested to USASI procedures in N5.10-1968, appendix B2.9 or to the more current ANSI procedure in N542-1977, appendix A2.2.3. In addition, a wipe (smear) test is applied to determine external contamination per the USASI procedure in N5.10-1968, appendix B2.1 except that the wipe is not moistened with a solvent or per the more current ANSI procedure in N542-1977, appendix A2.1.2. Sources with less than 10 counts per minute are shipped to the customer.

G. LABELING

Each neutron source of the Model 2720 series is marked with a unique serial number. If there is space enough, it is also marked with the warning "CAUTION RADIOACTIVE MATERIAL". The label information is permanently affixed to the source by etching, engraving, stamping or other permanent means.

Classification

Monsanto Model Numbers 2722, 2724 and 2728 meet the criteria for External Pressure Test 4 which consists of exposing the dummy source to a vacuum (3.4 psia) for 15 minutes, repeated four times and a pressure of a 1000 psia for 15 minutes, repeated four times.

c. Impact Test 5

Model No. 2722, 2724 and 2728 dummy sources were tested to impact class 5 as specified in section 8.4.1 thru 8.4.3 and evaluated by leak test methods B2.6 and B2.9. After the dummy sources passed B2.9, the test was re-run at a pressure of 300 psi with the time increased to 30 minutes.

Results

One or more of each of the models 2722, 2724 and 2728 were tested. All dummy sources were distorted but the hermetic seal remained intact.

Classification

Monsanto Model Number 2722, 2724 and 2728 meet the criteria for Impact Test 5 which consists of dropping a 20 lb. weight from 10 ft. onto the dummy source.

d. Vibration Test 2

This test was performed by Bowser-Morner Testing Laboratories, Inc. of Dayton, Ohio. This outside testing is covered by Bowser-Morner Report No. 739204 and Report No. 733085 where two each of models 2722, 2724 and 2728 dummy sources were tested. Bowser-Morner reported no dummy source failures.

APPENDIX A

1. References

- a. "Classification of Sealed Radioactive Sources" by United States of America Standards Institute Inc. as approved 22 April 1968.
- b. Monsanto Research Corporation source container, Drawings B2722-AA00, B2724-AA00 and B2728-AA00.*

2. ANSI (USASI) Test Results

| <u>Type of Source Container</u> | <u>Model No.</u> | <u>Drawing No.</u> |
|---------------------------------|------------------|--------------------|
| Neutron | MRC 2722 | B2722-AA00 |
| Neutron | MRC 2724 | B2724-AA00 |
| Neutron | MRC 2728* | B2728-AA00* |

All dummy sources newly manufactured for this testing program were complete except that the target quantity was increased to simulate actual isotope and target quantity. A new dummy source was used for each test. Target material in all dummy sources tested was beryllium.

Tests referred to in this appendix, except vibration tests, were performed and witnessed by Monsanto Research Corporation personnel. Bowser-Morner Testing Laboratories, Inc., Dayton, Ohio, performed the vibration tests; results are reported in Report No. 739204 and Report No. 733085. Test reports are kept on file at Monsanto Research Corporation.

* Model 2728 is the present description of the 1.50" O.D. X 3.50" long capsule which prior to 9/25/70 was the model 2727. The present model 2727 is 1.50" O.D. X 2.50" long.

a. Temperature Test 6

Model No. 2722, 2724 and 2728 dummy sources were tested to temperature class 6 as specified in section 8.2.1 thru 8.2.3 and evaluated by leak test methods B2.6 and B2.9. After the dummy sources passed B2.9, the test was re-run at a 1000 psi with a pressurization time of 30 minutes.

Results

Two each of the models 2722, 2724 and 2728 were tested and all dummy sources submitted passed this test.

Classification

Monsanto Model Numbers 2722, 2724 and 2728 meet the criteria for Temperature Test 6 which consists of holding the dummy source at -57°C and 1010°C for one hour each and then returning to ambient conditions in the test chamber; thermal shocking from 1010°C to 15°C in water.

b. External Pressure Test 4

Model No. 2722, 2724 and 2728 dummy sources were tested to external pressure class 4 as specified in section 8.3.1 thru 8.3.2. Evaluation was by visual inspection and as specified in section B2.6 and B2.9 for the 2722 and 2724 dummy sources and section B2.5 and B2.9 for the 2728 dummy source.

Results

One of more of each of models 2722, 2724 and 2728 were tested and all dummy sources passed this test.

Classification

Monsanto Model Numbers 2722, 2724 and 2728 meet the criteria for Vibration Test 2, which consists of vibration for 30 minutes, 25-500 cycles/sec. at 5G peak amplitude.

e. Puncture Test 5

Model No. 2722, 2724 and 2728 dummy sources were tested to puncture class 5 as specified in section 8.6.1 thru 8.6.2 and evaluated as specified in section B2.6 and B2.9. After the dummy sources passed B2.9 at 100 psi, they were further tested by increasing B2.9 pressure to 1000 psi and the pressurization time increased to 30 minutes.

Results

Two dummy sources each of Model No. 2722, 2724 and 2728 were submitted to this test and evaluation. All dummy sources passed this test.

Classification

Monsanto Model Numbers 2722, 2724 and 2728 meet the criteria for Puncture Test 5 which consists of dropping the source 15 feet onto a 1/8" diameter pin, or alternately, of positioning the source on a 1/8" diameter pin and dropping a weight (between 1 and 4 times the weight of the source) onto the source from 15 feet.

3. Special Form Criteria

As stated in section E of this document, since the models in the 2720 source series meet ANSI classification 64525 they will meet "special form" criteria. The discussion of this is as follows:

a. Free Drop

A free drop thru a distance of 30 feet onto a flat essentially unyielding horizontal surface, striking the surface in such a position as to suffer maximum damage.

The weight of a neutron source is the summation of the weights of the outer capsule, inner capsule and the isotope - target mixture.

The weights of the outer and inner capsules can be calculated with the following general formula:

$$W = \left[\frac{\pi}{4}(d_0^2 - d_i^2)\ell + \frac{\pi}{4}(d_i^2)(t + b) \right] \rho$$

Where d_0 and d_i are the outside and inside diameters, respectively, ℓ is the length, t is the thickness of the end plug, b is the thickness of the bottom and ρ is the density of 304 stainless steel.

The weight of the isotope/target mixture can be calculated with the following formula:

$$W = V_{IT}\rho$$

Where V_{IT} , in keeping with the "worst case policy, is 80% of the internal volume of the inner capsule and ρ is the density of beryllium.

Thus,

| | | | |
|----------------------|-----------------------|-----------------------|---|
| W(2721-A) = .027 lbs | W(2721-B) = .027 lbs | W(2721-C) = 0.029 lbs | + |
| W(2722-A) = .035 lbs | W(2722-B) = .035 lbs | W(2722-C) = 0.035 lbs | + |
| W(2723-A) = .085 lbs | W(2723-B) = .090 lbs | W(2723-C) = 0.089 lbs | + |
| W(2724-A) = .169 lbs | W(2724-B) = .179 lbs | W(2724-C) = 0.183 lbs | + |
| W(2725-A) = .210 lbs | W(2725-B) = .222 lbs | W(2725-C) = 0.228 lbs | + |
| W(2726-A) = .259 lbs | W(2726-B) = .277 lbs | W(2726-C) = 0.281 lbs | + |
| W(2727-A) = .628 lbs | W(2727-B) = .784 lbs | W(2727-C) = 0.782 lbs | + |
| W(2728-A) = .831 lbs | W(2728-B) = 1.052 lbs | W(2728-C) = 1.014 lbs | + |

The energy to be absorbed by the source due to a 30 foot drop can be calculated by the following formula:

$$E = DW$$

Where D is the distance of 30 feet and W is the weight of the source.

Thus,

| | | |
|--------------------------|--------------------------|--------------------------|
| E(2721-A) = 0.80 ft-lbs | E(2721-B) = 0.80 ft-lbs | E(2721-C) = 0.87 ft-lbs |
| E(2722-A) = 1.04 ft-lbs | E(2722-B) = 1.04 ft-lbs | E(2722-C) = 1.05 ft-lbs |
| E(2723-A) = 2.55 ft-lbs | E(2723-B) = 2.69 ft-lbs | E(2723-C) = 2.67 ft-lbs |
| E(2724-A) = 5.07 ft-lbs | E(2724-B) = 5.39 ft-lbs | E(2724-C) = 5.48 ft-lbs |
| E(2725-A) = 6.31 ft-lbs | E(2725-B) = 6.65 ft-lbs | E(2725-C) = 6.80 ft-lbs |
| E(2726-A) = 7.78 ft-lbs | E(2726-B) = 8.30 ft-lbs | E(2726-C) = 8.44 ft-lbs |
| E(2727-A) = 18.85 ft-lbs | E(2727-B) = 23.52 ft-lbs | E(2727-C) = 23.46 ft-lbs |
| E(2728-A) = 24.94 ft-lbs | E(2728-B) = 31.57 ft-lbs | E(2728-C) = 30.43 ft-lbs |

The models in the 2720 source series are ANSI classified Impact Class 5, which requires a 20 lb weight to be dropped on a dummy source from a height of 10 feet. The energy absorbed by the dummy source during the ANSI test is:

$$E = 10 \text{ ft} \times 20 \text{ lbs} = 200 \text{ ft-lbs}$$

Thus, it may safely be stated that the models in the 2720 source series pass the Special Form Free Drop Test.

b. Percussion

Impact of the flat circular end of a one inch diameter steel rod weighing 3 lbs thru a distance of 40 inches.

The energy per unit area to be imparted onto the source in the Percussion Test is:

for a cylindrical source, portion is cut off, not on side no. but impact is more severe

$$E/A = \frac{(40"/12"/ft)(3 \text{ lbs})}{\frac{\pi}{4}(1")^2} = 12.7 \text{ ft-lbs/in}^2$$

The models in the 2720 source series are ANSI Classified Puncture Test 4 which requires that a dummy source be dropped thru 10 feet onto a 1/8 inch diameter pin. The resulting energy per unit area is:

$$E/A = \frac{DW}{\frac{\pi}{4}d^2}$$

Where D is the 10 foot distance, W is the weight of the source and d is the diameter of the pin.

Thus,

| ENERGY PER UNIT AREA | | | | ← |
|----------------------|-----------------------------|-----------------------------|-------------|---|
| MODEL DESIGNATION | | | | ← |
| <u>MODEL NUMBER</u> | <u>A</u> | <u>B</u> | <u>C</u> | ← |
| 2721 | 22.0 ft-lbs/in ² | 22.0 ft-lbs/in ² | 23.6 ft-lbs | ← |
| 2722 | 28.5 ft-lbs/in ² | 28.5 ft-lbs/in ² | 28.5 ft-lbs | ← |

ENERGY PER UNIT AREA

MODEL DESIGNATION (continued)

| <u>MODEL NUMBER</u> | <u>A</u> | <u>B</u> | <u>C</u> | |
|---------------------|------------------------------|------------------------------|--------------|---|
| 2723 | 69.3 ft-lbs/in ² | 73.3 ft-lbs/in ² | 72.5 ft-lbs | ← |
| 2724 | 137.7 ft-lbs/in ² | 145.9 ft-lbs/in ² | 149.1 ft-lbs | ← |
| 2725 | 121.1 ft-lbs/in ² | 180.9 ft-lbs/in ² | 185.8 ft-lbs | ← |
| 2726 | 211.0 ft-lbs/in ² | 225.7 ft-lbs/in ² | 229.0 ft-lbs | ← |
| 2727 | 511.7 ft-lbs/in ² | 638.9 ft-lbs/in ² | 637.2 ft-lbs | ← |
| 2728 | 677.2 ft-lbs/in ² | 857.0 ft-lbs/in ² | 826.3 ft-lbs | ← |

Thus, it may safely be stated that the models in the 2720 source series will easily pass the Special Form Percussion Test.

c. Heating

Heating in air to a temperature of 1475°F (802°C), and remaining at that temperature for a period of 10 minutes.

The models in the 2720 source series are ANSI Classified Temperature Test 6, which requires that a dummy source be held at a temperature of 1010°C for one hour.

Thus, the sources not only meet but exceed the Special Form Temperature Test.

d. Immersion

Immersion for 24 hours in water at room temperature. The water shall be at pH6 - pH8, with a maximum conductivity of 10 micromhos/cm.

Since the source capsules are Type 304 stainless steel they will pass the Special Form Immersion Test.

APPENDIX B

SPECIAL FORM LIFE ANALYSIS

1. DIMENSIONS USED IN THE ANALYSIS

It is the policy of Monsanto Research Corporation to perform source analyses on a "worst case basis"; that is, to assume that tolerances on material properties, dimensions, isotope loading, etc. will accumulate so as to result in minimum capsule strength and maximum stress. With respect to capsule dimensions, this policy results in the following:

- A. Capsule dimensions to be used in stress calculations are those based on tolerance limits which produce the thinnest wall and the thinnest heads.
- B. Capsule dimensions to be used in calculating internal pressure build-ups due to isotope decay are those based on tolerance limits which produce the smallest internal volume.

Additional conservative and worst-case assumptions are used in the analysis, and are noted therein. The capsule stresses are calculated using the methods specified in RULES FOR CONSTRUCTION OF PRESSURE VESSELS, DIVISION 1, 1971 EDITION, BOILER AND VESSEL CODE, SECTION VIII. Even under the cumulative conservatism of the ASME Pressure Vessel Code and the numerous worst-case assumptions, each of the two source capsules (the inner and outer capsules) are shown to be independently able not only to withstand an operating environment of 400°F for 10 years, but also to be able to pass the Special Form Heating Test at any time within a 10 year period.

2. Stress Analysis Inner Capsule

Here, the maximum permissible internal pressure is determined by methods of analysis given in Rules for Construction of Pressure Vessels, Division 1, 1971 Edition, ASME Boiler and Vessel Code, Section VIII. Designing to Section VIII, Division 1, satisfies the design requirements for Class 2 and Class 3 vessels per Rules for Construction of Nuclear Power Plant Components, 1971 Edition, ASME Boiler and Pressure Vessel Code, Section III (see paragraphs NC-3310 and ND-3310).

At assembly, the plug is pressed into the capsule body and sealed in place by fusion welding. The resulting closure is assumed to be at least as strong as the unwelded, screwed-in end cap configuration depicted by Fig. UG-34(q) of the referenced ASME Code, Section VIII (p. 23). Accordingly, the allowable internal pressure, P_H , in psia, as limited by stress in the end plug (head stress), is taken to be related to the thickness of the plug, t , in inches, in the manner specified by the Code for Fig UG-34(q); namely (p 21), $t = D \sqrt{CP_H/S}$, where D is the diameter of the plug (inches), C is a dimensionless factor dependent upon such considerations as the method of attachment of the head and the shell dimensions, and S is the maximum allowable stress value (psi) obtained from the applicable table of stress values in the code.

Solving for P_H ,

$$t = D \sqrt{CP_H/S}$$

$$P_H = (t^2/CD^2)S$$

2. STRESS ANALYSIS INNER CAPSULE (continued)

Here, per the code discussion regarding Fig. UG-34(q), $C = 0.75$ (p 24).

There is to be acknowledged for the head stress analysis here employed the requirement that, as stated in the Code discussion regarding Fig UG-34(q), design of the weld joint against failure in shear must be based on a factor of safety of at least 4 (p 24). For the seal weld joining the plug to the capsule body, the area in shear is $A_s = \pi D t w$, where D is again the diameter of the (inches) and $t w$ is the weld penetration (inches). For this calculation the minimum weld penetration as specified by the drawing of the source capsule shall be used. Acting over the area $A_f = (\pi/4) D^2$ is a force given by $F = P_s A_f$, where P_s is the shear-stress-limited internal pressure (psia). The resulting shear stress is $S_s = F/A_s = P_s A_f/A_s$

$$= \frac{P_s (\pi/4) D^2}{\pi D t w} = \frac{P_s D}{4 t w}$$

Introducing the safety factor of 4, the shear stress developed is limited to $S_s = (1/4) S_{sa}$, where S_{sa} is the maximum allowable value of the shear stress.

Thus,

$$(1/4) S_{sa} = \frac{P_s D}{4 t w} \text{ or } S_{sa} = \frac{P_s D}{t w}$$

Taking the maximum allowable shear stress to be half the maximum allowable stress value in tension, $S_{sa} = (1/2) S$, so that

$$(1/2) S = \frac{P_s D}{t w}$$

Solving for P_s

$$P_s = \frac{(1/2) S t w}{D}$$

$$P_s = \left(\frac{t w}{2 D}\right) S$$

2. STRESS ANALYSIS INNER CAPSULE (continued)

Also to be considered are the maximum permissible internal pressure values obtainable from the code for stress limitations within the primary capsule shell. From paragraph UG-27 (p 11) for the cylindrical shell in question, the internal pressures limited by circumferential and longitudinal stresses are, respectively;

$$P_c = \frac{SE t_r}{R + 0.6 t_r}$$
$$= [Et_r \div (R + 0.6t_r)]S$$

and

$$P_L = \frac{2SE t_r}{R - 0.4 t_r}$$
$$= [2Et_r \div (R - 0.4t_r)]S$$

where E is a joint efficiency factor having in this instance the value of E = 1 since -- the only welds being those sealing the plugs to the body -- there are no joints in the capsule cylindrical shell portion proper (see paragraph UG-27 p 11), t_r is the minimum required shell thickness which is here simply equivalent to the wall thickness at the welded end of the capsule, R is half the diameter of the plug (inches), and S is the maximum allowable stress value (psi) as before.

Before determining the value of S, a comparison of the four pressure relations, (P_H , P_S , P_C and P_L) stated as functions of S will show that one will be most restrictive. To calculate the internal pressure allowed by the relation, it is necessary to arrive at a value to be used for S.

In this analysis, S will have two values in order to compare stress and pressure build-up due to: (a) operating temperature over a long time, ie, 400°F for 10 years; and (b) heating test temperature over a short period of time, ie, 1475°F for 10 minutes after 10 years.

2. STRESS ANALYSIS INNER CAPSULE (continued)

In the first case (operating temperatures which do not exceed 400°F), S, the maximum allowable stress value (in tension) for 304 stainless steel for metal temperatures not exceeding 400°F is 12,900 psi.* This value allows no significant creepage of the 304 stainless steel over a long period of time.

In the second case, the capsule temperature during the Special Form Heating Test is 1475°F. Here, then, S, the maximum allowable stress value (in tension) for 304 stainless steel for metal temperatures not exceeding 1500°F, is taken to be 0.2% offset yield strength at 1500°F, down-graded by 20%. The 0.2% offset yield strength of 304 stainless steel at 1500°F is 9,900 psi.**

3. STRESS ANALYSIS OUTER CAPSULE

The analysis follows the same format as that of the inner capsule.

4. CALCULATION OF VOLUME AVAILABLE FOR HELIUM PRESSURE BUILD-UP

In keeping with the "worst case" policy stated earlier in this analysis, when a calculation is made the maximum fuel, target density, ie the maximum packing fraction, P. F., allowable for that case shall be used. Thus the minimum volume allowed for helium pressure build-up is the volume within the capsule times the quantity (1-P.F.) We may now calculate the volume within

*Aforementioned "Rules for Construction of Pressure Vessels", Division 1, 1971 Edition, ASME Boiler and Vessel Code, Section VIII.

**"Steels for Nuclear Application", Section 3 p 43, United States Steel Corporation.

4. CALC. OF VOL. AVAILABLE FOR HELIUM PRESSURE BUILD-UP (continued)

the capsule which is available for helium pressure build-up, ie, "Void Volume", V_v . This is just the internal volume of the capsule, V_{IC} , minus any shims, spacers, etc. times the quantity (1-P.F.)

$$V_v = [V_{IC} - V \text{ (shims, spacers, etc.)}] \times [1 - \text{P.F.}]$$

5. INTERNAL GAS PRESSURE

The gas pressure inside the inner capsule is in general a function of temperature and of time after sealing the source. The latter is a result of the generation of helium gas from α -emitting isotopes.

At any given time after sealing, L , and at absolute temperature, T , the internal pressure is composed of two components: (a) that due to gas within the source at the time of sealing, P_I ; (b) that due to helium build-up, P_H . Thus,

$$P(L,T) = P_I(T) + P_H(L,T)$$

5.1 Pressure due to gas present at time of sealing of source

$$P_I(T) = P_0 \times T / T_0$$

where P_0 and T_0 are the pressure and temperature (absolute) at the time of sealing, 1 atm and 293.16°K, respectively. Thus,

$$\begin{aligned} P_I(T) &= 1 \text{ atm} \times \frac{T(^{\circ}\text{K})}{293.16^{\circ}\text{K}} \\ &= 3.41 \times 10^{-3} \times T \text{ (atm)} \end{aligned}$$

5.2 Pressure due to helium build-up

We conservatively assume that the isotope emits α -particles at a uniform rate equal to the initial emission rate. Thus, the

5.2 PRESSURE DUE TO HELIUM BUILD-UP (continued)

maximum number of α -particles (He atoms) produced by any isotope having one α -per decay is, in L years,

$$N(L) = [S_c(\text{ci})] \times [3.7 \times 10^{10} \frac{\text{d}}{\text{sec-ci}}] \times [3.156 \times 10^7 \frac{\text{sec}}{\text{yr}}] \times [L(\text{yr})] = 1.168 \times 10^{18} \times S_c \times L \text{ (\alpha-particles)}$$

The maximum number of moles of He produced, $n(L)$ is:

$$\begin{aligned} n(L) &= N(L)/N_0; N_0 = \text{Avagadro's number} \\ &= \frac{1.168 \times 10^{18} \times S_c \times L \text{ (atoms)}}{6.0235 \times 10^{23} \text{ (atoms/mole)}} \\ &= 1.94 \times 10^{-6} \times S_c \times L \end{aligned}$$

The maximum pressure due to HE build-up may now be calculated from the gas law under the worst-case assumption that no gas is retained within the fuel:

$$P_H(L,T) = \frac{Rn(L)T}{V_v}$$

Where R = gas constant = $8.205 \times 10^{-2} \frac{\text{liter-atm}}{\text{°K-mole}}$

$$\begin{aligned} P_H(L,T) &= \frac{8.205 \times 10^{-2} \frac{\text{liter-atm}}{\text{°K-mole}} \times 1.94 \times 10^{-6} \left(\frac{\text{moles}}{\text{Ci-yrs}}\right) \times S_c \text{ (Ci)} \times L \text{ (yrs)} \times T \text{ (°K)}}{V_v \text{ (cm}^3\text{)} \times 10^{-3} \text{ liter/cm}^3} \\ &= 1.59 \times 10^{-4} \times \frac{S_c \times L \times T}{V_v} \text{ (atm)} \end{aligned}$$

5.3 TOTAL INTERNAL PRESSURE

Total internal pressure at time L (yr) and temperature T (°K) is, as a maximum, for a given initial loading,

$$P(L,T) = (3.41 \times 10^{-3} \times T + 1.59 \times 10^{-4} \times \frac{S_c \times L \times T}{V_v})$$

For this analysis, internal pressures shall be calculated for three cases, ie. when the maximum packing fraction in the cap-

5.3 TOTAL INTERNAL PRESSURE (continued)

sule is 0.50, 0.68 and 0.80. If, for a given case, the calculated pressure at the end of 10 years at the operating temperature is below the pressure permitted by the limiting stress, the capsule will not deform at the operating temperature in a 10 year period. If the calculated pressure at the end of 10 years at the Heat Test temperature is below the pressure permitted by the limiting stress at that temperature, the capsule will pass the Special Form Heating Test at 10 years.

6. Data for Sources Analyzed

For each source analysed, the following data sheets and drawings are included in this appendix.

- (a) Dimensions of inner capsule and dimension used for stress and pressure calculation.
- (b) Dimension of outer capsule and dimensions used for stress and pressure calculation.
- (c) Results of Stress and Pressure calculations.
- (d) A drawing showing construction of the source.

DIMENSIONS OF MODEL 2721 A

Inner capsule dimensions

Dimensions per drawing number B 2721-AA00, Rev. 1

$$O.D. = \underline{.402 \pm .005}$$

$$I.D. = \underline{.312 \pm .005}$$

$$O.L. = \underline{.300 \pm .005}$$

$$I.L. = \underline{----}$$

$$t_h = \text{Thickness of head} = \underline{.100 \pm .005}$$

$$t_g = \text{Depth of trepan groove} = \underline{N/A}$$

$$t_b = \text{Thickness of bottom} = \underline{.100 \pm .005}$$

$$t_d = \text{Thickness of wiping disc} = \underline{N/A}$$

Dimensions to be used or stress calculations

$$(O.D.)_s = (\text{smallest } O.D.) = \underline{.397}$$

$$(I.D.)_s = (\text{largest } I.D.) = \underline{.317}$$

$$(t_w)_s = \text{Wall thickness} = 1/2[(O.D.)_s - (I.D.)_s] = \\ 1/2[\underline{.397} - \underline{.317}] = \underline{.040}$$

$$(t_h)_s = \text{Head thickness} = [(t_h - tol) - (t_g + tol)] = \\ [\underline{.095} - \underline{0}] = \underline{.095}$$

$$(t_b)_s = \text{Bottom thickness} = t_b - tol = \underline{.095}$$

Dimensions to be used for internal pressure calculations

$$(I.D.)_p = (I.D.) - (tol) = \underline{.307}$$

$$(I.L.)_p = [\text{shortest } I.L.] - [t_h + tol] - [t_d + tol] \\ = \underline{\hspace{2cm}} - \underline{\hspace{2cm}} - \underline{\hspace{2cm}} \\ = \underline{\hspace{2cm}}$$

$$or \bar{r} (I.L.)_p = [O.L. - tol] - [t_h + tol] - [t_b + tol] - [t_d + tol] \\ = \underline{.295} - \underline{.105} - \underline{.105} - \underline{0} \\ = \underline{.085}$$

DIMENSIONS OF MODEL 2721 A

Outer capsule dimensions

Dimensions per drawing number B 2721-AA00

$$O.D. = \underline{.500 \pm .005}$$

$$I.D. = \underline{.407 \pm .005}$$

$$O.L. = \underline{.500 \pm .005}$$

$$I.L. = \underline{\text{----}}$$

$$t_h = \text{Thickness of head} = \underline{.100 \pm .005}$$

$$t_g = \text{Depth of trepan groove} = \underline{N/A}$$

$$t_b = \text{Thickness of bottom} = \underline{.100 \pm .005}$$

Dimensions to be used for stress calculations

$$(O.D.)_s = (\text{smallest O.D.}) = \underline{.495}$$

$$(I.D.)_s = (\text{largest I.D.}) = \underline{.412}$$

$$(t_w)_s = \text{Wall thickness} = 1/2 [(O.D.)_s - (I.D.)_s] = \\ 1/2 [\underline{.495} - \underline{.412}] = \underline{.0415}$$

$$(t_h)_s = \text{Head thickness} = [(t_h - tol) - (t_g + tol)] = \\ [\underline{.095} - \underline{0}] = \underline{.095}$$

$$(t_b)_s = \text{Bottom thickness} = t_b - tol = \underline{.095}$$

RESULTS OF
STRESS AND PRESSURE
CALCULATIONS FOR MODEL 2721 A

INNER CAPSULE

$$P_H = \underline{.1197} \text{ S}, \quad P_C = \underline{.2192} \text{ S}, \quad P_L = \underline{.5614} \text{ S}$$

$$P_S = \underline{.03785} \text{ S Based on a minimum weld penetration of } \underline{.024"} \text{ S}$$

Most restrictive relationship, $P_S = \underline{.03785} \text{ S}$

Maximum internal pressure permitted

At 400°F 488.3 psig (S = 12,900)

At 1475°F 299.8 psig (S = 9,900 x 0.8)

OUTER CAPSULE

$$P_H = \underline{.07089} \text{ S}, \quad P_C = \underline{.1797} \text{ S}, \quad P_L = \underline{.43825} \text{ S}$$

$$P_S = \underline{.02913} \text{ S Based on a minimum weld penetration of } \underline{.024"} \text{ S}$$

Most restrictive relationship, $P_S = \underline{.02913} \text{ S}$

Maximum internal pressure permitted

At 400°F 375.7 psig (S = 12,900)

At 1475°F 230.7 psig (S = 9,900 x 0.8)

Pressure Build-up

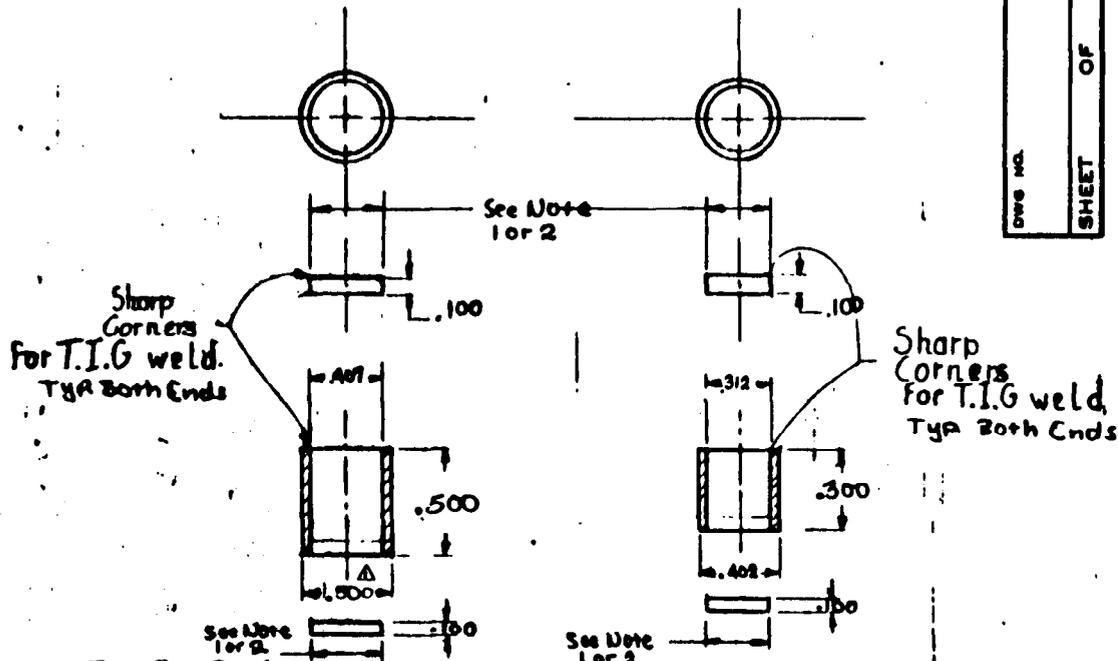
Calculated pressure build-up after 10 years with the maximum curie content and the maximum packing fraction as listed in the table below:

| Maximum Curies | Maximum P.F. | Pressure At 400°F, PSIA | Pressure At 1475°F, PSIA |
|----------------|--------------|-------------------------|--------------------------|
| 0.3 | .50 | 88.9 | 200.1 |
| 0.2 | .68 | 91.6 | 206.2 |
| 0.14 | .80 | 99.7 | 224.4 |

These capsules will not deform at operating temperature in a 10 year period and will pass the Special Form Heating Test at 10 years.

