The Electronic Industries Quality Registry
EQR, Inc.

Registers the Quality System
of

EQR, INC.

Linear Technology Corporation
Milpitas, California

Accredited
by the
Dutch Council
for
Certification

as conforming to
ISO 9001 - ANSI/ASQC Q9001
for
Design and manufacturing of a broad line of high
performance linear integrated circuits.

This Registration is valid from April 6, 1996.

Mike Burden
Certification Manager

Certificate Number
0203

Robert W. Lackland
President

QUALITY, RELIABILITY, AND SERVICE POLICY STATEMENT

The cornerstone of Linear Technology's Quality, Reliability, & Service (QRS) Program is to achieve 100% customer satisfaction by producing the most technically advanced product with the best quality, on-time delivery, and service. Top management is fully committed to this goal, but to achieve this goal requires the involvement and dedication of every employee.

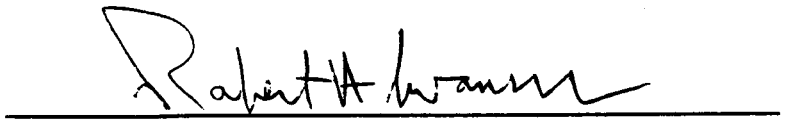
Since 1983 when the first product was shipped, Linear Technology has achieved numerous accomplishments in the area of quality and service, among which are:

- 1st company in the industry to achieve the Department Of Defense line certification for MIL-M-38510 Class B products during its first audit in 1984.
- Among the first group of manufacturers to be certified in the Ship-To-Stock Program at Compaq Computers in 1986.
- 1st company in Silicon Valley to achieve the Ford Q1 Award for Excellence in Quality in 1988.

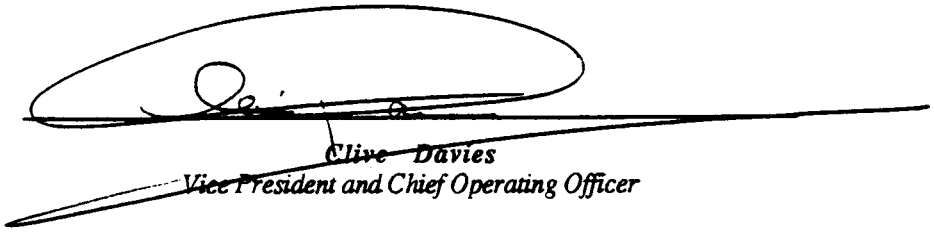
The above achievements were made possible by the commitment and dedication of employees who pay attention to details and whose motto is *"Do the job right the first time"* .

Customer requirements and expectations in the areas of Quality and Service are becoming increasingly more demanding. Linear Technology not only intends to *meet* those requirements and expectations for survival, but also to *exceed* them to maintain a *world-class leadership* position.

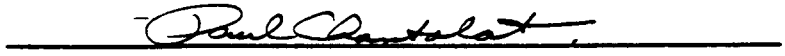
The standard will be error-free products and error-free performance. This standard commits all of Linear Technology's employees to a QRS Policy that takes precedence over all other considerations and leaves no room for error or failures. LTC's goal is zero defects.



Robert Swanson
President and Chief Executive Officer



Clive Davies
Vice President and Chief Operating Officer



Paul Chantalat
Vice President of Quality and Reliability

QUALITY SYSTEM FOR DESIGN, DEVELOPMENT, PRODUCTION, AND SERVICING

0 INTRODUCTION

This policy defines the organization and policies of Linear Technology Corporation (LTC) and assures conformance to requirements during design, development, production, testing, inspection, and shipment of products. It sets out the general quality policies, procedures, and practices of LTC.

1.0 SCOPE

The requirements specified in this Quality Manual are designed to prevent and detect any nonconformances during design, development, production, testing, and inspection.

2.0 FIELD OF APPLICATION

The Quality Program specified herein is designed to ensure 100% customer satisfaction by ensuring product conformance to achieve and maintain the highest level of product quality and reliability and to ensure a program for continuous improvement. This manual applies to all manufacturing locations and to all military and commercial products manufactured by LTC.

REFERENCES

ISO 8402	Quality Vocabulary
ISO 9000	Quality Management and Quality Assurance Standards: Guidelines for Selection and Use
ISO 9001	Quality Systems: Models for Quality Assurance in Design/Development, Production, Installation, and Servicing
ISO 9002	Quality Systems: Model for Quality Assurance in Production and Installation.
ISO 9004	Quality Management and Quality System Elements Guidelines
ISO 10011-1	Guidelines for Auditing Quality Systems, Part 1
ISO 10011-2	Guidelines for Auditing Quality Systems, Part 2
ISO 10011-3	Guidelines for Auditing Quality Systems, Part 3
ISO 10012-1	Quality Assurance Requirements for Measuring Equip.

3.0 DEFINITIONS

For the purpose of this quality manual, the definitions given in ISO 8402 shall apply.

Below is a list of acronyms used by LTC:

CMR	Customer Material Return
CSI	Customer Source Inspection
DI	De-Ionized
DMR	Discrepant Material Report
DRC	Design Rules Check
ECN	Engineering Change Notice
EOL	End-of-Line
F/A	Failure Analysis
GAGE R&R	Gage Repeatability and Reproducibility
GSI	Government Source Inspection
IFR	Inspection Failure Report
IQC	Incoming Quality Control
MPS	Material Procurement Specifications
MRB	Material Review Board
MSE	Measurement System Evaluation
OCAP	Out-of-Control-Action-Plan
PO	Purchase Order
PAT	Process (or Preventive) Action Team
PG	Pattern Generation
QA	Quality Assurance
QAP	Quality Assurance Policy
QAR	Quality Audit Report
QCT	Quality Control Teams
RMA	Return Material Authorization
RPL	Released Product Listing
SL	Special Lot
SOP	Standard Operating Procedure
SPC	Statistical Process Control
SSS	Stop/Start Sheet
TECN	Temporary Engineering Change Notice
TML	Top Mark Layout
TQMS	Total Quality Management System
VCAR	Vendor Corrective Action Request

4.0 QUALITY SYSTEM REQUIREMENT

LTC's Total Quality Management System (TQMS) encompasses the concept of strategic quality planning and management to ensure a program of continuous quality and reliability improvement.

The quality system is designed to meet the requirements of:

- ISO 9001
- MIL-STD-883
- MIL-M-38510 (Class B and Class S)
- MIL-PRF-38535, Appendix A
- MIL-I-45208
- MIL-STD-45662
- MIL-Q-9858
- ANSI/NCSL Z540-1-1994
- Our commercial customers
- Our goal of defect-free products

LTC pledges that its products shall be manufactured in accordance with the applicable specifications or to specific customer requirements.

4.1 MANAGEMENT RESPONSIBILITY

LTC's management with executive responsibility shall ensure that the Quality policy is understood, implemented, and maintained at all levels in the organization.

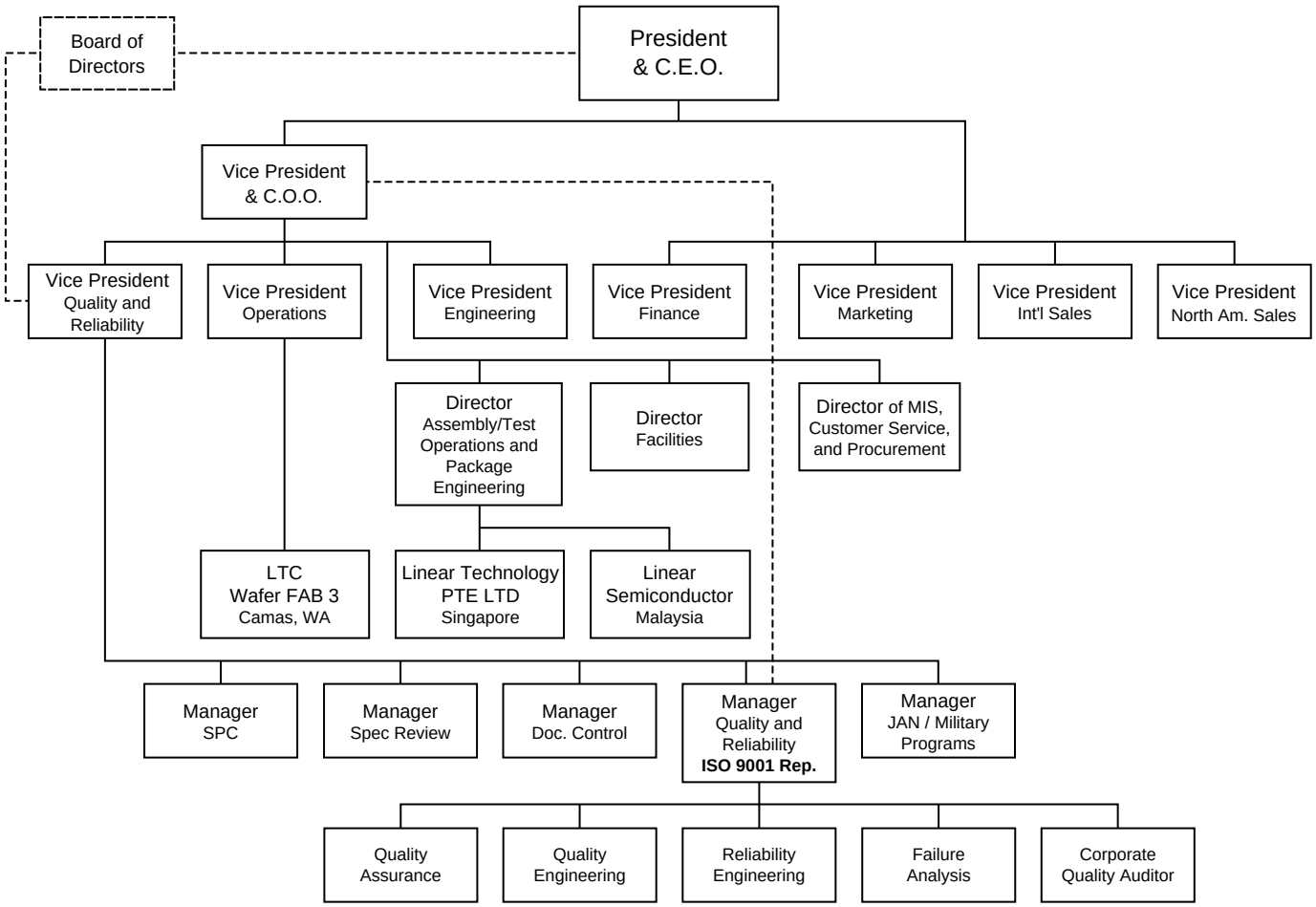
4.1.1 Quality Policy

See Policy Statement in the front of this manual.

