Rec'd 2-21-85

AMC
INDUSTRIAL DIVISION

BRANDHURST INCORPORATED

87 Sand Pit Road, Danbury, CT 06810
Telephone: (203) 798-1311 Telex: 4994886 BRAND

January 8, 1985

U. S. Nuclear Regulatory Commission
Section B
631 Park Avenue
King of Prussia, PA 19406

Att: Jenny M. Johansen
Ref: USNRC License No. ~~31-20726-01~~

Dear Ms. Johansen:

In the future, we will be expanding the range of devices covered under the above license. Our experience in the past, when our firm was located in New York State, has been that an application for a license amendment to add new devices benefits from prior regulatory agency approval of the gaseous tritium light sources contained within the devices. It is with this in mind that we are submitting herewith our application for Approval of Sealed Sources Containing Tritium Gas.

We look forward to hearing from you in regard to the enclosed.

Sincerely yours,

Ronald G. Harper
Vice President

RGH/jl
enc.

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Brandhurst Inc.
87 Sand Pit Road
Danbury, CT 06810

APPLICATION FOR APPROVAL OF SEALED SOURCES CONTAINING TRITIUM GAS

CONTENTS:

Document No. 82-11
Revision 0
Issued 25th. October, 1982

A. SUMMARY DATA

1. Date of Submission

2. Device Type: Gaseous tritium light source

3. Model No.s:
   S/
   CT/
   CC/
   RT/ For details, see generic drawings
   RC/
   DA/
   DR/

4. Applicant: Brandhurst Incorporated
   87 Sand Pit Road
   Danbury, CT 06810

5. Manufacturer: Brandhurst Company Limited
   P. O. Box 70
   Wellington Road
   High Wycombe, Buckinghamshire HP 12 3PS
   England

6. Sealed Source Model Designation: This application is for sources not devices.

7. Isotope & Maximum Activity: Tritium (H_3). For maximum activity see drawings.

8. Leak Test Frequency: Immediately after manufacture and in accordance with customer or regulatory requirements.

9. Principal use: Gaseous tritium light devices, self-illuminating

B. DESCRIPTIVE DATE

1. Summary Description

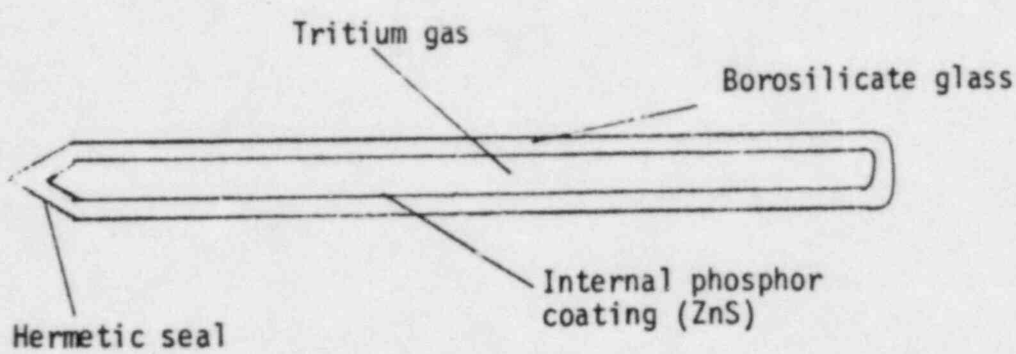
ANSI Classification T2GC, T3GC, T4GC, T5GC, T6GC

Microlights- tritium activated light sources are sealed borosilicate glass capsules coated internally with a phosphor and filled with tritium gas. Tritium is an isotope of hydrogen which emits low energy beta radiation which excites phosphor causing it to emit visible light. The wavelength and color of the light depends upon the make-up of the phosphor and can vary from red (603-618 nms) to blue (450-48 nms).

The brightness of microlights is varied by the tritium content; they are filled at pressures up to 2.5 atmospheres to achieve maximum brightness. The light output level of any microlight may be greatly increased by painting the unexposed surface with reflective white paint.

A comprehensive range of shapes and sizes are manufactured by either machine or hand blown techniques.

2. Diagram



3. CONDITIONS OF NORMAL USE

The gaseous tritium light sources will be assembled into safety signs and markers and various military optical equipment for the illumination of dials, graticules, etc., and will be shipped to intermediate and end users in accordance with license requirements of 10CFR.

4. SUPPORTING DATA

We enclose the following supporting documents: (exhibits)

A. Goods Inwards Inspection (Report)

B. Brandhurst Inspection Schedule

C. Microlight Works Order

D. Manufacturing and Quality Control Procedures for Microlight Gaseous Tritium Light Sources

BRANDHURST

Brandhurst Company Limited

P.O Box 70 Wellington Road
High Wycombe Bucks HP12 3PS
Telephone 0494 33411
Telex 837138

EXHIBIT A

GOODS INWARDS INSPECTION

PURCHASE ORDER NO. ....

DELIVERY NOTE NO. ....

DESCRIPTION ....

DATE ....

QUANTITY ....

QUANTITY PASS/FAIL ....

REJECT NOTE NO. ....

STOCK NO. ....

COMMENT ....

....

....

