MANUFACTURERS OF
LUMINOUS DIALS
NEUTRON SOURCES
RADIATION SOURCES
RADIOACTIVE SPECIALTIES
RADIOACTIVE LIGHT SOURCES

NAME PLATES
ETCHED AND LITHOGRAPHED

LUMINOUS COMPOUNDS

"IONOTRON"
STATIC ELIMINATORS

"RADELIN"
X-RAY SCREENS
TELEVISION PHOSPHORS

"LACKON" PANELS

"HELECON"
LUMINESCENT PIGMENTS

TELEPHONE JEFFERSON 9-4000

UNITED STATES RADIUM CORPORATION

P. O. BOX 246

MORRISTOWN, NEW JERSEY 07960

PLANTS AND LABORATORIES
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CABLE ADDRESS
RADELIN-MORRISTOWN, N. J.

July 12, 1965

Mr. William O. Miller
United States Atomic Energy Commission
Washington D.C. 20545

Dear Mr. Miller:

We are enclosing Test Report No. 1085-4368 from Lockheed Electronics Company, Plainfield, New Jersey, and a report from United States Radium Corporation Laboratory giving the results of prototype tests required by 30.24 (j)(1)(ii)(d) of 10 CFR, Part 30, on certain aircraft safety devices and other self-luminous items.

The samples tested comprise a number of devices illuminated by tritium filled, fusion sealed glass tubes held in place and cushioned by a clear silicone potting resin. The samples tested are listed below with the corresponding U. S. Radium Corporation drawing numbers.

Number of Samples	Description	Drawing Number
2	Commercial Exit Sign	LAB 737-2
2	Instrument Dial 3"	LAB 758-J
2	Instrument Dial 2"	LAB 758-J-3
2	Integrally Lighted Panel 2 tube	LAB 758-D-1
4	Integrally Lighted Panel 1 tube	LAB 758-D-1
2	Pull Handle Marker	LAB 758-H
1	Wrist Depth Gauge Dial	LAB 758 L
2	Level Vial	LAB 771
2	Aircraft Exit Placard	LAB 600-1B-1 Rev B

The method of construction in accordance with Drawing LAB 785 leads to high source integrity; and the method of assembly, in which the source is completely embedded in a resilient, stable potting resin, affords excellent protection against shock, vibration and temperature extremes. In these respects the light source is considered the equivalent of the type described on Drawing LAB 752-1 utilizing frit sealed metal caps. However, the glass fusion seal has the advantage that no other materials such as metal or frit are used in the system.

In addition to the use in aircraft as luminous safety devices, licensed under Paragraph 30.21(d), these light sources have application in many other areas not necessarily related to aircraft. Typical of other uses are the self-illuminated meter dials, represented by Drawings LAB 758-J and LAB 758-J-3, as well as the Wrist Depth Gauge Dial, Drawing LAB 758 L. Integrally lighted panels which have certain "fail safe" designations permanently lighted by tube sources to remain legible during electrical failure, will have extensive application in aerospace devices and other fields.

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Our purpose in submitting this report is threefold:

1. To request the amendment of our License GL-122 to permit the use of light sources constructed to Drawing LAB 785 in all devices now using sources constructed to Drawing LAB 752-1 and LAB 733.

2. To extend the scope of GL-122 to include various instrument dials and panels not necessarily related to safety devices.

3. To request consideration of the general licensing of these devices in other fields and services not related to aircraft.

In particular, we request amendment of GL-122 to include the tritium light source represented by U. S. Radium Corp. Drawing LAB 600-1B-1 RevB in combination with the various legends presently included under condition 10 B. Two standard placards conforming to LAB 600-1B-1 Rev B to be substituted for LAB 733 have over-all lengths of 6-15/32" and 9-1/4" and contain 2.2 and 3.3 curies of tritium respectively. The devices may carry various face plate legends, such as "EMERGENCY EXIT", "EXIT", "EXIT accompanied by one or two arrows at the ends" and various foreign legends. In view of the large number of drawings involved, procedures would be greatly simplified if the use of face plate legends specified by the general licensee were made a condition of GL-122.

Drawing LAB 758, enclosed, illustrates an instruction placard for the escape hatch handle cover on Viscount Aircraft. The unit may contain a light source constructed to Drawing LAB 752-1 or LAB 785. We request that LAB 758 be specifically covered in the amendment to GL-122.

