The document and process conversion measures necessary to comply with with this specification shall be completed by 30 June 1989.

INCH-POUND

MIL-H-38534
31 March 1989

MILITARY SPECIFICATION

HYBRID MICROCIRCUITS,
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 hybrid microcircuits and specifies the quality and reliability assurance requirements which shall be met in the acquisition of such devices. The types of devices covered by this specification include but are not limited to hybrid microcircuits and microwave hybrid or integrated circuits. Detail requirements, specific characteristics, and other provision which are sensitive to the particular intended use shall be specified in the applicable acquisition documents. Three quality assurance requirement options directed at, but not limited to, low volume custom devices, medium volume custom or catalog devices and high volume catalog standard hybrid microcircuits (table I, options 1, 2 and 3 respectively) are provided for in this specification. Two quality assurance levels for hybrid microcircuits, class S and B, are also provided for in this specification.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issue of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATIONS

MILITARY

MIL-S-19500 - Semiconductor Devices, General Specification for.

MIL-I-23011 - Iron-Nickel Alloys for Sealing to Glasses and Ceramics.

MIL-M-38510 - Microcircuits, General Specification for.

MIL-N-46025 - Nickel Bar, Flat Wire (Ribbon) and Strip (For Electronic Use).

MIL-N-46026 - Nickel Rod and Wire (Round) (For Electronic Use).

MIL-I-46058 - Insulating Compound, Electrical.

MIL-M-55565 - Microcircuits, Packaging of.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Rome Air Development Center (RBR-2), Griffiss AFB, NY 13441, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A FSC 5962

STANDARDS

FEDERAL

FED-STD-209 - Clean Room and Work Station Requirements, Controlled Environments.

MILITARY

MIL-STD-280 - Definitions of Item Levels, Item Exchangeability, Models and Related Terms.

MIL-STD-750 - Test Methods for Semiconductor Devices.

MIL-STD-883 - Test Methods and Procedures for Microelectronics.

MIL-STD-975 - NASA Standard Parts List.

MIL-STD-976 - Certification Requirements for Microcircuits.

MIL-STD-1285 - Marking of Electrical and Electronic Parts.

MIL-STD-1331 - Parameters to be Controlled for the Specification of Microcircuits.

MIL-STD-1520 - Corrective Action and Disposition for Nonconforming Materials.

MIL-STD-1772 - Certification Requirements for Hybrid Microcircuit Facilities and Lines.

MIL-STD-45662- Calibration Systems Requirements.

2.1.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

Handbook H4/H8 - Commercial and Government Entity (CAGE) Handbook.

DLAM 8200.2 - Procurement Quality Assurance Support manual for Defense Contract Administration Service.

NAVSHIPS 0967-190-4010 - Manufacturer's Designating Symbols.

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Naval Publications and Forms Center, (ATTN: NPODS), 5801 Tabor Avenue, Philadelphia, PA 19120-5099.)

2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM B487	-	Measurement of Metal and Oxide Coating Thickness by Microscopical Examination of a Cross Section.
ASTM B567	-	Measurement of Coating Thickness by the Beta Backscatter Method.
ASTM-F-15	-	Iron-Nickel-Cobalt Sealing Alloy.
ASTM-F-30	-	Nickel Sealing Alloys.
ASTM-B-170	-	Oxygen Free Electrolytic Copper Refinery Shapes.

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

ELECTRONIC INDUSTRIES ASSOCIATION (EIA)

JEP-19	-	General Standard for Statistical Process Control.
JEP-108	-	Distributor Requirements for Handling Electro-static Discharge Sensitive (ESDS) Devices.
JEP-109	-	General Requirements for Distributors of Military Integrated Circuits.
JEDEC-STD-9	-	Metal Package Specification for Microelectronic Packages and Covers.

(Application for copies should be addressed to the Electronic Industries Association, 2001 Eye Street, N. W., Washington, DC 20006.)

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein (except for related associated detail specifications, specification sheets, or MS standards), the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 General. The manufacturer of hybrid microcircuits, in compliance with this specification shall have and use production and test facilities and a quality and reliability assurance program adequate to assure successful compliance with the provisions of this specification and the associated acquisition documents. Adequacy of a hybrid manufacturer to meet the requirements of this specification shall be determined by the Government qualifying activity. The individual item requirements shall be as specified in the associated acquisition documents and herein. Only hybrid microcircuits which are inspected for and meet all the requirements of this specification and the associated acquisition documents shall be marked as compliant and delivered.

Facilities and programs listed on the Qualified Manufacturer's List (QML) may be used for the manufacture of other than compliant hybrid microcircuits; however, any use or reference to compliant device marking (3.6.8.3), class S or B certification status or this specification in such a way as to state or imply equivalency (and thereby Government endorsement) in connection with noncompliant devices is prohibited and may be cause for revocation of certification or QML status (or both).

NOTE: When any manufacturer, contractor, subcontractor or original equipment manufacturer (OEM) claims a device is compliant with MIL-STD-883, all provisions of MIL-STD-883 shall be met.

3.1.1 Reference to acquisition document. For the purposes of this specification, when the term "as specified" is used without additional reference to a specific location or document, the intended reference shall be to the applicable acquisition documents which constitutes the detailed hybrid specification.

3.1.2 Conflicting requirements. In the event of conflict between the requirements of this specification and other requirements of the applicable acquisition document, the precedence in which documents shall govern, in descending order, is as follows:

a. Applicable Standardized Military Drawing, source control document (or drawing) or detail drawing (or specification).

b. This specification.

c. Specifications, standards, and other documents referenced in section 2.

NOTE: Ordering data (see 6.2) may be provided in the purchase order or contract; however, any modification or deletion of any of the requirements of this specification will result in the manufactured device being deemed a noncompliant hybrid in accordance with this specification.

3.1.3 Terms, definitions, methods, and symbols. For the purposes of this specification, the terms, definitions, methods, and symbols of MIL-STD-883, MIL-STD-750, MIL-STD-1331 and those contained herein shall apply and shall be used in applicable acquisition documents wherever they are pertinent. The Government qualifying activity shall interpret the definitions of 6.6 for use wherever pertinent. The item levels of part, subassembly, assembly, unit, group, set and system, as well as the ancillary terms accessory and attachment, contained in MIL-STD-280, shall be applicable to this specification. To further describe a particular type of hybrid microcircuit additional modifiers may be prefixed to the type name.

3.1.3.1 Antistatic materials. Antistatic materials which resists triboelectric charging upon contact and separation with other materials shall be used as appropriate. Plastic materials impregnated with antistatic agents (antistats) are antistatic if their surface resistivity is between 1×10^{9} and 1×10^{14} ohms/sq.

3.1.3.2 Baseline index of documents. The qualifying activity shall review, approve, and maintain on file the procedures, process specifications and process qualification reports that are in general, the documents which establish the baseline for a given hybrid manufacturer in satisfying the requirements of certification and qualification in accordance with sections A and B of MIL-STD-1772.

3.1.3.3 Burn-in lot. The burn-in lot used for purposes of PDA or pattern failure accountability (or both) shall be as defined by the manufacturer and approved by the qualifying activity.

3.1.3.4 Compound bond. A wire bond placed on top of another wire bond or wire shall be permitted only as specified herein.

3.1.3.5 Conductive materials. Conductive materials capable of electrostatic field shielding and having a volume resistivity of 1×10^{3} ohm-cm maximum or a surface resistivity less than 1×10^{5} ohms/sq shall be used as appropriate.

3.1.3.6 Delta (Δ) limits. Delta limits, maximum changes in specified parameter readings which permit device acceptance on specified tests, shall be based on comparison of present measurements with specified previous measurements. Note: When expressed as a percentage value, they shall be calculated as a proportion of previously measured values.

3.1.3.7 Dissipative materials. Dissipative materials having a surface resistivity between 1×10^{5} and 1×10^{9} ohms/sq shall be used as appropriate.

3.1.3.8 Electrostatic discharge sensitivity (ESDS). The level of susceptibility of hybrid microcircuits to damage by static electricity, found by classification testing, shall be used as the basis for assigning an ESDS class.

3.1.3.9 Element. A constituent of a hybrid microcircuit that contributes directly to its operation, (e.g., chip resistor, capacitor, diode, transistor, integrated circuit, SAW, substrate, package, etc., incorporated into a hybrid microcircuit) shall be an element of the hybrid microcircuit.

3.1.3.10 Final seal. After manufacturing operations which complete the enclosure of a device following all allowable rework so that further internal processing cannot be performed, and for the purpose of seal date code identification and QCI testing, the final seal date code shall be used.

3.1.3.11 Compliant hybrid microcircuits. Compliant hybrid microcircuits shall meet, without exception, all of the requirements of this specification.

3.1.3.12 Hybrid microcircuits. Hybrid microcircuits shall consist of a combination of two or more of the following elements:

a. Film microcircuit (see 6.6.7).

b. Monolithic microcircuit (see 6.6.11).

c. Semiconductor element (see 6.6.20).

d. Passive chip or printed or deposited substrate elements (see 6.6.14).

3.1.3.13 Hybrid microcircuit type (device type). The term "hybrid microcircuit type" (device type) refers to a single specific hybrid microcircuit configuration. All samples of a hybrid microcircuit type shall be electrically and functionally interchangeable with each other, have the same electrical and environmental test limits and use the same package, materials, piece parts and assembly processes.

3.1.3.14 Inspection lots. Inspection lots shall consist of a quantity of hybrid microcircuits of a single hybrid microcircuit type (required for group A) or several different circuit types (allowed for group B, C, and D tests only) in a single package type and lead finish submitted at one time for final acceptance. All devices within each inspection lot shall be finally sealed in the same period not exceeding 13 weeks. Inspection lot identification shall be maintained from the time the lot is formed until the lot is accepted. Inspection lot traceability shall be maintained to the production lots from which it was formed. For class S devices, an inspection lot shall consist of one production lot.

3.1.3.14.1 Inspection lot formation. Inspection lot formation is required if the inspection lot is to be formally accepted by the lot related QCI testing of MIL-STD-883, method 5005 or method 5008. If the in-line process verification testing alternative is used, inspection lot formation is not required. For in-line process verification, process traceability must be maintained such that hybrid devices can be clearly identified to specific periods of in-line process testing.

3.1.3.15 Insulating materials. Insulating materials having a volume resistivity of 1×10^{12} ohm-cm minimum, or a surface resistivity of 1×10^{14} ohms/sq minimum shall be used as required.

3.1.3.16 Noncontinuous production. Noncontinuous production shall occur when devices are held by the manufacturer, with no additional assembly work performed, for more than 30 days.

3.1.3.17 Percent defective allowable (PDA). Percent defective allowable shall be the maximum observed percent defective which will permit the lot to be accepted after the specified 100 percent test.

3.1.3.18 Qualifying activity. The qualifying activity shall be the organizational element of the Government that grants certification and qualified manufacturers list (QML) status.

3.1.3.19 Acquisition documents. Acquisition documents shall consist of the purchase order or contract, source control document or drawing (see appendix C) Standardized Military Drawing, or detail drawings or specifications as applicable.

3.1.3.20 Acquiring activity (procuring activity). The organizational element of the Government which contracts for articles, supplies, or services may authorize a contractor or subcontractor to be its agent. When this organizational element of the Government has given specific written authorization to a contractor or subcontractor to serve as agent, the agent shall not have the authority to grant waivers, deviations or exceptions to this specification unless specific written authorization to do so has also been given by the Government organization which is the preparing activity, or qualifying activity.

In the absence of a specific acquiring activity, the acquiring activity shall be an organization within the supplier's company that is independent of the group responsible for device design, process development or screening, or may be an independent organization outside the supplier's company. Qualification, requalification or engineering data must be maintained on file and be available for review by the qualifying activity and future acquiring activities.

3.1.3.21 Production lot. A production lot shall consist of a device manufactured from the same basic raw materials on the same production line, processed under the same manufacturing techniques and controls using the same type of equipment. The production lot shall be formed at or prior to device kit preparation (i.e., release to manufacturing). In addition, for class S devices, all materials shall be from the same incoming inspection lot for each element.

3.1.3.22 Standard evaluation circuit (test coupon or vehicle). Test vehicles or coupons that simulate the assembly process, materials, and construction techniques used on the manufacture of actual hybrid microcircuit types shall be manufactured in an actual production environment by trained personnel using approved test methods and procedures with proper traceability records. Standard evaluation circuits may be used for process qualification purposes in lieu of actual devices.

3.1.3.23 Wafer lots. Wafer lots shall consists of microcircuit wafers formed into lots at the start of wafer fabrication for homogeneous processing as a group. Each lot shall be assigned a unique identifier or code to provide traceability and maintain lot integrity throughout the fabrication process.

Wafer lot processing as a homogeneous group shall be accomplished by any of the following procedures, providing process schedules and controls are sufficiently maintained to assure identical processing in accordance with process instructions of all wafers in the lot:

a. Batch processing of all wafers in the wafer lot through the same machine process steps simultaneously.

b. Continuous or sequential processing (wafer by wafer or batch portions of wafer lot) of all wafers through the same machine or process steps.

c. Parallel processing of portions of the wafer lot through multiple machines or process stations on the same certified line, provided statistical quality control assures and demonstrates correlation between stations and separately processed portions of the wafer lot.

Rework of a wafer (i.e., the strip and redeposition of a layer in order to correct a nonconformance to a specification limit) shall not be allowed. Additional etch to correct a nonconformance to a specification limit, photoresist strip and recoat, or processing to continue or finish incomplete processing, shall not be considered rework. For class S, additional deposition of oxidation, glassivation, or any interconnect layers (e.g., polysilicon, aluminum, etc.) shall not be allowed.

3.2 Item requirements. The individual item requirements for hybrid microcircuits delivered under this specification shall be documented in acquisition documents. Unless otherwise approved by the acquiring activity, all hybrid microcircuits shall have an operating temperature range from -55°C to +125°C and any references to minimum or maximum operating temperatures shall refer to the respective lower and upper limits of this range (i.e., the maximum applicable operating case temperature or ambient temperature shall be specified). Contractor prepared source control documents in accordance with appendix C shall be approved by the acquiring activity as acceptable for the requirements of a specific contract or order.

3.2.1 Country of manufacture. All hybrid microcircuits shall be manufactured, assembled, and tested within the U.S. and its territories, except as provided by international agreement establishing reciprocal and equivalent Government quality system and procedures.

3.3 Classification of requirements. The requirements for hybrid microcircuits are delineated herein as follows:

Title	Paragraph
Quality assurance	3.4
Certification and qualification	3.4.1
Element evaluation	3.4.2
Process control	3.4.3
Screening	3.4.4
Quality conformance inspection (QCI)	3.4.5
Traceability	3.4.6
Configuration control	3.4.7
Design and construction	3.5
Workmanship	3.7

3.3.1 Certification of conformance and acquisition traceability. Manufacturers or suppliers including dealers and distributors who offer the product described by this specification shall provide written certification, signed by the corporate officer who has management responsibility for the production of the product, (1) that the product being supplied has been manufactured and tested in accordance with this specification and conforms to all of its requirements, (2) that all products are as described on the certificate which accompanies the shipment, and (3) that dealers and distributors have handled the product in accordance with the requirements of JEDEC Publications 108 and 109. The responsible corporate official may, by documented authorization, designate other responsible individuals to sign the certificate, but, the responsibility for conformity with the facts shall rest with the responsible corporate officer. The certification shall be confirmed by documentation to the Government or to users with Government contracts or subcontracts, regardless of whether the products are acquired directly from the manufacturer or from another source such as a distributor. When other sources are involved, their acquisition certification shall be in addition to the certificates of conformance and acquisition traceability provided by the manufacturer and previous distributors. The certificate shall include the following information:

a. Manufacturer documentation:

(1) Manufacturer's name and address.

(2) Customer's or distributor's name and address.

(3) Device type and product assurance level.

(4) Lot date code and latest reinspection date, if applicable.

(5) Quantity of devices in shipment from manufacturer.

(6) Statement certifying product conformance and traceability.

(7) Signature and date of transaction.

b. Distributor documentation for each distributor:

(1) Distributor's name and address.

(2) Name and address of customer.

(3) Quantity of devices in shipment.

(4) Latest reinspection date, if applicable.

(5) Certification that this shipment is a part of the shipment covered by the manufacturer's documentation.

(6) Signature and date of transaction.

3.4 Quality assurance requirements. Two levels of quality assurance (class S and B) are provided for in this specification. Class S is the highest quality assurance level of this specification and is intended for space application. Delivered devices shall be those which have been subjected to and passed all applicable requirements, tests, and inspections detailed herein. Devices or lots which have failed to pass any tests applied or acceptance criterion (PDA, sample size (accept number)) shall not be downgraded to any lower quality assurance level even though that test or criterion may not be a requirement of the lower level (i.e., a failed device or lot shall not be accepted). All of the requirements contained in this specification apply to every compliant hybrid microcircuit except where table I specifically provides for an alternative.

The quality assurance requirements for a hybrid microcircuit type shall be determined at the time of contract negotiation and acceptance and shall consist of one of the three option flows provided in table I.

TABLE I. Quality assurance requirements.