4.1.2 Organizational Chart

A current organizational chart showing senior management and the organizational reporting structure is available upon request from the secretary of the Vice President of Finance.

LTC Organizational Chart



4.1.2.1 Responsibility and Authority

A) All employees in this organization have the authority to initiate action to prevent the occurrence of product, process, and quality system nonconformity by notifying the appropriate support or management personnel.

B) Inspectors have the responsibility to identify and record product and process problems, via a Stop/Start or Inspection Failure Report.

C) Any employee in the organization has the organizational freedom and authority to initiate, recommend, or provide solutions relating to product, process and quality system nonconformances.

D) Engineering, Quality Assurance and management have the responsibility to verify the implementation of solutions.

E) Any employee in the factory that is running a process at an SPC location has the responsibility in the event of an out-of-control process or situation to further control processing in accordance with the associated Out-of-Control-Action-Plan (OCAP).

Quality Assurance, Engineering, Production Control, and Customer Service have the responsibility to suspend or control the further processing and delivery of nonconforming product until the deficiency or unsatisfactory condition has been corrected. This can be done via the issuance of a Stop/Start or Inspection Failure Report (IFR) via an ECN/TECN to a specification or via a ship-hold.

4.1.2.2 Verification Resources and Personnel

All verification activities and requirements shall be documented in the appropriate standard operating procedures (SOP) or detailed specifications to include inspection, test, and monitoring of the design, production, and product. Design reviews and audits of the quality system, processes, and/or product shall be carried out by personnel independent of those having responsibility for the work being performed.

All verification personnel are required to be trained and certified per the LTC training and certification program (spec 06-09-0002 and 05-06-0007), and records of training are to be maintained. Adequate resources shall be identified and assigned for the areas of management, performance of work and verification activities, including internal quality audits.

4.1.2.3 Management Representative

The Manager of Quality Assurance and Reliability has the authority and responsibility for ensuring that the requirements of this Quality Manual are implemented and maintained.

A multidisciplinary approach is used for decision-making and to manage concept development through production and shipping.

4.1.3 Management Review

The Quality and Reliability Manager shall assure that the effectiveness of the quality system is reviewed and reported on, as shown below:

A) Annual strategic quality planning and goal setting to drive continuous quality and reliability improvement programs. This meeting is held at the beginning of each fiscal year with all department heads participating. The resulting goals are reviewed and approved by the management.

B) Quarterly management review of company performance vs. the annual Corporate Quality goals. The performance to goals is summarized by the Quality Assurance manager and distributed to the department heads. Semiannual reviews are distributed to the President and Vice Presidents.

C) Quality systems audit results shall be reviewed annually and at the end of each period by middle and upper management to determine the adequacy of, and compliance to, the documented quality system. Upper management includes the COO and President/CEO.

D) Quarterly Cpk reports of all critical process nodes by the appropriate Operations Group/QCT, and SPC Manager.

E) Monthly QA reports to management including the President and COO, to report detailed results and trend analysis of QA monitors and gates.

F) On a real-time basis, the following reviews and/or actions are performed:

* Quality system audit results shall be reviewed to determine the effectiveness of the quality system.
* Failure analysis, root cause identification, and corrective action.
* Customer request for corrective action.
* Process/Preventive Action Teams (PATs) findings and recommendations.
* Review of nonconforming material/product reports.

G) The Quality Manual and/or procedures shall be revised when necessary to reflect the decisions of management reviews.

H) Records of all reviews shall be maintained for evaluation, as required.

REFERENCES

Spec Number	Title
06-08-0014	Quality Audit
06-06-0001	SPC Procedure
06-09-0020	Corrective and Preventive Action Program

4.2 QUALITY SYSTEM

4.2.1 General

The quality system of LTC consists of the Quality Manual, quality procedures for inspection, surveillance, and monitoring to ensure that our products conform to customer requirements.

4.2.2 Quality System Procedures

Documented and implemented procedures consistent with the requirements of ISO 9001 and stated quality policy shall form a part of the quality system.

4.2.3 Quality Planning

The system is designed to meet the requirements of ISO 9001, and the other requirements outlined in Section 4.0. The quality planning process covers all processes from incoming inspection through shipping.

Quality planning includes:

A) The preparation of quality plans in accordance with the specific requirements.

B) The identification and acquisition of any controls, processes, inspection equipment, fixtures, and total production resources and skills that may be needed to achieve the required quality.

C) Ensuring the compatibility of the design, the production process installation, servicing, inspection and test procedures, and the applicable documentation.

D) The updating, as necessary of quality control; inspection, and testing techniques, including the development of new instrumentation.

E) The identification of any measurement requirement involving capability that exceeds the known state of the art in sufficient time for the needed capability to be developed.

F) The identification of suitable verification at all required test, and inspection gates.

G) The clarification of standards of acceptability for all features and requirements, including those which contain a subjective element (i.e., workmanship standards).

H) The identification and preparation of quality records. (*For records, see Section 4.16.)*

REFERENCES

Spec Number	Title
06-03-5000	Customer Specification Review
06-03-5001	Internal SL Specification Procedure
06-04-0011	Design to RPL Flowchart
00-01-1006	SOP: Engineering Change Notice
08-07-1001	Calibration Program Requirements
05-03-8082	Assembly Workmanship Standards
06-03-7050	Record Keeping

4.3 CONTRACT REVIEW

4.3.1 General

Documented procedures shall be implemented and maintained for the performance of contract review and for the coordination of these activities.

4.3.2 Review

Prior to acceptance of a contract or order, it shall be reviewed in accordance with the referenced specifications herein, resolving issues, and determining the capability of the organization to meet customer requirements. Any differences identified during contract review will be documented and defined by an "SL" (Special Lot) or by a special flow per the specifications below. If LTC cannot agree to any portion of the contract, a waiver agreement must be approved by the end-customer before the product is delivered.
(For records, see Section 4.16.)

REFERENCES

Spec Number	Title
06-03-5000	Customer Specification
06-03-5001	SL (Special Lot) Specification Procedure
Current Rev.	Device Catalogs, Data Book, Supplements

4.4 DESIGN CONTROL

4.4.1 General

LTC produces a broad line of standard, high performance linear integrated circuits which are defined in the marketing catalogs and data books. Design criteria and manufacturing capabilities have been established to support these products. (*For records, see Section 4.16.)*

4.4.2 Design and Development Planning

LTC Spec 06-04-0011 provides a guideline flowchart from design conception to product qualification and RPL. Since LTC manufactures primarily standard products, as opposed to custom products, there is no need to establish milestone

charts for the customer. Design and verification activities are planned and assigned to qualified personnel equipped with adequate resources.

4.4.3 Organizational and Technical Interfaces

A design review meeting is held weekly with engineering and management to review the status, document progress, and technical requirements of each design.

4.4.4 Design Input

Inputs for design typically come from review of customer's requirements, contract review, and marketing research to identify features which should be incorporated into a product. The primary goal is to provide customers with designs that reduce their component and board level costs, while providing leading edge technology. LTC manufactures primarily standard (non-custom) products. Based on the above inputs, the final design concept is developed in-house.

4.4.5 Design Output

The design output, an integrated circuit, is defined and described in a data sheet, which is released when the product is qualified. Product characterization and qualification are conducted to verify conformance to data sheet requirements.

The data sheet specifies the product performance limits as well as any other pertinent information pertaining to the product, e.g., design considerations that are critical in the safe and proper functioning of the product, regulatory requirements, etc.

4.4.6 Design Review

Design shall plan, conduct design reviews which are, documented, and assigned to competent personnel representing all applicable functions.

4.4.7 Design Verification

Design verification shall establish that the product meets the data sheet requirements. Since the products designed by LTC are proprietary products (defined by LTC), LTC may change the final data sheet to match the characterization results prior to release. This further ensures that the design input matches the design output.

4.4.8 Design Validation

Design validation shall be performed prior to release to ensure that the product conforms to design requirements in accordance with Quality Assurance and Reliability Assurance Qualification requirements, 06-04-0001.

4.4.9 Design Documentation

The identification, documentation, and appropriate review and approval of all changes and modifications are accomplished via ECNs to the *Mask Sequence Specification*, *02-01-xxxx .*

Design changes are controlled via LTC-supplied designs and bills of material to subcontractors.
(For records, see Section 4.16.)

