

Certification and Qualification Information for Manufacturers

MIL-PRF-31032



ISSUED BY:
DLA LAND AND MARITIME
SOURCING AND QUALIFICATIONS DIRECTORATE
COLUMBUS, OHIO

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INTRODUCTION

This document is applicable to the MIL-PRF-31032 program administered by DLA Land and Maritime in its capacity as the qualifying activity. The responsibilities and requirements relating to the QML-31032 program described herein are derived from MIL-PRF-31032, SD-6 and 4120.24-M. This document has been developed to support the manufacturer in obtaining and maintaining certification and qualification to MIL-PRF-31032. It is not the intent of this document to add requirements.

We thank you for your participation and support of the DoD Product Qualification Program.

Sincerely,



JOSEPH GEMPERLINE
Chief
Sourcing and Qualifications Division

CONTACT POINTS

Comments or recommendations, which may be of use in improving this document, should be addressed to:

U.S. Postal Mail

DLA Land and Maritime
ATTN: VQE
P.O. Box 3990
Columbus, OH 43218-3990

Private Carriers (e.g. UPS, Fed Ex., etc.)

DLA Land and Maritime
ATTN: VQE
3990 East Broad Street
Columbus, OH 43213

Requests for an audit, copies of the forms referenced within this document, questions, or requests for further information about the MIL-PRF-31032 program should be directed to 614-692-0627 or the our email address: 5998.qualifications@dla.mil

You may obtain a copy of any VQ documents by visiting the “Downloads” section of our World Wide Web site at: http://www.LandandMaritime.dla.mil/offices/sourcing_and_qualification/

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I. PREFACE

QML is an acronym for Qualified Manufacturers List. QML allows both the printed board manufacturers and the user community to take advantage of best commercial practices while still retaining Government oversight to assure printed boards meet the needs of the end-item military user. QML results in quick implementation of new technology into military systems at a higher level of quality, reliability, and at a lower price. This document is an introduction to the concept of QML and how the printed board industry can benefit from it.

Today's military printed board industry has evolved a great deal since the generic qualification concept was first added to MIL-PRF-55110 and MIL-P-50884. In the past, the Department of Defense (DoD) drove the leading edge technology and the commercial industry followed. Most printed board manufacturers were captive facilities building product for specific systems. Today, the commercial industry has much to offer the DoD in the way of technology and cost savings. QML attempts to capture these best commercial practices and apply them to military product.

A key concept to QML is the development of a working relationship between the manufacturer and the qualifying activity. This relationship is established during the certification process, and is maintained through status reports and revalidations. Although the certification process may seem quite involved, the development of this relationship will allow each manufacturer the flexibility to develop a quality system that best fit its unique plant size, management structure, and printed board technologies to provide certified products that meet specification requirements.

The major aspects of the MIL-PRF-31032 QML program are as follows:

Quality System

The manufacturer must maintain a documented and disciplined quality system which emphasizes process controls, defect prevention and continuous improvement. Manufacturers are encouraged to develop a Quality Management (QM) plan based on their existing process flow and quality system.

Technical Review Board (TRB)

The manufacturer forms a team of in house experts to make decisions regarding printed board acceptability and certification. This time saving step reduces costs and lead time by reducing the DoD approval process.

Test Optimization

The manufacturer may use statistical and historical commercial or military data to reduce, modify, or move verification tests to make them more cost effective or applicable to a technology. While manufacturers may incorporate test optimization, they are still responsible for delivering printed boards that meet specification and customer's requirements regardless of whether a test has been optimized.

Specification Sheets

These documents supplement the base document and contain detailed performance requirements for specific printed board technologies. Technologies are classified as different constructions or types of printed boards, such as rigid, flex, multilayer, high speed, etc. This allows special requirements for different technologies to be addressed, as well as a rapid implementation of new technologies. This specification also allows the development of custom technology requirements where there is no supporting specification sheet. This allows customers to push the envelope for new technological advances without waiting for specification changes.

QML Listing

This is a detailed listing of the capabilities that the manufacturer demonstrated during qualification testing. Customers can quickly determine which manufacturers are capable of meeting their needs.

II. QUALIFICATION PROCESS OVERVIEW

Understanding the Process

The first step to becoming a MIL-PRF-31032 qualified manufacturer is to understand how the process works. MIL-PRF-31032 is a high reliability Department of Defense specification and requires a dedicated effort by a manufacturer to achieve and maintain the quality level required by the document. The process of obtaining qualification is a multiple step process in which the manufacturer works closely at each step with the qualifying activity to ensure requirements of the specification are properly implemented.

Pre-Validation

The manufacturer notifies the qualifying activity of its intent to pursue qualification to MIL-PRF-31032, thus starting a dialogue between the two entities crucial to the success of the effort. The manufacturer modifies its current quality system to incorporate the requirements of MIL-PRF-31032. After the modified quality system is in place, a self-validation is performed to ensure all MIL-PRF-31032 elements have been successfully realized. The results of this self-validation and documentation of the implementation of MIL-PRF-31032 requirements are submitted to the qualifying activity. When the review is completed, an audit is scheduled by the qualifying activity.

