

DEPARTMENT OF THE ARMY US ARMY BELVOIR RESEARCH & DEVELOPMENT CENTER

FORT BELVOIR, VIRGINIA 22080

STRBE-VR 24 July 1984

➤ References:

- a. DAEN-ECE-E, (13 Oct 82) U.S. Army Corps of Engineers, 13 October 1982, Subject: Self Luminous Devices Containing Tritium, to DRCSF-P, HQ, USA DARCOM.
- b. DRCSF-P, (13 Oct 82) 1st Ind, HQ, USA DARCOM, 4 November 1982, to DAEN-ECE-E.
- c. DAEN-ECE-E, 2nd Ind, U.S. Army Corps of Engineers, dated 10 December 1982 to DRCSF-P, HQ, USA DARCOM.
- d. DRCSF-P (13 October 82) 3rd Ind., HQ, USA DARCOM, 18 Feb 83 to DAEN-ECE-E, U.S. Army Corps of Engineers.
- e. American National Standard N540: Classification of Radioactive Self-Luminous Light Source. NBS HANDBOOK 116, U.S. Department of Commerce/National Bureau of Standards, January 1976.
- f. DRDME-VR Report No: 03332RVRY-1 dated 20 May 1983.
- g. DRDME-VR Report No: 03332RVRY-2 dated 29 July 1983.
- h. STRBE-VR Report No: 03332RVRY-3 dated 20 October 1983.
- i. STRBE-VR Report No: 84/021/RVRY-2 dated 23 February 1984.
- j. STRBE-VR Report No: 84/021/RVRY-4 dated 18 May 1984.
- k. DASG-PSP Department of the Army Office of the Surgeon General, Washington, DC 20310, dated 20 February 1984, Subject: Performance Test Results for sample Self-Luminous Exit Signs Containing Tritium, to DRCSF-P USA DARCOM.
- l. HSHB-LR-R, Subject: Results of analyzing Self Luminous Exit Signs, dated 3 Jan 84.
- m. HSHB-LR-R, Subject: Results of Analyzing Soak Test Sample, dated 5 Apr 84.
- n. DRCSF-P (20 Feb 84) 1st Ind., HQ, USA DARCOM, dated 26 April 84, Subject: Performance Test Results For Sample Self-Luminous Exit Signs Containing Tritium, to STRBE-VP, US Army Belvoir Research and Development Center.

➤ Radioluminous (sometimes called self-luminous) building exit signs are being actively marketed throughout the United States. These signs are not dependent on the building power or batteries and provide exit directions at all times, even in emergencies when the power fails. The source of energy for the light is radioactive tritium and each sign contains up to 25 curies of tritium.

➤ This center was tasked to evaluate the commercially available exit signs for radiological safety using the testing procedures in the American National Standards Institute (ANSI) Standard N-540-1975 (Ref. 1.e). The following specific tests were conducted:

- a. Luminosity Test: The brightness of the exit sign is measured in the darkness using Gamma Scientific Model 2000 photometer which is calibrated against a standard lamp traceable to National Bureau of Standards. This initial brightness reading of the exit signs, expressed in microlamberts, is used to compare the brightness value with the final luminosity test which is performed after completion of all the other tests.
- b. Wipe test: Exit sign is wiped with Whatman-50 moistened filter paper of diameter 2.f cm. The removable surface contamination of tritium is determined by liquid scintillation system. The upper limit for tritium removable surface contamination is 1000 dpm/100 cm square.

- c. Atmospheric Weathering (Discoloration) Test: The exit sign is placed in the watherometer for 12 hours with alternation 102 minutes of Xenon-arc light followed by 18 minutes of light and water spray. After the test the exit sign is examined visually in the dark room.
- d. Temperature and Thermal Shock Test:: The exit sign is placed at -30° C for an hour and then heated to 65° C. The cycle is repeated twice. After each cycle the exit sign is visually examined in the dark room for lack of brightness.
- e. Pressure Test: The exit sign is kept in a vacuum chamber at 175 mm mercury pressure for 15 minutes. Then the chamber is brought to the atmospheric pressure and the exit sign is visually examined in the dark room. The low pressure test is repeated twice.
- f. Immersion (Soak) Test: The exit sign is immersed in 1.5 liters of deionized water for 24 hours in a glass trough. The tritium released in the water is computed by counting a aliquot of the water sample in a liquid scintillation counter. The acceptable upper limit for the tritium released per exit sign is 50 nanocurie per day.
- g. Drop Test: The exit sign is dropped from 8 feet height on a steel plate 20 times. (ANSI recommends 3 feet height drop test). After each drop the exit sign is carefully monitored with tritium monitor (Triton Model 955-8 Johnston Laboratory). If the alarm does not trigger the exit sign is tested visually in the dark room for brightness test. If all the letters of the exit sign are visible in the dark room then the exit sign has passed the drop test.
- h. Final wipe and Immersion Test: Tests and the specification for passing the tests are the same as in section b and f.
- i. Final Luminosity Test: The test are repeated as in section a. The loss of luminosity should not exceed 20% of that of initial luminosity for passing the final luminosity test.

