

ESTABLISHING A QUALITY SYSTEM FOR DEFENSE WORK

SUMMARY

The stringent quality specifications associated with defense work have long been the industry “standards” for many non-defense applications as well. Are they really any tougher than the specifications of your commercial customers? Probably not: but they are very specific and they do require you to “have your act together” in regard to quality. A true quality control program is much more than just an inspection system. It helps you do things right the first time and thus increases productivity. This BMA will help you get started on your company’s individual quality program whether you intend to use it for government or commercial work only.

GETTING QUALIFIED

If your company, like many others, is looking into defense business for the first time, you’re probably confused by the many vague references to standards, mil specs, and other requirements relating to quality control. This BMA is aimed at clearing up some of the confusion on the quality requirements of the Department of Defense.

The government’s basic Inspection System Requirements are described in a standard known as MIL-I-45208A. This document is approved by the Department of Defense and is mandatory for use by the Army, Navy, Air Force, and the Defense Supply Agency. Thus, if you meet this standard, you meet the basic requirements for all defense agencies.

Another standard, MIL-Q-9858A, “Quality Program Requirements,” provides a higher-level series of requirements than MIL-I-45208A. This higher-level standard is also used by all U.S. defense agencies and includes all of the provisions of MIL-I-45208A, plus additional quality control programs. Therefore, if you comply with MIL-Q-9858A, you automatically meet the requirements of the lower level MIL-I-45208A.

A third standard, MIL-STD-45662, “Calibration Systems Requirements,” is referenced and included as part of the other two standards. This document specifies the steps that must be taken to insure that your measuring instruments are properly calibrated and controlled.

The central source for all military standards and specs is the Naval Forms and Publications Center, 5801 Tabor Avenue, Philadelphia, PA 19120, (215) 697-2000. The documents are free, but service can be slow. Order forms (DD form 1425) are available upon request.

A commercial supplier of government standards is the National Standards Association, (800) 525-7052. They sell what the government gives away, but they provide a faster service. A free catalog is available upon request.

If you just want to get the quality standards to get your company geared up for government work or if you need to meet a bid deadline in a hurry, you might be better off ordering your needed specifications from one of the several commercial sources.

Either the Defense Department or any of the commercial sources can supply any of the other more specific mil specs that may be called out in any particular Defense contract. Document packages may also be available directly from the contracting officer or from the purchasing agency on some government jobs.

MIL-I-45208A states that “The contractor’s inspection system shall be documented” This is the heart of the military inspection and quality system and the place for that documentation is in your company’s quality manual.

Your quality manual will have to be developed especially for your particular company. There are no universal quality manuals ready-to-use right from the bookseller. Your quality manual will be unique to your company, your organization, and the kind of work your company does.

The various ready-made quality manuals are really only guidelines. This is also true of the standards MIL-I-45208A, MIL-STD-45662 and MIL-Q-9858A, even though they are mandatory when referenced. They tell you what must be covered in your inspection system, in your calibration system, and in your quality program, but you must still work out the

details as they apply to your company. For example, MIL-STD-45662 requires you to have a regular schedule for calibrating your measuring instruments, but leaves you with the task of working out your own schedule based upon your own applications, needs, and requirements.

Your company's quality manual is the "roadmap" that documents and describes the ways your company meets the government's requirements for inspection, calibration and quality systems and programs. Here is a summary of some of the highlights of the three standards we've been discussing so far:

MIL-I-45208A describes the requirements for Inspection Systems only. It does not address quality assurance provisions, preparation for delivery, nor other areas beyond the inspection system itself. The contractor's inspection system must be documented (written down) and must be available for review by the government's representative.

The standard describes exactly what is to be documented and how. For example, instructions must be provided for the inspection and testing of materials, work in progress, and finished articles, and records must be kept of inspections and their results.

The standard also makes the contractor responsible for providing and maintaining "gages and other measuring and testing devices" and for having such gages and instruments calibrated "at established intervals" in accordance with MIL-STD-45662 (which covers calibration system requirements).

Minimum standard procedures for inspecting government-supplied materials are prescribed, and responsibility for various other items is fixed, including corrective action for deficiencies; ways of identifying the inspection status of materials and goods: engineering changes, non-conforming material; alternate means of inspection; government inspections and subcontracted work.