On-Site Validation Audit

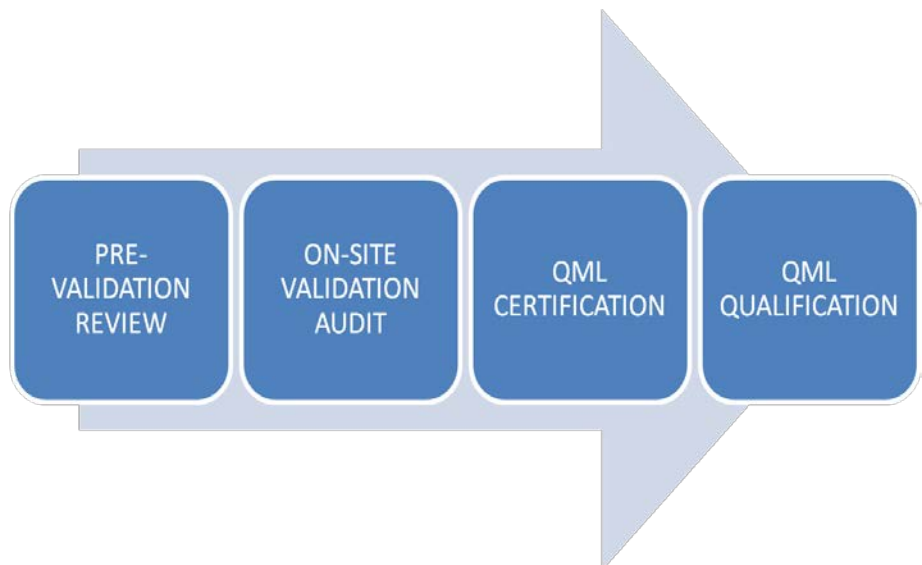
The qualifying activity performs a thorough audit of the quality system to verify compliance to MIL-PRF-31032.

QML Certification

After corrective actions are accepted from the initial validation audit, QML certification is granted to the manufacturer. This certifies that the manufacturer's testing capabilities and quality system comply with the requirements of MIL-PRF-31032.

QML Qualification

The last step before the manufacturer can ship product certified to MIL-PRF-31032 is qualification. Data is submitted to the qualifying activity proving out the capabilities of the manufacturer. Successful attempts result in the listing of the capabilities on the QML.



III. QML CERTIFICATION

Gather Information

After obtaining a basic understanding of how the qualification process works, manufacturers will need to acquire a copy of and carefully read through the MIL-PRF-31032 base document, the associated MIL-PRF-31032 specification sheets appropriate for the technology to be qualified, and all relevant documents referenced therein. Once the manufacturer determines which technologies to qualify, it reviews its quality system and compares it to the Quality Management (QM) program requirements of MIL-PRF-31032, Appendix A.

Initial Certification Request

It is advised that a manufacturer contact the qualifying activity prior to submitting the pre-validation package. This is to give the qualifying activity an idea of what technologies the manufacturer wants to certify. The qualifying activity will send a formal pre-validation letter with information on what is needed for review prior to the validation. This allows this Office to assign a main point-of-contact for coordinating the certification effort with the manufacturer. Other information such as past military business and process control data may be requested to better understand a manufacturer's QM program.



QM Plan Implementation and Self-Validation

One of the key concepts of QML is the merging of commercial and military quality systems. QML leverages a manufacturer's existing quality system as much as possible, avoiding the maintenance of two distinct quality systems. Section IV of this document lists most elements of the QM program that must be addressed in a QM plan and implemented by the manufacturer. Before the qualifying activity begins the certification process, the manufacturer must be confident that its QM program is working as documented and that it addresses the requirements of MIL-PRF-31032. A self-validation in accordance with the manufacturer's QM plan and MIL-PRF-31032 must be performed to verify this. Any discrepancies found should be corrected, including changes to the QM plan, before certification can be requested.

Pre-Validation Submission:

When a manufacturer is ready to begin the certification process, the following pre-validation items must be submitted to the qualifying activity:

1. A statement describing the scope of your MIL-PRF-31032 validation (what flows to certify) and explanation of any requirements of MIL-PRF-31032 that are not applicable or for which alternate methods of meeting the requirement will be used.
2. QM Plan: The QM plan should already be implemented, self-validated, and approved by the TRB.
3. Self-Validation Report: List all elements validated, discrepancies found, and corrective actions taken.
4. Qualification Test Plan: List the technology to be certified, the tests performed, where the testing will be performed, production travelers, and a description of the test vehicles

(coupons, specially designed panels, etc.). Any deviations to the required tests in the specification sheet are submitted at this time. Information on the use of existing data, if applicable, must also be submitted. Note: Actual completion of qualification testing is not recommended prior to the validation.

5. A list of testing capabilities for which you desire lab suitability, including inspection work instructions and forms.
6. Test coupon quantity, design, placement and usage procedures.
7. The process flows to be certified and associated process flow index.

To establish a good working relationship with each company, the qualifying activity must get to know how the company works. Don't be surprised if the qualifying activity has a lot of questions prior to the validation.

Qualifying Activity Review

The qualifying activity will review the pre-validation submissions for compliance to MIL-PRF-31032. Any concerns that arise will be addressed at this time. Additional information, such as other detailed procedures or procedure revisions, may be requested to answer questions. The qualifying activity will work with the manufacturer to ensure a MIL-PRF-31032 compliant quality system is clearly defined.

