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A11104 938483

NBS HANDBOOK 116

U.S. DEPARTMENT OF COMMERCE / National Bureau of Standards

American National Standard N540: Classification of Radioactive Self-Luminous Light Sources



AMERICAN NATIONAL STANDARD N540-1976

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.U51
no.116
1976

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American National Standard N540; Classification of Radioactive Self-Luminous Light Sources

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.U51
no. 116
1976

t. Handbook no. 116.

American National Standards Institute
Subcommittee N43-2

Under the sponsorship of the
National Bureau of Standards
Washington, D.C. 20234

Approved February 21, 1975
American National Standards Institute
New York, N.Y. 10018

ANSI N540-1975



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Issued January 1976

U.S.
111

Library of Congress Cataloging in Publication Data

American National Standards Institute. Subcommittee N43-2.
American national standard N540.

(NBS handbook; 116)

"ANSI N540-1975."

Includes bibliographical references.

Supt. of Docs. no.: C 13.11:116

1. Phosphors—Standards. 2. Radioactive substances—Standards.
I. Title. II. Title: Classification of radioactive self-luminous light
sources. III. Series: United States. National Bureau of Standards.
Handbook; 116.

QC100.U565 no. 116 [QC476.S6] 389'.08s

[539.2] 75-619239

National Bureau of Standards Handbook 116

Nat. Bur. Stand. (U.S.), Handb. 116, 15 pages (Jan. 1976)

CODEN: NBSHAP

U.S. GOVERNMENT PRINTING OFFICE

WASHINGTON: 1976

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402
(Order by SD Catalog No. C13.11:116). Price \$1.10. (Add 25 percent additional for other than U.S. mailing).

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Preface

(This Preface is not a part of American National Standard Classification of Radioactive Self-Luminous Light Sources, N540.)

The radiation from radioactive material is used as a source of energy for activating phosphors to produce light in self-luminous watches and clocks, instrument dials, aircraft exit markers, luminous switches, etc. Safety in the design and use of radioactive materials in self-luminous products continues to be of concern to the industry, regulatory bodies and the general public.

In 1967 a standard for Classification of Sealed Radioactive Sources [1]¹ was issued by the USA Standards Institute Committee N-5.4 in which some performance requirements for self-luminous devices were given.

Also in 1967 Committee N43 was organized under the sponsorship of the National Bureau of Standards to replace Sectional Committee Z54. The scope of the new committee is "standards pertaining to products and equipment, for nonmedical scientific, industrial, and educational uses, involving ionizing radiation sources including radioactive materials, accelerators, and x-ray equipment but excluding nuclear reactors."

The responsibility to develop standards for self-luminous sources was assigned to Subcommittee N43-2. This standard is an elaboration and refinement of the N5.4 standard for self-luminous sources.

Realizing that questions may arise from time to time concerning interpretations of this standard, provisions have been made for an Interpretations Committee in order that uniform handling of questionable cases may be provided. It is recommended that anyone using this standard and desiring an interpretation of a questionable case communicate with the American National Standards Institute.

Suggestions for improvement gained in the use of this standard will be welcome. They should be sent to the American National Standards Institute, 1430 Broadway, New York, N.Y. 10018.

¹ Figures in brackets refer to the references listed in Section 10 of this standard.

The American National Standards Committee N43, on Equipment for Non-Medical Radiation Applications, had the following personnel at the time it processed and approved this standard:

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Contents

	<i>Page</i>
Preface	iv
1. Scope	1
2. Definitions	1
3. General Conditions	2
3.1 Activity Level (Table 1)	2
3.2 Self-Luminous Light Source Performance Tests (Table 2)	2
3.3 Performance Standards for Classification of Self-Luminous Light Sources (Table 3)	3
3.4 Fire and Explosion	3
3.5 Radiotoxicity and Solubility	4
4. Classification and Testing	4
4.1 Classification Procedures	4
4.2 Testing	4
5. Classification Designation	5
6. Product Identification	5
7. Performance Testing Procedures	5
7.1 General	5
7.2 Discoloration	5
7.3 Temperature Test	5
7.4 Thermal Shock Test	6
7.5 Pressure (Reduced) Test	6
7.6 Impact Test	6
7.7 Vibration Test	6
7.8 Immersion Test	6
8. Evaluation	7
9. Additional Tests for Special Uses	7
9.1 Dust Resistance	7
10. References	7