It is important to remember that these requirements are mandatory only on government work where the standard is specifically referenced. However, once the necessary documentation is set up, you can use the same documented inspection system for all government work requiring MIL-I-45208A and the same methods can be used to provide a systematic approach to your commercial work.

MIL-STD-45662 requires contractors to have a system for calibration of instruments and gages used for inspection and testing. The contractor must also be able to provide "objective evidence" of accuracy, subject to spot checks by the government's representative.

The calibration system must be described in writing and must identify the intervals at which various instruments are calibrated as well as the calibration sources. Calibrations may be performed by outside contractors or by your own personnel as long as all documentation requirements are met. Outside calibration services can usually assist with your documentation paperwork, but your company, as the contractor, is responsible to the government. Your company is also responsible for the accuracy of employee-owned instruments used in the shop and your system should provide for checking and calibrating these tools as well. You are also held responsible for the accurate calibration of your subcontractors' equipment.

The calibration intervals for various instruments can vary based on stability, purpose, degree and severity of usage, and so on. You may also adjust the calibration schedules based upon documented past experience, but the intervals must be specified.

Calibration procedures for the various instruments must be available in writing, although manufacturer's instructions will meet the requirement. The calibration system description must also identify and keep track of serial numbers and calibration date and status of reference and transfer standards (shop masters).

Finally, MIL-STD-45662 requires procedures to analyze and correct products tested by instruments found to be out of tolerance. Procedures are also required to evaluate the calibration system itself. If your company regularly uses calibration service, or if you have a full-time inspector or inspection department, you are probably already meeting many of the requirements of this standard.

MIL-Q-9858A includes all of MIL-I-45208A's requirements for inspection systems, as well as MIL-STD-45662's requirements for calibration systems, and adds further requirements for achieving a complete quality program. MIL-Q-9858A requires the contractor to establish an effective program for quality that will permit control "at all points necessary to assure conformance" to contract requirements. The standard sets up specific requirements for: management, organization and planning of the quality program; work instructions; record-keeping; corrective actions; costs related to quality; facilities and standards for equipment, drawings, and tooling; control of purchases; and manufacturing controls. Additional requirements are also established for some of the areas covered in the lower level MIL-I-45208A.

The important distinction between MIL-I-45208A and MIL-Q-9858A is that one establishes requirements for an inspection system while the other provides for a comprehensive quality program. A program such as the one required by MIL-Q-9858A is designed to help your company "do the job right the first time." Since MIL-Q-9858A has been proven in practice by thousands of companies, it provides an excellent starting point for establishing a quality program even if you're not interested in doing government work.

In the meantime, for "homework" you can get copies of the standards themselves and start studying them. If you already have a quality program, you might want to make sure it's up-to-date. Also, it would be helpful to review the Guidelines for Government Procurement and Marketing found in your NTMA Business Management Advisories under "Marketing."

MIL-Q-9858A: THE BASIS FOR YOUR QUALITY PROGRAM

Although it is natural that we often associate the term "quality" with inspection, it is important to bear in mind that inspection is only one element of a quality program. A company can use very stringent inspections to wind up rejecting 50 percent of its parts before shipping - but that's hardly what anyone would call a quality operation.

Thus, a full quality program helps prevent rejects before they get to the final inspection stage. Preventing defective parts and rework throughout your production process can

obviously go a long way toward improving your overall productivity and profits. In fact, a good quality program can actually result in a reduced need for inspection through systematic improvements in quality at all stages of processing.

Many of the administrative control elements of MIL-Q-9858A require documentation—and in the past, that has meant paperwork. However, even the small, tabletop computers found in many small plants can help to greatly simplify the recordkeeping and documentation requirements of MIL-Q-9858A.

As you study MIL-Q-9858A to plan your company's quality program, you can begin developing your own quality manual at the same time. Your quality manual will be a specially prepared document, unique to your company, which describes how your company meets the requirements of the standard.

First, let's take a look at the eight major headings within MIL-Q-9858A:

1. Scope
2. Superseding, Supplementation and Ordering
3. Quality Program Management
4. Facilities and Standards
5. Control of Purchases
6. Manufacturing Control
7. Coordinated Government/Contractor Actions
8. Notes

Your quality manual can be easily organized to correspond with the organization of the standards itself, at least at first. As you revise and refine your program, you might want to try some different approaches. But for now, let's stick to the standard.