Validation

Once the pre-validation submission is approved by the qualifying activity a validation audit can be scheduled. The qualifying activity will form a validation team. The manufacturer may opt for the validation team to include two to three customers, invited by the manufacturer. This will increase customer awareness of the QML program, and promote the manufacturer's process. Customer participation must be coordinated with the qualifying activity prior to the validation audit.

The team will perform a sample validation to ensure that the TRB has control of the QM program and that it has been implemented as described in the approved QM plan. The areas validated will be reviewed in detail. The team will talk directly to the operators that verify that procedures accurately reflect the action being performed. Any concerns of the validation team will be brought to the attention of the TRB during the validation. All findings will be detailed in a report that will be provided to the TRB. In turn, the TRB is responsible for completing all corrective actions. Similar to the review of pre-validation information, the qualifying activity will request additional information when it feels a corrective action response is insufficient to address a finding or if clarification of the response is needed.

Issue Certification

Once corrective actions have been taken and approved by the qualifying activity, certification will be issued. The qualifying activity will issue an official certificate and a certification letter detailing which technologies are certified. The technologies are based on the the manufacturer's QP plan and process flow. When testing is performed at the manufacturing facility, a laboratory suitability letter listing all approved test methods will also be issued.

IV. QM PROGRAM

The QM program forms the backbone of a manufacturer's QML certification. It is the manufacturer's tailored system for meeting the requirements of MIL-PRF-31032. The QM program integrates all aspects of production and quality, from the initial order, through production, test, and shipment of product. In addition, it controls and provides feedback to allow continuous improvement. Appendix A of MIL-PRF-31032 is the baseline for a QM program and contains a QM Plan Outline, which lists the elements of a QM program that a manufacturer must address.

QM Plan

The QM Plan is the documentation used to describe the QM program implementation. It is a controlled document with, at a minimum, a separate section for each element noted in paragraph A.3.2.1 of MIL-PRF-31032. Any documents or procedures with specific or existing information may be referenced in the appropriate section of the QM plan. Manufacturers are encouraged to use their existing quality systems when possible. Quality systems based on ISO-9000 or equivalent standards are good building blocks for a QML system. The elements of a QM plan are detailed below.

Hints to a QM Program

1. Do not recreate something you already have.
2. Have a living system that can change easily.
3. Don't create a system so complex that it can not be implemented or controlled.
4. There is no "DoD format" to follow. Use your own system.

Technical Review Board (TRB)

The TRB is a cross-functional team made up of responsible individuals selected from the different areas covered by the QM program. The TRB assumes full responsibility for managing the QM program. Thus, the TRB is the mechanism that the qualifying activity uses to reduce oversight. The TRB members must be identified by name and title. Since the TRB will be making important decisions about QML product, a method for making decisions (majority rules, unanimous approval, etc.) must be documented. Other aspects of the TRB operation must also be described, such as how often the TRB meets to evaluate the status of the QM program, the standard meeting structure, and how records of these meetings are maintained. Keep in mind that no two manufacturers' TRB will be designed the same. TRB membership, meeting frequency, etc. will depend on the size, structure, and capabilities of each manufacturing facility. A summary of TRB responsibilities from MIL-PRF-31032 is shown below:

1. Implementation and maintenance of QM program: The TRB ensures the QM program, as listed in the QM plan, is in place and working properly. The TRB monitors the QM program and makes any changes that it deems necessary.
2. Self-assessment: The TRB monitors the self-assessment program and ensures results are effective and are leveraged to contribute to continuous improvement.
3. Maintenance of certified processes: Through process controls, process monitoring, and continuous improvement the TRB assures the processes are producing high quality product.
4. Process change control: The TRB must be privy to process changes and must approve any major changes prior to qualifying activity notification.

5. Reliability data analysis: The TRB must not only collect reliability data through lot and periodic conformance testing, but also analyze the results to assure continued compliance and product reliability.
6. Failure analysis: When failures occur, the TRB must determine the cause of failure to help prevent reoccurrence.
7. Customer returns: The TRB monitors and assesses returns from customers. These should be tied into the failure analysis and corrective action system as needed.
8. Corrective action approval: The TRB must assure corrective actions are taken, that they are effective, and that any changes comply with the QM plan.
9. QML product recall: When problems are discovered that may affect product in the field the TRB must communicate with customers to help assure continued operation and fielding of the affected weapon systems.
10. Review of qualification status: This is done periodically as part of Conformance Verification Inspection, to assure the QML-31032 accurately reflects proven capability.
11. Disposition of test failures: The TRB assures non-conforming product is properly segregated and oversees rework to make sure only fully compliant product is shipped.
12. Ensure communication throughout process: Good communication helps prevent costly failures later in the process.
13. Submit status reports to qualifying activity: A good status report involves all members of the TRB compiling data on the status of the QM program.
14. Assess impact of changes in personnel and business plans: These changes can impact the QM program, so the TRB must be aware of them and determine if any actions are necessary.
15. Approve and update QM plan: The qualifying activity bases QML certification on the QM plan, so it is important that it accurately reflect the manufacturer's QM program.
16. Assure correlation between test coupons and printed boards: Testing is expensive, and the TRB must assure that testing on coupons is accurately evaluating the product it represents and has traceability for future reference.
17. Approval of periodic conformance test vehicles, frequency, and procedures: The PCI and CVI programs are important for long-term reliability assurance and process characterization. The TRB must assure the program is meeting the specification requirements in a cost effective manner.
18. Manage quality improvement programs: Continuous improvement is an active element of all QM programs. The TRB directs this by setting goals and monitoring progress of activities.

