J.L. Shepherd & Associates

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September 25, 2012

Mr. Pierre Saverot
U.S. Nuclear Regulatory Commission
6003 Executive Center Dr.
Bethesda, MD

Re: Shielding Analysis for NPI Cask, Model NPI-20WC-6MKII

Dear Mr. Saverot:

J.L. Shepherd & Associates has undertaken a very extensive evaluation of the above model radioactive materials transportation package in considering that package as a substitute for the GE Model 1500 cask in transporting 19,000 Curies of Co-60 to a customer within the State of California.

This document will present a comparison of the benefits of use of each cask. Considerations are given to the following items:

1. Radiological Capability. Can each cask carry the proposed load?
2. Availability and Conditions of Use: Is the cask readily available? Is special training required? Will the owner permit JLS&A to load and unload the cask?
3. License capabilities of the owner of the cask. If the cask owner will not permit JLS&A to ship the cask, is the owner capable of loading the cask, taking possession of the radioactive material during transport of the cask, and then conducting the required source work in unloading the cask?
4. The number of nature of shipments required to move the radiological source material from city of origin to destination and then recovery of unwanted sources from that location.
5. The radiological output of the package during transportation (TI) and the type of shipment required.
6. Risk of exposure to both public and employee during transit, storage, and use.
7. Design restrictions that may impact any or all of the above.

RADIOLOGICAL CAPABILITY

The payload capability of the GE 1500 when transporting Co-60 is 3120 Watts or 200,000 Curies. The NPI Cask is restricted to 1000 Watts or 15,000 Curies, Co-60.

AVAILABILITY AND CONITIONS OF USE

GE 1500: The GE 1500 cask is readily available and certified for use by GE. J.L. Shepherd & Associates has requested "party status" from GE. GE has graciously requested party status from the DOT. Once approved, the GE 1500 use will be exclusive to J.L. Shepherd & Associates, with no operating restrictions imposed by GE beyond those normally associated with package operations and security.

NPI Cask: Neutron Products, Inc., has advised J.L. Shepherd & Associates that they will not condone a Party Status arrangement with regard to use of their cask because loading instructions are considered proprietary by NPI. There are two problems presented with this position. A) Sources made for J.L. Shepherd & Associates are manufactured by General Electric, Vallecitos Nuclear Center. While J.L. Shepherd & Associates enjoys a very favorable working relationship with GE, for liability concerns, all work accomplished within the GE compound must be performed by GE employees. NPI has advised JLS&A that they will not permit third parties to load the NPI cask. GE will not yield in their position, which then poses an additional problem: How do we move the material from GE to a location that will allow loading into the NPI cask? An additional concern is that this restriction results in JLS&A needing to disclose proprietary information to NPI, a competitor. B) NPI has indicated that the NPI Model 20WC-6MKII may not be available in sufficient time to meet the government's need for the materials ordered.

LICENSE CAPABILITIES OF THE CASK OWNER:

General Electric, if designated as the required shipper of record, has the ability to possess the 19,200 Curies Co-60 during the shipment phase of the project. GE will also permit JLS&A technical staff to operate, unload, and re-load the GE 1500, under GE supervision.

NPI will not permit JLS&A staff to operate, unload, and re-load the NPI-20WC-6MKII cask. This presents a problem regarding disclosure of proprietary information to a known competitor. Additionally, safety issues are also presented due to NPI personnel not having any experience with the JLS&A methods, tooling, or loading configurations required to accomplish the source unloading at the identified customer's location. Lastly, it has come to the attention of JLS&A by representatives of the State of Maryland, that NPI has had their radioactive materials license terminated by the State of Maryland. This means that NPI cannot perform radiological work or possess radioactive materials at the required limits during transport of the isotope between locations. The State of Maryland also advised JLS&A that NPI had a storage license issued by the State of West Virginia which JLS&A as requested from NPI.

NATURE AND NUMBER OF SHIPMENTS REQUIRED:

GE 1500: One shipment of 19,200 Curies, Co-60 in the form of two 9,500 Curie and one 200 Curie sources; followed by a return shipment of approximately 9,000 Curies, Co-60, both shipments made as “sole use”.