Some confusion exists regarding the use of the designation "(S)" in U. S. Radium drawings. The notation was adopted to indicate a "Sales Drawing" which presented only dimensional outline of the device without any structural details. Thus, for example, Drawings LAB 758(S)-H and LAB 758-H refer to the same device, with LAB 758-H giving the detailed dimensional and structural information.

Three copies of each of the following drawings are enclosed for reference: LAB 600-1B-1 Rev B: LAB 737-2: LAB 752-1: LAB 758: LAB 758 D-1 Rev A: LAB 758-E and LAB 758-E ATTACHMENT: LAB A 758-G: LAB 758-J1-Rev A: LAB 758-K: LAB 758-L: LAB 785: LAB 786.

We shall be glad to supply any additional information you may require.

Very truly yours,

C. C. Carroll
Manager - New Products

July 13, 1965

PROTOTYPE TEST REPORT

FOR

SELF LUMINOUS DEVICES

CONTAINING FUSION SEALED GLASS LIGHT SOURCES

EXCITED BY HYDROGEN^{3}

Section 30.24(j)(1)(ii)(d)10CFR30

UNITED STATES RADIUM CORPORATION

Bloomsburg, Pennsylvania

PROTOTYPE TEST REPORT
for
SELF LUMINOUS DEVICES
CONTAINING FUSION SEALED GLASS LIGHT SOURCES
EXCITED BY HYDROGEN-3

Section 30.24(j)(ii)(d)10CFR30

Purpose:

To submit various devices incorporating self-luminous sources, composed of Hydrogen^3 excited, phosphor coated, fusion sealed glass containers (as shown on USRC Drawing LAB 785) to the prototype tests outlined under Section 30.24(j)(i)(v), 10CFR part 30.

Items Tested:

The items tested which were selected as typical of any number of self-illuminated devices containing the fusion sealed, tritium light sources described, are listed in Table I with the corresponding U.S.R.C. drawing numbers and tritium contents.

Procedure:

The eighteen samples listed were subjected to the tests specified under Section 30.24(j)(i)(v), 10CFR Part 30.

Results of Tests:

The results of the tests are given in Table II (A) through (E). The units comply with the requirements of paragraph 30.24(j) of 10CFR Part 30.

Clayton C. Carroll
United States Radium Corp.
Morristown, New Jersey
July 13, 1965

TABLE I

LIST OF DEVICES TESTED

SAMPLE NUMBER	USRC S/N	USRC DRAWING NO.	DESCRIPTION	TRITIUM CONTENT CURIES
1	53758	737-2	Commercial Exit Sign	8.75
2	53759	758-J	3" Instrument Dial	1.2
3	53760	758-J	3" Instrument Dial	1.2
4	53767	758-J-3	2" Instrument Dial	0.5
5	53768	758-J-3	2" Instrument Dial	0.5
6	53761	758-D-1	Integrally Lighted Panel (2 tubes)	1.80
	53762	758-D-1	Integrally Lighted Panel (2 tubes)	1.80
	53763	758-D-1	Integrally Lighted Panel (Single Tube)	0.25
	53764	758-D-1	Integrally Lighted Panel (Single Tube)	0.25
	53765	758-D-1	Integrally Lighted Panel (Single Tube)	0.25
11	53766	758-D-1	Integrally Lighted Panel (Single Tube)	0.25
12	53769	758-H	Pull Handle Marker	1.00
13	53770	758-H	Pull Handle Marker	1.00
14	53771	758-L	Wrist Depth Gauge Dial	0.20
15	53772	771	Level Vial	0.05
16	53773	771	Level Vial	0.05
17	AB3395	600-1B-1 Rev B	Aircraft Exit Placard	2.2
18	AB3399	600-1B-1 Rev B	Aircraft Exit Placard	2.2

Test Methods

Temperature altitude (a) and vibration (b) were performed by Lockheed Electronics Company. The conditions of the tests and equipment used are detailed in Lockheed Test Report No. 1085-4368, enclosed.

Accelerated weathering (c), shock test (d) and hermetic seal and waterproof (e) were performed by the Laboratory and Engineering Department staff of U. S. Radium Corporation in Bloomsburg, Pennsylvania. The details of the test methods and equipment used are given in the following discussion.

(c) Accelerated Weathering:

The samples were subjected to 100 hours of exposure in an Atlas, Type DL-TS Twin-arc Weatherometer. The arcs were shielded by globes of Coxex D glass. The samples were mounted on a rotating drum and, in addition to the radiation from the arcs, were subjected to a tap water spray for three minutes out of each twenty minute cycle. This provided a temperature cycle ranging from a maximum of 57° C. to the water temperature, approximately 10° C., in each 20 minute period. This is considered a much more severe test than the constant temperature, ultraviolet exposure specified in paragraph (c).