SIGNATURE ....
(Inspector)

BRANDHURST
Brandhurst Company Limited

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EXHIBIT B

BRANDHURST INSPECTION SCHEDULE 1

GOODS INWARDS

1. All goods received which are either for inclusion in a manufactured item or for use in a manufacturing process must be examined and approved by the Quality Controller before use.

2. The person receiving the incoming goods should (a) sign any delivery notes as "unexamined", (b) notify the Quality Controller of the receipt of the goods and give him any delivery notes.

3. No incoming goods should be used unless approved for use by the Quality Controller.

4. The Quality Controller will examine the incoming goods and then notify the relevant Department Supervisor if approved or not. He will arrange for the removal to the relevant department of any goods approved and for the return of the rejected goods to the supplier.

5. A cardex system will be kept which will record the delivery date, quantity and approval or rejection of all material received. Specifications will be kept on the front of the card indicating the type of material.

6. A raw material reject note and supplier complaint will be issued for any rejected material.

7. A supplier complaint only will be issued for any substandard raw material approved for use by the Quality Controller.

INSPECTION PROCEDURE

a. Raw Glass Tubing

A random sample from each batch of incoming raw glass tubing will be checked for appearance, outside dimensions and wall thickness to ensure compliance with our purchase order.

MICROLIGHT WORKS ORDER EXHIBIT C

CUSTOMER	WORKS ORDER NO.
DATE	ACKNOWLEDGEMENT NO.
DESCRIPTION	SAMPLE NO. / QUANTITY REQ'D
BRIGHTNESS	DIMENSIONS
COATING	FILLING PRESSURE
TRITIUM CONTENT	DESPATCH DATE

	TOOLS GAUGES	INSP. REJECTS	QTY. REJECTS	QTY. PASSED
GLASS WORKING: MATERIALS: Select glass for Q.C. approval METHOD: Date/Sign:				
ANNEALING: Date/Sign:				
VAC. BAKE: Date/Sign:				
COATING: PHOSPHOR USED: BALLOTINI USED: METHOD: Date/Sign:				
FILLING: PYRO NO: TRITIUM CONTENT: REMARKS: FIRST OFF APPRO: PRESS USED: RIG NO: Date/Sign:				
INSPECTION: LASER LENGTHS Date/Sign:				
LASER: NO. ESTIMATED QTY. LENGTH. Date/Sign:				
INSPECTION: BEFORE FINISHING Date/Sign:				
PAINTING: NO. OF APPLICATIONS PAINT TYPE CODE: Date/Sign:				

(ii) Anodised Parts - all will be 100% visually inspected for finish.

(iii) Epoxy Powder Coated Parts - all will be 100% visually inspected for finish.

(iv) Lenses for Torch and Map Reader - these will be 100% visually inspected for surface defects, cracks, striations, etc., and sample checked for dimensions.

(v) Map Reader Glass Windows - these will be 100% visually checked for quality of etching, surface defects, size, etc.

(vi) Defile/Route Marker Windows - these will be 100% inspected after screen printing for print quality, surface finish, correctness of legend, etc.

BRANDHURST
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EXHIBIT D

MANUFACTURING AND QUALITY CONTROL PROCEDURES FOR MICROLIGHT GASEOUS TRITIUM LIGHT SOURCES

1. MATERIALS

1. Glass Tubing, borosilicate to specification No. Fed.Spec.DDG 541B type I, class A, manufactured by Corning Glass.

2. Phosphor/zinc sulphide.

3. Tritium Gas containing less than 1% tritium oxide. Manufactured and supplied by Union Carbide Corporation, Oakridge, Tennessee, U.S.A.

11. MANUFACTURING PROCEDURES

1. Glass Tubing

   All tubing is fully annealed after drawing at 600°C for three hours, followed by slow cooling.

2. Glassworking

   Glass of suitable cross-section is selected from the bonded store to suit the work piece to be produced. The shape is produced by either machine or hand-blowing techniques using pre-formed moulds and formers where applicable, all finished items being checked by specially made gauges. All work is re-annealed.

3. Washing

   All parts are washed internally and externally using hydrofluoric acid solution followed by water and acetone. This process involves the use of a coarse vacuum 26" mercury applied to the tubes which would cause failure of the glass wall if any weak areas exist.

2/ ...

b. Formed Glass Tubing

Will be 100% checked either by calipers, or gauge to the relevant dimensional specification and 100% visually checked for shape, distortion, constriction size, stem size, etc.

c. Phosphor Powder

A visual check only will be performed to check correct colour and grade. Supplier and batch number will be noted.

d. Tritium

The batch number will be noted and the certificate of purity retained. No further inspection is possible or necessary.

e. Ballotini

All incoming ballotini will be 100% sieved to ensure that it is the correct grade.

f. Luminous Compound

All incoming luminous compound will be checked for powder brightness after 24 hours retention in the dark. The colour and grain size will be checked visually.

g. Signs

(i) Frames - all metal frames will be sample checked with backplate on receipt from suppliers to check the finish, integrity of corner welds and dimensions. They will be 100% visually checked after painting for finish. All plastic frames will be 100% visually checked for finish, thickness of walls, integrity of corner pieces, etc. They will be sample checked for compliance with drawing dimensions.