NPI-20WC-MKII: Four shipments: Two at 9,500 each, and one at 200 Curies; followed by a return shipment of approximately 9,000 Curies. Transport risk is increased by a factor of 3.

Use of the NPI cask requires an additional high activity shipment between GE and the intended customer, or a total of four shipments, three having a Transport Index In excess of 10 requiring a Highway Route Control Shipment. Additionally, because of the activity levels and output of the cask, exposure considerations must be considered when evaluating drive times, workers and public in the immediate area of the cask, workers handling the inner shield within the cask, time taken to configure the shield for unloading into a transfer cask, and then re-loading used isotope (two approximately 4,500 to 4,800 Curie Co-60 sources).

RADIOLOGICAL OUTPUT OF PACKAGE AND TYPE OF SHIPMENT REQUIRED:

A Shielding Analysis was performed utilizing the NPI-20WC-6MKII Transport Cask. The analysis is attached to this document. Indications based upon industry accepted calculations are that the shield within the transport cask, when loaded with 9.500 Curies, Co-60 source, configured as necessary to re-load the government-owned irradiator will result in excessive radiological output from the shield as follows:

1) The shield is spherical. Any extension of the source beyond the exact center will result in a higher dose distribution at angular points extending toward the top/bottom of the shield which pose a significant exposure risk to persons handling the shield and those in proximity of the shield during source transfer. Loaded source configuration (for transportation) was obtained from Neutron Products drawing 240122, Sheet 1 of 2. The specific source configuration was obtained from J.L. Shepherd & Associates drawing information relative to the specific irradiator. (Note: At the time of manufacture, the complete source assembly design was based upon continued availability of the GE 1500 or similar cask. TS-R-1 was not envisioned at that time).
2) Calculations reveal that transportation of the NPI cask must be done under Highway Route Control supervision, requiring numerous inspections and increasing costs not otherwise necessary if the GE 1500 cask is used.

The GE 1500 cask presents minimal radioactive output at the surface and near background amounts at one meter when loaded with 19,200 Curies of Co-60, configured as necessary to effect a minimally invasive source transfer at the customer facility.

RISK OF EXPOSURE TO EMPLOYEES AND PUBLIC DURING TRANSPORT, STORAGE, AND USE:

The GE 1500 cask, as designed, offers a very large and stable mounting surface which can be used to mount a transfer shield and conduct a source transfer into a "mule" cask with very little exposure to workers and significantly reduced risk to public during all phases of cask operation. While very large, the cask presents a Transport Index of 0.05 (White I) when loaded with 19,200 Curies Co-60. The NPI cask (shield) does not offer a mating surface which easily accommodates alignment with JLS&A transfer cask resulting in an unstable (source tubes in drawer are off-center) working surface. By necessity, the source transfer must be done vertically which creates a very real danger of tipping. Tipping using this spherical shield could have extreme exposure consequences.

Additionally, the design of the NPI cask and shield prohibit achievement of low output readings. The NPI shield, when loaded with a 9,500 Curie source will present a surface reading as shown on the attached drawing of 1.398 R/hr. This amount will increase during source transfer as the source begins to move closer to the end of the shield due to the radius of the shield and resulting reduction in lead volume as the source moves toward the edge of the shield opening. Estimates are that each worker (minimum of two required) will receive at least 500 mR total dose as a consequence of making one source transfer. Four source transfers are required to complete the task. Any misalignment, gap, or other problem occurring between the carrying shield and the transfer shield will result in significantly higher exposure and has the potential to put employees working in the area at substantial risk – all of which can be avoided by use of the GE 1500 cask.

DESIGN RESTRICTIONS THAT IMPACT THE ABOVE:

The particular irradiator for which these sources are intended was manufactured in 1984. At the time of manufacture, there was no consideration given to the potential extinction of the GE 1500 cask, which was the basis for the source design configuration. An additional consideration was the fact that the GE 1500 presented a large center cavity which allowed design of large sources with fixed tungsten plugs. As can be seen from the uniqueness of each cask owner's design, this configuration cannot be safely accommodated by use of the NPI cask.

Attached is a detailed shielding analysis which highlights the comments made herein. As a part of that analysis, drawings are provided which substantiate the calculations provided.

Best regards,

W.H. (Bill) Brown
Quality Assurance Manager

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SHIELDING ANALYSIS FOR NPI CASK NPI-20WC-6MKII

BASIS.