(d) Shock Test:

Each sample was dropped 100 times onto a concrete surface in a 3 foot gravitational fall. The units were dropped in random orientation except that the commercial exit sign was specifically oriented so that an approximately equal number of impacts would be made on the face, back, edges, sides and corners.

(e) Hermetic Seal and Waterproof Test:

All samples as a group were immersed in water for the prescribed time and subjected to the pressure cycle required.

(f) Observations:

At the conclusion of each test each sample was examined for damage which might affect the containment of tritium and the surface was wiped with filter paper. The wipes were counted in a proportional counter (windowless) to determine the tritium removed, if any. The water from the hermetic seal and waterproof test was examined with a liquid scintillation counter calibrated for the determination of tritium.

TABLE II

ENVIRONMENTAL TEST RESULTS

(A) TEMPERATURE-ALTITUDE TESTS*

30.24(j)(1)(v)(a)

Sample No.	Visual Inspection See Note I	Wipe Test Micro-curies Removed
1	V ok	Bkgd
2	"	" SEE
3	"	" NOTE
4	"	" II
5	"	"
6	"	"
7	"	"
8	"	"
9	"	"
10	"	"
11	"	"
12	"	"
13	"	"
14	"	"
15	"	"
16	"	"
17	"	"
18	"	"

(B) VIBRATION TESTS*

30.24(j)(1)(v)(b)

Sample No.	Visual Inspection See Note I	Wipe Test Micro-curies Removed
1	V ok	Bkgd
2	"	" SEE
3	"	" NOTE
4	"	" III
5	"	"
6	"	"
7	"	"
8	"	"
9	"	"
10	"	"
11	"	"
12	"	"
13	"	"
14	"	"
15	" SEE	"
16	" NOTE IV	"
17	"	"
18	"	"

(C) ACCELERATED WEATHERING TEST**

30.24(j)(1)(v)(c)

Sample No.	Visual Inspection See Note I	Wipe Test Micro-curies Removed
1	V ok	Bkgd
2	"	"
3	"	"
4	"	"
5	"	"
6	"	"
7	"	"
8	"	"
9	"	"
10	"	"
11	"	"
12	"	"
13	"	"
14	"	"
15	"	"
16	"	"
17	"	"
18	"	"

(D) SHOCK TEST**

30.24(j)(1)(v)(d)

Sample No.	Visual Inspection See Note I	Wipe Test Micro-curies Removed
1	SEE NOTE V	9×10^{-5} SEE NOTE VI
2	V ok	Bkgd
3	"	"
4	"	"
5	"	"
6	"	"
7	"	"
8	"	"
9	"	"
10	"	"
11	"	"
12	"	9×10^{-5} SEE NOTE VI
13	"	Bkgd
14	"	"
15	"	"
16	"	"
17	"	"
18	"	"

(E) HERMETIC SEAL & WATERPROOF TEST**

30.24(j)(1)(v)(e)

Sample No.	Visual Inspection See Note I	Wipe Test Micro-curies Removed
1	V ok	Bkgd
2	"	" See
3	"	"
4	"	" Notes
5	"	"
6	"	" VIII
7	"	"
8	"	" and
9	"	"
10	"	" IX
11	"	"
12	"	"
13	"	"
14	"	"
15	"	"
16	"	"
17	" SEE NOTE VII	"
18	" SEE NOTE VII	"

NOTES

* Tests performed at Lockheed Electronics Company.

** Tests performed by U. S. Radium Corp. at Bloomsburg, Pa.

NOTE I: Visually O.K. No visible evidence of damage to luminescent source.

NOTE II: Filter paper wipe test on each unit made at Lockheed Electronics Co. and counted in Bloomsburg, Pa.

NOTE III: Wipe tests performed after samples were returned to Bloomsburg.

NOTE IV: The glass bubble vials cracked during Temperature-Altitude Test, allowing the liquid to escape. The lower transmission of the partially frosted, empty tube reduced the apparent brightness of the source.

NOTE V: As indicated in the Lockheed Test Report, two rivets which held the front metal mask against the plastic post were broken during the vibration test which permitted a separation between the reflective painted metal surface and the plastic diffusers containing the light sources. As a result the light normally contributed by reflection from the surface was lost.

NOTE VI: The slight amount of movable activity indicated for sample numbers 1 and 12 must have been due to minor accidental, external contamination, since there was no evidence of leakage in the Hermetic Seal and Waterproof Test.