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| | |
|---------|-------|
| REV | OF |
| DWG NO. | SHEET |

| REVISIONS | | | | |
|-----------|-----|----------------------------------|---------|----------|
| ZONE | SYM | DESCRIPTION | DATE | APPROVAL |
| | Δ | .500 WAS .80; ADDED NOTE 4 & "A" | 4-30-54 | ESL/BJ |

- 1) The fit Between Lid & Container on Both Outer & Inner's is to Be 0.0005 Interference fit
- 2. Ditto Above is to be Slip fit
- 3. Clearance between Inner & Outer Containers is to be .003 Nominal .002 minimum
- Δ 4. WELD PENETRATION .024" MINIMUM

| | | | | | |
|--|------------------|--------|-------|---|---------------|
| UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES: DECIMALS FRACTIONS .XX = ± .02 * .XXX = ± .005 * .XXXX BASIC * 30' ALL SURFACES ✓ | APPD | | | MONSANTO RESEARCH CORPORATION DAYTON LABORATORY DAYTON, OHIO | |
| | APPD | | | | |
| | APPD | | | Neutron Standard Source II Model 2781-A Δ | |
| | APPD | | | | |
| MATERIAL 304 S.S. II | CHECKED | | | DWG NO. | REV |
| FINISH | DRAWN <i>RED</i> | 4-2-54 | | B2721-AA00 | 1 |
| | SIGNATURE | DATE | SCALE | WT CALC ACT. | CODE IDENT NO |
| | | | | | SHEET OF |

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A

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DIMENSIONS OF MODEL 2722 A

Inner capsule dimensions

Dimensions per drawing number B2722-AA00, Rev. 1

O.D. = .402 ± .005

I.D. = .312 ± .005

O.L. = .500 ± .005

I.L. = -----

t_h = Thickness of head = .100 ± .005

t_g = Depth of trepan groove = N/A

t_b = Thickness of bottom = .100 ± .005

t_d = Thickness of wiping disc N/A

Dimensions to be used or stress calculations

$(O.D.)_s$ = (smallest O.D.) = .397

$(I.D.)_s$ = (largest I.D.) = .317

$(t_w)_s$ = Wall thickness = $1/2[(O.D.)_s - (I.D.)_s]$ =
 $1/2[.397 - .317] = .040$

$(t_h)_s$ = Head thickness = $[(t_h - tol) - (t_g + tol)]$ =
 $[.095 - 0] = .095$

$(t_b)_s$ = Bottom thickness = $t_b - tol = .095$

Dimensions to be used for internal pressure calculations

$(I.D.)_p$ = $(I.D.) - (tol) = .307$

$(I.L.)_p$ = $[shortest I.L.] - [t_h + tol] - [t_d + tol]$
 = _____ - _____ - _____
 = _____

or $(I.L.)_p$ = $[O.L. - tol] - [t_h + tol] - [t_b + tol] - [t_d + tol]$
 = .495 - .105 - .105 - 0
 = .285

DIMENSIONS OF MODEL 2722 A

Outer capsule dimensions

Dimensions per drawing number B 2722-AA00, Rev. 1

O.D. = .500 ± .005

I.D. = .407 ± .005

O.L. = .700 ± .005

I.L. = -----

t_h = Thickness of head = .100 ± .005

t_g = Depth of trepan groove = N/A

t_b = Thickness of bottom = .100 ± .005

Dimensions to be used for stress calculations

$(O.D.)_s$ = (smallest O.D.) = .495

$(I.D.)_s$ = (largest I.D.) = .412

$(t_w)_s$ = Wall thickness = $1/2 [(O.D.)_s - (I.D.)_s] =$
 $1/2 [\underline{.495} - \underline{.412}] = \underline{.0415}$

$(t_h)_s$ = Head thickness = $[(t_h - tol) - (t_g + tol)] =$
 $[\underline{.095} - \underline{0}] = \underline{.095}$

$(t_b)_s$ = Bottom thickness = $t_b - tol = \underline{.095}$

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RESULTS OF
STRESS AND PRESSURE
CALCULATIONS FOR MODEL 2722 A

INNER CAPSULE

$P_H = \underline{.1197} \text{ S}, \quad P_C = \underline{.2192} \text{ S}, \quad P_L = \underline{.5614} \text{ S}$

$P_S = \underline{.03785} \text{ S}$ Based on a minimum weld penetration of .024"

Most restrictive relationship, $P_s = \underline{.03785} \text{ S}$

Maximum internal pressure permitted

At 400°F 488.3 psig (S = 12,900)

At 1475°F 299.8 psig (S = 9,900 x 0.8)

OUTER CAPSULE

$P_H = \underline{.07089} \text{ S}, \quad P_C = \underline{.1797} \text{ S}, \quad P_L = \underline{.43825} \text{ S}$

$P_S = \underline{.02913} \text{ S}$ Based on a minimum weld penetration of .024"

Most restrictive relationship, $P_s = \underline{.02913} \text{ S}$

Maximum internal pressure permitted

At 400°F 375.7 psig (S = 12,900)

At 1475°F 230.7 psig (S = 9,900 x 0.8)

Pressure Build-up

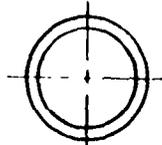
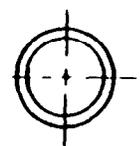
Calculated pressure build-up after 10 years with the maximum curie content and the maximum packing fraction as listed in the table below:

| Maximum Curies | Maximum P.F. | Pressure At 400°F, PSIA | Pressure At 1475°F, PSIA |
|----------------|--------------|-------------------------|--------------------------|
| 1 | .50 | 88.5 | 199.2 |
| 0.7 | .68 | 94.6 | 212.8 |
| 0.4 | .80 | 88.5 | 199.2 |

These capsules will not deform at operating temperature in a 10 year period and will pass the Special Form Heating Test at 10 years.

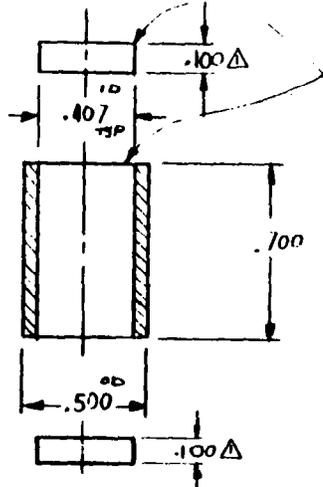
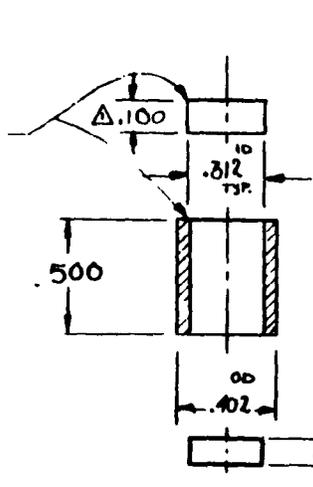
Inner Container

Outer Container



304
S.S.T.L.

| REVISIONS | | |
|-----------|---------|----------|
| NO. | DATE | APPROVAL |
| 1 | 9-27-54 | ESG/RS |



Sharp
Corners
for T.I.G. weld
TYP

Sharp
Corners
for T.I.G. weld
TYP

Note

- Δ 1. The Fit Between Lid & Container on Both Outer & Inner's is to Be a .0005 interference fit, TYP
- Δ 2. Clearance between inner & outer Container .005 nominal, .002 minimum, TYP.
- Δ 3. WELD PENETRATION .024" MINIMUM.

| | |
|---|--------------|
| UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES: | |
| DECIMALS | FRACTIONS |
| XX ± .02 | |
| XXX ± .005 | ANGLES |
| XXXX BASIC | 32 |
| ALL SURFACES | |
| MATERIAL | 304 S.S.T.L. |
| FINISH | |

| | |
|---------|--------|
| APPD | |
| APPD | |
| APPD | |
| APPD | |
| CHECKED | S.W. |
| DRAWN | J.F.Th |
| DATE | |

| | |
|--|---------------|
| MONSANTO RESEARCH CORPORATION DAYTON LABORATORY DAYTON, OHIO | |
| Neutron Source Container Model 2922-A Δ | |
| DWG NO | REV |
| B2722-AA00 | 1 |
| SCALE X | WT L.B.C. ACT |
| SHEET | OF |

29

B

A

DIMENSIONS OF MODEL 123 A

Inner capsule dimensions

Dimensions per drawing number B 2723-AA00, Rev. 2

O.D. = .652 ± .005

I.D. = .562 ± .005

O.L. = .670 ± .005

I.L. = ----

t_h = Thickness of head = .100 ± .005

t_g = Depth of trepan groove = N/A

t_b = Thickness of bottom = .100 ± .005

t_d = Thickness of wiping disc N/A

Dimensions to be used or stress calculations

$(O.D.)_s$ = (smallest O.D.) = .647

$(I.D.)_s$ = (largest I.D.) = .567

$(t_w)_s$ = Wall thickness = $1/2[(O.D.)_s - (I.D.)_s]$ =
 $1/2[.647 - .567] = .040$

$(t_h)_s$ = Head thickness = $[(t_h - tol) - (t_g + tol)]$ =
 $[.095 - 0] = .095$

$(t_b)_s$ = Bottom thickness = $t_b - tol = .095$

Dimensions to be used for internal pressure calculations

$(I.D.)_p$ = $(I.D.) - (tol) = .557$

$(I.L.)_p$ = $[shortest I.L.] - [t_h + tol] - [t_d + tol]$
 $=$ _____ $-$ _____ $-$ _____
 $=$ _____

or $(I.L.)_p$ = $[O.L. - tol] - [t_h + tol] - [t_b + tol] - [t_d + tol]$
 $= .665 - .105 - .105 - 0$
 $= .455$

DIMENSIONS OF MODEL 2723 A

Outer capsule dimensions

Dimensions per drawing number B 2723-AA00, Rev. 2

O.D. = .750 ± .005

I.D. = .657 ± .005

O.L. = .870 ± .005

I.L. = -----

t_h = Thickness of head = .100 ± .005

t_g = Depth of trepan groove = N/A

t_b = Thickness of bottom = .100 ± .005

Dimensions to be used for stress calculations

$(O.D.)_s$ = (smallest O.D.) = .745

$(I.D.)_s$ = (largest I.D.) = .662

$(t_w)_s$ = Wall thickness = $1/2 [(O.D.)_s - (I.D.)_s]$ =
 $1/2 [\underline{.745} - \underline{.662}] = \underline{.0415}$

$(t_h)_s$ = Head thickness = $[(t_h - tol) - (t_g + tol)]$ =
 $[\underline{.095} - \underline{0}] = \underline{.095}$

$(t_b)_s$ = Bottom thickness = $t_b - tol = \underline{.095}$

RESULTS OF
STRESS AND PRESSURE
CALCULATIONS FOR MODEL 2723 A

INNER CAPSULE

$$P_H = \underline{.03743} \text{ S}, \quad P_C = \underline{.1301} \text{ S}, \quad P_L = \underline{.2991} \text{ S}$$

$$P_S = \underline{.02116} \text{ S Based on a minimum weld penetration of } \underline{.024"} \text{ S}$$

Most restrictive relationship, $P_s = \underline{.02116} \text{ S}$

Maximum internal pressure permitted

At 400°F 273.0 psig (S = 12,900)

At 1475°F 167.6 psig (S = 9,900 x 0.8)

OUTER CAPSULE

$$P_H = \underline{.02746} \text{ S}, \quad P_C = \underline{.1166} \text{ S}, \quad P_L = \underline{.2640} \text{ S}$$

$$P_S = \underline{.01813} \text{ S Based on a minimum weld penetration of } \underline{.024"} \text{ S}$$

Most restrictive relationship, $P_s = \underline{.01813} \text{ S}$

Maximum internal pressure permitted

At 400°F 233.8 psig (S = 12,900)

At 1475°F 143.6 psig (S = 9,900 x 0.8)

Pressure Build-up

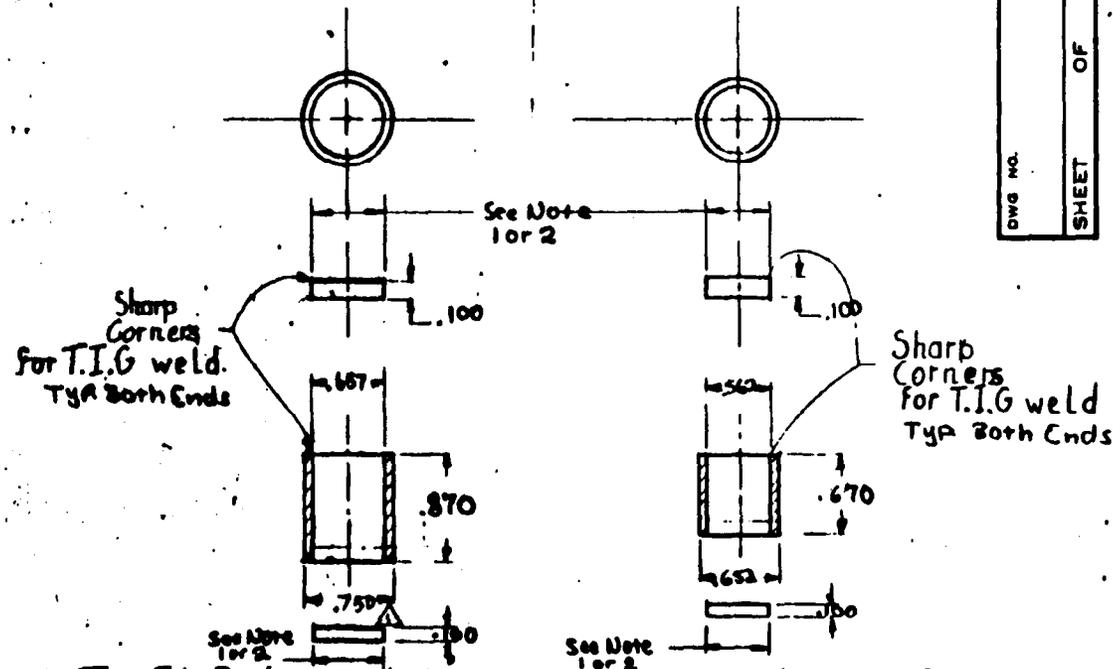
Calculated pressure build-up after 10 years with the maximum curie content and the maximum packing fraction as listed in the table below:

| Maximum Curies | Maximum P.F. | Pressure At 400°F, PSIA | Pressure At 1475°F, PSIA |
|----------------|--------------|-------------------------|--------------------------|
| 3 | .50 | 60.8 | 136.8 |
| 2 | .68 | 62.3 | 140.3 |
| 1.2 | .80 | 60.8 | 136.8 |

These capsules will not deform at operating temperature in a 10 year period and will pass the Special Form Heating Test at 10 years.

B

A



- 1) The fit Between Lid & Container on Both Outer & Inner's is to Be a .0005 Interference fit
2. DITTO ABOVE is to be a Slip Fit
3. Clearance between Inner & Outer Containers is to be .003 Nominal .002 minimum
- ▲ 4. WELD PENETRATION .024" MINIMUM.

| | |
|---------|-------|
| REV | OF |
| DWG NO. | SHEET |

| REVISIONS | | | | |
|-----------|-----|------------------------|----------|----------|
| ZONE | SYM | DESCRIPTION | DATE | APPROVAL |
| | ▲ | DIMENSION .750 WAS .75 | 11-14-72 | M.R. |
| | ▲ | ADDED NOTE 4 & 'A' | 5-3-79 | EFB/14 |

| | | | | | |
|---|------------------|--------------|---|--------------|------------------------------|
| UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES: DECIMALS FRACTIONS .XX = ±.02 ▲ .XXX = ±.005 ▲ ANGLES .XXXX BASIC ▲ 30' ALL SURFACES ✓ | APPD | | MONSANTO RESEARCH CORPORATION DAYTON LABORATORY DAYTON, OHIO | | |
| | APPD | | | | |
| | APPD | | | | |
| | APPD | | | | |
| MATERIAL 302 S.S. | CHECKED | | Neutron Standard Source Model 2723-A ▲ | | DWG NO. B2723-AA00 |
| FINISH | DRAWN <i>RCD</i> | DATE 10-2-79 | SCALE | WT CALC ACT. | CODE IDENT NO. SHEET OF |

B

A

133

DIMENSIONS OF MODEL 724 A

Inner capsule dimensions

Dimensions per drawing number B2724-AA00, Rev. 2

O.D. = .902 ± .005

I.D. = .812 ± .005

O.L. = .920 ± .005

I.L. = ----

t_h = Thickness of head = .100 ± .005

t_g = Depth of trepan groove = N/A

t_b = Thickness of bottom = .100

t_d = Thickness of wiping disc N/A

Dimensions to be used or stress calculations

$(O.D.)_s$ = (smallest O.D.) = .897

$(I.D.)_s$ = (largest I.D.) = .817

$(t_w)_s$ = Wall thickness = $1/2[(O.D.)_s - (I.D.)_s]$ =
 $1/2[.897 - .817]$ = .040

$(t_h)_s$ = Head thickness = $[(t_h - tol) - (t_g + tol)]$ =
 $[.095 - 0]$ = .095

$(t_b)_s$ = Bottom thickness = $t_b - tol$ = .095

Dimensions to be used for internal pressure calculations

$(I.D.)_p$ = $(I.D.) - (tol)$ = .807

$(I.L.)_p$ = $[shortest\ I.L.] - [t_h + tol] - [t_d + tol]$
 = _____ - _____ - _____
 = _____

or $(I.L.)_p$ = $[O.L. - tol] - [t_h + tol] - [t_b + tol] - [t_d + tol]$
 = .915 - .105 - .105 - 0
 = .705

DIMENSIONS OF MODEL 2724 A

Outer capsule dimensions

Dimensions per drawing number B 2724-AA00, Rev. 2

O.D. = 1.000 ± .005

I.D. = .907 ± .005

O.L. = 1.120 ± .005

I.L. = -----

t_h = Thickness of head = .100 ± .005

t_g = Depth of trepan groove = N/A

t_b = Thickness of bottom = .100 ± .005

Dimensions to be used for stress calculations

$(O.D.)_s$ = (smallest O.D.) = .995

$(I.D.)_s$ = (largest I.D.) = .912

$(t_w)_s$ = Wall thickness = $1/2 [(O.D.)_s - (I.D.)_s]$ =
 $1/2 [\underline{.995} - \underline{.912}] = \underline{.0415}$

$(t_h)_s$ = Head thickness = $[(t_h - tol) - (t_g + tol)]$ =
 $[\underline{.095} - \underline{0}] = \underline{.095}$

$(t_b)_s$ = Bottom thickness = $t_b - tol = \underline{.095}$

RESULTS OF
STRESS AND PRESSURE
CALCULATIONS FOR MODEL 2724 A

INNER CAPSULE

$$P_H = \underline{.01803} S, \quad P_C = \underline{.09249} S, \quad P_L = \underline{.2038} S$$

$$P_S = \underline{.01469} S \text{ Based on a minimum weld penetration of } \underline{.024"}$$

Most restrictive relationship, $P_S = \underline{.01469} S$

Maximum internal pressure permitted

At 400°F 189.5 psig (S = 12,900)

At 1475°F 116.3 psig (S = 9,900 x 0.8)

OUTER CAPSULE

$$P_H = \underline{0.1447} S, \quad P_C = \underline{.08630} S, \quad P_L = \underline{.1889} S$$

$$P_S = \underline{.01316} S \text{ Based on a minimum weld penetration of } \underline{.024"}$$

Most restrictive relationship, $P_S = \underline{.01316} S$

Maximum internal pressure permitted

At 400°F 169.7 psig (S = 12,900)

At 1475°F 104.2 psig (S = 9,900 x 0.8)

Pressure Build-up

Calculated pressure build-up after 10 years with the maximum curie content and the maximum packing fraction as listed in the table below:

| Maximum Curies | Maximum P.F. | Pressure At 400°F, PSIA | Pressure At 1475°F, PSIA |
|----------------|--------------|-------------------------|--------------------------|
| 5 | .50 | 42.8 | 96.4 |
| 3.5 | .68 | 44.6 | 100.4 |
| 2 | .80 | 42.8 | 96.4 |

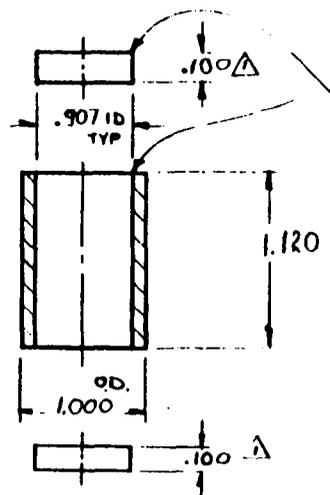
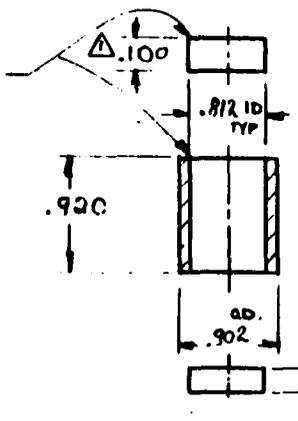
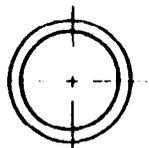
These capsules will not deform at operating temperature in a 10 year period and will pass the Special Form Heating Test at 10 years.

A

Inner Container

Outer Container

| REVISIONS | | | | |
|-----------|------|--|---------|----------|
| NO. | DATE | DESCRIPTION | DATE | APPROVAL |
| 1 | | .100 WAS .10 | 6/14/73 | STJ |
| 2 | | NUMBERED NOTES 1 & 2, ADDED NOTE 3 & 4 | 5-3-74 | EJH |



Sharp
Corners
for T.I.G.
weld,
TYP.

Sharp
Corners
for T.I.G. weld,
TYP.

Note

- ▲ 1. The Fit Between Lid & Container on both Outer & Inner's is to Be a .0005 interference fit, TYP.
- ▲ 2. Clearance between inner & outer Container .005 nominal .002 Minimum, TYP.
- ▲ 3. WELD PENETRATION .024" MINIMUM.

| | |
|---|-----------|
| UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES | |
| TOLERANCES: | |
| DECIMALS | FRACTIONS |
| XX .02 | |
| XXX .005 | ANGLES |
| XXXX BASIC | 52 |
| ALL SURFACES | |
| MATERIAL | 304L5311 |
| FINISH | |

| | | |
|-----------|-----|--------|
| APPD | | |
| CHECKED | JCS | 7/6/73 |
| DRAWN | REP | 7-5-73 |
| SIGNATURE | | DATE |

| | | | |
|--|----------------|----------------------|----------|
| MONSANTO RESEARCH CORPORATION DAYTON LABORATORY DAYTON, OHIO | | | |
| Neutral Source Container Model 2724-A ▲ | | DWG NO B2724-AA00 | |
| SCALE | WT CALC ACT | EQUIPMENT NO | REV 2 |
| SHEET | | OF | |

K-E

B

A

DIMENSIONS OF MODEL 25 A

Inner capsule dimensions

Dimensions per drawing number B 2725-AA00, Rev. 1

$$O.D. = \frac{.902 \pm .005}{\quad}$$

$$I.D. = \frac{.812 \pm .005}{\quad}$$

$$O.L. = \frac{1.300 \pm .005}{\quad}$$

$$I.L. = \frac{\text{----}}{\quad}$$

$$t_h = \text{Thickness of head} = \frac{.100 \pm .005}{\quad}$$

$$t_g = \text{Depth of trepan groove} = \frac{N/A}{\quad}$$

$$t_b = \text{Thickness of bottom} = \frac{.100 \pm .005}{\quad}$$

$$t_d = \text{Thickness of wiping disc} = \frac{N/A}{\quad}$$

Dimensions to be used or stress calculations

$$(O.D.)_s = (\text{smallest } O.D.) = \frac{.897}{\quad}$$

$$(I.D.)_s = (\text{largest } I.D.) = \frac{.817}{\quad}$$

$$(t_w)_s = \text{Wall thickness} = \frac{1}{2}[(O.D.)_s - (I.D.)_s] = \frac{1}{2}[\frac{.897}{\quad} - \frac{.817}{\quad}] = \frac{.040}{\quad}$$

$$(t_h)_s = \text{Head thickness} = [(t_h - tol) - (t_g + tol)] = [\frac{.095}{\quad} - \frac{0}{\quad}] = \frac{.095}{\quad}$$

$$(t_b)_s = \text{Bottom thickness} = t_b - tol = \frac{.095}{\quad}$$

Dimensions to be used for internal pressure calculations

$$(I.D.)_p = (I.D.) - (tol) = \frac{.807}{\quad}$$

$$(I.L.)_p = [\text{shortest } I.L.] - [t_h + tol] - [t_d + tol]$$

$$= \frac{\quad}{\quad} - \frac{\quad}{\quad} - \frac{\quad}{\quad}$$

$$= \frac{\quad}{\quad}$$

$$or (I.L.)_p = [O.L. - tol] - [t_h + tol] - [t_b + tol] - [t_d + tol]$$

$$= \frac{1.295}{\quad} - \frac{.105}{\quad} - \frac{.105}{\quad} - \frac{0}{\quad}$$

$$= \frac{1.085}{\quad}$$

DIMENSIONS OF MODEL 2725 A

Outer capsule dimensions

Dimensions per drawing number B2725-AA00, Rev. 1

O.D. = 1.000 ± .005

I.D. = .907 ± .005

O.L. = 1.500 ± .005

I.L. = -----

t_h = Thickness of head = .100 ± .005

t_g = Depth of trepan groove = N/A

t_b = Thickness of bottom = .100 ± .005

Dimensions to be used for stress calculations

$(O.D.)_s$ = (smallest O.D.) = .995

$(I.D.)_s$ = (largest I.D.) = .912

$(t_w)_s$ = Wall thickness = $1/2 [(O.D.)_s - (I.D.)_s]$ =
 $1/2 [\underline{.995} - \underline{.912}] = \underline{.0415}$

$(t_h)_s$ = Head thickness = $[(t_h - tol) - (t_g + tol)]$ =
 $[\underline{.095} - \underline{0}] = \underline{.095}$

$(t_b)_s$ = Bottom thickness = $t_b - tol = \underline{.095}$

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RESULTS OF
STRESS AND PRESSURE
CALCULATIONS FOR MODEL 2725 A

INNER CAPSULE

$$P_H = \underline{.01803} \text{ S}, \quad P_C = \underline{.092495} \text{ S}, \quad P_L = \underline{.2038} \text{ S}$$

$$P_S = \underline{.01469} \text{ S Based on a minimum weld penetration of } \underline{.024"} \text{ S}$$

Most restrictive relationship, $P_S = \underline{.01469} \text{ S}$

Maximum internal pressure permitted

At 400°F 189.5 psig (S = 12,900)

At 1475°F 116.3 psig (S = 9,900 x 0.8)

OUTER CAPSULE

$$P_H = \underline{.01447} \text{ S}, \quad P_C = \underline{.08630} \text{ S}, \quad P_L = \underline{.1889} \text{ S}$$

$$P_S = \underline{.01316} \text{ S Based on a minimum weld penetration of } \underline{.024"} \text{ S}$$

Most restrictive relationship; $P_S = \underline{.01316} \text{ S}$

Maximum internal pressure permitted

At 400°F 169.7 psig (S = 12,900)

At 1475°F 104.2 psig (S = 9,900 x 0.8)

Pressure Build-up

Calculated pressure build-up after 10 years with the maximum curie content and the maximum packing fraction as listed in the table below:

| Maximum Curies | Maximum P.F. | Pressure At 400°F, PSIA | Pressure At 1475°F, PSIA |
|----------------|--------------|-------------------------|--------------------------|
| 8.5 | .50 | 44.8 | 100.8 |
| 5.5 | .68 | 45.0 | 101.4 |
| 3.5 | .80 | 45.4 | 102.2 |

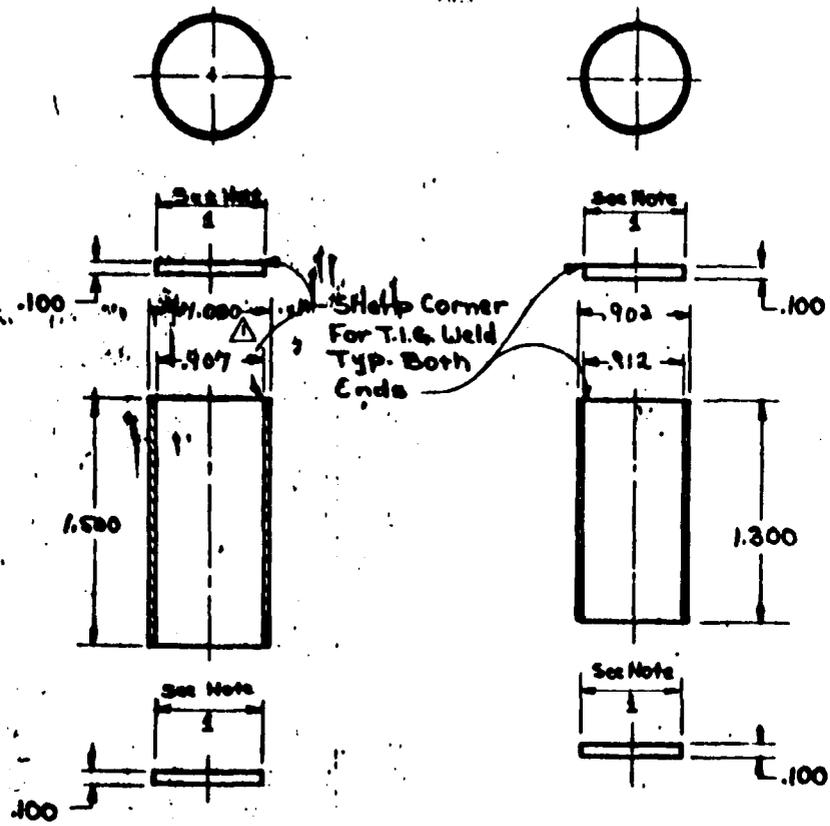
These capsules will not deform at operating temperature in a 10 year period and will pass the Special Form Heating Test at 10 years.

B

A

REV
OF
DWS NO. SHEET

| REVISIONS | | | | |
|-----------|-----|------------------------------------|---------|----------|
| ZONE | SYM | DESCRIPTION | DATE | APPROVAL |
| | △ | 1.000 WAS 1.00; ADDED NOTE 3 & "A" | 4-30-77 | EFJ |



- Notes
1. The fit between lid & Container on both outer & inner is to be .0005 interference fit
 2. Clearance between Outer & Inner Containers is to be .005 Nominal, .002 Minimum
 3. WELD PENETRATION .024" MINIMUM.