(ii) Windows - these will be sample checked for size prior to submitting to screen printers and 100% visually checked after printing for surface quality, correctness of legend and print quality.

(iii) Vacuum Forming - these will be sample checked after receipt from the silvering company, visually for finish, and by insertion into a frame for dimensions.

h. Military Products

(i) Machined or Cast Parts - all sub-contracted machined or cast parts will be sample checked for dimensional compliance to drawing before finishing.

11. 4. Coating

A binder in the form of a 1% solution of phosphoric acid in acetone is introduced into each work piece and distributed evenly with the aid of ballotini and a vibrational tool. Following this, the zinc sulphide is similarly introduced to produce a monocrystalline layer around the internal surface of the work piece. The vibrational process produces severe mechanical stress which will cause breakage if any weak areas exist.

5 Filling

After further cleaning and inspection operations, the coated tubes are baked at 200°C in a vacuum of 10^{-4}mm of mercury for 12 hours before being loaded into the automatic filling machine. This machine evacuates the tubes to 10^{-4}mm of mercury, leak tests the work piece and back-fills with tritium to the required pressure, as specified. The work piece is then sealed off by fusion of the glass at the specified sealing point using a gas/oxygen flame.

6. Laser Sealing

In the case of items to be laser sealed, the initially filled length measuring 30cms is inserted into the laser sealing system where it is sub-divided using an oscillating laser beam from a CO_2 laser.

7. Thermal Shock

All filled microlights are subjected to a 5 minute thermal shock at 550°C. This produces a dramatic temperature and pressure increase which will produce failure should there be any internal stresses or weaknesses present.

111. QUALITY CONTROL PROCEDURES

American National Standard No. N540 pre-supposes the environmental conditions which GTLS must withstand. The requirements for temperature and thermal shock are specified by the inherent properties of borosilicate glass tubing and confirmed by the thermal cycles encountered during the manufacturing process for GTLS outlined above. Similarly,

3/ ...

during manufacture the GTLS are subjected to reduced pressure conditions more severe than that specified in N540.

Since unmounted GTLS will only be distributed to Specific Licensees for assembly into complete devices, the N540 vibration and impact test requirements are, from a safety stand-point, best met by performing such tests on the completed device.

1. <u>Incoming Material Inspection</u>

Inspection sampling plan 1.5 AQL for mechanical characteristics of glass involves:-

Certificate of Conformance for glass material composition, phosphor and tritium gas. All raw materials are logged in by the Receiving Department and described on an Incoming Inspection Report. (See blank copy attached as Exhibit A.)

2. <u>In-Process Inspection</u>

Inspection sampling plan 1.5 AQL. All microlights are submitted to Inspection Department for first piece, in-process and final mechanical inspection. (See blank copy attached as Exhibit B).

3. <u>Final Inspection</u>

All light sources are subjected to a final inspection for:-

a. Appearance.

b. Dimensions - using standards and callipers which are callibrated regularly against National standards.

c. Brightness - using a photomultiplier and light standards callibrated against National standards.

4/ ...

4. Radiological Control and Sealed Integrity Inspection

All microlights manufactured are subjected to a 24 hour deionised water soak test for leakage or surface contamination. A sample of the soak water is tested by liquid scintillation techniques to determine that the detectable tritium does not exceed 0.050 μCi per source. Any light source exceeding this level is rejected. (See Appendix A)

Before Final Inspection all microlights are thoroughly washed using a radiological de-contaminant and rinsed off with water.

DAT/RAB
14.7.82.

C. Health & Safety Data.

Analysis of Radiation Safety.

Tritium gas (H^3 an isotope of hydrogen) emits very low energy beta particles (max energy 18 keV average energy 5.5 keV) which excite the internal phosphor layer of the borosilicate glass capsule producing the light output. Since the beta energy is low the range of the particles in air is only 6 mms and about 6 microns (0.006 mm) in water or human tissue and approximately 2.5 microns in glass. However the absorption of beta particles by matter produces secondary electromagnetic radiation or bremsstrahlung which is in the form of low energy X-rays.

At the surface of a microlight there is therefore a very low though measurable dose rate, this bremsstrahlung dose rate and energy cannot be predicted solely from the tritium content, it also depends on various other factors concerned with the source including the thickness of the glass and its geometry. Measurements indicate that for thin walls up to 0.1 mm the surface dose rate is about 100 millirads per hour per curie and for thicker walls, e.g. up to 1mm glass plus 2-3 mm plastic cover the dose rate is only about 0.1 millirads per hour per curie.

The effective energy of the bremsstrahlung is usually in the range of 8 to 14 keV and due to the generally small size of the sources, the inverse square law ensures a very rapid drop of dose rate with distance from the source. Also when considering the dose rates which may be received by various organs of the body the attenuation by tissue must also be taken into account. The half value thickness for 10 keV photon radiation in water is about 0.14 cm. thus the shielding provided by the tissue covering the bloodforming organs, ovaries and testes at normal depths of 5cm. 7cm. and 1cm. respectively is therefore considerable without taking into account the protection provided by clothing.

Thus it appears that the external dose rate from microlights is so low in existing applications that it may be discounted and personnel handling microlights either singly or in large numbers are not subject to any significant radiation hazard.