REFERENCES (Company proprietary)

Spec Number	Title
06-02-3001	Product Obsolesence
00-01-1008	SOP-Specs Format and Organ.
05-03-2045	Die Design Rules
80-01-xxxx	CMOS Design Rules
80-02-xxxx	Bipolar Design Rules
02-01-xxxx	Mask Sequence Specifications
02-02-1000	LTC Milpitas Fab New Product Documentation Requirements
02-02-1002	LTC Product Release to Fab Procedure
05-01-0000	Manual Buildsheet Generation and Revision
06-04-0001	Quality Assurance/Reliability Assurance Qualification Requirements
06-04-0011	Design to RPL Flowchart
09-01-0001	Released Product Listing/Top Mark Content and Layout Procedure
00-01-1009	SOP-Electronic Buildsheet Generation and Revision

4.5 DOCUMENT AND DATA CONTROL

4.5.1 General

Documented and implemented procedures shall govern the control of all documents and data relating to the quality system.

4.5.2 Document and Data Approval and Issue

Pertinent issues of appropriate documents are available at all locations where operations are essential to the effective functioning of the quality system. Any initiation or change of the documentation required for procurement, manufacturing, and inspection of materials and product is controlled by the Document Control department to ensure review and approval by authorized personnel prior to issue.

Data associated with this Quality System shall be maintained and documented per Section 4.16 Records.

The Document Control group is responsible for the maintenance, control, reproduction, distribution, and historical archiving of all of LTC's product and procedural documentation. Document Control services all internal

areas in which Document Control Books (DCBs) are located, per the internal specifications listed below:

REFERENCES

Spec Number	Title
00-01-0010	Specification ID Master Plan
00-01-0005	Temporary Engineering Change Notice Procedure
00-01-1006	Standard Operating Procedure (SOP): Engineering Change Notice
00-01-1008	SOP: Specification Format and Organization
00-01-3100	ECN Approval Matrix
00-01-0001	Standard Operating Procedure: Document Control
00-01-0003	Distribution of Level 1 Specifications
00-01-3111	DCB Locations Report

4.5.3 Document and Data Changes

Document control shall promptly post or route ECNs (Engineering Change Notices) and TECNs (Temporary Engineering Change Notices) to the appropriate locations when ECN approval is complete. The information on the ECN shall contain, as a minimum, the affected document number, description of the change, effective date and duration, affected documentation, justification for the change, documentation of material disposition, distribution, and approval signatures.

Previous revision history is available from the Document Control department. Additional justification and background information shall be provided by the ECN originator upon request of the designated signatory.

Document Control maintains a Master Spec Listing which includes the revision letter, effectivity date, specification number, product number (when applicable), and title. *See 00-01-0001, SOP: Document Control.*

When any change is made, LTC's standard practice is to generate an ECN or TECN to a specification or process. Each time an ECN or a TECN is generated, the revision changes and spec copies are reissued to all required Level 1 and Level 2 Document Control Book locations within the factory and all satellite locations as called out on the document footer.

REFERENCES

Spec Number	Title
00-01-1006	SOP: Engineering Change Notice
00-01-3100	ECN Approval Matrix
00-01-1008	SOP: Specification Format and Organization
00-01-0005	Temporary Engineering Change Notice
00-01-0001	SOP: Document Control

4.6 PURCHASING

4.6.1 General

Purchasing shall ensure that material purchased from suppliers and subcontractors is in conformance to specified requirements. Records of qualified suppliers shall be maintained.

4.6.1.1 Supplier Responsibility

It is the responsibility of the supplier to provide and maintain a quality system which will assure compliance with the requirements of the applicable material procurement specification, 01-xx-xxxx, and the specifications listed below.

REFERENCES

Spec Number	Title
06-09-0003	Purchasing Procedure
01-xx-xxxx	Material Procurement Specification
09-01-0004	Qualified Vendor Listing Procedure
09-01-0008	Approved Subcontractor Listing
06-01-0011	Vendor Corrective Action
06-09-0018	SOP: Inventory Control
06-01-0006	Incoming Inspection, General
06-01-0007	Incoming Inspection, Subcontracted Materials
01-xx-xxxx	Applicable Drawing And Stores Item Numbers

4.6.2 Assessment of Subcontractors

Selection of sources to be qualified will be made upon the supplier's ability to conform to agreed upon requirements for quality, cost, delivery, and based upon previous performance.

LTC exercises tight control over critical subcontractors to prevent field reliability problems. The effectiveness of these controls is continually assessed through on-site engineering surveillances, incoming inspection results, reliability monitor results, and subcontractor-supplied SPC and Cpk data. This is defined in Specification 06-06-0001.

Previously qualified suppliers may continue to be used as long as they demonstrate the capability to meet all conditions and requirements.

Suppliers and subcontractors are granted approval after qualification testing and inspection of materials purchased under preliminary approval status. A monthly record of approved suppliers' and subcontractors' history is maintained and updated after completion of inspections and the disposition of all lots. (*For records, see Section 4.16.)*

Process changes from assembly subcontractors are approved by Package and QA Engineering via major change control notification from the assembly subcontractor.

Suppliers and subcontractors that consistently demonstrate exceptionally high acceptance rates will become candidates for participation in the Preferred Vendor Program. Determination of suitability will be based on the following:

A) Consistently high acceptance rate through Incoming Inspection.

B) No field-related problems.

C) Recommendation by LTC's Preferred Vendor Board after reviewing the survey results from the vendor.

D) Willingness on the part of the supplier to provide periodic statistical data on the critical nodes/parameters that have been identified.

E) Suppliers and subcontractors that qualify for the partnership program will be placed on a reduced surveillance schedule, and they will be awarded a greater share of the business.

REFERENCES

Spec Number	Title
06-09-0003	Purchasing Procedure
01-xx-xxxx	Material Procurement Specifications
09-01-0004	Approved Vendor List
06-01-0007	Incoming Inspection, Subcontracted Material
09-01-0008	Approved Subcontractor Listing
06-01-0020	Distributor/Supplier/Subcontractor Survey and Audit for Qualification and Disqualification Procedures
06-06-0001	Statistical Process Control (SPC)
06-04-0014	Reliability Monitor and Boxstock Audit
06-09-0022	Nonconforming Material Procedure
06-09-0008	Preferred Vendor Program
06-01-0021	Qualification of Subcontractors

4.6.3 Purchasing Data

The purchase order shall list the LTC stock number, the description of the part, and designate the material as Type A, B, C, or D if applicable. The purchase order shall also state the drawing number or part number and the current revision level, the quantity needed, the applicable material procurement spec. and revision (for Type A & B materials only), the required delivery date(s) and the negotiated price. It shall also include inspection, test, and packaging requirements, as applicable. All Type A and B parts and materials shall be purchased from original equipment manufacturers, approved vendors and subcontractors, and authorized distributors. Below is a list of the categories:

Type A: Direct material that has distinct value-added identity on the finished product.

Type B: Indirect material consists of all material other than direct that is directly used in the manufacture of a product.

Type C: Indirect material consists of all material not directly used in the manufacture of a product.

Type D: Engineering evaluations consist of material specifically purchased for evaluations purposes and which Engineering will inspect. Type D material is not used as direct material, and will not be stored in an area where Type A material is stored. Type D material can be upgraded to Type A by having the requester complete a "Request to Enter a Part into Stores" and by having QA perform an incoming inspection on the material.

The purchase order is reviewed and approved by the management of the originating department. Additionally, Quality Assurance reviews and approves Purchase Orders for Type A and B material.

REFERENCES

Spec Number	Title
06-09-0003	Purchasing Procedure
01-xx-xxxx	Material Procurement Specifications

4.6.4 Verification of Purchased Products

4.6.4.1

The supplier verifies purchased product at the subcontractor's premises, using the following arrangements:

A) Only product which passes Qualification testing is acceptable for shipment to LTC, (see #06-04-0001).

B) Assembly Subcontractors are audited on-site periodically by an LTC Surveillance Engineer. Corrective action is required for all discrepancies, (see #06-09-0021 and 06-01-0020).

C) Assembled Product is evaluated at incoming inspection, (see #06-01-0007).

4.6.4.2

When specified in the contract, the purchaser or his/her representative shall be afforded the right to verify at source or upon receipt that the purchased product conforms to specific requirements. Verification by the purchaser shall not absolve the supplier/subcontractor of his/her

responsibility to provide acceptable products, nor shall it preclude subsequent rejection.

When the purchaser or his/her representative elects to carry out verification at the subcontractor's plant, such verification shall not be used by the supplier or subcontractor as evidence of effective controls of quality by the supplier/subcontractor.

REFERENCES

Spec Number	Title
06-04-0001	QA/RA Qualification Req.
06-09-0021	Supplier Certification Program (SUB)
06-01-0020	Distr./Vendor Survey/Audit/Qual/Disqual Pro.
06-01-0007	Incoming Inspection - Subcontracted Materials

4.7 CONTROL OF CUSTOMER-SUPPLIED PRODUCT

It is currently not LTC's practice to include purchaser-supplied materials in products. Therefore, this clause of ISO 9001 does not apply. In the event that LTC should agree contractually to accept/use purchaser-supplied product, LTC will document the procedures to verify, store, and maintain such product. Verification by the supplier does not absolve the customer of the responsibility to provide acceptable product.

4.8 PRODUCT IDENTIFICATION AND TRACEABILITY

Inventory identification and traceability shall be controlled through the assignment of product numbers, run numbers, lot numbers, serial numbers, date codes and back mark codes as appropriate.

Run card and lot traveler must, as a minimum, specify the lot number or run number, operation, device type or stock number, quantity in/out or quantity inspected/rejected (for inspection points). Runcards and lot travelers accompany the material through the factory until it reaches Boxstock.