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES:
DECIMALS FRACTIONS
.XX = ±.02
.XXX = ±.005
.XXXX BASIC
ALL SURFACES ✓ 30°

MATERIAL 304 S.S.
FINISH

| | | |
|-----------|-----|---------|
| APPD | | |
| CHECKED | | |
| DRAWN | RED | 10-8-78 |
| SIGNATURE | | DATE |

MONSANTO RESEARCH CORPORATION
DAYTON LABORATORY
DAYTON, OHIO

Neutron Standard Source
Model 2725-A △

| | | |
|-----------------------|--------------|----------------|
| DWG NO. B2725-AA00 | REV 1 | |
| SCALE | WT CALC ACT. | CODE IDENT NO. |
| SHEET | OF | |

B

A

DIMENSIONS OF MODEL 2/26 A

Inner capsule dimensions

Dimensions per drawing number B 2726-AA00, Rev. 3

$$O.D. = \underline{.902 \pm .005}$$

$$I.D. = \underline{.812 \pm .005}$$

$$O.L. = \underline{1.600 \pm .005}$$

$$I.L. = \underline{-----}$$

$$t_h = \text{Thickness of head} = \underline{.100 \pm .005}$$

$$t_g = \text{Depth of trepan groove} = \underline{N/A}$$

$$t_b = \text{Thickness of bottom} = \underline{.100 \pm .005}$$

$$t_d = \text{Thickness of wiping disc} = \underline{N/A}$$

Dimensions to be used or stress calculations

$$(O.D.)_s = (\text{smallest O.D.}) = \underline{.897}$$

$$(I.D.)_s = (\text{largest I.D.}) = \underline{.817}$$

$$(t_w)_s = \text{Wall thickness} = 1/2[(O.D.)_s - (I.D.)_s] = \\ 1/2[\underline{.897} - \underline{.817}] = \underline{.040}$$

$$(t_h)_s = \text{Head thickness} = [(t_h - tol) - (t_g + tol)] = \\ [\underline{.095} - \underline{0}] = \underline{0.95}$$

$$(t_b)_s = \text{Bottom thickness} = t_b - tol = \underline{0.95}$$

Dimensions to be used for internal pressure calculations

$$(I.D.)_p = (I.D.) - (tol) = \underline{.807}$$

$$(I.L.)_p = [\text{shortest I.L.}] - [t_h + tol] - [t_d + tol]$$

$$= \underline{\hspace{2cm}} - \underline{\hspace{2cm}} - \underline{\hspace{2cm}}$$

$$= \underline{\hspace{2cm}}$$

$$\text{or } (I.L.)_p = [O.L. - tol] - [t_h + tol] - [t_b + tol] - [t_d + tol] \\ = \underline{1.595} - \underline{.105} - \underline{\hspace{2cm}} - \underline{0} \\ = \underline{1.385}$$

DIMENSIONS OF MODEL 2726 A

Outer capsule dimensions

Dimensions per drawing number B 2726-AA00, Rev. 2

O.D. = $\frac{1.000 \pm .005}{\text{-----}}$

I.D. = $\frac{.907 \pm .005}{\text{-----}}$

O.L. = $\frac{2.000 \pm .005}{\text{-----}}$

I.L. = $\frac{\text{-----}}{\text{-----}}$

t_h = Thickness of head = $\frac{.100 \pm .005}{\text{-----}}$

t_g = Depth of trepan groove = $\frac{\text{N/A}}{\text{-----}}$

t_b = Thickness of bottom = $\frac{.100 \pm .005}{\text{-----}}$

Dimensions to be used for stress calculations

$(O.D.)_s$ = (smallest O.D.) = $\frac{.995}{\text{-----}}$

$(I.D.)_s$ = (largest I.D.) = $\frac{.912}{\text{-----}}$

$(t_w)_s$ = Wall thickness = $\frac{1}{2} [(O.D.)_s - (I.D.)_s] =$
 $\frac{1}{2} [\frac{.995}{\text{-----}} - \frac{.912}{\text{-----}}] = \frac{.0415}{\text{-----}}$

$(t_h)_s$ = Head thickness = $\frac{[(t_h - tol) - (t_g + tol)]}{\text{-----}}$
 $\frac{[\frac{.095}{\text{-----}} - \frac{0}{\text{-----}}]}{\text{-----}} = \frac{.095}{\text{-----}}$

$(t_b)_s$ = Bottom thickness = $t_b - tol = \frac{.095}{\text{-----}}$

RESULTS OF
STRESS AND PRESSURE
CALCULATIONS FOR MODEL 2726 A

INNER CAPSULE

$$P_H = \underline{.01803} \text{ S}, \quad P_C = \underline{.09248} \text{ S}, \quad P_L = \underline{.2038} \text{ S}$$

$$P_S = \underline{.01469} \text{ S Based on a minimum weld penetration of } \underline{.024"} \text{ S}$$

Most restrictive relationship, $P_S = \underline{.01469} \text{ S}$

Maximum internal pressure permitted:

At 400°F 189.5 psig (S = 12,900)

At 1475°F 116.3 psig (S = 9,900 x 0.8)

OUTER CAPSULE

$$P_H = \underline{.01447} \text{ S}, \quad P_C = \underline{.08630} \text{ S}, \quad P_L = \underline{.1889} \text{ S}$$

$$P_S = \underline{.01316} \text{ S Based on a minimum weld penetration of } \underline{.024} \text{ S}$$

Most restrictive relationship, $P_S = \underline{.01316} \text{ S}$

Maximum internal pressure permitted:

At 400°F 169.7 psig (S = 12,900)

At 1475°F 104.2 psig (S = 9,900 x 0.8)

Pressure Build-up

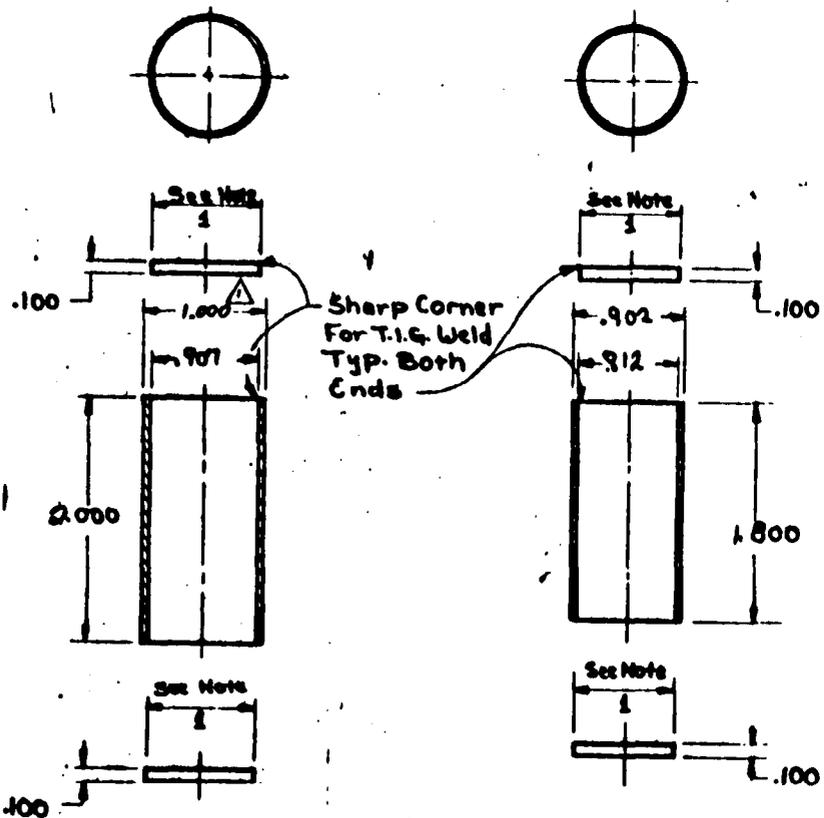
Calculated pressure build-up after 10 years with the maximum curie content and the maximum packing fraction as listed in the table below:

| Maximum Curies | Maximum P.F. | Pressure At 400°F, PSIA | Pressure At 1475°F, PSIA |
|----------------|--------------|-------------------------|--------------------------|
| 12 | .50 | 44.1 | 99.3 |
| 8.5 | .68 | 46.3 | 104.1 |
| 5 | .80 | 44.9 | 101.1 |

These capsules will not deform at operating temperature in a 10 year period and will pass the Special Form Heating Test at 10 years.

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| REV | NO. | OF |
| | | |
| DWG NO. | SHEET | |

| REVISIONS | | | | |
|-----------|-----|--------------------|---------|----------|
| ZONE | SYM | DESCRIPTION | DATE | APPROVAL |
| | △ | 1.000 WAS 1.00 | 2/18/73 | EFJ |
| | △ | ADDED NOTE 3 & "A" | 5-3-74 | ESD |
| | △ | .02" WAS .024" | 8-28-75 | ESD |

Notes

1. The fit between lid & Container on both outer & inner is to be .0005 interference fit
2. Clearance between Outer & Inner Containers is to be .005 Nominal, .002 Minimum
3. WELD PENETRATION .027" MINIMUM.

| | |
|---|----------------|
| UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES: | |
| DECIMALS | FRACTIONS |
| .XX = ±.02 | * ANGLES ± 30' |
| .XXX = ±.005 | |
| .XXXX BASIC | |
| ALL SURFACES | ✓ |
| MATERIAL | 304 S.S. |
| FINISH | |

| | |
|-----------|------|
| APPD | |
| APPD | |
| APPD | |
| APPD | |
| CHECKED | |
| DRAWN | ESD |
| SIGNATURE | DATE |

| | | | |
|--|-----------------|---|----------|
| MONSANTO RESEARCH CORPORATION DAYTON LABORATORY DAYTON, OHIO | | Neutron Standard Source model 2726-A △ | |
| | | DWG NO. B2726-AA00 | REV 3 |
| SCALE | WT CALC ACT. | GOOD IDENT NO. | SHEET OF |

B

A

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DIMENSIONS OF MODEL 2727 A

Inner capsule dimensions

Dimensions per drawing number B 2727-AA00, Rev. 1

$$O.D. = \underline{1.370 \pm .005}$$

$$I.D. = \underline{1.250 \pm .005}$$

$$O.L. = \underline{2.300 \pm .005}$$

$$I.L. = \underline{\text{----}}$$

$$t_h = \text{Thickness of head} = \underline{.100 \pm .005}$$

$$t_g = \text{Depth of trepan groove} = \underline{N/A}$$

$$t_b = \text{Thickness of bottom} = \underline{.100 \pm .005}$$

$$t_d = \text{Thickness of wiping disc} = \underline{N/A}$$

Dimensions to be used or stress calculations

$$(O.D.)_s = (\text{smallest } O.D.) = \underline{1.365}$$

$$(I.D.)_s = (\text{largest } I.D.) = \underline{1.255}$$

$$(t_w)_s = \text{Wall thickness} = 1/2[(O.D.)_s - (I.D.)_s] = \\ 1/2[\underline{1.365} - \underline{1.255}] = \underline{.055}$$

$$(t_h)_s = \text{Head thickness} = [(t_h - tol) - (t_g + tol)] = \\ [\underline{.095} - \underline{0}] = \underline{.095}$$

$$(t_b)_s = \text{Bottom thickness} = t_b - tol = \underline{.095}$$

Dimensions to be used for internal pressure calculations

$$(I.D.)_p = (I.D.) - (tol) = \underline{\hspace{2cm}}$$

$$(I.L.)_p = [\text{shortest } I.L.] - [t_h + tol] - [t_d + tol]$$

$$= \underline{\hspace{2cm}} - \underline{\hspace{2cm}} - \underline{\hspace{2cm}}$$

$$= \underline{\hspace{2cm}}$$

$$\text{or } (I.L.)_p = [O.L. - tol] - [t_h + tol] - [t_b + tol] - [t_d + tol] \\ = \underline{2.295} - \underline{.105} - \underline{.105} - \underline{0} \\ = \underline{2.085}$$

DIMENSIONS OF MODEL 2727 A

Outer capsule dimensions

Dimensions per drawing number B 2727-AA00, Rev. 1

O.D. = 1.500 ± .005

I.D. = 1.375 ± .005

O.L. = 2.500 ± .005

I.L. = -----

t_h = Thickness of head = .100 ± .005

t_g = Depth of trepan groove = N/A

t_b = Thickness of bottom = .100 ± .005

Dimensions to be used for stress calculations

$(O.D.)_s$ = (smallest O.D.) = 1.495

$(I.D.)_s$ = (largest I.D.) = 1.380

$(t_w)_s$ = Wall thickness = $1/2 [(O.D.)_s - (I.D.)_s] =$
 $1/2 [\underline{1.495} - \underline{1.380}] = \underline{0.575}$

$(t_h)_s$ = Head thickness = $[(t_h - tol) - (t_g + tol)] =$
 $[\underline{.095} - \underline{0}] = \underline{.095}$

$(t_b)_s$ = Bottom thickness = $t_b - tol = \underline{.095}$

RESULTS OF
STRESS AND PRESSURE
CALCULATIONS FOR MODEL 2727 A

INNER CAPSULE

$$P_H = \underline{.008019} \text{ S}, \quad P_C = \underline{.08521} \text{ S}, \quad P_L = \underline{.1863} \text{ S}$$

$$P_S = \underline{.01347} \text{ S Based on a minimum weld penetration of } \underline{.033"}$$

Most restrictive relationship, $P_H = \underline{.008019} \text{ S}$

Maximum internal pressure permitted

At 400°F 103.4 psig (S = 12,900)

At 1475°F 63.5 psig (S = 9,900 x 0.8)

OUTER CAPSULE

$$P_H = \underline{.006319} \text{ S}, \quad P_C = \underline{.08002} \text{ S}, \quad P_L = \underline{.1739} \text{ S}$$

$$P_S = \underline{.01196} \text{ S Based on a minimum weld penetration of } \underline{.033"}$$

Most restrictive relationship, $P_H = \underline{.006319} \text{ S}$

Maximum internal pressure permitted

At 400°F 81.5 psig (S = 12,900)

At 1475°F 50.0 psig (S = 9,900 x 0.8)

Pressure Build-up

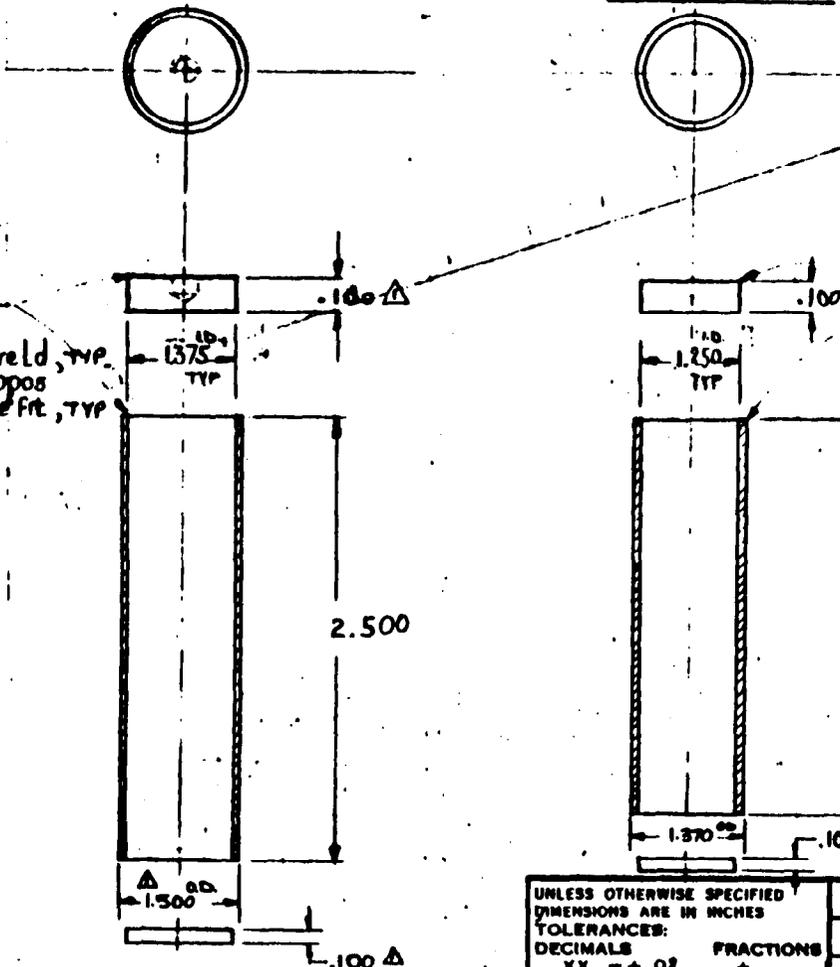
Calculated pressure build-up after 10 years with the maximum curie content and the maximum packing fraction as listed in the table below:

| Maximum Curies | Maximum P.F. | Pressure At 400°F, PSIA | Pressure At 1475°F, PSIA |
|----------------|--------------|-------------------------|--------------------------|
| 6 | .50 | 27.2 | 61.1 |
| Not useable | .68 | | |
| Not useable | .80 | | |

These capsules will not deform at operating temperature in a 10 year period and will pass the Special Form Heating Test at 10 years.

Outer Container

Inner Container



1. Sharp
Corners
for T.I.G. weld, TYP.
2. mach. for .0005
interference fit, TYP.

1. Sharp
Corners
for T.I.G. weld TYP.
2. mach. for .0005
interference fit TYP.

Note:
1. Clearance between inner & outer
Container .005 Nominal .002 Minimum
2. WELD PENETRATION .033" MINIMUM.

| REVISIONS | | | | |
|-----------|-----|---|---------|----------|
| ZONE | SYM | DESCRIPTION | DATE | APPROVAL |
| | A | .100 WAS .102; 1.500 WAS 1.60; ADDED NOTE 2 | 1-30-19 | CFB 01 |

| | | | |
|-----|-----|------|----|
| REV | NO. | DATE | BY |
| | | | |

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES:
DECIMALS FRACTIONS
.XX = ±.02 * ANGLES
.XXX = ±.005 * 30'
.XXXX BASIC
ALL SURFACES

MATERIAL 304 S.S. STL

FINISH

| | |
|-----------|---------|
| APPD | |
| APPD | |
| APPD | |
| APPD | |
| CHECKED | 9-16-69 |
| DRAWN | J.F.T. |
| SIGNATURE | DATE |

MONSANTO RESEARCH CORPORATION
DAYTON LABORATORY
DAYTON, OHIO

Norton Standard Source
Containers 2727-A

| | |
|------------------------|----------|
| DWG NO. B2727 AA-00 | REV 1 |
|------------------------|----------|

| | | | |
|-------|----|-----------|----------------|
| SCALE | WT | CALC ACT. | CODE IDENT NO. |
|-------|----|-----------|----------------|

SHEET OF

DIMENSIONS OF MODEL 2 A

Inner capsule dimensions

Dimensions per drawing number B 2728-AA00, Rev. 2

$$\text{O.D.} = \frac{1.370 \pm .005}{\text{-----}}$$

$$\text{I.D.} = \frac{1.250 \pm .005}{\text{-----}}$$

$$\text{O.L.} = \frac{3.300 \pm .005}{\text{-----}}$$

$$\text{I.L.} = \frac{\text{----}}{\text{-----}}$$

$$t_h = \text{Thickness of head} = \frac{.100 \pm .005}{\text{-----}}$$

$$t_g = \text{Depth of trepan groove} = \frac{\text{N/A}}{\text{-----}}$$

$$t_b = \text{Thickness of bottom} = \frac{.100 \pm .005}{\text{-----}}$$

$$t_d = \text{Thickness of wiping disc} = \frac{\text{N/A}}{\text{-----}}$$

Dimensions to be used or stress calculations

$$(\text{O.D.})_s = (\text{smallest O.D.}) = \frac{1.365}{\text{-----}}$$

$$(\text{I.D.})_s = (\text{largest I.D.}) = \frac{1.255}{\text{-----}}$$

$$\begin{aligned} (t_w)_s &= \text{Wall thickness} = 1/2[(\text{O.D.})_s - (\text{I.D.})_s] = \\ &1/2[\frac{1.365}{\text{-----}} - \frac{1.255}{\text{-----}}] = \frac{.055}{\text{-----}} \end{aligned}$$

$$\begin{aligned} (t_h)_s &= \text{Head thickness} = [(t_h - \text{tol}) - (t_g + \text{tol})] = \\ &[\frac{.095}{\text{-----}} - \frac{0}{\text{-----}}] = \frac{.095}{\text{-----}} \end{aligned}$$

$$(t_b)_s = \text{Bottom thickness} = t_b - \text{tol} = \frac{.095}{\text{-----}}$$

Dimensions to be used for internal pressure calculations

$$(\text{I.D.})_p = (\text{I.D.}) - (\text{tol}) = \frac{1.245}{\text{-----}}$$

$$(\text{I.L.})_p = [\text{shortest I.L.}] - [t_h + \text{tol}] - [t_d + \text{tol}]$$

$$= \text{-----} - \text{-----} - \text{-----}$$

$$= \text{-----}$$

$$\begin{aligned} \text{or } (\text{I.L.})_p &= [\text{O.L.} - \text{tol}] - [t_h + \text{tol}] - [t_b + \text{tol}] - [t_d + \text{tol}] \\ &= \frac{3.295}{\text{-----}} - \frac{.105}{\text{-----}} - \frac{.105}{\text{-----}} - \frac{0}{\text{-----}} \\ &= \frac{3.085}{\text{-----}} \end{aligned}$$

DIMENSIONS OF MODEL 2728 A

Outer capsule dimensions

Dimensions per drawing number B 2728-AA00, Rev. 2

O.D. = 1.500 ± .005

I.D. = 1.375 ± .005

O.L. = 3.500 ± .005

I.L. = ----

t_h = Thickness of head = .100 ± .005

t_g = Depth of trepan groove = N/A

t_b = Thickness of bottom = .100 ± .005

Dimensions to be used for stress calculations

$(O.D.)_s$ = (smallest O.D.) = 1.495

$(I.D.)_s$ = (largest I.D.) = 1.380

$(t_w)_s$ = Wall thickness = $1/2 [(O.D.)_s - (I.D.)_s] =$
 $1/2 [\underline{1.495} - \underline{1.380}] = \underline{0.0575}$

$(t_h)_s$ = Head thickness = $[(t_h - tol) - (t_g + tol)] =$
 $[\underline{.095} - \underline{0}] = \underline{.095}$

$(t_b)_s$ = Bottom thickness = $t_b - tol = \underline{.095}$

—
=

RESULTS OF
STRESS AND PRESSURE
CALCULATIONS FOR MODEL 2728 A

INNER CAPSULE

$$P_H = \underline{.007640} \text{ s}, \quad P_C = \underline{.08327} \text{ s}, \quad P_L = \underline{.1817} \text{ s}$$

$$P_S = \underline{.01315} \text{ s Based on a minimum weld penetration of } \underline{.033"} \text{ s}$$

Most restrictive relationship, $P_H = \underline{.007640} \text{ s}$

Maximum internal pressure permitted

At 400°F 98.6 psig (S = 12,900)

At 1475°F 60.5 psig (S = 9,900 x 0.8) or 75.2 psia

OUTER CAPSULE

$$P_H = \underline{.006319} \text{ s}, \quad P_C = \underline{.08002} \text{ s}, \quad P_L = \underline{.1740} \text{ s}$$

$$P_S = \underline{.01196} \text{ s Based on a minimum weld penetration of } \underline{.033"} \text{ s}$$

Most restrictive relationship, $P_H = \underline{.006319} \text{ s}$

Maximum internal pressure permitted

At 400°F 81.5 psig (S = 12,900)

At 1475°F 50.0 psig (S = 9,900 x 0.8) or 64.7 psia

Pressure Build-up

Calculated pressure build-up after 10 years with the maximum curie content and the maximum packing fraction as listed in the table below:

| Maximum Curies | Maximum P.F. | Pressure At 400°F, PSIA | Pressure At 1475°F, PSIA |
|----------------|--------------|-------------------------|--------------------------|
| 10 | .50 | 27.6 | 62.0 |
| Not useable | .68 | | |
| Not useable | .80 | | |

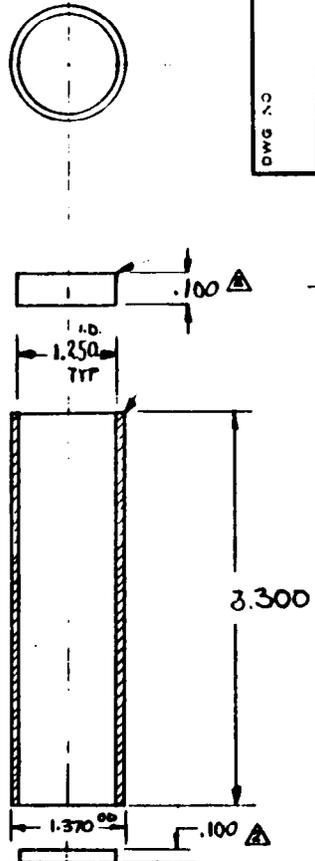
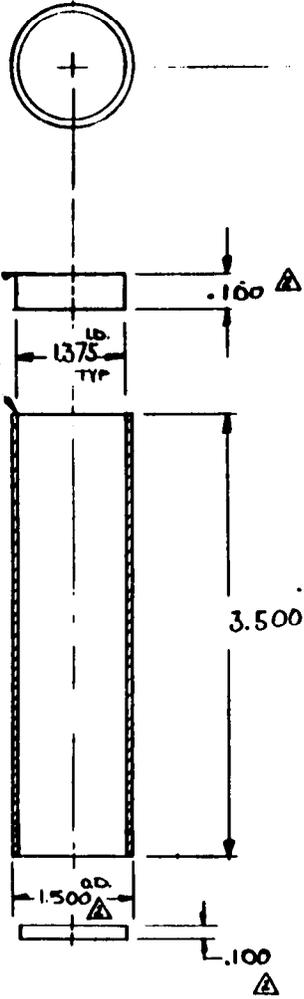
These capsules will not deform at operating temperature in a 10 year period and will pass the Special Form Heating Test at 10 years.

B

A

Outer Container

Inner Container



1. Sharp Corners for T.I.G. weld, TYP.
2. mach. for .0005 interference fit, TYP

1. Sharp Corners for T.I.G. weld TYP.
2. mach. for .0005 interference fit TYP.

Note:
1. Clearance between inner & outer container .005 Nominal .002 Minimum
2. WELD PENETRATION .033" MINIMUM.

| REVISIONS | | | | |
|-----------|-----|--|---------|----------|
| ZONE | SYM | DESCRIPTION | DATE | APPROVAL |
| | | Dwg. No. was B2727 AA-00 | 9/25/70 | CER |
| | △ | .100 WAS .10; 1.500 WAS 1.50; ADDED NOTE 2 & "A" | 5-1-79 | EPB/gj |

REV
DWG NO
SHEET

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES:
DECIMALS FRACTIONS
XX = ±.02 ±
XXX = ±.005 ANGLES
.XXXX BASIC ± 30'
ALL SURFACES 32
MATERIAL 304 S.S.TL
FINISH

| | | |
|-----------|----------|---------|
| APPD | | |
| CHECKED | J.F.T.H. | 9-16-69 |
| DRAWN | J.F.T.H. | |
| SIGNATURE | | DATE |

MONSANTO RESEARCH CORPORATION
DAYTON LABORATORY
DAYTON, OHIO

Neutron Standard Source
Containers 2728-A

| | |
|------------------------|--------------|
| DWG NO. B2728 AA-00 | REV 2 |
| SCALE | WT CALC ACT. |
| CORREIDENT NO | SHEET OF |

53

B

A

DIMENSIONS OF MODEL 2721 B

Inner capsule dimensions

Dimensions per drawing number A 2721-BA00, Rev. 1

$$O.D. = \frac{.402 \pm .005}{\quad}$$

$$I.D. = \frac{.312 \pm .005}{\quad}$$

$$O.L. = \frac{.300 \pm .005}{\quad}$$

$$I.L. = \frac{N/I}{\quad}$$

$$t_h = \text{Thickness of head} = \frac{.100 \pm .005}{\quad}$$

$$t_g = \text{Depth of trepan groove} = \frac{N/A}{\quad}$$

$$t_b = \text{Thickness of bottom} = \frac{.100 \pm .005}{\quad}$$

$$t_d = \text{Thickness of wiping disc} = \frac{N/A}{\quad}$$

Dimensions to be used or stress calculations

$$(O.D.)_s = (\text{smallest } O.D.) = \frac{.397}{\quad}$$

$$(I.D.)_s = (\text{largest } I.D.) = \frac{.317}{\quad}$$

$$(t_w)_s = \text{Wall thickness} = \frac{1}{2}[(O.D.)_s - (I.D.)_s] = \frac{1}{2}[\frac{.397}{\quad} - \frac{.317}{\quad}] = \frac{.040}{\quad}$$

$$(t_h)_s = \text{Head thickness} = [(t_h - tol) - (t_g + tol)] = [\frac{.095}{\quad} - \frac{0}{\quad}] = \frac{.095}{\quad}$$

$$(t_b)_s = \text{Bottom thickness} = t_b - tol = \frac{.095}{\quad}$$

Dimensions to be used for internal pressure calculations

$$(I.D.)_p = (I.D.) - (tol) = \frac{.307}{\quad}$$

$$(I.L.)_p = [\text{shortest } I.L.] - [t_h + tol] - [t_d + tol]$$

$$= \frac{\quad}{\quad} - \frac{\quad}{\quad} - \frac{\quad}{\quad}$$

$$= \frac{\quad}{\quad}$$

$$\text{or } (I.L.)_p = [O.L. - tol] - [t_h + tol] - [t_b + tol] - [t_d + tol]$$

$$= \frac{.295}{\quad} - \frac{.105}{\quad} - \frac{.105}{\quad} - \frac{0}{\quad}$$

$$= \frac{.085}{\quad}$$

N/I - not indicated

RESULTS OF
STRESS AND PRESSURE
CALCULATIONS FOR MODEL 2721 B

INNER CAPSULE

$$P_H = \underline{.1197} \text{ S}, \quad P_C = \underline{.2192} \text{ S}, \quad P_L = \underline{.5614} \text{ S}$$

$$P_S = \underline{.04259} \text{ S Based on a minimum weld penetration of } \underline{.027''}$$

Most restrictive relationship, $P_S = \underline{.04259} \text{ S}$

Maximum internal pressure permitted

At 400°F 549.4 psig (S = 12,900)

At 1475°F 337.3 psig (S = 9,900 x 0.8)

OUTER CAPSULE

$$P_H = \underline{.07089} \text{ S}, \quad P_C = \underline{.1797} \text{ S}, \quad P_L = \underline{.4382} \text{ S}$$

$$P_S = \underline{.03277} \text{ S Based on a minimum weld penetration of } \underline{.027''}$$

Most restrictive relationship, $P_S = \underline{.03277} \text{ S}$

Maximum internal pressure permitted

At 400°F 422.7 psig (S = 12,900)

At 1475°F 259.5 psig (S = 9,900 x 0.8)

Pressure Build-up

Calculated pressure build-up after 10 years with the maximum curie content and the maximum packing fraction as listed in the table below:

| Maximum Curies | Maximum P.F. | Pressure At 400°F, PSIA | Pressure At 1475°F, PSIA |
|----------------|--------------|-------------------------|--------------------------|
| 0.4 | .50 | 110.6 | 248.8 |
| 0.25 | .68 | 108.5 | 244.2 |
| 0.16 | .80 | 110.6 | 248.8 |

These capsules will not deform at operating temperature in a 10 year period and will pass the Special Form Heating Test at 10 years.

DIMENSIONS OF MODEL 2721 B

Outer capsule dimensions

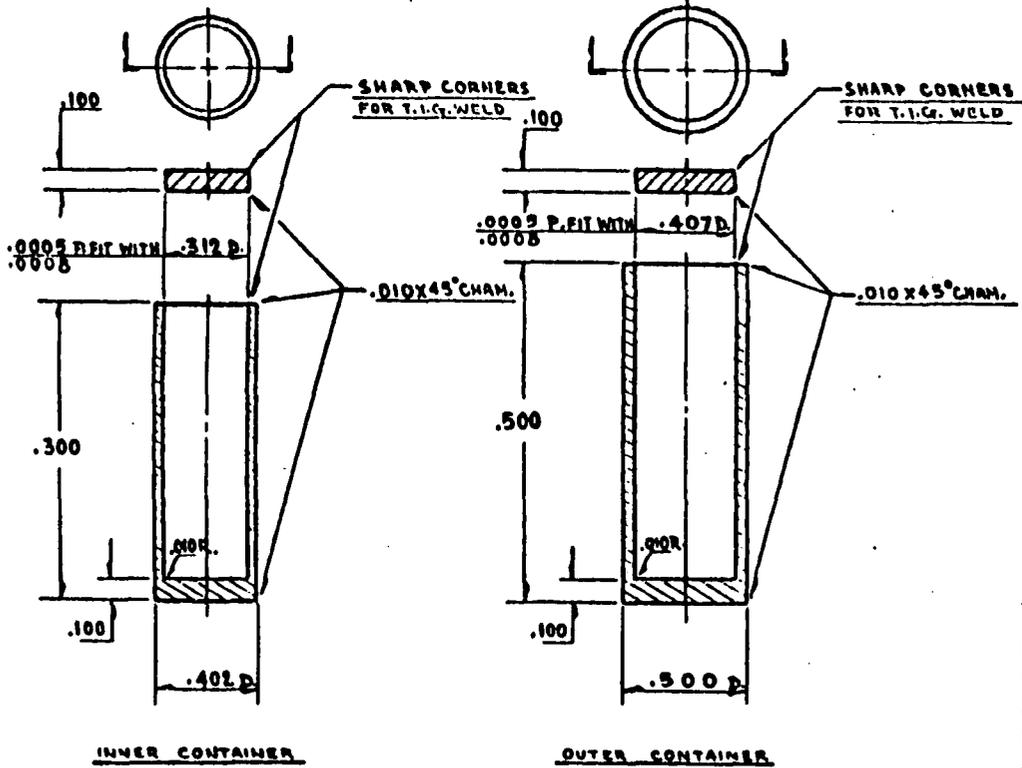
Dimensions per drawing number A 2721-BA00, Rev. 1

- O.D. = .500 ± .005
- I.D. = .407 ± .005
- O.L. = .500 ± .005
- I.L. = N/I
- t_h = Thickness of head = .100 ± .005
- t_g = Depth of trepan groove = N/A
- t_b = Thickness of bottom = .100 ± .005

Dimensions to be used for stress calculations

- $(O.D.)_s$ = (smallest O.D.) = .495
- $(I.D.)_s$ = (largest I.D.) = .412
- $(t_w)_s$ = Wall thickness = $1/2 [(O.D.)_s - (I.D.)_s] =$
 $1/2 [\underline{.495} - \underline{.412}] = \underline{.0415}$
- $(t_h)_s$ = Head thickness = $[(t_h - tol) - (t_g + tol)] =$
 $[\underline{.095} - \underline{0}] = \underline{.095}$
- $(t_b)_s$ = Bottom thickness = $t_b - tol = \underline{.095}$

| ZONE | | SYM | DESCRIPTION | DATE | APPROVAL |
|------|--|-----|--------------------|--------|-------------------|
| | | Δ | DE, MFG & QA ADDED | 1-7-76 | EJH [initials] HE |



NOTE:
 1. DIA. CLEARANCE BETWEEN INNER AND OUTER CONTAINER .005 NOMINAL .002 MINIMUM.
 2. MINIMUM WELD PENETRATION .027"

NOTICE
 This drawing is the property of Monsanto Research Corporation and must be returned, without reproduction or duplication, at any time upon request, but in any event at completion of the work or job. While in the possession of the recipient, it must be properly safeguarded against revelation or disclosure to anyone except those employees who require it for the work or job. The recipient must keep confidential, and require his (its) employees to keep confidential, the information contained herein.

