MILITARY SPECIFICATION

DISPLAYS, DIODE, LIGHT EMITTING, SOLID STATE, GENERAL SPECIFICATION FOR

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification establishes the general requirements for solid state, visible, single or multichip displays. Specific ratings, characteristics, requirements, and quality assurance provisions shall be as specified in the detail specification (see 3.1). Four levels of product assurance are provided in this specification by quality level designators A through D.

1.2 Classification. Displays are classified by one of the following quality level suffix letters:

Quality level	Description
A	Hermetically sealed displays with 100% screening tests.
B	Hermetically sealed displays without 100% screening tests.
C	Nonhermetic displays with 100% screening tests.
D	Nonhermetic displays without 100% screening tests.

1.3 Part number. The part number for displays furnished under this specification shall be formulated as follows:

JAN or J	87157/024	01	A
U.S. Government certification mark (see 1.3.1)	Detail specification number (see 1.3.2)	Sequentially assigned dash number (see 1.3.3)	Quality level designator (see 1.2)

1.3.1 Government certification mark. The certification mark JAN or the abbreviated prefix J shall indicate a military specification item produced in full compliance with MIL-D-87157 and the applicable detail specification.

1.3.2 Detail specification number. The detail specification number shall consist of 87157 and three digits from 001 to 999 as applicable.

1.3.3 Dash number. The dash number shall be a sequentially assigned, nonsignificant number given to displays covered by the same detail specification.

2. APPLICABLE DOCUMENTS

2.1 Government specifications and standards. Unless otherwise specified, the following specifications and standards, of the issue listed in that issue of the Department of Defense Index of Specifications and Standards specified in the solicitation, form a part of this specification to the extent specified herein.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Aeronautical Systems Division, ASD/ENESS, Wright-Patterson AFB, OH 45433, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

SPECIFICATIONS

MILITARY

MIL-S-19491 - Semiconductor Devices, Packaging of.

STANDARDS

MILITARY

MIL-STD-129 - Marking for Shipment and Storage.
MIL-STD-750 - Test Methods for Semiconductor Devices.
MIL-STD-883 - Test Methods and Procedures for Microelectronics.
MIL-STD-45662 - Calibration Systems Requirements.

PUBLICATIONS

NAVSHIPS 0967-190-4010 - Manufacturer's Designating Symbols.
SD-6 - Provisions Governing Qualification.

(Copies of specifications, standards, handbooks, drawings, and publications required by manufacturers in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer).

3. REQUIREMENTS

3.1 Detail specifications. The individual item requirements shall be as specified herein and in accordance with the applicable detail specification. In the event of any conflict between requirements of this specification and the detail specification, the latter shall govern. When applicable, the detail specification shall establish provisions for categorization of devices with respect to their light output and color. The categories or bins shall be defined such that devices with minimum and maximum values of light output and color within a category or bin, will appear visually uniform.

3.2 Reference to detail specification. For purposes of this specification, when the term "specified" or "as specified" is used without reference to a specific document, the intended reference is to the detail specification.

3.3 Qualification. Displays furnished under this specification shall be products which are qualified for listing on the applicable qualified products list at the time set for opening of bids. Only those displays so qualified shall be marked with the "JAN" military designator.

3.4 Product assurance requirements. Displays furnished under this specification shall comply with the applicable product assurance provisions of Section 4 herein, and be prepared for delivery in accordance with Section 5 herein.

3.5 Terms, definitions, abbreviations, and symbols. For the purpose of common understanding, usage, preparation of the detail specifications, and the recording of data, the terms, definitions, abbreviations, and symbols contained herein, in the appendices, and in the detail specification shall apply.

3.6 Design, construction and materials. Design, construction, and materials for displays furnished under this specification shall be as specified herein or as specified in the detail specification.

3.6.1 Hermetic packages. All displays furnished to quality levels A and B of this specification shall be hermetically sealed in glass, metal, or ceramic (or combinations of these) packages. The qualifying activity shall approve any organic or polymeric materials which are used as a package seal.

3.6.2 Nonhermetic packages. The materials used in the package shall be controlled as documented in the product assurance program and shall enable the displays to meet the performance requirements of quality levels C and D of this specification and the detail specification.

3.6.3 Lead material and finish. Lead material and finish shall be as specified in the detail specification (see 3.1 and 6.1).

3.6.4 Internal conductors. When specified, internal conductors which are in thermal contact with a substance along their entire lengths (such as metallization strips, contact areas and bonding interfaces) shall be designed so that no properly fabricated conductor shall experience, at device maximum rated current, a current density in excess of the values shown below for the applicable conductor material including allowances for worst case conductor composition and cross sectional area, normal production tolerances on design dimensions, and actual thickness at critical areas such as steps in the elevation or contact windows:

Conductor material	Maximum allowable continuous current density (RMS for pulsed applications)
Aluminum (99.99% pure or doped) without glassivation	2×10^5 Amperes/cm^2
Aluminum (99.99% pure or doped) glassivated	5×10^5 Amperes/cm^2
Gold	6×10^5 Amperes/cm^2
All other (unless otherwise specified)	2×10^5 Amperes/cm^2

3.7 Marking.

3.7.1 Marking on each display. The following marking shall be placed on each display and shall be legible at time of shipment:

a. Index point if applicable (see 3.7.2).

b. Part number (see 1.3).

c. Manufacturer's designating symbol.

d. Lot identification code and code of assembly plant (see 3.7.6).

e. Manufacturer's name, trademark, or identification.

f. Country of origin.

The maximum marking commensurate with display size and the above order of precedence shall apply.

3.7.2 Index point. The index point, tab, or other marking indicating the starting point for numbering of leads or mechanical orientation shall be as specified.

3.7.3 Marking on initial container (unit package). All display marking (except for index point) including the inspection date and the latest reinspection date (if reinspection is applicable) shall appear on the unit package used as the initial protection for delivery (see 5.2).

3.7.3 Special marking. If any special marking is used, it shall in no way interfere with or obscure the marking required in 3.7.1.

3.7.4 Marking legibility. Marking shall remain legible after all quality conformance tests. Damage to marking caused by mechanical fixturing shall not be cause for lot rejection, but displays with damaged marking shall be remarked to insure legibility prior to shipment.

3.7.5 JAN prefix. The part number of all displays procured to and meeting the requirements of this specification and the applicable military detail specification shall bear the prefix JAN, except that in the case of small size displays the abbreviated prefix J, may be used. The JAN brand or the abbreviation shall not be used on any display procured under contracts which permit or require any changes to this specification or the applicable detail specification, except for lead length, material, or finish of the leads. The JAN brand is a U.S. Government certification mark registered as number 504860 by the U.S. Patent Office and its application shall constitute certification by the manufacturer that all tests of the applicable detail specification and this specification have been satisfactorily completed; that verifiable test data will be retained in files for not less than 3 years; and that within the specified time period, test data will be made available for on-site review by Government representatives upon request. The JAN brand shall be used as a prefix, except that where the location places an undue hardship on the manufacturer in connection with marking, the JAN brand may be located on the first line above the component designation. If a lot fails to pass inspection, the manufacturer shall remove or obliterate within 30 days the JAN or J prefix from the sample tested and also from all devices represented by the sample.

3.7.6 Lot identification code. Displays shall be marked by a code indicating the last week of sealing for the inspection lot accumulation period. The first two numbers in the code shall be the last two digits of the number of the year. The third and fourth numbers shall be two digits indicating the calendar week of the year. When the number of the week is a single digit, it shall be preceded by a zero. The code number shall designate the year and week when read from left to right or top to bottom. When more than one lot of a display type, sealed within the same six week period, is submitted for quality conformance inspection, a lot identification suffix letter shall be chosen consisting of a single capital letter, and shall appear on each display immediately following the date code. This letter shall be chosen by the manufacturer so that each inspection lot is uniquely identified by the lot identification code and by the lot identification suffix letter, if one is required.

3.7.6.1 Code for final assembly plants. If the displays are assembled at an assembly plant outside the U.S.A or its territories, the lot identification code shall include a single letter assigned by the qualifying activity which uniquely identifies the country where the final assembly plant is located. When the full name of the country of assembly in which the display is assembled is marked on the display, the letter code is not required. This final assembly plant designator shall appear immediately preceding and adjacent to the lot identification code.

3.7.7 Manufacturer's name, abbreviation, or trademark. Displays shall be marked with the name, abbreviation, or trademark of the actual manufacturer.

3.7.8 Marking option. The manufacturer has the option of marking the entire lot or only the sample displays prior to inspection. If the manufacturer exercises the option to mark only the sample displays, the procedure shall be as follows:

a. The sample displays shall be marked prior to performance of quality conformance inspection.

b. At the completion of inspection, the marking of the sample displays shall be inspected for conformance with the requirements of 3.7.1.

c. The inspection lot represented by a conforming inspection sample shall then be marked and any specified visual and mechanical inspection performed.

d. The marking materials and processing (including cure cycle) applied to the inspection lot shall be to the same specification as those used for the inspection sample.

e. All marking, marking removal, and remarking shall be performed by the display manufacturer or performed under his jurisdiction.

3.8 Workmanship. Displays shall be uniform in quality and shall be free from pits, corrosion, cracks, chips, and other defects that will affect life, serviceability or appearance.