Source; 9,500 Ci. Co-60 in Special Form capsule 1.077" diameter x 3.180" long permanently mounted to a Tungsten source rod 1 1/8" diameter x 10" long.

Location: centered in a 2.5" diameter SS tube mounted in Item 5 per NPI drawing 240122 Sheet 1 of 2. In this configuration the source extends 2 7/16"past the centerline of the spherical cask significantly reducing shielding surrounding the source and increasing radiation levels associated with cask usage.

The highest radiation level will be at a point located at a 45° angle from the end of the source. This is shown on the attached drawing.

To determine radiation levels the Co-60 content in the source was broken into 6 segments as shown on the drawing, 5 at 1728 Ci and 1 at 864 Ci. Calculations were made at the center line of each segment.

Calculations were made at surface, 12" from surface and 1 meter from surface. For cask use the exposure level to operating personnel would be conservatively considered at the 12" distance. Operating time for the multiple source exchanges, 2 each new 9,500 Ci sources to be shipped and loaded and 2 each ~ 4,000 Ci. Co-60 sources in the same configuration to be reloaded, including time to align the NPI cask with the JLS&A transfer cask, based on multiple previous source loadings using the GE 1500 cask is considered to be one hour. It is obvious that 2 each NPI casks would be required to ship 2 each 9,500 Ci. Co-60 sources because of the 15,000 Ci. limit for the cask.

The dose rate of 1.2 R/hour/Ci. of Co-60 at one meter distance was used for the basis of the calculations. This is a typical measured output per Ci. of Co-60 from a source of this configuration as measured using NIST traceable air equivalent ionization chamber and electrometers.

Shielding curves for both lead and Steel(SS) taken from NCRP report No.49 were used as the basis of shielding calculations

CALCULATIONS

Segment 1 at 1,728 Ci. at end of source.

Distance to surface is 9".

Dose rate is 3.97 x 10^7 mR/hr.
Shielding is 8" lead with reduction factor of 9 x 10^4 , including shielding in lead plug in end of tube and 1/2" steel with reduction factor of 1.3 for total reduction factor of 1.17 x 10^5.

Dose rate at surface is 340 mR/hour
Dose rate at 1" from surface (21" total) is 62mR/hr.
Dose at 1 meter from surface is 12 mR/hr.

Segment # 2 at 1728Ci. (next in line to Segment # 1).

Distance to surface is 9 ½".
Dose rate is 3.6 x 10^7 mR/hr
Shielding is 7 ¾" lead with reduction factor of 6 x 10^4 and 3/4" steel with reduction factor of 1.5 for total reduction factor of 9 x 10^4.

Dose rate at surface is 400 mR./hr
Dose ate at 12" fro surface is 778 mr/hr
Dose ate at 1 meter from surface is 15 mR/hr.

Segment # 3, 864 Ci. next to segment # 2.

Distance to surface is 9 ¾"
Dose rate is 1.69 x 10^7 mR/hr.
Shielding is 7 5/8" lead with reduction factor of 5 x 10^4 and 1 18" steel with reduction factor of 1.9 for total reduction factor of 9.5 x 10^4.

Dose rate at surface is 178 mR/hr
Dose rate at 12" from surface is 36 mR/hr
Dose rate at one meter from surface is 7 mR/hr

Segment # 4, 1,728Ci nest to segment # 3.

Distance to surface is 10".
Dose rate is 3.22 x 10^7 mR/hr.

Shielding is 7 ¾" lead with reduction factor of 6×10^4 and 1 1/8" steel with reduction factor of 1.9 for total reduction factor of 1.14×10^5.

Dose rate at surface is 281 mR/hr.
Dose rate at 12" from surface is 58 mR/hr.
Dose rate at one meter from surface is 12 mr/hr

Segment # 5, 1,728 Ci. next to segment # 4.

Distance to surface is 10 ½"
Dose rate at surface is 2.92×10^7 mR/hr.
Shielding is 8 1/8" lad with reduction factor of 1.1×10^5 and 1 3/8" steel with reduction factor of 2.2 for total reduction factor of 2.42×10^5

Dose rate at surface is 121 mR/hr.
Dose rate a 12" from surface is 27 mR/hr
Dose rate at one meter from surface is 5.3 mr/hr.