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
 TOLERANCES:
 DECIMALS FRACTIONS Δ
 .XX = ±.02 ± 1/64
 .XXX = ±.005 ANGLES
 .XXX BASIC 32' ± 30'
 ALL SURFACES ✓
 MATERIAL 304 S. STEEL
 FINISH

| | | |
|-----------|--------|--------|
| APPD | | |
| QA APPD | HE | 1/4/76 |
| MFG APPD | WDM | 5-8-74 |
| DE APPD | EJH | 5-8-77 |
| CHECKED | E.J.H. | 5-8-74 |
| DRAWN | W.R. | 5-3-74 |
| SIGNATURE | | DATE |

MONSANTO RESEARCH CORPORATION
 DAYTON LABORATORY
 DAYTON, OHIO

NEUTRON SOURCE CONTAINER
MODEL 2721-B

| | |
|------------------|------------|
| STANDARD DRAWING | EJH |
| DWG NO. | A2721-BA00 |
| SHEET | OF 1 |

SCALE WT CALC ACT. CODE IDENT NO.

57

DIMENSIONS OF MODEL 2722 B

Inner capsule dimensions

Dimensions per drawing number A 2722-BA00, Rev. 3

$$\text{O.D.} = \underline{.402 \pm .005}$$

$$\text{I.D.} = \underline{.312 \pm .005}$$

$$\text{O.L.} = \underline{.500 \pm .005}$$

$$\text{I.L.} = \underline{\text{N/I}}$$

$$t_h = \text{Thickness of head} = \underline{.100 \pm .005}$$

$$t_g = \text{Depth of trepan groove} = \underline{\text{N/A}}$$

$$t_b = \text{Thickness of bottom} = \underline{.100 \pm .005}$$

$$t_d = \text{Thickness of wiping disc} = \underline{\text{N/A}}$$

Dimensions to be used or stress calculations

$$(\text{O.D.})_s = (\text{smallest O.D.}) = \underline{.397}$$

$$(\text{I.D.})_s = (\text{largest I.D.}) = \underline{.317}$$

$$\begin{aligned}
 (t_w)_s &= \text{Wall thickness} = 1/2[(\text{O.D.})_s - (\text{I.D.})_s] = \\
 &1/2[\underline{.397} - \underline{.317}] = \underline{.040}
 \end{aligned}$$

$$\begin{aligned}
 (t_h)_s &= \text{Head thickness} = [(t_h - \text{tol}) - (t_g + \text{tol})] = \\
 &[\underline{.095} - \underline{0}] = \underline{.095}
 \end{aligned}$$

$$(t_b)_s = \text{Bottom thickness} = t_b - \text{tol} = \underline{.095}$$

Dimensions to be used for internal pressure calculations

$$(\text{I.D.})_p = (\text{I.D.}) - (\text{tol}) = \underline{.307}$$

$$(\text{I.L.})_p = [\text{shortest I.L.}] - [t_h + \text{tol}] - [t_d + \text{tol}]$$

$$= \underline{\hspace{2cm}} - \underline{\hspace{2cm}} - \underline{\hspace{2cm}}$$

$$= \underline{\hspace{2cm}}$$

$$\begin{aligned}
 \text{or } (\text{I.L.})_p &= [\text{O.L.} - \text{tol}] - [t_h + \text{tol}] - [t_b + \text{tol}] - [t_d + \text{tol}] \\
 &= \underline{.495} - \underline{.105} - \underline{.105} - \underline{0} \\
 &= \underline{.285}
 \end{aligned}$$

DIMENSIONS OF MODEL 2722 B

Outer capsule dimensions

Dimensions per drawing number A 2722-BA00, Rev. 3

O.D. = .500 ± .005

I.D. = .407 ± .005

O.L. = .700 ± .005

I.L. = N/I

t_h = Thickness of head = .100 ± .005

t_g = Depth of trepan groove = N/A

t_b = Thickness of bottom = .100 ± .005

Dimensions to be used for stress calculations

$(O.D.)_s$ = (smallest O.D.) = .495

$(I.D.)_s$ = (largest I.D.) = .412

$(t_w)_s$ = Wall thickness = $1/2 [(O.D.)_s - (I.D.)_s]$ =
 $1/2 [\underline{.495} - \underline{.412}] = \underline{.0415}$

$(t_h)_s$ = Head thickness = $[(t_h - tol) - (t_g + tol)]$ =
 $[\underline{.095} - \underline{0}] = \underline{.095}$

$(t_b)_s$ = Bottom thickness = $t_b - tol = \underline{.095}$

RESULTS OF
STRESS AND PRESSURE
CALCULATIONS FOR MODEL 2722 B

INNER CAPSULE

$$P_H = \underline{.1197} \text{ S}, \quad P_C = \underline{.2192} \text{ S}, \quad P_L = \underline{.5614} \text{ S}$$

$$P_S = \underline{.04259} \text{ S Based on a minimum weld penetration of } \underline{.027"} \text{ S}$$

Most restrictive relationship, $P_S = \underline{0.4259} \text{ S}$

Maximum internal pressure permitted

At 400°F 549.4 psig (S = 12,900)

At 1475°F 337.3 psig (S = 9,900 x 0.8)

OUTER CAPSULE

$$P_H = \underline{.07089} \text{ S}, \quad P_C = \underline{.1797} \text{ S}, \quad P_L = \underline{.4382} \text{ S}$$

$$P_S = \underline{.03277} \text{ S Based on a minimum weld penetration of } \underline{.027"} \text{ S}$$

Most restrictive relationship, $P_S = \underline{.03277} \text{ S}$

Maximum internal pressure permitted

At 400°F 422.7 psig (S = 12,900)

At 1475°F 259.5 psig (S = 9,900 x 0.8)

Pressure Build-up

Calculated pressure build-up after 10 years with the maximum curie content and the maximum packing fraction as listed in the table below:

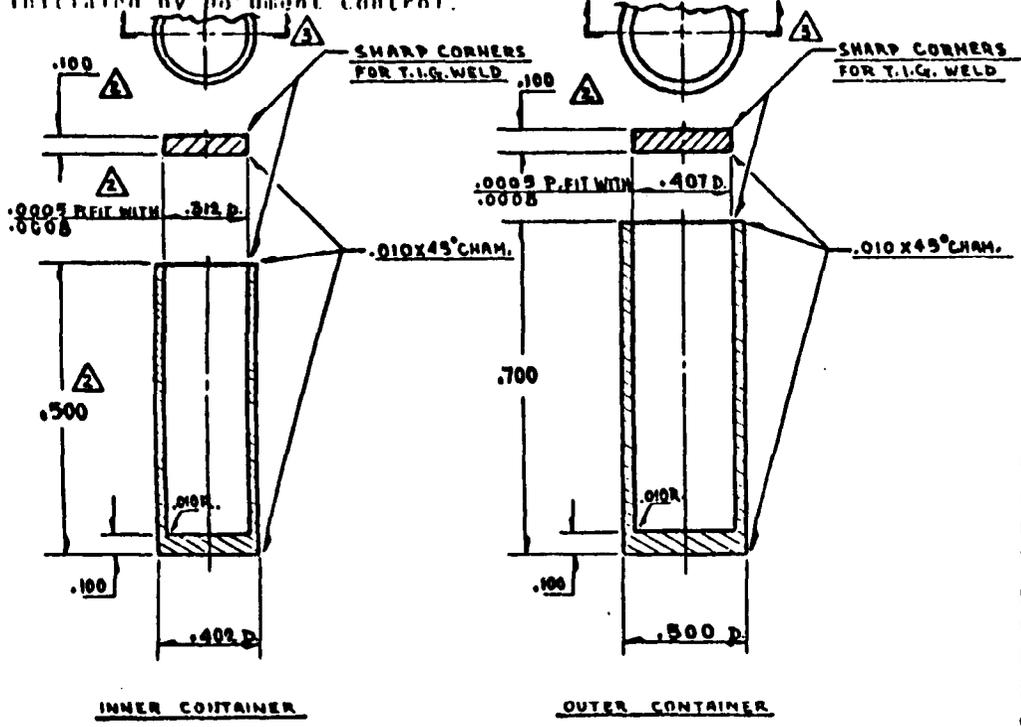
| Maximum Curies | Maximum P.F. | Pressure At 400°F, PSIA | Pressure At 1475°F, PSIA |
|-----------------|--------------|-------------------------|--------------------------|
| 1.4 | .50 | 114.4 | 257.3 |
| 0.9 | .68 | 114.8 | 258.3 |
| 0.56 | .80 | 114.4 | 257.3 |

These capsules will not deform at operating temperature in a 10 year period and will pass the Special Form Heating Test at 10 years.

Document is valid without approvals of original issue or latest revision by Design Engineering, Manufacturing, and Quality Assurance. Copies shall be used in manufacture pursuant to a Manufacturing Order only when marked in red as released for manufacturing of that MO and initiated by Document Control.

| REVISIONS | | | | |
|-----------|-----|---|----------|-------------------------|
| ZONE | SYM | DESCRIPTION | DATE | APPROVAL |
| | △ | A2722-BA00 WNS A2722-AA01 | 4-16-74 | |
| | △ | .100 FLAT HEADS WERE TREPANMED HEADS; REMOVED .050 WIPING DISC; .500 WAS .441; .027 WAS .020.; REDRAWN. | 5-6-74 | <i>E.J.G.</i> |
| | △ | CONTROL CLASS & DOCUMENT ADDED; TOP VIEW CHANGED. | 10-20-75 | <i>E.J.G. H.C. R.M.</i> |

DWG. FILE



NOTE:
 1. DIA. CLEARANCE BETWEEN INNER AND OUTER CONTAINER .005 NOMINAL .002 MINIMUM.
 2. MINIMUM WELD PENETRATION .027.

NOTICE
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| | |
|---|---------------|
| UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES | |
| TOLERANCES: | |
| DECIMALS | FRACTIONS |
| .XX = ± .02 | ± 1/64 |
| .XXX = ± .005 | ANGLES |
| .XXX BASIC | ± 30' |
| ALL SURFACES | ✓ |
| MATERIAL | 304 ST. STEEL |
| FINISH | |

| | | |
|-----------|---------------|--------|
| APPD | | |
| APPD | | |
| APPD | <i>N.R.</i> | 5-8-74 |
| APPD | <i>E.J.G.</i> | 5-8-74 |
| CHECKED | <i>E.J.G.</i> | 5-8-74 |
| DRAWN | <i>N.R.</i> | 5-6-74 |
| SIGNATURE | | DATE |

| | | |
|--|--------------|------------------|
| MONSANTO RESEARCH CORPORATION DAYTON LABORATORY DAYTON, OHIO | | |
| NEUTRON SOURCE CONTAINER MODEL 2722-B | | STANDARD DRAWING |
| | | <i>E.J.</i> |
| | | <i>N.R.</i> |
| | | REV |
| | | 3 |
| SCALE | WT CALC ACT. | CODE IDENT NO. |
| SHEET | | OF |

DIMENSIONS OF MODEL 2723 B

Inner capsule dimensions

Dimensions per drawing number A 2723-BA00, Rev. 3

$$\text{O.D.} = \underline{.662 \pm .005}$$

$$\text{I.D.} = \underline{.562 \pm .005}$$

$$\text{O.L.} = \underline{.611 \pm .005}$$

$$\text{I.L.} = \underline{\text{N/I}}$$

$$t_h = \text{Thickness of head} = \underline{.150 \pm .005}$$

$$t_g = \text{Depth of trepan groove} = \underline{.049 \pm .005}$$

$$t_b = \text{Thickness of bottom} = \underline{.100 \pm .005}$$

$$t_d = \text{Thickness of wiping disc} = \underline{.050 \pm .005}$$

Dimensions to be used or stress calculations

$$(\text{O.D.})_s = (\text{smallest O.D.}) = \underline{.657}$$

$$(\text{I.D.})_s = (\text{largest I.D.}) = \underline{.567}$$

$$\begin{aligned}
 (t_w)_s &= \text{Wall thickness} = 1/2[(\text{O.D.})_s - (\text{I.D.})_s] = \\
 &1/2[\underline{.657} - \underline{.567}] = \underline{.091}
 \end{aligned}$$

$$\begin{aligned}
 (t_h)_s &= \text{Head thickness} = [(t_h - \text{tol}) - (t_g + \text{tol})] = \\
 &[\underline{.145} - \underline{.054}] = \underline{.091}
 \end{aligned}$$

$$(t_b)_s = \text{Bottom thickness} = t_b - \text{tol} = \underline{.105}$$

Dimensions to be used for internal pressure calculations

$$(\text{I.D.})_p = (\text{I.D.}) - (\text{tol}) = \underline{.557}$$

$$\begin{aligned}
 (\text{I.L.})_p &= [\text{shortest I.L.}] - [t_h + \text{tol}] - [t_d + \text{tol}] \\
 &= \underline{\hspace{2cm}} - \underline{\hspace{2cm}} - \underline{\hspace{2cm}} \\
 &= \underline{\hspace{2cm}}
 \end{aligned}$$

$$\begin{aligned}
 \text{or } (\text{I.L.})_p &= [\text{O.L.} - \text{tol}] - [t_h + \text{tol}] - [t_b + \text{tol}] - [t_d + \text{tol}] \\
 &= \underline{.606} - \underline{.155} - \underline{.105} - \underline{.055} \\
 &= \underline{.291}
 \end{aligned}$$

DIMENSIONS OF MODEL 2723 B

Outer capsule dimensions

Dimensions per drawing number A 2723-BA00, Rev. 3

$$O.D. = \underline{.750 \pm .005}$$

$$I.D. = \underline{.657 \pm .005}$$

$$O.L. = \underline{.870 \pm .005}$$

$$I.L. = \underline{N/I}$$

$$t_h = \text{Thickness of head} = \underline{.150 \pm .005}$$

$$t_g = \text{Depth of trepan groove} = \underline{.050 \pm .005}$$

$$t_b = \text{Thickness of bottom} = \underline{.100 \pm .005}$$

Dimensions to be used for stress calculations

$$(O.D.)_s = (\text{smallest } O.D.) = \underline{.745}$$

$$(I.D.)_s = (\text{largest } I.D.) = \underline{.662}$$

$$(t_w)_s = \text{Wall thickness} = 1/2 [(O.D.)_s - (I.D.)_s] = \\ 1/2 [\underline{.745} - \underline{.662}] = \underline{.0415}$$

$$(t_h)_s = \text{Head thickness} = [(t_h - tol) - (t_g + tol)] = \\ [\underline{.145} - \underline{.005}] = \underline{.090}$$

$$(t_b)_s = \text{Bottom thickness} = t_b - tol = \underline{.095}$$

RESULTS OF
STRESS AND PRESSURE
CALCULATIONS FOR MODEL 2723 B

INNER CAPSULE

$$P_H = \underline{.03434} \text{ S}, \quad P_C = \underline{.1449} \text{ S}, \quad P_L = \underline{.3390} \text{ S}$$

$$P_S = \underline{.02645} \text{ S Based on a minimum weld penetration of } \underline{.030"} \text{ S}$$

Most restrictive relationship, $P_S = \underline{.02645} \text{ S}$

Maximum internal pressure permitted

At 400°F 341.3 psig (S = 12,900)

At 1475°F 209.5 psig (S = 9,900 x 0.8)

OUTER CAPSULE

$$P_H = \underline{.02464} \text{ S}, \quad P_C = \underline{.1166} \text{ S}, \quad P_L = \underline{.2640} \text{ S}$$

$$P_S = \underline{.02266} \text{ S Based on a minimum weld penetration of } \underline{.030} \text{ S}$$

Most restrictive relationship, $P_S = \underline{.02266} \text{ S}$

Maximum internal pressure permitted

At 400°F 292.3 psig (S = 12,900)

At 1475°F 179.5 psig (S = 9,900 x 0.8)

Pressure Build-up

Calculated pressure build-up after 10 years with the maximum curie content and the maximum packing fraction as listed in the table below:

| Maximum Curies | Maximum P.F. | Pressure At 400°F, PSIA | Pressure At 1475°F, PSIA |
|----------------|--------------|-------------------------|--------------------------|
| 2.9 | .50 | 79.7 | 179.3 |
| 1.8 | .68 | 78.0 | 175.5 |
| 1.1 | .80 | 76.8 | 172.8 |

These capsules will not deform at operating temperature in a 10 year period and will pass the Special Form Heating Test at 10 years.

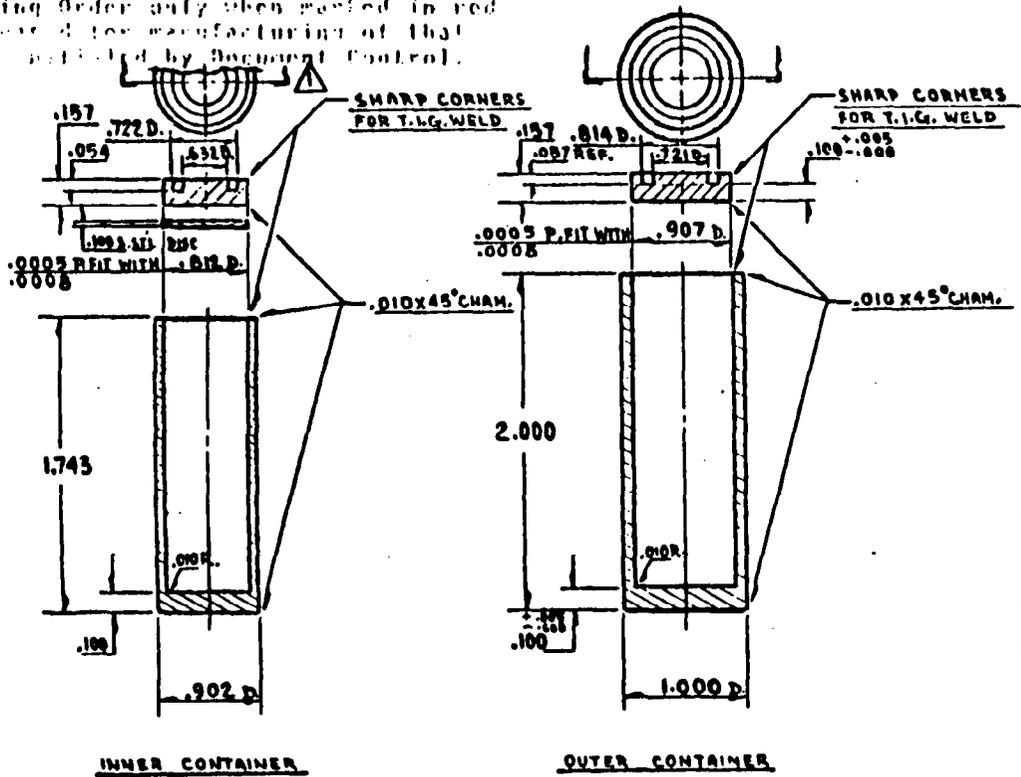
CONTROL CLASS 2 DOCUMENT

Revisions shall be made without approval of original issue or latest revision by Design Engineering, Manufacturing, and Quality Assurance. Copies shall be used in manufacture pursuant to a Manufacturing Order only when marked in red to select for manufacturing of that design controlled by Design Control.

REVISIONS

| ZONE | SYM | DESCRIPTION | DATE | A. PROVAL |
|------|-----|--|----------|-------------|
| | △ | CONTROL CLASS 2 DOCUMENT ADDED; TOP VIEW ORANGED | 10-23-75 | E.J.P. H.C. |

DWG. P.O.



- NOTE:**
1. DIA. CLEARANCE BETWEEN INNER AND OUTER CONTAINER .005 NOMINAL .002 MINIMUM.
 2. MINIMUM WELD PENETRATION .050"

NOTICE

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UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES:
 DECIMALS FRACTIONS
 .XX = ± .02 ± 1/64
 .XXX = ± .005 ANGLES
 .XXX BASIC 32' ± 30'
 ALL SURFACES ✓

MATERIAL 304 ST. STEEL
 FINISH _____

| | | |
|-----------|---------------|--------|
| APPD | | |
| APPD | | |
| APPD | <i>E.J.P.</i> | 5-8-74 |
| APPD | <i>E.J.P.</i> | 5-8-74 |
| CHECKED | <i>E.J.P.</i> | 5-8-74 |
| DRAWN | <i>N.R.</i> | 5-7-74 |
| SIGNATURE | | DATE |

MONSANTO RESEARCH CORPORATION
 DAYTON LABORATORY
 DAYTON, OHIO

NEUTRON SOURCE CONTAINER
MODEL 2726-B

| | |
|-------------------|--------------|
| STANDARD DRAWING | E. J. P. |
| DWG NO. | REV |
| A2726-BA00 | 1 |
| SCALE | WT CALC ACT. |
| CODE IDENT NO. | |
| SHEET | OF |

77

DIMENSIONS OF MODEL 2724 B

Inner capsule dimensions

Dimensions per drawing number A 2724-BA00, Rev. 3

$$O.D. = \underline{.902 \pm .005}$$

$$I.D. = \underline{.812 \pm .005}$$

$$O.L. = \underline{.861 \pm .005}$$

$$I.L. = \underline{N/I}$$

$$t_h = \text{Thickness of head} = \underline{.150 \pm .005}$$

$$t_g = \text{Depth of trepan groove} = \underline{.049 \pm .005}$$

$$t_b = \text{Thickness of bottom} = \underline{.100 \pm .005}$$

$$t_d = \text{Thickness of wiping disc} = \underline{.050 \pm .005}$$

Dimensions to be used or stress calculations

$$(O.D.)_s = (\text{smallest O.D.}) = \underline{.897}$$

$$(I.D.)_s = (\text{largest I.D.}) = \underline{.817}$$

$$(t_w)_s = \text{Wall thickness} = 1/2[(O.D.)_s - (I.D.)_s] = \\ 1/2[\underline{.897} - \underline{.817}] = \underline{.040}$$

$$(t_h)_s = \text{Head thickness} = [(t_h - tol) - (t_g + tol)] = \\ [\underline{.145} - \underline{.054}] = \underline{.091}$$

$$(t_b)_s = \text{Bottom thickness} = t_b - tol = \underline{.095}$$

Dimensions to be used for internal pressure calculations

$$(I.D.)_p = (I.D.) - (tol) = \underline{.807}$$

$$(I.L.)_p = [\text{shortest I.L.}] - [t_h + tol] - [t_d + tol]$$

$$= \underline{\hspace{2cm}} - \underline{\hspace{2cm}} - \underline{\hspace{2cm}}$$

$$\text{or } (I.L.)_p = [O.L. - tol] - [t_h + tol] - [t_b + tol] - [t_d + tol] \\ = \underline{.856} - \underline{.155} - \underline{.105} - \underline{.054} \\ = \underline{.542}$$

DIMENSIONS OF MODEL 2724 B

Outer capsule dimensions

Dimensions per drawing number A 2724-BA00, Rev. 3

$$O.D. = \underline{1.000 \pm .005}$$

$$I.D. = \underline{.907 \pm .005}$$

$$O.L. = \underline{1.120 \pm .005}$$

$$I.L. = \underline{N/I}$$

$$t_h = \text{Thickness of head} = \underline{.150 \pm .005}$$

$$t_g = \text{Depth of trepan groove} = \underline{N/S \text{ (see Dwg.)}}$$

+ .005

$$t_b = \text{Thickness of bottom} = \underline{.100 - .000}$$

Dimensions to be used for stress calculations

$$(O.D.)_s = \text{(smallest O.D.)} = \underline{.995}$$

$$(I.D.)_s = \text{(largest I.D.)} = \underline{.912}$$

$$(t_w)_s = \text{Wall thickness} = 1/2 [(O.D.)_s - (I.D.)_s] =$$

$$1/2 [\underline{.995} - \underline{.912}] = \underline{.0415}$$

$$(t_h)_s = \text{Head thickness} = [(t_h - tol) - (t_g + tol)] =$$

$$[\underline{\text{see drawing}}] = \underline{.100}$$

$$(t_b)_s = \text{Bottom thickness} = t_b - tol = \underline{.100}$$

RESULTS OF
STRESS AND PRESSURE
CALCULATIONS FOR MODEL 2724 B

INNER CAPSULE

$$P_H = \underline{.01654} \text{ S}, \quad P_C = \underline{.09248} \text{ S}, \quad P_L = \underline{.2038} \text{ S}$$

$$P_S = \underline{.01836} \text{ S Based on a minimum weld penetration of } \underline{.030"} \text{ S}$$

Most restrictive relationship, $P_H = \underline{.01654} \text{ S}$

Maximum internal pressure permitted

At 400°F 213.4 psig (S = 12,900)

At 1475°F 131.0 psig (S = 9,900 x 0.8)

OUTER CAPSULE

$$P_H = \underline{.01603} \text{ S}, \quad P_C = \underline{.08630} \text{ S}, \quad P_L = \underline{.1889} \text{ S}$$

$$P_S = \underline{.01645} \text{ S Based on a minimum weld penetration of } \underline{.030"} \text{ S}$$

Most restrictive relationship, $P_H = \underline{.01603} \text{ S}$

Maximum internal pressure permitted

At 400°F 206.8 psig (S = 12,900)

At 1475°F 127.0 psig (S = 9,900 x 0.8)

Pressure Build-up

Calculated pressure build-up after 10 years with the maximum curie content and the maximum packing fraction as listed in the table below:

| Maximum Curies | Maximum P.F. | Pressure At 400°F, PSIA | Pressure At 1475°F, PSIA |
|----------------|--------------|-------------------------|--------------------------|
| 6 | .50 | 53.4 | 120.2 |
| 4 | .68 | 54.7 | 123.0 |
| 2.5 | .80 | 54.7 | 123.0 |

These capsules will not deform at operating temperature in a 10 year period and will pass the Special Form Heating Test at 10 years.

DIMENSIONS OF MODEL 2725 B

Inner capsule dimensions

Dimensions per drawing number A 2725-BA00, Rev. 1

$$\text{O.D.} = \underline{.902 \pm .005}$$

$$\text{I.D.} = \underline{.812 \pm .005}$$

$$\text{O.L.} = \underline{1.243 \pm .005}$$

$$\text{I.L.} = \underline{\text{N/I}}$$

$$t_h = \text{Thickness of head} = \underline{.157 \pm .005}$$

$$t_g = \text{Depth of trepan groove} = \underline{.054 \pm .005}$$

$$t_b = \text{Thickness of bottom} = \underline{.100 \pm .005}$$

$$t_d = \text{Thickness of wiping disc} = \underline{.100 \pm .005}$$

Dimensions to be used or stress calculations

$$(\text{O.D.})_s = (\text{smallest O.D.}) = \underline{.897}$$

$$(\text{I.D.})_s = (\text{largest I.D.}) = \underline{.817}$$

$$\begin{aligned} (t_w)_s &= \text{Wall thickness} = 1/2[(\text{O.D.})_s - (\text{I.D.})_s] = \\ &1/2[\underline{.897} - \underline{.817}] = \underline{.040} \end{aligned}$$

$$\begin{aligned} (t_h)_s &= \text{Head thickness} = [(t_h - \text{tol}) - (t_g + \text{tol})] = \\ &[\underline{.152} - \underline{.059}] = \underline{.091} \end{aligned}$$

$$(t_b)_s = \text{Bottom thickness} = t_b - \text{tol} = \underline{.105}$$

Dimensions to be used for internal pressure calculations

$$(\text{I.D.})_p = (\text{I.D.}) - (\text{tol}) = \underline{.807}$$

$$(\text{I.L.})_p = [\text{shortest I.L.}] - [t_h + \text{tol}] - [t_d + \text{tol}]$$

$$= \underline{\hspace{2cm}} - \underline{\hspace{2cm}} - \underline{\hspace{2cm}}$$

$$= \underline{\hspace{2cm}}$$

$$\begin{aligned} \text{or } (\text{I.L.})_p &= [\text{O.L.} - \text{tol}] - [t_h + \text{tol}] - [t_b + \text{tol}] - [t_d + \text{tol}] \\ &= \underline{1.238} - \underline{.162} - \underline{.105} - \underline{.105} \\ &= \underline{.866} \end{aligned}$$

DIMENSIONS OF MODEL 2725 B

Outer capsule dimensions

Dimensions per drawing number A 2725-BA00, Rev. 4

O.D. = 1.000 ± .005

I.D. = .907 ± .005

O.L. = 1.500 ± .005

I.L. = N/I

t_h = Thickness of head = .157 ± .005

t_g = Depth of trepan groove = N/I (see dwg)

t_b = Thickness of bottom = .100 ^{+ .005} - .000

Dimensions to be used for stress calculations

$(O.D.)_s$ = (smallest O.D.) = .995

$(I.D.)_s$ = (largest I.D.) = .912

$(t_w)_s$ = Wall thickness = $1/2 [(O.D.)_s - (I.D.)_s] =$
 $1/2 [\underline{.995} - \underline{.912}] = \underline{.0415}$

$(t_h)_s$ = Head thickness = $[(t_h - tol) - (t_g + tol)] =$
 $[\underline{\text{see dwg.}} - \underline{\hspace{2cm}}] = \underline{.100}$

$(t_b)_s$ = Bottom thickness = $t_b - tol = \underline{.100}$

RESULTS OF
STRESS AND PRESSURE
CALCULATIONS FOR MODEL 2725 B

INNER CAPSULE

$$P_H = \underline{.01727} \text{ S}, \quad P_C = \underline{.09249} \text{ S}, \quad P_L = \underline{.2038} \text{ S}$$

$$P_S = \underline{.01836} \text{ S Based on a minimum weld penetration of } \underline{.030"} \text{ S}$$

Most restrictive relationship, $P_H = \underline{.01727} \text{ S}$

Maximum internal pressure permitted

At 400°F 222.9 psig (S = 12,900)

At 1475°F 136.8 psig (S = 9,900 x 0.8)

OUTER CAPSULE

$$P_H = \underline{.01603} \text{ S}, \quad P_C = \underline{.08630} \text{ S}, \quad P_L = \underline{.1889} \text{ S}$$

$$P_S = \underline{.01645} \text{ S Based on a minimum weld penetration of } \underline{.030"} \text{ S}$$

Most restrictive relationship, $P_H = \underline{.01603} \text{ S}$

Maximum internal pressure permitted

At 400°F 206.8 psig (S = 12,900)

At 1475°F 127.0 psig (S = 9,900 x 0.8)

Pressure Build-up

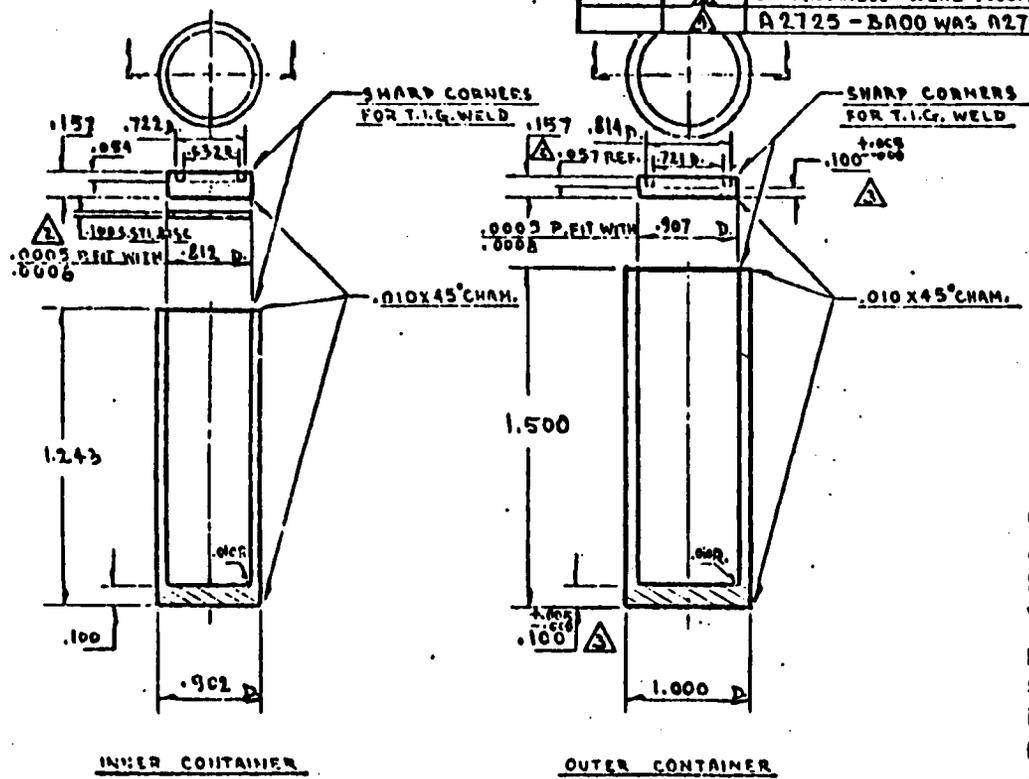
Calculated pressure build-up after 10 years with the maximum curie content and the maximum packing fraction as listed in the table below:

| Maximum Curies | Maximum P.F. | Pressure At 400°F, PSIA | Pressure At 1475°F, PSIA |
|----------------|--------------|-------------------------|--------------------------|
| 10 | .50 | 54.7 | 123.1 |
| 6.5 | .68 | 55.2 | 124.2 |
| 4 | .80 | 54.7 | 123.1 |

These capsules will not deform at operating temperature in a 10 year period and will pass the Special Form Heating Test at 10 years.

| REVISIONS | | | |
|-----------|-----|--|---------|
| ZONE | SYM | DESCRIPTION | DATE |
| | △ | WELD PENETRATION CHANGED TO .030" WAS .025" | 3-15-73 |
| | △ | DIM. .1005 STL. DISC WAS .0905. STL. DISC, .100 MINIMUM WERE .100, .097 REF. WAS .057. | 2-19-74 |
| | △ | DIM. .100 ^{±.005} WERE .100 MINIMUM | 4-1-74 |
| | △ | A 2725 - BA00 WAS A 2725 - A002 | 4-16-74 |

DWG NO.