3.8.1 Rework provisions. All rework permitted on displays furnished under this specification shall be documented and this documentation shall be available for review by the preparing activity or his designated agent. Delidding or package opening for rework of displays with polymeric or organic seals may be permitted provided the resealed displays are submitted to any required screening and combined with the remainder of the lot for quality conformance inspection. After any plating, replating, retinning, etc., of the package or leads, all displays shall be subjected to and pass as a 100% screen the functional electrical tests in group A and on an LTPD sample, resistance to solvents and solderability test of group B. In addition, level A and B displays shall pass the hermetic seal test of group B.

3.9 Location of manufacturer. For all display quality levels, wafer processing, 100 percent screening test, and groups A, B, and C inspections shall be performed in the U.S.A or its territories. Displays may be assembled in a foreign country provided that the foreign assembly plant is wholly owned or technically and quality conformance controlled by the basic plant.

3.9.1 Location of final seal. For those hermetic displays requiring a pre-seal visual inspection, the final seal shall be performed in the U.S.A unless the glass case allows for an internal visual after final seal. For nonhermetic displays requiring a pre-seal visual inspection, the visual inspection and final seal may be performed in a foreign country.

4. QUALITY ASSURANCE PROVISIONS.

4.1 Responsibility for inspection. The contractor is responsible for the performance of all inspection requirements as specified herein, and in the detail specification. The contractor may use his own or other suitable facilities (which have been approved and granted laboratory suitability by the preparing activity or his designated agent) for the performance of the inspection requirements specified herein. The Government or procuring activity reserves the right to witness or perform any of these inspections set forth herein or in the detail specification and to audit the data resulting from the contractor's performance of these inspections. The responsible Government inspection agency shall be given adequate notification prior to the initiation of all inspections, when government source inspection is invoked.

4.2 Procedure for lots held more than 24 months. Displays which have passed quality conformance inspection and have been held by manufacturers or suppliers for a total time period (time held by manufacturer plus time held by supplier) exceeding 24 months shall be reinspected by the manufacturer or supplier for all specified group A inspection requirements prior to shipment (shipped displays shall have a quality conformance inspection date or a reinspection date less than 24 months old). In case of lot failures during reinspection, the lot shall be subjected to 100 percent inspection for all failed parameters and characteristics. All displays that fail any of these tests shall be removed from the lots, rejected, and the military designator removed within 30 days. The remaining displays shall retain the original inspection lot identification code. Reinspection date marking shall be in accordance with 3.7.3.

4.3 Inspection lot. The total number of displays that the supplier submits at any one time for qualification or quality conformance inspection shall constitute an inspection lot. The inspection lot is submitted to determine compliance with the requirements of the detail specification. Each inspection lot may consist of a collection of sublots of structurally identical displays contained on one or more detail specifications manufactured on the same production line(s) within the same 6-week period. Lot identification shall be maintained from the time the lot is assembled to the time it is accepted or rejected.

4.3.1 Inspection sublot. An inspection sublot shall consist of a single display quality level contained on a single detail specification manufactured on the same production line(s) through final seal by the same fabrication technique and to the same display design with the same material requirements and within the same 6-week period.

4.3.1.1 Structurally identical displays. Structurally identical displays are displays manufactured on the same production line(s) through final seal, by the same fabrication technique and to the same display design with the same basic material requirements, and differ only in their electrical/optical characteristics or character configuration. Examples of structurally identical displays are those grouped for peak wave length, luminuous intensity, power rating, or character font.

4.3.2 Disposal of samples. Displays subjected to destructive tests or which fail any test shall not be shipped on the contract. Sample displays from lots which have passed quality conformance inspection and which have been subjected to mechanical or environmental tests specified in group B inspection and not classified as destructive, may be shipped on the contract provided sufficient evidence indicates that the test is nondestructive and each of the displays subsequently passes group A inspection.

4.3.2.1 Destructive tests. Unless otherwise demonstrated, the following tests are classified as destructive:

Post seal internal inspection (class C and D displays only)
Moisture resistance
Lead integrity
Thermal shock
Temperature cycling greater than 20 cycles
Accelerated steady state life
Salt atmosphere
Solderability

All other mechanical or environmental tests (other than those listed in 4.3.2.2) shall be considered destructive initially, but may subsequently be considered nondestructive on accumulation of sufficient data to indicate that the tests are nondestructive. The accumulation of data from five repetitions of the specified test on the same sample of product, without significant evidence of cumulative degradation in any display in the sample, is considered sufficient evidence that the test is nondestructive for the display of that manufacturer. Any test specified as a 100 percent screen shall be considered nondestructive for the stress level and duration or number of cycles applied as a screen.

4.3.2.2 Nondestructive tests. Unless otherwise specified, the following tests are classified as nondestructive:

Post seal internal inspection (class A and B displays only)
Physical dimensions
Radiographic inspection
External visual
Internal visual (pre-cap)
Burn-in screen
Hermetic seal tests
High temperature life (nonoperating)
Steady state life
Intermittent life
Temperature cycling $\leq$ 20 cycles

4.3.3 Resubmission of failed lots. Resubmitted lots shall be kept separate from any new lots and shall be clearly identified as resubmitted lots. When any lot submitted for quality conformance inspection fails any subgroup requirement of groups A, B, or C, the lot may be resubmitted once for that particular subgroup using tightened inspection criteria (as defined in 20.1 of appendix B). A second resubmission using tightened inspection criteria is permitted only if failure analysis is performed to determine the mechanism of failure for each failed display from the prior submission and it is determined that failure is due to:

a. A defect that can be effectively removed by rescreening the entire lot, and that rescreen has been performed or

b. Random type defects which do not reflect poor basic display design or poor basic fabrication procedures.

In all instances where analysis of the failed displays indicates that the failure mechanism is due to poor basic fabrication procedures, a basic design fault, or nonscreenable defects, the lot shall not be resubmitted.

4.4 Levels A and C displays. The procedure for testing and screening for levels A and C displays shall be in accordance with tables I, II, III, IV, figure 1 and the applicable detail specification.

4.4.1 Alternate procedure for screening of levels A and C displays. Levels B and D displays may be processed and marked as levels A and C displays by the original display manufacturer on his own qualified product provided the following procedures are satisfied:

a. Groups A, B, and C inspection shall have met levels A and C requirements in accordance with tables II, III, figure 2, and the applicable detail specification.

b. Screening shall be conducted in accordance with table I, figure 2, and the applicable detail specification. All displays failing these tests shall be removed from the lot and the quantity removed shall be noted in the lot history.

c. A sample of the screened displays shall be submitted to and pass the requirements of group A inspection (table II), and solderability and resistance to solvents (table III, subgroups 2 and 3) subsequent to the 100 percent screening (of the lot or separate portions thereof) specified in figure 2.

4.4.2 Levels A and C pre- and post-burn-in electrical measurements. Alternate methods to variables recording may be used to determine delta end point requirements of levels A and C burn-in provided the qualifying activity has granted written approval. When alternate methods to variables recording are used to determine delta end point requirements, displays shall be separated into groups, each of which shall have maximum and minimum limits on the variable parameter(s). The difference in parameter limits for any group shall not exceed the delta requirements for the variable parameter(s).

4.4.3 Alternative test methods. Other test methods or circuits may be substituted for those specified in the applicable military standards, provided it is demonstrated to the government that such a substitution in no way relaxes the requirements of this specification. The set up wiring diagram of the test equipment shall be made available for checking by the Government.. Control and calibration of the test equipment shall be established and documented in accordance with MIL-STD-45662.

4.4.4 Procedure in case of test equipment failure or operator error. If a display fails as a result of faulty test equipment or operator error, the failure shall be entered in the test record which shall be submitted to the cognizant government quality assurance representatives along with a complete explanation verifying why the failure is believed to be invalid. The government quality assurance representative will then decide whether or not the failure is due to a valid part defect. If the government quality assurance representative rules that the failure is invalid, a replacement display from the same inspection lot may be added to the sample. The replacement display shall be subjected to all those tests and inspections to which the discarded display was subjected prior to its failure and to any remaining specified tests to which the discarded display was not subjected prior to its failure.

4.4.5 Percent defective allowed (PDA). Selected electrical parameters shall be designated in the detail specification as interim and end point measurements for the 100 percent burn-in test of screen 8 of table I. These pre- and post-test parameter measurements may also be compared to determine whether the change during burn-in (delta) is indicative of a lot stability problem. When these parameters are specified, the quantity in the lot which fail these parameters or associated delta limits shall not exceed 10 percent. If the percent defective of the failed display parameters in the lot exceeds 20 percent, or exceeds 10 percent and is not going to be resubmitted (see 4.4.6), the lot shall not be acceptable for any level.

4.4.6 Lots resubmitted for burn-in. Unless otherwise specified, lots may be resubmitted for burn-in one time only and may be resubmitted only when the observed percentage of defectives does not exceed twice the specified PDA. Resubmitted lots shall contain only those displays which were in the original lot. Resubmitted lots shall be kept separate from new lots and shall be inspected for all specified characteristics using a tightened PDA of 5 percent. If the percent defective for resubmitted lot exceeds the tightened PDA, the entire resubmitted lot shall be unacceptable for any level.

4.5 Classification of inspections. The inspections specified herein are classified as follows:

a. Qualification inspection (see 4.6).

b. Quality conformance inspection (see 4.7).

4.6 Qualification inspection. Qualification inspection shall be performed at a laboratory acceptable to the Government (see 6.2) on sample displays produced with equipment and procedures normally used in production. Application for qualification inspection shall be in accordance with "Provisions Governing Qualifications SD-6".