Requirement	Reference paragraph	Option 1	Option 2	Option 3
Certification General MIL-STD-1772	3.4.1 3.4.1.1	Required Section A	Required Section A	Required Section A
Qualification Product, MIL-STD-883	3.4.1	Not required	Not required	Method 5005, test conditions A, B, C, D
Process, MIL-STD-1772		Section B	Section B	Not required
Configuration control	3.4.1.3 and 3.4.7	Required	Required	Required
Traceability	3.4.6	Required	Required	Required
Element evaluation	3.2.4 and 4.4	Required	Required	Not required
Process control	3.4.3	Required	Required	Required
Serialization	3.6.6	Class S	Class S	Class S
Screening	3.4.4 and 4.5	Method 5008	Method 5008 Method 2017	Method 5004 except preseal
Quality conformance inspection Group A Group B Group C Group D	3.4.5 and 4.6	In-line 4.6.2.1.1 4.6.2.1.2 4.6.2.1.3 4.6.2.1.4	Method 5008 4.6.2.2.1 4.6.2.2.2 4.6.2.2.3 4.6.2.2.4	Method 5005 4.6.2.3 4.6.2.3 4.6.2.3 4.6.2.3

3.4.1 Certification and qualification.

3.4.1.1 General. All hybrid microcircuits furnished under this specification (except option 3, MIL-M-38510 QPL devices - see note) shall be devices which are fabricated at a facility certified in accordance with MIL-STD-1772 for the applicable device class.

NOTE: Option 3 hybrid microcircuit manufacturers that have a hybrid microcircuit type listed on the QPL for MIL-M-38510 may also have that device listed on the QML for MIL-H-38534. MIL-STD-1772 certification is not required for the specified QPL/QML listed hybrid microcircuit type; however, the facility at which the device is manufactured must be a MIL-STD-976 certified facility and must be within the U.S. and its territories, except as provided by international agreement establishing reciprocal and equivalent Government quality system and procedures.

3.4.1.2 Procedure. The hybrid microcircuit manufacturer shall establish and implement a product assurance program as defined in appendix A and MIL-STD-1772. The hybrid manufacturer shall arrange to have the Government qualifying activity perform an audit in accordance with section A of MIL-STD-1772 for the purpose of certifying a manufacturer. All documentation required by appendix A and MIL-STD-1772 shall be available for review at the time of audit. When the qualifying activity determines on the basis of their manufacturer audit that the manufacturer is eligible to produce hybrid microcircuits, the manufacturer shall receive written notification of certification. The audit and written notification will be performed by the Government since it is the intent of this specification to provide a single qualifying activity to approve the facilities and lines.

Following written notification of certification, the manufacturer shall successfully complete the testing of processes and materials required by section B of MIL-STD-1772, if required by table I. Approval of the section B qualification test results by the qualifying activity shall result in the manufacturer's listing on QML-38534.

3.4.1.3 Change of the quality assurance program. A certified manufacturer shall not implement any change in certified material, process, or control without concurrent change to the process control or quality control documents listed in the approved baseline index of documents. The manufacturer shall notify the qualifying activity of any major change to the QA program as defined in 3.4.7.

3.4.1.4 Use of certified lines. When other than compliant product is being manufactured on a certified line, controls shall be maintained such that adverse impact does not occur to compliant product. The controls and procedures for noncompliant products shall be as specified on the manufacturer's flow chart documentation (see 30.1.3.2 of appendix A).

3.4.1.5 Reaudits of certified lines. Following initial certification, a certification audit team will periodically inspect the manufacturer's facilities and equipment, review his processes and techniques and audit the implementation of the product assurance program plan and records. The date, location, time of audit, and extent of participation of manufacturer personnel required to accomplish the task will be established on a schedule which is mutually acceptable to the qualifying activity and the manufacturer. Upon completion of the audit, the manufacturer will be provided an exit critique and will be provided with a written report of the results of such an audit. A schedule for correction of any significant deficiencies will be required and will subsequently be reviewed for completeness, adequacy, and timeliness of completed closure actions.

3.4.1.6 Qualification to radiation hardness assurance (RHA) levels. Qualification to an RHA level shall consist of qualification to the appropriate quality and reliability assurance level (class S or B) plus group E tests of MIL-STD-883, method 5005. Special qualification requirements were developed for a number of moderately hard microcircuits which obviated qualification inspection for class B, levels M and D. QPL-38510 provides a footnote for these microcircuits. RHA levels are defined as follows:

Radiation hardness assurance (RHA) level (see note below)

RHA level designator (see 3.6.8.4)	Radiation and total dose (Rad (Si))	Level neutron fluence (n/cm^2)
/	No RHA	No RHA
M	3000	2×10^{12}
D	1×10^{4}	2×10^{12}
R	1×10^{5}	2×10^{12}
H	1×10^{6}	2×10^{12}

NOTE: The detail specification may allow for a higher neutron level.

Hybrid microcircuits are considered to meet a specific RHA level if all dice used in the manufacture of the hybrids are acquired from wafers that have passed QCI to that RHA level, or a higher level.

Where dice from such wafers are unavailable, a sample of the dice to be used shall be packaged and tested in accordance with the requirements of MIL-STD-883, method 5005, group E for microcircuits or MIL-S-19500, group D for discrete devices. Samples must be taken from the specific wafer lot to be used in the hybrid for class B or from each wafer to be used for class S. The manufacturer may elect to replace the element testing by testing of completed hybrids. The lot definitions, sampling procedures, and test methods of MIL-M-38510 and MIL-STD-883, method 5005, as related to group E, may be applied as an alternate test plan.

3.4.1.7 Qualification to ESDS classes. Initial qualification to an ESDS class or requalification after redesign shall consist of qualification to the appropriate quality and reliability level (class S or B) plus ESDS classification in accordance with method 3015 of MIL-STD-883. ESDS classification levels and associated marking are defined in 3.6.8.2.

NOTE: Manufacturers may, at their option, classify devices as class 1 without performing the ESD sensitivity test based on their own history, judgment, or performance. ESD classification can be determined either by testing the hybrids using method 3015 or marking to the lowest electrostatic voltage class level of the active devices ESDS classified in accordance with MIL-M-38510 that are accessible to the leads of the hybrid devices. Support data (from device tests or ICD manufacturers' ESD results) shall be retained by the hybrid manufacturer for device types compliant with 1.2.1c of MIL-STD-883.

3.4.2 Element evaluation. Before hybrid microcircuit assembly, element characteristics shall be evaluated to assure compatibility with device requirements and assembly procedures. Characteristics to be verified shall be those necessary for compatibility with the element specification and assembly procedures and at least those critical characteristics which cannot be verified after assembly but could cause functional failure.

Element evaluation may be performed at either the element supplier or the hybrid microcircuit manufacturing facility. Element evaluation shall consist of the tests and procedures specified in MIL-STD-883, method 5008 for the applicable element and device class except where excluded in accordance with table I, herein.

3.4.2.1 Alternate Integrated Circuit Die (ICD) evaluation. Alternate ICD evaluation shall be used only in cases where complex ICD testing is impractical outside the actual end item (i.e., hybrid microcircuit). The ICD sample built into hybrids must successfully complete evaluation prior to release of the balance of the incoming ICD lot. Acquiring activity approval must be obtained prior to implementation.

In lieu of packaged element evaluation tests, ICD's may be assembled into hybrid microcircuits and acceptance of these elements shall be based on the ability of the hybrid microcircuit to meet all group A, subgroup 1, 2, 3, and 4 or 7, electrical tests required, for the hybrid microcircuit. A minimum of 10 ICD's (1 defect) or a sample of ICD's based on an sample size (accept number) of 15(0) shall be assembled into at least 3 hybrid microcircuit devices. Hybrid microcircuit devices assembled for the purpose of ICD evaluation are shippable provided all of the provisions of this specification are met. Element wire bond evaluation for ICD's may be accomplished using an additional sample of ICD's wire bonded for that purpose only. When the hybrid microcircuit build option for ICD evaluation is selected, the manufacturer shall establish and maintain a sample plan or procedure to identify the sample prior to electrical test.

In case of lot failure when alternative ICD evaluation is used, all of the hybrid samples and the ICD inspection lot shall be rejected. When the manufacturer chooses to analyze the failed hybrids to isolate the cause of failure and this analysis determines that the cause of failure is not related to the ICD being tested and that the ICD has been correctly stressed during the required screening and testing, then the ICD inspection lot may be accepted. If the ICD has not been correctly stressed, the failed hybrid device may be reworked or new sample replacement hybrids may be assembled.

3.4.3 Process control. As a minimum, process control in accordance with MIL-STD-883, method 5008 is required for hybrid microcircuit assembly. If statistical process control (SPC) is utilized (see 4.1 and 4.1.2.2).

3.4.4 Screening. All hybrid microcircuits to be delivered in accordance with this document shall have been subjected to, and passed, all the screening tests detailed in method 5004 (except methods 2017 and 2032 shall replace method 2010) or method 5008 of MIL-STD-883 as applicable. All hybrid microcircuits shall have passed all the screening requirements prior to any quality conformance inspections except in-line verification testing. Sampling inspections shall not be an acceptable substitute for any specified 100 percent screening test (see 4.5) unless statistical process control procedures have been approved by the qualifying activity (see 4.1.2.2).

3.4.5 Quality conformance inspection (QCI). QCI shall consist of the tests and procedures specified in MIL-STD-883, method 5008 and 4.6 herein or MIL-STD-883, method 5005 and MIL-M-38510, 4.5. Hybrid microcircuits shall not be accepted or approved for delivery until all applicable QCI requirements have been met. The acquiring activity may approve delivery if group A, B, and D testing has been completed and group C, life test has commenced. The hybrid manufacturer must maintain traceability of all devices delivered to the acquiring activity prior to completion of QCI testing for the purpose of device recall in case of test failure. Statistical process control shall not be an acceptable substitute for QCI unless the procedures have been approved by the qualifying activity (see 4.1.2.2).

3.4.6 Traceability.

3.4.6.1 Material and element traceability. Traceability shall be such that for each hybrid microcircuit, all adhesives and coatings shall be traceable to a material production lot, inspection lot, or other specified grouping. All elements and materials used shall be traceable to their incoming inspection lots. For class S,

records shall be maintained to provide traceability from the hybrid microcircuit serial number to the specific wafer lot from which each semiconductor and microcircuit element originated.

3.4.6.2 Process traceability. Each hybrid microcircuit, or each group of hybrid microcircuits which have been fabricated as a common batch, shall be identifiable through means of production travelers or similar documentation such that the complete manufacturing history, including rework, shall be recorded. The records should include, as a minimum, the performance date of all identified production process steps, the specification, number of production process steps, and the identification of the operator performing the process steps. The records shall be retained for a minimum of 5 years (7 years for class S) after delivery of the hybrids, and shall be available for review upon request of the acquiring activity.

3.4.6.3 Production lot traceability. The manufacturer shall maintain production lot traceability.

3.4.7 Configuration control. Unless otherwise specified, changes shall be categorized into three classifications.

Class	Description
I	Major changes
II	Minor changes
III	Editorial changes

All changes in design, substitution of materials or processes, or modifications to baselined documentation (i.e., all class I, II, and III changes) for any hybrid microcircuit must be processed in accordance with established change control procedures (see 30.1.2.4 of appendix A). In addition, for class S devices, all class I and II changes shall be considered major changes and treated in accordance with 3.4.7.1.

Class I, major changes, are detailed in 3.4.7.1 and are those changes that may affect the performance, quality, reliability, or interchangeability of the product. Major design changes require the documented approval of the acquiring activity. The qualifying activity shall have been notified of the change by means of the issuance of a request for performing material or process qualification. Where such a change occurs, implementation of the change shall be at the risk of both the OEM and the hybrid manufacturer and not the Government.

Class II, minor changes, are all other changes except editorial changes (e.g., vendor metallization mask change, package height change within the envelope tolerances of the detail drawing, etc.). Minor changes do not require acquiring or qualifying activity approval except that the qualifying activity shall be notified when there is uncertainty as to a change being major or minor in nature. Control procedures and records shall be in accordance with appendix A product assurance program requirements and be available for on-site review.

Class III, editorial changes, are those changes to documentation necessary to insure the understanding and execution of the affected document (e.g., format changes, spelling, word identity, etc.). Change documentation history for editorial type changes shall be available for on-site review.

3.4.7.1 Class I, major changes. The manufacturer shall, prior to implementation, notify the acquiring activity of any major change in product design and the qualifying activity of any major changes in the approved baselined index of documents. This notification shall include a thorough description of the proposed change, acceptable engineering data or a suggested test plan designed to

demonstrate that the changed product will continue to meet the acquisition document requirements including performance, quality, reliability, or interchangeability. The acquiring or qualifying activity, as applicable, will review the proposed change and the engineering data or information or test plan and will authorize the manufacturer to proceed with the change or approve the test plan. To minimize the need for additional tests due to insufficient details or data on the proposed changes, it is recommended that the test plan be discussed with the acquiring or qualifying activity prior to commencing the test program. Test guidelines for each major change listed herein are provided in table II for product design changes and section B of MIL-STD-1772 for baselined process changes.
Tests shall be performed on samples of the first hybrid microcircuits or sub-assemblies manufactured incorporating the changes. Upon completion of the prescribed test program, the results shall be provided to the acquiring activity for review and approval or disapproval. At the manufacturer's option, hybrid microcircuits incorporating the change may be manufactured and tested prior to approval; however, all shipments of these changed devices shall be withheld until formal documented approval is granted by the acquiring or qualifying activity. The following are "major" changes to hybrid microcircuits requiring notification in accordance with the details herein:

a. Substitution of substrate material (e.g., alumina vs. BeO).

b. Substitution of materials or inks deposited on hybrid substrate (e.g., conductor: gold vs. copper; resistor: ruthenium base vs. carbon) or deposit method (e.g., thinfilm vs. thickfilm).

c. Cumulative change of deposited materials nominal process time exceeding ±25 percent or nominal process temperature exceeding ±50° C or ±10 percent, whichever is greater since the last qualification or major change notification.

d. Cumulative changes to hybrid substrate mask design that alter nominal design dimensions, electrical parameters, spacing or isolation more than ±25 percent since the last qualification or major change notification.

e. Substitution of trimming method (e.g., abrasive vs. laser).

f. Substitution of die type (e.g., 2N2484 vs. 2N2905) or other element types (e.g., tantalum vs. ceramic capacitors or thinfilm vs. thickfilm resistors) mounted on the hybrid substrate.

g. Substitution of attach material (e.g., epoxy A vs. epoxy) or of attachment method (e.g., epoxy vs. eutectic) for hybrid microcircuit elements.

h. Change in the baselined die, element, or substrate attach process temperature which exceeds 25° C or 10 percent whichever is greater.

i. Substitution of package configuration (e.g., platform vs. bathtub), lid or covers (e.g., step lid vs. drawn cover), or plating material (e.g., electroless nickel vs. electrolytic nickel).

j. Substitution of package or lid base material (nickel vs. stainless steel).

k. Changes to finished hybrid dimensions exceeding source control document (or drawing) or Standardized Military Drawing (SMD) envelope tolerances.

l. Substitution of baselined wire bond method (e.g., ultrasonic vs. thermal compression) or wire size changes greater than ±0.25 mil.

m. Any change in specified material composition or purity of the wire.

n. Substitution of seal method (e.g., seam weld vs. laser weld) or seal material (e.g., SnAg vs. AuSn).

o. Change in the baselined seal process time or temperature vacuum of more than 10 percent or sealing atmosphere except for the addition of helium.

p. Changes to the baselined product flow chart in which operations are added or deleted except for additional inspections and statistical process control (SPC) operations.

q. Assembly operation or test facility move.

TABLE II. Testing guidelines for major product design changes. 1/ 2/ 3/ 4/ 5/ 6/

Major changes or substitutions (see 3.4.7.1)	Recommended tests MIL-STD-883, method 5008 subgroup (sample size)	Variable data required (subgroup)
d. Substrate mask design	A1, B4, C2 (5)	C2
e. Substitution of trim method	A, C2 (5)	C2
f. Substitution of die type	A, C2 (5)	C2
g.,h. Substitution of attach material or process temperature	C1 (5), C3	C3
k. Change to finished hybrid dimensions	Notify acquiring activity	
m. Substitution of wirebound material	B5, C1	B5
n.,o. Substitution of seal method, profile or seal material	C1 (5), C3	C3

1/ Sampling shall be in accordance with method 5008 or method 5005 except as indicated in parentheses in accordance with individual subgroup in which case the accept number is zero.

2/ All electrical parameter testing shall be in accordance with the source control document or drawing or Standardized Military Drawing.

3/ Data histograms providing a parametric data summary may be submitted in place of variables data.

4/ The acquiring or qualifying activity (or both) may add or reduce testing as warranted by detail specification requirements, unique design, or process circumstances after notification by the manufacturer.

5/ The acquiring activity shall determine testing requirements for design changes affecting class S devices.

6/ For product processed in accordance with option 3, reference to method 5008 is for test method subgroup identification only.

3.5 Design and construction. Hybrid microcircuit design and construction shall be in accordance with all the requirements specified, herein, and the source control document or Standardized Military Drawing.

3.5.1 Package. All hybrid microcircuits supplied to this specification shall be hermetically sealed in glass, metal, or ceramic (or combinations of these) packages. No adhesive or polymeric materials shall be used for package lid attach (or seal) or repair. Flux shall not be used in the final sealing process. The minimum distance between the glass to metal seals and the package sealing surface for seam welded packages after final seal shall be 0.040 inch (1.02 mm) minimum for class B devices and 0.050 inch (1.27 mm) minimum for class S devices.

The internal water vapor content shall be determined in accordance with MIL-STD-883, method 1018 and shall not exceed 5,000 ppm at 100° C for class B or class S devices. Polymer impregnations or secondary seal (backfill, coating, or other uses of organic or polymeric materials to effect, improve, or repair the seal) of the hybrid microcircuit package shall not be permitted. Packages for class S hybrid microcircuits shall have a metal body with hard glass or ceramic seals, a hard glass body, or a ceramic body; and the lid shall be welded, brazed, soldered, or glass frit with a frit sealing temperature greater than 385° C. Glass frit sealed packages shall pass the lid torque test of MIL-STD-883, method 2024. Also for class S, the use of glass frit seal shall have glass on the mating surface only and the inside surface of the cavity shall not be coated with the seal glass. Single layer alumina metallized (SLAM) chip carrier packages are prohibited.