Each time you see the words "shall" or "must" in the specification, you need to add a statement to your quality manual dealing with each requirement as it affects your plant. Now, get a copy of the specification and refer to it as you read through this BMA. Ready?

Part one of MIL-Q-9858A covers the specification's scope, including applicability, contractual intent, a summary, relation to other contract requirements and relation to MIL-I-45208 (Inspection System Requirements).

Part two simply covers the requirements for keeping current with the latest revisions and amendments of the specifications involved.

The real "meat" of the specification begins in part three, "Quality Program Management." The introduction to your quality manual might cover everything in the specification through "Organization" and "Initial Quality Planning." It is important that your manual contain a personal statement of commitment to quality from the company's chief executive at the very beginning. Responsibility for quality must extend to all employees, but top management must ultimately take responsibility for the success or failure of the quality program.

Your manual's introduction should contain at least: a) a statement of commitment to quality from the chief executive; b) a simple organization chart showing the chain of command and responsibilities for your quality program; c) an overview

or outline of the scope of your quality program; and d) a statement or listing of the government and/or commercial standards and specifications the program is designed to meet.

Part three of MIL-Q-9858A continues with subheadings on requirements for work instructions, records, corrective action and costs related to quality. These items should each be covered in detail in the body of your quality manual.

The purpose of requiring explicit written procedures, records and so on is to insure uniformity and consistent repeatability in your operations. Thus, the written materials serve as "how to" instructions for your employees and also help management's efforts to plan, schedule and control.

General procedures should be detailed in the quality manual. If you intend to meet MIL-Q-9858A, be sure that you specifically address each of the requirements under each subheading as it applies to your company. Specific instructions and procedures for individual contracts can be spelled out in shop work orders or routing tickets.

Section four of the specifications covers "Facilities and Standards" and begins by requiring you to establish a method of keeping up-to-date on drawings, documentation and engineering changes. Smaller companies handling small contracts can usually meet this requirement just by assigning one individual the responsibility to assure that prints, specs and change notices being used throughout the plant are current. Larger companies dealing in more complex contracts will require a more structured approach, but in either case, the methods must be specified in your quality manual.

The Facilities and Standards section of MIL-Q-9858A also contains the requirements for measuring and testing equipment, including the requirements for calibration of instruments according to MIL-STD-45662, Calibration System Requirements.

As you may recall, MIL-STD-45662 requires that you establish a regular, periodic calibration program but allows you to establish your own calibration intervals. The calibration schedule can be revised, based upon experience, but it must be documented and specified in your quality manual. Contract calibration services and instrument suppliers can suggest appropriate schedules for your plant's inspection equipment.

This section of MIL-Q-9858A also provides for "proving out" production tooling which will be used as inspection media. Periodic checking intervals for such tooling should also be specified. Section four concludes by stating the government customer's right to spot check gages and measuring instruments in your plant and by providing for special arrangements if highly advanced measurement techniques are required.

The next section deals with control of purchases. The government makes the contractor responsible for assuring that all supplies and services from vendors and subcontractors conform to the contract requirements.

As the contractor, MIL-Q-9858A requires you to use "objective evidence" of effective quality control by your suppliers. This responsibility extends to a) the selection of qualified vendors; b) transmitting the contract's quality requirements to the vendor; c) evaluation of vendor's products or services; and d) effective methods for corrective

measures. Test reports, inspection records, certificates and other documents can be used to provide evidence of consistent quality.

Your quality manual can meet these purchasing control requirements by stating your procedures and recordkeeping methods for controlling vendor performance. Using fully documented written purchase orders for all supplies will also help keep your requirements explicit and can help to avoid mistakes or disputes. It is particularly important to reference all government specs involved in purchase orders for subcontract work or supplies including drawings, engineering change orders, specifications, any special performance or safety requirements, unusual test requirements and so on.

The longest section of MIL-Q-9858A deals with Manufacturing Control. Control of incoming materials is the first item covered, requiring provisions for receiving inspection. It specifies that outside test labs may be utilized when necessary. You must also require your subcontractors to use "equivalent controls" for material used in parts for your contract. Methods of identifying material and its inspection status must also be used. This is usually accomplished by a combination of tagging and marking. Whatever methods you choose should be specified in your manual.