Other TRB activities include:

1. Approval and documentation of specification deviations when requested by the acquiring activity.
2. Approval and monitoring of test optimizations.
3. Development of custom technology specification sheets.
4. Approval of add-on qualification (test plans, data to submit to qualifying activity).
5. Approval of process flow charts and control plans for all processes.
6. Concurrent notification to the qualifying activity of any major changes to the certified QM Plan, including inspection, process flow, or TRB membership changes.

Organizational Chart

The organizational chart shows all organizations affecting QML product and should specifically show where each TRB member fits into the organization.

Process Flow

A process flow is a sequential list of all processes required to build printed boards from the time the order is taken to the time the product is shipped. A process flow must be generated for each technology to be qualified. This may include flow charts, production travelers, or any other means of documenting the flow. The flow must include any possible processes to be used for QML product, including rework steps, key process monitors, and contract services. Procedure numbers, process procedures, or other references for each step must be identified.

Process Flow Documentation Index

A document control system must be in place to control all procedures used in the QM program. A list of all procedures must be compiled that includes at least the procedure identification (e.g. number), title, revision level, and physical location if applicable. The process flow documentation index should be periodically reviewed and updated. The list needs to include any work instructions, forms, charts, guides, etc. that are used throughout the certified process flow. External specifications and standards must also be controlled.

Conversion of Customer Requirements (Conversion)

Conversion of customer requirements is the manufacturer's system to review the customer's printed board procurement documentation (purchase order, master drawing, electronic data files, etc.) and assure the customer's needs are met. This conversion includes the transfer of hard copy and computerized data into manufacturing tools such as drill files, phototools, route programs, travelers, etc. When performing panelization, coupons must be added to comply with all necessary testing per MIL-PRF-31032. This is a part of the conversion process and must be documented, including quantity, design, placement, usage, and traceability of test coupons.

Conversion of customer requirements also checks that a manufacturer's QML listing meets the design requirements. When the conversion system identifies that the current QML listing or certified process do not cover a particular part number or technology, the conversion system determines what process changes are needed, what testing must be done, and how to demonstrate the capability of these changes. Conversion should include feedback to customers when the review indicates problems.

Conversion evaluates procurement documentation for:	What happens if it is not in the procurement documentation?:
Design standard	Use the default design standard listed in the associated specification sheet
Design parameters (such as minimum annular ring)	Use the design parameters listed in the associated specification sheet if applicable or the applicable design standard
Material requirements	TRB determines what materials will meet the performance requirements of the associated specification
Coupon configuration	Use the coupon configuration listed in the applicable design standard
Current QML listing covers the complexity of the design	TRB determines what test data must be collected to qualify the capabilities required, including the addition of coupons to complete tests. Collected data is submitted to the qualifying activity as an add-on qualification.

Self-Validation

Self-validation is the manufacturer's means of determining compliance to MIL-PRF-31032 and the QM program. Self-validation results must be reported to the TRB. An effective self-validation program reporting to the TRB shows that the manufacturer has taken responsibility for its own system and therefore is key to the reduction in qualifying activity oversight. As a minimum, the self-validation should cover all areas of the QM program, including self-validation. Areas that may be used by the quality system on a regular basis for all job types, but have MIL-PRF-31032 specific requirements should be reviewed in a manner sufficient to validate those requirements. Likewise, validation of testing areas should be thorough enough to touch on MIL-PRF-31032 specific requirements. The program should also include the frequency of review, auditor eligibility, how corrective actions are assigned and followed-up, and how records are retained.

QML Status Report and TRB Reporting

The manufacturer's TRB will compile and submit status reports to the qualifying activity describing the status of the QML manufacturer's process flow, quality system, and printed board production. The frequency of the QML status summary to the qualifying activity will be agreed upon by the TRB and qualifying activity, but are done at a minimum of quarterly for the first year.

Status reporting has taken the place of the QPL's annual retention reporting and gives the qualifying activity a status of the QML program at the manufacturer and insight into TRB operations and decision making. The information in the QML status summary may be addressed in various ways, such as, copies of TRB meeting minutes, summary of major actions, etc. Details can be found in the specification, section A.4.6. These details include:

- ✓ Summary of TRB activity.
- ✓ Self-validation results.
- ✓ Continuous improvement update.
- ✓ Process control initiatives and accomplishments.
- ✓ Corrective actions taken.
- ✓ Changes to manufacturing and test equipment or facilities.
- ✓ Summary of compliant boards shipped (includes both QPL and QML product).
- ✓ Customer return information.
- ✓ Summary of LCI testing, including part fallout and pass/fail information.
- ✓ Summary of PCI information and assessment of test vehicles.
- ✓ Summary of CVI inspection assessment
- ✓ Summary of major and minor changes
- ✓ Future business plans.