Segment # 6, 1,728 Ci next to Segment # 5 at top end of source,

Distance to surface is 10 ½"
Dose rate at surface is 2.66×10^6 mR/hr.

Shielding is 8 3/8" lead with reduction factor of 1.55×10^5 and 1 3/8" steel with reduction factor of 2.2 for total reduction factor of 3.4×10^5.

Dose rate at surface is 78 mR/hr
Dose rate at 12" from surface is 18 mR/hr
Dose rate a one mter from surface is 3.8 mR/hr.

Total dose rates are:

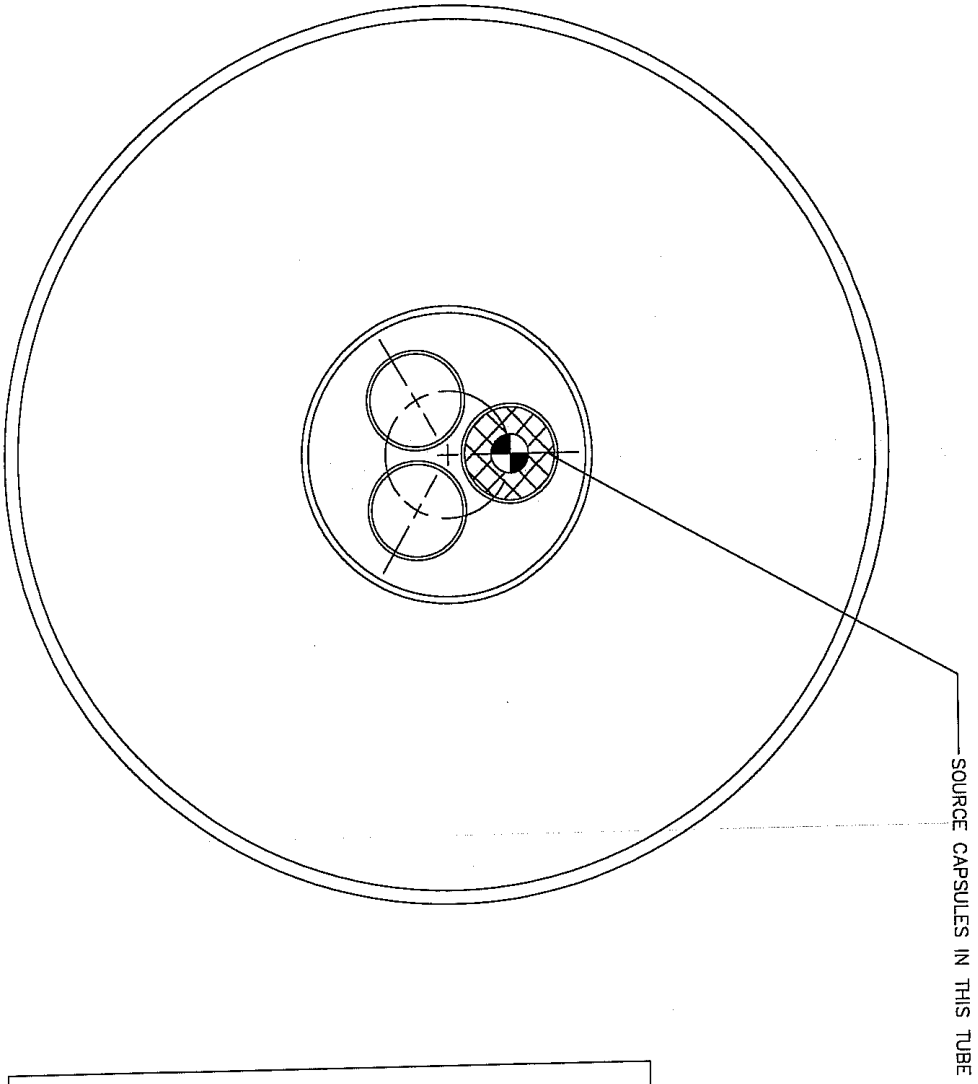
Surface:	1,398 mRhr
12"from surface:	279 mRhr
One meter from surface:	55 mR/hr

Calculations were also made for points perpendicular to the centerline of the cask using a single 9,500 Ci. point located at centerline of source.