On the subject of production processing and fabricating, the specification requires you to assure that machining, assembly and other operations take place under "controlled conditions." These controlled conditions primarily refer to written work instructions, as on job tickets or routing slips. Controlled conditions are also interpreted to include adequate equipment and therefore, your quality manual should also mention your machine maintenance program.

Inspection and monitoring at each work operation are necessary, and inspection procedures and results should also be recorded. Furthermore, the criteria for acceptance and rejection and ways of identifying acceptable and rejected parts must be specified. The specification also notes that special exotic situations may also require additional documentation. These obligations must be detailed separately for the requirements of each job, but developing a simple systematic method with control forms that can be used routinely will greatly simplify this task.

Your control form should have space for written instructions for machining and for inspection. It should specify the drawing number, contract or job number, material, machine to be used, tooling, setup information, identification of appropriate NC tapes or programs and any other pertinent details. Space may be provided for a sketch on the form itself or drawings may be attached.

If your work usually involves quantity runs, a separate form can be used for inspection results, identifying only the job number, batch date, work station, operation and results. If your work tends to be in small lots, this information could be on the reverse side of the job ticket itself.

The specification requires a system for final inspection and testing of completed products. The standard states that "Such testing shall be performed so that it stimulates, to a sufficient degree, product end use and functioning" (emphasis added).

Obviously, simulation of many defense products' end use in a machine shop can be virtually impossible. If there is any question as to what constitutes "a sufficient degree," get the answer in writing from your contract officer.

Handling, storage and delivery of government work is also covered in the specification's section on manufacturing controls. Work and inspection instructions must also cover handling, storage and shipping considerations. Special crates, boxes, wrappings, etc. must be used when parts require protection in handling.

If parts are to be stored at your facilities, they must be periodically inspected for deterioration or damage. Any special storage or handling requirements must be noted on containers or in the storage areas. The quality program must also include provisions to assure compliance with ICC regulations on shipping and must monitor shippers' protection of products in transit.

The contractor is required to "establish and maintain" an effective and positive system for controlling nonconforming material. Requirements include specifying procedures for keeping such material segregated, getting clearance for rework and tracking costs associated with nonconforming materials.

The use of statistical quality control methods is permitted under MIL-Q-9858A even when the contract does not specifically require such techniques. The use of statistical methods is permitted whenever such procedures are appropriate to improve quality control. Effective use of statistical techniques can actually reduce your inspection requirements, saving time, labor and money. We'll discuss statistical quality control at greater length elsewhere, but for right now, you can note that the government specs on statistical quality control most often used for tooling and machining work are MIL-STD-105, and to a lesser extent, MIL-STD-414, or Handbooks H-106, 107 and 108. If you elect to use some other statistical method you must obtain clearance from your contract officer.

MIL-Q-9858A briefly states a requirement for maintaining a system of identifying the inspection status of products. Your controls can be whatever methods you choose to use, as long as they differ from the government's own inspection identification.

The final major section of the specification covers two main areas: government inspection at subcontractor or vendor facilities and government-furnished property. When the government requires inspections at your suppliers' plants the following statement must be included in your purchase order to your vendors:

"Government inspection is required prior to shipment from your plant. Upon receipt of this order, promptly notify the government representative who normally services your plant so that appropriate planning for government inspection can be accomplished."

The government may sometimes require that copies of the purchase order itself be furnished to the vendor's government rep, and an additional purchase order statement is provided for that case.

A series of requirements for handling government-furnished materials is also provided, and these generally parallel the material control requirements elsewhere in the specification.

As you can see, setting up a quality program and an effective quality manual is not something to be taken lightly. When done correctly, a good quality program will pay off by

raising your efficiency through reduced scrap and rework. A sound quality program also gives you a competitive edge by opening up many new markets for high quality parts, tooling and machining services.

QUALITY IS THE KEY

Perhaps some of the simplest and best advice on quality manuals comes from a retired NTMA member on the West Coast: "My suggestion to anyone embarking on the establishment of a quality assessment system and the attending quality control manual is to keep it simple. The less said the better. You say what you do and do what you say."

The point is well-taken. First of all, most government work, whether at the prime or subcontract level, doesn't even require MIL-A-9858A. The point about "saying what you do and doing what you say" is worth repeating. Your quality manual must be realistic and honest. A customer conducting a quality survey in your plant will quickly see through any overblown "sales literature" in your QC manual. The customer's inspector doesn't expect a small company to have a quality manual as thick as a law dictionary.