QML Traceability

Each printed board and test coupon shall be traceable to the following:

1. Material lot.
2. Production lot.
3. Lot conformance inspection lot.
4. Coupon to printed board.
5. Location on panel
6. Production history (date, equipment, operator, etc.).

Traceability must be maintained for a minimum of 3 years after product delivery.

Documentation, Data Retention, Storage, and Disposition

The manufacturer demonstrates how it will maintain the traceability, history, and certification information of QML product. This may include production and test travelers, test data sheets, process procedures, used and unused test vehicles, wet lab analysis records, and other data used to record the process history of QML product. Specific information that must be documented in a procedure includes the identification, protection, retention time, retrieval, storage, and disposal of data and records.

Continuous Improvement

For a QM program to be effective and strong it must be monitored and improved. Continuous improvement is the system that identifies problems and works to correct them. Consideration should be given to identification of goals, mechanisms for measuring improvement, the frequency of reviewing progress and adjustments to the goals, and employee awareness.

Failure Analysis

The TRB describes when failure analysis is performed, how the tests are determined, what data is to be taken, who is informed of the failure, how it ties to corrective and follow-up actions, and how records of the analysis are kept. Failure analysis should include consideration as to whether the failure is related to only the product or is also related to the process flow.

Failure Analysis Triggers

- LCI Failures
- PCI Failures
- CVI Failures
- PDA violations
- Customer or field returns
- Process control violations

Process Control

The process control section provides a general description of how processes are controlled. This may include, but is not limited to, machine settings, periodic calibration or verification, material controls, statistical methods, etc. System-wide process controls with procedures that span several different process steps, such as statistical process control (SPC) should be addressed in the process control section of the QM Plan.

Corrective Action

The QM plan must outline when corrective actions are necessary (field returns, test failures, validation findings, etc.), what actions are taken to initiate corrective actions, and what is done to assure that they are carried out. Additional actions may be necessary to follow-up on corrective actions to ensure their effectiveness. The corrective action system should also be used by the TRB as a feedback loop to prevent the reoccurrence of a similar problem.

Change Control

As changes are made to the QM program a methodology must be in place to control these changes. Change control should explain how to determine if a change is major or minor, who approves changes, what evaluations must be performed, and how the changes are recorded and reported. Manufacturers are required to notify the qualifying activity concurrently of all major changes. This process should be reflected in the change control procedure.

Major Changes Include

- Changes that affect the performance, quality, or reliability of the printed board.
- Changes to the QM Plan.
- Changes to the TRB.

List of Test and Inspection Methods

All testing must be performed at a laboratory approved by the qualifying activity. The qualifying activity grants lab suitability to printed board manufacturers as well as commercial and Government testing laboratories. The manufacturer will indicate tests that are performed at its facility and which tests will be performed at other facilities. An equipment list for all tests performed at their facility is also required. This list should provide a unique equipment identification number or serial number, the calibration interval, the last calibration date, and any other special notes (capability if limited, etc.).

A list of the tests required to be performed are contained in the specification sheet for the technology that is being tested.

Qualification Testing

Qualification is the process in which the manufacturer demonstrates its ability to produce a selected printed board technology to a set of design limits, referred to in MIL-PRF-31032 as the QML manufacturer's capability. The TRB is responsible for establishing a qualification process procedure, which describes the different methods the manufacture intends to use for qualifying its capabilities. The procedure also describes how to create a qualification test plan. Each qualification test plan outlines the specific details of an individual qualification attempt. See Section IV for more information.

Periodic Conformance Inspection (PCI)

Periodic Conformance Inspection is performed periodically at defined intervals rather than on each lot. The tests and frequencies listed in the associated specifications are guidelines to a PCI assessment program. The TRB defines the actual test frequency, methods, test vehicles, and procedures in the QM plan.

The inspection vehicle(s) used for the periodic conformance inspection program are designed for their role as a quality and reliability monitoring vehicle. The conformance inspection vehicle can be a dedicated test coupon incorporated into a production panel, be within a printed board, or a separate, dedicated test vehicle. The complexity of the conformance inspection vehicle shall reflect, as a minimum, the functionality of the process and technology characteristics. It is possible to use MIL-PRF-55110 or MIL-P-50884 group B/C data to cover the PCI test requirements. Also note that thermal shock is not a part of group B/C PCI testing, but is a recommended part of Capability Verification Inspection (CVI) in Appendix C of MIL-PRF-31032.

Calibration

Manufacturers must establish a documented calibration system for all measuring and test equipment used for verification, inspection, and process control. The system must comply with NCSL Z540-1 or an equivalent document, as defined in the manufacturers' approved procedures. Some aspects of calibration/verification to include are as follows: frequency of calibration, guidelines on adjusting these frequencies, action when equipment is out of tolerance, recall procedures, adequacy of standards used, calibration procedures per equipment, control of certificates of calibration, procedures for any calibration performed internally and requirements for contracted calibration services.

Training

Employees involved in the certified process flow must be evaluated for knowledge and proficiency of their assigned tasks through a documented training program. Training procedures should indicate who must be trained, what training is performed, operator evaluation prior to release to a process, periodic evaluation of performance, training to changes in process flow procedures, and maintenance of records.

