

QUALITY AND RELIABILITY ASSURANCE

HANDBOOK

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EVALUATION OF A CONTRACTOR'S QUALITY PROGRAM



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INTRODUCTION

Quality and Reliability Assurance Handbook H 50 provides guidance to personnel responsible for the evaluation of a contractor's quality program when Military Specification MIL-Q-9858A is invoked in his contract. MIL-Q-9858A, "Quality Program Requirements," requires contractors to establish a quality program which will assure compliance with the requirements of their contracts.

Users of this handbook are cautioned that MIL-Q-9858A supersedes MIL-Q-9858 and contains such extensive changes that it must be treated as an entirely new specification, rather than as a revision. Among the far reaching new concepts in MIL-Q-9858A are requirements for Quality Programs, Quality Program Management, Initial Quality Planning, Costs Related to Quality, Facilities and Standards, Advanced Metrology Requirements, Manufacturing Control (involving work instructions) and other new or expanded requirements.

MIL-Q-9858A is intended for use in contracts involving the more complex types of military hardware and systems, while MIL-I-45208A is the specification pertinent to less complex items. A decision as to which of these specifications to invoke in a contract must be made by the technical and procurement personnel who specify the other technical or contractual requirements. Whichever specification is used, the contractor is not absolved from his responsibility for the quality and reliability of the product he delivers to the Government.

Proper and efficient use of this handbook and the specifications mentioned above require that the reader become familiar with Sections VII and XIV of the Armed Services Procurement Regulation; with MIL-I-45208A, "Inspection System Requirements" and its complement, Quality and Reliability Assurance Handbook 51 (when published); and with MIL-C-45662A, "Calibration System Requirements" and its complement, MIL-HDBK-52.

Both MIL-Q-9858A and this handbook are based on established Department of Defense concepts and policies which provide that:

a. The contractor is solely responsible for the control of product quality and for offering to the government for acceptance only products determined by him to conform to contractual requirements.

b. The Government Representative is responsible for determining that contractual requirements have, in fact, been complied with prior to the acceptance of the product.

c. Final decision of product acceptability is solely the responsibility of the Government.

The contractor, in accordance with MIL-Q-9858A, must design and maintain an effective and economical quality program that includes both processes and products and which makes data available to the Government adequate for use in establishing product acceptance criteria. Facilities, products, and management techniques vary so widely within the broad pattern of national security industrial establishments that this evaluation handbook cannot provide detailed checklists. Instead, it reflects the most reliable quality program control patterns used by much of American industry. It encourages the training of planners and evaluators in all areas that affect the quality program. The emphasis throughout this handbook is on the planning and execution of a comprehensive quality program. The evaluation of such a program depends upon how well decision criteria have been selected, applied and enforced.

The Government's evaluation plan should apply to all aspects of a contractor's program. Thus, the Government Representative must be familiar with all requirements of the procurement if he is to assure himself that the contractor provides effective quality control coverage throughout the entire sequence of operations.

Quality programs are not intended to correct deficiencies in other contractual requirements. The contractor is not obligated to

perform more than the requirements specified in the contract and in MIL-Q-9858A.

A consistent format has been followed throughout this handbook. In order to relate the program evaluation suggestions as directly as possible to the requirements of MIL-Q-9858A, each subsection of the specification is quoted verbatim and followed by appropriate comments, as follows:

SUBSECTION OF MIL-Q-9858A

A. "Review of Requirement"—Discussion of the requirements set forth in the subsection.

B. "Application"—Descriptions and examples of practices applied by contractors in the past that are typical and illustra-

tive rather than all-inclusive or mandatory.

C. "Criteria for Evaluation"—Questions which should be asked to evaluate that particular part of a contractor's quality program.

It is most important to note that the questions contained in the various "Criteria for Evaluation" are essentially YES/NO questions. Asking and answering them alone will not provide a thorough and complete evaluation of a contractor's quality program. The questions serve only as indicators and reminders of important points to cover; *the evaluation is expected to cover them in appropriate depth and detail to assure an effective and complete evaluation.*

EVALUATION OF A CONTRACTOR'S QUALITY PROGRAM

1. SCOPE

1.1 Applicability. This specification shall apply to all supplies (including equipments, sub-systems and systems) or services when referenced in the item specification, contract or order.