CUSTOMER AUDITS

While we're on the subject of quality audits in your plant by customers, a few words on that topic are in order. Such a visit usually has three parts: an opening conference, the plant tour, and the closing conference. In a small company, the chief executive will probably be familiar enough with all of the shop's operations to be able to handle any questions that the inspector may have. But in a slightly larger company it is more important to have the inspector accompanied by someone knowledgeable in the details of the operation, rather than by a "front office" executive who might be overly concerned about making a good impression.

It is also important to be able to show the inspector that your quality controls are used and enforced at the workplace. Answers to the inspector's questions should be specific: refer to your manual and appropriate standards instead of just saying "we check everything real good." Housekeeping and well-maintained machines and instruments will also help make a good impression.

INSTRUMENT CONTROL AND EVIDENCE OF QUALITY

A common question that arises when establishing a program to maintain calibration and control of instruments and gages is "How often should I calibrate if I don't have any past history to follow?" The American Society for Quality Control (ASQC) suggests the following guidelines: Dial Indicators (Quarterly); Micrometers (Quarterly-plus each time before use); Optical Comparators (Annually).

To be safe, calibration intervals should be constantly observed and lengthened or shortened as your experience dictates. If you have any special gages which will not be used for long periods of time, you can avoid calibration costs by placing them out of service until needed again.

For certain types of critical work, customers may require documentation and traceability measures above and beyond those already discussed in this series. In these cases, the customer may issue a "certificate of compliance" to vendors meeting especially rigid requirements. Customers may request "objective quality evidence" before issuing such a certificate. This objective evidence is likely to be the result of a good quality program on your part and a detailed plant quality survey by your customer. Objective quality evidence can also be a strong defense if your quality controls are questioned.

PERSONAL SKILLS

Despite the careful painstaking measures taken to insure the accuracy and reliability of equipment, people and their abilities are still the key to any effective quality program. Although requirements will vary from company to company, it is likely that much of your quality training can be conducted on the job through traditional apprenticeship methods whether formal or informal. Local community colleges and technical schools often offer excellent evening classes or sometimes even in-plant programs tailored to your own personal needs.

Some personal skills may require certification. For example, the Department of Defense may require periodic demonstration of your employees' skills in such areas as nondestructive testing (MIL-STD-410D).

STATISTICAL QUALITY CONTROL

Statistical quality control was pioneered by the American statistician W. Edwards Deming in the 1950s, but his work was largely ignored here at the time. Deming did however find a receptive audience in Japan, which at the time was looking for efficient ways of revitalizing its war-torn manufacturing industries. Today, the highest award that a Japanese industrialist can receive is named in Deming's honor.

The math behind statistical quality control is a little too involved to go into here, but once a statistical system is set up, it can be understood and maintained by nonstatisticians without undue difficulty. Most statistical techniques suited for machining applications involve the use of control charts which help to show the variation of measurements from a baseline within range of a "standard deviation." The standard deviation can be thought of as the "tolerance" or expected range of permissible error. When measurements approach the limits of the permissible range, corrective action can be taken.

Statistical techniques can be used to sample repetitive runs of parts or to monitor the accuracy of machine tools such as jig borers or boring mills used on one-off items such as special tooling. While statistical techniques aren't for every company, they are a powerful tool that can actually help you reduce the amount (and therefore the cost) of physical inspections.

Most contract tooling and machining companies would probably want to enlist the help of a consultant before embarking on a statistical quality program. You can get some recommendations on reputable quality consultants in your

area by contracting the American Society for Quality , 611 E. Wisconsin Avenue, Milwaukee, WI 53201-3005, telephone (414) 272-8575.

If you look for a consultant, use the same cautions you would exercise in selecting any other professional service. Find out if there is a fee for an initial consultation. Get a proposal in writing. Talk to several potential candidates if possible, and also ask other NTMA members nearby if they can recommend someone.

Your company's quality problems and needs are unique to your company alone even though you share many of the same concerns with companies doing similar work. Your quality program will have to be custom tailored to your own particular requirements with or without outside help. Don't be afraid to ask for advice from your customers.

This BMA was prepared by NTMA's Technical Department.