American National Standard

Classification of Radioactive Self-Luminous Light Sources

This standard establishes the classification of certain radioactive self-luminous light sources according to radionuclide, type of source, activity, and performance requirements. The objectives are to establish minimum prototype testing requirements for radioactive self-luminous light sources, to promote uniformity of marking such sources, and to establish minimum physical performance for such sources. This standard is primarily directed toward assuring adequate containment of the radioactive material. Testing procedures and classification designations are specified for discoloration, temperature, thermal shock, reduced pressure, impact, vibration, and immersion. A range of test requirements is presented according to intended usage and source activity.

Key words: Classification; designation; containment; light sources; national standard; radiation source; radioactive; radioluminous products; self-luminous sources; test procedures.

1. Scope

This standard establishes the classification of certain radioactive self-luminous light sources according to radionuclide, type of source, activity and performance requirements. The standard does not attempt to establish design standards, but leaves the design features to the judgment of the supplier and user, provided that the performance requirements are met.

Note: Radioactive self-luminous light sources used in or on timepieces are not covered by this standard.

The objectives of this standard are to establish minimum prototype testing requirements for radioactive self-luminous light sources, to promote uniformity of marking such sources, and to establish minimum physical performance for such sources.

This standard is primarily directed toward assuring adequate containment of the radioactive material. Other factors, such as quality control, external radiation levels, radiotoxicity of the isotope and its form, and quantity of radioactive material in the source, also will require consideration in view of the ever present objective of keeping exposures as low as practicable. Compliance with this standard does not necessarily satisfy all requirements for manufacture and use which may be imposed by governmental regulatory agencies.

2. Definitions

The definitions and terms contained in this standard, or in other American National Stand-

ards referred to in this document, are not intended to embrace all legitimate meanings of the terms. They are applicable only to the subject treated in this standard.

activity—the number of spontaneous nuclear disintegrations occurring in a given quantity of material during a suitably small interval of time divided by that interval of time. It is commonly expressed in curies. (also called disintegration rate)

capsule—a protective envelope used to prevent leakage of the radioactive material.

container—a general term to designate any enclosure which surrounds the encapsulated radioactive material.

device—any piece of equipment designed to utilize self-luminous light source(s).

distributor—any person or organization supplying self-luminous light sources.

fixed sources—sources intended for usage at a specific location(s), designed for environmental conditions existing at the intended location(s), and to be used, except for accidental or unavoidable circumstances, under environmental conditions for which the source was designed.

leakage—a transfer of radioactive material from the self-luminous light source to the environment.

manufacturer—any person or organization fabricating a self-luminous light source(s).

mobile sources—sources designed to meet certain anticipated environmental conditions, not necessarily intended for usage at any specific location(s), and known to be subject to possible frequent or severe environmental changes.

model—descriptive term or number to identify a specific self-luminous light source design.

prototype source—the original of a model of a source which serves as a pattern for the manufacture of all sources identified by the same model designation.

prototype testing—the performance testing of a new source design before sources of such design are put into actual use.

quality control—such tests and procedures as are necessary to establish that the sources comply with the performance characteristics for that source design as defined in Table 3 of this standard.