NOTE: Packages containing beryllia shall not be ground, sandblasted, machined, or have other operations performed on them which will produce beryllia or beryllium dust. Furthermore, beryllium oxide packages shall not be placed in acids that will produce fumes containing beryllium.

3.5.2 Polymeric materials. The cure temperature of polymeric materials shall not be exceeded after completion of final seal.

3.5.2.1 Polymeric adhesives. All adhesive polymeric materials shall meet the requirements of MIL-STD-883, method 5011 and shall be approved by the qualifying activity.

3.5.2.2 Other polymeric materials. Any other use of polymeric materials shall be approved by both the acquiring and qualifying activities for the specific application for which it is intended.

3.5.3 Metals. Metal surfaces shall be corrosion resistant or shall be plated or treated to resist corrosion and shall meet the requirements specified in 3.5.8.

3.5.4 Other materials. External parts, elements or coatings including markings shall be non-nutrient to fungus and shall not blister, crack, outgas, soften, flow, or exhibit defects that adversely affect storage, operation, or environmental capabilities of hybrid microcircuits delivered to this specification under the specified test conditions.

3.5.5 Design and manufacturing documentation. Design, topography, schematic circuit information, manufacturing flowcharts, and process control documents for all hybrid microcircuits supplied under this specification shall be available in-plant for review by the acquiring activity and the process certification audit team. This documentation shall be sufficient to depict completely the physical and electrical construction of the hybrid microcircuits supplied under this specification. Hybrid microcircuits shall be traceable to the specific part, drawing, or type numbers to which it applies, and to the production lot and inspection lot codes under which hybrid microcircuits are manufactured and tested so that revisions can be identified. Changes to product shall be controlled in accordance with 3.4.7.

3.5.5.1 Device topography. Color photomicrographs (8" x 10") or 35 mm color slides capable of being enlarged to 8" x 10" shall be required for initial design verification and after a design change. These photomicrographs or transparencies shall show the specific interconnection pattern used to connect the elements. They shall apply to the substrate and all conductor patterns and active or passive elements deposited thereon, as well as to semiconductor die, as applicable. This requirement can be satisfied by the manufacturer's assembly drawing having a minimum scale of 10X.

3.5.5.2 Schematic diagrams. For hybrid microcircuits supplied under this specification, the actual schematic diagram, logic diagram, or combination thereof, shall be available with sufficient detail to represent all electrical elements functionally designed into the hybrid microcircuit together with their values (when applicable). For complex devices or those with redundant detail, the overall hybrid microcircuit may be represented by a logic diagram in combination with schematic details. Where parasitic elements are important to the proper functioning of any hybrid microcircuit, they shall be included in the schematic diagram.

3.5.6 Internal conductors. Internal thin film conductors on a substrate (metallization stripes, contact areas, bonding interfaces, etc.) shall be designed so that no properly fabricated conductor shall experience in normal operation (at worst case specified operating conditions), a current density in excess of the maximum allowable value shown below for the applicable conductor material:

Conductor material	Maximum allowable current density
Aluminum (99.99 percent pure or doped) without glassivation	2×10^5 A/cm^2
Aluminum (99.99 percent pure or doped) glassivated	5×10^5 A/cm^2
Gold	6×10^5 A/cm^2
All other (unless otherwise specified)	2×10^5 A/cm^2

The current density shall be calculated at the point of maximum current density (i.e., greatest current per unit cross section; see 3.5.6a) for the specified device type and schematic or configuration.

a. Use a current value equal to the maximum continuous current (at full fanout for digitals or at maximum load for linears) or equal to the simple time-averaged current obtained at maximum rated frequency and duty cycle with maximum load, whichever results in the greater current value at the point of maximum current density. This current value shall be determined at the maximum recommended supply voltage and with the current assumed to be uniform over the entire conductor cross sectional area.

b. Use the minimum allowed metal thickness in accordance with manufacturing specifications and controls including appropriate allowance for thinning experienced in the metallization step (via). The thinning factor over a metallization step is not required unless the point of maximum current density is located at the step.

c. Use the minimum actual design conductor widths (not mask widths) including appropriate allowance for narrowing or undercutting experienced in metal etching.

d. Areas of barrier metals and nonconducting material shall not be included in the calculation of conductor cross section.

Thick film conductors on hybrid microcircuits or multichip substrates (metallization strips, bonding interfaces, etc.) shall be designed so that no properly fabricated conductor shall dissipate more than 4 watts/cm^2 when carrying maximum design current.

3.5.7 Internal lead wires. Internal lead wires or other conductors which are not in thermal contact with a substrate along their entire length (such as wire or ribbon conductors) shall be designed to experience, at maximum rated current, a continuous current for direct current, or an rms current, for alternating or pulsed current, not to exceed the values established by the following relationship:

$$I = Kd^{3/2}$$

Where: I = Maximum allowed current in amperes.

d = Diameter in inches for round wire (or equivalent round wire diameter which would provide the same cross-sectional area for other than round wire internal conductor.

K = A constant taken from below for the applicable wire or conductor length and composition used in the device.

"K" values for bond-to-bond total conductor length		
Composition	Length ≤ 0.040" (0.10 cm)	Length > 0.040" (0.10 cm)
Aluminum	22,000	15,200
Gold	30,000	20,500
Copper	30,000	20,500
Silver	15,000	10,500
All other	9,000	6,300

3.5.8 Package element material and finish.

3.5.8.1 Package body material. Package body material shall be metal or ceramic or a combination of these materials and shall conform to MIL-STD-883, method 2009. In addition, metal packages shall conform to JEDEC-STD-9. In case of conflict, method 2009 shall take precedence.

3.5.8.2 Lead or terminal material. Unless otherwise specified, the lead or terminal material shall conform to one of the following compositions:

a. Type A: Iron-Nickel-Cobalt alloy: MIL-1-23011, class 1, ASTM F-15.

b. Type B: Iron-Nickel alloy (41 percent Ni): MIL-I-23011, class 5, ASTM F-30.

c. Type C: Co-fired metallization such as nominally pure tungsten. The composition and application processing of these materials shall be subject to qualifying activity approval.

d. Type D: Copper core-iron nickel ASTM F-30 alloy (50.5 percent Ni). The core material shall consist of copper (oxygen-free) ASTM B-170, grade 2.

e. Type E: Copper core ASTM F-15 alloy. The core material shall consist of copper (oxygen-free) ASTM B-170, grade 2.

f. Type F: Copper (oxygen free) ASTM B-170, grade 2. This material shall not be used as an element of any glass-to-metal seal structure.

g. Type G: Iron-Nickel alloy (50.5 percent Ni): MIL-I-23011, class 2 ASTM F-30.

h. Type H: Nickel: MIL-N-46025 (for ribbon leads) and MIL-N-46026 (for round wire leads).

3.5.8.3 Hybrid microcircuit finishes. Finishes of all external leads or terminals and all external metallic package elements shall conform to either 3.5.8.3.2 or 3.5.8.3.3 as applicable. The leads or terminals shall meet the applicable solderability and corrosion resistance requirements. The other metallic package elements (including metallized ceramic elements) shall meet the applicable corrosion resistance requirements. Finishes on interior elements (e.g., bonding pads, posts, tabs) shall be such that they meet lead bonding requirements and any applicable design and construction requirements. The use of strike plates is permissible to a maximum thickness of 10 microinches (0.25 µm). All plating of finishes and undercoats shall be deposited on clean, non-oxidized metal surfaces. Suitable deoxidation or cleaning operations shall be performed before or between plating processes. All hybrids and packages (cases and covers) shall be capable of meeting the following requirements:

a. MIL-STD-883, method 5008, table V, package evaluation.

b. MIL-STD-883, method 2025, adhesion of lead finishes.

c. ASTM B487, measurement of metal and oxide coating thickness by microscopical examination of a cross-section.

d. ASTM B567, measurement of coating thickness by the beta backscatter method, X-ray florescence, or equivalent.

Compliance to the above requirements shall be demonstrated when and as specified. The aforementioned ASTM methods are provided as reference methods to be used when the failure to pass other finish requirements suggests deficiencies in plating thickness.

3.5.8.3.1 Finish thickness measurements. Lead finish thickness measurements shall be taken halfway between the seating plane and the tip of the lead. This requirement is to avoid having the inspector select a nontypical portion of the lead on which to perform the measurement. Measurements taken on the shorting bar shall be correlated by direct measurement on the lead. Finish thickness measurements for package elements other than leads shall be taken at the center of major flats.

3.5.8.3.2 Lead finish. The finish system on all external leads or terminals shall conform to one of the following:

a. Hot solder dip. The hot solder dip shall be homogeneous with a minimum thickness of 60 microinches (1.52 µm) for round leads and, for other shapes, a minimum thickness at the crest of the major flats of 200 microinches (5.08 µm) solder (SN60 or Sn63). In all cases, the solder dip shall extend up to and beyond the effective seating plane for packages with standoffs or within .030 inch (0.76 mm) of the lead or package interface for leaded flush mounted devices. For leadless chip carrier devices, the hot solder dip shall cover a minimum of 95 percent of the

metallized side castellation or notch and metallized areas above and below the notch except the index feature if not connected to the castellation. Terminal area intended for device mounting shall be completely covered. The hot solder dip is applicable:

(1) Over a finish in accordance with entry b or c below, or

(2) Over electroplated nickel or electroless nickel phosphorous in accordance with 3.5.8.3.4, or

(3) Over the basis metal. When applied over the basis metal, underplate that is nonconforming, or other finishes that are nonconforming (e.g., fused tin less than 200 microinches), hot solder dip shall cover the entire lead to the glass seal or point of emergence of the lead or metallized contact through the package wall.

b. Tin plate. As plated tin shall be a minimum of 300 microinches thick and shall be dense, homogeneous and continuous. As plated tin shall contain no more than 0.05 percent by weight co-deposited organic material measured as elemental carbon. Tin plate shall be fused after plating before or after burn-in by heating above its liquidus temperature. Fused tin plate shall be visually inspected after fusing and shall exhibit a dense, homogeneous and continuous coating. Fused tin plate shall be a minimum of 200 microinches thick when measured at the crest of major flats. Fused tin plate is applicable:

(1) Over electroplated nickel or electroless nickel phosphorous in accordance with 3.5.8.3.4 or

(2) Over the basis metal.

As plated tin need not be fused if the leads are subsequently hot solder dipped in complete accordance with 3.5.8.3.2a. Tin-lead plating may be used as an alternative to tin plate and shall have in the plated deposit 2 percent to 50 percent by weight lead (balance nominally tin) homogeneously co-deposited. As plated tin-lead shall be a minimum of 300 microinches thick. As plated tin-lead shall contain no more than 0.05 percent by weight co-deposited organic material measured as elemental carbon.

Tin-lead plate is applicable:

(1) Over as-plated tin.

(2) Over electroplated nickel or electroless nickel phosphorous in accordance with 3.5.8.3.4.

(3) Over the basis metal.

Tin-lead plating may be fused after plating before or after burn-in by heating above its liquidus temperature. Fused tin-lead shall be visually inspected after fusing, and shall exhibit a dense, homogeneous, and continuous coating. Fused tin-lead shall be a minimum of 200 microinches thick. The maximum carbon content for both tin and tin-lead plate (and minimum lead content in the tin-lead plate) on the as-plated finish shall be determined by the manufacturer on at least a weekly basis.

The visual inspection after fusing shall be conducted on a sampling basis by the manufacturer as an in-process control. Visual inspection of the fusing shall be performed at a frequency sufficient to assure uniform compliance with these requirements on the finished product. The determination of carbon and lead content may be made by any accepted

analytical technique (e.g., for carbon: pyrolysis, infrared detection using an IR212, IR244 infrared detector, or equivalent; for lead: X-ray florescence, emission spectroscopy) so long as the assay reflects the actual content in the deposited finish.

c. Gold plate. Gold plating shall be a minimum of 99.7 percent gold, and only cobalt shall be used as the hardener. Gold plating shall be a minimum of 50 microinches (1.27 µm) and a maximum of 225 microinches (5.72 µm) thick. Gold plating shall be permitted only over nickel plate or undercoating in accordance with 3.5.8.3.4.

3.5.8.3.3 Package body finish. External metallic package elements other than leads or terminals (e.g., lids, covers, bases, seal rings, etc.) shall meet the applicable corrosion resistance and environmental requirements or shall be finished so that they meet those requirements using finishes conforming to one or more of the following as applicable:

a. Solder in accordance with 3.5.8.3.2a.

b. Tin plate in accordance with 3.5.8.3.2b.

c. Gold plate shall be a minimum of 99.7 percent gold and only cobalt shall be used as a hardener. Gold plating shall be a minimum of 10 microinches (0.25 µm) and a maximum of 225 microinches (5.72 µm) thick. The gold plate shall be applied over electroless or electroplated nickel or undercoating in accordance with 3.5.8.3.4.

Multilayered finish structures are acceptable provided the outer gold layer meets the minimum thickness of 10 microinches (0.25 µm) and each of the nickel undercoats meets the thickness requirements of 3.5.8.3.4 with the total nickel thickness not to exceed 600 microinches (15.24 µm).

d. Nickel plate in accordance with 3.5.8.3.4.

3.5.8.3.4 Nickel plate or undercoating. Electroplated nickel undercoating or finishes from a sulfamate nickel bath is preferred and shall be 50 to 350 microinches (1.27 µm to 8.89 µm) thick measured on major flats or diameters. Electroless nickel undercoating or finishes, when allowed, shall be 50 to 350 microinches (1.27 µm to 8.89 µm) thick measured on major flats or diameters. The addition of organic "wetting agents" is prohibited for either sulfamate or phosphorous nickel baths. Electroplate or electroless nickel plate (or combinations thereof) as well as nickel cladding may be used as the finish for package elements other than flexible leads or terminals provided the corrosion resistance and environmental requirements are met.

In all cases, electroplated nickel undercoating from a nickel sulfamate bath is preferred for lead finishes. Electroless nickel shall not be used as the undercoating on flexible or semiflexible leads (see 3.3.1 and 3.3.2 of method 2004 of MIL-STD-883) and shall be permitted only on rigid leads or package elements other than leads.

3.5.9 Device elements. All active and passive elements utilized in the manufacture of hybrid microcircuits shall conform to the applicable requirements of 3.4.2. In addition for class S devices, active elements shall be from certified class S lines and passive elements shall be from established reliability lots when available.

3.5.10 Thermal design. Thermal design analysis shall be performed and shall establish as a minimum that functional hybrid microcircuit elements are operating within their design temperature ratings when the hybrid microcircuit is operated at

the specified maximum operating case temperature. Finite element analysis is an acceptable thermal design analysis technique. All active and passive elements shall be derated (see 3.5.11a). In addition, for class S devices, all active and passive elements shall as a minimum be derated to the requirements of MIL-STD-975.

3.5.11 Electrical circuit design. Worst case circuit design analysis shall be performed and include the following evaluations as a minimum (applicable to the design):

a. Electrical element stress over the specified operating temperature range shall be within the specified derating criteria.

b. Voltage and timing margins under worst case temperature conditions. Margins should be assessed at external device terminals.

3.6 Marking of microcircuits. Marking shall be in accordance with the requirements of this specification, and the identification and marking provisions of the detail specification or drawing. The marking shall be legible and complete, and shall meet the resistance to solvents requirements of MIL-STD-883, method 2015. When mechanical or laser marking is performed it shall be clearly visible through those conformal coatings approved for use in MIL-I-46058 (See method 2015 of MIL-STD-883 if contrasting material or ink is used to highlight the trace). Mechanical or laser marked metal surfaces shall meet all applicable microcircuit finish and group D test requirements. Mechanical or laser marking shall be approved by the qualifying activity. If any special marking is used, it shall in no way interfere with the marking required herein, and shall be visibly separated therefrom. The following marking shall be included on each microcircuit unless otherwise specified.

a. Index point (see 3.6.1).

b. Part number (see 3.6.2).

c. Lot identification code or date code (see 3.6.3).

d. Hybrid manufacturer's identification (see 3.6.4).

e. Hybrid manufacturer's designating symbol (see 3.6.5).

f. Country of origin.(see 3.6.6).

g. Serialization, when applicable (see 3.6.7).

h. Special marking (see 3.6.8, 3.6.8.1).

i. Certification mark (see 3.6.8.3).

j. Electrostatic discharge sensitivity identifier (see 3.6.8.2).

Unless otherwise specified, the certification mark, the part number, the inspection lot identification code, and the ESD identifier shall be located on the top surface of flat packages or dual-in-line configurations and on either the top or the side of cylindrical packages (TO configurations and similar configurations).

3.6.1 Index point. The index point, tab, or other marking indicating the starting point for numbering of leads or for mechanical orientation shall be as specified and shall be applied so that it is visible from above when the microcircuit is installed in its normal mounting configuration. The outline of an equilateral triangle (i.e., Δ), which may be used as an electrostatic identifier (see 3.6.8.2), may also be used as the pin 1 identifier.

3.6.2 Part number. Each hybrid microcircuit shall be marked with the part number as specified in the acquisition document.

3.6.3 Lot identification code (date code). Hybrid microcircuits shall be marked by a unique code to identify the week of final seal. The first two numbers in the code shall be the last two digits of the number of the year, and 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. Reading from left to right or from top to bottom, the code number shall designate the year and week, in that order (e.g., 8806 equals week 6 of 1988). If QCI is performed on an inspection lot basis and 2 or more different inspection lots (or class S sublots), each having the same part number, are to be marked with the same identification code, a unique suffix letter immediately following the identification code shall be added.