4.6.1 Sample size. For qualification, displays shall be subjected to the inspections specified in groups A, B, and C. All quality level A and C displays shall be subjected to 100 percent screening tests prior to qualification and quality conformance testing. Displays which fail any test criteria in the screening sequence shall be removed from the lot at the time of the observation or immediately at the conclusion of the test in which the failure was observed and these displays shall not be shipped. The specified screening tests shall apply and shall be conducted in the sequence shown in table I. The specific screening procedures, conditions and limits shall be specified in the detail specification.

TABLE I. (100 percent screen format for quality levels A and C)

Test screen	MIL-STD-750 Method	Level A	Level C
1. Pre cap visual 1/	2072	When specified	When specified
2. High temperature storage 1/	1032	100 percent	100 percent
3. Temperature cycling 1/	1051	100 percent	100 percent
4. Constant acceleration 1/ 2/	2006	100 percent	When specified
5. Fine leak 1/	1071	100 percent	N/A
6. Gross leak 1/	1071	100 percent	N/A
7. Interim electrical/optical tests 1/	---	When specified	When specified
8. Burn-in 1/ 3/	1015	100 percent	100 percent
9. Final electrical/optical tests	---	100 percent	100 percent
10. Delta determinations 1/	---	When specified	When specified
11. External visual 3/	2009	100 percent	100 percent

1/ These tests are design dependent. The conditions and limits shall be specified in the detail specification when these tests are applicable.

2/ Applicable to cavity type displays only.

3/ MIL-STD-883 test method applies.

TABLE II. Group A electrical tests. 1/

Subgroups	LTPD
Subgroup 1 DC electrical tests at 25°C	5
Subgroup 2 Selected DC electrical tests at high temperatures	7
Subgroup 3 Selected DC electrical tests at low temperatures	7
Subgroup 4 Dynamic electrical tests at T_A = 25°C	5
Subgroup 5 Dynamic electrical tests at high temperatures	7
Subgroup 6 Dynamic electrical tests at low temperatures	7
Subgroup 7 Optical and functional tests at 25°C	5
Subgroup 8 External visual	7

1/ The specific parameters to be included for tests in each subgroup shall be as specified in the applicable detail specification. Where no parameters have been specified in a particular subgroup or test within a subgroup, no group A testing shall be required for that subgroup or test to satisfy group A requirements. A single sample may be used for all subgroup testing. These tests are considered nondestructive and displays may be shipped.

TABLE IIIa. Group B environmental tests (class A and B displays only).

Test	MIL-STD-750 Method	Sampling plan
Subgroup 1		
Resistance to solvents 1/	1022	4 devices/0 failures
Internal visual and mechanical 4/	2014	1 device/0 failures
Subgroup 2 2/ 3/		LTPD = 15
Solderability 1/	2026	
Subgroup 3		LTPD = 15
Thermal shock 1/	1051	
(Temperature cycling)		
Moisture resistance 1/	1021	
Fine leak 1/	1071	
Gross leak 1/	1071	
Electrical/optical endpoints 1/		
Subgroup 4		LTPD = 10
Operating life test (340 hrs) 1/	1027	
Electrical/optical endpoints 1/		
Subgroup 5		LTPD = 10
Nonoperating (storage) life test (340 hrs) 1/	1032	
Electrical/optical endpoints 1/		

1/ Test method or conditions in accordance with detail specification.

2/ Whenever electrical/optical tests are not required as end points, electrical rejects may be used.

3/ The LTPD applies to the number of leads inspected except in no case shall less than three displays be used to provide the number of leads required.

4/ MIL-STD-883 test method applies.

TABLE IIIb. Group B environmental tests (class C and D displays only).

Test	MIL-STD-750 Method	Sampling plan
Subgroup 1		
Resistance to solvents 1/	1022	4 devices/0 failures
Internal visual and mechanical 2/ 5/	2014	1 device/0 failures
Subgroup 2 3/ 4/		LTPD = 15
Solderability 1/	2026	
Electrical/optical endpoints 1/		
Subgroup 3		LTPD = 15
Thermal shock 1/ (Temperature cycling)	1051	
Moisture resistance 1/	1021	
Electrical/optical endpoints 1/		
Subgroup 4		LTPD = 10
Operating life test (340 hrs) 1/	1027	
Electrical/optical endpoints 1/		
Subgroup 5		LTPD = 10
Nonoperating (storage) life test (340 hrs) 1/	1032	
Electrical/optical endpoints 1/		

1/ Test method or conditions in accordance with detail specification.

2/ Not required for solid encapsulated displays.

3/ The LTPD applies to the number of leads inspected except in no case shall less than three displays be used to provide the number of leads required.

4/ Whenever electrical/optical test are not required as endpoints, electrical rejects may be used.

5/ MIL-STD-883 test method applies.

TABLE IVa. Group C periodic inspection (class A and B displays only).

Test	MIL-STD-750 Method	Sampling plan
Subgroup 1 1/		2 devices/0 failures
Physical dimensions	2066	
Subgroup 2		LTPD = 15
Lead integrity 2/ 8/	2004	
Fine leak 3/	1071	
Gross leak 3/	1071	
Subgroup 3		LTPD = 15
Shock	2016	
Vibration, variable frequency	2056	
Constant acceleration	2006	
External visual 5/	1001 or 1011	
Electrical/optical endpoints 3/		
Subgroup 4 1/ 4/		LTPD = 15
Salt atmosphere	1041	
External visual 5/	1010 or 1011	
Subgroup 5		LTPD = 20 (c = 0)
Bond strength 6/	2037	
Subgroup 6		λ = 10
Operating life test 3/ 7/	1026	
Electrical/optical endpoints 3/		

1/ Whenever electrical/optical tests are not required as endpoints, electrical rejects may be used.

2/ The LTPD applies to the number of leads inspected except in no case shall less than three displays be used to provide the number of leads required.

3/ Test method or conditions in accordance with detail specification.

4/ Solderability samples shall not be used.

5/ Visual requirements shall be as specified in MIL-STD-883, method 1010 or 1011.

6/ Displays may be selected prior to seal.

7/ If a given inspection lot undergoing group B inspection has been selected to satisfy group C inspection requirements, the 340 hour life tests may be continued on test to 1000 hours in order to satisy the group C life test requirements. In such cases, either the 340 hour end point measurements shall be made a basis for group B lot acceptance or the 1000 hours endpoint measurements shall be used as the basis for both group B and C acceptance.

8/ MIL-STD-883 test method applies.

TABLE IVb. Group C periodic tests (class C and D displays only).

Test	MIL-STD-750 Method	Sampling plan
Subgroup 1 1/		2 devices/0 failures
Physical dimensions	2066	
Subgroup 2 1/		LTPD = 15
Lead integrity 6/	2004	
Subgroup 3		LTPD = 15
Shock 2/	2016	
Vibration, variable frequency 2/	2056	
Constant acceleration 2/	2006	
External visual 3/	1001 or 1011	
Electrical/optical endpoints 4/		
Subgroup 4		λ = 10
Operating life test 4/ 5/	1026	
Electrical/optical endpoints 4/		
Subgroup 5		LTPD = 20
Temperature cycling (25 cycles min) 4/	1051	
Electrical/optical endpoints 4/		

1/ Whenever electrical/optical tests are not required as endpoints, electrical rejects may be used.

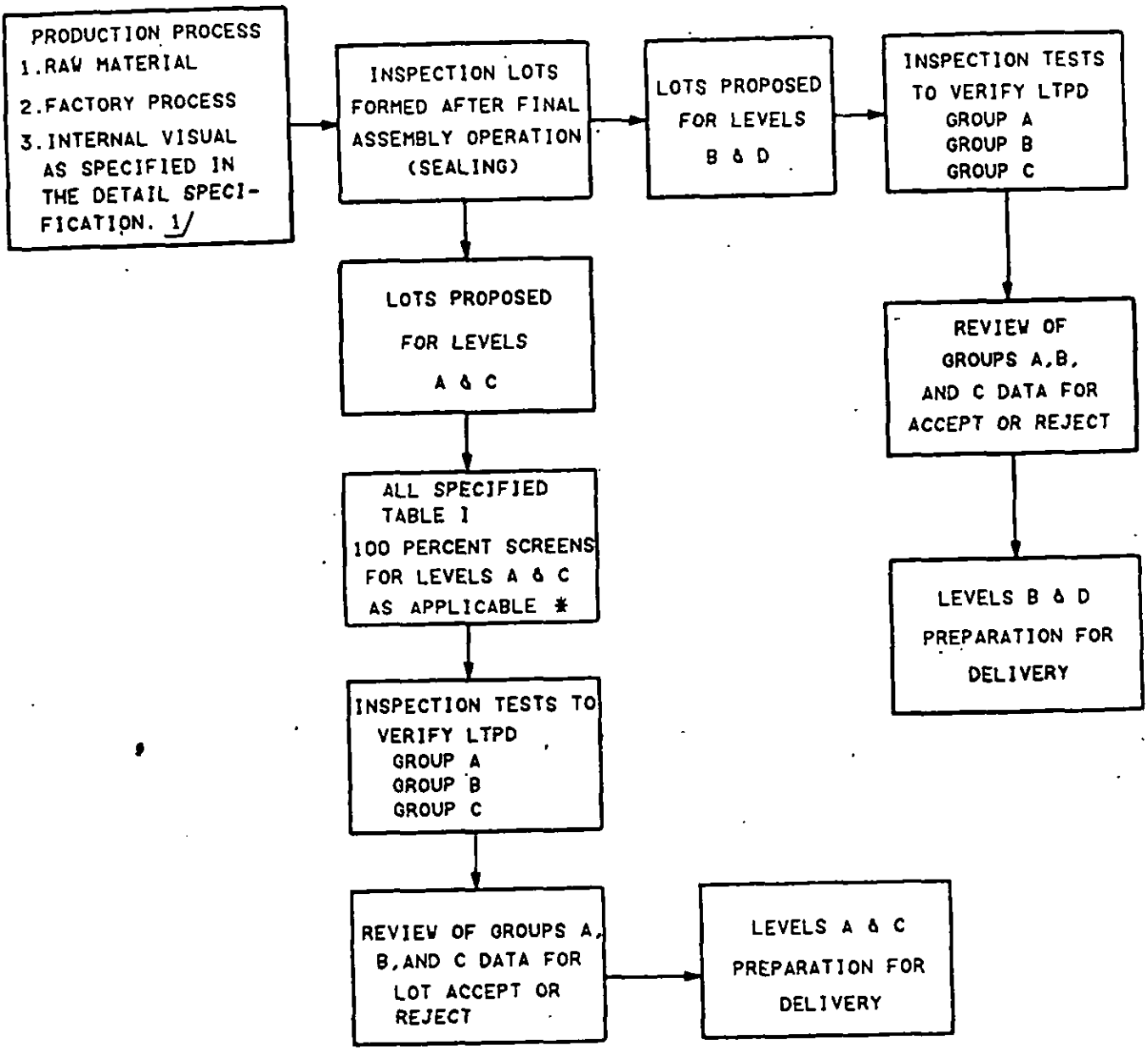
2/ Not required for solid encapsulated displays.