- NOTE:**
1. DIA. CLEARANCE BETWEEN INNER AND OUTER CONTAINER .003 NOMINAL .002 MINIMUM.
 2. WELD PENETRATION .030 MIN.

NOTICE

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| | | | | | | |
|--|------|------|--------|---|--|------------------------|
| UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES: DIMENSIONAL FRACTIONS XX ± .001 XXX ± .005 XXXX BASIC ALL SURFACES ✓ MATERIAL 304 S. STL. FINISH | APPD | | | MONSANTO RESEARCH CORPORATION DAYTON LABORATORY DAYTON, OHIO | STANDARD DRAWING | ESJ |
| | APPD | | | | NEUTRON STANDARD SOURCE MODEL 2725-B. | DWG NO. A 2725-BA00 |
| | APPD | W.P. | 9-7-72 | SCALE | 1/4" = 1" | SHEET OF |
| | APPD | ESJ | 9-7-72 | DATE | | |

DIMENSIONS OF MODEL 2726 B

Inner capsule dimensions

Dimensions per drawing number A 2726-BA00, Rev. 4

O.D. = .902 ± .005

I.D. = .812 ± .005

O.L. = 1.743 ± .005

I.L. = N/S

t_h = Thickness of head = .157 ± .005

t_g = Depth of trepan groove = .054 ± .005

t_b = Thickness of bottom = .100 ± .005

t_d = Thickness of wiping disc .100 ± .005

Dimensions to be used or stress calculations

$(O.D.)_s$ = (smallest O.D.) = .897

$(I.D.)_s$ = (largest I.D.) = .812

$(t_w)_s$ = Wall thickness = $1/2[(O.D.)_s - (I.D.)_s]$ =
 $1/2[.897 - .812]$ = .040

$(t_h)_s$ = Head thickness = $[(t_h - tol) - (t_g + tol)]$ =
 $[.152 - .059]$ = .093

$(t_b)_s$ = Bottom thickness = $t_b - tol$ = .095

Dimensions to be used for internal pressure calculations

$(I.D.)_p$ = $(I.D.) - (tol)$ = .807

$(I.L.)_p$ = $[shortest I.L.] - [t_h + tol] - [t_d + tol]$

= _____ - _____ - _____

= _____

or $(I.L.)_p$ = $[O.L. - tol] - [t_h + tol] - [t_b + tol] - [t_d + tol]$

= 1.738 - .162 - .105 - .105

= 1.366

DIMENSIONS OF MODEL 2726 B

Outer capsule dimensions

Dimensions per drawing number A 2726-BA00, Rev. 4

$$O.D. = \underline{1.000 \pm .005}$$

$$I.D. = \underline{.907 \pm .005}$$

$$O.L. = \underline{2.000 \pm .005}$$

$$I.L. = \underline{N/I}$$

$$t_h = \text{Thickness of head} = \underline{.157 \pm .005}$$

$$t_g = \text{Depth of trepan groove} = \underline{N/I \text{ (see dwg.)}}$$

$$t_b = \text{Thickness of bottom} = \underline{.100 \begin{matrix} + .005 \\ - .000 \end{matrix}}$$

Dimensions to be used for stress calculations

$$(O.D.)_s = \text{(smallest O.D.)} = \underline{.995}$$

$$(I.D.)_s = \text{(largest I.D.)} = \underline{.912}$$

$$(t_w)_s = \text{Wall thickness} = 1/2 [(O.D.)_s - (I.D.)_s] = \\ 1/2 [\underline{.995} - \underline{.912}] = \underline{.0415}$$

$$(t_h)_s = \text{Head thickness} = [(t_h - tol) - (t_g + tol)] = \\ [\underline{\text{see dwg.}}] = \underline{.100}$$

$$(t_b)_s = \text{Bottom thickness} = t_b - tol = \underline{.100}$$

RESULTS OF
STRESS AND PRESSURE
CALCULATIONS FOR MODEL 2726 B

INNER CAPSULE

$$P_H = \underline{.01728} \text{ S}, \quad P_C = \underline{.09249} \text{ S}, \quad P_L = \underline{.2038} \text{ S}$$

$$P_S = \underline{.01836} \text{ S Based on a minimum weld penetration of } \underline{.030"} \text{ S}$$

Most restrictive relationship, $P_H = \underline{.01728} \text{ S}$

Maximum internal pressure permitted

At 400°F 222.9 psig (S = 12,900)

At 1475°F 136.8 psig (S = 9,900 x 0.8)

OUTER CAPSULE

$$P_H = \underline{.01603} \text{ S}, \quad P_C = \underline{.08630} \text{ S}, \quad P_L = \underline{.1889} \text{ S}$$

$$P_S = \underline{.01645} \text{ S Based on a minimum weld penetration of } \underline{.030"} \text{ S}$$

Most restrictive relationship, $P_H = \underline{.01603} \text{ S}$

Maximum internal pressure permitted

At 400°F 206.8 psig (S = 12,900)

At 1475°F 127.0 psig (S = 9,900 x 0.8)

Pressure Build-up

Calculated pressure build-up after 10 years with the maximum curie content and the maximum packing fraction as listed in the table below:

| Maximum Curies | Maximum P.F. | Pressure At 400°F, PSIA | Pressure At 1475°F, PSIA |
|----------------|--------------|-------------------------|--------------------------|
| 16 | .50 | 55.1 | 124.1 |
| 10 | .68 | 54.4 | 122.4 |
| 6 | .80 | 53.2 | 119.7 |

These capsules will not deform at operating temperature in a 10 year period and will pass the Special Form Heating Test at 10 years.

DIMENSIONS OF MODEL 2727 B

Inner capsule dimensions

Dimensions per drawing number A 2727-BA00, Rev. 3

O.D. = 1.370 ± .005

I.D. = 1.250 ± .005

O.L. = 2.122 ± .005

I.L. = N/I

t_h = Thickness of head = .225 ± .005

t_g = Depth of trepan groove = .075 ± .005

t_b = Thickness of bottom = .150 ± .005

t_d = Thickness of wiping disc .050 ± .005

Dimensions to be used or stress calculations

$(O.D.)_s$ = (smallest O.D.) = 1.365

$(I.D.)_s$ = (largest I.D.) = 1.255

$(t_w)_s$ = Wall thickness = $1/2[(O.D.)_s - (I.D.)_s]$ =
 $1/2[$ 1.365 $-$ 1.255 $]$ = .005

$(t_h)_s$ = Head thickness = $[(t_h - tol) - (t_g + tol)]$ =
 $[$.220 $-$.080 $]$ = .140

$(t_b)_s$ = Bottom thickness = $t_b - tol$ = .145

Dimensions to be used for internal pressure calculations

$(I.D.)_p$ = $(I.D.) - (tol)$ = 1.245

$(I.L.)_p$ = $[shortest\ I.L.] - [t_h + tol] - [t_d + tol]$

= _____ - _____ - _____

= _____

or $(I.L.)_p$ = $[O.L. - tol] - [t_h + tol] - [t_b + tol] - [t_d + tol]$
 = 2.117 - .230 - .155 - .055
 = 1.677

DIMENSIONS OF MODEL 2727 B

Outer capsule dimensions

Dimensions per drawing number A 2727-BA00, Rev. 3

$$O.D. = \frac{1.500 \begin{matrix} + .005 \\ - .000 \end{matrix}}{\underline{\hspace{2cm}}}$$

$$I.D. = \frac{1.375 \begin{matrix} + .000 \\ - .005 \end{matrix}}{\underline{\hspace{2cm}}}$$

$$O.L. = \frac{2.500 \pm .005}{\underline{\hspace{2cm}}}$$

$$I.L. = \frac{N/I}{\underline{\hspace{2cm}}}$$

$$t_h = \text{Thickness of head} = \frac{.225 \pm .005}{\underline{\hspace{2cm}}}$$

$$t_g = \text{Depth of trepan groove} = \frac{N/I \text{ (see dwg.)}}{\underline{\hspace{2cm}}}$$

$$t_b = \text{Thickness of bottom} = \frac{.150}{\underline{\hspace{2cm}}}$$

Dimensions to be used for stress calculations

$$(O.D.)_s = (\text{smallest O.D.}) = \frac{1.500}{\underline{\hspace{2cm}}}$$

$$(I.D.)_s = (\text{largest I.D.}) = \frac{1.375}{\underline{\hspace{2cm}}}$$

$$(t_w)_s = \text{Wall thickness} = \frac{1}{2} [(O.D.)_s - (I.D.)_s] = \frac{1}{2} [\underline{1.501} - \underline{1.375}] = \underline{.0625}$$

$$(t_h)_s = \text{Head thickness} = [(t_h - \text{tol}) - (t_g + \text{tol})] = \begin{matrix} \text{see dwg.} \\ \underline{\hspace{2cm}} - \underline{\hspace{2cm}} \end{matrix} = \underline{.150}$$

$$(t_b)_s = \text{Bottom thickness} = t_b - \text{tol} = \underline{.150}$$

RESULTS OF
STRESS AND PRESSURE
CALCULATIONS FOR MODEL 2727 B

INNER CAPSULE

$$P_H = \underline{.01659} S, \quad P_C = \underline{.08327} S, \quad P_L = \underline{.1817} S$$

$$P_S = \underline{.01793} S \text{ Based on a minimum weld penetration of } \underline{.45"}$$

Most restrictive relationship, $P_H = \underline{.01659} S$

Maximum internal pressure permitted

At 400°F 214.0 psig (S = 12,900)

At 1475°F 131.4 psig (S = 9,900 x 0.8)

OUTER CAPSULE

$$P_H = \underline{0.1587} S, \quad P_C = \underline{.08621} S, \quad P_L = \underline{.1887} S$$

$$P_S = \underline{0.1636} S \text{ Based on a minimum weld penetration of } \underline{.045"}$$

Most restrictive relationship, $P_H = \underline{.01587} S$

Maximum internal pressure permitted

At 400°F 204.7 psig (S = 12,900)

At 1475°F 125.7 psig (S = 9,900 x 0.8)

Pressure Build-up

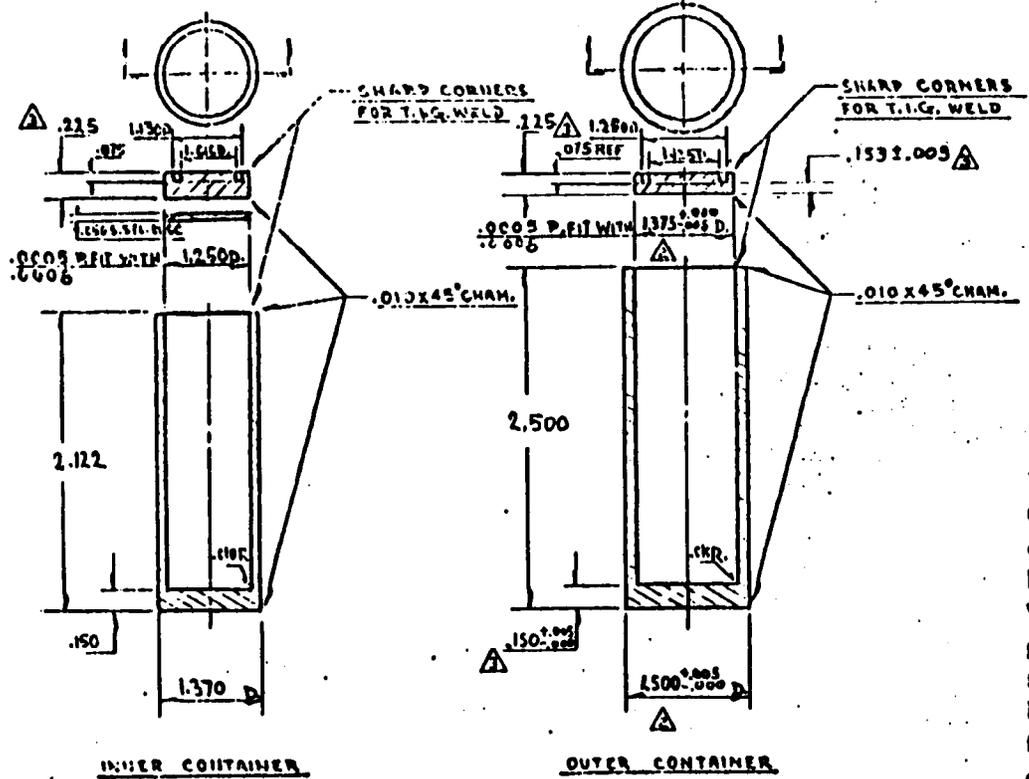
Calculated pressure build-up after 10 years with the maximum curie content and the maximum packing fraction as listed in the table below:

| Maximum Curies | Maximum P.F. | Pressure At 400°F, PSIA | Pressure At 1475°F, PSIA |
|----------------|--------------|-------------------------|--------------------------|
| 47 | .50 | 55.3 | 124.4 |
| 30 | .68 | 55.2 | 124.3 |
| 18 | .80 | 54.0 | 121.5 |

These capsules will not deform at operating temperature in a 10 year period and will pass the Special Form Heating Test at 10 years.

| REVISIONS | | | | |
|-----------|-----|--|---------|--------------------|
| LINE | SYM | DESCRIPTION | DATE | APPROVAL |
| | △ | A2727-BA00 WAS A2727-AA02 | 4-10-74 | <i>[Signature]</i> |
| | △ | 1.500 ^{+0.005} / _{-0.002} WAS 1.500, 1.375 ^{+0.002} / _{-0.002} WAS 1.375 | 4-13-74 | <i>[Signature]</i> |
| | △ | .225 WAS .228; .075 REF WAS .076; .150 ^{+0.002} / _{-0.002} WAS .150; .153 ^{+0.002} / _{-0.002} ADDED; .045 WAS .040 | 5-2-74 | <i>[Signature]</i> |

DWG. NO.



NOTE:

1. DIA. CLEARANCE BETWEEN INNER AND OUTER CONTAINER .002 INCHES MINIMUM.
2. WELD PENETRATION .045" MINIMUM.

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UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

TOLERANCES:

| | |
|-------------|-----------|
| DECIMALS | FRACTIONS |
| XX ± .02 | 1/4 |
| .XXX ± .005 | ANGLES |
| .XXXX BASIC | 32' ± 30' |

ALL SURFACES ✓

MATERIALS: S STEEL

FINISH

| | | |
|-----------|---------------|----------|
| APPD | | |
| APPD | | |
| APPD | <i>H.A.M.</i> | 12-73 |
| APPD | <i>C.E.R.</i> | 12-29-72 |
| CHECKED | <i>C.E.R.</i> | 12-29-72 |
| DESIGN | <i>R.R.</i> | 12-29-72 |
| SIGNATURE | | DATE |

MONSANTO RESEARCH CORPORATION.
DAYTON LABORATORY
DAYTON, OHIO

| | | | |
|--|----------------|---------------------------------|-----------------|
| NEUTRON SOURCE CONTAINER MODEL 2727-B | | STANDARD DRAWING | E.P. N.R. |
| SCALE | | DWG NO. A 2727-BA00 △ | REV 3 |
| WT CALC ACT. | CODE IDENT NO. | SHEET | OF |

DIMENSIONS OF MODEL 2728 B

Inner capsule dimensions

Dimensions per drawing number A 2728-BA00

$$\text{O.D.} = \underline{1.370 \pm .005}$$

$$\text{I.D.} = \underline{1.250 \pm .005}$$

$$\text{O.L.} = \underline{3.122 \pm .005}$$

$$\text{I.L.} = \underline{\text{N/I}}$$

$$t_h = \text{Thickness of head} = \underline{.225 \pm .005}$$

$$t_g = \text{Depth of trepan groove} = \underline{.075 \pm .005}$$

$$t_b = \text{Thickness of bottom} = \underline{.150 \pm .005}$$

$$t_d = \text{Thickness of wiping disc} = \underline{.050 \pm .005}$$

Dimensions to be used or stress calculations

$$(\text{O.D.})_s = (\text{smallest O.D.}) = \underline{1.365}$$

$$(\text{I.D.})_s = (\text{largest I.D.}) = \underline{1.255}$$

$$\begin{aligned}
 (t_w)_s &= \text{Wall thickness} = 1/2[(\text{O.D.})_s - (\text{I.D.})_s] = \\
 &1/2[\underline{1.365} - \underline{1.255}] = \underline{.055}
 \end{aligned}$$

$$\begin{aligned}
 (t_h)_s &= \text{Head thickness} = [(t_h - \text{tol}) - (t_g + \text{tol})] = \\
 &[\underline{.220} - \underline{.080}] = \underline{.140}
 \end{aligned}$$

$$(t_b)_s = \text{Bottom thickness} = t_b - \text{tol} = \underline{.145}$$

Dimensions to be used for internal pressure calculations

$$(\text{I.D.})_p = (\text{I.D.}) - (\text{tol}) = \underline{1.245}$$

$$\begin{aligned}
 (\text{I.L.})_p &= [\text{shortest I.L.}] - [t_h + \text{tol}] - [t_d + \text{tol}] \\
 &= \underline{\hspace{2cm}} - \underline{\hspace{2cm}} - \underline{\hspace{2cm}} \\
 &= \underline{\hspace{2cm}}
 \end{aligned}$$

$$\begin{aligned}
 \text{or } (\text{I.L.})_p &= [\text{O.L.} - \text{tol}] - [t_h + \text{tol}] - [t_b + \text{tol}] - [t_d + \text{tol}] \\
 &= \underline{3.117} - \underline{.230} - \underline{.155} - \underline{.055} \\
 &= \underline{2.677}
 \end{aligned}$$

DIMENSIONS OF MODEL 2728 B

Outer capsule dimensions

Dimensions per drawing number A 2728-BA00, Rev. 1

$$O.D. = \frac{1.500 - \overset{+.005}{.000}}{\quad}$$

$$I.D. = \frac{1.375 \pm .005}{\quad}$$

$$O.L. = \frac{3.500 \pm .005}{\quad}$$

$$I.L. = \frac{N/I}{\quad}$$

$$t_h = \text{Thickness of head} = \frac{.225 \pm .005}{\quad}$$

$$t_g = \text{Depth of trepan groove} = \frac{N/I \text{ (see dwg.)}}{+.005}$$

$$t_b = \text{Thickness of bottom} = \frac{.150 - .000}{\quad}$$

Dimensions to be used for stress calculations

$$(O.D.)_s = (\text{smallest O.D.}) = \frac{1.500}{\quad}$$

$$(I.D.)_s = (\text{largest I.D.}) = \frac{1.380}{\quad}$$

$$(t_w)_s = \text{Wall thickness} = 1/2 [(O.D.)_s - (I.D.)_s] = \\ 1/2 [\frac{1.500}{\quad} - \frac{1.380}{\quad}] = \frac{.060}{\quad}$$

$$(t_h)_s = \text{Head thickness} = [(t_h - tol) - (t_g + tol)] = \\ [\quad \text{(see drawing)} \quad] = \frac{.150}{\quad}$$

$$(t_b)_s = \text{Bottom thickness} = t_b - tol = \frac{.150}{\quad}$$

RESULTS OF
STRESS AND PRESSURE
CALCULATIONS FOR MODEL 2728 B

INNER CAPSULE

$$P_H = \underline{.01659} \text{ S}, \quad P_C = \underline{.08327} \text{ S}, \quad P_L = \underline{.1817} \text{ S}$$

$$P_S = \underline{.01793} \text{ S Based on a minimum weld penetration of } \underline{.045''}$$

Most restrictive relationship, $P_H = \underline{.01659} \text{ S}$

Maximum internal pressure permitted

At 400°F 214.0 psig (S = 12,900)

At 1475°F 131.4 psig (S = 9,900 x 0.8)

OUTER CAPSULE

$$P_H = \underline{.01575} \text{ S}, \quad P_C = \underline{.08264} \text{ S}, \quad P_L = \underline{.1802} \text{ S}$$

$$P_S = \underline{.01630} \text{ S Based on a minimum weld penetration of } \underline{.045''}$$

Most restrictive relationship, $P_H = \underline{.01575} \text{ S}$

Maximum internal pressure permitted

At 400°F 203.2 psig (S = 12,900)

At 1475°F 124.8 psig (S = 9,900 x 0.8)

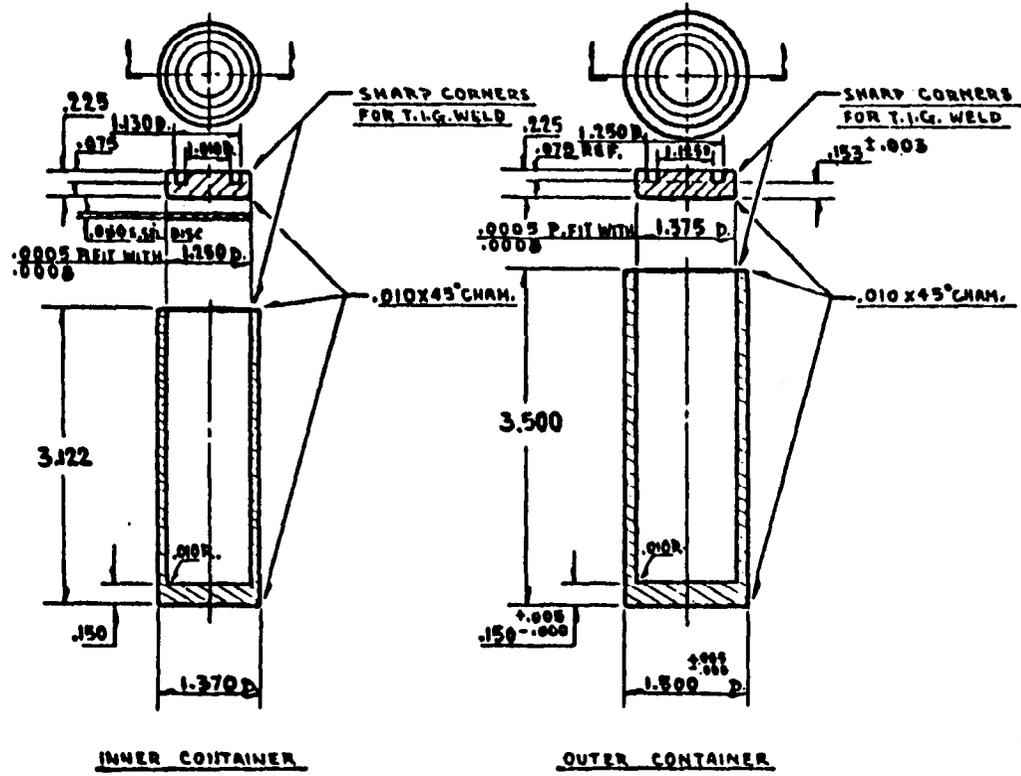
Pressure Build-up

Calculated pressure build-up after 10 years with the maximum curie content and the maximum packing fraction as listed in the table below:

| Maximum Curies | Maximum P.F. | Pressure At 400°F, PSIA | Pressure At 1475°F, PSIA |
|----------------|--------------|-------------------------|--------------------------|
| 75 | .50 | 55.3 | 124.4 |
| 45 | .68 | 53.3 | 120.0 |
| 30 | .80 | 55.3 | 124.4 |

These capsules will not deform at operating temperature in a 10 year period and will pass the Special Form Heating Test at 10 years.

| ZONE | | SYM | DESCRIPTION | DATE | APPROVAL |
|------|--|-----|------------------------|---------|---------------|
| | | Δ | D.E., MFG., G.A. ADDED | 11-6-75 | <i>E.H.G.</i> |



- NOTES:
1. DIA. CLEARANCE BETWEEN INNER AND OUTER CONTAINER .005 NOMINAL .002 MINIMUM.
 2. MINIMUM WELD PENETRATION .045.

NOTICE

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UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
 TOLERANCES:
 DECIMALS FRACTIONS
 .XX = ±.005 ± 64
 .XXX = ±.003 ANGLES
 .XXXX BASIC 32' ± 30'
 ALL SURFACES ✓
 MATERIAL 304 ST. STEEL
 FINISH _____

| | | |
|-----------|---------------|---------|
| APPD | | |
| QA APPD | <i>H.C.</i> | 11/6/75 |
| MFG APPD | <i>A.P.</i> | 5-8-74 |
| DR APPD | <i>E.H.G.</i> | 5-8-74 |
| CHECKED | <i>E.H.G.</i> | 5-8-74 |
| DRAWN | <i>V.P.</i> | 5-8-74 |
| SIGNATURE | | DATE |

MONSANTO RESEARCH CORPORATION
 DAYTON LABORATORY
 DAYTON, OHIO

NEUTRON SOURCE CONTAINER
MODEL 2728-B

| | | | | | |
|-------|----|-----------|----------------|-------------------|---------------|
| SCALE | WT | CALC ACT. | CODE IDENT NO. | STANDARD DRAWING | <i>E.H.G.</i> |
| | | | | DWG NO. | <i>455</i> |
| | | | | A2728-BA00 | 1 |
| | | | | SHEET | OF |

DWG. NO.

DIMENSIONS OF MODEL 2721 C

Inner capsule dimensions

Dimensions per drawing number C 2721-CA00, Rev. 0

O.D. = .397/.401

I.D. = .315 ± .005

O.L. = .275 ± .005

I.L. = .170 ± .005

t_h = Thickness of head = .100 ± .005

t_g = Depth of trepan groove = N/A

t_b = Thickness of bottom = .105 ± .010

t_d = Thickness of wiping disc N/A

Dimensions to be used or stress calculations

$(O.D.)_s$ = (smallest O.D.) = .397

$(I.D.)_s$ = (largest I.D.) = .320

$(t_w)_s$ = Wall thickness = $1/2[(O.D.)_s - (I.D.)_s]$ =
 $1/2[.397 - .320]$ = .0385

$(t_h)_s$ = Head thickness = $[(t_h - tol) - (t_g + tol)]$ =
 $[.095 - 0]$ = .095

$(t_b)_s$ = Bottom thickness = $t_b - tol$ = .095

Dimensions to be used for internal pressure calculations

$(I.D.)_p$ = $(I.D.) - (tol)$ = .310

$(I.L.)_p$ = $[shortest\ I.L.] - [t_h + tol] - [t_d + tol]$
 $= .165 - .105 - 0$
 $=$.060

or $(I.L.)_p$ = $[O.L. - tol] - [t_h + tol] - [t_b + tol] - [t_d + tol]$
 $=$ _____
 $=$ _____

DIMENSIONS OF MODEL 2721 C

Outer capsule dimensions

Dimensions per drawing number C 2721-CA00 Rev. 0

O.D. = .500 ± .005

I.D. = .405/.411

O.L. = .495 ± .005

I.L. = .395 ± .005

t_h = Thickness of head = .100 ± .005

t_g = Depth of trepan groove = N/A

t_b = Thickness of bottom = .105 ± .

Dimensions to be used for stress calculations

$(O.D.)_s$ = (smallest O.D.) = .495

$(I.D.)_s$ = (largest I.D.) = .411

$(t_w)_s$ = Wall thickness = $1/2 [(O.D.)_s - (I.D.)_s] =$
 $1/2 [\underline{.495} - \underline{.411}] = \underline{.042}$

$(t_h)_s$ = Head thickness = $[(t_h - tol) - (t_g + tol)] =$
 $[\underline{.095} - \underline{0}] = \underline{.095}$

$(t_b)_s$ = Bottom thickness = $t_b - tol = \underline{.095}$

RESULTS OF
STRESS AND PRESSURE
CALCULATIONS FOR MODEL 2721 C

INNER CAPSULE

$$P_H \text{ (LID)} = \underline{.1175 S}, \quad P_H \text{ (BOT)} = \underline{.1763 S}, \quad P_C = \underline{.2103 S}, \quad P_L = \underline{.5325 S}$$

$$P_S = \underline{.04219 S} \text{ Based on a minimum weld penetration of } \underline{.027''}$$

Most restrictive relationship, $P_S = \underline{.04219 S}$

Maximum internal pressure permitted

At 400°F 544.2 psig (S = 12,900)

At 1475°F 334.1 psig (S = 9,900 x 0.8)

OUTER CAPSULE

$$P_H = \text{(LID)} = \underline{.07124 S}, \quad P_H \text{ (BOT)} = \underline{.1069 S}, \quad P_C = \underline{.1821 S}, \quad P_L = \underline{.4452 S}$$

$$P_S = \underline{.03285 S} \text{ Based on a minimum weld penetration of } \underline{.027''}$$

Most restrictive relationship, $P = \underline{.03285 S}$

Maximum internal pressure permitted

At 400°F 423.7 psig (S = 12,900)

At 1475°F 260.1 psig (S = 9,900 x 0.8)

Pressure Build-up

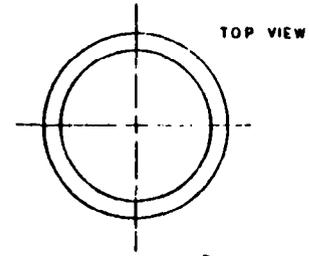
Calculated pressure build-up after 10 years with the maximum curie content and the maximum packing fraction as listed in the table below:

| Maximum Curies | Maximum P.F. | Pressure At 400°F, PSIA | Pressure At 1475°F, PSIA |
|----------------|--------------|-------------------------|--------------------------|
| 0.3 | 0.50 | 114.2 | 257.0 |
| 0.19 | 0.68 | 113.3 | 254.9 |
| 0.12 | 0.80 | 114.2 | 257.0 |

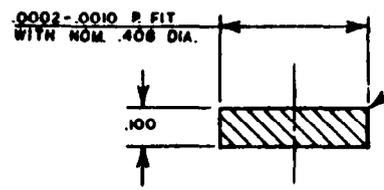
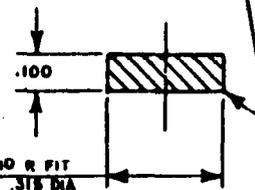
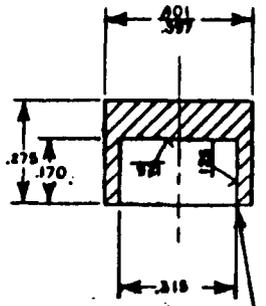
These capsules will not deform at operating temperature in a 10 year period and will pass the Special Form Heating Test at 10 years.

| REVISIONS | | | | DATE | APPROVAL |
|-----------|----|-------------|------|----------|----------|
| ZONE | BY | DESCRIPTION | DATE | APPROVAL | |
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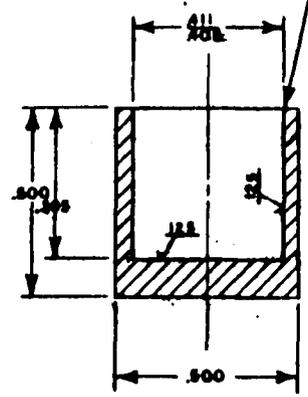
- NOTES:
1. MIN. WELD PENETRATION $-.027"$ FOR EACH CONTAINER.
 2. UNLESS OTHERWISE SPECIFIED: BREAK OUTSIDE CORNERS $.010 - .020"$
 3. *INDICATES VISUAL INSPECTION IS ACCEPTABLE.
 4. INNER CAPSULE TO BE INSERTED WELDED END FIRST INTO THE OUTER CAPSULE.
 5. IF NECESSARY, S.S. SPRINGS MAY BE PLACED BETWEEN INNER AND OUTER CONTAINER TO LIMIT MOVEMENT.