➤ The following companies submitted samples of their building exit signs for evaluation:

- a. Brandhurst Incorporated,
Box 238 RR3, Robin Hill Corporate Park
Route 22,
Patterson, NY 12563
Telephone: (914) 878-2033
- b. NRD
2937 Alr Boulevard
North Grand Island, NY 14072
Telephone: (716) 773-7634
- c. Safety Light Corporation,
4150-A Old Berwick Road
Bloomsburg, PA 17815
Telephone: (717) 784-4344
- d. Self Powered Lighting Inc.*
8 Westchester Plaza
Elmsford, NY 10523
Telephone: (914) 592-8230

➤ In addition to the testing performed at this center, those samples that did not leak tritium during the drop test were submitted to the Army Environmental Hygiene Agency * for additional tests for surface contamination and immersion.

➤ Summary of testing:

- a. Brandhurst, LTD

Model	Performance - Test Failed	Comments
B-100-U15	Immersion	3.5 Millicurie of tritium was detected in initial immersion test. Letter "T" was not visible in the dark. Drop test was not conducted.
B-100-U15	Immersion	16 microcurie of tritium was detected in initial immersion test. Letter "T" was not visible in the dark.
	Drop	Tritium alarm activated during the drop test. After the test, letter "X" was not visible in the dark.

b. NRD

Model	Performance - Test Failed	Comments
T-4001	Discoloration	Water drops were noted along all letters of word "E".
	Drop	Tritium leak was detected.
	Luminosity	Letter "I" failed to illuminate post drop test.
T-4001	Discoloration	Water drops were noted along all letters of word "E".
	Immersion	Excessive tritium (53 microcurie) was detected in water immersion test.

c. Safety Light

Model	Performance - Test Failed	Comments
880-12-6-5	Drop	Tritium leak was detected.
880-12-6-5		No drop test conducted.
2040-XX	None	Initial and post drop test results showed 100 and 50 microcurie of tritium, respectively. Drop in successive tritium level was noted. Contamination from an outside source (surface contamination) was detected. This sign was considered to meet the minimum ANS requirements.
		USAEHA* detected no significant amount of tritium in the immersion test. This sign was considered to meet the minimum ANS requirements.

d. Self-Powered Lighting, Inc

Model	Performance - Test Failed	Comments
710-A-1	Discoloration	Red Background deteriorated.
	Immersion	Styrofoam pieces fell out.
	Drop	Tritium leak was detected.
710-A-1	Discoloration	Red background deteriorated.
	Immersion	Styrofoam pieces fell out.
710-A-1	Discoloration	Paint Peeled.
	Pressure	Front Plexiglas partially separated from frame.
	Immersion	Frame and Plexiglas separated.
	Drop	Not performed.
710-A-1	Discoloration	Paint peeled.
	Pressure	Front Plexiglas partially separated from frame.
	Immersion	Frame and Plexiglas separated. USAEHA detected tritium in amounts of 100 and 20 nanocurie in first and second water baths respectively. Sharp drop in successive tritium levels indicates contamination from an out side source (surface contamination).
700	None	No detectable tritium leakage.
		USAEHA* detected no significant amount of tritium.

➤ Discussion of results.

- a. A review of the test results reported above reveals that the first products from all tested manufacturers failed to meet at least one of the test requirements.
- b. The failure of the exit signs poses two potential problems. The first problem occurs during the installation of the exit signs when the signs may be dropped releasing tritium into the building. The second problem occurs when the sign fails to show the letters properly and becomes non-functional in an emergency.
- c. After these initial tests, two of the manufacturers on their own initiative developed improved products that met all of the test requirements. This indicates the ability of manufacturers to produce acceptable merchandise when they are made aware of the requirements.
- d. An important lesson to be learned from this series of tests is: without independent testing, the quality of commercial products may be inferior to the quality required for Army applications.

➤ Recommendations:

- a. Based on the test results to date, the only building exit signs that have passed the test requirements are:
 - i. Safety Light Corporation Model 2040-XX
 - ii. Self-Powered Lighting, Inc. Model 700
- a. Based on recommendation from the Army Surgeon General's Office (Ref. 1.k.). The installation of exit signs is limited to locations where risk of damage to the sign is negligible. Army barracks are considered to be an area of high risk for these signs.
- b. All exit signs should be checked before installation to insure that all letters are visible in the dark. If there are letters or portions of letters that are not visible, report the information to the health physicist for checking and further instructions.
- c. When the sign is dropped from distances greater than 8 feet there is still the potential that

tritium can be released from the sign. Therefore it is recommended that when a sign is dropped the area should be evacuated, ventilation in the area be increased, the health physicist called to check the sign and work progress after the approval of the health physicist. If a health physicist is not available, place the source in a well ventilated non-occupied area for 24 hours before performing any checking for luminosity.

- d. Other models of building exit signs than those identified in paragraph 8a. may already be in storage or in use. These signs have higher potential for breaking and the recommendations in paragraphs 8b and 8c should be followed.

➤ NRD has submitted a redesigned building exit sign for evaluation and the results of the evaluation will be provided in another report.

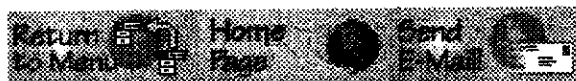
➤ Point of contact at this Center, if additional information is required, is Dr. Ramachandra K. Bhat, DSN 354-5437.

FOR THE COMMANDER:

EMIL J. YORK
Director, Materials, Fuels and
Lubricants Laboratory

**Note: The address and phone number for Self Powered Lighting Inc. has changed to:
169 Western Highway
W. Nyack, NY 10994
Telephone: (914) 353-0235*

**Note: Army Environmental Hygiene Agency (AEHA) is now the Center for Health Promotion and Preventive Medicine (CHPPM)*



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