Offshore subcontracted material shall be identified by general back mark codes.

The device back mark code is used to provide complete traceability to test lot traveler, assembly lot traveler, wafer fab traveler, and raw materials used. Where space allows, the *complete* backside mark code is imprinted, as follows: *(For records, see Section 4.16.)*

C/AA/BBB/XX/YY, where:	
C	Denotes Plant of Origin: Country of Origin (COO)
AA	Denotes Device Type
BBB	Denotes Assembly Lot Number
XX	Denotes Year
YY	Denotes Seal Week

REFERENCES

Spec Number	Title
05-03-4601	Country of Origin and Backside Mark
MIL-M-38510	Slash Sheet Drawings
SMD	Standard Military Drawings
DESC Drawing	SMD or Slash Sheet Drawings
MIL-STD-883	Compliant Data Sheets, LTC Data Book

4.9 PROCESS CONTROL

4.9.1 General

Processes which directly affect the quality of products or services delivered by LTC shall be carried out under controlled conditions. Controlled conditions include a production plan as well as appropriate controls for material, production and servicing equipment, processes and procedures, computer software, personnel, associated supplies, facilities, and environment.

A) Documented work instructions and necessary equipment and facilities shall be available and approved for all processes that affect the quality of the product.

B) It is the responsibility of each organization that handles product to monitor and control its processes.

C) Each organization has the responsibility for establishing requirements for the approval of processes, equipment, and personnel.

D) Standards for workmanship shall be defined in each area either in documents called "workmanship standards" or "standard operating procedures," or by physical examples of product that conforms to requirement.

E) It is the responsibility of each department to assure its equipment is suitably maintained.

F) Only certified personnel perform qualified processes.

G) *For records, see Section 4.16.*

REFERENCES

Spec Number	Title
00-01-1008	SOP: Specification Format and Organization
06-02-XXXX	Quality Process Monitor Specs
06-08-XXXX	Procedures, Quality Audit
06-09-XXXX	Procedures, QA Standard Operating
05-03-8082	Assembly Workmanship Standards
08-07-1001	Calibration Program Requirements
06-09-0002	Operator Training and Certification Program
06-03-7050	Record Keeping
08-07-1003	Fab Maintenance P.M.
08-07-0656	Special Facilities Safety Guidelines and Procedures
06-06-0001	SPC Procedure

4.9.2 Special Processes

Statistical Process Control (SPC) is implemented on all critical processes throughout the manufacturing flow.

All products shipped by LTC are 100% tested and inspected several times. All new products are fully characterized and qualified before release. LTC's Reliability program is designed to continually assess the performance of LTC devices in the field.

All of the above controls work together to ensure that any processing deficiencies become apparent before the product is delivered to the end customer. *Therefore, LTC does **not** have any "**special** processes."* See specifications listed below.

REFERENCES

Spec Number	Title
00-01-1006	SOP: Engineering Change Notice
06-03-5001	SL (Special Lot) Specification Procedure
06-06-0001	Statistical Process Control (SPC)
06-04-0014	Reliability Monitor and Boxstock Audit
06-04-0012	QR2 (Quick Reaction Reliability) Program
06-04-0001	Quality Assurance/Reliability Assurance Qualification Requirements
xx-xx-xxxx	Applicable Standard Operating Procedures
xx-xx-xxxx	(Also, Specifications referenced in 4.10.2 apply to 4.9.)

4.10 INSPECTION AND TESTING

4.10.1 General

All final inspection and testing shall be performed in accordance with referenced procedures to verify acceptance to specified requirements.

4.10.2 Receiving Inspection and Testing

Receiving/Production Control shall be responsible for segregating all incoming material until completion of IQC inspection and for routing subcontracted assembly lots to IQC for inspection.

4.10.2.1

In accordance with LTC's Quality Assurance procedures, all Type A and Type B purchased materials shall be subjected to QA Incoming Inspection.

Type A: Direct material that has distinct value-added identity on the finished product.

Type B: Indirect material consists of all material other than direct that is directly used in the manufacture of a product.

4.10.2.2

Lots may be released for further processing prior to completion of incoming inspection. However, IQC must be completed within 24 hours or 72 hours, depending upon the type of material that was released. If the sample fails, IQC notifies Production Control who works together to recapture the lot, provided that PC ensures that the affected lot(s) are not shipped prior to completion of IQC inspection.

Lots which pass all the criteria specified shall be considered acceptable. All logs, lot travelers, and boxes are stamped with a box IQC accept-date stamp prior to releasing the appropriate location.

If a lot fails any criteria, the lot is rejected and an inspection failure report (IFR) is initiated. All reject samples must be segregated and attached to the IFR. The responsible QA and Manufacturing Engineer must review and disposition the rejects and complete the IFR form.

The applicable Package and QA Engineers shall be responsible for notifying the supplier of any rejections and for following up on corrective action Discrepant Material Reports (DMR).

REFERENCES

Spec Number	Title
06-09-0003	Purchasing Procedure
06-01-0006	Incoming Inspection, General
06-01-0007	Incoming Inspection, Sub-Material
06-01-0011	Vendor Corrective Action
06-02-0020	Inspection Failure Report (IFR) Procedure
01-xx-xxxx	Material Procurement Specifications
06-08-0013	Control of Age/Temperature Sensitive Materials
08-07-1001	Calibration Program Requirements

4.10.3 In-Process Inspection and Testing

LTC shall:

A) Inspect, test and identify product as required by the quality plan or documented procedures.

B) Establish product conformance to specified requirements by use of process monitoring and control methods. *See Section 4.20 for specifics.*

C) Hold product until the required inspections and tests have been completed or necessary reports have been received and verified except when product is released under positive recall procedures. *See Section 4.10.2.2*. Release under positive recall procedures shall not preclude the activities outlined in Section 4.10.2.1.

D) Identify nonconforming products.

See specifications listed below.

REFERENCES (Representative)

Inspection	Hold	Monitors	Test	Records
06-02-0001	06-02-0020	06-02-0002	06-02-0006	06-03-7050
06-02-0003		06-02-0004	06-02-0011	06-03-7051
06-02-0005		06-02-0008	06-02-0019	06-03-5000
06-02-0007		06-02-0012	06-02-0031	06-03-5001
06-02-0009		06-02-0017	06-03-0011	06-03-7068
06-02-0014		06-02-0022	06-03-0012	09-01-0002
06-02-7002		06-02-5001	06-03-7001	09-01-0004
06-02-7003		06-02-7036	06-03-7003	09-01-0005
06-02-7004		06-08-0002	06-03-7004	09-01-0008
06-02-7070		06-08-0003	06-03-7006	
06-03-7028		06-08-0004	06-03-7007	
06-03-7029		06-08-0005	06-03-7008	
06-03-7030		06-08-0015	06-03-7009	
06-03-7031		06-09-0018	06-03-7011	
06-03-7035		06-09-0019	06-03-7012	
06-03-7036		06-09-9001	06-03-7016	
06-03-7038		06-09-9003	06-03-7017	
06-03-7061			06-03-7018	
06-03-7062			06-03-7019	
06-03-7066			06-03-7025	
06-06-0001			06-03-7026	
06-08-0014			06-03-7027	
08-07-1001			06-03-7032	
			06-03-7033	
			06-03-7034	
			06-03-7063	
			06-03-7064	
			06-03-7065	
			06-03-7067	
			06-04-0001	
			06-08-0006	

4.10.4 Final Inspection and Testing

All products will undergo a final test according to the applicable test procedure, and will be inspected for completeness of specified requirements, appearance against applicable workmanship standards, and all associated data and documentation are available and authorized.

Electrical test and visual/mechanical acceptance shall precede transfer to the Finished Goods inventory area. Finished Goods inventory consists only of products formally on the released product listing (RPL). Additionally, it is impossible to ship product that is not on the RPL, as the computer will not print a shipper. Inspection of product prior to shipment shall assure compliance to contractual requirements as described by referenced procedures and applicable "SL" or special flow requirements.

The government shall be allowed access to LTC and subcontractor facilities to verify acceptability, when contractually required.

REFERENCES

Spec Number	Title
06-02-0014	Outgoing QA Electrical Test for 883, STANDARD MIL, and Commercial Devices
06-02-7002	QA Post Pack Inspection
06-02-7003	QA Shipbench Inspection
04-04-XXXX	Final Test Set-Up Specifications

4.10.5 All Inspection and Test Records

Records that product has passed all required inspections and tests as defined in the Quality plan must be maintained. These include records from: Test, Visual/Mechanical, Post-pack, Boxstock, Shipbench, SL, and Flows.

Specific procedures defining acceptance criteria for inspection and test records may be found by referring to the specifications listed below, or on the applicable lot travelers. Records shall identify the inspection authority responsible for the release of product, and shall clearly show the acceptance or failure of required inspections or tests (reference Section 4.12).

Nonconforming material shall be identified, segregated, and dispositioned in accordance with Section 4.13 and referenced procedures. *See Section 4.16 for specifics*.

REFERENCES

Spec Number	Title
06-03-7050	Record Keeping
00-01-1006	SOP: Engineering Change Notice

4.10.6 Test Software Control

Test software shall be approved before use by Test Engineering. Test software shall be stored for use in a controlled access "server," from which only the most current and approved software shall be used to test product.

A document-controlled Test Program Book contains released (04-12-xxxx) test program listings, including the program name and latest revision for each device type for Wafer Sort, Final Test, and QA tests. Revisions used are recorded on the test flow traveler, which also serves as a test specification.