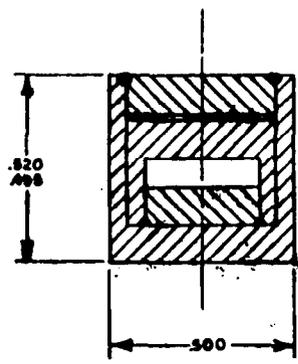
INNER CONTAINER



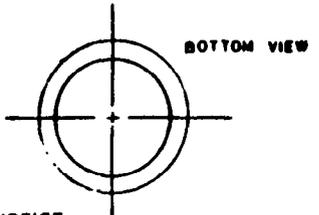
LEAVE SHARP,* NO BURRS



OUTER CONTAINER



COMPLETED ASSEMBLY



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| | |
|----------|----|
| WORK NO. | |
| SHEET | OF |

| | | | | |
|--|----------|--------|--------|--|
| UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES DECIMALS FRACTIONS .XX $-.02$.XXX $-.005$.XXXX BASIC ALL SURFACES MATERIAL FINISH | APPROVED | RPK | 2-7-51 | MONSANTO RESEARCH CORPORATION DAYTON LABORATORY DAYTON, OHIO |
| | DESIGNED | DFH | 3/1/51 | |
| | CHECKED | HE | 3/7/51 | |
| | DATE | 2-4-51 | 2-4-51 | |
| NEUTRON SOURCE CONTAINER MODEL 2721 - C | | | | WORK NO. C2721-CA00 |
| SIGNATURE | | DATE | | SCALE 4:1 WT CALS ACT. |
| | | | | SHEET OF |

68

B

A

B

A

DIMENSIONS OF MODEL 2722 C

Inner capsule dimensions .

Dimensions per drawing number C2722-CA00 Rev. 0

$$O.D. = \underline{.397 / .401}$$

$$I.D. = \underline{.315 \pm .005}$$

$$O.L. = \underline{.475 \pm .005}$$

$$I.L. = \underline{.370 \pm .005}$$

$$t_h = \text{Thickness of head} = \underline{.100 \pm .005}$$

$$t_g = \text{Depth of trepan groove} = \underline{N/A}$$

$$t_b = \text{Thickness of bottom} = \underline{.105 \pm .010}$$

$$t_d = \text{Thickness of wiping disc} = \underline{N/A}$$

Dimensions to be used or stress calculations

$$(O.D.)_s = (\text{smallest } O.D.) = \underline{.397}$$

$$(I.D.)_s = (\text{largest } I.D.) = \underline{.320}$$

$$(t_w)_s = \text{Wall thickness} = 1/2[(O.D.)_s - (I.D.)_s] = \\ 1/2[\underline{.397} - \underline{.320}] = \underline{.0385}$$

$$(t_h)_s = \text{Head thickness} = [(t_h - tol) - (t_g + tol)] = \\ [\underline{.095} - \underline{0}] = \underline{.095}$$

$$(t_b)_s = \text{Bottom thickness} = t_b - tol = \underline{.095}$$

Dimensions to be used for internal pressure calculations

$$(I.D.)_p = (I.D.) - (tol) = \underline{.310}$$

$$(I.L.)_p = [\text{shortest } I.L.] - [t_h + tol] - [t_d + tol] \\ = \underline{.365} - \underline{.105} - \underline{0} \\ = \underline{.260}$$

$$\text{or } (I.L.)_p = [O.L. - tol] - [t_h + tol] - [t_b + tol] - [t_d + tol] \\ = \underline{\hspace{2cm}} - \underline{\hspace{2cm}} - \underline{\hspace{2cm}} - \underline{\hspace{2cm}} \\ = \underline{\hspace{2cm}}$$

DIMENSIONS OF MODEL 2722 C

Outer capsule dimensions

Dimensions per drawing number C 2722-CA00 Rev. 0

O.D. = .500 ± .005

I.D. = .405/.411

O.L. = .695/.720

I.L. = .595 ± .005

t_h = Thickness of head = .100 ± .005

t_g = Depth of trepan groove = N/A

t_b = Thickness of bottom = .105 ± .010

Dimensions to be used for stress calculations

$(O.D.)_s$ = (smallest O.D.) = .495

$(I.D.)_s$ = (largest I.D.) = .411

$(t_w)_s$ = Wall thickness = $1/2 [(O.D.)_s - (I.D.)_s]$ =
 $1/2 [\underline{.495} - \underline{.411}] = \underline{.042}$

$(t_h)_s$ = Head thickness = $[(t_h - tol) - (t_g + tol)]$ =
 $[\underline{.095} - \underline{0}] = \underline{.095}$

$(t_b)_s$ = Bottom thickness = $t_b - tol = \underline{.095}$

RESULTS OF
STRESS AND PRESSURE
CALCULATIONS FOR MODEL 2722 C

INNER CAPSULE

P_H (LID) = .1175 S, P_H (BOT) = .1763 S, P_c = .2103 S, P_L = .5325 S
 P_S = .04219 S Based on a minimum weld penetration of .027

Most restrictive relationship, $P_s =$.04219 S

Maximum internal pressure permitted

At 400°F 544.2 psig (S = 12,900)

At 1475°F 334.1 psig (S = 9,900 x 0.8)

OUTER CAPSULE

P_H (LID) = .07124 S, P_H (BOT) = .1069 S, P_c = .1821 S P_L = .4452 S
 P_S = .03285 S Based on a minimum weld penetration of .027

Most restrictive relationship, $P_s =$.03285 S

Maximum internal pressure permitted

At 400°F 423.7 psig (S = 12,900)

At 1475°F 260.1 psig (S = 9,900 x 0.8)

Pressure Build-up

Calculated pressure build-up after 10 years with the maximum curie content and the maximum packing fraction as listed in the table below:

| Maximum Curies | Maximum P.F. | Pressure At 400°F, PSIA | Pressure At 1475°F, PSIA |
|----------------|--------------|-------------------------|--------------------------|
| 1.3 | 0.50 | 114.2 | 257.0 |
| 0.84 | 0.68 | 115.1 | 258.9 |
| 0.52 | 0.80 | 114.2 | 257.0 |

These capsules will not deform at operating temperature in a 10 year period and will pass the Special Form Heating Test at 10 years.

B

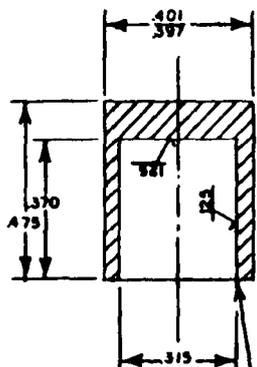
A

| REVISIONS | | | | DESIGNATIONS | |
|-----------|----|-------------|------|--------------|--|
| ZONE | BY | DESCRIPTION | DATE | APPROVAL | |
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NOTES:

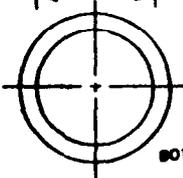
1. MIN. WELD PENETRATION $\approx .007$ " FOR EACH CONTAINER.
2. UNLESS OTHERWISE SPECIFIED: BREAK OUTSIDE CORNERS $.010 \pm .000$.
3. *INDICATES VISUAL INSPECTION IS ACCEPTABLE.
4. INNER CAPSULE TO BE INSERTED WELDED END FIRST INTO THE OUTER CAPSULE.
5. IF NECESSARY, S.S. SHIMS MAY BE PLACED BETWEEN INNER AND OUTER CONTAINER TO LIMIT MOVEMENT.

INNER CONTAINER



$.0002 - .0010$ P. FIT WITH NOM. $.315$ DIA.

LEAVE SHARP * NO BURRS



BOTTOM VIEW

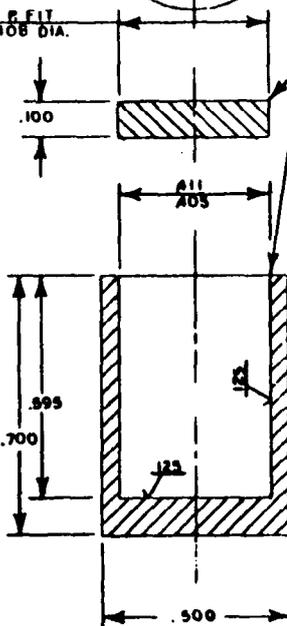
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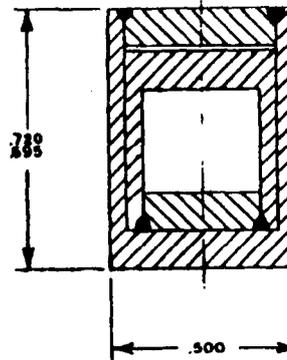
TOP VIEW

$.0002 - .0010$ P. FIT WITH NOM. $.408$ DIA.

LEAVE SHARP * NO BURRS



OUTER CONTAINER



COMPLETED ASSEMBLY

| | |
|----------|------|
| DRW. NO. | REV. |
| SHEET | OF |

| | | | | | |
|---|---------------------------|--|---|---|---|
| UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES | | DRAWN BY <i>RRH</i> DATE <i>5/10/64</i> CHECKED BY <i>JAB</i> DATE <i>5/10/64</i> | | MONSANTO RESEARCH CORPORATION DAYTON LABORATORY DAYTON, OHIO | |
| DECIMALS | FRACTIONS | DRW. NO. <i>378</i> DE APP. <i>JAB</i> DATE <i>5-12-64</i> | CHECKED BY <i>JAB</i> DATE <i>5-12-64</i> | | |
| .XX $\approx .02$.XXX $\approx .005$.XXXX BASIC ALL SURFACES | ANGLES $\approx 90^\circ$ | MATERIAL <i>304 SS</i> | FINISH | SCALE 4:1 WT. CALS. ACT. | DRW. NO. C 2722-CA00 REV. 0 |
| SIGNATURE | | DATE | SCALE 4:1 | WT. CALS. ACT. | SHEET OF |

2
93

2

DIMENSIONS OF MODEL 2723 C

Inner capsule dimensions

Dimensions per drawing number C 2723-CA00 Rev. 0

O.D. = .646/.650

I.D. = .562 ± .005

O.L. = .595 ± .005

I.L. = .500 ± .005

t_h = Thickness of head = .150 ± .005

t_g = Depth of trepan groove = .050 ± .005

t_b = Thickness of bottom = .095 ± .010

t_d = Thickness of wiping disc .100 ± .005

Dimensions to be used or stress calculations

$(O.D.)_s$ = (smallest O.D.) = .646

$(I.D.)_s$ = (largest I.D.) = .567

$(t_w)_s$ = Wall thickness = $1/2[(O.D.)_s - (I.D.)_s]$ =
 $1/2[.646 - .567] = .0395$

$(t_h)_s$ = Head thickness = $[(t_h - tol) - (t_g + tol)]$ =
 $[.145 - .055] = .090$

$(t_b)_s$ = Bottom thickness = $t_b - tol = .085$

Dimensions to be used for internal pressure calculations

$(I.D.)_p$ = $(I.D.) - (tol) = .557$

$(I.L.)_p$ = $[shortest I.L.] - [t_h + tol] - [t_d + tol]$
 $= .495 - .155 - .105$
 $= .235$

or $(I.L.)_p = [O.L. - tol] - [t_h + tol] - [t_b + tol] - [t_d + tol]$
 $=$ _____
 $=$ _____

DIMENSIONS OF MODEL 2723 C

Outer capsule dimensions

Dimensions per drawing number C2723-CA00 Rev. 0

O.D. = .750 ± .005

I.D. = .654 / .660

O.L. = .865 / .890

I.L. = .765 ± .005

t_h = Thickness of head = .150 ± .005

t_g = Depth of trepan groove = .050 ± .005

t_b = Thickness of bottom = .095 ± .010

Dimensions to be used for stress calculations

$(O.D.)_s$ = (smallest O.D.) = .745

$(I.D.)_s$ = (largest I.D.) = .660

$(t_w)_s$ = Wall thickness = $1/2 [(O.D.)_s - (I.D.)_s]$ =
 $1/2 [$.745 $-$.660 $]$ = .0425

$(t_h)_s$ = Head thickness = $[(t_h - tol) - (t_g + tol)]$ =
 $[$.145 $-$.055 $]$ = .090

$(t_b)_s$ = Bottom thickness = $t_b - tol$ = .085

RESULTS OF
STRESS AND PRESSURE
CALCULATIONS FOR MODEL 2723 C

INNER CAPSULE

$$P_H \text{ (LID)} = \underline{.03359 S}, \quad P_H \text{ (BOT)} = \underline{.04495 S}, \quad P_C = \underline{.1286 S}, \quad P_L = \underline{.2951 S}$$

$$P_S = \underline{.02646 S} \text{ Based on a minimum weld penetration of } \underline{.030"}$$

Most restrictive relationship, $P = \underline{.02646 S}$

Maximum internal pressure permitted

At 400°F 341.3 psig (S = 12,900)

At 1475°F 209.5 psig (S = 9,900 x 0.8)

OUTER CAPSULE

$$P_H \text{ (LID)} = \underline{.02479 S}, \quad P_H \text{ (BOT)} = \underline{.03317 S}, \quad P_C = \underline{.1196 S}, \quad P_L = \underline{.2716 S}$$

$$P_S = \underline{.02273 S} \text{ Based on a minimum weld penetration of } \underline{.030"}$$

Most restrictive relationship, $P = \underline{.02273 S}$

Maximum internal pressure permitted

At 400°F 293.2 psig (S = 12,900)

At 1475°F 180.0 psig (S = 9,900 x 0.8)

Pressure Build-up

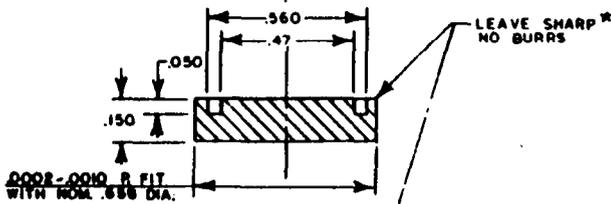
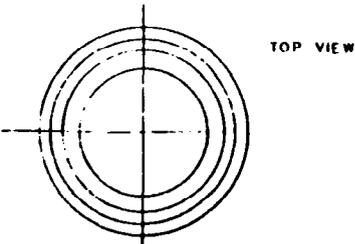
Calculated pressure build-up after 10 years with the maximum curie content and the maximum packing fraction as listed in the table below:

| Maximum Curies | Maximum P.F. | Pressure At 400°F, PSIA | Pressure At 1475°F, PSIA |
|----------------|--------------|-------------------------|--------------------------|
| 2.35 | 0.5 | 79.8 | 179.7 |
| 1.50 | 0.68 | 79.7 | 179.4 |
| 0.94 | 0.80 | 79.8 | 179.7 |

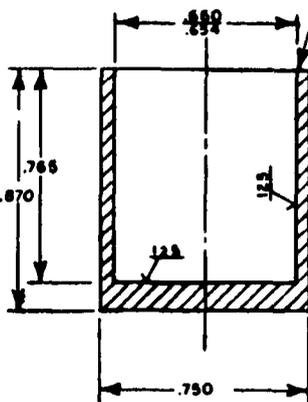
These capsules will not deform at operating temperature in a 10 year period and will pass the Special Form Heating Test at 10 years.

| REVISIONS | | | | DATE | APPROVAL |
|-----------|-----|-------------|------|----------|----------|
| ZONE | SYM | DESCRIPTION | DATE | APPROVAL | |
| | | | | | |
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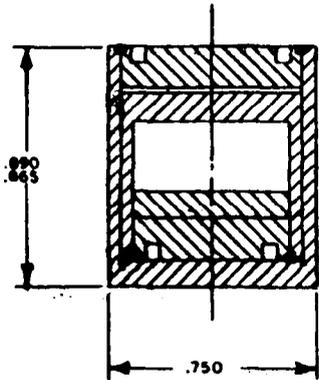
- NOTES:
1. MIN. WELD PENETRATION $\approx .030"$ FOR EACH CONTAINER.
 2. UNLESS OTHERWISE SPECIFIED, BREAK OUTSIDE CORNERS $.010 \sqrt{R}$ RADIUS INSIDE CORNERS $.010"$
 3. *INDICATE VISUAL INSPECTION IS ACCEPTABLE.
 4. INNER CAPSULE TO BE INSERTED WELDED END FIRST INTO THE OUTER CAPSULE.
 5. IF NECESSARY, S.S. SHIMS MAY BE PLACED BETWEEN INNER AND OUTER CONTAINER TO LIMIT MOVEMENT.



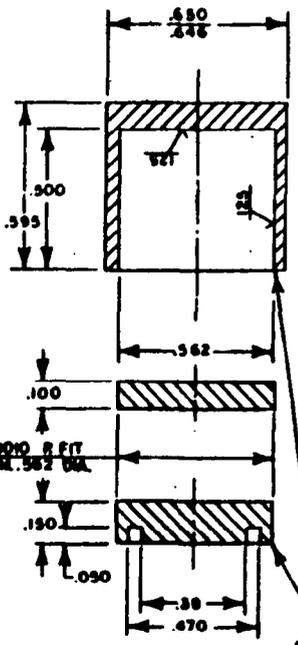
INNER CONTAINER



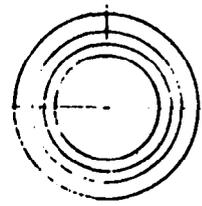
OUTER CONTAINER



COMPLETE ASSEMBLY



BOTTOM VIEW



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| | | | | | |
|---|--|------------------------|--|--|--|
| UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES | | MS RKH 3-10-61 | | MONSANTO RESEARCH CORPORATION DAYTON LABORATORY DAYTON, OHIO | |
| TOLERANCES: | | DATE JFK 3/10/61 | | | |
| DECIMALS | | FRACTIONS | | NEUTRON SOURCE CONTAINER MODEL 2723-C | |
| .XX = .02 | | ANGLES | | | |
| .XXX = .005 | | ALL SURFACES | | DATE JFK 3/10/61 | |
| .XXX BASIC | | MATERIAL 304 S.S. | | SHEET NO. C2723-CA00 | |
| FINISH | | SIGNATURE HAM | | REV 0 | |
| DATE | | SCALE 3:1 | | SHEET OF | |
| WT | | CALC | | DATE | |
| ACT. | | DATE | | DATE | |

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DIMENSIONS OF MODEL 2724 C

Inner capsule dimensions

Dimensions per drawing number C 2724-CA00 Rev. 0

$$\text{O.D.} = \frac{.898/.902}{\text{_____}}$$

$$\text{I.D.} = \frac{.812 \pm .005}{\text{_____}}$$

$$\text{O.L.} = \frac{.825 \pm .005}{\text{_____}}$$

$$\text{I.L.} = \frac{.720 \pm .005}{\text{_____}}$$

$$t_h = \text{Thickness of head} = \frac{.160 \pm .005}{\text{_____}}$$

$$t_g = \text{Depth of trepan groove} = \frac{.050 \pm .005}{\text{_____}}$$

$$t_b = \text{Thickness of bottom} = \frac{.105 \pm .010}{\text{_____}}$$

$$t_d = \text{Thickness of wiping disc} = \frac{.100 \pm .005}{\text{_____}}$$

Dimensions to be used or stress calculations

$$(\text{O.D.})_s = (\text{smallest O.D.}) = \frac{.898}{\text{_____}}$$

$$(\text{I.D.})_s = (\text{largest I.D.}) = \frac{.817}{\text{_____}}$$

$$\begin{aligned} (t_w)_s &= \text{Wall thickness} = 1/2[(\text{O.D.})_s - (\text{I.D.})_s] = \\ &1/2[\frac{.898}{\text{_____}} - \frac{.817}{\text{_____}}] = \frac{.0405}{\text{_____}} \end{aligned}$$

$$\begin{aligned} (t_h)_s &= \text{Head thickness} = [(t_h - \text{tol}) - (t_g + \text{tol})] = \\ &[\frac{.155}{\text{_____}} - \frac{.055}{\text{_____}}] = \frac{.100}{\text{_____}} \end{aligned}$$

$$(t_b)_s = \text{Bottom thickness} = t_b - \text{tol} = \frac{.095}{\text{_____}}$$

Dimensions to be used for internal pressure calculations

$$(\text{I.D.})_p = (\text{I.D.}) - (\text{tol}) = \frac{.807}{\text{_____}}$$

$$\begin{aligned} (\text{I.L.})_p &= [\text{shortest I.L.}] - [t_h + \text{tol}] - [t_d + \text{tol}] \\ &= \frac{.715}{\text{_____}} - \frac{.165}{\text{_____}} - \frac{.105}{\text{_____}} \\ &= \frac{.445}{\text{_____}} \end{aligned}$$

$$\begin{aligned} \text{or } (\text{I.L.})_p &= [\text{O.L.} - \text{tol}] - [t_h + \text{tol}] - [t_b + \text{tol}] - [t_d + \text{tol}] \\ &= \text{_____} - \text{_____} - \text{_____} - \text{_____} \\ &= \text{_____} \end{aligned}$$

DIMENSIONS OF MODEL 2724 C

Outer capsule dimensions

Dimensions per drawing number C 2724-CA00

O.D. = 1.000 ± .005

I.D. = .906 / .912

O.L. = 1.120 ± .005

I.L. = 1.015 ± .005

t_h = Thickness of head = .170 ± .005

t_g = Depth of trepan groove = .050 ± .005

t_b = Thickness of bottom = .105 ± .010

Dimensions to be used for stress calculations

$(O.D.)_s$ = (smallest O.D.) = .995

$(I.D.)_s$ = (largest I.D.) = .912

$(t_w)_s$ = Wall thickness = $1/2 [(O.D.)_s - (I.D.)_s]$ =
 $1/2 [\underline{.995} - \underline{.912}] = \underline{.0415}$

$(t_h)_s$ = Head thickness = $[(t_h - tol) - (t_g + tol)]$ =
 $[\underline{.165} - \underline{.055}] = \underline{.110}$

$(t_b)_s$ = Bottom thickness = $t_b - tol = \underline{.095}$

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=

RESULTS OF
STRESS AND PRESSURE
CALCULATIONS FOR MODEL 2724 C

INNER CAPSULE

$$P_H \text{ (LID)} = \underline{.01998S}, \quad P_H \text{ (BOT)} = \underline{.02704S}, \quad P_C = \underline{.0936 S}, \quad P_L = \underline{.2065S}$$

$$P_S = \underline{.01836 S} \text{ Based on a minimum weld penetration of } \underline{.030"}$$

Most restrictive relationship, $P_s = \underline{.01836 S}$

Maximum internal pressure permitted

At 400°F 236.8 psig (S = 12,900)

At 1475°F 145.4 psig (S = 9,900 x 0.8)

OUTER CAPSULE

$$P_H = \text{(LID)} = \underline{.01940S}, \quad P_H \text{ (BOT)} = \underline{.02170S}, \quad P_C = \underline{.08630 S}, \quad P_L = \underline{.1889 S}$$

$$P_S = \underline{.01645 S} \text{ Based on a minimum weld penetration of } \underline{.030"}$$

Most restrictive relationship, $P = \underline{.01645 S}$

Maximum internal pressure permitted

At 400°F 212.2 psig (S = 12,900)

At 1475°F 130.3 psig (S = 9,900 x 0.8)

Pressure Build-up

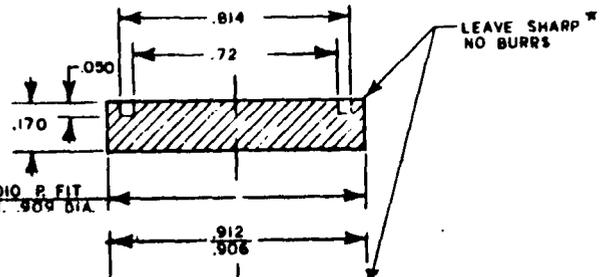
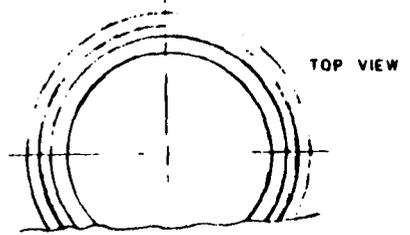
Calculated pressure build-up after 10 years with the maximum curie content and the maximum packing fraction as listed in the table below:

| Maximum Curies | Maximum P.F. | Pressure At 400°F, PSIA | Pressure At 1475°F, PSIA |
|----------------|--------------|-------------------------|--------------------------|
| 5.6 | 0.5 | 57.5 | 129.3 |
| 3.6 | 0.68 | 57.6 | 129.6 |
| 2.2 | 0.80 | 56.9 | 128.0 |

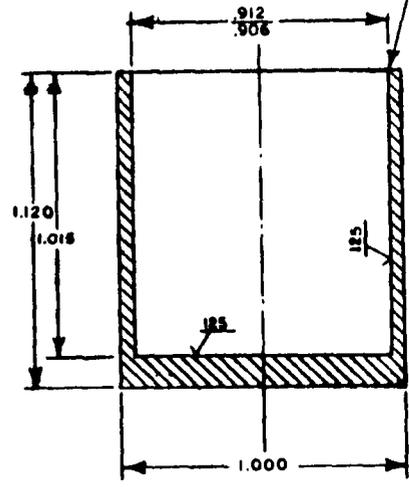
These capsules will not deform at operating temperature in a 10 year period and will pass the Special Form Heating Test at 10 years.

| REVISIONS | | | | |
|-----------|-----|-------------|------|----------|
| ZONE | SYM | DESCRIPTION | DATE | APPROVAL |
| | | | | |
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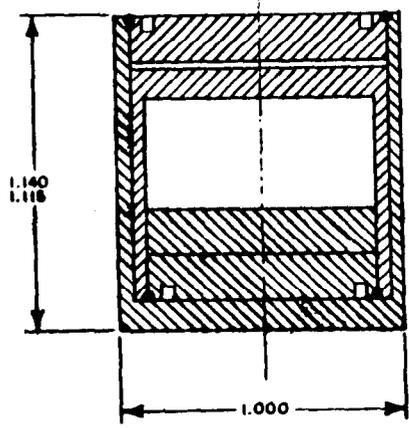
- NOTES:
1. MIN. WELD PENETRATION .030 FOR EACH CONTAINER.
 2. UNLESS OTHERWISE SPECIFIED: BREAK OUTSIDE CORNERS .010 - .005° RADIUS INSIDE CORNERS .010°
 3. *INDICATES VISUAL INSPECTION IS ACCEPTABLE.
 4. INNER CAPSULE TO BE INSERTED WELDED END FIRST INTO THE OUTER CAPSULE.
 5. IF NECESSARY, S.S. SHIMS MAY BE PLACED BETWEEN INNER AND OUTER CONTAINER TO LIMIT MOVEMENT.



.0002-.0010 R FIT WITH NOM. .909 DIA.

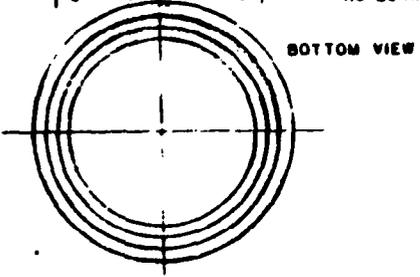
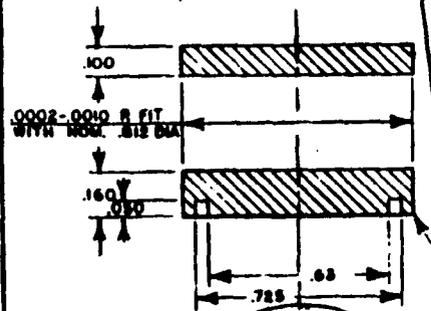
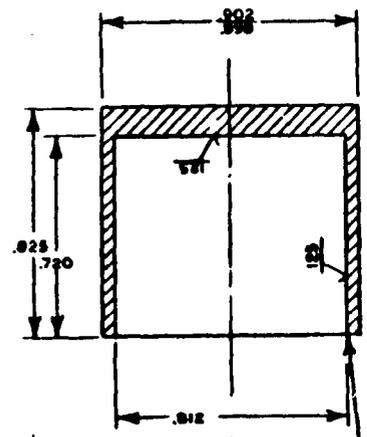


OUTER CONTAINER



COMPLETED ASSEMBLY

INNER CONTAINER



BOTTOM VIEW

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| | | | |
|---|-----------|-----|---------|
| UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES | DRW | RRH | 3-10-62 |
| TOLERANCES: | QA | DEF | KFB |
| DECIMALS | WT | AK | 7/6/61 |
| FRACTIONS | CL | AS | 10/2/62 |
| .XX = .02 | CHECKED | | |
| .XXX = .005 | DRW | HAM | 2-26-62 |
| .XXXX BASIC | DATE | | |
| ALL SURFACES | SIGNATURE | | |
| MATERIAL | | | |
| FINISH | | | |

| | | | |
|-------------------------------|------|----------|--------------|
| MONSANTO RESEARCH CORPORATION | | | |
| DAYTON LABORATORY | | | |
| DAYTON, OHIO | | | |
| NEUTRON SOURCE CONTAINER | | | |
| MODEL 2724 C | | | |
| DRW NO. | REV | SHEET OF | |
| C2724-CA00 | 0 | | |
| SCALE 3:1 | WT | GALS | QCS FROM PL. |
| | ACT. | | |

101

2

DIMENSIONS OF MODEL 2725 C

Inner capsule dimensions

Dimensions per drawing number C 2725-CA00 Rev. 0

$$O.D. = \underline{.898/.902}$$

$$I.D. = \underline{.812 \pm .005}$$

$$O.L. = \underline{1.205 \pm .005}$$

$$I.L. = \underline{1.100 \pm .005}$$

$$t_h = \text{Thickness of head} = \underline{.160 \pm .005}$$

$$t_g = \text{Depth of trepan groove} = \underline{.050 \pm .005}$$

$$t_b = \text{Thickness of bottom} = \underline{.105 \pm .010}$$

$$t_d = \text{Thickness of wiping disc} = \underline{.100 \pm .005}$$

Dimensions to be used or stress calculations

$$(O.D.)_s = (\text{smallest O.D.}) = \underline{.898}$$

$$(I.D.)_s = (\text{largest I.D.}) = \underline{.817}$$

$$(t_w)_s = \text{Wall thickness} = 1/2[(O.D.)_s - (I.D.)_s] = \\ 1/2[\underline{.898} - \underline{.817}] = \underline{.0405}$$

$$(t_h)_s = \text{Head thickness} = [(t_h - tol) - (t_g + tol)] = \\ [\underline{.155} - \underline{.055}] = \underline{.100}$$

$$(t_b)_s = \text{Bottom thickness} = t_b - tol = \underline{.095}$$

Dimensions to be used for internal pressure calculations

$$(I.D.)_p = (I.D.) - (tol) = \underline{.807}$$

$$(I.L.)_p = [\text{shortest I.L.}] - [t_h + tol] - [t_d + tol] \\ = \underline{1.095} - \underline{.100} - \underline{.095} \\ = \underline{0.900}$$

$$\text{or } (I.L.)_p = [O.L. - tol] - [t_h + tol] - [t_b + tol] - [t_d + tol] \\ = \underline{\hspace{2cm}} - \underline{\hspace{2cm}} - \underline{\hspace{2cm}} - \underline{\hspace{2cm}} \\ = \underline{\hspace{2cm}}$$

DIMENSIONS OF MODEL 2725 C

Outer capsule dimensions

Dimensions per drawing number C 2725-CA00 Rev. 0

O.D. = 1.000 ± .005

I.D. = .906/.912

O.L. = 1.495/1.520

I.L. = 1.395

t_h = Thickness of head = .170 ± .005

t_g = Depth of trepan groove = .050 ± .005

t_b = Thickness of bottom = .105 ± .010

Dimensions to be used for stress calculations

$(O.D.)_s$ = (smallest O.D.) = .995

$(I.D.)_s$ = (largest I.D.) = .912

$(t_w)_s$ = Wall thickness = $1/2 [(O.D.)_s - (I.D.)_s]$ =
 $1/2 [\underline{.995} - \underline{.912}] = \underline{.0415}$

$(t_h)_s$ = Head thickness = $[(t_h - tol) - (t_g + tol)]$ =
 $[\underline{.165} - \underline{.055}] = \underline{.110}$