3/ Visual requirements shall be as specified in MIL-STD-883, method 1010 or 1011.

4/ Test method or conditions in accordance with detail specification.

5/ If a given inspection lot undergoing group B inspection has been selected to satisfy group C inspection requirements, the 340 hour life tests may be continued on test to 1000 hours in order to satisfy the group C life test requirements. In such cases, either the 340 hour endpoint measurements shall be made as a basis for group B lot acceptance or the 1000 hours endpoint measurements shall be used as the basis for both group B and C acceptance.

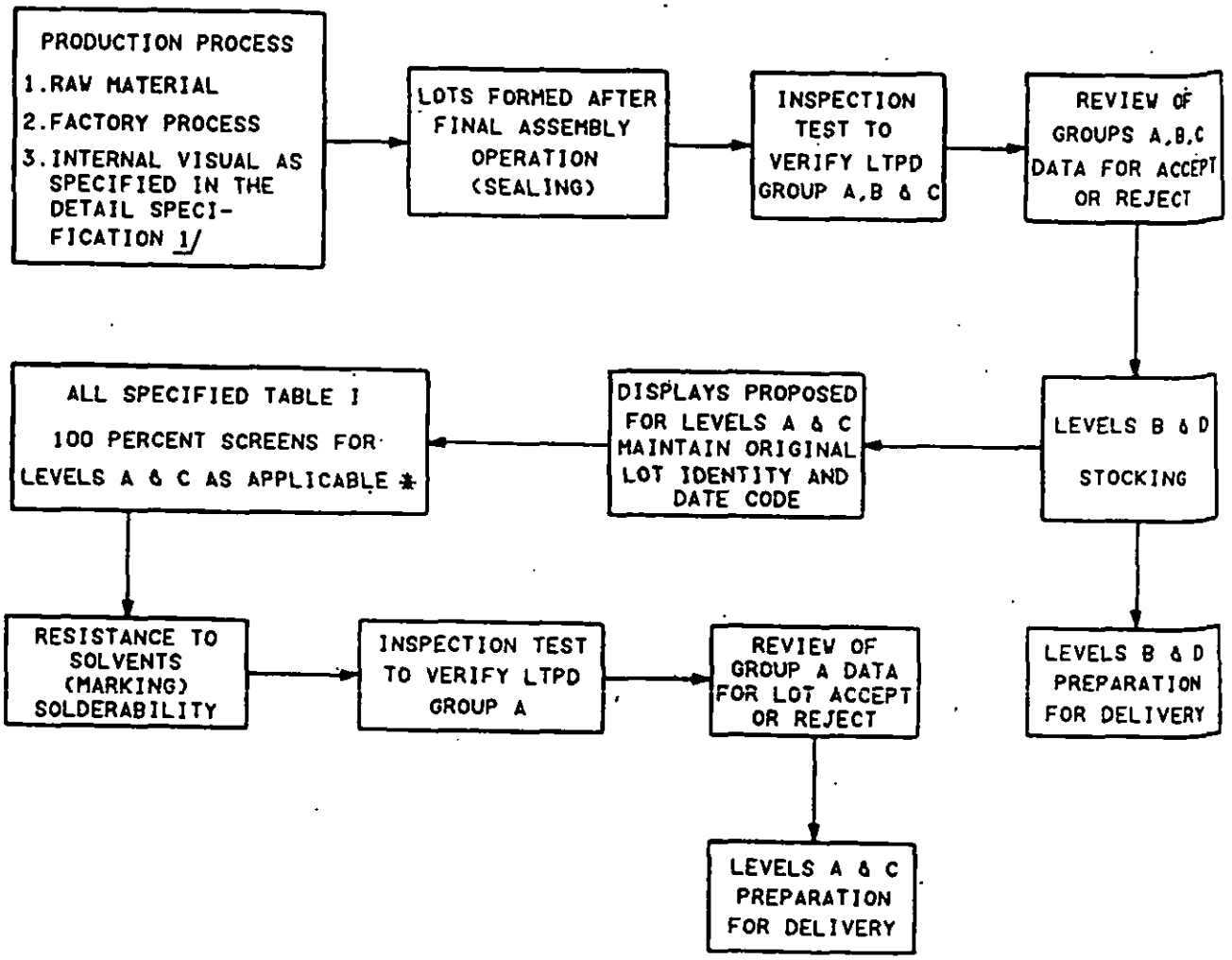
6/ MIL-STD-883 test method applies.



* Order of the tests shall be performed as specified in table I.

1/ Clear glass displays shall be subjected to internal visual inspection prior to painting or marking.

Figure 1. Order of procedure diagram for quality levels A, B, C, and D.



* ORDER OF THE TESTS IN THE BLOCKS SHALL BE PERFORMED AS SHOWN IN TABLE I.

1/ See footnote 1/ from figure 1.

Figure 2. Alternate order of procedure diagram for Quality levels A, B, C, and D.

4.6.2 Inspection routine. Sample displays shall be subjected to the qualification inspections specified in tables II, III, and IV (see 4.7.6). A manufacturer may qualify to any single quality level. If the manufacturer has qualified to either level B or D, he may be granted extension of this qualification to level A or C respectively, on written request to the qualifying activity, provided that suitable screening facilities are available. If the manufacturer is qualified to either quality level A or C, full qualification testing shall be required to obtain qualification approval to level B or D. Qualification by extension between hermetic and nonhermetic quality levels shall not be granted.

4.6.3 Retention of qualification. To retain qualification, the contractor shall forward a report at 12-month intervals to the qualifying activity. The qualifying activity shall establish the initial reporting data. The report shall consist of the following:

a. A summary of the results of the group A quality conformance inspection test results, indicating as a minimum the number of lots that have passed and the number that have failed with the number and mode of any subgroup failures. The results of tests of all reworked or resubmitted lots shall be identified and accounted for.

b. The results of tests performed for group B and C quality conformance inspection, including the number and mode of failures. If the test results indicate nonconformance with specification requirements, and corrective action acceptable to the qualifying activity has not been taken, action may be taken to remove the failing product from the qualified products list.

Failure to submit the report within 60 days after the end of each 12-month period may result in loss of qualification for the product. In addition to the periodic submission of inspection data, the contractor shall immediately notify the qualifying activity at any time that the inspection data indicates noncompliance of the product to meet the requirements of this specification. If there has been no production during the reporting period, a report shall be submitted certifying that the company still has the capabilities and facilities necessary to produce the item.

4.7 Quality conformance inspection. Quality conformance inspection shall be conducted in accordance with the requirements of groups A, B, and C. Lot sampling shall be in accordance with appendix B of this specification. Each lot shall be subjected to groups A and B inspections.

4.7.1 Corrective action. If six of ten consecutive lots or if three successive lots of a display group or structurally similar display group are rejected for the same reason, corrective action acceptable to the preparing activity or his designated agent shall be initiated.

4.7.2 Nonconformance. Lots which fail subgroup requirements of groups A, B, or C may be resubmitted in accordance with the provisions of 4.3.3. However, if the lot is not resubmitted or fails resubmission, the lot shall not be shipped and the certification mark shall be removed within 30 days. Samples from subsequent lots of the display types in the structurally identical display grouping represented by a failed group C inspection in the case of group C failures, shall then be subjected to all the tests in the subgroup in which the failure occurred, on a lot by lot basis until three successive lots pass the failed subgroup. The testing may then return to periodic testing. A display type which fails a group C inspection shall not be accepted until the display type which failed successfully completes the failed group C subgroup(s). Other displays from the same qualified group represented by the failed display may be accepted provided group C inspection requirements have been satisfied for those displays.