3.6.4 Manufacturer's identification. Hybrid microcircuits shall be marked with the name or trade mark of the manufacturer. The identification of the equipment manufacturer may appear on the hybrid microcircuit only if the equipment manufacturer is also the hybrid microcircuit manufacturer.

3.6.5 Manufacturer's designating symbol. The manufacturer's designating symbol or CAGE code number shall be as listed on NAVSHIPS 0967-190-4010 or cataloging Handbook H4/H8. The designating symbol shall be used only by the manufacturer to whom it has been assigned and only on those devices manufactured at the manufacturer's plant. In the case of small hybrid microcircuits, the manufacturer's designating symbol may be abbreviated by omitting the first "C" in the series of letters.

3.6.6 Country of origin. The phrase "Made in the U.S.A." shall be marked in small characters below or adjacent to the other marking specified, except that for hybrid microcircuits made in a foreign country the phrase shall be changed accordingly. If there is limited space, the marking may be shortened to "U.S.A" or to the appropriate accepted abbreviation for the country of origin. At the option of the manufacturer, for QML hybrid microcircuits only, the country of origin marking may be omitted from the body of the hybrid microcircuit but shall be retained on the initial container.

3.6.7 Serialization. Serialization allows traceability of electrical tests results (variables data) to an individual hybrid microcircuit.

3.6.7.1 Class S serialization. Prior to the first recorded electrical measurement in screening, each class S hybrid microcircuit shall be marked with a unique serial number assigned consecutively. Lot records shall be maintained to provide traceability from the serial number to the specific incoming inspection lots from which the elements originated.

3.6.7.2 Class B serialization. Serialization of class B hybrid microcircuits shall only be required when specified in the acquisition documents.

3.6.8 Special marking. When the size of a package is insufficient to allow marking of special process identifiers on the top surface, the back side of the package may be used for these markings except the ESD identifier shall be marked on the top. Button cap flat packs with less than or equal to 16 leads may have the identifier marked on the ceramic. Back side marking with conductive or resistive ink shall be prohibited on nonconductive surfaces.

3.6.8.1 Beryllium oxide package identifier. If a hybrid microcircuit package contains beryllium oxide, the device shall be marked with this designation: BeO.

3.6.8.2 Electrostatic discharge sensitivity (ESD) identifier. ESD classification levels are defined as follows when tested in accordance with MIL-STD-883, method 3015.

ESD class designator	Prior designation category	Part marking	Electrostatic voltage
1	A	Δ	0-1,999 V
2	B	Δ Δ	2,000-3,999 V
3	-	- -	4,000 V

Devices not yet ESD classification tested shall be marked as class 1 until testing determines the appropriate class. Devices previously classed by test as category A shall be marked as class 1. Devices previously classified as category B shall be marked as class 2.

3.6.8.3 Certification mark. All hybrid microcircuits acquired to and meeting the requirements of this specification and the applicable associated acquisition documents, and which are approved for listing on QML-38534 shall bear the "QML" certification mark for SMD controlled hybrid microcircuits and the "CH" (compliant hybrid) certification mark for non-SMD controlled hybrid microcircuits. The certification mark shall be located preceding the date code. The certification mark abbreviation "Q" or "C" may be used for small devices. The "QML" or "CH" certification mark or the abbreviation "Q" or "C" shall not be used for any hybrid microcircuit acquired under contracts or orders which permit or require any changes to this specification. The "QML" or "CH" certification mark and its application shall constitute certification by the manufacturer that all tests of the applicable acquisition documents and this specification have been satisfactorily completed; that verifiable test data will be retained in files for not less than 5 years; and that within the specified time period, test data will be made available for on-site review by Government representatives upon request. In the event that a lot fails to pass inspection, the manufacturer shall remove or obliterate the "QML" or "Q" or "CH" or "C" certification mark from the sample tested and also from the devices represented by the sample.

3.6.8.4 RHA designator. Radiation hardness designators M, D, R, or H defined in 3.4.1.6 shall be marked on the part as indicated in the acquisition documents.

3.6.9. Marking option for controlled storage of class B. Where hybrid microcircuits are subjected to testing and screening in accordance with some portion of the quality assurance requirements and stored in controlled storage areas pending receipt of orders requiring conformance to the same or a different level, the inspection lot identification code shall be placed on the hybrid microcircuit package along with the other markings specified in 3.6 sufficient to assure identification of the material. As an alternative, if the microcircuits are stored together with sufficient data to assure traceability to processing and inspection records, all markings may be applied after completion of all inspection to the specified level.

3.6.10. Marking option for quality conformance inspection. The manufacturer has the option of marking the entire lot or only the sample devices to be submitted to groups B, C, and D quality conformance inspection. If the manufacturer exercises the option to mark only the sample devices, the procedures shall be as follows:

a. The sample devices shall be marked prior to performance of groups B, C, and D qualification or quality conformance inspections, as applicable.

b. At the completion of quality conformance inspection, the marking of the sample devices shall be inspected for conformance with the requirements of 3.6.

c. The inspection lot represented by the quality conformance sample shall then be marked and any specified visual and mechanical inspection performed.

d. The marking materials and processing procedures applied to the inspection lot shall be the same as those used for the inspection sample.

3.6.11 Remarking. If sealed devices are remarked (to change or correct the marking as specified in 3.6) the reason for remarking shall be recorded. The remarking procedure and its qualification test plan shall be approved by the qualifying activity. Approval shall be required once only for each package material composition (marking surface base material and plating).

3.7 Workmanship. Hybrid microcircuits shall be manufactured, processed, and tested in a careful and workmanlike manner in accordance with good engineering practice, with the requirements of this specification and with the production practices, workmanship instructions, inspection and test procedures, and training aids prepared by the manufacturer in fulfillment of the product assurance program (see appendix A). For contamination and foreign material identification, see internal visual inspection requirements of MIL-STD-883, methods 2017 and 2032.

3.7.1 Environment control. The following are minimum environmental control requirements. The air particle counts for the classifications indicated shall be as described in Federal Standard 209. All fabrication, assembly, and testing of hybrid devices prior to preseal visual shall be in an environment meeting class 100,000 particle count requirements. Devices awaiting preseal visual inspection, devices accepted at preseal visual inspection and awaiting further processing and noncontinuous production lots (see 3.1.3.16) accumulated after element attach and prior to preseal visual (including parts delidded for rework or repair) shall be stored in a dry nitrogen environment. The preseal visual inspection and the preparation for sealing environment shall be in accordance with MIL-STD-883, methods 2017 and 2032. In addition, for class S devices, all photolithographic operations shall be performed in a class 100 environment.

3.7.2 Rework and repair provisions. All rework and repair permitted on devices shall be accomplished in accordance with procedures and safeguards in accordance with MIL-STD-1772 and 30.1.1.6 of appendix A. This documentation shall reflect the processes, procedures, and materials to be used including verification or test data, and be approved by the qualifying activity. Each process or procedure shall be designated as rework or repair. This documentation shall indicate that a decision to rework is made solely by the manufacturer while a repair decision shall be made with the concurrence of the qualifying activity except for repairs permitted by this specification. When required, the Government shall participate in repair decisions (see MIL-STD-1520). A typical example of rework is the removal of a defective element and replacement with a new element. An example of repair is the use of an organically attached molytab to replace a previously alloy attached semiconductor element.

3.7.2.1 General rework and repair provisions.

a. All temperature excursions during any rework or repair shall not exceed the baselined rework or repair limitations. Time and temperature limits shall be specified.

b. Touch-up of package sealing surface plating on delided packages is not permitted.

c. The minimum distance between the glass to metal seals and the package sealing surface shall be at least .040 inch (.050 inch for class S) after final seal to prevent damage to lead seals by welding adjacent to them. (Applies to seam welding only.)

d. Any device which is reworked or repaired after preseal visual inspection shall be subjected to full screening or rescreening as applicable. If a device has not been subjected to a given required screen prior to rework or repair, then that device must be subjected to that screen after repair or rework. For class S devices, full rescreening beginning with preseal visual inspection is required after any rework or repair operation involving unlidded (includes delidded) devices. For class B devices, if a device has been subjected to a given screen prior to rework or repair, then rescreening applies as follows:

(1) Preseal visual inspection. Inspect for general damage (low magnification in accordance with MIL-STD-883, method 2017 and method 2032) which might have been caused by the rework or repair and perform a complete method 2017 or method 2032 inspection of the reworked or repaired element or area (e.g., replaced die, wirebonds, etc.).

(2) Stabilization bake, temperature cycle or shock, mechanical shock or centrifuge, seal, and external visual. Rescreen all rework or repair devices 100 percent.

(3) Burn-in. Devices delidded to rework package seal failures do not require burn-in rescreen. Devices which have had elements replaced or have been wirebonded or rewirebonded require 100 percent burn-in rescreen.

e. When flux is required for rework or repair, the specific flux and detailed procedures for its use and subsequent special cleaning operations shall be documented and approved in accordance with 30.1.1.6 of appendix A.

f. Replacement elements shall not be bonded onto the chip element they are to replace.

3.7.2.2 Element wire rebonding. Wire rebonding of elements other than substrates shall be permitted with the following limitations:

a. No scratched, voided, or discontinuous paths or conductor patterns on an element shall be repaired by bridging with or addition of bonding wire or ribbon.

b. All rebonds shall be placed on at least 50 percent undisturbed metal (excluding probe marks that do not expose underlying oxide). No more than one rebond attempt at any design bond location shall be permitted. No rebonds shall touch an area of exposed oxide caused by lifted or blistered metal. A bond shall be defined as a wire to post or wire to pad bond. Bond-offs required to clear the bonder after an unsuccessful bond attempt need not be visible, shall not be cause for reject and shall not be counted as a rebond.

For class S, the total number of rebond attempts (exclusive of total element replacement) shall be limited to a maximum of 10 percent of the total number of bonds in the hybrid microcircuit. The 10 percent limit on rebond attempts may be interpreted to the nearest whole number to the 10 percent value.

3.7.2.3 Substrate wire rebonding or repair. Wire rebonding on substrates shall be permitted with the following limitations:

a. Scratched, open, or discontinuous substrate metallization paths or conductor pattern on a substrate, not caused by poor adhesion, may be repaired by bridging with or by addition of bonded conductors having current carrying capacity at least 3.5 times the maximum calculated operating load current for the conductor or 3.5 times the current capacity of the wire bond connection terminating on the damaged conductor path. The quantity of repairs shall be limited to one for each one half (1/2) square inch or fraction thereof of substrate area.

b. No rebonds shall be made over intended bonding areas in which the top layer metallization has lifted, peeled, or has been damaged such that underlying metallization or substrate is exposed at the immediate bond site.

3.7.2.4 Compound bonding. Compound bonding for rework or repair is permitted only as follows:

a. A gold ball bond on a substrate wire, a gold ball or a crescent bond.

b. Only monometallic compound bonds are permitted (i.e., the original bond wire and that used for compound bonding must be the same material).

c. The new bond must cover at least 75 percent of the original bond or wire.

d. The maximum number of compound bonds shall not exceed 10 percent of the total number of wires.

e. A corrective action system must be utilized in order to reduce the number of compound bonds.

f. All compound bonds shall be 100 percent nondestructive pull tested in accordance with MIL-STD-883, method 2023.

g. A compound bond shall not be used to connect two wires.

h. All compound bonds shall meet the visual criteria in MIL-STD-883, methods 2017 and 2032.

3.7.2.5 Element replacement. Element replacement shall be permitted with the following limitations:

a. Any polymer attached element may be replaced two times at a given location (not more than one time for class S) on any device.

b. Any metallic attached element may be replaced one time at a given location.

c. Any metallic attach element onto a plated tab where the tab is attached to a substrate with a higher temperature metallic attach process, may be replaced two times.

d. Substrates may be removed and put into a new package one time.

3.7.2.6 Seal rework. It shall be permissible to perform seal rework without delidding on hybrid microcircuits that fail fine leak testing one time, only if tracer gas is included during the original sealing operation and under all of the following conditions:

a. Fine leak testing, without pressurization (bomb), must be performed immediately after sealing prior to any other test.

b. Devices shall be stored in nitrogen environment for a maximum of 4 hours between initial seal and reseal without replacing the cover.

c. Devices shall be submitted to a predetermined vacuum bake prior to reseal.

d. Only lid to package seals shall be resealed. Solder sealed packages may not be reworked in accordance with this procedure.

NOTE: The above leak testing shall not be used as a substitute for the fine leak testing required in MIL-STD-883.

3.7.2.7 Delidding of devices. Hybrid microcircuits may be delidded and relidded for rework or repair provided the delid-reseal procedures, controls, qualification plan, and resulting data are baselined and approved by the qualifying activity. Qualification of the delid-reseal process shall be in accordance with subsection B-4 or B-5 of MIL-STD-1772. The number of delid-reseal cycles allowed shall be in accordance with 3.7.2.7.1 or 3.7.2.7.2. Delid-reseal history (i.e., traceability by lot number or serial numbers) shall be maintained by the hybrid manufacturer and shall be made available for acquiring or qualifying activity review upon request.

3.7.2.7.1 Solder sealed devices. Class B solder sealed devices may be delidded-resealed one time. Class S solder sealed devices may not be delidded-relidded.

3.7.2.7.2 Welded devices. Only seam sealed, overlapping pulse welded, or laser welded packages designed for delid-reseal may be delidded-resealed. Class B devices may be delidded-resealed two times and class S devices may be delidded-resealed one time. For class B welded devices only, additional (i.e., more than 2) delid-reseal cycles may be approved by the acquiring activity.

Qualifying of more than one delid-reseal cycle shall be in accordance with subsection B-4 or B-5 of MIL-STD-1772, except the samples shall be delidded and relidded N + 1 times to qualify for "N" delid-reseal cycles. For example, the samples shall be delidded and relidded three times to qualify for two delid-reseal cycles, four times to qualify for three delid-reseal cycles, etc.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements (examinations and tests) as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in this specification where such inspections are deemed necessary to insure supplies and services conform to prescribed requirements.

The Government also reserves the right to witness any of the tests and inspections set forth herein or in the detail specification and to audit the data resulting from the manufacturer's performance of these examinations and tests. The responsible Government inspection agency shall be given adequate notification prior to the initiation of all tests and inspections. If a manufacturer elects to eliminate a quality conformance inspection step or 100 percent screen step by substituting a statistical process control program (see 4.1.2.2), the manufacturer is only relieved of the responsibility of performing the QCI or 100 percent screen step.

4.1.1 Responsibility for compliance. All items shall meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of insuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

4.1.1.1 Quality assurance program. A quality assurance program shall be established in accordance with appendix A.

4.1.2 Inspection during manufacture. The manufacturer shall establish and maintain in-process production controls, quality controls and inspections at appropriately located points in the manufacturing process in accordance with the procedures described in 30.1.1 of appendix A to assure continuous control of quality of materials, subunits, and parts during manufacture and testing. These controls and inspections shall be adequate to assure compliance with the applicable acquisition documentation and quality standards of hybrid microcircuits manufactured to this specification.

4.1.2.1 Control of critical processes and procedures. Critical processes and procedures shall be monitored in accordance with MIL-STD-883, method 5008.

4.1.2.2 Statistical process control (SPC). The use of statistical process control (SPC) is strongly encouraged. As a minimum, the SPC program should include training, definition of controlled critical processes, installation of statistical control techniques and a control action system as defined by JEP-19. Process control is recommended for (but not limited to) wirebonding, lid seal, lead trim, and final lead finishing (solder dip, etc.). When implemented as allowed by manufacturer's option in 4.1, the program shall be documented and approved by the qualifying activity. The implementing procedures shall provide for frequency, sample size, reject criteria, allowable rework, and disposition of failed product or lot. Also, a procedure is required for the traceability, recovery, and disposition of all devices manufactured since the last successful test in case of process failure. Records of process control shall be available for review. The use of SPC control charts is recommended.

4.1.2.3 Inspection verification for class S devices. Following each 100 percent visual inspection during assembly, trained quality control inspectors shall reinspect a sample of the materials, assemblies, or devices to the same criteria used for the 100 percent inspection. Sampling will be to a sample size (accept number) of 22(0). Lots failing to meet the sample size (accept number) requirement shall be 100 percent reinspected and resampled to a sample size (accept number) of 32(0). This reinspection requirement shall not be applied to the 100 percent nondestructive bond pull test.

4.1.2.4 Metal package isolation test for class S devices. Prior to die mount, each metal-bodied package with leads glass-isolated within 0.005 inch (0.13 mm) of the metal body shall have 600 V dc applied between the case and leads not connected to the case. Packages which exhibit leakage greater than 100 nA shall be rejected. This test may be performed as part of incoming (receiving) inspection.

4.1.3 Control and inspection records. The manufacturer shall maintain objective evidence documenting that each lot has been subjected to all processing controls, inspections, and tests accomplished in accordance with sections 3 and 4 herein. Records shall be retained as specified in 30.1.1 of appendix A.

4.1.4 Configuration documents. The supplier shall upon request furnish device specification documentation to the acquiring activity. The documentation submitted for review, upon the request of the acquiring activity, shall include the current design, topography, schematic circuit, and related information.

4.1.5 Control and inspection of acquisition sources. The manufacturer shall be responsible for assuring that all supplies and services used in the manufacture and test of hybrid microcircuits conform to all the requirements of this specification, the detail specification, and other provisions of the applicable acquisition documentation.

4.1.6 Test equipment and inspection facilities. All measurements for process control or product acceptance shall be made with instruments whose accuracy has been certified. Calibration shall be traceable to the National Institute of Standards and Technology (NIST). Calibration of measurement and test equipment and test standards which control the accuracy of inspection and test equipment and facilities shall be in accordance with MIL-STD-45662.