Changes to test procedures can only be made after an ECN has been approved and signed off. Major changes to software (as defined in spec 06-04-0007) can only be made after an ECN has been approved and signed off.

Whenever possible, equipment accuracy to parameter tolerance shall be of at least a 10:1 ratio. However, when 10:1 accuracy is not possible, electrical quality is guaranteed by guard banding test limits against the published data sheet.

Guard bands are set by a combination of published test equipment specifications and SPC techniques. This ensures that parametric readings outside device specifications are deleted, resulting in the faulty unit being rejected.

Additionally, a final QA sampling plan guarantees acceptance to quality limits inside of published data sheet parameters.

REFERENCES

Spec Number	Title
00-01-1006	SOP: Engineering Change Notice
04-04-6300	Test Area SOP
04-01-xxxx	Standard Product Test Flows
04-13-xxxx	SL Product Test Flows
04-21-xxxx	SMD and DESC Drawing Test Flows
04-12-xxxx	Test Program List
04-14-xxxx	SL Product Test Program Index
04-25-xxxx	SMD and DESC Drawing Test Programs
06-04-0007	Customer Notification of Major Changes
06-04-0009	Datasheet Change Control
04-04-6367	Test Software Control and Security

4.11 CONTROL OF INSPECTION, MEASURING, AND TEST EQUIPMENT

A) LTC measuring and test equipment shall be controlled, calibrated, and maintained prior to release for use during production, installation, or servicing to demonstrate the conformance of product to the specified requirements. Subcontractors and vendors shall demonstrate conformance to the intent of MIL-STD-45662.

B) A unique identification must be provided for all equipment and tools requiring calibration. This will be included on the calibration recall list which includes the department number, equipment type and due date.

C) The re-calibration frequency must be determined and recorded. The calibration of inspection, measuring and test equipment, including torque tools, shall be checked before use or if the equipment is dropped (or otherwise subjected to impact).

D) LTC uses outside calibration laboratories or services provided by the original equipment manufacturer.

Prior to any contractual agreement, all outside calibration labs used to calibrate any of LTC's test and measurement equipment must be audited by QA to MIL-STD-45662 and 08-07-1001 "Calibration Program" requirements. The outside calibration system and controls must comply with MIL-STD-45662 requirements.

Outside calibration labs shall be responsible for maintaining a complete and accurate list of instruments and equipment from LTC under the service agreement.

The list shall identify the instruments to be serviced by means of coded symbols to identify the service performed and recall period.

The outside lab shall furnish data sheets or certification for each calibration performed.

E) Criteria are established for review of equipment to determine if calibration is required. If **any** of the following conditions is met, calibration will **not** be required.

1) Equipment performs a particular function, but it is required that other calibrated equipment be used with equipment at initial setup.
2) The performance of equipment is monitored through the use of calibrated equipment.
3) Equipment is used for indication only.
4) Equipment where calibration has no meaning or cannot be performed.
5) Equipment will be identified with a sticker stating, "calibration not required."

F) New equipment calibrated directly by original manufacturers shall be accepted if they meet the following requirements:
   1) Calibrates equipment in accordance with established written calibration procedures.
   2) Records all out-of-spec conditions with *before* and *after* values.
   3) Supplies original calibration data and paperwork which satisfy these requirements:
      a) The appropriate inspection, measuring, and test equipment are selected to provide the required accuracy for all measurements to be made. The equipment to be used and measurements to be made shall be defined in the detailed procedures or travelers.
      b) Calibration and adjustment are performed as required by the individual calibration procedure and/or manufacturer's specifications. Primary, secondary, and working standards are to be traceable to the National Institute of Standards and Technology (NIST) or to natural physical constants.

G) Where test hardware or test software is used, correlation units are tested to ensure equipment has been set up and running properly. Correlation units are run at the frequency defined in the applicable procedures. Correlation wafer/units are also used to verify the set-ups and test programs if the operators are experiencing a large number of rejects.

   In general, test hardware, software, and techniques are considered proprietary to LTC. Such information is not released except by non-disclosure agreement and by authorization of the Chief Operating Officer. However, to resolve correlation difficulties with customers, LTC can provide serialized and data logged devices.

H) Procedures describing the verification of calibrated equipment are listed below:
   1) The accuracy, precision, and capability of inspection and measurement equipment must be sufficient to provide meaningful results. Equipment is selected based on manufacturers' guaranteed operating specifications and tolerances. During initial inspection/test development, correlation studies are conducted to verify desired results.
   2) For critical inspections or where an SPC control chart is to be used, a Measurement System Evaluation (MSE) or Gage Repeatability and Reproducibility (Gage R & R) is conducted to ensure capability.
   3) Every user is responsible for checking the calibration status of a calibrated tool or piece of equipment *before it is used* and is responsible to see that it is **not** used if calibration is required before use. This is done by verifying the data on the calibration sticker and/or as defined in the applicable detailed procedure.

I) Records of recall notices shall also be maintained along with calibration certificates of conformance (C of C) in the applicable equipment history file.

   A history file shall be kept by QA for each piece of calibrated equipment. The file shall consist of calibration data sheets, calibration certificate of conformance, and out-of-tolerance evaluation forms (if applicable).

   The test maintenance group shall be responsible for maintaining the calibration data sheets on equipment under their calibration program, with a copy going to QA for the history file.

   Records shall be kept a minimum period of 5 years (or longer, if required by customer contract). (*For records, see Section 4.16.)*.

J) In the event that a piece of equipment is found to be out of calibration, consideration is given to review all previous work completed with the equipment since the previous calibration.

   Any out-of-calibration condition that is determined to adversely affect product quality or reliability will require rectification, customer notification and possible recall of product.

K) Calibration procedures shall have the specified temperature and humidity for specific environmental conditions listed in the various equipment calibration specifications. Areas where operations are sensitive to surrounding environment shall be specified, monitored, and controlled.

L) Upon receipt and before use, equipment is inspected for damage and verification that appropriate calibration stickers have been affixed to the equipment.

M) Production tooling used as inspection media shall be controlled and checked for accuracy at set intervals, according to calibration procedures.

N) As deemed necessary to verify acceptability, government and customer representatives shall be allowed access to personnel and use of calibrated equipment.

O) Any advanced metrology requirement (exceeding the known state-of-the-art technology) identified during contract review shall be addressed by Test Engineering and reported on the spec review form.

REFERENCES

Spec Number	Title
MIL-STD-45662	Calibration Systems Requirements
08-07-1001	Calibration Program Requirements
04-05-xxxx	*Applicable Test Preventive Maintenance (PM) Calibration Procedures*
02-05-xxxx	Applicable Fabrication P.M. Calibration Procedures
08-07-1003	Fab Maintenance P.M. Specification
06-06-0001	Statistical Process Control (SPC)
06-08-0002	Controlled Environment Surveillance
08-07-xxxx	Applicable Facilities P.M. Procedures
ANSI Z-540.1	American National Standard for Calibration

4.12 INSPECTION AND TEST STATUS

Inspection stamps serve to identify the inspector who has accepted or made an authorized disposition of material or product. Trained and certified inspectors shall be issued inspection stamps which are to be used to indicate completion of acceptance testing.

Inspection stamp design is unique to LTC.

Each inspection area shall segregate inventory according to inspection status and implement positive controls to segregate accepted materials from rejected material.

Manufacturing lot travelers shall accompany all material. The traveler shall show at least those manufacturing steps from the last quality gate function and/or all manufacturing operations which describe work operations being inspected. Lot travelers shall indicate completion of manufacturing operations by operator initials or number, date and quantity out.

The identification of inspection and test status shall be maintained (as defined in the procedures referenced herein); throughout production of the product to ensure that only product that has passed the required inspections and tests is shipped.

Each gate inspection shall include verification that specified manufacturing and inspection steps have been completed.

Only accepted material which passes QA Final Inspection is allowed in the Boxstock area. All containers are identified with a QA stamp on the label of the box. Only product which is fully qualified and on the Released Products List (RPL) can be shipped from Boxstock.

REFERENCES

Spec Number	Title
06-02-0001	Quality Assurance Inspection, Wafer Sort
06-06-0002	QA Inspection Stamp Control
06-02-0020	Inspection Failure Report
06-02-7003	QA Shipbench Inspection
06-02-7002	QA Post-Pack Inspection
06-02-0003	QA 2nd Optical Inspection
06-02-0007	QA 3rd Optical Inspection
06-02-0009	Group-A Electrical Test
06-02-0014	Outgoing QA Electrical Test for 883, STANDARD MIL, and Commercial
09-01-0002	Released Product Listing

4.13 CONTROL OF NONCONFORMING PRODUCT

4.13.1 General

Nonconforming material shall be identified and segregated to prevent unauthorized or accidental use. Where nonconformance is detected during a verification step, the nonconformance shall be recorded and corrected before the product is moved to the next step in the process, with notification to the functions concerned.

All processes, work operations, quality records, service reports, and customer complaints are analyzed to detect and eliminate potential causes of nonconforming product.

4.13.2 Review and Disposition of Nonconforming Material

Where a nonconformance is detected in process, the product shall be scrapped, reworked, or returned to the preceding step for correction. MRB dispositions for raw materials are as specified in #06-01-0006. (*For records, see Section 4.16.)*.

All rework shall be performed per approved procedures and results shall be recorded on the appropriate rework traveler. Reworked product shall be re-inspected/re-screened in accordance with documented procedures.

LTC does not perform *repair* on any shippable product.