There remains a consideration of possible radiation dose received by individuals from inhalation and skin exposure of any tritium released from the sealed sources.

1. Normal Use in Unrestricted Area. (10CFR 32 23 (a))

The manufacturers Production Quality Control procedures for gaseous tritium light sources only permit a maximum leakage of 0.050 microcuries over a 24 hour period per light source and a maximum tritium oxide content of 1%.

The calculation given in Appendix B shows that an individual remaining in an unrestricted area where a single microlight containing 2.0 curies is placed and assuming a maximum leakage rate, would receive a total annual dose of approximately 1.7 10^{-8} rems compared to the limit of 0.5 rems in 10 CFR 20 105 (a).

Thus the probability is negligible that a sufficient number of light sources would be placed in a room of 2500 ft^3 to collectively result in a total dose of 0.5 rems per year to any individual.

2. Normal Handling & Storage (10CFR 32 23 (b))

The calculation given in Appendix C shows that the number of gaseous tritium light sources required to be held in any one situation during marketing , distribution or installation to give anyone exposed to tritium released from the source for one year a dose exceeding the values of Column II of Table 32.24 i.e. 0.01 rems/year is in the order of 2 million. This is extremely unlikely.

3. Use & Disposal (10CFR 32 23 (d))

The calculations given in Appendix D show that 360 tritium gas filled sources each containing 2.0 curies would have to be broken per year to give a person a radiation dose exceeding 0.5 rems/year or 10,000 such units a year for the person to exceed 15 rems/year. The possibility of such events can be considered low and negligible respectively.

APPENDIX A

Leakage Testing of Microlights by Soak Testing to ANS N540 8.3.2 i.e. to max of 50 nanocuries/24 hrs

Consider:-

N nanocuries/24 hrs	=	leakage rate of the microlight source
V_1 mls.	=	volume of water used for soak test at least 10 times the volume of the source
T Hours	=	Period of soak test
V_2 mls	=	Sample volume taken from V_1 and placed in polythene minitube containing 5 mls of scintillant cocktail.
A nanocuries	=	Activity of standard in glass vial
C_1	=	Counts from sample in minitube
C_2	=	Counts from standard over the same period of time

From these counts the activity of the minitube

$$= \frac{A}{K}\frac{C_1}{C_2} \text{ nanocuries}$$

When K is a numerical factor to correct for the differing counting geometries between the standard in a glass vial and the sample in a polythene millitube. Experiments with constant activity solutions has shown that K = 0.783

$$\therefore \text{ Activity in minitube} = \frac{A}{0.783}\frac{C_1}{C_2} \text{ nanocuries}$$

This activity is from a sample V_2 mls taken out of a soak test value of V_1 mls.

$$\therefore \text{ Activity in soak test value} = \frac{V_1}{V_2}\frac{A}{0.783}\frac{C_1}{C_2} \text{ nanocuries}$$

The soak test is taken over T hours compared to the test requirement of 24 hours

$$\therefore \text{ Value for 24 hrs.} = N = \frac{24}{T} \frac{V_1}{V_2} \frac{A}{0.783} \frac{C_1}{C_2} \text{ nanocuries}$$

The following values have been standardised

V_1 = 20 mls

V_2 = 0.5 mls

T = 24 hrs.

$$\text{when } N = \frac{24}{24} \frac{20}{0.5} \frac{A}{0.783} \frac{C_1}{C_2} \text{ nanocuries}$$

$$N = 51 A \frac{C_1}{C_2} \text{ nanocuries}$$

Typical values for the standards are

A = 28 nanocuries

C_2 = 2000

So for max leak rate of 50 nanocuries:-

$$50 = \frac{51\ 28\ C_1}{2000}$$

$$\therefore \text{ max } C_1 = \frac{2000 \times 50}{51 \times 28} = \underline{70}$$

APPENDIX B

Calculation of Total Radiation Dose from a Single Tritium Gas Filled source in an Unrestricted Area (10 CFR 20 105 (a))

a) Tritium in Air concentration arising from normal leakage from a single source

Consider

i) A single source having a maximum leak rate 0.050 microcuries per 24 hours.

ii) This source situated in a room 25 x 10 x 10 ft. (2500 ft^3) = 7.08 10^7 mls.

iii) A ventilation rate of 15 charges/hour.

iv) Tritium oxide content of 2% (i.e. twice the controlled value)

v) An individual remaining in the room 40hrs/week continually for 1 year.

vi) The inhalation intake of the standard man is approximately 2 10^7 ml per 24 hour day.

Then concentration =

$$\left(\frac{2}{100}\right) \frac{(0.050 \text{ microcurie/24 hrs.})}{(7.08\ 10^7 \text{ ml})\ (15/\text{hr})}$$

$$= \frac{0.02 \quad 0.05}{7.08 \quad 15 \quad 24} \quad 10^{-7} \text{ microcuries/ml.}$$

$$= 0.04 \quad 10^{-12} \text{ microcuries/ml}$$

b) Dose Equivalent to Tritium Intake

The maximum permissible dose for an individual in an unrestricted area is 0.5 rems/year (10 CFR 20 105 (a)). This dose would be received by an individual remaining continually 24hrs/day, 365days/year in a tritium environment where concentration is given in 10 CFR 20 106 2 and Appendix B Table II, i.e. 2 10^{-7} microcuries/ml. However as stated in the footnote to 10 CFR 20 103 (a)(i) since this concentration specified for tritium oxide vapour assumes equal intakes by skin absorption and inhalation the total intake permitted is twice that which would result from inhalation alone at the concentration specified for H3 (S) in Appendix B Table II so is 4 10^{-7} microcuries/ml.