4.1.7 Manufacturer control over its distributors. The manufacturer shall be responsible for assuring that its distributors maintain adequate controls to assure that products sold are of the same quality as products acquired directly from the manufacturer.

4.1.8 Distributor inventory, traceability, and handling control. Distributors shall, as a minimum, maintain an adequate inventory control system, traceability documentation required by this specification and their appropriate certification, adequate handling, storage, ESD controls (see JEP-108), and repackaging methods to protect quality and prevent damage and degradation of products.

4.1.9 Government source inspection for class S devices. For class S device programs, Government personnel, and other Government designated representatives (when required by contract or order), shall perform surveillance and monitoring functions related to inspection, assembly, and substrate fabrication from substrate lot acceptance through acceptance of the completed product. The mandatory inspection requirements will be performed or witnessed by the Government representative at designated manufacturing and test steps as depicted in the manufacturing or inspection flow chart. Adequate inspection stations shall be provided to the Government representative. These designated mandatory manufacturing and test steps are reflected in the procedures of section III, part 5 of DLAM 8200.2, and as a minimum shall include the following:

a. Review of substrate lot acceptance results.

b. Right to witness and analyze SEM photography, if applicable.

c. Perform visual inspection at preseal (at each power specified) on a sample basis unless 100 percent inspection is required by the applicable contract.

d. Surveillance of in-process bond strength test.

e. Surveillance of burn-in board checkout for circuit continuity.

f. Surveillance of group B tests.

g. Audit of documentation.

h. Surveillance of failure analysis, DPA activities and the results and corrective actions related thereto, if applicable.

i. Surveillance of radiation hardness assurance tests, if applicable.

j. Surveillance of ESDS classification tests.

4.2 Procedure for lots held more than 36 months. Hybrid microcircuits held by manufacturers or authorized distributors for a period exceeding 36 months following the date of the inspection lot identification code, shall be reinspected by the manufacturer for all specified group A inspection requirements, prior to shipment. In case of lot failure during reinspection, the lot shall be subjected to 100 percent inspection for all tests in the subgroup failed and all hybrid microcircuits which fail any of these tests shall be removed from the lots and rejected.

All reinspection lots with date codes of 8601 or later shall also be resubjected to and pass the solderability subgroup B-7 of method 5008 (B-3 for method 5005) of MIL-STD-883.

The devices shall retain the original inspection lot identification code (see 3.6.3). Records of reinspection shall be maintained as specified in 30.1.2 of appendix A.

4.3 General inspection conditions. The general requirements of MIL-STD-883 shall apply.

4.3.1 Classification of examinations and tests. The examinations and tests required to assure conformance to the specified product assurance levels of hybrid microcircuits or lots thereof are classified as follows:

Title	Paragraph
Element evaluation	4.4 (See 3.4.2)
Screening	4.5 (see 3.4.4)
Quality conformance inspection (QCI)	4.6 (See 3.4.5)
Data recording	4.7

4.3.2 Sampling. Statistical sampling for quality conformance inspections shall be in accordance with the sampling procedures of appendix B of this specification, and as specified in the acquisition document or drawing, as applicable. Reserve sample devices may be tested with the subgroups to provide replacements in the case of test equipment failure or operator error (see 4.3.5). These devices shall be used in predesignated order. Initial samples and samples used for resubmission shall be randomly selected from the inspection lot or sublot, as applicable.

4.3.2.1 Disposal of samples. Hybrid microcircuits subjected to destructive tests or which fail any test shall not be shipped on the contract or purchase order as acceptable product. They may, however, be delivered at the request of the acquiring activity if they are isolated from, and clearly identified so as to prevent their being mistaken for acceptable product. Sample hybrid microcircuits from inspection lots which have passed product assurance inspection or tests and which have been subjected to mechanical or environmental tests classified non-destructive (see 4.3.2.3) or found to be nondestructive by repetitive testing (see 4.3.2.2), may be shipped as acceptable product provided they pass 100 percent external visual inspection in accordance with MIL-STD-883, method 2009 and 100 percent group A electrical tests in accordance with the applicable device specification.

4.3.2.2 Destructive tests. All mechanical or environmental tests (other than those listed in 4.3.2.3), shall be considered destructive initially, but may subsequently be considered nondestructive upon accumulation of sufficient data to indicate that the test is nondestructive. The accumulation of data from five repetitions of the specified tests on the same sample of product, without evidence of cumulative degradation or failure to pass the specified test requirements in any hybrid microcircuit in the sample, is considered sufficient evidence that the test is nondestructive. 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. Unless otherwise specified or subsequently determined to be otherwise, the following MIL-STD-883 tests shall be initially classified as destructive.

Internal visual and mechanical (method 2014).

NOTE: This inspection is nondestructive when performed at preseal visual.

Bond strength (method 2011)
Solderability (except for lead finish A)
Moisture resistance
Lead integrity (method 2004)
Salt atmosphere
SEM inspection for metallization
Steady state life test (accelerated)
Die shear strength test
Total dose radiation hardness test
Electrostatic discharge sensitivity test
Lid torque test
Adhesion of lead finish
Vibration, variable frequency
Internal water vapor test
Pin grid package lead pull (method 2028)

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

Barometric pressure
Steady state life (see note)
Intermittent life (see note)
Hermeticity
External visual
Internal visual (preseal)
Burn-in screen (see note)
Radiography
Particle impact noise detection (PIND)
Physical dimensions
Nondestructive bond pull test (method 2023)
Resistance to solvents
Solderability (for lead finish A only)

NOTE: When the test temperature exceeds the maximum specified junction temperature for the device (including maximum specified for operation or test), these tests shall be considered destructive unless otherwise specified.

4.3.3 Formation of lots. Hybrid microcircuits shall be segregated into identifiable production lots as defined in 3.1.3.21 as required to meet the production control and inspection requirements of appendix A. Hybrid microcircuits shall be formed into inspection lots as defined in 3.1.3.14.1 as required to meet the quality assurance inspection and test requirements of this specification.

4.3.3.1 Resubmission of failed lots. Resubmitted lots shall be kept separate from new lots and shall be clearly identified as resubmitted lots. When any lot submitted for quality conformance inspection fails any subgroup requirement of group A, B, C, or D tests, it may be resubmitted once for that particular subgroup at double the sample size with zero failures allowed. A second resubmission using double the initial sample size with zero failures allowed is permitted only if failure analysis is performed to determine the mechanism of failure for each failed hybrid microcircuit from the prior submissions and it is determined that failure is due to:

a. A defect that can be effectively removed by rescreening the entire lot, or

b. Random type defects which do not reflect poor basic device design or poor basic processing procedures.

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

4.3.4 Test method alternatives. Alternate test methods are allowed provided that it is demonstrated to the qualifying activity that such alternatives in no way relax the requirements of this specification and that they are approved before testing is performed. For proposed electrical test alternatives, schematic wiring diagrams of the test equipment shall be made available for checking by the acquiring activity. Electrical test and burn-in circuits shall be approved by the acquiring activity.

4.3.5 Procedure in case of test equipment failure or operator error. Whenever a hybrid microcircuit is believed to have failed as a result of faulty test equipment or operator error, the failure shall be entered in the test record which shall be retained for review along with a complete explanation verifying why the failure is believed to be invalid. When Government source inspection (GSI) is required, the Government quality assurance representative (QAR) shall be notified within one working day and given details from the test record and the opportunity to challenge the validity of the error claimed. If no challenge is made within the next working day, the error will be considered valid as recorded.

NOTE: ESD failures shall be counted as rejects and not attributed to equipment or operator error for screening, group A and endpoint electrical tests of method 5005 and method 5008 of MIL-STD-883.

4.3.5.1 Procedure for sample tests. When it has been established that a failure is due to test equipment failure or operator error and it has been established that the sample device has been damaged or degraded, a replacement hybrid microcircuit from the same inspection lot may be added to the sample. The replacement hybrid microcircuit shall be subjected to all those tests to which the discarded hybrid microcircuit was subjected prior to its failure and to any remaining specified tests to which the discarded hybrid microcircuit was not subjected prior to its failure. The manufacturer, at his own risk, has the option of replacing the failed hybrid microcircuit and continuing with the tests before the validity of the test equipment failure or operator error has been established.

4.3.5.2 Procedure for screening tests. When it has been established that a lot failure during screening test is due to operator or equipment error and it has been established that the remaining product has not been damaged or degraded, the lot or surviving portion of the lot, as the case may be, may be resubmitted to the corrected screening test in which the error occurred. Failures verified as having been caused by test equipment failure or operator error shall not be counted in the PDA calculation (when applicable).

4.3.5.3 Failure and corrective action reports. When the procedures of 4.3.5.1 and 4.3.5.2 are utilized in continuing sample tests or resubmitting lots for screening tests, the manufacturer shall document the results of his failure investigations and corrective actions and shall make this information available to the Government QAR, the acquiring activity, or the qualifying activity, as applicable.

4.3.6 Test equipment verification. The manufacturer shall define and utilize a method (e.g., correlation samples; diagnostic routines, etc.) to verify the measurement or operation characteristics of the electrical test equipment. When in use, electrical test equipment shall be verified at the start of a test run and after any physical changes to the test system (i.e., replacement of test equipment, etc.). When a test run exceeds one day, verification shall be accomplished at the end of the test run.

4.3.7 Manufacturer imposed tests. For class B, any manufacturer imposed tests (e.g., gross and fine leak) conducted after any screening tests, but prior to any qualification or quality conformance testing, are to be reported in both the qualification and quality conformance reports. The number of devices tested and the number of devices failed shall be included in the report. If any manufacturer imposed tests detect a problem, the manufacturer shall submit all devices in the lot to those tests to eliminate rejects and shall take steps to determine and eliminate the cause of failure (e.g., rough handling which has produced gross leaks).

4.4 Element evaluation. Element evaluation shall be conducted in accordance with 3.4.2, herein. Inspection lot sampling shall be in accordance with appendix B of this specification.

4.5 Screening. Hybrid microcircuits shall have been subjected to and passed all the screening tests detailed in 3.4.4 in order to be acceptable for delivery. When PDA or pattern failure or delta limits have been specified or other conditions for lot acceptance have been imposed, the required data shall be recorded and maintained as a basis for lot acceptance. Devices which fail any test criteria in the screening sequence shall be removed from the lot at the time of observation or immediately at the conclusion of the test in which the failure was observed. Once rejected and verified as a device failure, rework and subsequent rescreening in accordance with the limitations of 3.7.2 may be performed.

4.5.1 Burn-in. Burn-in shall be performed on all devices and the specified pre burn-in (interim burn-in for class S devices) and post burn-in electrical parameters shall be measured. Burn-in for class B devices shall be 160 hours (320 hours for class S).

4.5.1.1 Failure analysis of burn-in screen failures for class S devices. Catastrophic failures (i.e., shorts or opens measurable or detectable at 25°C) subsequent to burn-in shall be analyzed. Analysis of catastrophic failures may be limited to a quantity and degree sufficient to establish failure mode and cause and the results shall be documented and made available to the Government representative.

4.5.1.2 Lots resubmitted for burn-in. Unless otherwise specified, burn-in lots may be resubmitted for burn-in one time only. Resubmitted lots shall be kept separate from new lots and shall be inspected for all specified characteristics using a tightened inspection PDA equal to the next lower number in the PDA series (see appendix B). The number of pattern failures allowed shall be the same as was required for the original burn-in.

4.5.1.3 Burn-in acceptance criteria. At the option of the manufacturer burn-in acceptance shall be based on PDA or PDA pattern failures.

4.5.1.3.1 General. Pattern failures are multiple device failures within a device burn-in lot (two or more depending on lot size) with the same root cause of failure.

Manufacturers must determine and document, prior to beginning burn-in, the criteria for the formation of burn-in lots (i.e. devices submitted to burn-in at one time, a production lot, an inspection lot or some other collection of devices) for the purposes of PDA calculation. In all cases, the burn-in lot shall be ≥ 41 devices or all devices submitted to burn-in during a one-week period, whichever is less.

The supplier shall not conduct burn-in in addition to that specified. Delta limits shall be defined in the acquisition documents when required. When the PDA or pattern failures applies to delta limits, the delta parameter values measured after burn-in (100 percent screening test) shall be compared with the delta parameter values measured prior to that burn-in. Unless otherwise specified in the acquisition documents, PDA and pattern failure analysis shall be applicable only to 25°C static tests (group A, subgroup 1).

4.5.1.3.2 PDA option. If acceptance is based solely on PDA and unless otherwise specified in the acquisition documents, the PDA shall be 10 percent or 1 device, whichever is greater, for class B devices (2 percent or 1 device for class S) regardless of burn-in lot size.

4.5.1.3.3 PDA or pattern failure option. If acceptance is based on PDA pattern failures, the following shall apply:

4.5.1.3.3.1 Lot size less than 40. Pattern failure analysis shall be the basis for determining lot acceptance for lot sizes of 40 devices or less. The maximum number of device static failures at 25° C allowed before a "failure pattern" has been established shall be as follows:

Pattern failure analysis
device failures allowed

Lot size (x)	Class B	Class S
x ≤ 20	2	0
21 ≤ x ≤ 40	3	0

Example: Lot size is 25 with 4 device static failures at 25° C.

a. Class S device fails.

b. If all 4 device failures do not have the same root cause of failure (i.e. 3 or less failures with the same root cause), then no "failure pattern" exists for class B devices and the passing 21 devices are acceptable.

c. If all 4 failures have the same root cause of failure, then a "failure pattern" exists for class B devices and the lot would be rejected.

4.5.1.3.3.2 Lot size greater than 40. PDA and pattern failure analysis shall be the basis for determining lot acceptance for lot sizes greater than 40 devices. Device failures resulting in a percent defective for 25° C static parameters in excess of the required PDA may be failure analyzed for pattern failures. If the number of device failures exceed the required PDA but the number of device failures with the same root cause is less than or equal to the number of failures required to establish a "failure pattern", then the lot is acceptable. Unless otherwise specified in the acquisition documents, the maximum allowable PDA and the number of device failures allowed before a "failure pattern" is established shall be as follows:

Pattern failure analysis

	Device failures allowed		PDA	
Lot size (x)	Class B	Class S	Class B	Class S
40 < x ≤ 100	4	0	10%	2%
100 < x ≤ 300	5	0	10%	2%
300 < x ≤ 500	10	0	10%	2%
500 < x	15	0	10%	2%

Example 1: Lot size is 400 with 15 device static failures at 25°C.

a. If class B, the lot is acceptable (i.e. 10 percent PDA allows 40 device failures).

b. If class S, the lot fails PDA and must be rejected.

Example 2: Lot size 400 with 41 device static failures at 25° C.

a. If class B and 10 or less of the device failures are due to the same root cause, then a "failure pattern" does not exist and the lot is acceptable.

b. If class B and 11 or more of the device failures are due to the same root cause, then a "failure pattern" has been established and the lot is unacceptable.

4.5.2 External visual screen. The final external visual screen shall be conducted in accordance with MIL-STD-883, method 2009 after all other 100 percent screens have been performed to determine that no damage to, or contamination of the package exterior has occurred.

4.5.3 Lead forming. When lead forming (bending) is specified for any device class, a 100 percent fine and gross seal test shall be performed after the lead forming operations and prior to final visual inspection of these devices. Devices which fail seal tests shall be removed from the lot.

4.5.4 Nondestructive bond pull test for class S devices. Nondestructive 100 percent bond pull test shall be performed for class S devices. The total number of failed wires and the total number of devices failed shall be recorded. The lot shall have a percent defective allowable (PDA) of 2 percent or less based on the number of wires pulled in the production lot. The test shall be performed in accordance with MIL-STD-883, method 2023. Devices from lots which have been subjected to the nondestructive 100 percent bond pull test and have failed the specified class S PDA requirement shall not be delivered as class B product.

4.6 Quality conformance inspection

4.6.1 General. Quality conformance inspection for a given hybrid microcircuit type is determined by selection of a requirements option flow (see table I) at the time of contract negotiation and acceptance. The requirements option flow selected shall determine the QCI requirements for the specific hybrid microcircuit manufactured. Where applicable, inspection lot sampling shall be in accordance with appendix B of this specification. Except where the use of electrical rejects or simulation samples (i.e., test coupons) is allowed, all hybrid microcircuits shall have been previously screened (see 3.4.4 and 4.5) and subjected to and passed all final electrical tests. Successful completion of quality conformance inspection for a given product assurance level shall satisfy the quality conformance requirements for any lower level hybrid microcircuit manufactured on the same certified line. If a lot is withdrawn in a state of failing to meet quality conformance requirements and is not resubmitted, it shall be considered a failed lot and reported as such. Lots submitted for quality conformance inspection shall meet the requirements of 3.4.5 for all device classes.

NOTE: The hybrid manufacturer has the right to elect not to use any solution or solvent identified within this specification or related specifications that has also been identified by the American Congress of Government Industrial Hygienists as being a potential or suspect carcinogen. Where the hybrid manufacturer elects not to use a material, he must notify the acquiring or qualifying activities and the customer in writing in clear, unambiguous language not subject to misinterpretation that this right has been exercised.

4.6.1.1 Sample selection. The number of hybrid microcircuits to be tested shall be chosen (independent of lot size) by the manufacturer in accordance with the applicable requirements of options 1, 2, or 3 herein and MIL-STD-883, method 5005 or method 5008.

Initial samples and resubmitted samples, when applicable, shall be randomly selected from the inspection lot. Lot acceptance is based on an accept number of zero. If a failure occurs, the failed subgroup or test may be performed once using double the sample size with zero failures allowed. The manufacturer shall retain a sufficient number of hybrid microcircuits from the lot to provide for doubling the sample size.