The responsibility for review and the authority for disposition of nonconforming product and materials are described on the following page:

REFERENCES

Spec Number	Title
06-02-0020	Inspection Failure Report
06-01-0006	Incoming Inspection, General (¶9.8-9.16)
06-01-xxxx	Applicable Incoming Inspection Procedures
06-02-xxxx	Applicable Inspections and Monitoring Procedures
06-03-xxxx	Applicable Inspection and Test Operational Procedures
06-09-0018	SOP: Inventory Control
06-09-0019	Engineering Alert: Minimum Yield Requirements
06-09-0022	Nonconforming Material Control Procedure
02-04-1102	Stop/Start Procedure
06-02-3000	CMR

4.14 CORRECTIVE AND PREVENTIVE ACTION

4.14.1 General

Prevention procedures and corrective action procedures to ensure that the product conforms to established specification and quality standards are vital parts of LTC's continuous quality improvement program.

A) The intent is to identify the **root cause** of a nonconformance and for correction and prevention of recurrence. This applies to all manufacturing and support operations responsible for the manufacture of product, and shall apply to (but not be limited to): Design, Purchasing, Manufacturing, Testing, Final Packaging for Shipment, Customer Material Returns and Failure Analysis.

   Emphasis shall be placed on identifying the root cause and the prevention of recurrence of the nonconformance. This may include containment, an interim corrective action, a final corrective action, and subsequent audits to ensure that the required corrective action measures are in place and are effective in preventing recurrence of nonconformances.

   The response time goals are:
   - Containment within 24 hours.
   - Verification within 48 hours.
   - Root cause and corrective action identification plan within 10 days.

B) Discrepancies found during incoming inspection of raw material lots are documented on a Discrepant Material Report (DMR) by the QA group. Once a rejection is determined by the MRB to be valid, the QA Group is required to generate a Vendor Corrective Action Request (VCAR). Upon receipt of the completed VCAR from the supplier, Quality Engineering shall determine if the corrective action is sufficient to prevent a recurrence of the problem. If a supplier does not provide effective corrective action, the supplier may be disqualified.

   Discrepancies found during in-process or outgoing inspection are documented on an Inspection Failure Report (IFR) by QA, or on a Stop/Start by Production if the in-process inspection is performed by the production group. The IFR or Stop/Start is reviewed by the appropriate Engineering group to determine lot disposition and appropriate corrective action. All IFRs are summarized in a monthly trend report by the QA department. The report is issued to the responsible Production and Engineering groups for review with emphasis placed on eliminating recurring problems.

Other activities which may identify the need for initiating corrective action are:
- calibration (out of tolerance)
- failures from a QA inspection step (IFR)
- results from reliability monitoring
- results from quality measurement analysis
- corrective action reports
- SPC chart OCAPs
- findings from process audits and quality system audits
- management reviews of the quality system and quality trends
- customer feedback
- vendor ratings and audits
- failure analysis

C) When quality problems or undesirable trends occur, the Quality Control Team (QCT) is responsible for initiating a meeting or series of meetings to establish a Process Action Team (PAT) to identify and define corrective action measures. These meetings are held until the problems are resolved or when quality levels are improved to an acceptable level.

D) The responsibility for taking appropriate preventive and corrective action is to be shared among Production, Quality Assurance, Reliability, and Engineering groups. Representation on the PATs should reflect this shared responsibility of preventive/corrective action. All of the above groups are responsible for ensuring that the corrective actions are effective.

E) Any changes in procedures which result from a corrective action are documented through the Engineering Change Notice (ECN) procedure and are recorded in the Document Control department.

F) All customer failure analysis reports are distributed to management, including the president and chief operating officer.

REFERENCES

Spec Number	Title
06-02-0020	Inspection Failure Report (IFR) Procedure
06-01-0011	Vendor Corrective Action
02-04-1102	Stop/Start Procedure
06-02-3000	Customer Material Return Processing Procedure
06-05-7001	Failure Analysis Program
06-06-0001	Statistical Process Control
06-08-0014	Quality Audit Procedure
06-01-0006 / 06-09-0003	Material Review Board (MRB) Procedures
06-06-0003	Team Problem-Solving
06-09-0020	Corrective and Preventive Action Program
20-01-0012	Customer Complaint-Problems

4.14.2 Corrective Action

The procedures for corrective action shall include:

A) the effective handling of customer complaints and reports of product nonconformities;

B) investigation of the cause of nonconformities relating to product, process, and quality system, and recording the results of the investigation (see 4.16);

C) determination of the corrective action needed to eliminate the cause of nonconformities;

D) application of controls to ensure that corrective action is taken and that it is effective.

4.14.3 Preventive Action

The procedures for preventive action shall include:

A) the use of appropriate sources of information such as processes and work operations which affect product quality, audit results, quality records, service reports, and customer complaints to detect, analyze, and eliminate potential causes of nonconformities;

B) determination of the steps needed to deal with any problems requiring preventive action;

C) initiation of preventive action and application of controls to ensure that it is effective;

D) confirmation that relevant information on actions taken is submitted for management review *(see 4.1.3)*.

4.15 HANDLING, STORAGE, PACKAGING, AND DELIVERY

4.15.1 General

Documented procedures define the system for the preservation, segregation, and handling of all items and government-owned property throughout the entire manufacturing and inspection flow through storage and shipping. Precautions shall be taken to protect material from abuse, misuse, damage, deterioration, and unauthorized use.

4.15.2 Handling

All production parts, supplies, and components shall be handled in a manner that will prevent damage or deterioration. Handling requirements are further defined in the following:

REFERENCES

Spec Number	Title
06-09-0015	SOP to Prevent Product Mixing
06-09-9001	Electrostatic Discharge Control Requirements
06-08-0005	Environment Requirements for Processing and Storage
06-09-0018	SOP: Inventory Control
04-04-6300	Test Area SOP
05-03-7903	Mark and Pack SOP
06-01-0006	Incoming Inspection, General
06-01-0007	Incoming Inspection, Subcontracted Material

4.15.3 Storage

All materials processed shall be stored in a manner that will minimize the possibility of incurring damage or deterioration. During the scheduled quality system audit, samples of stock shall be checked for damage and deterioration of packaging. Access to the Stores, Boxstock, and Dispatch areas shall be limited to authorized personnel.

The condition of product in stock shall be assessed at appropriate intervals for the detection of deterioration.

Procedures for receipt, dispatch, and storage of material are referenced in the specifications on the following page:

REFERENCES

Spec Number	Title
06-07-0001	Dispatch Procedure
06-07-0002	Boxstock Procedure
06-08-0005	Environment Requirements for Processing and Storage
06-09-0004	SOP: Stores
06-09-0018	SOP: Inventory Control
06-09-9001	Electrostatic Discharge Control Requirement
09-07-0003	Special Flows
06-04-0014	Reliability Monitor and Boxstock Audit
06-08-0013	Control of Age/Temperature Sensitive Materials

4.15.4 Packaging

All materials shall be packaged in a manner that will minimize the possibility of incurring damage or deterioration during storage and handling. Procedures defining further requirements for packaging may be found by referencing procedures in the following specs:

REFERENCES

Spec Number	Title
05-03-2000	Wafer Pack
05-03-2003	Break and Plate
05-03-4601	Back/Side Mark
05-03-4604	Mark and Pack Incoming Procedure
05-03-7899	Pack Partial Finish Product Singapore
05-03-7900	Pack
05-03-7901	Die Pack
05-03-7903	Mark and Pack SOP
06-01-0026	Incoming Inspection Age Sensitive Material
06-01-0010	Incoming Inspection Anti-Static/Conductive Packaging Material
06-02-7002	QA Post-Pack Inspection
06-07-0002	Boxstock Procedure
06-08-0013	Control of Age/Temperature Sensitive Materials
06-09-9001	Electrostatic Discharge Control Requirements
09-01-0005	Top Mark Layout Listing (TML)
09-07-0003	Special Flows

4.15.5 Preservation

(Does not apply)

4.15.6 Delivery

Unless specified in the contract, the Customer Service department is responsible for the selection of carriers and the arrangement of shipments. The final boxing and shipping of finished products is the responsibility of the shipping department to ensure protection of product quality after final inspection and during transit to its final destination.

Specific procedures defining the details of these processes are listed below:

REFERENCES

Spec Number	Title
06-07-0002	Boxstock Procedure
06-02-7003	QA Shipbench Inspection
06-09-9001	Electrostatic Discharge Control Requirements

4.16 CONTROL OF QUALITY RECORDS

Quality records shall be retained in such a manner as to be retrievable. These records document conformance to specifications and the effective operation of the quality system.

All records used to substantiate controls for military/aerospace, high reliability, MIL-M-38510, MIL-PRF-38535 and MIL-STD-883 product shall be retained for a minimum of five (5) years.

For commercial products not covered by customer purchase order record retention requirements, records of manufacturing, quality assurance, and support groups are retained for a period shown below.

All quality records shall be legible and traceable to the product involved. Quality records shall be stored and maintained so that they are readily retrievable in facilities that provide a suitable environment to minimize deterioration, damage, or loss.

Where contractually agreed upon, quality records shall be made available for evaluation by the customer or the customer's representative for an agreed period.

The following procedures contain additional requirements regarding record keeping:

REFERENCES

Spec Number	Title
06-03-7050	Record Keeping
06-03-7051	Electronic Archiving Operating Procedure

4.16.1 Quality Records Matrix

The following table (Quality Records Matrix) identifies the types of quality record, where the record is kept, the method of storage, the position or function responsible and the minimum retention period.