So an individual of standard inhalation $2\ 10^7$ ml/day remaining continually in an environment of $4\ 10^{-7}$ microcuries/ml will receive an annual intake of

$$(2\ 10^7 \text{ ml/day})\ (365 \text{ days/year})\ (4\ 10^{-7} \text{ microcurie/ml})$$

= 2920 microcuries/year

= 2.9 millicuries/year

This intake will result in a maximum permissible dose of 0.5 rems/year

$$\therefore \text{Dose equivalent} = \frac{0.5 \text{ rems/year}}{2.9 \text{ mCi/year}}$$

$$= 0.17 \text{ rems/mCi}$$

c) Total Annual Dose

Finally consider an individual situated in an unrestricted area for 8 hour work day 260 days/year and of inhalation intake approximately 10^7 ml/8 hr. day.

Total annual dose:-

Concentration x Inhalation x Dose Equivalent

$0.04\ 10^{-12}$ microcuries/ml 10^7 ml/day 260 days/year 0.17rems/mCi

= $10.4\ 10^{-5}$ microcuries/year 0.17rems/mCi

= $0.01\ 10^{-5}$ millicuries/year 0.17rems/mCi

= $0.0017\ 10^{-5}$ rems/year

= $1.7\ 10^{-8}$ rems/year

This is approximately 0.3×10^{-8} of the maximum permissible level of 0.5 rems/year.

APPENDIX C

Calculation of Total Radiation Dose from Normal Handling & Storage of Gaseous Tritium filled sources (10 CFR 32 23 (b))

For these conditions the following assumptions are made:-

1.	Number of sources held in one room	N
2.	Tritium release per source	0.050 uCi/24hrs
3.	Storage room size 10,000 ft.^{3}	2.83 10^8ml.
4.	Ventilation rate	15 charges/hr
5.	Tritium oxide	2%
6.	Individual remaining in the room 40hrs/week continually for 1 year	2080 hrs
7.	Inhalation intake of standard man during 8 hour day.	10^7 ml.

Concentration

$$= \left(\frac{2}{100}\right)\left(\frac{N \times 0.050 \text{ microcuries/24hrs}}{2.83\ 10^8 \text{ ml } \ 15/\text{hr}}\right)$$

$$= 1.0 \times N\ 10^{-14} \text{ microcuries/ml}$$

Total Dose

= Concentration x Inhalation x Dose Equivalent

$$= \left(1.0\ N\ 10^{-14} \text{ microcuries/ml}\right)\left(10^7 \text{ml/8hrs}\right)\left(2080 \text{hrs/year}\right)\left(0.17 \text{rems/mCi}\right)$$

$$\frac{1.0\ N\ 10^{-14}\ 10^{+7}\ 2080}{8} \text{ microcuries/year} \left\{0.17 \text{ rems/mCi}\right\}$$

$$= \frac{N\ 2.080\ 10^{-7}}{8} \text{ millicuries/year} \quad 0.17 \text{ rems/millicurie}$$

$$= N\ 0.04\ 10^{-7}$$

$$= 4\ N\ 10^{-9} \text{ rems/year}$$

Number of sources required to give a dose commitment of Column II of Table 32.24 (0.01 rems)

given by $4\ N\ 10^{-9} = 0.01$

$$\therefore \quad N = \frac{0.01}{4\ 10^{-9}}$$

$$= 2.5\ 10^{6}$$

APPENDIX D

Use and Disposal

For these conditions the following assumptions are made:-

1. The number of sources held in one room	N
2. The average tritium content per source	2.0 Ci.
3. Room size 10,000 ft^3	2.83 10^8 ml
4. Ventilation rate	15 charges/hr
5. Tritium Oxide	2%

Assume accidental damage causing failure of all sources and release of total tritium into the room.

Initial concentration

$$= \frac{(\text{oxide content}) \times (\text{Tritium released})}{\text{room volume}}$$

$$= \frac{2}{10} \quad 2.0 \quad \frac{N \text{ Curies}}{2.83 \quad 10^8 \text{ mls}}$$

$$= \frac{4 \, N \quad 10^3}{283 \quad 10^8} \text{ microcuries/ml} \quad = \quad 0.014 \, N \quad 10^{-5} \text{ mCi/ml}$$

$$= \quad 1.4 \, N \quad 10^{-7} \text{ mCi/ml}$$

Total intake assuming no ventilation

= (concentration) (Intake standard man)

$1.4 \, N \quad 10^{-7}$ mCi/ml $\quad 2 \quad 10^7$ ml/24 hrs

= 0.12 N mCi/hr.

Now since the room containing the release tritium is being ventilated at a constant rate of 15 charges per hour we can assume that a constant fraction of tritium is removed per unit time.