For group C inspection, limited sample quantities may be used to meet the requirements of 3.4.5 for production start-up. When limited sampling is used for start-up, a subsequent full sample group C test shall be performed within 6 months of the initial group C or prior to exceeding the limited usage requirements of MIL-STD-883, method 5008, whichever occurs first.

4.6.1.2 End point. Electrical endpoints shall be measured (and recorded when required) before starting and after completion of all tests in the subgroups of group C for which electrical end point measurements are specified and intermediate measurements shall be made as required by the applicable detail specification. Test samples which require variable data shall be serialized prior to tests.

4.6.1.3 Data. Test results shall be recorded by inspection lot identification code (see 3.6.3) for each inspection lot. For in-line group B inspections where inspection lots are not applicable, data records or logs shall be maintained and available for review by the qualifying and acquiring activities. A summary of attributes results for all tests and measurements shall be part of the test report. Variable data shall be provided when required by the acquisition document.

4.6.2 Quality conformance routines. Hybrid microcircuits shall be tested for conformance in accordance with the applicable requirements option as follows:

4.6.2.1 Option 1 (in-line inspection). Option 1 quality conformance inspection shall be satisfied by in-line inspection performed in accordance with the applicable procedures of MIL-STD-883 as detailed herein.

4.6.2.1.1 Group A electrical testing. Group A electrical testing shall be performed in accordance with MIL-STD-883, method 5008 and the applicable acquisition document.

4.6.2.1.2 Group B inspection. Group B inspection shall be satisfied by performing in-line inspection sampling monitoring as follows. Electrically rejected devices or test vehicles may be used in all subgroup tests in lieu of actual product.

a. Physical dimensions. Randomly select hybrid microcircuits from devices at final inspection such that as a minimum 2 devices of each package configuration presented for inspection are inspected each month. Confirm that all critical dimensions affected by the assembly process (e.g., package length, width, height; pin length; etc.) meet the requirements of the detail drawing. Critical dimensions unaffected by assembly processes may be inspected at final visual inspection or as a part of incoming (receiving) inspection.

b. Resistance to solvents. Each inspection lot of marking ink shall be tested prior to acceptance in accordance with MIL-STD-883, method 2015. This series of tests shall be performed on each type of surface which is used as the marking surface on completed hybrids (e.g., silver plate, abraded nickel plate, nonabraded nickel plate, etc.). One piece of each surface type shall be tested in each solvent.

   Each week one device or element (lid or package) representative of each of the marking surfaces of each device marked during the week shall be tested in accordance with MIL-STD-883, method 2015 except that only "solvent D" is required.

c. PIND. PIND testing is not required for class B devices. PIND testing for class S devices shall be performed in accordance with MIL-STD-883, method 5008.

d. Internal visual and mechanical. Internal visual and mechanical inspection shall be performed at preseal visual inspection in accordance with the requirements of MIL-STD-883, method 2014. As a minimum, one device of each hybrid microcircuit type received at preseal visual inspection each month shall be inspected.

e. Bond strength. Wire bond strength in-line inspection shall be performed as a part of wire bond certification (method 5008) and in accordance with MIL-STD-883, method 2011. Weekly a minimum of two samples from each wire bond process (i.e., thermosonic gold, ultrasonic aluminum, thermal compressions gold, etc.) shall be tested. Where more than one machine exists for a specific process, the test sample shall be rotated between machines such that all machines are tested at least once during each 13 week period when in operation. At the time of certification, an additional minimum 10 wires total (15 wires for class S) shall be bonded in the certification sample parts. After completion of certification bond pulls, the parts with the additional 10 wires (15 wires for class S) intact shall be preconditioned for one hour at 300° C minimum in either air or an inert atmosphere followed by destructive pull tests. No failures are allowed.

The minimum allowable bond strength shall be one gram for 0.001 inch wire (aluminum or gold). With diameters greater than 0.001 inch, refer to method 2011, table I post seal bond strength and use the bond strength value indicated minus one gram. For wire (gold or aluminum) with diameters greater than 0.003 inch, refer to figure 2011-1 and use the post seal bond strength value less 10 percent.

f. Die shear. Die shear testing shall be performed on 2 devices as a part of group C inspection (i.e., first lot and any element attach changes). Die shear testing during group C shall be performed in accordance with MIL-STD-883, method 2019.

g. Solderability. Solderability testing shall be performed as a part of incoming inspection (i.e., package evaluation, method 5008) as follows:

Packages shall be temperature aged to one of the following conditions prior to performing the solderability test.

24 ±1 hours at T_A = 250° C, ±10° C
36 ±2 hours at T_A = 225° C, ±9° C
57 ±3 hours at T_A = 200° C, ±8° C
160 ±8 hours at T_A = 150° C, ±6° C

When the hybrid process flow includes an operation in which the package lead finish is changed prior to delivery of the hybrid (i.e., a solder coating is applied), this operation shall be performed on the package evaluation sample packages subsequent to the temperature aging.

Following the temperature aging (and the lead finish application, if applicable) the sample packages shall be solderability tested in accordance with method 2003 including a 7 to 8 hour steam aging.

h. Seal. Seal tests shall be performed in accordance with MIL-STD-883, method 1014. 100 percent testing shall be performed on all devices between final electrical test and external visual.

4.6.2.1.3 Group C inspection. Group C inspection shall be performed only on the first inspection lot submitted for inspection and as required to evaluate or qualify changes listed in 3.4.7. Group C inspection shall be performed in accordance with MIL-STD-883, method 5008 and include die shear and wire bond strength tests as follows. Sample devices for die shear and wirebond strength tests may be devices from subgroup 3 or testing may be performed in-line.

a. Group C sample selection. Samples for group C inspection shall be drawn from the first inspection submitted.

b. Wire bond strength. One device minimum shall be tested to assure conformance to the applicable requirements of MIL-STD-883, method 2011. The device shall be preconditioned for one hour at 300° C minimum in either air or an inert atmosphere. Sample criteria shall be based on the number of wires pulled using a sample size(accept number) of 22(0) for class B devices and a sample size(accept number) of 45(0) for class S devices. Sample wires shall include one wire from each type transistor, diode, capacitor, and resistor chip; 3 wires from each type of integrated circuit; and 5 wires from package leads as applicable. For test conditions F and H, test 3 dice for each method of interconnection, or all flip chips and beam lead dice, if less. The minimum allowable bond strength shall be one gram for 0.001 inch aluminum or gold wire. For aluminum or gold wire with diameters greater than 0.001 inch, refer to method 2011, table I post seal bond strength and use the bond strength value indicated minus one gram. For gold or aluminum wire with diameters greater than 0.003 inch, refer to figure 2011-1 and use the post seal bond strength value less 10 percent.

c. Die shear. Die shear testing shall be performed in accordance with MIL-STD-883, method 2019. Testing shall be performed to a sample size(accept number) of 22(0) based on elements. The shear sample shall be uniformly divided among all element types in the hybrid microcircuit and shall be performed in a minimum of two devices. The sample shall include as applicable typical resistor, capacitor, integrated circuit, transistor and diode elements.

4.6.2.1.4 Group D inspection. This testing is accomplished during package evaluation at incoming inspection and need not be repeated.

4.6.2.1.5 Nonconformance. Should failure occur in any of the above in-line inspections, an analysis to determine cause shall be performed and corrective action, as necessary, shall be imposed. The cause of failure, applicable corrective action, and disposition of product affected by the failure shall be documented. This documentation shall be available for qualifying and acquiring activity review.

4.6.2.2 Option 2 (method 5008). Option 2 quality conformance inspection shall be conducted in accordance with the applicable requirements of groups A, B, C, and D of method 5008 of MIL-STD-883 for the specific device class.

4.6.2.2.1 Group A electrical testing. Group A testing shall be performed in accordance with method 5008 of MIL-STD-883 and the applicable detail specification.

4.6.2.2.2 Group B inspection. Group B inspection shall be performed on each inspection lot for each package type and lead finish in accordance with MIL-STD-883, method 5008. The criteria for the internal visual and mechanical examination shall be the general requirements for design and construction (see 3.5), the requirements of the detail specification and confirmation that the actual device construction is in accordance with the design documentation on file in accordance with 3.5.5.

4.6.2.2.3 Group C inspection. Group C inspection shall be performed only on the first inspection lot submitted for inspection and as required to evaluate or qualify a change listed in 3.4.7. Group C inspection shall be performed in accordance with MIL-STD-883, method 5008.

4.6.2.2.4 Group D inspection. Group D inspection shall be performed on the initial inspection lot and at intervals not exceeding 26 weeks for additional inspection lots. Group D inspection shall be performed in accordance with MIL-STD-883, method 5008. Sealed empty packages that have been subjected to the handling and stress conditions of screening may be used for group D testing.

4.6.2.2.5 Nonconformance. Lots which fail subgroup requirements of group A, B, C, or D may be resubmitted in accordance with the provisions of 4.3.3.1. A failed lot which is reworked (see 3.7.2) or is rescreened (resubmittal to inadvertently missed process steps is not considered a rescreen) may not be resubmitted to the failed subgroups (and must be counted as a failure) for periodic groups B, C, or D quality conformance inspection coverages. The lot may be resubmitted only to the failed subgroup to determine its own acceptance. If a lot is not resubmitted or fails the resubmission, the lot shall not be shipped and the compliant marking and all references to MIL-H-38534 shall be removed. Lots that are not resubmitted, fail the resubmission, are withdrawn from compliant hybrid microcircuit consideration, reworked, or rescreened (excluding resubmittal to final electrical test when test conditions or limits are not changed) due to the failure of a PDA or QCI requirement of this specification must be reported to the qualifying activity within 30 days of such action. Confirmed lot failures on returned materials, shall be reported to the qualifying activity within 30 days of such action. The reporting of these lots shall be in written format and shall include the following as applicable:

a. Part number.

b. Inspection lot identification code.

c. Quantity of lot.

d. Point of scrap in manufacturer's flow.

e. Test results and date of failure (including all rescreening, reworks and resubmissions).

f. Reason for failure or scrapping including applicable test results.

g. Date of scrapping or withdrawal from compliant hybrid microcircuit.

h. Disposition action of affected lots.

NOTE: The qualifying activity reserves the right to request and receive information concerning implementation of corrective actions and justification for rework and rescreening.

4.6.2.3 Option 3 (method 5005). Option 3 quality conformance inspection shall be conducted in accordance with the applicable requirements of 4.5 of MIL-M-38510, and groups A, B, C, and D of method 5005 of MIL-STD-883 for the specified device class.

4.6.3 Retention of QML status. To retain QML status, the manufacturer shall forward a report to the qualifying activity at 12 month intervals summarizing activities associated with QML processes and materials. The qualifying activity shall establish the initial reporting date. The report shall include the following:

a. Identification by part number, date code, and quantity of lots that have completed group A, B, C, and D inspections. Information should be formatted such that the periodic QCI tests and lots represented by them are clearly presented. When option 1 (in-line inspection) is performed, information shall be organized to demonstrate in-line inspection coverage for all compliant product.

b. A list of all QML processes and materials for which there has been no quality conformance inspection. The manufacturer shall certify that they still have the capabilities and facilities to produce these items to the qualified level.

c. A summary of failure analysis results and corrective action of failures which result in changes to the manufacturer's QML listing.

d. Certification that the design and construction of all compliant product was verified and found to be identical to QML requirements and that the quality conformance inspection requirements have been satisfactorily met.

If the summary results indicates nonconformance with the requirements of this specification, and corrective action acceptable to the qualifying activity has not been taken, action may be taken to remove the failing processes and materials from the QML. Failure to submit the summary report within 30 days of the 12-month period may result in loss of the manufacturer's QML listing and certification.

If during two consecutive reporting periods, there has been no quality conformance inspection of product utilizing QML processes and materials on a certified line, the manufacturer may, at the discretion of the qualifying activity, be required to perform supplemental process qualification testing in accordance with MIL-STD-1772, section B.

4.6.4 Removal of a manufacturer from the qualified manufacturers list.

4.6.4.1 Reasons for removal. A manufacturer may be removed from the QML by the preparing activity for any of the reasons listed below. Removal for any other reason must be approved in advance by the Departmental Standardization Office of the preparing activity.

a. The product or material offered under contract does not meet the requirements of the specification, drawing or Standardized Military Drawing.

b. The manufacturer has terminated manufacturing the product or material represented by the sample test specimen for which a QML listing was granted.

c. The manufacturer requests that his company's name be removed from the list.

d. One or more of the conditions under which certification and qualification were granted have been violated.

e. The manufacturer has failed to notify the qualifying activity of a change in design, material, manufacturing facility, process, or fabrication line.

f. An audit of manufacturing facilities and fabrication lines indicates nonconformance to the applicable specification.

g. The manufacturer's name appears on the "Consolidated List of Debarred, Ineligible, and Suspended Contractors."

h. The manufacturer has failed to comply with the requirements for retention of qualification, as stated in the specification.

4.6.4.2 Notification of proposed removal. Excepting cases of immediate removal for reasons c., g., and h. of 4.6.4.1, the manufacturer will be notified of the proposed removal of his company from the list and the reasons for removal and be granted at least 14 days from the date of the notifying letter in which to respond. If removal is for reasons a., b., d., e., or f. of 4.6.4.1, the manufacturer will be invited to furnish comment.

4.6.4.3 Notification of removal. After determination has been made to remove a company from the list, the manufacturer will be sent a notification of removal and his company will be deleted from the QML without delay.

4.6.5 Inspection of packaging. The sampling and inspection of the preservation, packing, and container marking shall be in accordance with the requirements of MIL-H-55565.

4.7 Data recording. The results of all screening and quality conformance tests and inspections and the results of all required failure analyses shall be recorded and maintained in the manufacturer's facility in accordance with appendix A. Data and reports required by the applicable acquisition document shall be submitted to the acquiring activity. The disposition of all lots or samples submitted for screening (when PDA is specified) 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, resubmission, and withdrawals.

4.7.1 Screening test data for class S hybrid microcircuits. When specified in the acquisition document, a copy of the attributes test data, a copy of the variables data and the delta calculations resulting from the applicable delta parameter tests before and after each burn-in, and a copy of the X-rays required by the detail specification shall accompany each lot of class S hybrid microcircuits shipped. Unless otherwise specified in the acquisition document, the manufacturer shall maintain one complete copy of all screening data for 5 years after delivery of the parts. This data shall be legible and shall be correlatable to the applicable part number, the lot date code, and the individual serial number. The data shall be verified by the manufacturer's quality assurance organization and must bear evidence of such verification.

5. PACKAGING

5.1 Packaging requirements. The requirements for packaging shall be in accordance with MIL-M-55565.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. Hybrid microcircuits conforming to this specification are intended for use for Government hybrid microcircuit application and logistic purposes. For maximum cost effectiveness while maintaining essential quality and reliability requirements, it is recommended that, for initial acquisitions for original equipment complements, the device class appropriate to the need of the application (see 3.4) be acquired. For acquisition of spare parts for logistic support, it is recommended that, unless otherwise specified, all hybrid microcircuits be acquired to class B requirements.

6.2 Acquisition requirements. Acquisition documents must specify the following:

a. Title, number, and date of this specification.

b. Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see section 2).

c. Part number.

d. Title, number and date of applicable detail specification or drawing and identification of the originating design activity.

e. Hybrid microcircuit finishes (See 3.5.8.3).

f. Product assurance level (See 1.1).

g. Change notification (i.e., who to contact).

6.2.1 Optional acquisition data. The following items are optional and are only applicable when specified in the acquisition documents.

a. Requirements for failure analysis.

b. Special requirements (See 30.4 of appendix C).

c. Disposition of samples (from group B, C, and D tests).

d. Requirement for qualification or QCI plan.

6.3 Preparation of detail specifications. The items for the preparation of detail specifications are listed in appendix C of this specification.

6.4 Reevaluation of lot quality. When deemed necessary, the purchase order may specify detailed criteria for lot reevaluation and disposition. Government source inspection procedures or resubmissions of failed lots shall not be considered as reevaluation of lot quality but rather as a part of the initial quality conformance procedure.

6.5 Subject term (key word) listing.

Audit
Burn-in
Class B
Class S
Classification
Construction
Custom
Design
Deviation
ESD
Element
Inspection lot
Lead finish
Metallization
PDA
PIND
QML
Qualification
Repair
Rework
SPC
Screen(ing)
Seal
Substrate
Traceability
Workmanship

6.6 Definitions.

6.6.1 Catalog standard hybrid microcircuit. A hybrid microcircuit, the design and right to the design (i.e., ownership, control, or proprietary rights), of which are completely in the control of the device manufacturer, and is advertised and made available to any acquiring activity through the publication and distribution of product catalogs or product data sheets.

6.6.2 Custom hybrid microcircuit. A hybrid microcircuit built in accordance with this specification but for which the design is under the specification or control of the purchaser or user of the hybrid microcircuit.

6.6.3 Case outline. The device configuration including dimensions and dimensional tolerances.

6.6.4 Device. A hybrid microcircuit.

6.6.5 Device type. A single specific hybrid microcircuit.

6.6.6 Die family. All elements manufactured by the same basic process (e.g., Low power Schottky, HCMOS, FAST).

6.6.7 Film microcircuit (or film integrated circuit). A microcircuit consisting exclusively of elements which are films formed in-situ upon or within an insulating substrate.

6.6.8 Microwave or R.F. hybrid. A hybrid microcircuit that requires one or more of the following:

a. Input and output terminals or connectors with matched impedance.

b. Use of specific impedance transmission lines on an insulating substrate.

c. Device whose R.F. performance characteristics are affected by conductor length, width, or topology.

6.6.9 Microelectronics. That area of electronic technology associated with or applied to the realization of electronic systems from extremely small electronic parts or elements.