Quality Records Matrix

Quality Record	Location	Method	Responsible	Period
Quality System Review Report	QA	File	QA	Min. 3 Years
Design Verification	Engineering	File	P.E./D. Engr.	Life of Product
Contract Review, P. O. Review, SLs	Cust. Spec. Review	File	QA	5 Years - Military 3 Years - Commercial
Inspection Records	QA/IQC	Elect. File/File	QA/IQC	Min. 5 Years
Failure Analysis Reports	QA/Rel.	Elect. File/Data Base	QA/Rel.	Min. 5 Years
Initial Documentation/Subsequent Changes in Design, Material or Processing, Qualification Test and Change Records	QA/Hi Rel.	Elect. File/Data Base	QA/Hi Rel.	Min. 7 Years
Specification (Documents, Applicable Forms)	Doc. Control	File/Data Base	Doc. Control	Life of Document
Calibration	QA/Test Maint.	File/Data Base	QA/Test Maint.	Life of Equipment
In-Process Monitor Inspection Logs Control Charts Stop/Start Sheets/ IFRs	QA/IQC	Elect. File	QA/IQC	Min. 5 Years
All JAN 38510/38535, 883, Customer Rel, Wafer Fab Assembly, Screening Qualification, Quality Inspection Records (including all printouts, read/record data)	Hi Rel/JAN Prog/QA	Elect. File	Hi Rel/Jan Prog/QA	Min. 5 Years from Date of Last Shipment
All Commercial Fab Travellers, Wafer Sort Summaries, Final Electrical Screening, QA Inspection Records, and Mark and Pack Travellers	QA/Manufacturing	Manufacturing/ VAX File/QA Elect. File	Wafer Fab, Test, Mark & Pack	Min. 3 Years
All Commercial Assembly, Qualification and Quality Inspection Records, (including all printouts, read/record data)	QA	Elect. File/File	QA	Min. 1 Year
All Procurement Documents	Purchasing	File/Data Base	Purchasing	Min. 5 Years
All QA Inspection Stamp Control Records	Doc. Control	File	Doc. Control	Min. 5 Years
Quality Audit Reports (QARs), Audit Logs (two years), Vendor/Sub-Contractor Audits, Customer Audits, Quality Deficiency Records (QDRs) generated by DESC or DCMC, International Distributor Audit Reports, DESC Self Audit, Customer Mail Surveys, Quality Audit Period Reports (2 yrs); Annual Quality Audit Reports	QA Audit	File	QA Audit	Min. 5 Years
Operator Training/ Certification	Personnel/ Applicable Trainer	File Elect. File/File	Personnel Applicable Trainer	Active File, 6 Mos. Min. 5 Years
Control Charts (SPC)	Applicable Area	File	Area Supervisor	Min. 3 Years
MIL-SPEC Library	QA	File	QA	Life of Document
DOE Results, Problem Analysis and Preferred Vendor Records	SPC Dept.	File	QA	Min. 5 Years
Release Product Listing ECN	Doc. Control	File	Doc. Control	Life of Product
QR^2 Records	Rel. QE	Elect. File/File	Rel. QE	3 Mos.-1 Yr./ Min. 5 Years
Process Logs	Manufacturing	File	Area Supervisor	Min. 5 Years
Subcontractor/Vendor Ratings	Purchasing	File	Purchasing	Min. 5 Years
RPL/Top Mark	Doc. Control	Elect. File	Doc. Control/Engr.	Life of Product
Inspection Records/Logs/IFRs (Assembly Subcontractors)	IQC	File	IQC	5 Years - Military 3 Years - Commercial
Inspection Records/Logs/DMRs (Raw Materials)	IQC	File	IQC	Min. 5 Years

4.17 INTERNAL QUALITY AUDITS

Internal audits of the quality system shall be conducted according to a schedule established by the Corporate Quality Audit department. The schedule shall ensure that all areas operating under the quality system described in this quality manual are audited at least once per year.

The results of these audits shall be documented and communicated to the management of the area being audited. Management will ensure that corrective actions are taken to resolve audit findings. *(See Section 4.16).*

Quality system audit results shall be reviewed to determine the adequacy of, and compliance to, the documented quality system.

The corporate auditor will follow-up until corrective action is implemented. *(See Section 4.16).*

The results of internal quality audits shall be part of the input to management review activities. *(See Section 4.1.3).*

The audit process is detailed in the following procedures:

REFERENCES

Spec Number	Title
06-08-0014	Quality Audit
06-08-0015	MIL-PRF-38535 Quality Audit Checklist
06-01-0020	Distributor/Supplier/Sub-Contractor/ Vendor Survey/Audit Qualification/Disqualification Procedure
09-01-0008	Approved Subcontractor Listing
09-01-0004	Approved Vendor Listing
06-03-7050	Record Keeping

4.18 TRAINING

Each department shall establish training requirements for all jobs that effect the quality of product shipped to customers. Individual departments shall maintain records to indicate that a person has satisfactorily completed the appropriate training for his/her assigned job.

It is the responsibility of each functional manager to insure that his/her personnel receive proper training. All employees are to be trained and motivated to provide excellence in workmanship throughout the manufacturing process and to provide the service to our customers which is the standard by which other companies are judged.

Training needs are identified in #06-09-0002, and as necessary, on the Employee Performance Review.

Personnel performing specific assigned tasks shall be qualified on the basis of appropriate education, training and/or experience, as required.

Training records shall be maintained by each functional supervisor, and a copy is to be sent to Human Resources. Records shall indicate: Employee Name, Date of Hire, Badge Number, Department Number, Supervisor, Spec Trained to (Title of Spec and Number), number of training hours, Initials of Trainer, Operator's Initials, Date Certified. *(See Section 4.16).*

It shall be the responsibility of the quality systems audit department and area supervisor to monitor the training and certification records to ensure compliance with the documented requirements.

REFERENCES

Spec Number	Title
06-09-0002	Operator Training and Certification Program
05-06-0007	EOL Operator Training and Certification Program
xx-xx-xxxx	Applicable Specifications / Training Specifications per Work Area
06-09-0010	Review Cycle Process/Late Notice

4.19 SERVICING (FAILURE ANALYSIS)

Failure analysis of devices returned from customers is the only service which is provided by LTC.

Failure analysis is the joint responsibility of the Reliability group, Product Engineering, and Design Engineering. Outside analytical labs are utilized in special areas which require capabilities beyond the scope of the in-house equipment.

Procedures for identification, handling, and analysis of reject or defective devices shall be documented. This information will be conveyed to the customer and government representative via a formal Failure Analysis Report in accordance with established industry standards including, but not limited to, MIL-PRF-38535 Appendix A, and MIL-Q-9858.

A summary report of failure analysis activity findings shall be prepared and submitted to management on a quarterly basis, or more frequently, if necessary.

REFERENCES

Spec Number	Title
06-05-7001	Failure Analysis Program
MIL-PRF-38535	General Spec for Microcircuits
MIL-Q-9858	Quality Program Requirement

4.20 STATISTICAL TECHNIQUES

4.20.1 Identification of Need

A Statistical Process Control (SPC) program is in place to improve process capability, reduce process variations, provide continuous improvement, and provide robust designs along with the statistical sampling plans used as an integral part of inspection and testing.

The SPC program is applicable to all manufacturing processes, to operations which use statistical sampling for control or acceptance purposes, and to designs that are deemed critical.

Statistical techniques are employed by LTC to analyze process data and to identify the root causes of process variation so that the process can be modified to achieve:

A) Continuous reduction of variability around the desired target;
B) Consistency over time;
C) Conformance to requirements.

The SPC program comprises the following key elements:

A) An SPC structure: Steering Committee (Corporate level), Quality Control Teams (area SPC facilitators/ management), and Process Action Teams (PATs).
B) Employee training: Basic SPC, Advanced SPC, Design of Experiments, and Team Organization.
C) Establishment and documentation of Critical Nodes in manufacturing/related processes via flow charts and Control Plan Detail tables.
D) LTC's Self-Audit program of the SPC program.
E) Application of SPC to manufacturing, inspection, calibration, maintenance, preventive maintenance, environmental control, document control, purchasing materials, service data, and other areas as the need arises.
F) Formation of SPC Process Action Teams (PATs) composed of representation from manufacturing, engineering, maintenance, (and as applicable, quality engineering) with the objective of applying SPC to solve problems, improve process capabilities and reduce process variation.
G) Reports shall be established to measure progress made in terms of improved process capabilities (Cp & Cpk indexes) and quality improvements.
H) Statistical Sampling procedures are employed for those operations not requiring 100% inspection or which are destructive in nature.
I) Goal setting for continuous quality improvement.

Specific statistical methods and applications available include, but are not limited to, the following:

A) Design of Experiments/factorial analysis
B) Analysis of variance/factorial analysis
C) Safety evaluation/risk analysis
D) Tests of significance
E) Quality control charts/Cum-Sum techniques
F) Statistical sampling inspection

4.20.2 Procedures

Documented procedures shall be implemented and maintained for controlling the application of the identified statistical techniques.

REFERENCES

Spec Number	Title
MIL-STD-105	Sampling Procedures and Tables for Inspection by Attributes
06-06-0001	Statistical Process Control (SPC) Procedure
06-06-0003	Team Problem Solving
06-02-4000	Sampling Procedures

4.21 QUALITY COST

Quality cost data, the cost of scrap, rework, and prevention of defective material are of primary concern at LTC.

Quality cost data shall be collected, analyzed, and used to improve effectiveness, efficiency, and control waste. This data is in the form of yield reports and scrap reports, which are compared to their respective specified goals.