The concentration at any one time can be expressed as an exponential function of time:-

$$Tc = Te^{-vt}$$

Tc = Tritium concentration at time t

To = Initial concentration (t = o)

v = Ventilation rate (air charges/hr)

t = Time after release (hrs)

The mean residence time for tritium is given by

$$\int_{o}^{\infty} e^{-vt}\, dt = \left(\frac{1}{v} e^{-vt} \right)_{t=o}^{t=\infty} = 1/V$$

So with 15 air changes per hour the mean residence time is

$^{1}/_{15}$ = 0.07 hr.

So total intake = 0.12 N mCi/hr x 0.07 hrs

= 8.4 N 10^{-3} mCi

Using the dose equivalent for 168 hrs residence as calculated in Appendix B then

Total dose = (Dose Equivalent) x (Total Intake)

= 0.17 rems/mCi x 8.4 N 10^{-3} mCi

= 1.4 N 10^{-3} rems/year

For the level of Column III of the table 10 CFR 32.24 as specified in 10 CFR 32.23 (d) i.e. 0.5 rems to be reached the number of 2.0 Ci tritium gas filled sources needed to be broken is given by

$$1.4 \text{ N } 10^{-3} = 0.5$$

$$N = \frac{0.5}{1.4} 10^{3}$$

$$= \underline{360}$$

and for the level in Column III i.e. 15 rems to be reached

$$1.4 \text{ N } 10^{-3} = 15$$

$$N = \frac{15}{1.4} 10^{-3}$$

$$= \underline{10,000}$$

NOTES

1. Marking, Labelling and Shipping of packages and containers shall be in accordance with MIL-STD-1458.

2. There shall be no evidence of physical failure such as fracturing or light loss due to exposing the lamp to -80°F and +160°F for a period of eight hours at each temperature.

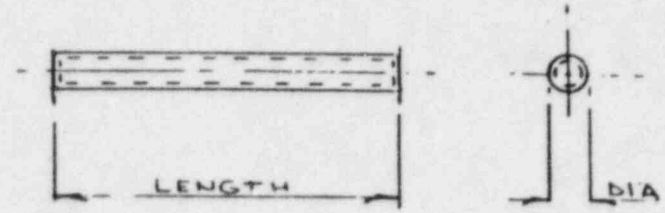
3. After submerging the lamp in room temperature water for four hours, radioactive content of the water shall not exceed .005 microcuries.

4. Vial filled with 99% pure (less than 1% tritium oxide) Tritium (H_3).

5. Glass, Type 1, Class A, Spec DD-G-541.

6. Zinc Sulphide Phosphor.

7. Binder - Phosphoric Acid.

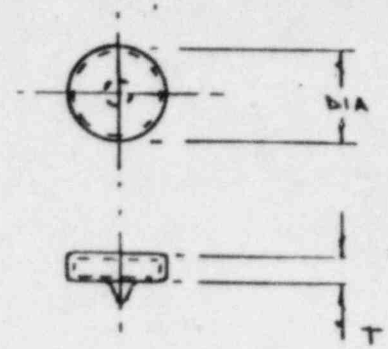


	MIN.	MAX
DIAMETER	0.5MM	7 MM
LENGTH	3 MM	250 MM
WALL THICKNESS	0.15MM	1.5 MM
FILLING PRESSURE	–	2.5 BAR
TRITIUM CONTENT	–	15 Ci

TYPE CT

			DRAWN. RHA	TOLERANCES UNLESS OTHERWISE STATED.	SURFACE TEXTURE	TITLE. CYLINDRICAL LIGHT SOURCE
			CKD.			
			SCALE. —	MATERIAL.	BRANDHURST CO. LTD. WELLINGTON ROAD, HIGH WYCOMBE, BUCKS.	DRG. No. P.1660
ISSUE	MODIFICATION	DATE	DATE 25-10-82	FINISH		

THIRD ANGLE PROJECTION



NOTES

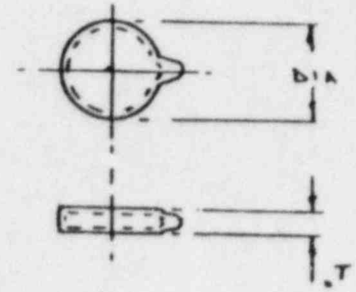
1. Marking, Labelling and Shipping of packages and containers shall be in accordance with MIL-STD-1458.
2. There shall be no evidence of physical failure such as fracturing or light loss due to exposing the lamp to -80^{0}F and $+160^{0}$F for a period of eight hours at each temperature.
3. After submerging the lamp in room temperature water for four hours, radioactive content of the water shall not exceed .005 microcuries.
4. Vial filled with 99% pure (less than 1% tritium oxide) Tritium (H_3).
5. Glass, Type 1, Class A, Spec DD-G-541.
6. Zinc Sulphide Phosphor.
7. Binder - Phosphoric Acid.