4.7.3 Group A inspection. Group A inspection shall be performed on each inspection lot and shall consist of electrical tests as specified in table II and the detail specification. Group A inspection may be performed in any order. If an inspection lot is made up of a collection of sublots of structurally similar displays, each sublot shall pass group A inspection as specified.

4.7.5 Group C inspection. Group C inspection shall be in accordance with table IV and shall include those tests specified which are performed periodically at 6-month intervals on at least one display type from each structurally identical display grouping (from the same or different detail specification) in which the manufacturer has qualified display types. This inspection shall be applied only to completed and fully marked samples that have satisfied the specified group A LTPD requirements.

4.7.5.1 Group C sample selection. Samples for subgroups in group C shall be chosen at random from the first lot submitted for quality conformance inspections during the specified group C inspection interval. Testing of one display type for each subgroup shall be considered as complying with the requirements for that subgroup for all types represented from the same line. A different display type(s) shall be tested at each successive inspection interval until all display types qualified on the detail specification from the same qualified line have been tested. When none of the lots passing group A during the week in which the first lot is submitted contains the display type which is due to be tested, the samples for inspection shall be chosen from those types in the lots being tested which have not been used for the longest time for group C inspection. Successful completion of group C inspection shall initiate a new group C inspection period.

4.7.6 Groups B and C end points. Post-test end points specified in the detailed specification shall be measured for each display of the sample after completion of all specified tests in the subgroup. Except as specified or otherwise required, all life test end-point measurements shall be performed within 96 hours after sample displays have been subjected to and removed from required tests. All other end-point test measurements shall be made at the discretion of the manufacturer. At the end of each group B and C subgroup, end-point measurements shall include visual examination without magnification to assure marking on each display tested is legible and complete. When necessary to determine legible marking, a magnification of 3X may be used. Damage to marking caused by mechanical fixturing or handling during test shall not be cause for lot rejection, but displays so damaged shall be rejected or shall be individually remarked prior to shipment.

4.7.7 Inspection of packaging. The sampling and inspection of the preservation, packing, and contained marking shall be in accordance with the requirements of MIL-S-19491.

4.8 Data requirements. The results of all quality conformance tests and inspections and the results of all required failure analyses shall be recorded and maintained in the manufacturer's facility for at least three years. The periodic summary report, and any other required data reports shall be submitted to the preparing activity or his designated agent. The disposition of all lots or samples submitted for screening or quality conformance inspection shall be fully documented, and lots which fail any specified requirement shall be recorded as failed lots whether resubmitted or withdrawn. Disposition of resubmitted lots shall likewise be recorded so that a complete history is available for every lot tested from initial submission to final disposition including all failures, resubmissions, and withdrawals.

4.8.1 Preservation of lot identity. Each lot and sublot shall be kept segregated, secure, and traceable during all screening, inspection, and marking operations.

4.8.2 Security of completed displays. Marked displays which have passed all screening and quality conformance requirements shal be retained in a secure area prior to shipment or delivery. Display inventory shall be controlled by display quantity, quality level, lot date code, transaction data, and authorized stamp. Provisions shall be made for surveillance by government representatives.

5. PACKAGING

5.1 Packaging requirements. The requirements for packaging shall be in accordance with MIL-S-19491.

5.2 Special marking of unit container. Except for polarity and index point, the marking specified in 3.7.1, including the inspection date and latest reinspection date (if applicable), shall appear on the unit container as specified in MIL-S-19491.

6. NOTES

6.1 Ordering data. Acquisition documents should specify the following:

a. Part number.

b. Number of the applicable detail specifications.

c. Lead length, material, and finish if other than that specified, or when a choice is required by the display application.

d. Data requirements, when applicable (see 4.8).

6.2 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time set for opening of bids, qualified for inclusion in qualified products list, whether or not such products have actually been so listed by that data. The attention of the suppliers is called to this requirement, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification, in order that they may be eligible to be awarded contracts for the products covered by this specification. The activity responsible for the qualification products list is the Defense Electronics Supply Center, Dayton, OH 45444. Application for qualification tests shall be made in accordance with "Provisions Governing Qualification SD-6".

6.3 Reevaluation of lot quality. The specified LTPD method is designed for source inspection and provides a high degree of assurance that a lot has a proportion defective no greater than the specified LTPD value. Reevaluation of any given lot to the same LTPD and acceptance number has the net effect of increasing the probability of rejection or the manufacturer's risk. This is especially true when the initial sampling plan is based on a low acceptance number or when lot reevaluation is done using a lower acceptance number than was used in the initial sampling plan. Table B-I of Appenidx B herein provides examples of the approximate quality levels required to satisfy any selected sampling plan. To minimize the effect of reevaluation on the manufacturer's risk, whenever the quality of a lot is reevaluated by sampling inspection subsequent to the manufacturer's demonstration of compliance with the quality requirements, the sampling plan shall be based on the next higher acceptance number (for the same LTPD) above that used in the initial lot evaluation. If the initial acceptance number is not known, or if the original inspection was conducted as a screening or 100 percent inspection, then the lot being reevaluated shall not be rejected using an acceptance number less than three. Lots may, however, be accepted on reevaluation using an acceptance number as low as 0. When deemed necessary, the purchase order may specify detailed criteria for reevaluation and disposition other than the above. (Government source inspection procedures shall not be considered as reevaluation of lot quality but rather as a part of the initial quality conformance procedure.)

6.4 International standardization agreements. Certain provisions of this specification are the subject of international standardization agreement. When amendment, revision, or cancellation of this specification is proposed which will affect or violate the international agreement concerned, the preparing activity will take appropriate reconciliation action through international standardization channels including departmental standardization offices, if required.

6.5 Supplementary procedure for deliveries. The manufacturer may, at his option, supply displays that have met a higher quality level against orders for a lower quality level.

Custodians:
Air Force - 11
Army - ER
NASA-MSFC-EG02

Review activities:
Air Force - 17, 19, 85
Army - AR, MI
Navy - SH

User activities:
Air Force - 13
Army - SM
Navy - AS, CG, MC, OS

Agent:
DLA - ES

Preparing activity:
Air Force - 11

(Project 5961-0688)

APPENDIX A

LETTER SYMBOLS AND DEFINITIONS

10. SCOPE

10.1 This appendix contains definitions of terms and symbols that are commonly used with solid state display devices. These symbols, terms, and definitions are in accordance with those established by International Electrotechnical Commission (IEC), American National Standards Institute (ANSI), Institute of Electrical and Electronic Engineers (IEEE) and the JEDEC Council of the Electronic Industries Association (EIA).

20. ELECTRICAL PARAMETERS

20.1 CURRENT

I_F Forward current - - - - - - - - - -	The current that flows through an element of a solid state display in the forward direction.
I_{PEAK} Peak forward current - - - - - -	The peak forward current through an element of a solid state display.
I_{AVG} Average forward current - - - - -	The time average forward current through an element of a solid state display.
I_R Reverse current - - - - - - - - - -	The current that will flow through an element of a solid state display in the reverse direction.
I_{CC} Supply current - - - - - - - - - -	The current into * the V_{CC} supply terminal of a solid state display.
I_{IH} High-level input current - - - - -	The current into * an input when a high-level voltage is applied to that input.
I_{IL} Low-level input current- - - - - -	The current into * an input when a low-level voltage is applied to that input.
I_{OH} High-level output current- - - - -	The current into * an output with input conditions applied to establish a high level at the output.
I_{OL} Low-level output current - - - - -	The current into * an output with input conditions applied to establish a low level at the output.

* Current into a terminal is taken as positive. Current out of a terminal is given a negative value.

20.2 Voltage

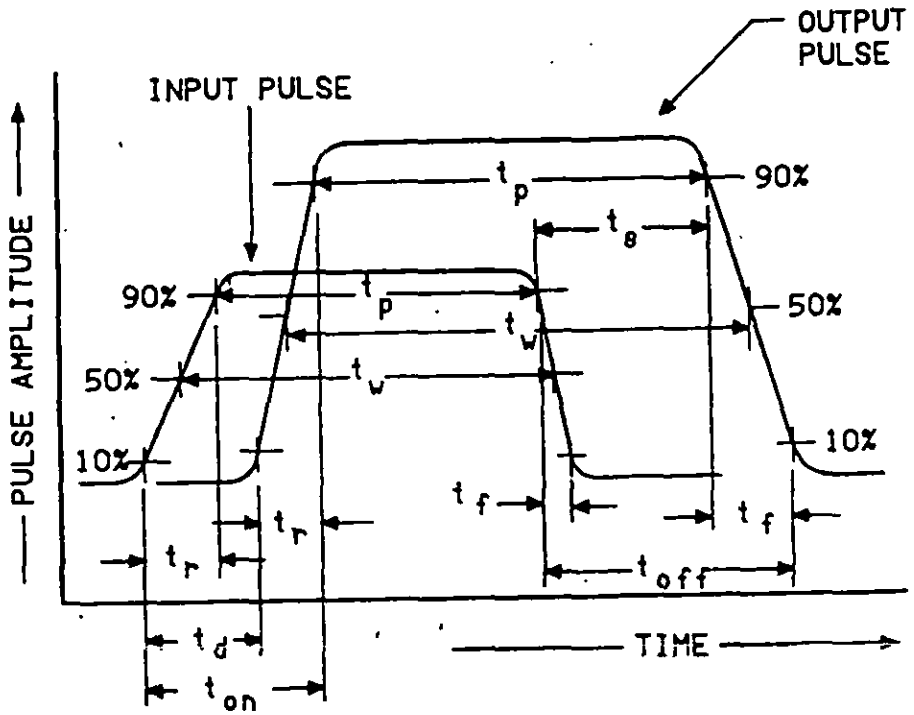
V_F Forward voltage - - - - - - - - - -	The voltage drop across an element of a solid state display associated with the flow of forward current.
V_R Reverse voltage - - - - - - - - - -	The voltage applied to an element of a solid state display that causes current to flow in the reverse direction.
$\Delta V_F/°C$ Forward voltage temperature coefficient - - - - - - - -	The change in forward voltage due to a change in the temperature of a display element.
V_{CC} Supply voltage - - - - - - - - - -	The voltage applied to the logic supply voltage terminal.
V_{IH} High-level input voltage - - - - -	An input voltage level within the more positive (less negative) of the two ranges of values used to represent the binary variables, logic high and logic low. NOTE: A minimum is specified that is the least positive value of high-level input voltage for which operation of the logic element within specification limits is guaranteed.
V_{IL} Low-level input voltage - - - - -	An input voltage level within the less positive (more negative) of the two ranges of values used to represent the binary variables, logic low and logic high. NOTE: A maximum is specified that is the most positive value of low-level input voltage for which operation of the logic element within specification limits is guaranteed.
V_{OH} High-level output voltage- - - - -	The voltage at an output terminal with input conditions applied to establish a high level at the output.
V_{OL} Low-level output voltage - - - - -	The voltage at an output terminal with input conditions applied to establish a low level at the output.