The overall operating expenses of the Quality Assurance Department are forecast and budgeted on an annual basis. The cost of department operation is broken down into specific categories. Each category is reviewed on a monthly basis to assess actual cost versus planned cost.

All yield, scrap, and cost data are considered *LTC Confidential,* and may only be reviewed with customers upon the express, written permission of LTC's Chief Operating Officer.

APPENDIX A—RELIABILITY ASSURANCE

- The Reliability Assurance group shall be made up of professional individuals with training and experience in environmental stress testing, failure analysis techniques, reliability calculations, and reliability predictions of integrated circuits.
- The activities of the Reliability Assurance group shall focus on measurements of product reliability, as well as the identification and timely elimination of design and processing deficiencies which limit or otherwise compromise product reliability.
- Reliability Assurance shall exercise full authority over the qualification of all products, processes, materials, and manufacturing locations.
- The Reliability Assurance group shall prepare and implement written program plans and detailed procedures covering, *as a minimum*, these areas:

  Wafer Fabrication Reliability Monitor Program

  Quick Reaction Reliability Audit Program

  Long-Term Reliability Audit Program

  New Product/Process/Material Qualification Program

  Major Change Qualification

  Assembly Subcontractor Qualification

  Failure Analysis and Corrective Action Program
- Achieving extremely low failure rates during product life in the field demands that the integrated circuit manufacturer audit reliability performance of outgoing products.
- Product reliability audits are the responsibility of the Reliability group, with immediate responsibility for program implementation, performance, and reporting assigned to the Manager of Quality and Reliability Assurance.
- A summary data file shall be maintained on all product families. This summary shall include, *as a minimum*, the device type tested, the package type, the assembly location, the manufacturing date code, the actual test condition used, the sample size, the duration of the test, and the number of failures observed.
- Management shall be apprised *immediately* of any audit results which indicate that failure rate goals are not being met or that significant degradation in performance is evident.

PRODUCT QUALIFICATION PROGRAM

- New products will not be released without acceptable reliability data as defined by Reliability and Quality Assurance and the responsible engineering groups.
- Before any major design or process change is considered qualified, sufficient test data shall be collected to demonstrate that the processes used conform to applicable government, industry, customer, and internal specifications. The finished devices must be capable of passing all tests as required by applicable government, industry, customer and LTC specifications.
- *A **major change*** is defined as a significant departure from the existing approved process/design, as agreed by Reliability Assurance and Manufacturing, or Design and documented in LTC's 06-04-0001 and 06-04-0006 Qualification Specifications.
- Similarity in materials and design to previously qualified products shall be considered sufficient for purposes of new product or ***process change qualification***. Similarity data may be supplemented with test data on the product in question in those areas where similarity does not justify blanket qualification of the product or change approval.
- Life test data on one device within a product family can be used to generically qualify other devices within the same product family, providing the devices are encapsulated in packages made from the same materials and sealed using the same sealing process. For purposes of qualification, a product family includes all microcircuit chips of equivalent complexity or function made in the same wafer fab area using the same process.
- Qualification requirements shall be established and documented for all products and processes. Documentation shall include the tests, test conditions, and pass/fail criteria which must be met before the product or process is considered fully qualified.
- Qualification tests shall include environmental tests and mechanical tests as specified in the LTC 06-04-0001 spec, but shall not necessarily be limited to these tests where device service conditions are known to be more severe than the test conditions in the standard qualification.
- Qualification requirements on MIL-STD-883, SMD (standard military device), and MIL-M-38510 devices shall be per Method 5005 of MIL-STD-883, *as a minimum*.

- Major changes on MIL-M-38510 devices shall be as defined in MIL-PRF-38535, Appendix A and qualification requirements as specified in MIL-PRF-38535, Appendix A.
- Qualification test reports shall be retained for a *minimum* period of five years for military, and one year for commercial.

REFERENCES

Spec Number	Title
06-04-0001	Quality Assurance/Reliability Assurance Qualification Requirements
06-04-0006	Qualification of Changes on 38510 Products
06-04-0014	Reliability Monitor and Boxstock Audit
06-04-0012	QR² (Quick Reaction Reliability) Program
06-03-7035	Class B Qualification
06-03-7036	Class S Qualification

APPENDIX B—MAJOR CHANGE NOTIFICATION

- The major change definitions and requirements per MIL-PRF-38535 for military products, LTC's major change requirements for commercial products, and specific customer change requirements shall be fully documented by the Quality Assurance group.
- The responsible Engineering group and/or Quality Assurance group is responsible for initiating a major change via an ECN processed through the Document Control group. Appropriate qualification and test data justifying the major change shall support the ECN.
- The Quality Assurance and Reliability manager is responsible for maintaining a database of customers who require major change notification.
- The Quality Assurance and Reliability manager is responsible for ensuring that a major change is not implemented until customers who have major change notification requirements are notified and have approved the major change.
- The Quality Assurance and Reliability manager is responsible for sending the customer appropriate qualification and test data justifying the major change and for maintaining a record of all customer major change notifications.

REFERENCES

Spec Number	Title
06-04-0007	Customer Notification of Major Changes
06-04-0006	Qualification of Changes on 38510 Products

APPENDIX C—ENVIRONMENTAL CONTROL

- The Facilities and Maintenance departments are responsible for control of following items to support the manufacture of integrated circuits:

  Temperature and humidity control

  Controlled filtered air hoods

  Airborne particle control

  De-ionized (DI) water

  Gases

  Clean dry air

- It shall be the responsibility of the Facilities Engineering and Maintenance departments to establish and maintain the necessary equipment and controls to provide the services listed above.
- It shall be the responsibility of the Facilities Engineering and Maintenance departments to define and document the requirements for such facilities based on the requirements of the various product groups.
- It shall be the responsibility of the Quality Assurance and Systems Quality Audit departments to monitor the quality of these services listed above.
- The Quality and Reliability Assurance department shall perform a periodic surveillance of the environmental controls.
- Surveillance inspection records shall be maintained by Quality Assurance and shall include *as a minimum* a monthly report of hood/area temperature, humidity and particle count, and DI water bacteria count and resistivity.
- Surveillance inspection records shall be maintained for a minimum of *five years*, per MIL-PRF-38535.

REFERENCES

Spec Number	Title
06-08-0002	Controlled Environment Surveillance
06-08-0004	Deionized Water Monitor
06-01-0016	Incoming Inspection: Gases
01-07-0001	MPS: Gases
06-01-0005	Incoming Inspection: Chemicals
01-65-0001	MPS: Chemicals

APPENDIX D—MILITARY STANDARD CROSS REFERENCE MATRIX

06-09-0005 Section Number	Quality System Element	ISO 9001 1994	MIL-Q-9858	MIL-I-45208	MIL-PRF-38535 Appendix A	MIL-STD-45662
Preface	Quality Policy	4.1.1	N/A	N/A	N/A	N/A
4.1.2	Organizational Chart	4.1.2	3.1	N/A	40.8.1.3.1	N/A
4.1	Management Responsibility	4.1.2.1-4.1.3	1.3	3.1	30.1, 40.8.1	4.1
4.2	Quality System	4.2	1.3	3.1	40.8	4.1, 5.1
4.3	Contract Review	4.3	3.2	N/A	40.8.1.1.1	N/A
4.4	Design Control	4.4	1.3	N/A	40.8.1.1.6, 40.8.1.1.8	N/A
4.5	Document and Data Control	4.5	3.3, 4.1	3.2.1, 3.2.4	40.8.1.12.4	5.5, 5.8
4.6	Purchasing	4.6	5.1, 5.2, 7.1	3.11.2, 3.11.3	40.8.1.1.12	5.11
4.7	Control of Customer Supplied Product	4.7	7.2	3.6, 3.12	N/A	N/A
4.8	Product Identification and Traceability	4.8	6.1	3.5	40.8.1.1.12, 40.8.1.2.7	5.2, 5.10
4.9	Process Control	4.9	6.2	3.4	40.8.1.2.6	N/A
4.10	Inspection and Testing	4.10	6.1-6.3, 7.1	3.1, 3.10-3.12	40.8.1.1.3, 40.8.1.1.12, 40.8.1.2.2	N/A
4.11	Control of Inspection, Measuring, and Test Equipment	4.11	4.2-4.5	3.3	40.8.1.2.5, 40.8.1.1.9	5.2, 5.4
4.12	Inspection and Test Status	4.12	6.7	3.5	40.8.1.2.8	5.10
4.13	Control of Nonconforming Product	4.13	6.5	3.7	40.8.1.1.10	5.6
4.14	Corrective and Preventive Action	4.14	3.5	3.2.3	40.8.1.1.11	5.6, 5.7
4.15	Handling, Storage, Packaging, and Delivery	4.15	6.4	N/A	40.8.1.1.14 40.8.1.1.12	5.12
4.16	Control of Quality Records	4.16	3.4	3.2.2	40.8.7.2	5.9
4.17	Internal Quality Audits	4.17	N/A	N/A	40.9.3.1	5.7
4.18	Training	4.18	N/A	N/A	40.8.1.2.1.1, 40.8.1.1.2	N/A
4.19	Servicing (Failure Analysis)	4.19	3.5	N/A	40.8.1.2.3	N/A
4.20	Statistical Techniques	4.20	6.6	3.9	40.8.1.2.6	N/A
4.21	Quality Cost	N/A	3.6	N/A	N/A	N/A
Appendix A	Reliability Assurance	N/A	N/A	N/A	N/A	5.4
Appendix B	Major Change Notification	N/A	N/A	3.1	40.8.1.2.4	5.6
Appendix C	Environmental Control	N/A	6.2	N/A	40.8.1.1.7	5.3