	MIN.	MAX.
DIAMETER	4 MM	60 MM
THICKNESS T	2 MM	10 MM
WALL THICKNESS	0.5 MM	3 MM
FILLING PRESSURE	–	2.5 BAR
TRITIUM CONTENT	–	15 CI

TYPE. DA

			DRAWN. RHA	TOLERANCES UNLESS OTHERWISE STATED.	SURFACE TEXTURE	TITLE. AXIAL DISC LIGHT SOURCE
			CKD.			
			SCALE. –	MATERIAL.	BRANDHURST CO. LTD. WELLINGTON ROAD, HIGH WYCOMBE, BUCKS.	DRG. No. P1661
ISSUE	MODIFICATION	DATE	DATE 25-10-92	FINISH		

THIRD ANGLE PROJECTION



NOTES

1. Marking, Labelling and Shipping of packages and containers shall be in accordance with MIL-STD-1458.

2. There shall be no evidence of physical failure such as fracturing or light loss due to exposing the lamp to -80°F and +160°F for a period of eight hours at each temperature.

3. After submerging the lamp in room temperature water for four hours, radioactive content of the water shall not exceed .005 microcuries.

4. Vial filled with 99% pure (less than 1% tritium oxide) Tritium (H_3).

5. Glass, Type 1, Class A, Spec DD-G-541.

6. Zinc Sulphide Phosphor.

7. Binder - Phosphoric Acid.

	MIN	MAX.
DIAMETER	4 MM	60 MM
THICKNESS T	2 MM	10 MM
WALL THICKNESS	0.5 MM	3 MM
FILLING PRESSURE	—	2.5 BAR
TRITIUM CONTENT	—	15 Ci

TYPE. DR

ISSUE	MODIFICATION	DATE	DRAWN. RHA	TOLERANCES UNLESS OTHERWISE STATED.		SURFACE TEXTURE	TITLE. RADIAL DISC. LIGHT SOURCE
			CKD.				
			SCALE. —	MATERIAL.		BRANDHURST CO. LTD. WELLINGTON ROAD, HIGH WYCOMBE, BUCKS.	DRG. No. P1662
			DATE 25-10-82	FINISH			

.HIRD ANGLE PROJECTION

NOTES

1. Marking, Labelling and Shipping of packages and containers shall be in accordance with MIL-STD-1458.

2. There shall be no evidence of physical failure such as fracturing or light loss due to exposing the lamp to -80°F and +160°F for a period of eight hours at each temperature.

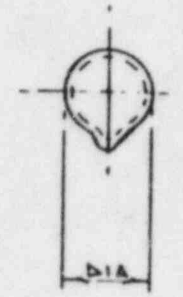
3. After submerging the lamp in room temperature water for four hours, radioactive content of the water shall not exceed .005 microcuries.

4. Vial filled with 99% pure (less than 1% tritium oxide) Tritium (H_3).

5. Glass, Type 1, Class A, Spec DD-G-541.

6. Zinc Sulphide Phosphor.

7. Binder - Phosphoric Acid.

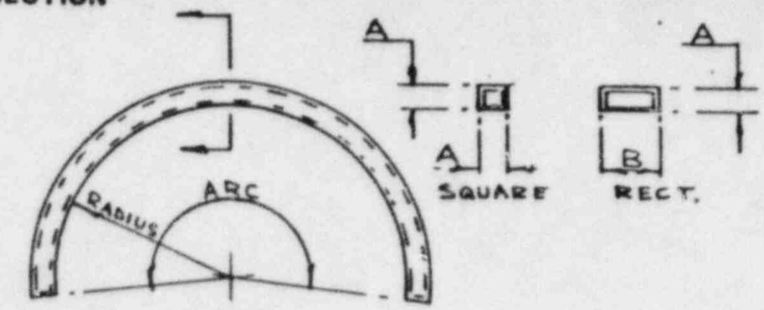


	MIN	MAX
DIAMETER	4 MM	20 MM
WALL THICKNESS	0.5MM	1.0 MM
FILLING PRESSURE	—	2.5 BAR
TRITIUM CONTENT	—	15 CI

TYPE S

		DRAWN. DHA	TOLERANCES UNLESS OTHERWISE STATED.		SURFACE TEXTURE	TITLE. SPHERICAL. LIGHT SOURCE
		CKD.				
		SCALE. —	MATERIAL.		BRANDHURST CO. LTD. WELLINGTON ROAD. HIGH WYCOMBE. BUCKS	DRG. No. P1659
ISSUE	MODIFICATION	DATE	DATE 25-10-82	FINISH		

THIRD ANGLE PROJECTION



NOTES

1. Marking, Labelling and Shipping of packages and containers shall be in accordance with MIL-STD-1458.

2. There shall be no evidence of physical failure such as fracturing or light loss due to exposing the lamp to -80°F and +160°F for a period of eight hours at each temperature.

3. After submerging the lamp in room temperature water for four hours, radioactive content of the water shall not exceed .005 microcuries.