self-luminous light source—a source consisting of a radioactive nuclide(s) firmly incorporated in solid and/or inactive materials, or sealed in a protective envelope strong enough to prevent any leakage of the contained radioactive substances to the environment under ordinary circumstances of use and incorporating a phosphor for the purpose of emitting light. Self-luminous light sources include:

dry powder sources in which the activated phosphor is introduced into a sealed container without the use of any binding medium,

gaseous sources in which the phosphor is coated on the inside wall of or on a component within the container in which the radioactive nuclide, in gaseous form, is contained,

painted sources in which a radioactive nuclide is intimately mixed and bound with the phosphor and incorporated into a capsule, and

separable sources in which the radioactive nuclide, bonded to or in a supporting strata, and the phosphor constitute independent elements which can be isolated from each other.

shall—where “shall” is used for a provision specified herein, that provision is intended to be a requirement.

should—“should” is used to indicate provisions

which are not required but which are here recommended as good practice.

source holder—a mechanical support for the self-luminous light source.

3. General Conditions

3.1 Activity Level (Table 1)

Self-luminous light sources, considered in this standard, are of four general types: dry powder sources, gaseous sources, painted sources and separable sources.

Table 1 establishes the maximum activity of an individual self-luminous source for classification of that type of source under this standard. The radioactive nuclides most commonly used and those exhibiting potential use in self-luminous sources are listed.

3.2 Self-luminous Light Source Performance Tests (Table 2)

Table 2 is a listing of the tests for evaluating the physical performance of self-luminous sources under average environmental conditions in which a self-luminous source, or source-device, will be used. The tests are based on normal and abnormal use (typical accidents considered) but do not include exposure to fire or explosion. The tests shall be run consecutively, in the order shown in table 2.

TABLE 1. Maximum Activity in Curies of an Individual Self-Luminous Light Source

Radionuclide	Dry Powder	Painted	Separable	Gaseous
Tritium H-3	1	5	5	50 ^a
Carbon C-14	0.06	0.3	0.3	30 (CO ₂)
Chlorine Cl-36 . . . . .	.006	.03 ^b	.03	3
Nickel Ni-63 . . . . .	.06	.3	.3	—
Krypton Kr-85 . . . . .	.006 ^c	.03 ^c	.03 ^c	30
Technetium Tc-99 . . . . .	.06	.3	.3	—
Promethium Pm-147 . . . . .	.06	.3	.3	—
Thallium Tl-204 . . . . .	.006	.03	.03	—
Lead Pb-210 . . . . .	.0003	.0015	.0075	—
Radium Ra-226 . . . . .	.00002	.0001	.0005	—
Thorium Th-230 . . . . .	.00002	.0001	.0005	—
Americium Am-241 . . . . .	.00002	.0001	.0005	—

^a Tritium oxide content shall not exceed the greater of (a) 1 percent of tritium in source, or (b) 1mCi.

^b Cl Salt

^c Kryptonate

TABLE 2. *Self-luminous light source performance tests*

Type of Test	Test Levels				
	1	2	3	4	X
Discoloration	12 h lamp	—	—	—	Special
Temperature	No test	0 °C and 50 °C	-30 °C and 65 °C	-55 °C and 80 °C	Special
Thermal Shock	No Test	0 °C to 50 °C	-30 °C to 65 °C	-55 °C to 80 °C	Special
Pressure (Reduced)	No test	226 mm Hg abs.	175 mm Hg abs.	87 mm Hg abs.	Special
Impact	No test	Free fall to steel plate 1 m 2x	Free fall to steel plate 1 m 20x	Free fall to steel plate 1 m 20x and 2 m 2x	Special
Vibration	No test	Simple harmonic motion having an amplitude of 0.75 cm (0.03") and a maximum total excursion of 0.15 cm (0.06"), the frequency being varied uniformly between the approximate limits of 10 and 55 Hertz (Hz). The entire frequency range, between 10 and 55 Hz and return to 10 Hz, shall be traversed in approximately one (1) minute.			Special
		10 minutes	30 minutes	60 minutes	
Immersion	No test	Immerse in cold bath, 15 minutes. Immediately (one minute max), transfer to hot bath, 15 minutes. Immediately (one minute max), transfer to cold bath. A dye may be used to observe obvious, gross penetration.			Special
		0 °C to 50 °C 2 cycles	0 °C to 65 °C 2 cycles	0 °C to 80 °C 5 cycles	