20.3 Power

P_D Power dissipation - - - - - - - - -	The power dissipated within a solid state display on a per character or per device basis.

30 Timing parameters

30.1 Diagram illustrating pulse time symbology



30.2 Timing parameters

f_{max}	Maximum clock frequency - - - - -	The fastest rate at which the clock input of a display can be driven through its required sequence while maintaining stable transitions of logic level within the display logic in accordance with the truth table or other specified logic rules.
t_d	Delay time - - - - - - - - - - - - -	The time interval from the point at which the leading edge of the input pulse has reached 10 percent of its maximum amplitude to the point at which the leading edge of the output pulse has reached 10 percent of its maximum amplitude.

t_f Fall time - - - - - - - - - - - - -	The time duration during which the trailing edge of a pulse is decreasing from 90 to 10 percent of its maximum amplitude.
t_{off} Turn-off time - - - - - - - - - -	The sum of $t_s + t_f$.
t_{on} Turn-on time- - - - - - - - - - - -	The sum of $t_d + t_r$.
t_p Pulse time - - - - - - - - - - - - -	The time duration from the point on the leading edge which is 90 percent of the maximum amplitude to the point on the trailing edge which is 90 percent of the maximum amplitude.
t_r Rise time- - - - - - - - - - - - - -	The time duration during which the leading edge of a pulse is increasing from 10 to 90 percent of its maximum amplitude.
t_s Storage time - - - - - - - - - - - -	The time interval from a point 90 percent of the maximum amplitude on the trailing edge of the input pulse to a point 90 percent of the maximum amplitude on the trailing edge of the output pulse.
t_w Pulse average time - - - - - - - - -	The time duration from the point on the leading edge which is 50 percent of the maximum amplitude to a point on the trailing edge which is 50 percent of the maximum amplitude.

40. Temperature parameters

T_A Ambient or free air Temperature- -	The air temperature measured below a display, in an environment of substantially uniform temperature, cooled only by natural air convection and not materially affected by reflective and radiant surfaces.
T_C Case temperature - - - - - - - - - -	The temperature measured at a specified location on the case of a display.
T_J Junction temperature - - - - - - - -	The temperature of a semiconductor junction.
T_{STG} Storage temperature- - - - - - - -	The temperature at which the display, without any power applied, is stored.
$R_{\theta CA}$ Thermal resistance case to ambient - - -	The thermal resistance (steady-state) from the display case to the ambient.
$R_{\theta JA}$ Thermal resistance junction to ambient(formerly θ_{J-A}) - -	The thermal resistance (steady-state) from the semiconductor junction(s) to the ambient.
$R_{\theta JC}$ Thermal resistance junction to case (formerly θ_{J-C}) - -	The thermal resistance (steady-state) from the semiconductor junction(s) to a stated location on the case.

50. Optical parameters

50.1 Units of measurement

Symbol	Unit	Note
A	ampere *	
Å	angstrom	1 Å = 10^{-10} m = 10^{-4} µm = 0.1 nm
cd	candela *	1 cd = 1 lm/sr
cd/ft^2	candela/foot^2	1 cd/ft^2 = 10.76391 cd/m^2
cd/m^2	candela meter^2 *	
°C	degree Celsius	
°K		See K
ft	foot	1 ft = 0.3048m (exactly)
fc	footcandle	1 fc = 1 lm/ft^2 = 10.7639 lx
fL	footlambert	1 fL = (1/π) cd/ft^2 = 3.426259 cd/m^2
Hz	hertz *	
in	inch	1 in = 2.54 cm (exactly)
K	kelvin *	Formerly °K, degree Kelvin
L	lambert	1 L = 3183.099 cd/m^2
lm	lumen *	
lx	lux *	1 lx = 1 lm/m^2
m	meter *	
µ	micron	The equivalent unit µm is preferred
nt	nit	1 nt = 1 cd/m^2
ph	phot	1 ph = 1 lm/cm^2
Ω	ohm *	
s	second *	
sr	steradian *	
sb	stilb	1 sb = 1 cd/cm^2
V	volt *	
W	watt *	

* International system (SI) units.

50.2 Metric multipliers

Many of the preceding unit symbols can be combined with the metric multipliers which follow.

Symbol	Prefix	Multiple
M	mega	10^6
k	kilo	10^3
h	hecto	10^2
da	deka	10
d	deci	10^{-1}
c	centi	10^{-2}
m	milli	10^{-3}
µ	micro	10^{-6}
n	nano	10^{-9}

50.3 Optical definitions

I	Luminous intensity; radiant intensity	The respective luminous or radiant flux per unit solid angle in a given direction.
I_V	Luminous intensity, axial	The luminous flux per unit solid angle where the given direction is the optical axis.
	Luminous intensity, angular	The luminous flux per unit solid angle where the given direction is at a specified angle from the optical axis.
η_V	Luminous efficiency	The ratio of the total luminous flux to the total radiant flux.

50.3 Optical definitions - Continued

$\eta v(\lambda)$	Spectral luminous efficiency - - - -	The ratio of the luminous flux at a given wavelength to the radiant flux at that wavelength.
L	Luminance; radiance- - - - - - - - -	The respective luminous or radiant intensity of any surface in a given direction per unit of projected area of the surface as viewed from that direction.
M	Luminous sterance; - - - - - - - - - radiant sterance	The density of the respective luminous or radiant flux leaving an emitter surface; ratio of flux to area of emitting surface.
M_{bb}	Total blackbody sterance - - - - - -	The total radiant sterance of a blackbody at all wavelengths.
$M_{\lambda b}$	Peak spectral luminous sterance- - - Peak spectral radiant sterance	The luminous sterance or radiant sterance at that wavelength where the spectral sterance is at the peak value.
$V(\lambda)$	Spectral luminous efficiency - - - -	The ratio of the luminous efficiency for a given wavelength to the value of luminous efficiency at the wavelength of maximum luminous efficiency (Ref. IEEE Std. 100-1972 Pg. 547 and ANSI Z7.1 Subclause 3.7.1.).
w	Luminous density; radiant density- -	The respective luminous energy or radiant energy per unit of volume.
$\Delta\lambda$ 1/2	Spectral bandwidth - - - - - - - - -	The wavelength interval in which a photometric or radiometric quantity is not less than half of its maximum value.

APPENDIX B

STATISTICAL SAMPLING, LIFE TEST PROCEDURES

10. SCOPE

10.1 This appendix contains statistical sampling and life test procedures used with displays.

20. GENERAL

20.1 Definitions. The following definitions shall apply for all statistical sampling procedures:

a. LTPD series. The lot tolerance percent defective (LTPD) series is defined as the following decreasing series of LTPD or lambda (λ) values: 50, 30, 20, 15, 10, 7, 5, 3, 2, 1.5, 1, 0.7, 0.5, 0.3, 0.2, 0.15, 0.1.

b. Tightened inspection. Tightened inspection is defined as inspection performed using the next LTPD or lambda value in the LTPD series lower than that specified.

c. Acceptance number (c). The acceptance number is defined as an integral number associated with the selected sample size which determines the maximum number of defectives permitted for that sample size.

d. Rejection number (r). Rejection number is defined as one plus the acceptance number.

e. Lambda (λ). Lambda is defined as LTPD per 1,000 hours.

20.2 Symbols. The following symbols shall apply for all statistical sampling procedures:

a. LTPD - Lot Tolerance Percent Defective.

b. λ - Lambda

c. c - Acceptance number

d. r - Rejection number

30. STATISTICAL SAMPLING PROCEDURES AND TABLE - LTPD METHOD

30.1 General. Statistical sampling shall be conducted using the LTPD method. The LTPD method as specified herein is a double sampling plan which provides a high degree of assurance that a lot having a proportion defective equal to or greater than the specified LTPD value will not be accepted. The choice of any one procedure is optional. The procedures specified herein are suitable for all quality conformance requirements, but are not suitable if the objective of the inspection is to determine that the proportion defective in the lot represented is greater than the specified LTPD value since the assurance for that purpose is normally only 10 percent (see 6.3).