4. Vial filled with 99% pure (less than 1% tritium oxide) Tritium (H_3).

5. Glass, Type 1, Class A, Spec DD-G-541.

6. Zinc Sulphide Phosphor.

7. Binder - Phosphoric Acid.

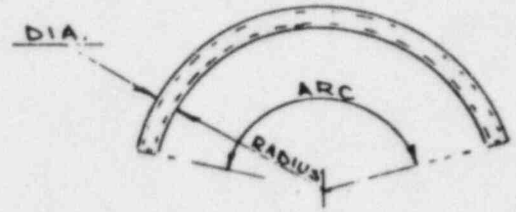
	MIN	MAX
DIMENSION A	2 MM	6 MM
DIMENSION B	3 MM	16 MM
RADIUS	5 MM	250 MM
ARC	5°	310°
WALL THICKNESS	0.4 MM	2 MM
FILLING PRESSURE	–	2.5 BAR
TRITIUM CONTENT	–	15 CI

TYPE. RC

ISSUE	MODIFICATION	DATE				
			DRAWN. RHd	TOLERANCES UNLESS OTHERWISE. STATED.	SURFACE TEXTURE	TITLE. CURVED LIGHT SOURCE
			CKD.			
			SCALE. –	MATERIAL.	BRANDHURST CO. LTD. WELLINGTON ROAD. HIGH WYCOMBE. BUCKS.	DRG. No. P1665
			DATE 25-10-82	FINISH		

NOTES

1. Marking, Labelling and Shipping of packages and containers shall be in accordance with MIL-STD-1458.
2. There shall be no evidence of physical failure such as fracturing or light loss due to exposing the lamp to -80°F and +160°F for a period of eight hours at each temperature.
3. After submerging the lamp in rodm temperature water for four hours, radioactive content of the water shall not exceed .005 microcuries.
4. Vial filled with 99% pure (less than 1% tritium oxide) Tritium (H_3).
5. Glass, Type 1, Class A, Spec DD-G-541.
6. Zinc Sulphide Phosphor.
7. Binder - Phosphoric Acid.



	MIN.	MAX.
DIAMETER	2 MM	7 MM
RADIUS	5 MM	250MM
ARC	5°	310°
WALL THICKNESS	0.4MM	1.5MM
FILLING PRESSURE	—	2.5BAR
TRITIUM CONTENT	—	15 Ci

TYPE. CC

			DRAWN. RHA	TOLERANCES UNLESS OTHERWISE STATED.		SURFACE TEXTURE	TITLE. CURVED LIGHT SOURCE
			CKD.				
			SCALE. —	MATERIAL.		BRANDHURST CO. LTD. WELLINGTON ROAD. HIGH WYCOMBE. BUCKS.	DRG. No. P1664
SSUE	MODIFICATION	DATE	DATE 25-10-82	FINISH			

THIRD ANGLE PROJECTION

NOTES

1. Marking, Labelling and Shipping of packages and containers shall be in accordance with MIL-STD-1458.

2. There shall be no evidence of physical failure such as fracturing or light loss due to exposing the lamp to -80°F and +160°F for a period of eight hours at each temperature.

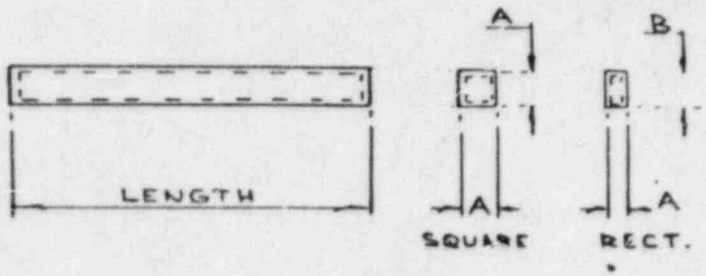
3. After submerging the lamp in room temperature water for four hours, radioactive content of the water shall not exceed .005 microcuries.

4. Vial filled with 99% pure (less than 1% tritium oxide) Tritium (H_3).

5. Glass, Type 1, Class A, Spec DD-G-541.

6. Zinc Sulphide Phosphor.

7. Binder - Phosphoric Acid.



	MIN	MAX
DIMENSION A	0.6 MM	6 MM
DIMENSION B	1.5 MM	16 MM
LENGTH	3 MM	250 MM
WALL THICKNESS	0.15 MM	2 MM
FILLING PRESSURE	–	2.5 BAR
TRITIUM CONTENT	–	15 Ci

TYPE. RT

			DRAWN. RW	TOLERANCES UNLESS OTHERWISE STATED.		SURFACE TEXTURE	TITLE. RECTANGULAR LIGHT SOURCE
			CKD.				
			SCALE. –	MATERIAL.		BRANDHURST CO. LTD. WELLINGTON ROAD, HIGH WYCOMBE, BUCKS	DRG. No. P1663
ISSUE	MODIFICATION	DATE	DATE 25-10-82	FINISH			

BETWEEN: William O. Miller, Chief
License Fee Management Branch
Office of Administration

John E. Glenn, Chief
Nuclear Materials Section B
Division of Engineering and
Technical Programs

Fee Needed

LICENSE FEE TRANSMITTAL

A. REGION I

1. APPLICATION ATTACHED

Applicant/Licensee: Brandhurst

Application Dated: 1-8-85

Control No.: 03413

License No.: 06-20804-01 030-22096

2. FEE ATTACHED -02G 030-22097

Amount: 0

Check No.: 0

3. COMMENTS

~~Device~~ sealed source Review.
Doesn't affect -02G.

Signed SLJ

Date 2/8/85

B. LICENSE FEE MANAGEMENT BRANCH

1. Fee Category and Amount: 3P($60) 9C($350) S&D application fee

2. Correct Fee Paid. Application may be processed for:

Amendment ✓

Renewal

License

Signed Frances Brown

Date 4/16/85

REGION I FORM 213
(MARCH 1983)