Contract Services

Manufacturers must establish methods for selecting and monitoring service providers for any contracted service identified in the certified process flow. The TRB must assure that the QM plan is still met when contract services are used. In some cases, a contract service provider may be included as part of the qualifying activity's validation audit.

Test Optimization

Appendix D of MIL PRF 31032 gives guidance on test optimization. Test optimization includes adjusting the frequency of a test, modification of a test method via test procedure, equipment, or test vehicle, moving the point at which a test is performed in the manufacturing process, elimination of a test and using alternative test methods to replace a test. The TRB must create a test optimization plan and discuss this with the qualifying activity prior to implementation. Manufacturers who use test optimization are still responsible for the product meeting all specified performance requirements just as if the tests were performed. Test optimization is a major change to the certified QM Plan, requiring concurrent notification to the qualifying activity and affected customers.

A test optimization procedure must be created to ensure control of this change. This includes addressing how the TRB will be involved in the process, creation and approval of a test optimization plan, outline of the analysis involved, and the evaluation of testing results. The procedure should also have provisions for testing failures both in the initial test optimization and when the test optimization is being used. These would include failure analysis, corrective and preventative actions, notification to the qualifying activity and customers if the product shipped, etc. Periodic review of the adequacy of the optimization and review when process changes occur should be included as well. A list of all test optimizations in use should be maintained.

Capability Verification Inspection (CVI)

Capability Verification Inspection (CVI) shall be used to validate that the qualified materials and processes continue to conform to the originally qualified capabilities. In this regard, CVI serves as a tool for monitoring the quality and reliability of the manufacturer's technology, capabilities, materials, and processes. The inspection is performed at a minimum of every two years. The CVI data must reflect the capabilities of the manufacturer as related to the QML listing for each material type.

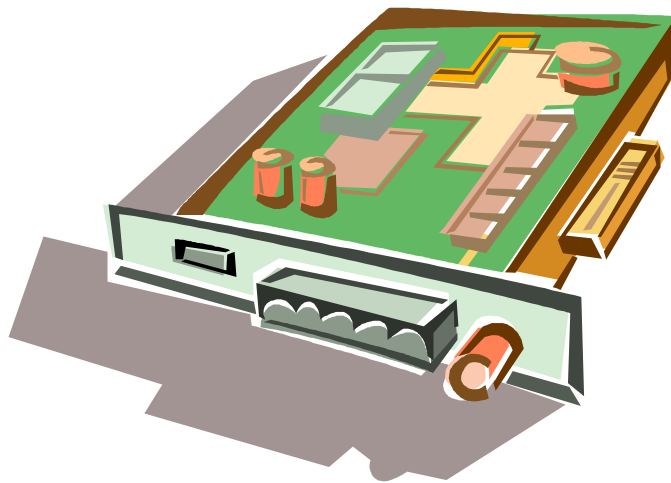
The TRB is responsible for creating a procedure that provides the CVI guidelines, including testing frequencies, information to submit to the qualifying activity, procedure if a failure is found, etc. Certain details of CVI testing may change based on the qualified capabilities of a manufacturer. These details must also be documented and submitted to the qualifying activity with CVI data. Examples of the details that may change include test vehicle description, tests to be performed, sampling information, etc.

The manufacturer has different options to meet the inspection requirements for CVI. The first option is to build and test dedicated test vehicles. Some manufacturers choose to build the same test vehicle that was used for initial qualification.

A second option available to manufacturers is to use data from jobs that have already been inspected and shipped. The benefit of this option is that additional testing costs may be diminished. However, manufacturers are still responsible for the appropriate testing and may need to send test specimens to a third party laboratory for shock testing or other testing. The test specimens do not have to be from a design or part number that has been certified to MIL-PRF-31032 or one of the QPL specifications. However, the manufacturer must still maintain the ability to produce product to the default requirements of the appropriate MIL-PRF-31032 slash sheet.

When submitting data to the qualifying activity, enough information must be supplied to give evidence that a) the test specimens used are appropriate to cover all capabilities currently qualified (i.e. design details for the test vehicles/printed boards) and b) the test results were successful, documented, and approved by the TRB. To accomplish this effectively, when preparing to conduct CVI, the TRB must first assess the group B/C, PCI, and other data to assure that the capabilities listed on the QML are still valid.

CVI allows the TRB to review the current qualified listing and certified processes to determine if any additions or modifications are needed. The TRB may decide that the listings need to be extended, in which case an add-on qualification may be performed with the CVI test data, or the TRB may decide that the listings need to be reduced to better reflect the manufacturer's current capabilities to build printed boards compliant to the DoD specifications. For example, if the data presented to the qualifying activity does not prove out the manufacturer's listed capabilities, some capabilities may be reduced to match the CVI information that was submitted. Creating a side-by-side comparison of the manufacturer's current listings and the chosen test specimen is an easy way to ensure that all capabilities are being considered. This side-by-side document or a similar document must be submitted with CVI data to the qualifying activity as supporting evidence that test specimens do prove out the current capability listing.