6.6.10 Microcircuit. A small circuit having a high equivalent circuit element density, which is considered as a single part composed of interconnected elements on one or more substrates to perform an electronic circuit function. (This excludes printed wiring boards, circuit cards assemblies, and modules composed exclusively of discrete electronic parts mounted on a non-ceramic substrate or board.)

6.6.11 Monolithic microcircuit (or integrated circuit). A microcircuit consisting exclusively of elements formed in-situ on or within a single semiconductor substrate with at least one of the elements formed within the substrate.

6.6.12 Multichip microcircuit. A microcircuit consisting of elements formed on or within two or more semiconductor chips which are separately attached to a substrate or package.

6.6.13 Package type. Packages which have the same case outline, configuration, materials, finish, construction techniques and seal method.

6.6.14 Passive element. Planar resistors, capacitors, inductors and patterned substrates (single and multilayer) and nonplanar chip resistors, capacitors, inductors, and transformers.

6.6.15 Pattern failure. Multiple hybrid microcircuit failures with the same root cause.

6.6.16 Qualified manufacturers list (QML). A list of manufacturers, by name and plant address, who have met the certification and qualification requirements stated herein. The listing includes identification of the certified quality control level (class S or B), qualified materials, and qualified manufacturing construction techniques. QML is the accepted abbreviation for the term Qualified Manufacturers List.

6.6.17 Radiation hardness assurance (RHA). The portion of product assurance which insures that parts continue to perform as specified or degrade in a specified manner when subjected to a specified radiation environmental stress.

6.6.18 Repair. Repair is an operation performed on a nonconforming hybrid to make it functionally usable but does not completely eliminate the nonconformance.

6.6.19 Rework. Rework is an operation performed on a nonconforming hybrid that restores all nonconforming characteristics to the requirements in the contract, specification, drawing, or other approved product description.

6.6.20 Semiconductor element. Transistor or diode.

6.6.21 Source control document or drawing. The detail drawing or specification prepared by the contractor and approved by the acquiring activity which contains the detailed performance and test requirements specific to a hybrid microcircuit type (see appendix C).

6.6.22 Substrate. The supporting material upon or within which the elements of a hybrid microcircuit are fabricated or attached. Substrates may not have conductor patterns or printed or deposited components.

6.6.23 Traceability. The ability to retrieve records as required herein (see 3.4.6).

APPENDIX A

QUALITY ASSURANCE PROGRAM

10. SCOPE

10.1 Scope. This appendix contains details of the quality assurance program requirements which serve as the basis for manufacturer certification and constitute a precondition for hybrid microcircuit qualification. This appendix is a mandatory part of the specification. The information contained herein is intended for compliance.

20. APPLICABLE DOCUMENTS

This section is not applicable to this appendix.

30. QUALITY ASSURANCE PROGRAM

30.1 Manufacturer certification. The manufacturer shall establish, implement, and maintain a product assurance program in accordance with 30.1 through 30.1.3.9 (summarized in table III) in order to become a certified manufacturer of hybrid microcircuits. The manufacturer's quality assurance program shall demonstrate and assure that design, manufacture, inspection, and testing of hybrid microcircuits are adequate to assure compliance with the applicable requirements and quality standards of this specification and the acquisition documents. Where the manufacture or any portion of the manufacturing and testing operation is other than the manufacturer's facility, it shall be the responsibility of the manufacturer to secure and prove the documentation and control of the quality assurance program as described herein. The program shall be documented in these ways:

a. Design, processing, manufacturing, and testing instructions (see 30.1.1).

b. Records to be maintained (see 30.1.2).

c. Product assurance program plan (see 30.1.3).

All required documentation shall be available at, and continually effective in the manufacturer's plant while producing hybrid microcircuits which are intended to be offered for shipment as compliant devices. All required program documentation and records shall be available for review by the qualifying or acquiring activity upon request. The acquiring activity shall have access to nonproprietary areas of the manufacturer's plant for the purpose of verifying its implementation, and the qualifying activity shall have access to all areas of the manufacturer's plant for the purpose of verifying its implementation. Personnel performing quality functions shall have sufficient well defined responsibility, authority and the organizational freedom to identity and evaluate quality problems and to initiate, recommend, and provide solutions.

30.1.1 Design, processing, manufacturing, and testing instructions. The manufacturer shall have in effect documented instructions covering, as a minimum, these areas:

a. Conversion of customer requirements into manufacturer's internal instructions (see 30.1.1.1).

b. Personnel training and testing (see 30.1.1.2).

c. Inspection of incoming materials, utilities, and work in process (see 30.1.1.3).

d. Quality control operations (see 30.1.1.4).

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e. Quality assurance operations (see 30.1.1.5).

f. Design, processing, rework, tool and materials standards and instructions (see 30.1.1.6).

g. Cleanliness and atmosphere control in work areas (see 30.1.1.7).

h. Design, material, and process change control (see 30.1.1.8).

i. Tool, gauge, and test equipment maintenance and calibration (see 30.1.1.9).

j. Failure and defect analysis and data feedback (see 30.1.1.10).

k. Corrective action and evaluation (see 30.1.1.11).

l. Incoming, in-process, and outgoing inventory control (see 30.1.1.12).

m. Schematics (see 30.1.1.13).

n. Electrostatic discharge handling control program (see 30.1.1.14).

Detailed requirements for coverage of these items are stated in 30.1.1.1 through 30.1.1.14. These requirements will normally be expected to be met by the manufacturer's standard drawings, specifications, process instructions, and other established manufacturing practices. If particular requirements are not covered by the manufacturer's established practices, suitable documentation shall be added to satisfy those requirements.

30.1.1.1 Conversion of customer requirements into manufacturer's internal instructions. The procedure by which customer requirements, as expressed in specifications, purchase orders, etc., are converted into working instructions for the manufacturer's personnel shall be documented.

30.1.1.2 Personnel training and testing. The motivational and work training and testing practices, employed to establish, evaluate, and maintain the skills of personnel engaged in reliability critical work shall be documented as to form, content, and frequency of use.

30.1.1.3 Inspection of incoming materials, utilities, and work in-process. Inspection operations shall be documented as to type of inspection, sampling and test procedures, acceptance rejection criteria, and frequency of use.

30.1.1.4 Quality control operations. Quality control operations shall be documented as to type, procedures, rating criteria, action criteria, records, and frequency of use. The use of statistical quality control (SQC) and statistical process control (SPC) is strongly encouraged.

30.1.1.5 Quality assurance operations. Quality assurance operations shall be documented as to type, procedures, equipment, judgment, and action criteria, records, and frequency of use. The use of statistical quality control (SQC) and statistical process control (SPC) is strongly encouraged.

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30.1.1.6 Design, processing, manufacturing equipment, and materials instructions. Device design, processing, manufacturing equipment and materials shall be documented in drawings, standards, specifications, or other appropriate media which shall cover the requirements and tolerances for all aspects of design and manufacturing including equipment test and prove-in, materials acquisition and handling, design verification testing and processing steps. As a minimum requirement, detailed documentation must exist for the following items and must be adequate to assure that quantitative controls are exercised, that tolerances or limits of control are sufficiently tight to assure a reproducible high quality product and that process and inspection records reflect the results actually achieved:

a. Incoming materials control (substrates, packages, active and passive chips or elements, wire, water purification, etc.).

b. Masking, photoresist, and mask registration.

c. Glassivation or passivation.

d. Metallization and film deposition.

e. Die, element, or substrate attachment.

f. Wirebonding.

g. Rework.

h. Sealing.

30.1.1.7 Cleanliness and atmosphere control in work areas. The requirements for cleanliness and atmosphere control in each work area in which unsealed devices, or parts thereof, are processed or assembled shall be documented. Air particle counts shall be in accordance with Federal Standard 209. The manufacturer shall establish action and absolute control limits (at which point work stops until corrective action is completed) based on historical data and criticalness of the process in each particular area. For foreign material identification and control, see internal visual inspection requirements of MIL-STD-883, method 2017.

30.1.1.8 Design, material, and process change control. The methods and procedures for implementation and control of changes in device design, material and processing, and for making change information available to the acquiring activity, when applicable, shall be documented.

30.1.1.9 Tool and test equipment maintenance and calibration. The maintenance and calibration procedures, and the frequency of scheduled actions, for tools, gauges, and test equipment shall be documented and in accordance with the requirements of MIL-STD-45662.

NOTE: Corrective action specified in MIL-STD-45662 shall not require a manufacturer to recall those hybrid microcircuit devices tested or inspected on equipment found to be out of tolerance during calibration provided the government quality assurance representative has verified the acceptability of the manufacturer's calibration and corrective action procedures for equipment found to be out of calibration and the periodic checking procedures for assuring acceptability of product between calibration intervals. For major discrepancies, as determined by the quality assurance representative, a written report shall be prepared and a copy submitted to the qualifying activity detailing the circumstances and corrective action.

30.1.1.10 Failure and defect analysis and data feedback. The procedures for identification, handling, and analysis of failed or defective devices and for dissemination of analysis data shall be documented, including the procedure for informing the qualifying activity of analysis results, when applicable.

30.1.1.11 Corrective action and evaluation. The procedure and responsibility for decisions regarding the necessity for corrective action as a result of failure or defect analysis, and for evaluation and approval of proposed corrective actions, shall be documented. If the procedure for evaluation and approval of changes proposed for other reasons, such as cost reduction or product improvement, differs from the above, it shall also be documented.

30.1.1.12 Incoming, in-process, and outgoing inventory control. The methods and procedures shall be documented which are used to control storage and handling of incoming materials, work in-process, and warehoused and outgoing product in order to achieve such factors as age control of limited-life materials, and prevent inadvertent mixing of conforming and nonconforming materials, work or finished product. Each area shall maintain identity of work in process to facilitate access by Government source inspectors. In addition, for class S devices, tests and inspections performed by the manufacturers on acquired materials and supplies shall include verification of chemical, physical, and functional characteristics required by manufacturer drawings and specifications. Procedures shall be prepared and maintained for controlling the receipt of acquired materials and supplies. The procedures shall provide the following:

a. Withholding received materials or supplies from use pending completion of the required inspection or tests, or the receipt of necessary reports.

b. Segregation and identification of nonconforming material and supplies from conforming materials and supplies and removal of nonconforming subassemblies and parts for class S lines.

c. Identification and control of limited-life materials and supplies.

d. Identification and control of raw materials.

e. Assurance that the required test reports, certification, etc., have been received.

f. Clear identification of materials released from receiving inspection and test to clearly indicate acceptance or rejection status of material pending review action.

30.1.1.13 Schematics. Schematics pertaining to the testing of hybrid microcircuits shall be under document control. This includes device schematics, burn-in schematics in accordance with the applicable detail military specification for qualified product or those for which qualification test authorization has been requested.

30.1.1.14 ESD handling control program. The ESD handling control program documentation shall be under document control. This includes methods, equipment and materials, training, packaging, handling, and procedures for handling ESD sensitive devices.

APPENDIX A

30.1.2 Records to be maintained. The records required by this section shall be continuously maintained during the manufacture of hybrid microcircuits which are intended to be submitted for shipment as compliant devices in accordance with this specification. The records pertaining to production processes, incoming and in-process inspections and those pertaining to screening and quality conformance inspection shall be retained for a minimum of five years (seven years for class S) after performance of the inspections. Records shall be maintained as a minimum for:

a. Personnel training and testing in accordance with 30.1.2.1 (1 year record retention).

b. Inspection operations in accordance with 30.1.2.2 (1 year record retention for production processes, incoming and in-process; 5 year record retention for screening, qualification and quality conformance inspection).

c. Failure reports and analyses in accordance with 30.1.2.3 (5 year record retention).

d. Initial documentation and subsequent changes in designs, materials or processing in accordance with 30.1.2.4 (5 year record retention).

e. Equipment calibrations in accordance with 30.1.2.5 (See MIL-STD-45662 for records retention).

f. Process, utility, and material controls in accordance with 30.1.2.6 (1 year record retention).

g. Product lot identification in accordance with 30.1.2.7 (5 year record retention).

h. Product traceability in accordance with 30.1.2.8 (5 year record retention). Altered records shall not be considered acceptable data unless documented instructions are followed which shall include:

i. For changed data:

(1) Identification of individual making new entry.

(2) Maintain identity of all original data entries ("white out" is not permitted).

(3) Justification noted for change and verification by a second party (QA shall verify screening, qualification and quality conformance inspection records) when change affects lot jeopardy (i.e., lot originally considered to be rejected is changed to pass status).

j. For transferred data to new test record:

(1) Identification of individual transferring data.

(2) All original record entries shall be transferred.

(3) New test records entries shall be verified against the original record by a second party.

k. Computerized records are optional provided they clearly and objectively indicate that all requirements of MIL-H-38534 have been met. The computerized records for traceability, screening and QC inspection shall be readily accessible and available to Government personnel for review and an appropriate electronic or hard copy provided to the qualifying activity as required. The requirements below shall be met.

(1) Entry verification.

(a) Each individual making entries shall be uniquely identified.

(b) All manually entered data shall be verified at the time of entry by the same operator.

(c) All accepted transactions (i.e. entered data) shall be identified by time/date of date/entry sequence to protect against "out of sequence" entries. No recorded transactions shall be deleted or changed.

(2) Control procedure for lot history records.

(a) Lot histories may be modified only by additions (i.e., original entries plus corrective addenda).

(b) All corrective addenda shall meet all the requirements of (i) above.

(c) Only limited designated operators shall be able to access lot history computer records for corrective addenda. Documented security procedures shall be followed to assure that limited access is maintained (e.g., restricted terminals, passwords, etc.).

(d) A quality assurance representative shall verify screening, qualification and quality conformance inspection records when corrective addenda affect lot jeopardy.

(3) Control of computerized lot history records.

(a) All computer lot history records shall have an accurate tape or equivalent backup generated prior to lot shipment. Within 3 months of lot shipment, the backup record shall be transferred to a secure location to be archived.

(b) These archived tapes or equivalent media shall be kept for a minimum of 5 years.

30.1.2.1 Personnel training and testing. Records shall cover the nature of training or testing given, the date thereof by week and length in hours, and the group of personnel given work training and testing. Records are required only for product related training and testing as distinguished from safety, first aid, etc.

APPENDIX A

30.1.2.1.1 Training of operators and inspectors. All critical processes and production inspection shall be performed by personnel who have been trained by the manufacturer to perform their assignment task in accordance with manufacturer's in-house standards, including a formal training (e.g., classroom or on the job training supervised by a certified trainer) and test procedure to assure the proficiency of each individual. Each individual shall be retested or retrained at the end of a designated period or when personnel performance indicates poor proficiency. Personnel shall not be used in critical processes or inspections until the required level of proficiency has been demonstrated.

30.1.2.2 Inspection operations. Records of inspection operations shall cover the tests or inspections made, the materials group (lot, batch, etc.) inspected, the controlling documentation, the date of completion of inspection, the amount of material tested, and acceptance, rejection, or other final disposition of the material.

30.1.2.3 Reports and analyses of defective devices and failures. Records or defective devices shall cover the source from which each device was received, the test or operation during which failure occurred or defects were observed, and prior testing or screening history of the device, the date of receipt, and the disposition of the device. Records of failure and defect analyses shall cover the nature of the reported failure or defect (failure or defect mode), verification of the failure or defect, the nature of any device discrepancies which were found during analysis (failure or defect mechanism), assignment of the failure-activating cause if possible, the date of completion of the analysis, identification of the group performing the analysis, disposition of the device after analysis, and the distribution of the record. The record shall also treat the relationship of observed failure or defect modes in related lots or devices and, where applicable, corrective action taken as a result of the findings.

30.1.2.4 Changes in design, materials, or processing. Records shall cover the initial documentation and all changes, with the date upon which each change in design, materials, or processing becomes effective for devices intended to be submitted for quality conformance inspection under this specification. The documents authorizing and implementing the change, and identification of the first production or quality conformance inspection lot (as applicable) within which product incorporating the change is included shall be maintained when the change requires approval of the qualifying activity (see 3.4.1.3 and 3.4.7).

30.1.2.5 Equipment calibrations. Records shall cover the scheduled calibration intervals for each equipment item, the dates of completion of actual calibration, identification of the group performing the calibration, and certification of the compliance of the equipment with documented requirements after calibration, in accordance with MIL-STD-45662.

30.1.2.6 Process, utility, and materials controls. Records shall cover the implementation of devices such as control charts (e.g., X and R charts) or other means of indication of the degree of control achieved at the points in the material, utility, and assembly process flow documented in the manufacturing instructions. Records shall also indicate the action taken when each out-of-control condition is observed, and the disposition of product processed during the period of out-of-control operation.

30.1.2.7 Product lot identification. Records shall be maintained to identify when each production or inspection lot was processed through each area. Records shall be capable of identifying for each production or acceptance-inspection lot (as applicable) of finished product, these items as a minimum:

a. The acceptance-inspection tests performed on the lot, and their results.

b. The serial numbers (when applicable) of all devices in the lot.

c. The date of completion of acceptance inspection of the lot.

d. Identification of the lot.

e. The pertinent associated detail specification under which inspection was performed.

f. Final disposition of the lot (withdrawn, not accepted, accepted).

g. Acquiring activity source inspection consideration of the lot.

h. The number of devices, by device type, in each lot at the time of seal.

i. Independently identify, by device type, the number of devices shipped and the number of devices in stock inventory.

30.1.2.8 Product traceability. The traceability system shall be maintained such that the qualifying activity can trace and determine that the hybrid microcircuits passed the applicable screening, qualifications and quality conformance inspections and that the hybrids microcircuits were assembled on the proper certified assembly line.