$(t_b)_s$ = Bottom thickness = $t_b - tol = \underline{.095}$

RESULTS OF
STRESS AND PRESSURE
CALCULATIONS FOR MODEL 2725 C

INNER CAPSULE

$$P_H \text{ (LID)} = \underline{.01998} \text{ S}, \quad P_H \text{ (BOT)} = \underline{.02704} \text{ S}, \quad P_C = \underline{.09358} \text{ S}, \quad P_L = \underline{.2065} \text{ S}$$

$$P_S = \underline{.01836} \text{ S Based on a minimum weld penetration of } \underline{.030''}$$

Most restrictive relationship, $P_s = \underline{.01836} \text{ S}$

Maximum internal pressure permitted

At 400°F 236.8 psig (S = 12,900)

At 1475°F 145.4 psig (S = 9,900 x 0.8)

OUTER CAPSULE

$$P_H = \text{(LID)} = \underline{.01940} \text{ S}, \quad P_H \text{ (BOT)} = \underline{.02170} \text{ S}, \quad P_C = \underline{.08630} \text{ S}, \quad P_L = \underline{.1889} \text{ S}$$

$$P_S = \underline{.01645} \text{ S Based on a minimum weld penetration of } \underline{.030''}$$

Most restrictive relationship, $P = \underline{.01645} \text{ S}$

Maximum internal pressure permitted

At 400°F 212.2 psig (S = 12,900)

At 1475°F 130.3 psig (S = 9,900 x 0.8)

Pressure Build-up

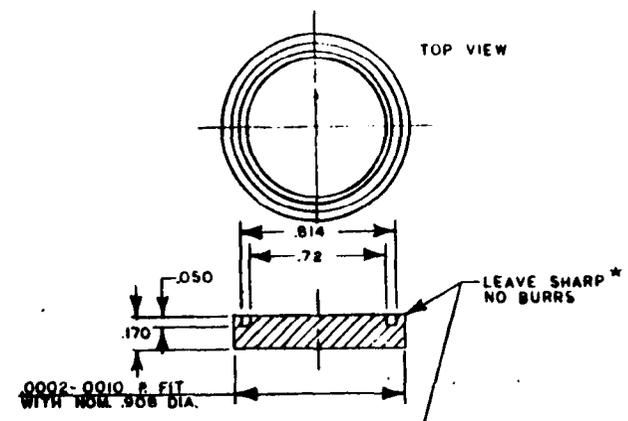
Calculated pressure build-up after 10 years with the maximum curie content and the maximum packing fraction as listed in the table below:

| Maximum Curies | Maximum P.F. | Pressure At 400°F, PSIA | Pressure At 1475°F, PSIA |
|----------------|--------------|-------------------------|--------------------------|
| 11.4 | 0.5 | 57.7 | 129.8 |
| 7.3 | 0.68 | 57.7 | 129.8 |
| 4.5 | 0.80 | 57.2 | 128.8 |

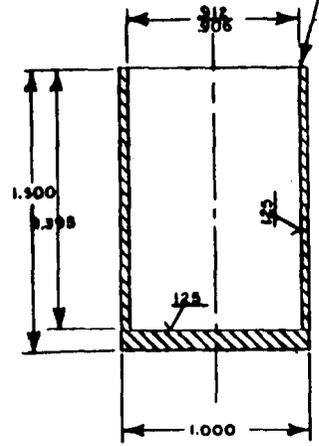
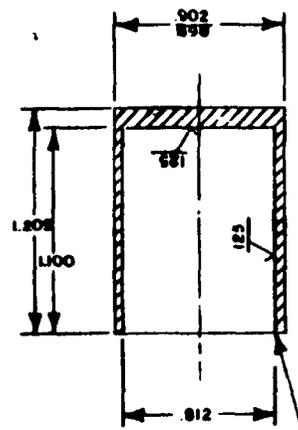
These capsules will not deform at operating temperature in a 10 year period and will pass the Special Form Heating Test at 10 years.

| REVISIONS | | | | |
|-----------|-----|-------------|------|----------|
| ZONE | SYM | DESCRIPTION | DATE | APPROVAL |
| | | | | |
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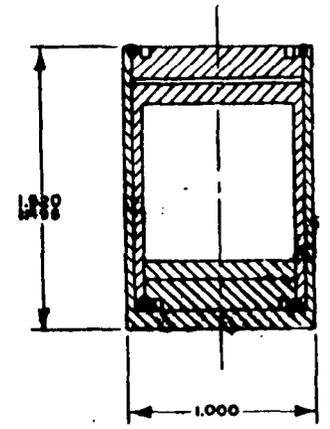
- NOTES:
1. MIN. WELD PENETRATION $\cdot\cdot\cdot\cdot\cdot$ FOR EACH CONTAINER.
 2. UNLESS OTHERWISE SPECIFIED: BREAK OUTSIDE CORNERS $\cdot\cdot\cdot\cdot\cdot$ RADIUS INSIDE CORNERS $\cdot\cdot\cdot\cdot\cdot$
 3. *INDICATES VISUAL INSPECTION IS ACCEPTABLE.
 4. INNER CAPSULE TO BE INSERTED WELDED END FIRST INTO THE OUTER CAPSULE.
 5. IF NECESSARY, S.S. SHIMS MAY BE PLACED BETWEEN INNER AND OUTER CONTAINER TO LIMIT MOVEMENT.



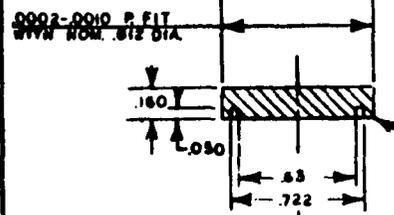
INNER CONTAINER



OUTER CONTAINER



COMPLETED ASSEMBLY



BOTTOM VIEW

LEAVE SHARP * NO BURRS

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| | | | |
|---|------|-------|------|
| UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES | DATE | APP'D | DATE |
| TOLERANCES: | DATE | APP'D | DATE |
| DECIMALS | DATE | APP'D | DATE |
| FRACTIONS | DATE | APP'D | DATE |
| .XX = \pm .02 | DATE | APP'D | DATE |
| .XXX = \pm .005 | DATE | APP'D | DATE |
| ANGLES | DATE | APP'D | DATE |
| XXX BASIC | DATE | APP'D | DATE |
| ALL SURFACES | DATE | APP'D | DATE |
| MATERIAL | DATE | APP'D | DATE |
| FINISH | DATE | APP'D | DATE |

| | | |
|------|-------|------|
| DATE | APP'D | DATE |

MONSANTO RESEARCH CORPORATION
 BAYTON LABORATORY
 BAYTON, MISSISSIPPI

NEUTRON SOURCE CONTAINER
 MODEL 2725-C

SCALE 2:1 WT CALS

DATE NO. C2725-CAOQ

REV 0

105

DIMENSIONS OF MODEL 2726 C

Inner capsule dimensions

Dimensions per drawing number C 2726-CA00 Rev. 0

$$\text{O.D.} = \underline{\underline{.898/.902}}$$

$$\text{I.D.} = \underline{\underline{.812 \pm .005}}$$

$$\text{O.L.} = \underline{\underline{1.705 \pm .005}}$$

$$\text{I.L.} = \underline{\underline{1.600 \pm .005}}$$

$$t_h = \text{Thickness of head} = \underline{\underline{.160 \pm .005}}$$

$$t_g = \text{Depth of trepan groove} = \underline{\underline{.050 \pm .005}}$$

$$t_b = \text{Thickness of bottom} = \underline{\underline{.105 \pm .010}}$$

$$t_d = \text{Thickness of wiping disc} = \underline{\underline{.100 \pm .005}}$$

Dimensions to be used or stress calculations

$$(\text{O.D.})_s = (\text{smallest O.D.}) = \underline{\underline{.898}}$$

$$(\text{I.D.})_s = (\text{largest I.D.}) = \underline{\underline{.817}}$$

$$\begin{aligned} (t_w)_s &= \text{Wall thickness} = 1/2[(\text{O.D.})_s - (\text{I.D.})_s] = \\ &1/2[\underline{\underline{.898}} - \underline{\underline{.817}}] = \underline{\underline{.0405}} \end{aligned}$$

$$\begin{aligned} (t_h)_s &= \text{Head thickness} = [(t_h - \text{tol}) - (t_g + \text{tol})] = \\ &[\underline{\underline{.155}} - \underline{\underline{.055}}] = \underline{\underline{.100}} \end{aligned}$$

$$(t_b)_s = \text{Bottom thickness} = t_b - \text{tol} = \underline{\underline{.095}}$$

Dimensions to be used for internal pressure calculations

$$(\text{I.D.})_p = (\text{I.D.}) - (\text{tol}) = \underline{\underline{.807}}$$

$$\begin{aligned} (\text{I.L.})_p &= [\text{shortest I.L.}] - [t_h + \text{tol}] - [t_d + \text{tol}] \\ &= \underline{\underline{1.595}} - \underline{\underline{.100}} - \underline{\underline{.105}} \\ &= \underline{\underline{1.39}} \end{aligned}$$

$$\begin{aligned} \text{or } (\text{I.L.})_p &= [\text{O.L.} - \text{tol}] - [t_h + \text{tol}] - [t_b + \text{tol}] - [t_d + \text{tol}] \\ &= \underline{\underline{\hspace{2cm}}} - \underline{\underline{\hspace{2cm}}} - \underline{\underline{\hspace{2cm}}} - \underline{\underline{\hspace{2cm}}} \\ &= \underline{\underline{\hspace{2cm}}} \end{aligned}$$

DIMENSIONS OF MODEL 2726 C

Outer capsule dimensions

Dimensions per drawing number C 2726-CA00 Rev. 0

O.D. = 1.000 ± .005

I.D. = .906 / .912

O.L. = 1.995/2.020

I.L. = 1.895 ± .005

t_h = Thickness of head = .170 ± .005

t_g = Depth of trepan groove = .050 ± .005

t_b = Thickness of bottom = .105 ± .010

Dimensions to be used for stress calculations

$(O.D.)_s$ = (smallest O.D.) = .995

$(I.D.)_s$ = (largest I.D.) = .912

$(t_w)_s$ = Wall thickness = $1/2 [(O.D.)_s - (I.D.)_s] =$
 $1/2 [\underline{.995} - \underline{.912}] = \underline{.0415}$

$(t_h)_s$ = Head thickness = $[(t_h - tol) - (t_g + tol)] =$
 $[\underline{.165} - \underline{.055}] = \underline{.110}$

$(t_b)_s$ = Bottom thickness = $t_b - tol = \underline{.095}$

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RESULTS OF
STRESS AND PRESSURE
CALCULATIONS FOR MODEL 2726 C

INNER CAPSULE

$$P_H \text{ (LID)} = \underline{.01998 S}, \quad P_H \text{ (BOT)} = \underline{.02704 S}, \quad P_C = \underline{.09358 S}, \quad P_L = \underline{.2065 S}$$

$$P_S = \underline{.01836 S} \text{ Based on a minimum weld penetration of } \underline{.030"}$$

Most restrictive relationship, $P_S = \underline{.01836 S}$

Maximum internal pressure permitted

At 400°F 236.8 psig (S = 12,900)

At 1475°F 145.4 psig (S = 9,900 x 0.8)

OUTER CAPSULE

$$P_H = \text{(LID)} = \underline{.01940 S}, \quad P_H \text{ (BOT)} = \underline{.02170 S}, \quad P_C = \underline{.08630 S}, \quad P_L = \underline{.1889 S}$$

$$P_S = \underline{.01645 S} \text{ Based on a minimum weld penetration of } \underline{.030"}$$

Most restrictive relationship, $P = \underline{.01645 S}$

Maximum internal pressure permitted

At 400°F 212.2 psig (S = 12,900)

At 1475°F 130.3 psig (S = 9,900 x 0.8)

Pressure Build-up

Calculated pressure build-up after 10 years with the maximum curie content and the maximum packing fraction as listed in the table below:

| Maximum Curies | Maximum P.F. | Pressure At 400°F, PSIA | Pressure At 1475°F, PSIA |
|----------------|--------------|-------------------------|--------------------------|
| 17.7 | .5 | 57.9 | 130.2 |
| 11.2 | .68 | 57.5 | 129.3 |
| 7.0 | .80 | 57.5 | 129.3 |

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These capsules will not deform at operating temperature in a 10 year period and will pass the Special Form Heating Test at 10 years.

B

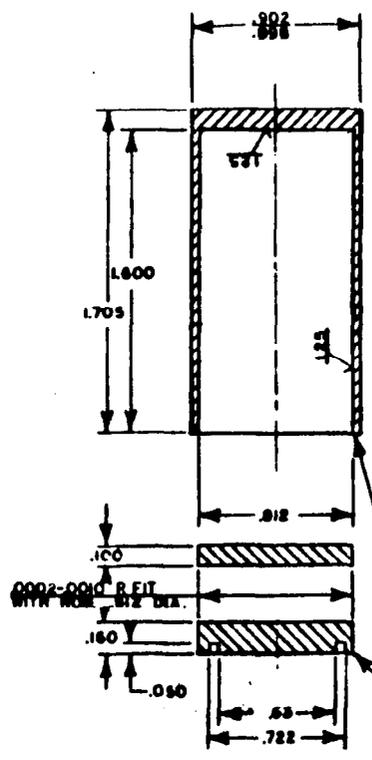
A

| REVISIONS | | | | DATE | APPROVAL |
|-----------|-----|-------------|--|------|----------|
| ZONE | SYM | DESCRIPTION | | | |
| | | | | | |
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- NOTES:
1. MIN. WELD PENETRATION -.030 FOR EACH CONTAINER.
 2. UNLESS OTHERWISE SPECIFIED: BREAK OUTSIDE CORNERS .010 - .020° RADIUS INSIDE CORNERS .010°
 3. *INDICATES VISUAL INSPECTION IS ACCEPTABLE.
 4. INNER CAPSALE TO BE INSERTED WELDED END FIRST INTO THE OUTER CAPSALE.
 5. IF NECESSARY, S.S. SHIMS MAY BE PLACED BETWEEN INNER AND OUTER CONTAINER TO LIMIT MOVEMENT.

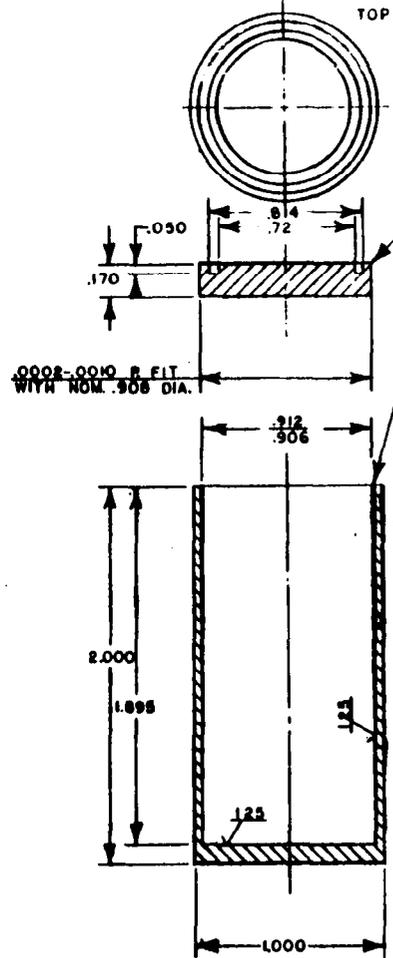
109

INNER CONTAINER



BOTTOM VIEW

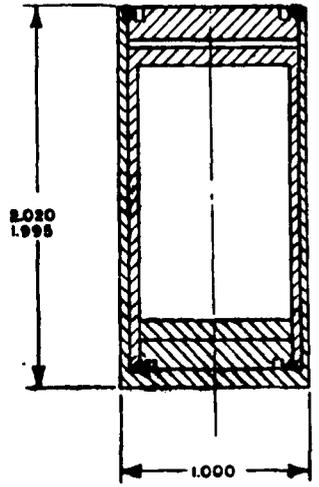
TOP VIEW



OUTER CONTAINER

LEAVE SHARP* NO BURRS

LEAVE SHARP* NO BURRS



COMPLETED ASSEMBLY

| | |
|---------|-----|
| DWG NO. | REV |
| SHEET | OF |

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| | | | |
|---|-----------|-----|--------|
| UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES | AS APP | RRH | 3-2-81 |
| TOLERANCES: | CA APP | DFD | 3-2-81 |
| DECIMALS | DF APP | JE | 3-2-81 |
| FRACTIONS | DC APP | JAO | 3-2-81 |
| .XX = .02 | CHECKED | | |
| .XXX = .005 | DRAWN | NAM | 3-3-81 |
| ANGLES | DATE | | |
| XXXX BASIC 32 ± .20° | SIGNATURE | | |
| MATERIAL 304 SS | | | |
| FINISH | | | |

| | | | | | |
|-------------------------------|-------------|-------------------|------|--------------|--|
| MONSANTO RESEARCH CORPORATION | | BAYTON LABORATORY | | BAYTON, OHIO | |
| NEUTRON SOURCE CONTAINER | | | | | |
| MODEL 2726-C | | | | | |
| DWG NO. | C 2726-CA00 | REV | 0 | | |
| SCALE | 2:1 | WT | CALC | DATE | |
| SHEET | | OF | | | |

DIMENSIONS OF MODEL 2727 C

Inner capsule dimensions

Dimensions per drawing number C 2727-CA00 Rev. 0

$$O.D. = \underline{1.364/1.368}$$

$$I.D. = \underline{1.250 \pm .005}$$

$$O.L. = \underline{2.105 \pm .005}$$

$$I.L. = \underline{1.950 \pm .005}$$

$$t_h = \text{Thickness of head} = \underline{.225 \pm .005}$$

$$t_g = \text{Depth of trepan groove} = \underline{.060 \pm .005}$$

$$t_b = \text{Thickness of bottom} = \underline{.155 \pm .010}$$

$$t_d = \text{Thickness of wiping disc} = \underline{.100 \pm .005}$$

Dimensions to be used or stress calculations

$$(O.D.)_s = (\text{smallest O.D.}) = \underline{1.364}$$

$$(I.D.)_s = (\text{largest I.D.}) = \underline{1.255}$$

$$(t_w)_s = \text{Wall thickness} = 1/2[(O.D.)_s - (I.D.)_s] = \\ 1/2[\underline{1.364} - \underline{1.255}] = \underline{.0545}$$

$$(t_h)_s = \text{Head thickness} = [(t_h - tol) - (t_g + tol)] = \\ [\underline{.220} - \underline{.065}] = \underline{.155}$$

$$(t_b)_s = \text{Bottom thickness} = t_b - tol = \underline{.145}$$

Dimensions to be used for internal pressure calculations

$$(I.D.)_p = (I.D.) - (tol) = \underline{1.245}$$

$$(I.L.)_p = [\text{shortest I.L.}] - [t_h + tol] - [t_d + tol] \\ = \underline{1.945} - \underline{.230} - \underline{.105} \\ = \underline{1.61}$$

$$\text{or } (I.L.)_p = [O.L. - tol] - [t_h + tol] - [t_b + tol] - [t_d + tol] \\ = \underline{\hspace{2cm}} - \underline{\hspace{2cm}} - \underline{\hspace{2cm}} - \underline{\hspace{2cm}} \\ = \underline{\hspace{2cm}}$$

DIMENSIONS OF MODEL 2727 C

Outer capsule dimensions

Dimensions per drawing number C 2727-CA00, Rev. 0

O.D. = 1.500 ± .005

I.D. = 1.372/1.378

O.L. = 2.495/2.520

I.L. = 2.350 ± .005

t_h = Thickness of head = .225 ± .005

t_g = Depth of trepan groove = .060 ± .005

t_b = Thickness of bottom = .150 ± .010

Dimensions to be used for stress calculations

$(O.D.)_s$ = (smallest O.D.) = 1.495

$(I.D.)_s$ = (largest I.D.) = 1.378

$(t_w)_s$ = Wall thickness = $1/2 [(O.D.)_s - (I.D.)_s] =$
 $1/2 [\underline{1.495} - \underline{1.378}] = \underline{.0585}$

$(t_h)_s$ = Head thickness = $[(t_h - tol) - (t_g + tol)] =$
 $[\underline{.220} - \underline{.065}] = \underline{.155}$

$(t_b)_s$ = Bottom thickness = $t_b - tol = \underline{.140}$

RESULTS OF
STRESS AND PRESSURE
CALCULATIONS FOR MODEL 2727 C

INNER CAPSULE

P_H (LID) = .02034, P_H (BOT) = .02670 S, P_c = .08255 S, P_L = .1800 S
 P_s = .01793 S Based on a minimum weld penetration of .045

Most restrictive relationship, P_s = .01793 S

Maximum internal pressure permitted

At 400°F 231.3 psig (S = 12,900)

At 1475°F 142.0 psig (S = 9,900 x 0.8)

OUTER CAPSULE

P_H (LID) = .01687S, P_H (BOT) = .02064S, P_c = .08079S P_L = .1758S

P_s = .01633 S Based on a minimum weld penetration of .045

Most restrictive relationship, P = .01633 S

Maximum internal pressure permitted

At 400°F 210.6 psig (S = 12,900)

At 1475°F 129.3 psig (S = 9,900 x 0.8)

Pressure Build-up

Calculated pressure build-up after 10 years with the maximum curie content and the maximum packing fraction as listed in the table below:

| Maximum Curies | Maximum P.F. | Pressure At 400°F, PSIA | Pressure At 1475°F, PSIA |
|----------------|--------------|-------------------------|--------------------------|
| 48 | 0.5 | 57.3 | 129.0 |
| 30.5 | 0.68 | 57.1 | 128.4 |
| 19 | 0.8 | 57.0 | 128.2 |

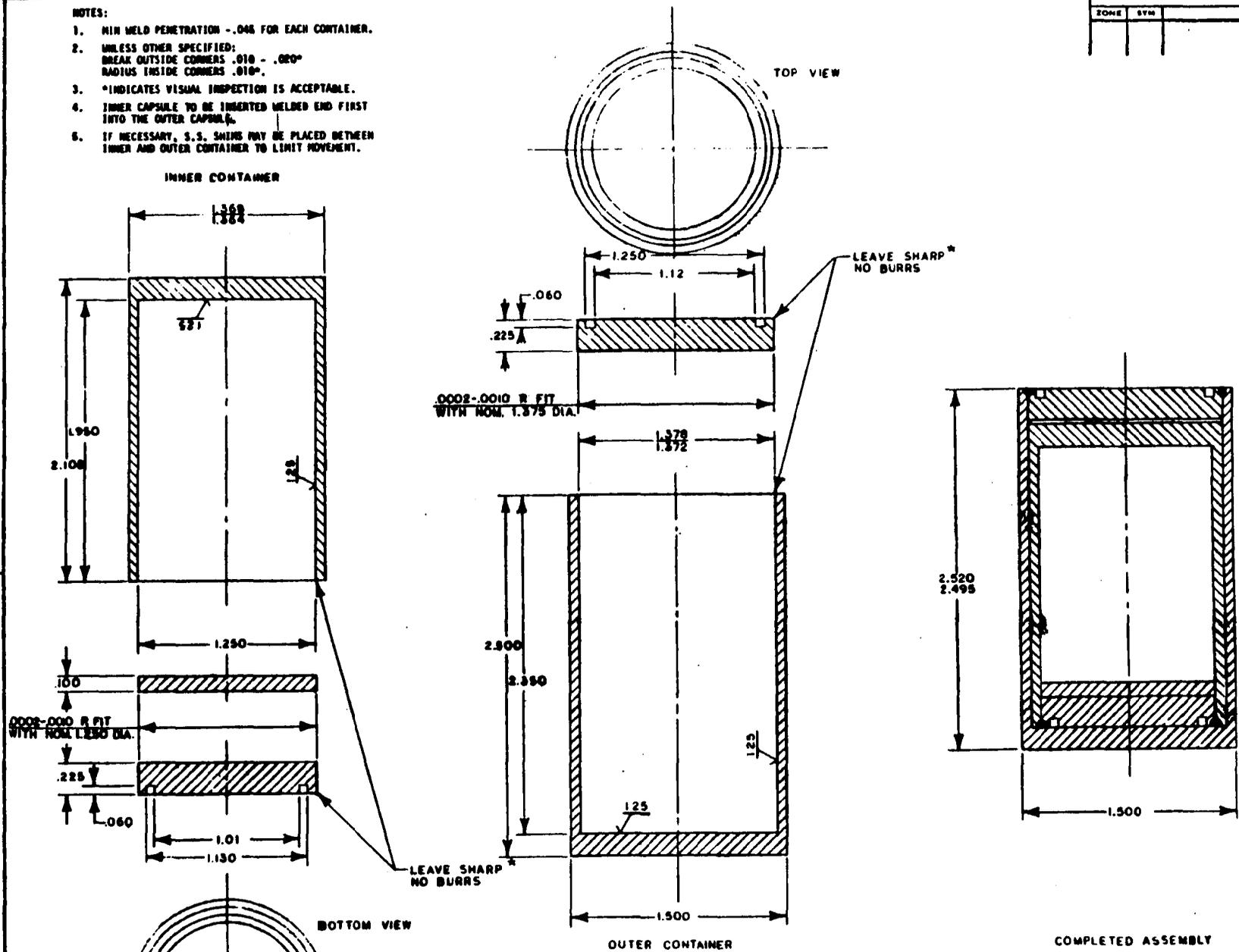
These capsules will not deform at operating temperature in a 10 year period and will pass the Special Form Heating Test at 10 years.

NOTES:

1. MIN WELD PENETRATION -.046 FOR EACH CONTAINER.
2. UNLESS OTHER SPECIFIED:
BREAK OUTSIDE CORNERS .010 - .020"
RADIUS INSIDE CORNERS .010".
3. *INDICATES VISUAL INSPECTION IS ACCEPTABLE.
4. INNER CAPSULE TO BE INSERTED WELDED END FIRST INTO THE OUTER CAPSULE.
5. IF NECESSARY, S.S. SHIMS MAY BE PLACED BETWEEN INNER AND OUTER CONTAINER TO LIMIT MOVEMENT.

| REVISIONS | | | DATE | APPROVAL |
|-----------|-----|-------------|------|----------|
| ZONE | SYM | DESCRIPTION | | |
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113



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|----------|-----|
| WORK NO. | REV |
| SHEET | OF |

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| | | | | | |
|---|-----------|-----------|------|---|-----|
| UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES | | DATE | | MONSANTO RESEARCH CORPORATION DAYTON LABORATORY DAYTON, OHIO | |
| TOLERANCES: | FRACTIONS | DATE | DATE | NEUTRON SOURCE CONTAINER MODEL 2727-C | |
| .XX = ± .02 | ANGLES | DATE | DATE | WORK NO. | REV |
| .XXX = ± .005 | ± 30° | DATE | DATE | C2727-0A00 | 0 |
| .XXXX BASIC | | DATE | DATE | SHEET OF | |
| ALL SURFACES | | DATE | DATE | SCALE 2:1 WT CALS | |
| MATERIAL 304 SS | | DATE | DATE | ACT | |
| FINISH | | SIGNATURE | DATE | DATE | |

DIMENSIONS OF MODEL 2728 C

Inner capsule dimensions

Dimensions per drawing number C 2728-CA00, Rev. 0

$$\text{O.D.} = \frac{1.364}{1.368}$$

$$\text{I.D.} = \frac{1.250 \pm 0.005}{}$$

$$\text{O.L.} = \frac{3.105 \pm .005}{}$$

$$\text{I.L.} = \frac{2.950 \pm .005}{}$$

$$t_h = \text{Thickness of head} = \frac{.225 \pm .005}{}$$

$$t_g = \text{Depth of trepan groove} = \frac{.060 \pm .005}{}$$

$$t_b = \text{Thickness of bottom} = \frac{.155 \pm .010}{}$$

$$t_d = \text{Thickness of wiping disc} = \frac{.100 \pm .005}{}$$

Dimensions to be used or stress calculations

$$(\text{O.D.})_s = (\text{smallest O.D.}) = \frac{1.364}{}$$

$$(\text{I.D.})_s = (\text{largest I.D.}) = \frac{1.255}{}$$

$$\begin{aligned}
 (t_w)_s &= \text{Wall thickness} = 1/2[(\text{O.D.})_s - (\text{I.D.})_s] = \\
 &1/2[\frac{1.364}{} - \frac{1.255}{}] = \frac{.0545}{}
 \end{aligned}$$

$$\begin{aligned}
 (t_h)_s &= \text{Head thickness} = [(t_h - \text{tol}) - (t_g + \text{tol})] = \\
 &[\frac{.220}{} - \frac{.065}{}] = \frac{.155}{}
 \end{aligned}$$

$$(t_b)_s = \text{Bottom thickness} = t_b - \text{tol} = \frac{.145}{}$$

Dimensions to be used for internal pressure calculations

$$(\text{I.D.})_p = (\text{I.D.}) - (\text{tol}) = \frac{1.245}{}$$

$$\begin{aligned}
 (\text{I.L.})_p &= [\text{shortest I.L.}] - [t_h + \text{tol}] - [t_d + \text{tol}] \\
 &= \frac{2.945}{} - \frac{.230}{} - \frac{.105}{} \\
 &= \frac{2.61}{}
 \end{aligned}$$

$$\begin{aligned}
 \text{or } (\text{I.L.})_p &= [\text{O.L.} - \text{tol}] - [t_h + \text{tol}] - [t_b + \text{tol}] - [t_d + \text{tol}] \\
 &= \frac{\quad}{} - \frac{\quad}{} - \frac{\quad}{} - \frac{\quad}{} \\
 &= \frac{\quad}{}
 \end{aligned}$$

DIMENSIONS OF MODEL 2728 C

Outer capsule dimensions

Dimensions per drawing number C 2728 - CA00 Rev. 0

O.D. = 1.500 ± .005

I.D. = 1.372 ± 1.378

O.L. = 3.495/3.520

I.L. = 3.350 ± .005

t_h = Thickness of head = .225 ± .005

t_g = Depth of trepan groove = .060 ± .005

t_b = Thickness of bottom = .150 ± .010

Dimensions to be used for stress calculations

$(O.D.)_s$ = (smallest O.D.) = 1.495

$(I.D.)_s$ = (largest I.D.) = 1.378

$(t_w)_s$ = Wall thickness = $1/2 [(O.D.)_s - (I.D.)_s] =$
 $1/2 [\underline{1.495} - \underline{1.378}] = \underline{0.585}$

$(t_h)_s$ = Head thickness = $[(t_h - tol) - (t_g + tol)] =$
 $[\underline{.220} - \underline{.065}] = \underline{.155}$

$(t_b)_s$ = Bottom thickness = $t_b - tol = \underline{.140}$

—
=

RESULTS OF
STRESS AND PRESSURE
CALCULATIONS FOR MODEL 2728 C

INNER CAPSULE

P_H (LID) = .02034 S, P_H (BOT) = .02670 S, P_C = .08255 S, P_L = .1800 S

P_S = .01793 S Based on a minimum weld penetration of .045

Most restrictive relationship, $P_S =$.01793 S

Maximum internal pressure permitted

At 400°F 231.3 psig (S = 12,900)

At 1475°F 142.0 psig (S = 9,900 x 0.8)

OUTER CAPSULE

P_H (LID) = .01687 S, P_H (BOT) = .02064 S, P_C = .08079 S P_L = .1758 S

P_S = .01633 S Based on a minimum weld penetration of .045

Most restrictive relationship, $P_S =$.01633 S

Maximum internal pressure permitted

At 400°F 210.6 psig (S = 12,900)

At 1475°F 129.3 psig (S = 9,900 x 0.8)

Pressure Build-up

Calculated pressure build-up after 10 years with the maximum curie content and the maximum packing fraction as listed in the table below:

| Maximum Curies | Maximum P.F. | Pressure At 400°F, PSIA | Pressure At 1475°F, PSIA |
|----------------|--------------|-------------------------|--------------------------|
| 78 | 0.50 | 57.4 | 129.1 |
| 50 | 0.68 | 57.4 | 129.3 |
| 31 | 0.80 | 57.2 | 128.7 |

These capsules will not deform at operating temperature in a 10 year period and will pass the Special Form Heating Test at 10 years.