30.1.1 Selection of samples. Samples shall be randomly selected from the inspection lot or inspection sublots. (For an explanation of random sampling, see MIL-HDBK-H53, Section 13.).

30.1.1.1 Identification of samples for quality conformance tests. The authorized Government Quality Assurance representative may, at his option, mark or authorize the marking of each sample to be subjected to quality conformance inspection in order to distinguish these units from those not intended for Government conformance inspection (see 3.7.3).

30.1.2 Failures. Failures of a display for one or more tests of a subgroup shall be charged as a single failure.

30.2 Single-lot sampling method. Quality conformance inspection information (sample sizes and number of observed defectives) shall be accumulated from a single inspection lot to demonstrate conformance to the individual subgroup criteria.

30.2.1 Sample size. The sample size for each subgroup shall be determined from B-I and shall meet the specified LTPD or lambda. The supplier may, at his option, select a sample size greater than that required; however, the number of failures permitted shall not exceed the acceptance number associated with the required sample size in table B-I.

30.2.2 Acceptance procedure. For the first sampling, an acceptance number shall be chosen and the associated number of sampling displays for the specified LTPD selected and tested (see 30.2.1). If the observed number of defectives from the first sample is less than or equal to the preselected acceptance number, the lot shall be accepted. If the observed number of defectives exceeds the preselected acceptance number, an additional sample may be chosen such that the total sample complies with 30.2.3.

30.2.3 Additional sample. The supplier may add an additional quantity to the initial sample, but this may be done only once for any subgroup and the added samples shall be subjected to all the tests within the subgroup. The total sample size (initial and added samples) shall be determined by a new acceptance number selected from table B-I.

30.2.4 Multiple criteria. Except where otherwise specified, when a subgroup contains more than one acceptance criterion, the entire sample for a subgroup shall be used for all criteria within the subgroup. In table B-I, the acceptance number shall be that one associated with the largest sample size in the appropriate LTPD column which is less than or equal to the sample size used.

30.2.5 One-hundred percent inspection. Inspection of 100 percent of the lot shall be allowed, at the option of the manufacturer, for any or all subgroups other than those which are considered "destructive." The maximum observed percent defective for the inspection lot shall not exceed the specified LTPD or λ value. Displays that fail any test shall be removed from the lot.

30.2.6 Disposition of failed lot. A lot that fails quality conformance inspection may, at the option of the manufacturer, be screened for defectives or reworked and resubmitted for reinspection (see 4.3.3).

40. LIFE TEST

40.1 General. Life tests shall be conducted in accordance with the procedures in this section. Life tests performed on displays at or within their maximum ratings shall be considered nondestructive. If a lot is made up of a collection of sublots, each sublot shall pass all applicable electrical end points as specified.

40.2 Selection of samples. Samples for life tests shall be selected at random from the inspection lot (see 30.1.1). The sample size for a 1,000-hour test shall be chosen by the supplier from table B-I from the column under the specified λ. The acceptance number shall be the one associated with the particular sample size chosen.

40.3 Failures. A display which exceeds one or more of the endpoint limits specified for life test at any specified or other reading interval shall be considered a failure and shall not be considered acceptable at any subsequent reading interval. For the purpose of computing display hours, the test-time hours credited to a failed display shall not exceed the test time associated with the the last measurement time that the display was observed to be within the specified endpoint limits. If the sample fails, the test may be terminated at the discretion of the supplier.

40.4 Life-test time and sample size. Whenever a lambda (λ) is specified, the life-test time shall be 1,000 hours initially. Once a lot has passed the 1,000-hour test, life tests with minimum of 340 hours and maximums of 2,000 hours may be initiated for new lots provided that 120 days have not elapsed since a 1,000-hour life test. If 120 days have elapsed, the new lot shall pass a 1,000-hour life test. The sample size for a life-test time other than 1,000 hours shall be chosen according to the relationship of inverse proportionality between test time and sample size, such that the total display test hours accumulated (sample sizes multiplied by test hours) equal the amount that would have been chosen for the 1,000-hour life test, had it been performed. The acceptance number shall also be determined from the sample size associated with the same 1,000-hour test, had it been performed. The lot shall be accepted if the number of failures at the end of the test period does not exceed the acceptance number.

40.5 Procedure to be used if number of observed failures exceeds the acceptance number. In the event that the number of failures observed on life test exceeds the acceptance number, the supplier shall choose one of the following options: (1) discontinue the life test, screen or rework and resubmit in accordance with 30.2.6, (2) add additional samples in accordance with 40.5.1, or (3) extend the test time to 1,000 hours in accordance with 40.5.2, if a test time less than 1,000 hours was originally chosen. Only one of these options shall be used for a given submission, and this option shall be used only once.

40.5.1 Additional samples. When this option is chosen, a new total sample size (initial plus added) shall be chosen by the manufacturer from table B-I from the column under the specified λ. A quantity of additional units sufficient to increase the sample to the newly chosen total sample size shall be selected from the lot. A new acceptance number shall be determined and shall be the one associated with the new total sample size chosen. The added sample shall be subjected to the same life-test conditions and time period as the initial sample. If the total observed number of defectives (initial plus added) does not exceed the acceptance number for the total sample, the lot shall be accepted. If the observed number of defectives exceeds this acceptahce number, the lot shall not be accepted, but may be resubmitted (see 30.2.6).

40.5.2 Extension of life-test period. If a life test time period less than 1,000 hours is being used and the number of failures observed in the initial sample exceeds the acceptance number, the manufacturer may in lieu of adding additional samples, choose to extend the test time of the entire initial sample to 1,000 hours and determine a new acceptance number from table B-I. The new acceptance number shall be that one associated with the largest sample size in the specified λ column which is less than or equal to the sample size on test. A display which is a failure at the initial reading interval shall not be considered acceptable at the 1,000 hour reading interval. If the observed number of defectives at 1,000 hours does not exceed the new acceptance number, the lot shall be accepted. If the observed number of defectives exceeds this acceptance number, the lot shall not be accepted, but may be resubmitted (see 30.2.6).

40.5.3 Failure of life test. If a lot fails to meet life-test requirements (including resubmission in accordance with 30.2.6, if elected) such that it is eliminated or withdrawn from further quality conformance inspection consideration, then 1,000-hour life tests shall be required until three successive lots have passed the specified life tests. Then life testing in accordance with 40.2 and 40.4 may be resumed.

TABLE B-I LTPD Sampling plans 1/ 2/

Minimum size of sample to be tested to assure, with a 90 percent confidence, that a lot having percent-defective equal to the specified LTPD will not be accepted (single sample).