Tests to be performed in the order shown. All temperatures specified ± 3 °C

Table 2 does not cover all source-use situations. If the environmental conditions to which a source is expected to be exposed in use differ from the particular environment shown, the specifications for the source and the test requirements shall be considered on an individual basis by the supplier, the user, and the regulating authority. If the environmental conditions are more severe than the test conditions of Level 4 in table 2, "special" tests shall be developed by the supplier which satisfy the user and the regulating agency.

3.3 Performance Standards for Classification of Self-Luminous Light Sources (Table 3)

Table 3 establishes test requirements for self-luminous light sources according to intended usage and source activity. These performance requirements are minimums for applications involving normal usage (including typical accidents). Where generally extreme environmental conditions may be encountered a "special" test appropriate to that situation shall be developed. There also may be situations where a source in its intended usage will encounter only one extreme environmental condition. Under such conditions the

general classification shall be modified to accommodate the abnormal condition.

3.4 Fire and Explosion

Table 2 does not consider exposure of the source or source-device to fire and explosion. In the evaluation of self-luminous light sources and source-devices, the manufacturer and user shall consider the probability of fire and explosion and the possible results. Factors which should be considered in determining the need for tests more stringent than those suggested for specific classes in table 3 are; consequences of loss of activity, quantity of material in the source, radiotoxicity, physical form of the material, environment in which the source is used, and protection afforded the source or source-device combination.

It is recognized that the possibility of fire or explosion exists in many areas where light sources are used. However, light sources, because of certain inherent characteristics, cannot always be constructed so as to completely resist the effects of fire or explosion. Therefore, special test requirements shall be specified where the probability of fire or explosion is known to be abnormally high. These special tests shall include temperature, thermal shock, pressure and impact resistance.

TABLE 3. Performance standards for classification of self-luminous light sources

Source activity	Intended usage	Classification	Performance test level (table 2)						
			Discoloration	Temperature	Thermal shock	Pressure (reduced)	Impact	Vibration	Immersion
<0.1% of Table 1	any	1	1	1	1	1	1	1	1
≥0.1% to <1% of Table 1	any	2	1	2	2	2	2	2	2
≥1% to ≤10% of Table 1	fixed	3	1	3	3	3	2	2	2
	mobile	4	1	3	3	3	3	3	3
≥10% to ≤100% of Table 1	fixed	5	1	3	3	3	3	3	3
	mobile	6	1	3	3	3	4	4	4
Does not exceed Table 1	maximum normal environment	7	1*	4*	4*	4*	4*	4*	4*

NOTE: The above figures are minimum requirements for applications involving normal usage. Where special environmental conditions are involved, either more or less stringent than what might be considered normal, the user shall specify the abnormal condition or conditions, or request the necessary class change.

*Or special, as required for specific abnormal environmental condition(s). Use an X where applicable to indicate the special test(s).

3.5 Radiotoxicity and Solubility

Except as limited by paragraph 3.4, radiotoxicity of the radioactive material and its solubility shall be considered only when the activity of the source exceeds the value shown in table 1. If the activity exceeds the value shown in table 1, the classification of the source shall be considered on an individual basis. If the activity does not exceed the values shown in table 1, table 3 may be used without consideration of either radiotoxicity or solubility.

4. Classification and Testing

4.1 Classification Procedures

The performance classification of a specific type of self-luminous source or source-device shall be determined as follows:

4.1.1 Determine from table 1 the activity allowable for that type of source.

4.1.2 If the desired quantity of radioactive material does not exceed the allowable quantity of table 1 and no abnormal fire or explosion hazard exists, the performance requirements for classification of that type of source may be taken directly from table 3. If a significant fire or explosion hazard exists, the factors listed in paragraph 3.4 shall be evaluated and applied.