RESULTS OF
STRESS AND PRESSURE
CALCULATIONS FOR MODEL 2728 C

INNER CAPSULE

$$P_H \text{ (LID)} = \underline{.02034 S}, \quad P_H \text{ (BOT)} = \underline{.02670 S}, \quad P_c = \underline{.08255 S}, \quad P_L = \underline{.1800 S}$$

$$P_s = \underline{.01793 S} \text{ Based on a minimum weld penetration of } \underline{.045}$$

Most restrictive relationship, $P_s = \underline{.01793 S}$

Maximum internal pressure permitted

At 400°F 231.3 psig (S = 12,900)

At 1475°F 142.0 psig (S = 9,900 x 0.8)

OUTER CAPSULE

$$P_H \text{ (LID)} = \underline{.0168 S}, \quad P_H \text{ (BOT)} = \underline{.0206 S}, \quad P_c = \underline{.0807 S}, \quad P_L = \underline{.1758 S}$$

$$P_s = \underline{.01633 S} \text{ Based on a minimum weld penetration of } \underline{.045}$$

Most restrictive relationship, $P_s = \underline{.01633 S}$

Maximum internal pressure permitted

At 400°F 210.6 psig (S = 12,900)

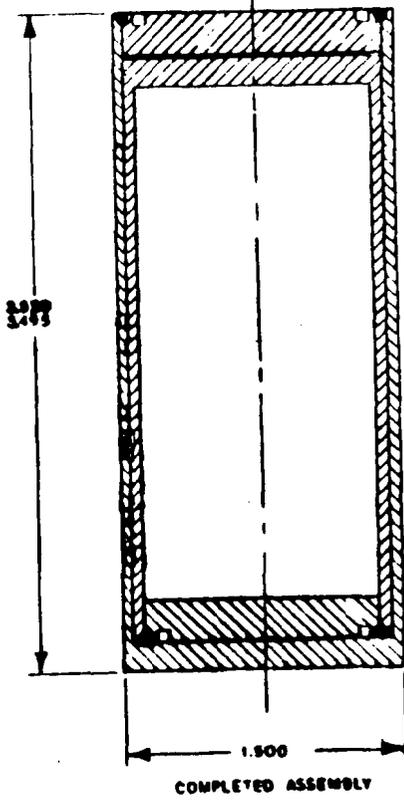
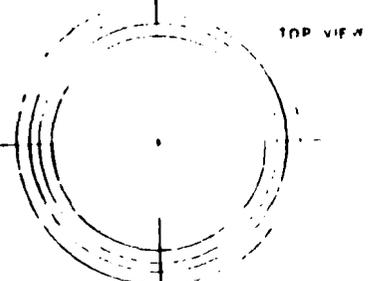
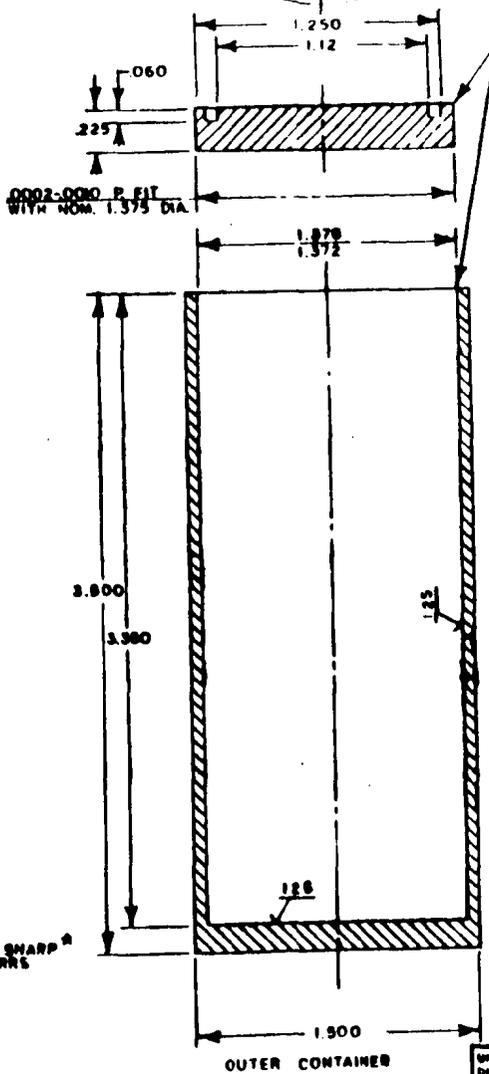
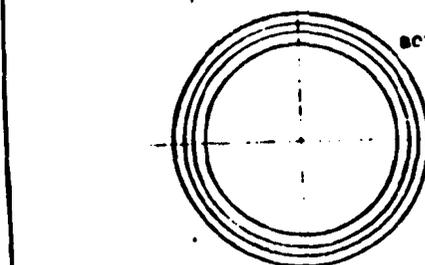
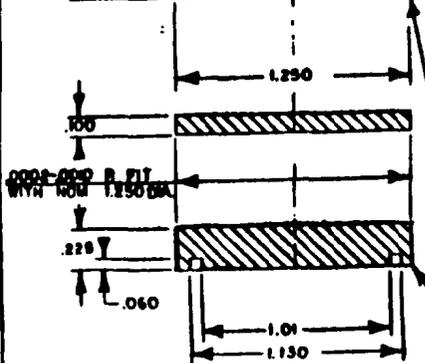
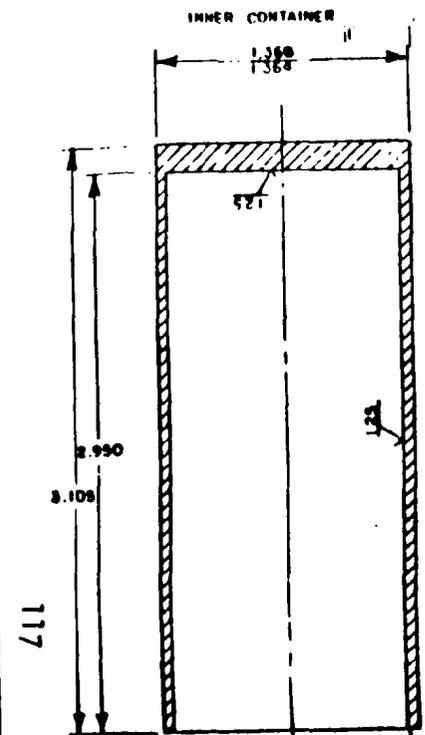
At 1475°F 129.3 psig (S = 9,900 x 0.8)

Pressure Build-up

Calculated pressure build-up after 10 years with the maximum curie content and the maximum packing fraction as listed in the table below:

| Maximum Curies | Maximum P.F. | Pressure At 400°F, PSIA | Pressure At 1475°F, PSIA |
|----------------|--------------|-------------------------|--------------------------|
| 78 | 0.50 | 57.4 | 129.1 |
| 50 | 0.68 | 57.4 | 129.3 |
| 31 | 0.80 | 57.2 | 128.7 |

These capsules will not deform at operating temperature in a 10 year period and will pass the Special Form Heating Test at 10 years.



| REVISIONS | | | DATE | APPROVAL |
|-----------|--|--|------|----------|
| | | | | |

- NOTES:
1. MIN WELD PENETRATION -.045 FOR EACH CONTAINER.
 2. UNLESS OTHER SPECIFIED: BREAK OUTSIDE CORNERS .010 - .020", RADIUS INSIDE CORNERS .010".
 3. *INDICATES VISUAL INSPECTION IS ACCEPTABLE.
 4. INNER CAPSULE TO BE INSERTED WELDED END FIRST INTO THE OUTER CAPSULE.
 5. IF NECESSARY, S.S. SHIMS MAY BE PLACED BETWEEN INNER AND OUTER CONTAINER TO LIMIT MOVEMENT.

| | |
|--------|-----|
| DRG NO | REV |
| INVEST | OP |

NOTICE
 This drawing is the property of Monsanto Research Corporation and must be returned, without reproduction or duplication, at any time upon request, but in any event at completion of the work or job while in the possession of the recipient. It must be properly safeguarded against revelation or disclosure to anyone except those employees who are to do the work or job. The recipient must keep confidential, and require his (its) employees to keep confidential, the information contained herein.

| | | | |
|---|------|--------|-----|
| UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES | DATE | DRG NO | REV |
| TOLERANCES | | | |
| DECIMALS | | | |
| FRACTIONS | | | |
| XXX = .02 | | | |
| XXX = .005 | | | |
| XXX BASIC | | | |
| ALL SURFACES | | | |
| MATERIAL | | | |
| FINISH | | | |

| | | | | |
|-------------------------------|----|------|--------|-----|
| MONSANTO RESEARCH CORPORATION | | DATE | DRG NO | REV |
| DAYTON LABORATORY | | | | |
| DAYTON, OHIO | | | | |
| NEUTRON SOURCE CONTAINER | | | | |
| MODEL 2728-C | | | | |
| SCALE 2:1 | WT | CALL | | |
| | | | | |
| | | | | |
| | | | | |

| | |
|------------|-----|
| DRG NO | REV |
| C2728-CA00 | 0 |
| INVEST | OP |

DIMENSIONS OF MODEL - 29C

Inner capsule dimensions

Dimensions per drawing number C2729-CA00

O.D. = 1.366 ± .002

I.D. = 1.250 ± .005

O.L. = 1.658 ± .005

I.L. = 1.503 ± .005

t_h = Thickness of head = .225 ± .005

t_g = Depth of trepan groove = .060 ± .005

t_b = Thickness of bottom = N. I.

t_d = Thickness of wiping disc .100 ± .005

Dimensions to be used or stress calculations

$(O.D.)_s$ = (smallest O.D.) = 1.364

$(I.D.)_s$ = (largest I.D.) = 1.255

$(t_w)_s$ = Wall thickness = $1/2[(O.D.)_s - (I.D.)_s]$ =
 $1/2[\underline{1.364} - \underline{1.255}] = \underline{.0545}$

$(t_h)_s$ = Head thickness = $[(t_h - tol) - (t_g + tol)]$ =
 $[\underline{.220} - \underline{.065}] = \underline{.155}$

$(t_b)_s$ = Bottom thickness = $t_b - tol = \underline{.145}$

Dimensions to be used for internal pressure calculations

$(I.D.)_p$ = $(I.D.) - (tol) = \underline{1.245}$

$(I.L.)_p$ = $[shortest I.L.] - [t_h + tol] - [t_d + tol]$
 $= \underline{1.498} - \underline{.230} - \underline{.105}$
 $= \underline{1.163}$

or $(I.L.)_p = [O.L. - tol] - [t_h + tol] - [t_b + tol] - [t_d + tol]$
 $= \underline{\hspace{2cm}} - \underline{\hspace{2cm}} - \underline{\hspace{2cm}} - \underline{\hspace{2cm}}$
 $= \underline{\hspace{2cm}}$

DIMENSIONS OF MODEL 2729C

Outer capsule dimensions

Dimensions per drawing number C2729-CA00

O.D. = 1.500 ± .005

I.D. = 1.375 ± .003

O.L. = 2.056 ± .005

I.L. = 1.906 ± .005

t_h = Thickness of head = .228 ± .005

t_g = Depth of trepan groove = .060 ± .005

t_b = Thickness of bottom = N. I.

Dimensions to be used for stress calculations

$(O.D.)_s$ = (smallest O.D.) = 1.495

$(I.D.)_s$ = (largest I.D.) = 1.378

$(t_w)_s$ = Wall thickness = $1/2 [(O.D.)_s - (I.D.)_s]$ =
 $1/2 [\underline{1.495} - \underline{1.378}] = \underline{.0585}$

$(t_h)_s$ = Head thickness = $[(t_h - tol) - (t_g + tol)]$ =
 $[\underline{.223} - \underline{.065}] = \underline{.158}$

$(t_b)_s$ = Bottom thickness = $t_b - tol = \underline{.140}$

RESULTS OF
STRESS AND PRESSURE
CALCULATIONS FOR MODEL 2729c

INNER CAPSULE

$$P_H \text{ (LID)} = .02034 S, \quad P_H \text{ (BOT)} = .02670 S, \quad P_c = .08255 S, \quad P_L = 1800 S$$

$$P_S = .01793 S \text{ Based on a minimum weld penetration of } .045$$

Most restrictive relationship, $P = .01793 S$

Maximum internal pressure permitted

At 400°F 231.3 psig (S = 12,900)

At 1475°F 142.0 psig (S = 9,900 x 0.8)

OUTER CAPSULE

$$P_L = \text{(LID)} = .01753 S, \quad P_H \text{ (BOT)} = .02064 S, \quad P_c = .08079 S, \quad P_L = .1758 S$$

$$P_S = .01633 S \text{ Based on a minimum weld penetration of } .045$$

Most restrictive relationship, $P = .01633 S$

Maximum internal pressure permitted

At 400°F 210.6 psig (S = 12,900)

At 1475°F 129.3 psig (S = 9,900 x 0.8)

Pressure Build-up

Calculated pressure build-up after 10 years with the maximum curie content and the maximum packing fraction as listed in the table below:

| Maximum Curies | Maximum P.F. | Pressure At 400°F, PSIA | Pressure At 1475°F, PSIA |
|----------------|--------------|-------------------------|--------------------------|
| 34.7 | .5 | 57.3 | 129.0 |
| 22.2 | .68 | 57.3 | 129.0 |
| 13.9 | .80 | 57.4 | 129.1 |

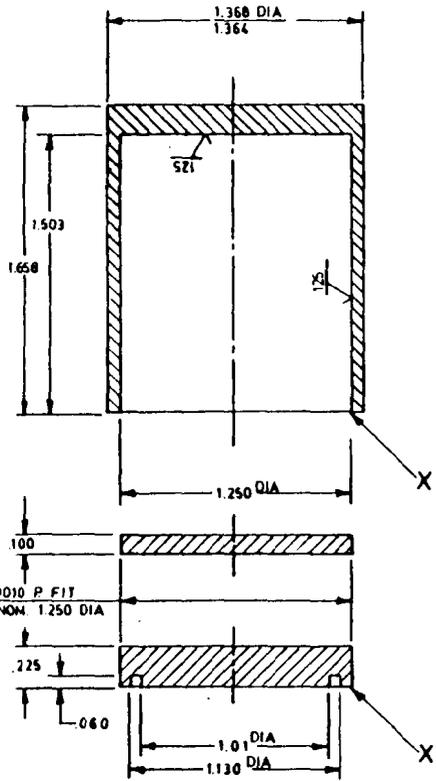
These capsules will not deform at operating temperature in a 10 year period and will pass the Special Form Heating Test at 10 years.

| REVISIONS | | | DE | MFG | QA | MS |
|-----------|-------------|------|----------|-----|----|----|
| SYM | DESCRIPTION | DATE | APPROVAL | | | |
| | | | | | | |

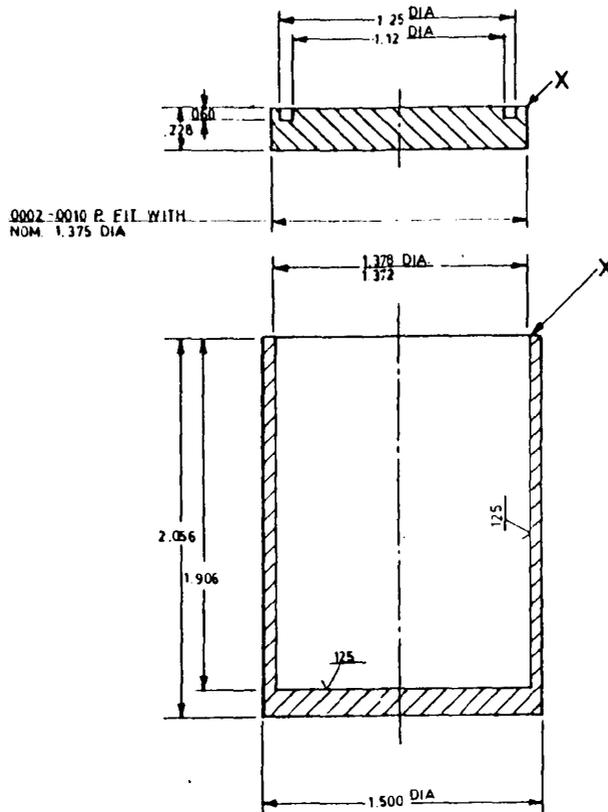
NOTES:

- UNLESS OTHERWISE SPECIFIED:
BREAK OUTSIDE CORNERS .010 - .020"
RADIUS INSIDE CORNERS .010
- ALL CORNERS DESIGNATED WITH AN X SHALL BE LEFT SHARP*, NO BURRS.
- *INDICATES VISUAL INSPECTION IS ACCEPTABLE.
- INNER CAPSULE TO BE INSERTED WELDED END FIRST INTO THE OUTER CAPSULE.
- IF NECESSARY, S.S. SHIMS MAY BE PLACED BETWEEN INNER AND OUTER CONTAINER TO LIMIT MOVEMENT.
- MIN. WELD PENETRATION - .045" FOR EACH CONTAINER.

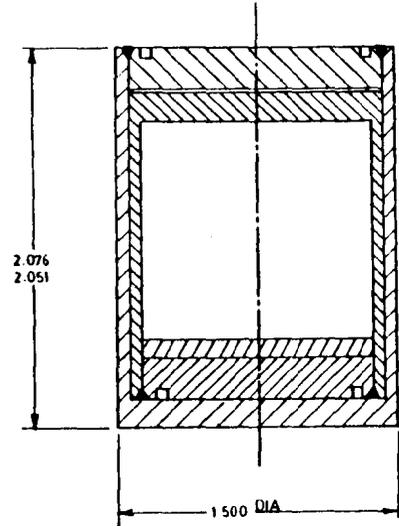
1/21



INNER CONTAINER



OUTER CONTAINER



ASSEMBLY

0002-0010 P. FIT WITH
NOM. 1.375 DIA

DIMENSIONS ARE IN INCHES □ MILLIMETERS

| | | | | |
|--|-------|-----|--------|---|
| UNLESS OTHERWISE SPECIFIED TOLERANCES DECIMALS FRACTIONS XX = .02 1 XXX = .005 ANGLES XXXX BASIC 1 ALL SURFACES \sqrt{R} | MS | AK | 2-8-53 | MONSANTO RESEARCH CORPORATION DAYTON LABORATORY DAYTON, OHIO |
| | QA | CEP | 2-8-53 | |
| | MFG | HR | 1/4/53 | |
| | DE | JAO | 11-53 | |
| MATERIAL 304 STAINLESS STEEL | DRAWN | HAM | 2-7-53 | NEUTRON SOURCE CAPSULE MODEL 2729-C SCALE 2:1 WT CALC |
| | | | | REV NO C2729-CA00 REV 0 |

COMPARISON OF MRC-N-S-W-AmBe Series and MRC 2720A Series FABRICATION DIMENSIONS

MRC-N--SS-W-AmBe

| Activity (Ci) | Inner ID (in) | Inner OD (in) | Inner wall thick (in) | Inner lgth (in) | Outer ID (in) | Outer OD (in) | Outer wall thick (in) | Outer lgth (in) |
|---------------|---------------|---------------|-----------------------|-----------------|---------------|---------------|-----------------------|-----------------|
| 0.0-0.2 | 0.312 | 0.402 | 0.045 | 0.48 | 0.407 | 0.50 | 0.047 | 0.70 |
| 0.2-1.0 | 0.562 | 0.652 | 0.045 | 0.65 | 0.657 | 0.75 | 0.047 | 0.87 |
| 1 - 3 | 0.812 | 0.902 | 0.045 | 0.9 | 0.907 | 1.00 | 0.047 | 1.12 |
| 3 - 6 | 0.812 | 0.902 | 0.045 | 1.28 | 0.907 | 1.00 | 0.047 | 1.50 |
| 6 - 10 | 0.812 | 0.902 | 0.045 | 1.78 | 0.907 | 1.00 | 0.047 | 2.00 |
| 10 - 50 | 1.25 | 1.37 | 0.060 | 3.28 | 1.375 | 1.50 | 0.063 | 3.50 |

MRC 2720 A Series

| Model | Activity* Max. (Ci) | Inner ID (in) | Inner OD (in) | Inner wall thick (in) | Inner lgth (in) | Outer ID (in) | Outer OD (in) | Outer wall thick (in) | Outer lgth (in) |
|--------|---------------------|---------------|---------------|-----------------------|-----------------|---------------|---------------|-----------------------|-----------------|
| 2721 A | 0.3 | 0.312 | 0.402 | 0.045 | 0.300 | 0.407 | 0.500 | 0.047 | 0.500 |
| 2722 A | 1.0 | 0.312 | 0.402 | 0.045 | 0.500 | 0.407 | 0.500 | 0.047 | 0.700 |
| 2723 A | 3.0 | 0.562 | 0.652 | 0.045 | 0.670 | 0.657 | 0.750 | 0.047 | 0.870 |
| 2724 A | 5.0 | 0.812 | 0.902 | 0.045 | 0.920 | 0.907 | 1.000 | 0.047 | 1.120 |
| 2725 A | 8.5 | 0.812 | 0.902 | 0.045 | 1.300 | 0.907 | 1.000 | 0.047 | 1.500 |
| 2726 A | 12.0 | 0.812 | 0.902 | 0.045 | 1.600 | 0.907 | 1.000 | 0.047 | 2.000 |
| 2727 A | 6.0 | 1.250 | 1.370 | 0.060 | 2.300 | 1.375 | 1.500 | 0.063 | 2.500 |
| 2728 A | 10.0 | 1.250 | 1.370 | 0.060 | 3.300 | 1.375 | 1.500 | 0.063 | 3.500 |

* Depends on packing factor (pf), which is the fraction of the theoretical density achieved by compression of the source material in the source shell. Maximum activity is allowed for pf of 0.5.

Source is of the tube and plug design. Minimum weld thickness is 0.024".

Material 304 SS. Earliest drawings 9/5/69. Last Drawing Revision in set 8-28-75.

2720 B Series

| Model | Activity* Max. (Ci) | Inner ID (in) | Inner OD (in) | Inner wall thick (in) | Inner lgth (in) | Outer ID (in) | Outer OD (in) | Outer wall thick (in) | Outer lgth (in) |
|--------|---------------------|---------------|---------------|-----------------------|-----------------|---------------|---------------|-----------------------|-----------------|
| 2721 B | 0.4 | 0.312 | 0.402 | 0.045 | 0.300 | 0.407 | 0.500 | 0.047 | 0.500 |
| 2722 B | 1.4 | 0.312 | 0.402 | 0.045 | 0.500 | 0.407 | 0.500 | 0.047 | 0.700 |
| 2723 B | 2.9 | 0.562 | 0.652 | 0.045 | 0.611 | 0.657 | 0.750 | 0.047 | 0.870 |
| 2724 B | 6.0 | 0.812 | 0.902 | 0.045 | 0.861 | 0.907 | 1.000 | 0.047 | 1.120 |
| 2725 B | 10.0 | 0.812 | 0.902 | 0.045 | 1.243 | 0.907 | 1.000 | 0.047 | 1.500 |
| 2726 B | 16.0 | 0.812 | 0.902 | 0.045 | 1.743 | 0.907 | 1.000 | 0.047 | 2.000 |
| 2727 B | 47.0 | 1.250 | 1.370 | 0.060 | 2.122 | 1.375 | 1.500 | 0.063 | 2.500 |
| 2728 B | 75.0 | 1.250 | 1.370 | 0.060 | 3.122 | 1.375 | 1.500 | 0.063 | 3.500 |

Improved design incorporating a machined bottom. Head and botton cross sections are thicker than "A" series.

Minimum weld thickness is 0.027". Earliest drawings 9/7/72. Last Drawing Revision in set 7-19-76.

COMPARISON OF MRC-N-S-W-AmBe Series and MRC 2720A Series FABRICATION DIMENSIONS

MRC 2720 C Series

| Model | Activity* Max. (Ci) | Inner ID (in) | Inner OD (in) | Inner wall thick (in) | Inner lgth (in) | Outer ID (in) | Outer OD (in) | Outer wall thick (in) | Outer lgth (in) |
|--------|------------------------|------------------|------------------|--------------------------|--------------------|------------------|------------------|--------------------------|--------------------|
| 2721 C | 0.3 | 0.315 | 0.397 / 0.401 | 0.042 | 0.275 | 0.408 | 0.500 | 0.046 | 0.495 |
| 2722 C | 1.3 | 0.315 | 0.397 / 0.401 | 0.042 | 0.500 | 0.405 / 0.411 | 0.500 | 0.046 | 0.695 / 0.720 |
| 2723 C | 2.4 | 0.562 | 0.646 / 0.650 | 0.043 | 0.595 | 0.654 / 0.660 | 0.750 | 0.047 | 0.865 / 0.890 |
| 2724 C | 5.6 | 0.812 | 0.898 / 0.902 | 0.044 | 0.825 | 0.906 / 0.912 | 1.000 | 0.046 | 1.120 |
| 2725 C | 11.4 | 0.812 | 0.898 / 0.902 | 0.044 | 1.205 | 0.906 / 0.912 | 1.000 | 0.046 | 1.495 / 1.520 |
| 2726 C | 17.7 | 0.812 | 0.898 / 0.902 | 0.044 | 1.705 | 0.906 / 0.912 | 1.000 | 0.046 | 1.995 / 2.020 |
| 2727 C | 48.0 | 1.250 | 1.364 / 1.368 | 0.058 | 2.105 | 1.372 / 1.378 | 1.500 | 0.063 | 2.495 / 2.520 |
| 2728 C | 78.0 | 1.250 | 1.364 / 1.368 | 0.058 | 3.105 | 1.372 / 1.378 | 1.500 | 0.063 | 3.495 / 3.520 |

Improved design incorporating a machined bottom. Head and botton cross sections are thicker than "A" series. Minimum weld thickness is 0.027".

Earliest in C Series drawings 2/4/81. No Drawing Revisions indicated.

Submitted to DOT for Special Form CoC 12/10/81

COMPARISON OF MRC-N-S-W-AmBe Series and MRC 2720A Series FABRICATION DIMENSIONS

MRC-N--SS-W-AmBe

| Activity (Ci) | Inner ID (in) | Inner OD (in) | Inner wall thick (in) | Inner lgth (in) | Outer ID (in) | Outer OD (in) | Outer wall thick (in) | Outer lgth (in) |
|---------------|---------------|---------------|-----------------------|-----------------|---------------|---------------|-----------------------|-----------------|
| 0.0-0.2 | 0.312 | 0.402 | 0.045 | 0.48 | 0.407 | 0.50 | 0.047 | 0.70 |
| 0.2-1.0 | 0.562 | 0.652 | 0.045 | 0.65 | 0.657 | 0.75 | 0.047 | 0.87 |
| 1 - 3 | 0.812 | 0.902 | 0.045 | 0.9 | 0.907 | 1.00 | 0.047 | 1.12 |
| 3 - 6 | 0.812 | 0.902 | 0.045 | 1.28 | 0.907 | 1.00 | 0.047 | 1.50 |
| 6 - 10 | 0.812 | 0.902 | 0.045 | 1.78 | 0.907 | 1.00 | 0.047 | 2.00 |
| 10 - 50 | 1.25 | 1.37 | 0.060 | 3.28 | 1.375 | 1.50 | 0.063 | 3.50 |

MRC 2720 A Series

| Model | Activity* Max. (Ci) | Inner ID (in) | Inner OD (in) | Inner wall thick (in) | Inner lgth (in) | Outer ID (in) | Outer OD (in) | Outer wall thick (in) | Outer lgth (in) |
|--------|---------------------|---------------|---------------|-----------------------|-----------------|---------------|---------------|-----------------------|-----------------|
| 2721 A | 0.3 | 0.312 | 0.402 | 0.045 | 0.300 | 0.407 | 0.500 | 0.047 | 0.500 |
| 2722 A | 1.0 | 0.312 | 0.402 | 0.045 | 0.500 | 0.407 | 0.500 | 0.047 | 0.700 |
| 2723 A | 3.0 | 0.562 | 0.652 | 0.045 | 0.670 | 0.657 | 0.750 | 0.047 | 0.870 |
| 2724 A | 5.0 | 0.812 | 0.902 | 0.045 | 0.920 | 0.907 | 1.000 | 0.047 | 1.120 |
| 2725 A | 8.5 | 0.812 | 0.902 | 0.045 | 1.300 | 0.907 | 1.000 | 0.047 | 1.500 |
| 2726 A | 12.0 | 0.812 | 0.902 | 0.045 | 1.600 | 0.907 | 1.000 | 0.047 | 2.000 |
| 2727 A | 6.0 | 1.250 | 1.370 | 0.060 | 2.300 | 1.375 | 1.500 | 0.063 | 2.500 |
| 2728 A | 10.0 | 1.250 | 1.370 | 0.060 | 3.300 | 1.375 | 1.500 | 0.063 | 3.500 |

* Depends on packing factor (pf), which is the fraction of the theoretical density achieved by compression of the source material in the source shell. Maximum activity is allowed for pf of 0.5.

Source is of the tube and plug design. Minimum weld thickness is 0.024".

Material 304 SS. Earliest drawings 9/5/69. Last Drawing Revision in set 8-28-75.

2720 B Series

| Model | Activity* Max. (Ci) | Inner ID (in) | Inner OD (in) | Inner wall thick (in) | Inner lgth (in) | Outer ID (in) | Outer OD (in) | Outer wall thick (in) | Outer lgth (in) |
|--------|---------------------|---------------|---------------|-----------------------|-----------------|---------------|---------------|-----------------------|-----------------|
| 2721 B | 0.4 | 0.312 | 0.402 | 0.045 | 0.300 | 0.407 | 0.500 | 0.047 | 0.500 |
| 2722 B | 1.4 | 0.312 | 0.402 | 0.045 | 0.500 | 0.407 | 0.500 | 0.047 | 0.700 |
| 2723 B | 2.9 | 0.562 | 0.652 | 0.045 | 0.611 | 0.657 | 0.750 | 0.047 | 0.870 |
| 2724 B | 6.0 | 0.812 | 0.902 | 0.045 | 0.861 | 0.907 | 1.000 | 0.047 | 1.120 |
| 2725 B | 10.0 | 0.812 | 0.902 | 0.045 | 1.243 | 0.907 | 1.000 | 0.047 | 1.500 |
| 2726 B | 16.0 | 0.812 | 0.902 | 0.045 | 1.743 | 0.907 | 1.000 | 0.047 | 2.000 |
| 2727 B | 47.0 | 1.250 | 1.370 | 0.060 | 2.122 | 1.375 | 1.500 | 0.063 | 2.500 |
| 2728 B | 75.0 | 1.250 | 1.370 | 0.060 | 3.122 | 1.375 | 1.500 | 0.063 | 3.500 |

Improved design incorporating a machined bottom. Head and bottom cross sections are thicker than "A" series.

Minimum weld thickness is 0.027". Earliest drawings 9/7/72. Last Drawing Revision in set 7-19-76.

COMPARISON OF MRC-N-S-W-AmBe Series and MRC 2720A Series FABRICATION DIMENSIONS

MRC 2720 C Series

| Model | Activity* Max. (Ci) | Inner ID (in) | Inner OD (in) | Inner wall thick (in) | Inner lgth (in) | Outer ID (in) | Outer OD (in) | Outer wall thick (in) | Outer lgth (in) |
|--------------|--------------------------------|--------------------------|--------------------------|----------------------------------|----------------------------|--------------------------|--------------------------|----------------------------------|----------------------------|
| 2721 C | 0.3 | 0.315 | 0.397 / 0.401 | 0.042 | 0.275 | 0.408 | 0.500 | 0.046 | 0.495 |
| 2722 C | 1.3 | 0.315 | 0.397 / 0.401 | 0.042 | 0.500 | 0.405 / 0.411 | 0.500 | 0.046 | 0.695 / 0.720 |
| 2723 C | 2.4 | 0.562 | 0.646 / 0.650 | 0.043 | 0.595 | 0.654 / 0.660 | 0.750 | 0.047 | 0.865 / 0.890 |
| 2724 C | 5.6 | 0.812 | 0.898 / 0.902 | 0.044 | 0.825 | 0.906 / 0.912 | 1.000 | 0.046 | 1.120 |
| 2725 C | 11.4 | 0.812 | 0.898 / 0.902 | 0.044 | 1.205 | 0.906 / 0.912 | 1.000 | 0.046 | 1.495 / 1.520 |
| 2726 C | 17.7 | 0.812 | 0.898 / 0.902 | 0.044 | 1.705 | 0.906 / 0.912 | 1.000 | 0.046 | 1.995 / 2.020 |
| 2727 C | 48.0 | 1.250 | 1.364 / 1.368 | 0.058 | 2.105 | 1.372 / 1.378 | 1.500 | 0.063 | 2.495 / 2.520 |
| 2728 C | 78.0 | 1.250 | 1.364 / 1.368 | 0.058 | 3.105 | 1.372 / 1.378 | 1.500 | 0.063 | 3.495 / 3.520 |

Improved design incorporating a machined bottom. Head and botton cross sections are thicker than "A" series.
Minimum weld thickness is 0.027".

Earliest in C Series drawings 2/4/81. No Drawing Revisions indicated.

Submitted to DOT for Special Form CoC 12/10/81