Max. Percent Defective (LTPD) or λ	50	30	20	15	10	7	5	3	2	1.5	1	0.7	0.5	0.3	0.2	0.15	0.1
Acceptance Number (c) (r = c - 1)	Minimum Sample sizes (For display-hours required for life test, multiply by 1000)																
0	5 (1.03)	8 (0.64)	11 (0.46)	15 (0.34)	22 (0.23)	32 (0.16)	45 (0.11)	76 (0.07)	116 (0.04)	153 (0.03)	231 (0.02)	328 (0.02)	461 (0.01)	767 (0.007)	1152 (0.005)	1534 (0.003)	2303 (0.002)
1	8 (4.4)	13 (2.7)	18 (2.0)	25 (1.4)	38 (0.94)	55 (0.65)	77 (0.46)	129 (0.28)	195 (0.18)	258 (0.14)	390 (0.09)	555 (0.06)	778 (0.045)	1296 (0.027)	1946 (0.018)	2592 (0.013)	3891 (0.009)
2	11 (7.4)	18 (4.5)	25 (3.4)	34 (2.24)	52 (1.6)	75 (1.1)	105 (0.78)	176 (0.47)	266 (0.31)	354 (0.23)	533 (0.15)	759 (0.11)	1065 (0.080)	1773 (0.045)	2662 (0.031)	3547 (0.022)	5321 (0.015)
3	13 (10.5)	22 (6.2)	32 (4.4)	43 (3.2)	65 (2.1)	94 (1.5)	132 (1.0)	221 (0.62)	333 (0.41)	444 (0.31)	668 (0.20)	953 (0.14)	1337 (0.10)	2226 (0.062)	3341 (0.041)	4452 (0.031)	6681 (0.018)
4	16 (12.3)	27 (7.3)	38 (5.3)	52 (3.9)	78 (2.6)	113 (1.8)	158 (1.3)	265 (0.75)	398 (0.50)	531 (0.37)	798 (0.25)	1140 (0.17)	1599 (0.12)	2663 (0.074)	3997 (0.049)	5327 (0.037)	7994 (0.025)
5	19 (13.8)	31 (8.4)	45 (6.0)	60 (4.4)	91 (2.9)	131 (2.0)	184 (1.4)	308 (0.85)	462 (0.57)	617 (0.42)	927 (0.28)	1323 (0.20)	1855 (0.14)	3080 (0.085)	4638 (0.056)	6181 (0.042)	9275 (0.028)
6	21 (15.6)	35 (9.6)	51 (6.6)	68 (4.9)	104 (3.2)	149 (2.2)	209 (1.6)	349 (0.94)	528 (0.62)	700 (0.47)	1054 (0.31)	1503 (0.22)	2107 (0.155)	3509 (0.093)	5267 (0.062)	7019 (0.047)	10533 (0.031)
7	24 (16.6)	39 (10.2)	57 (7.2)	77 (5.3)	116 (3.5)	166 (2.4)	234 (1.7)	390 (1.0)	589 (0.67)	783 (0.51)	1178 (0.34)	1680 (0.24)	2355 (0.17)	3922 (0.101)	5886 (0.067)	7845 (0.051)	11771 (0.034)
8	26 (18.1)	43 (10.9)	63 (7.7)	85 (5.6)	128 (3.7)	184 (2.6)	258 (1.8)	431 (1.1)	648 (0.72)	864 (0.54)	1300 (0.36)	1854 (0.25)	2599 (0.18)	4329 (0.108)	6498 (0.072)	8660 (0.054)	12995 (0.036)
9	28 (19.4)	47 (11.5)	69 (8.1)	93 (6.0)	140 (3.9)	201 (2.7)	282 (1.9)	471 (1.2)	709 (0.77)	945 (0.58)	1421 (0.38)	2027 (0.27)	2842 (0.19)	4733 (0.114)	7103 (0.077)	9468 (0.057)	14206 (0.038)
10	31 (19.9)	51 (12.1)	75 (8.4)	100 (6.3)	152 (4.1)	218 (2.9)	306 (2.0)	511 (1.2)	770 (0.80)	1025 (0.60)	1541 (0.40)	2199 (0.28)	3082 (0.20)	5133 (0.120)	7704 (0.080)	10268 (0.060)	15407 (0.040)
11	33 (21.0)	54 (12.8)	83 (8.3)	111 (6.2)	166 (4.2)	238 (2.9)	332 (2.1)	555 (1.2)	832 (0.83)	1109 (0.62)	1664 (0.42)	2378 (0.29)	3523 (0.21)	5546 (0.12)	8319 (0.083)	11092 (0.062)	16638 (0.042)
12	36 (21.4)	59 (13.0)	89 (8.6)	119 (6.5)	178 (4.3)	254 (3.0)	356 (2.2)	594 (1.3)	890 (0.86)	1187 (0.65)	1781 (0.43)	2544 (0.3)	3562 (0.22)	5936 (0.13)	8904 (0.086)	11872 (0.065)	17808 (0.043)
13	38 (22.3)	63 (13.4)	95 (8.9)	126 (6.7)	190 (4.5)	271 (3.1)	379 (2.26)	632 (1.3)	948 (0.89)	1264 (0.67)	1896 (0.44)	2709 (0.31)	3793 (0.22)	6321 (0.134)	9482 (0.089)	12643 (0.067)	18964 (0.045)
14	40 (23.1)	67 (13.8)	101 (9.2)	134 (6.9)	201 (4.6)	288 (3.2)	403 (2.3)	672 (1.4)	1007 (0.92)	1343 (0.69)	2015 (0.46)	2878 (0.32)	4029 (0.23)	6716 (0.138)	10073 (0.092)	13431 (0.069)	20146 (0.046)
15	43 (23.3)	71 (14.1)	107 (9.4)	142 (7.1)	213 (4.7)	305 (3.3)	426 (2.36)	711 (1.41)	1066 (0.94)	1422 (0.71)	2133 (0.47)	3046 (0.33)	4265 (0.235)	7108 (0.141)	10662 (0.094)	14216 (0.070)	21324 (0.047)
16	45 (24.1)	74 (14.6)	112 (9.7)	150 (7.2)	225 (4.8)	321 (3.37)	450 (2.41)	750 (1.44)	1124 (0.96)	1499 (0.72)	2249 (0.48)	3212 (0.337)	4497 (0.241)	7496 (0.144)	11244 (0.096)	14992 (0.072)	22487 (0.048)
17	47 (24.7)	79 (14.7)	118 (9.86)	158 (7.38)	236 (4.93)	338 (3.44)	473 (2.46)	788 (1.48)	1182 (0.98)	1576 (0.74)	2364 (0.49)	3377 (0.344)	4728 (0.246)	7880 (0.148)	11819 (0.098)	15759 (0.074)	23639 (0.049)
18	50 (24.9)	83 (15.0)	124 (10.0)	165 (7.54)	248 (5.02)	354 (3.51)	496 (2.51)	826 (1.51)	1239 (1.0)	1652 (0.75)	2478 (0.50)	3540 (0.351)	4956 (0.251)	8260 (0.151)	12390 (0.100)	16520 (0.075)	24780 (0.050)
19	52 (25.5)	86 (15.4)	130 (10.2)	173 (7.76)	259 (5.12)	370 (3.58)	518 (2.56)	864 (1.53)	1296 (1.02)	1728 (0.77)	2591 (0.52)	3702 (0.358)	5183 (0.256)	8638 (0.153)	12957 (0.102)	17276 (0.077)	25914 (0.051)
20	54 (26.1)	90 (15.8)	135 (10.4)	180 (7.82)	271 (5.19)	386 (3.65)	541 (2.60)	902 (1.56)	1353 (1.04)	1803 (0.78)	2705 (0.52)	3864 (0.364)	5410 (0.260)	9017 (0.156)	13526 (0.104)	18034 (0.078)	27051 (0.052)
25	65 (27.0)	109 (16.1)	163 (10.8)	217 (8.08)	326 (5.38)	464 (3.76)	652 (2.69)	1086 (1.61)	1629 (1.08)	2173 (0.807)	3259 (0.538)	4656 (0.376)	6518 (0.269)	10863 (0.161)	16295 (0.108)	21726 (0.081)	32589 (0.054)

1/ Sample sizes are based upon the Poisson exponential binomial limit.

2/ The minimum quality (approximate AQL) required to accept on the average 19 of 20 lots is shown in parenthesis for information only.

10. SCOPE

10.1 This appendix contains procedures for the categorization of displays with respect to their light output and color.

20. DEFINITION

20.1 Color. The color of the emitted light of a display is defined in terms of color coordinates or dominant wavelength on the 1931 CIE Chromaticity Diagram.

30. PROCEDURE FOR THE SPECIFICATION AND CATEGORIZATION OF COLOR.

30.1 Color specification. The color of the emitted light of a display may be specified in the detail specification. In as much as most light emitting displays produce a saturated color, the use of dominant wavelength (λd), expressed in nanometers (nm), to specify a color is preferred.

30.2 Color categorization. Displays may be categorized as to the color of the emitted light within a given color range. Typically, there may be a number of color categories for any given color range. These color categories are typically expressed as allowable limits of equal size. For example, a category size, as expressed in nanometers, may be selected to be 3 nm wide with 6 categories defining the acceptable color range.

30.3 Color variation within a device. The color variation between the light emitting elements within a device may also be specified. Typically, the maximum variation is equal to the size of a color category.

40. PROCEDURE FOR COLOR MEASUREMENT

40.1 Color measurement. The measurement of the color of the display emitted light is accomplished by performing an integration of the product of the spectrum of the emitted light and the 3 CIE color matching functions $\bar{X}$, $\bar{Y}$, $\bar{Z}$ to obtain three tristimulus values X, Y, and Z. The increment of integration must be no larger than 5 nm wide in order to achieve acceptable accuracy. The 2 chromatic color coordinates X and Y are then calculated from the three tristimulus values. The corresponding dominant wavelength may be determined by calculation or by selection from a reference table combined with linear interpolation. The acceptable error in the determination of dominant wavelength is typically ±0.5 nm.

40.2 Color measurement procedure.

a. Obtain an accurate plot of the spectral energy distribution of the radiated spectrum using a spectroradiometer. The plot is then normalized to 1.0 at the peak wavelength of the spectrum (λ peak). The result is a normalized function of the radiated spectrum ($S\lambda$).

b. Perform the integration of the radiated spectrum ($S\lambda$) with the 3 CIE color matching functions $\bar{X}(\lambda)$, $\bar{Y}(\lambda)$, and $\bar{Z}(\lambda)$ to obtain the three tristimulus values X, Y, and Z.

$$X = \int_{\text{Spectrum}} S(\lambda)\ \bar{X}(\lambda)\ d\lambda$$

$$Y = \int_{\text{Spectrum}} S(\lambda)\ \bar{Y}(\lambda)\ d\lambda$$

$$Z = \int_{\text{Spectrum}} S(\lambda)\ \bar{Z}(\lambda)\ d\lambda$$

c. Calculate the chromatic coordinates:

$$x = \frac{X}{X + Y + Z}$$

$$y = \frac{Y}{X + Y + Z}$$

These 2 chromatic coordinates accurately define the color on the 1931 Chromaticity Diagrams.

50. DETERMINATION OF DOMINANT WAVELENGTH

50.1 Dominant wavelength (λd). A dominant wavelength is a single wavelength that defines the saturated color of monochromatic light. A saturated color is defined as having a color purity of 1.000. To the human eye, the color of most light emitting displays appears to be saturated, or nearly monochromatic, and will typically have a color purity of 0.999x. The color coordinates essentially plot on the locus of dominant wavelengths. Based on this observation, the X chromatic coordinate may typically be used to directly determine the corresponding dominant wavelength from a reference table.

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STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE

3a. NAME OF SUBMITTING ORGANIZATION	4. TYPE OF ORGANIZATION *(Mark one)*
	☐ VENDOR
b. ADDRESS *(Street, City, State, ZIP Code)*	☐ USER
	☐ MANUFACTURER
	☐ OTHER *(Specify)*: _____

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional	b. WORK TELEPHONE NUMBER *(Include Area Code)* – Optional
c. MAILING ADDRESS *(Street, City, State, ZIP Code)* – Optional	8. DATE OF SUBMISSION (YYMMDD)

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