4.1.3 If the desired quantity of radionuclide exceeds the allowable limits of table 1, a separate evaluation of the specific source use and source design shall be made in accordance with paragraph 3.5.

4.1.4 Performance requirements may be determined directly from table 3 for normal usage.

When conditions of use indicate that abnormal resistance to one or more environmental conditions is necessary or desirable, suitable test conditions may be selected from table 2 and substituted for those normally specified in table 3. Since table 3 is arranged in order of increasing severity, sources of an established classification may be used in any application having less severe specific performance requirements.

4.2 Testing

The verification of the classification (sec. 5) of each source type shall be determined by subjecting a minimum of two prototype or production sources consecutively to the performance tests specified or by evaluation of prior test data on sources of comparable size and identical materials of construction.

For self-luminous light sources normally mounted in devices, the complete device may be tested. Where the source constitutes a part of a complete assembly which may not adapt to the performance tests, the source only or the source in its holder may be subjected to the specified tests.

Compliance with the tests shall be determined by the ability of the self-luminous light source to maintain its integrity and brightness after each test is performed, i.e., retain its radioactive material and maintain, within the limits specified in section 8, its physical and operating characteristics.

In the event any of the source units tested fails the test series, the source design shall be considered unacceptable.

5. Classification Designation

The classification of a self-luminous light source shall be designated by a series of letters and digits in accordance with the following designation scheme:

5.1 The first one or two characters will designate the radionuclide and, with the exception of tritium, shall consist of the chemical symbol of the element, using the letter "T" for tritium, "Kr" for krypton-85, "Pm" for promethium-147, etc.

5.2 The first character following the radionuclide identification shall be a digit, from 1 to 7, taken from table 3, which will indicate the classification assigned on the basis of the tests to which the source has been subjected. For emphasis, that digit shall be underlined whenever used.

5.3 The first character following identification of the general classification test will designate the type of source, as classified in table 1, using the letter "D" to identify a dry powder source, "P" for painted, "S" for separable and "G" for gaseous.

5.4 The first character following identification of the type of source will indicate whether the curie content does or does not exceed the maximum amounts given in table 1. Use the letter "C" to indicate that the amount does not exceed table 1 limits and "E" to indicate that the activity exceeds table 1 limits.

5.5 If the source testing involved any specific tests more or less stringent than normal for the indicated classification, the curie content designation ("C" or "E") shall be followed by seven additional digits to indicate the level at which each specific test was made. Table 2 shows seven tests and five test levels for each. Using the applicable designator for test levels (1 to 4 or X), indicate the deviation from the general test level in the manner illustrated in the following example:

Assume that a source under consideration is one containing two curies of gaseous tritium, is intended for a mobile type application involving abnormal shock resistance, and has been tested in accordance with classification 4, except for the more severe impact test requirements of test level 4. The proper designation for such a source would be:

T4GC1333433

The proper designation for a similar source involving no abnormal conditions and tested in accordance with the requirements of the performance standards classification 4 would be:

T4GC

6. Product Identification

The ANSI classification designation shall be marked on the self-luminous light source, source container or source holder. If space limitation does not permit such marking, the classification designation shall appear on accompanying documents.

7. Performance Testing Procedures

7.1 General

The testing procedures described below are acceptable and recommended procedures for conducting the performance tests prescribed in table 2. Procedures demonstrated to be at least equivalent are also acceptable.

Tests shall be run consecutively on the same source, in the order shown in table 2. Unless otherwise specified the tests shall be performed at $23\text{ }^{\circ}\text{C} \pm 10\text{ }^{\circ}\text{C}$, at barometric pressure of 710-790 mm (28-31") mercury and at a maximum relative humidity of 80 percent. Temperature changes, unless otherwise specified, shall be gradual to reduce the possibility of thermal shock.

7.2 Discoloration

7.2.1 **Equipment.** Weatherometer or S-4 Sunlamp, Corex D filter, calcium chloride, 8 liters or larger, glass container.