NOTE VII: Plastic face plates had cracked during Shock Test allowing water to enter space between face plate and diffuser. Water did not penetrate the potting compound, and there was no evidence of damage to the source itself.

NOTE VIII: All samples were subjected to test (e) at one time. The water did not penetrate the potting material to reach the source in any instance, and there was no evidence of tritium leakage when samples of the water were counted in a scintillation counter calibrated for the determination of tritium.

NOTE IX: Wipe tests were made following Immersion Test after samples had been allowed to dry.

Discussion:

The samples tested comprise a group representative of an illumination method utilizing a phosphor coated glass container with a fused glass seal. The sources contain Hydrogen-3 gas as the exciting agent at pressures which may range from 0.1 to 2½ atmospheres, depending on brightness requirements and the size, shape and configuration of the device to be illuminated. All of the units tested contained tubular sources in conformity with Drawing LAB-785; however bulb types, curved tubes and flat sources are contemplated.

The types of luminescent devices tested represent two methods for mounting the light sources, both of which involve the use of a clear silicone potting resin which completely surrounds the self-luminous source.

In Method No. 1, represented by the samples listed below, the source is potted directly into a recess which may be drilled, routed or molded in the plastic part.

Sample No. 1 - Commercial Exit Sign
Samples No. 6, 7, 8, 9, 10 & 11 - Integrally Lighted Panels
Sample No. 14 - Wrist Depth Gauge Dial
Samples No. 15 and 16 - Level Vials

By Method No. 2, the light source is pre-potted in a metal channel which is usually aluminum. In assembly the source is mounted in such a way that the potting material is held in intimate contact with the plastic part by a frame which maintains constant pressure on the assembly. The following test samples illustrate Method No. 2.

Samples No. 2 & 3 - Instrument Dials, 2"
Samples No. 4 & 5 - Instrument Dials, 3"
Samples No. 11 & 12 - Pull Handle Markers
Samples No. 17 & 18 - Aircraft Exit Placards

In most instances an edge lighting principle is employed in which the light from the source is transmitted edge-wise through a plastic block and reflected out through one or more surfaces carrying various markings. Thus the light path is through the glass wall of the luminous tube, through the potting material and through a plastic block before emerging. To provide maximum efficiency in the system it is necessary to maintain a minimum number of interfaces in the light path, secure maximum reflection from all surfaces, and to avoid light emission at any point except through the marked surface.

It was surprising to note that some of the samples prepared by Method No. 1 especially suffered an abnormal decrease in brightness which was detected by visual comparison following the temperature altitude and vibration tests. Since the leakage tests indicated that the sources themselves were intact, the samples were thoroughly examined to determine the reasons for the brightness decreases. Several factors not affecting the containment of the tritium were discovered.

1. Any light source of the type under discussion normally suffers an initial decrease in brightness of 8 to 10% in the first 30 to 60 days after fabrication. Since 90 days had elapsed between the initial assembly and the completion of the tests, the initial decay is reflected in the observations.

2. Any shrinkage of the potting compound which would create an interface between the luminous tube or the plastic surface and the potting medium produces a reflective surface which diverts the light. Examination of the directly potted units disclosed a lack of adhesion between the silicone and plexiglass surfaces which permitted the partial development of interfaces in the contact area. A primer to act as a bonding agent between the two materials is now available and will be used in production runs. By comparison, brightness drops suffered by the channel potted units in which the surface of the potting compound was held in intimate contact by mechanical means was much less severe.

3. To obtain the most efficient conversion of the low energy beta radiation from tritium into visible light it is necessary to use a minimum amount of binder in coating the tubes with phosphor. Coating the phosphor crystals with any material which either reacts chemically with the surface or interposes a barrier layer to the beta radiation results in an appreciable

diminution of light output. The phosphor is also very sensitive to contaminants which cause discoloration and a severe decrease in efficiency. Strict control over the cleaning of the glass before coating and of the coating technique are essential to avoid loss of adhesion and discoloration. One of the small sources in Sample No. 14, Wrist Depth Gauge Dial had become brown during the test which accounted for the brightness drop. The phosphor had dropped off the tubes in Samples No. 8 and 11, small Integrally Lighted Panels.

The various items discussed are all manufacturing problems which will be solved by improvement in technique and better process control. The test requirements of this section are extremely severe, and the fact that no loss of tritium occurred indicates that the basic construction of the light source with the shock mounting technique described provide excellent integrity.