V. QML QUALIFICATION

Review the Qualification Procedure

A manufacturer may qualify its capabilities in more than one manner. This procedure describes the different methods. They include:

- **Initial Qualification:** This is performed when a manufacturer is not yet listed on QML-31032. An initial qualification is also performed for a specific base material that is not yet listed on QML-31032. If the manufacturer decides to add a number of additional capabilities, they may choose to use this method as well
- **Add-on Qualification:** This is performed when a set of capabilities for a base material has been established and is listed on QML-31032, but the manufacturer would like to extend or add a capability. Due to the nature of the few capabilities being qualified, testing is usually limited to a subset of that in an initial qualification. Also, the testing may be done in-line with product being built for a customer to make the qualification quicker and more cost effective.
- **Qualification by Similarity:** No additional testing is necessary. For capabilities that include numerical values or ranges, the manufacturer may certify product using these capabilities up to 25% beyond the value listed on QML-31032

To describe the different methods of qualification, the qualification procedure should include how the manufacturer will develop qualification test plans, collect supporting data, present data for the TRB review, determine acceptability, utilize failure analysis and corrective actions prior to any resubmission of additional vehicles for retesting after failure, complete and retain the qualification test report, and report the results to the qualifying activity. The procedure must provide a basic outline of a test plan and describe what details will be included.

Create a Qualification Test Plan

Qualification test plans must be created when performing an initial or add-on qualification. A qualification test plan itself lists the capabilities that the manufacturer desires to qualify and describes how the manufacturer will demonstrate its ability to meet the MIL-PRF-31032 specification sheet requirements for said capabilities. An acceptable qualification test plan must detail:

- the methods used for gathering qualification test data
- the test flow, including the number of test vehicles to be tested
- the applicable accept/reject criteria and tolerances for testing results
- a description of the test vehicles (including prints and coupon information)
- the test facilities for the performance of each test
- the proposed QML listing to be achieved
- the proposed production lot travelers
- the master drawing and / or procurement documentation, as applicable

The first step is for the TRB to identify the printed board capabilities to be listed on the QML-31032; an example QML listing appears at the end in this section. Then, for each capability, the TRB explains how it will demonstrate that it can meet the performance requirements for the MIL-PRF-31032 specification sheet. Multiple test vehicle designs may be incorporated into a qualification test report. Qualification for some technologies may require a test plan to deviate from a specification sheet's standard testing flow; in this case, the TRB should get prior authorization from the qualifying activity for an alternate test flow to ensure the final qualification report will be accepted for listing on QML-31032. For initial qualification, the test plan must be submitted to the qualifying activity prior to the start of qualification testing.

Custom Technologies

Manufacturers wishing to qualify products that do not fit any of the current specification sheets may still seek qualification on these custom technologies. The TRB develops a test plan, test specimens, etc. and discusses qualification with the qualifying activity. Qualification can be granted to /custom listing until a specification sheet is written to address the technology.

MIL-PRF-31032 allows the use of existing test data if it is applicable to the certified process flow. A portion of the qualification data requirement can be fulfilled using data previously compiled for either the manufacturer's internal evaluation or an external customer. In this way, it is possible for a manufacturer to compile the necessary information and data with little to no additional testing costs. Note that at least the default requirements of MIL-PRF-31032 must be met when initially qualifying.

Perform Qualification Testing

Testing in accordance with the approved qualification test plan must be performed at a facility with laboratory suitability for the test methods used. A list of these facilities may be obtained from the qualifying activity. The TRB must review and approve the test data prior to submission to the qualifying activity.

Submit Test Report to Qualifying Activity

Once the testing is completed, the TRB is responsible for incorporating the data and results of the testing into a qualification test report. In addition to submitting a copy to the qualifying activity, this report must be retained by the manufacturer as evidence of successful qualification testing for QML-31032 listing.

The qualification test report should include production and test travelers, test vehicles used, sample sizes, test conditions, procedure used, pass/fail information, and recorded data on all dimensional and electrical measurements. This should also include a summary of the proposed listing compared with actual testing results, especially if multiple qualification test vehicles were used. Destructive test samples should also be included with the report. The completed qualification test report must be reviewed and approved by the TRB, and must include a statement of TRB approval along with TRB membership signatures. The qualifying activity will review the report and compare it to the approved test plan. Upon approval of the test report qualification will be granted.

QML Listing

Once the test report is approved the qualifying activity will list the manufacturer's qualification on the QML. The first section of QML-31032 lists each manufacturers' capabilities per associated specification and base material. An example is given below. Links to the current QML-31032 and a list of all capabilities is also provided.



The Qualified Manufacturers List (QML-31032)