7.2.2 **Procedure.**(a) Expose sources in weatherometer for twelve hours, alternating one-half hour wet and dry cycles or, (b) expose sources for twelve hours to the light from an S-4 lamp, filtered by a Corex D filter, at a distance of 20 centimeters from the S-4 lamp. All tests shall be performed in air with an ambient temperature of $27\text{ }^{\circ}\text{C} \pm 10\text{ }^{\circ}\text{C}$ and a relative humidity of 95 to 100 percent. The samples shall be irradiated with the light impinging on the translucent surface of the source.

7.2.3 **Evaluation.** Test sources shall be examined visually and any discoloration or other effects observed. The light spectrum and output after the test shall be compared with that before the test. When measured with a visual photometer or a color corrected photocell, no greater loss of luminosity than 20 percent shall be observed.

7.3 Temperature Test

7.3.1 **Equipment.** The heating or cooling equipment shall have a test zone volume (that volume at essentially constant temperature) of at least five times the volume of the test specimen. The temperature of the test chamber shall be determined by at least two recently calibrated temperature measuring instruments, and the average of the readings shall be taken as the true temperature.

If a gas or oil-fired furnace is used for the temperature test, an oxidizing atmosphere must be maintained at all times.

7.3.2 Procedure. All temperature tests shall be performed in air. All test sources shall be held at or above the maximum (or at or below the minimum for low temperature tests) test temperature for a period of at least one hour. The test sources shall be allowed to remain in the test chamber until they return to ambient conditions.

Sources to be subjected to temperatures below ambient shall be cooled to the test temperature in less than 45 minutes.

Sources to be subjected to temperatures above ambient shall be heated to the test temperature within a 5 minute period.

7.3.3 Evaluation. Test sources shall be examined visually for any evidence of failure and, in the absence of any evident failure, shall be used in the succeeding thermal shock test. In the event of any uncertainty regarding possible failure, the person performing the test may, at his option, subject the source(s) to the final immersion test before proceeding with the next test.

7.4 Thermal Shock Test

7.4.1 Equipment. Same as 7.3—Temperature test.

7.4.2 Procedure. Use the sources used in temperature test. Heat the source(s) to the maximum test temperature (required for that particular class) and hold at this temperature for at least 15 minutes. Transfer the source, in 15 seconds or less, to the cold chamber, held at or below the minimum temperature required for the particular class. If water is used for the cold test, it shall be flowing at a rate of at least ten times the source volume per minute, or, if the water is stationary, it shall have a volume of at least twenty times the source volume.

7.4.3 Evaluation. Test sources shall be examined visually for any evidence of failure and, in the absence of any evident failure, shall be used in the succeeding pressure test. In the event of any uncertainty regarding possible failure, the person performing the test may, at his option, subject the source(s) to the final immersion test before proceeding with the next test.

7.5 Pressure (Reduced) Test

7.5.1 Equipment. The apparatus used for the pressure test shall consist of a vacuum pump, vented to a suitable exhaust system, and a suitable sealed chamber having means for visual observation of the sources under test. The pressure gauge shall be recently calibrated and should have a range at least 10 percent greater than the test pressure.

7.5.2 Procedure. The test sources shall be put into the chamber and exposed to the test pres-

sure for four periods of 15 minutes each, the pressure being returned to atmospheric between each period.

7.5.3 Evaluation. Test sources shall be examined visually for any evidence of failure and, in the absence of any evident failure, shall be used in the succeeding impact test. In the event of any uncertainty regarding possible failure, the person performing the test may, at his option, subject the source(s) to the final immersion test before proceeding with the next test.

7.6 Impact Test

7.6.1 Equipment. Rigid steel plate. Support or shelf for sources. The steel plate shall be rigidly mounted on an unyielding surface so that it will not deflect appreciably during the test.