30.1.3 Product assurance program plan (PAPP). The PAPP shall be established and maintained by the manufacturer, and shall be delivered to the qualifying activity for review (prior to survey, when applicable) as a basis for manufacturer certification in accordance with 3.4.1. The PAPP shall consist of a volume or portfolio, or series of same, which will serve to demonstrate to the qualifying activity that the manufacturer's understanding of a complete quality assurance program, as exemplified by his documentation system, is adequate to assure compliance of his product with the applicable specifications and quality-standards. If the quality assurance program exemplified is applied consistently to all product lines intended to be submitted for acceptance inspection under this specification, only one PAPP is required for each manufacturing plant; any difference in treatment of different product lines within a plant shall be stated and explained in the PAPP, or separate PAPPs prepared for such different lines. The PAPP shall contain, as a minimum, these items (see table III):

a. Functional block organization chart (30.1.3.1).

b. Example of manufacturing flow chart (30.1.3.2).

c. Proprietary document identification (30.1.3.3).

d. Examples of design, material, equipment, visual standard, and process instructions (30.1.3.4).

e. Examples of records (30.1.3.5).

f. Examples of design, material and process change control documents (30.1.1.8 and as required in 3.4.1.3 and 3.4.7.

g. Examples of failure and defect analysis and feedback documents (30.1.1.10).

h. Examples of corrective action and evaluation documents (30.1.1.11).

i. Manufacturer's internal instructions for internal visual inspection (30.1.3.6).

j. Examples of test travelers (30.1.3.7).

k. Examples of design and construction baseline (30.1.3.8).

l. Manufacturer's self audit (30.1.3.9).

Detail requirements for these items are described in 30.1.3.1 through 30.1.3.6, 30.1.1.2, 30.1.1.8, 3.4.1.3, 3.4.7, 30.1.1.10 and 30.1.1.11.

30.1.3.1 Functional block organization chart. This chart shall show, in functional block-diagram form, the lines of authority and responsibility (both line and staff) for origination, approval, and implementation of the several aspects of the product assurance program. Names of the incumbents are not required in this chart.

30.1.3.2 Examples of manufacturing flow chart. The flow chart for all devices shall reflect the complete manufacturing processes being used at the time and shall show all manufacturing, inspection, testing and quality verification points and the point where all materials or subassemblies enter the flow. The chart will identify all major documents pertaining to the inspection of materials, the production processes, the production environments and production controls which were used. The documents will be identified by name and number. Changes approved thereafter will be treated in accordance with the approved document change control procedures in 3.4.7. For class S the manufacturers shall maintain a file or book of all referenced documents noted on the flow chart, including in-house documents referenced there for use by the qualification or certification teams and the designated Government representative.

30.1.3.3 Proprietary document identification. A listing of proprietary documents and areas shall be included in the program plan and maintained on a current basis (see 30.1).

30.1.3.4 Examples of design, material, equipment, and process instructions. An example of each type of design, material, equipment, visual standard, and process instruction used in the manufacture of microcircuits intended to be submitted for acceptance inspection under this specification shall be included in the program plan. These may be either dummies or actual working documents, but shall in either event show the form of the pertinent document; blank forms shall not be included.

30.1.3.5 Examples of records. Examples of records, complying with the requirements of 30.1.3.4 for instructions, shall be included in the program plan.

30.1.3.6 Manufacturer's internal instructions for internal visual inspection. The manufacturer's internal instructions for internal visual inspection in accordance with method 2017 and method 2032 of MIL-STD-883 for the applicable device class, shall be included in the program plan.

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30.1.3.7 Examples of test travelers. Screening and groups A, B, C, and D test travelers shall be included in the program plan and maintained on current basis. The test traveler utilized for quality conformance inspection lots may be the same traveler as used for qualification lots. When in-line inspections are allowed (i.e., alternate group A or B) the traveler shall include documentation of required inspections. The test travelers shall include all manufacturer imposed tests. Alternative methods of meeting these requirements may be approved by the qualifying activity. The test traveler shall include all the following minimum information:

a. Identification as to whether the lot is qualification or QCI.

b. Name or title of operation and specification number of each process or test.

c. Identify part number, date code, and manufacturer internal lot identification number.

d. Date of test and operator identification.

e. Calibration control number or equipment identification of all major equipment components used for test.

f. Quantity tested and rejected for each process or test and actual quantity tested if sampled.

g. Serial numbers of passing and failing devices when applicable.

h. Time in and out of process or test if critical to process or test results (i.e., burn-in and 96 hour window).

i. Specific major conditions of test that are verifiable by operator including times, temperature, rpm, etc. (required for MIL-STD-1772, section B only).

j. The percent defective calculated and the pattern failure analysis for burn-in.

k. Burn-in or life test board serial number or test circuit identification number and revision.

l. All required variables data (see 4.6) except for electrical tests (attachments permitted). Not required for QCI traveler.

m. For electrical tests, test program number and revision and identify when variables data is required.

30.1.3.8 Examples of design and construction baseline. The design and construction baseline form (i.e., a listing of the process specifications to be qualified through MIL-STD-1772, section B testing) shall be included in the manufacturer's program plan and maintained under document control.

30.1.3.9 Manufacturer's self audit. The manufacturer's self audit which identifies key review areas, their frequency of audit and the corrective action system to be employed when variations from approved procedures or specification requirements are identified shall be included in the program plan.

APPENDIX A

40. SELF AUDIT REQUIREMENTS

40.1 Self audit requirements. This portion of appendix A contains, details for implementation of the minimum requirements to be used in the manufacturer's self audit program. The intent of this self audit program is to assure continued conformance to military specification requirements.

40.2 DEFINITIONS

40.2.1 Self audit. The performance of periodic surveys and reviews by the device manufacturer's designated personnel to evaluate compliance to military specifications.

40.2.2 Audit checklist. A form listing specific items which are to be audited.

40.3 GENERAL

40.3.1 Self audit program. The manufacturer shall establish an independent self audit program under the direction of the quality organization to assess the effectiveness of the manufacturer's quality assurance system. The self audit shall identify any deficiencies for resolution in the processing, testing, or deviations from specification requirements. The self audit shall also review any differences from the qualifying activity approved baseline, flow chart, test facility list, etc.

40.3.2 Self audit representatives. The quality assurance representatives or their designated appointees shall perform all self audits. The designated auditors shall be independent from the area being audited. If the use of an independent auditor is not practical, then as a minimum another individual should be assigned to participate in the audit or review the results with the auditor from the area. The auditors shall be trained in the area to be audited, in the applicable military specification requirement and provided with an appropriate checklist for annotating deficiencies. Prior to the audit, the assigned auditor shall review the previous audit checklist to assure corrective actions have been implemented and are sufficient to correct the deficiencies.

40.3.3 Audit deficiencies. All audit deficiencies shall be documented on the appropriate checklist and a copy submitted to the department head for corrective action. All corrective actions shall be agreed to by the quality organization or Material Review Board.

40.3.4 Audit follow up. All audit reports will be filed and maintained by the quality organization. The quality organization shall establish a procedure to follow up on all audit deficiencies to assure that the corrective actions have been implemented in a timely manner. A system (e.g., management review) shall also be established to review the acceptability and timeliness of all corrective actions and to determine if any deficiencies have repeated since the last required self audit. If any deficiencies have occurred two or more times in the predetermined time period, additional corrective actions shall be taken to assure immediate correction of the problem and the qualifying activity shall be notified.

40.3.5 Audit schedules. The original audit frequency shall be established by the quality organization but in no case exceed one year for each area, unless authorized by the qualifying activity. Changes to the frequency of audit due to being consistently above or below average performance on the self audit shall require approval of the quality organization.

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40.3.6 Self audit areas. The self audit will be performed to assure conformance to the checklist and military specification in at least the following areas:

Areas

Calibration	Training
Fabrication	Failure analysis
DI water controls	Qualification/QCI system
Assembly operations	Document control
Electrical test	Design change control
Test methods	Incoming inspection
Environmental control	Inventory control and traceability

40.3.7 Self audit checklist. The audit checklist shall be approved by the quality organization and maintained under document control. The checklist shall be provided to the auditor prior to initiation of each self audit. The checklist shall assure that the quality assurance system is adequate and followed by all personnel in each area.

40.3.8 Deficiency review. The manufacturer shall submit to the qualifying activity for review, any deficiencies that are considered major, any deficiency that has repeated within the specified time period and all corrective actions. The qualifying activity may modify the frequency of the self audit or require additional testing based on the data from the self audit.

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TABLE III. Product assurance program requirements.

In-house documentation covering these areas (30.1.1)	In-house records covering these areas (30.1.2)	A program plan covering these areas (30.1.3)	Self audit plan covering these areas (40.3)
a. Conversion of customer requirements into manufacturer's internal instructions (30.1.1.1)	a. Personnel training and testing (30.1.2.1)	a. Functional block organization chart (30.1.3.1)	a. Self audit program (40.3.1)
b. Personnel training and testing (30.1.1.2)	b. Inspection operations (30.1.2.2)	b. Examples of manufacturing flow chart (30.1.3.2)	b. Self audit representatives (40.3.2)
c. Inspection of incoming materials and utilities and of work inprocess (30.1.1.3)	c. Failure and defect reports and analyses (30.1.2.3)	c. Proprietary-document identification (30.1.3.3)	c. Audit deficiencies (40.3.3)
d. Quality-control operations (30.1.1.4)	d. Change in design, materials, or processing (30.1.2.4)	d. Examples of design, material, equipment, and process instructions (30.1.3.4)	d. Audit follow-up (40.3.4)
e. Quality assurance operations (30.1.1.5)	e. Equipment calibrations (30.1.2.5)	e. Examples of records (30.1.3.5)	e. Audit schedules (40.3.5)
f. Design, processing, manufacturing equipment and materials instructions (30.1.1.6)	f. Process utility and material controls (30.1.2.6)	f. Examples of design, material and process change control documents (30.1.1.8) and as required in 3.4.1.3	f. Self audit areas (40.3.6)
g. Cleanliness and atmosphere control in work areas (30.1.1.7)	g. Product lot identification (30.1.2.7)	g. Examples of failure and defect analysis and data feedback documents (30.1.1.10)	g. Self audit checklist (40.3.7)
h. Design, material, and process change control (30.1.1.8)	h. Product traceability (30.1.2.8)	h. Examples of corrective action and evaluation documents (30.1.1.11)	h. Deficiency review (40.3.8)
i. Tool and test equipment maintenance and calibration (30.1.1.9)		i. Manufacturer's internal instructions for internal visual inspection (30.1.3.6)	

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TABLE III. Product assurance program requirements - Continued.

In-house documentation covering these areas (30.1.1)	In-house records covering these areas (30.1.2)	A program plan covering these areas (30.1.3)	Self audit plan covering these areas (40.3)
j. Failure and defect analysis and data feedback (30.1.1.10)		j. Examples of test travelers (30.1.3.7)	
k. Corrective action and evaluation (30.1.1.11)		k. Examples of design and construction baseline (30.1.3.8)	
l. Incoming, in process, and outgoing inventory control (30.1.1.12)		l. Manufacturer's self audit (30.1.3.9)	
m. Schematics (30.1.1.13)			
n. ESD handling control program (30.1.1.14)			

APPENDIX B

STATISTICAL SAMPLING, TEST AND INSPECTION PROCEDURES

10. SCOPE

10.1 Scope. This appendix contains statistical sampling qualification procedures used with hybrid microcircuits. This appendix is a mandatory part of the specification. The information contained herein is intended for compliance.

20. APPLICABLE DOCUMENTS

This section is not applicable to this document.

30. GENERAL

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

a. PDA series: The percent defective allowable (PDA) series is defined as the following decreasing series of PDA 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 PDA inspection: Tightened PDA inspection is defined as inspection performed using the next PDA value in the PDA series which is lower than that specified.

c. Acceptance number (c): The acceptance number is defined as zero.

d. Rejection number (r): Rejection number is defined as one or more.

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

a. c: Acceptance number.

b. r: Rejection number.

40. STATISTICAL SAMPLING PROCEDURES AND TABLE

40.1 General. Statistical sampling shall be conducted using a sample size (accept number) method as specified in Table IV herein. The procedures specified herein are suitable for all quality conformance requirements. For reevaluation purposes, see 6.4.

40.1.1 Selection of samples. Samples shall be randomly selected from the inspection lot or inspection sublots. For continuous production, the manufacturer, at his option, may select the sample in a regular periodic manner during manufacture provided the lot meets the formation of lots requirement.

40.1.2 Failures. Failure of a unit for one or more tests of a subgroup shall be charged as a single failure.

40.2 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.

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40.2.1 Sample size. The sample size for each subgroup shall be determined from table IV and shall meet the specified sample size (accept number).

40.2.2 Acceptance procedure. If zero failures are found in the initial sample of the required sample size, the lot shall be accepted. If the observed number of defectives from the initial sample is greater than zero, a second sample of double the initial sample size may be selected from the original sub(lot). The sub(lot) may be accepted if zero defectives are observed in this double-size sample.

40.2.3 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 called "destructive". If the observed percent defective for the inspection lot exceeds the specified PDA series value for the sample size specified, the lot shall be considered to have failed the appropriate subgroup. 100 percent sampling is required where lot size is smaller than the required sample size with zero defectives allowed. Resubmission of lots tested on a 100 percent inspection bases shall also be on a 100 percent inspection basis and in accordance with the tightened PDA inspection criteria (see 30.1b).

TABLE IV. Sample size (accept number) sampling plan. 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 sample size (accept number) will not be accepted (single sample)

PDA series	50	30	20	15	10	7	5	3	2
	Minimum sample size (accept number)								
Accept number c = 0, r ≥ 1	5(0)	8(0)	11(0)	15(0)	22(0)	32(0)	45(0)	76(0)	116(0)

PDA series	1.5	1	0.7	0.5	0.3	0.2	.15	0.1
	Minimum sample sizes (accept number)							
Accept number c = 0, r ≥ 1	153(0)	231(0)	328(0)	461(0)	767(0)	1152(0)	1534(0)	2303(0)

1/ Sample sizes are based upon the Poisson exponential binomial limit.
2/ In this specification Lot Tolerance Percent Defective (LTPD) has been replaced with sample size (accept number) where the accept number is zero. Where reference is made by unrevised test methods of MIL-STD-883 to an LTPD value, that value shall be found in the PDA series and the sample size shall be the value immediately below the PDA series value. The accept number shall always be zero.

APPENDIX C

REQUIREMENTS FOR THE PREPARATION
OF
SOURCE CONTROL DOCUMENTS OR DRAWINGS

10. SCOPE

10.1 Scope. This appendix contains the details of source control documents or drawings (SCD) and detail element specifications or drawing requirements needed to define individual hybrid microcircuit types, families, or elements for acquisition. This appendix is a mandatory part of the specification. The information contained herein is intended for compliance.

20. APPLICABLE DOCUMENTS

This section is not applicable to this appendix.

30. GENERAL

30.1 Contractor-prepared hybrid microcircuit SCD's. Contractor prepared SCD's for hybrid microcircuits shall be prepared in military format and shall utilize relevant portions of this specification. Contractor-prepared hybrid microcircuit SCD's shall be approved by the acquiring activity as acceptable for the requirements of a specific contractor order at the time of acquisition.

30.2 Applicable documents. Hybrid microcircuit SCDs shall comply with the requirements of MIL-STD-883, MIL-STD-1331, and this specification.

30.3 Content and format. The hybrid microcircuit SCD shall be prepared in a format and contain details so as to clearly identify which parameters, limits, and conditions of test shall be applied in response to any given requirement of this specification (i.e., qualification, quality conformance inspection, screening, etc.). All parameters, limits, and conditions of test which reflect the intended functions of the hybrid microcircuit and which are characteristic of the hybrid microcircuit shall be specified.

30.4 Special requirements. Any special requirements (e.g., extended or accelerated reliability demonstration tests) shall be stated in the hybrid microcircuit SCD or acquisition document. The hybrid microcircuit SCD shall specify the basis for sample selection, sample size, test conditions, accept or reject criteria, failure analysis or reporting and inspection status (qualification, quality conformance groups A, B, C, D or screening) as applicable.

30.5 Contractor-prepared detail element specifications or drawings. Contractor-prepared specifications for the elements (substrates, semiconductor chips, packages, etc.) used in the manufacture of hybrid microcircuits shall be prepared in military format and shall be approved by the acquiring activity as acceptable for the requirements of a specific contractor order at the time of acquisition.

40. SPECIFIC REQUIREMENTS

40.1 Individual item requirements. The hybrid microcircuit SCD or element drawings shall cover the items listed in a through n below:

a. Part number of the applicable detail specification (including date and revision letter, if applicable).

b. Design, construction, and physical dimensions (see 3.5).

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c. Special marking provisions (see 3.6).

d. Acceptance numbers as applicable.

e. Identification of the following electrical test parameters:

(1) Pre burn-in (if applicable).

(2) Final electrical.

(3) Group A.

(4) End points for groups C and D (if applicable).

f. Specify whether the case is conductive or nonconductive.

g. For metal cases, specify whether the case is connected to the ground lead or to any part of the device.

h. Delta limits

i. Burn-in and life test circuits

j. Schematic diagram

k. Lead designations and internal connections

l. Test circuits

m. Electrostatic sensitivity

n. Radiation Hardness assurance (as applicable)

o. Test data (variables or attributes)

p. Pre/post burn-in test parameters

40.2 MIL-STD-883 details. In addition to the items listed in 40.1, the applicable details required by MIL-STD-883 shall be listed in the SCD.

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Civil Agency Coordinating Activities:
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Agent:
DLA - ES

(Project 5962-1126)

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE
MIL-H-38534	HYBRID MICROCIRCUITS, GENERAL SPECIFICATION FOR

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