Distance is 10 1/4" with dose rate of a 1.68×10^8 mR/hr.

Shielding is 8 ½" lead with reduction factor of 1.85×10^5 and 1.7" steel with reduction factor of 1.7 for total reduction factor of 3.14×10^5.

Dose rate at surface is 535 mR/hr
Dose rate at 12"om surface is 114 mR/hr
Dose ate at 1 meter from surface is 23 mR/hr



J. L. SHEPHERD and Associates			
DRAWN BY D. TRAN	DATE 24SEP12	APPROVED BY	SCALE NONE
9,500 Ci LOADING CONFIGURATION			
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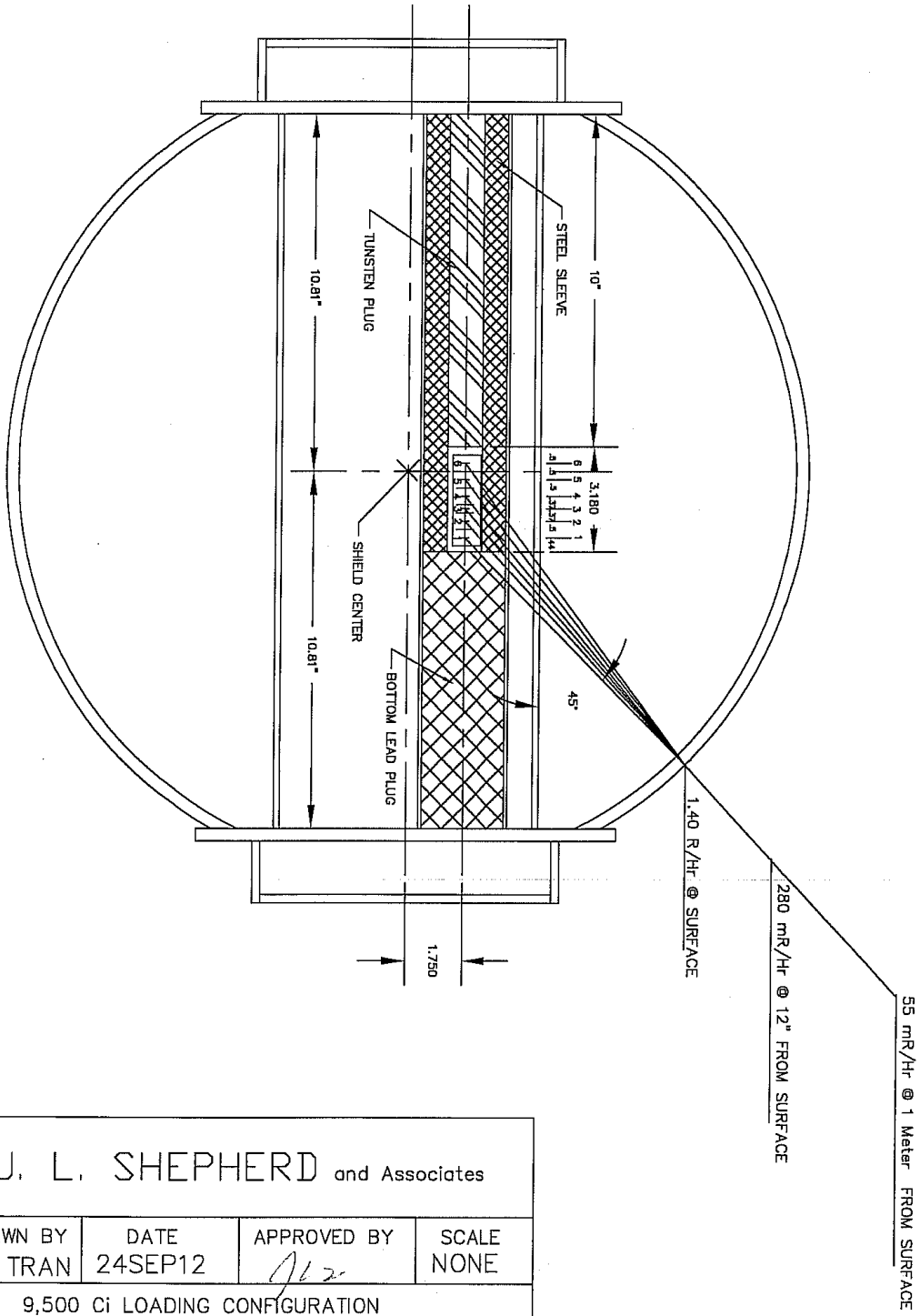