7.6.2 Procedure. Mount the source support above the steel plate at the appropriate height. Place the source to be tested on the support and, using any device or means which will not have a tendency to orient the source, push the source from the support and allow it to free fall and impact the steel plate in a random manner. Repeat the required number of times specified for the particular test level.

7.6.3 Evaluation. Each test source shall be examined visually for any evidence of failure and, in the absence of any evident failure, shall be used for the succeeding vibration test. In the event of uncertainty regarding possible failure, the person performing the test may, at his option, subject the source(s) to the final immersion test before proceeding with the next test.

7.7 Vibration Test

7.7.1 Equipment. The equipment shall be capable of providing a simple harmonic motion having an amplitude of 0.075 centimeter (0.03") and a maximum total excursion of 0.15 centimeter (0.06"), the frequency being varied uniformly between the approximate limits of 10 and 55 hertz (Hz).

7.7.2 Procedure. Test sources shall be subjected to the above simple harmonic motion for the time interval indicated for the specific test level. The entire frequency range, between 10 and 55 Hz and return to 10 Hz, shall be traversed in approximately one (1) minute.

7.7.3 Evaluation. Test sources shall be examined visually for any evidence of failure and, in the absence of any evident failure, shall be used for the succeeding immersion test.

7.8 Immersion Test

7.8.1 Equipment. Hot and cold baths.

7.8.2 Procedure. Immerse the test source(s) in a water bath, maintained at 0 °C, and allow to remain for 15 minutes. Immediately (one minute maxi-

mum) transfer the source(s) to a hot water bath, maintained at the temperature specified for the particular test level ($\pm 3^\circ\text{C}$), and allow to remain for 15 minutes. Immediately (one minute maximum), transfer to the cold bath and allow to remain for 15 minutes. Repeat the cycle as indicated for the specific test level. A dye may be used to observe any gross penetration.

Bath volume, or temperature control, shall be such that bath temperature does not change by more than $\pm 3^\circ\text{C}$ during the test cycle.

7.8.3 Evaluation. The radioactivity in the hot and cold baths shall be determined. The radioactivity in the liquid shall not exceed 1 microcurie for painted tritium sources, 50 nanocuries for gaseous tritium sources, or 5 nanocuries for other sources.

8. Evaluation

Determination of compliance with the performance test requirements shall be made on all sources in accordance with the procedures described below, after the sources have been subjected to the entire test sequence. These evaluations shall be made in addition to the evaluation procedures specified for the individual tests.

8.1 The test sources shall be examined visually for any evidence of failure, visible leakage or degradation.

8.2 The test sources shall be subjected to brightness measurements and the loss of luminosity shall not exceed 20 percent of that observed prior to this series of tests. And

8.3 The test sources shall be tested for loss of radioactive contents as follows:

8.3.1 Each source shall be wet wipe tested. An acceptable wipe (smear) test consists of wiping all external surfaces of the source thoroughly with a piece of filter paper or other suitable material of high wet strength and absorbent capacity, moistened with a solvent which will not attack the material of which the outer surfaces of the source are made and which, under the conditions of this test, has been demonstrated to be effective in removing the radionuclide involved. Measure the total activity on the paper. It shall not exceed 1 microcurie for painted tritium sources or 5 nanocuries for other sources. Wipe tests are not required for gaseous sources.

8.3.2 Each source shall be soak tested for 24 hours in a volume of water about equal to 10 times the volume of the source. The source shall be removed and the activity in the solution measured. The activity in the solution shall not exceed 1 microcurie for painted tritium sources, 50 nanocuries for gaseous tritium sources, or 5 nanocuries for other sources. Gaseous krypton sources are exempted from the soak test.

8.3.3 Leakage of gas from gaseous sources shall be monitored by enclosing the source in a closed system or through suitable means to determine rate of leakage. Leakage shall not exceed 5 nanocuries in 24 hours. Tritium sources shall be exempted from this test.

9. Additional Tests for Special Uses

Under certain environmental conditions, additional tests, not applicable to all sources, may be required or desirable. The following covers one such additional test. Other additional tests should be developed and applied as special situations become evident.