<http://www.LandandMaritime.dla.mil/programs/qmlqpl/QPLdetail.asp?QPL=31032>

QML-31032 Full Capability Listing

<http://www.LandandMaritime.dla.mil/downloads/VQGeneral/IE31032CLcurrent.pdf>

Example QML Detailed Listing

MANUFACTURER INFORMATION Random Circuits 3990 E. Broad Street Columbus, OH 43213	PLANT LOCATION Same Address as Manufacturer	CAGE CODE: XXXXX PHONE: (614) 692-0627 FAX: (614) 693-1659 EMAIL: 5998.Qualifications @dla.mil
CAPABILITIES BY TECHNOLOGY/ASSOCIATED SPECIFICATION:		
Specification: MIL-PRF-31032/1, MIL-PRF-31032/2		
Qualification Letters: VQE-12-030201 (intial), VQE-12-030405 (add-on)		
Rigid Base Material: GF: Woven E-Glass, Epoxy Resin, Flame Resistant		
Max. Panel size: 18" x 24"		
Max. Number of Layers: 24		
Max. Board Thickness: 0.25"		
Min. Hole Size: 0.008" Drilled Plated-Through Hole Before Plating		
Min. Hole Size: 0.005" Laser Abated Plated Hole Before Plating		
Aspect Ratio: 11:1 Through-Hole, 0.5:1 Microvia		
Min. Conductor Width / Spacing: 0.003" / 0.003"		
Hole Preparation: Permanganate Desmear, Permanganate Etchback, Plasma Desmear, Plasma Etchback		
Hole Wall Conductive Coating: Electroless Copper		
Copper Plating: Direct Current Plate, Pulse Plate		
Hole Fill/Via Plug: Non-Conductive		
Solder Resist: Liquid Photoimageable, Dry Film		
Finish System: HASL, Hot Oil Reflow of Plated Sn/Pb, Electrolytic Ni / Hard Au, Electrolytic Ni / Soft Au, ENIG		
Additional Fab Capabilities: Foil Lamination, Sequential Lamination Blind Vias, Sequential Lamination, Foil Lamination, Press Fit Mounting		
Controlled Impedance: Single-Ended, Differential		

VI. QML MAINTENANCE

Status Reports

The status report allows the qualifying activity to monitor the manufacturer's QM Program. The frequency of submission is quarterly for the first year, then as determined by the TRB and qualifying activity. Well prepared status reports increase the confidence level of a manufacturer with the qualifying activity, thereby reducing the amount of oversight.

Changes to the QM Program

As changes occur in a manufacturing environment, so will a QM program change. The TRB must decide if changes are major or minor, as defined in the QM plan. All major changes are reported to the qualifying activity concurrent with their implementation. As changes are made to the qualified processes and the QM program, the TRB must assess these changes to determine if the QML listing and/or MIL-PRF-31032 Certification is affected. The TRB must also notify the qualifying activity of any modifications to its QML listing resulting from these changes.

Add-on Qualifications

Add-on qualifications allow a manufacturer to more easily expand its QML listing than performing initial qualifications. Add-on qualifications are governed by the QM plan and the manufacturer's qualification test procedure and are controlled by the TRB. One benefit of add-on qualification is that it allows the TRB to use current jobs to extend their QML listing. It also allows jobs outside the manufacturer's current capability listing to be accepted. In order to do this, though, careful attention must be paid to the add-on qualification test plan when it is generated. Also, open communication with the customer should be practiced. In the case that the boards do not meet testing requirements, the shipped product cannot be considered to be 31032 certified.

Revalidations

The qualifying activity will determine the need to perform revalidations based on findings from the original validation, status reports, and other correspondence. As the confidence level between the manufacturer and the qualifying activity increases, the need for revalidations decreases. Revalidations are similar to validations regarding submission of pre-validation info, customer participation, etc.

CCR and CAGE Database Maintenance

The Central Contractor Registration (CCR) database is used in conjunction with the Commercial and Government Entity (CAGE) database in order to identify businesses doing business with the government and as a part of the contract award process. These databases are tied directly to the QML. Manufacturers are responsible for maintaining current information in these databases. If CCR accounts are not renewed or there is a discrepancy of data between it and the CAGE database, a manufacturer's qualification listing on QML-31032 will not appear.

VII. OTHER ASPECTS OF QML

Process Monitors

The manufacturer must identify the key steps in its process flow and assign process monitors. These key processes will likely be different for each manufacturer. Feedback from failure analysis, process control, and continuous improvement will help the TRB identify processes which need monitors.

Percent Defective Allowed (PDA)

PDA is most useful when the nature of the commodity makes it unreasonable to perform destructive testing on finished product, such as printed boards. The idea behind PDA is that if a significant portion of a lot is defective or if a significant portion of representative test vehicles has defects, there is a chance that the remaining lot may have defects that the inspections did not uncover. PDA is a flag for the TRB to look twice at suspect lots before shipment.

PDA's do not normally apply to inspections based on a sampling plan. One exception is when an inspection lot fails sample inspection. If the lot goes through a 100 percent sort to remove defective product, a PDA would apply to this "tightened inspection" lot.

When the specified inspection has been completed, the number of printed boards or panels rejected for the failures listed in the specification sheet is totaled. Divide the number rejected by the number in the lot and multiply by 100. If this percentage exceeds the PDA limit, the lot is rejected. Reduced producability production lots (e.g. higher technology designs) where there is an expected high fall-out rate may require the TRB to adjust how the PDA limits will be calculated and applied to these individual lots.

If a lot is rejected due to PDA failure this does not mean the entire lot is scrapped. The manufacturer must evaluate the rest of the lot and take corrective actions, approved by the company's TRB, and scrap any further defective product discovered. The TRB may have to perform failure analysis or review the process parameters before disposition of the remaining product.

In-process Inspections

Tests requirements listed in the specification sheet may not be defined as to where in the process flow they must be performed. The manufacturer is responsible for all testing in the associated specification. If the only way to properly perform a test or inspection is to perform it in-process, the TRB must account for this and include it in the process flow.