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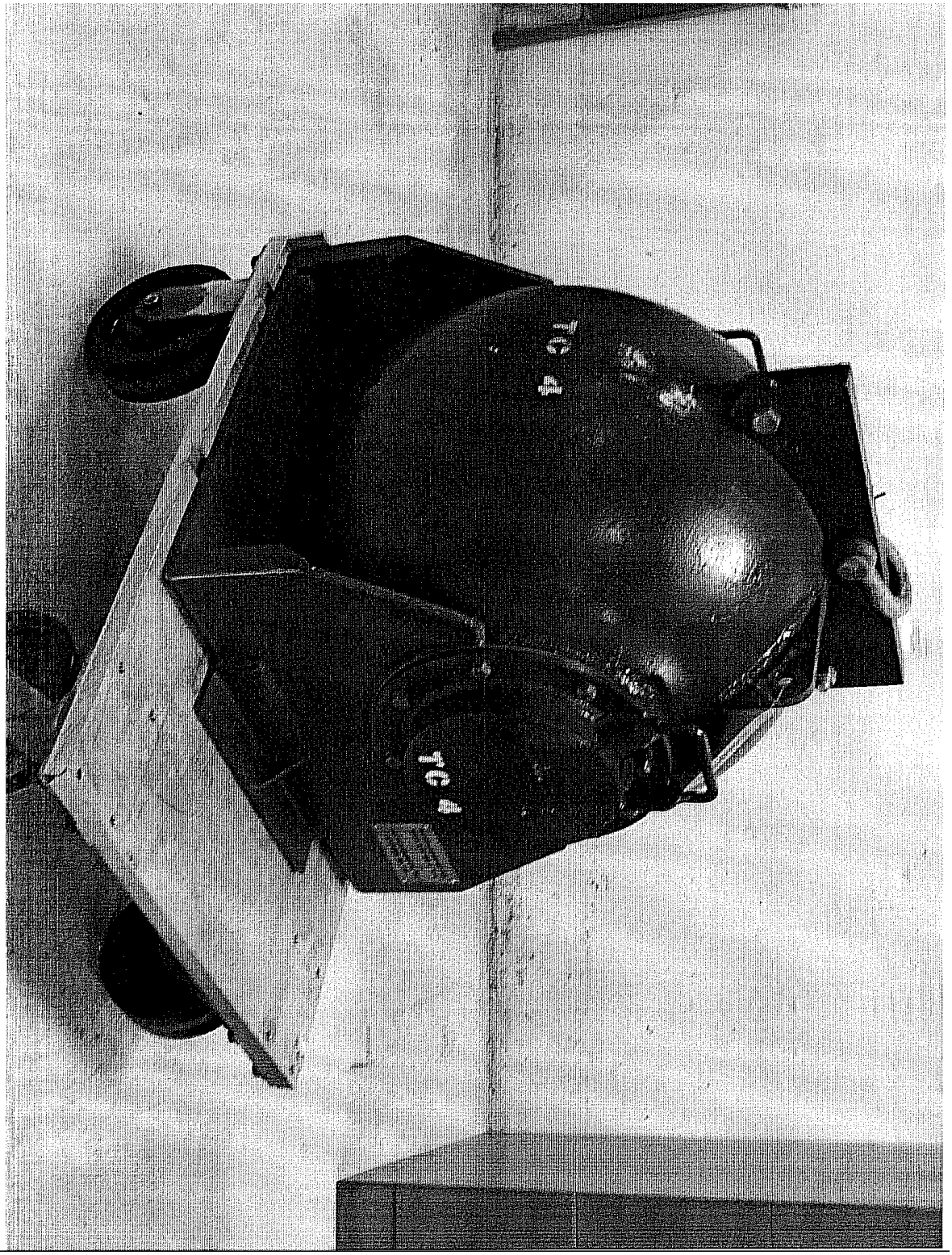
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