9.1 Dust Resistance

9.1.1 Equipment. Humidity chamber, heat source, dusting chamber, carbon black, MgO_2 or other opaque powder.

9.1.2 Procedure

9.1.2.1 Prepare test sources as follows:

9.1.2.1.1 Rub surface of source to create surface charge. Dust source using the procedure described under 9.1.2.2.

9.1.2.1.2 Expose test source for one hour in air with a relative humidity of 95 to 100 percent. Dust source using the procedure described under 9.1.2.2.

9.1.2.1.3 Expose source for one hour in air at $80^\circ\text{C} \pm 10^\circ\text{C}$ to drive plasticizer or residual solvent to surface. Dust source using the procedure described under 9.1.2.2.

9.1.2.2 Sources prepared under each procedure above should be mounted or suspended in the dusting chamber, in the position in which it is to be used, and dusted with opaque powder, to simulate dust laden air, or atmosphere. Dusting powder should be introduced in an air stream, in such a manner that the air stream does not impinge directly on the translucent surface of the source but creates a dust suspension, resembling a dust laden atmosphere. Expose the source for thirty minutes in such an atmosphere.

9.1.3 Evaluation. Remove the source, without disturbing the surface, and measure brightness through any accumulated dust, or make such measurement without removing the source from the chamber. Surface brightness shall not be less than 90 percent of pretest brightness.

10. References

Publication 1 listed below is referred to in the Preface in this standard. Publication 2 is an international standard for radioluminous timepieces recommended by the European Nuclear Energy Agency and the International Atomic Energy Agency.

- [1] USA Standard Classification of Sealed Radioactive Sources, (ANSI N5.10-1968, August 29, 1967).
- [2] Radiation Protection Standards for Radioluminous Timepieces, Safety Series No. 23, International Atomic Energy Agency, Vienna, Austria (1967).

U.S. DEPT. OF COMM. BIBLIOGRAPHIC DATA SHEET	1. PUBLICATION OR REPORT NO. NBS HB-116	2. Gov't Accession No.	3. Recipient's Accession No.
4. TITLE AND SUBTITLE American National Standard N540; Classification of Radioactive Self-Luminous Light Sources		5. Publication Date January 1976	6. Performing Organization Code
7. AUTHOR(S) American National Standards Comm. N43 (Chairman	E. H. Eisenhower,)	8. Performing Organ. Report No.	
9. PERFORMING ORGANIZATION NAME AND ADDRESS NATIONAL BUREAU OF STANDARDS DEPARTMENT OF COMMERCE WASHINGTON, D.C. 20234		10. Project/Task/Work Unit No. NA	11. Contract/Grant No. NA
12. Sponsoring Organization Name and Complete Address (Street, City, State, ZIP) Same as item 9		13. Type of Report & Period Covered Final	14. Sponsoring Agency Code
15. SUPPLEMENTARY NOTES Library of Congress Catalog Card Number: 75-619239			
16. ABSTRACT (A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.) This standard establishes the classification of certain radioactive self-luminous light sources according to radionuclide, type of source, activity, and performance requirements. The objectives are to establish minimum prototype testing requirements for radioactive self-luminous light sources, to promote uniformity of marking such sources, and to establish minimum physical performance for such sources. This standard is primarily directed toward assuring adequate containment of the radioactive material. Testing procedures and classification designations are specified for discoloration, temperature, thermal shock, reduced pressure, impact, vibration, and immersion. A range of test requirements is presented according to intended usage and source activity.			
17. KEY WORDS (six to twelve entries; alphabetical order; capitalize only the first letter of the first key word unless a proper name; separated by semicolons) Classification; designation; containment; light sources; national standard; radiation source; radioactive; radioluminous products; self-luminous sources; test procedures.			
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		20. SECURITY CLASS (THIS PAGE) UNCLASSIFIED	22. Price

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