A. REVIEW OF REQUIREMENT. Specification MIL-Q-9858A, Quality Program Requirements, applies to the more complex items of military hardware and systems, when it is essential to assure conformance to contractual requirements through control of all work operations and manufacturing processes, as well as inspections and tests. Complex components and subsystems which are part of a complex system may also require application of MIL-Q-9858A. In any case, when the need for MIL-Q-9858A has been determined by technical and procurement personnel, the following clause (ASPR 7-104.28) shall be used in contracts for these items:

"Quality Program (July 1964). The contractor shall provide and maintain a quality program acceptable to the Government for supplies or services covered by this contract. The quality program shall be in accordance with Military Specifications MIL-Q-9858A."

For those less complex items whose quality can be assured adequately by control of inspection and testing alone, MIL-I-45208A, "Inspection System Requirements," will be used. However, a contractor may, at his option, substitute any or all of the requirements of MIL-Q-9858A for those of MIL-I-45208A specified in his contract, provided that price or fee is not increased. This option permits a contractor to use one system rather than two, if he so desires.

B. APPLICATION. Among the types of complex items to which MIL-Q-9858A should be applied are:

(1) Items of complex design, such as missiles, aircraft, tanks, ships, space suits and specialized medicine.

(2) Major components, such as fire control systems, electronic systems, navigation systems, engines, turbines and rocket motors.

(3) Smaller components or parts, such as assemblies, accessories or pieces, when sufficiently complex or required to be ultra-reliable.

C. CRITERIA FOR EVALUATION.

(1) Is the procurement for complex supplies or services?

(2) Does the contract or order reference specification MIL-Q-9858A?

(3) Is use of MIL-Q-9858A at the contractor's option?

(4) When used optionally, is MIL-Q-9858A used in whole or in part? If only used partially, are all of the remaining contract requirements being met?

1.2 Contractual Intent. This specification requires the establishment of a quality program by the contractor to assure compliance with the requirements of the contract. The program and procedures used to implement this specification shall be developed by the contractor. The quality program, including procedures, processes and product shall be documented and shall be subject to review by the Government Representative. The quality program is subject to the disapproval of the Government Representative whenever the contractor's procedures do not accomplish their objectives. The Government, at its option, may furnish written notice of the acceptability of the contractor's quality program.

A. REVIEW OF REQUIREMENT. MIL-Q-9858A requires contractors to design and use a complete quality program. The program must be designed to assure adequate controls throughout all areas of contract performance; e.g., development, manufacturing and shipping. The quality program is not acceptable unless all necessary procedures are available and complete when needed. All or any part of a contractor's quality program may be disapproved by the Government when the program does not accomplish its objectives. In some cases the Government may furnish written notice of the acceptability of the quality program.

B. APPLICATION. A complete quality program is often the most comprehensive and extensive activity of a contractor. Because the program is dynamic and must be documented throughout, substantial amounts of documentation result. The individual instructions and the records for each job document a quality program. Although also necessary, directions

for preparing instructions and records do not document a program.

In describing the functions to be performed, contractors document the procedures and instructions that apply. Production documentation, for example, frequently takes the form of job operations sheets, routing forms, tote tickets, shop travelers, inspection method sheets and test procedures. For other functions, purchasing manuals, engineering handbooks and similar forms of instruction may be used.

Records are another form of required documentation. Inspection and test records, laboratory analyses, shipping records, records of the effective dates of engineering changes and records of engineering approval are examples of some records used.

Nonconforming products will be disapproved at any time. In addition, when contractors' procedures are unsatisfactory, a DoD activity will disapprove part or all of the quality program and immediately notify the contractor of such action. Conversely, when a DoD activity elects to advise a contractor that his quality program is acceptable, a letter similar to the following shall be used:

"Government representatives of the Department of Defense on _____
(date)
 reviewed the quality program employed by your firm at _____
(describe the location)
 on the production of _____
(type of product)
 _____. On the basis of that review the aforesaid quality program appears to be acceptable.

"This evaluation does not relieve you in any way from continuing to comply with the requirements of MIL-Q-9858A and the contract.

"This notice does not signify a preference for or endorsement of your product by the Department of Defense and shall not be so used in advertisements or other publicity. Nevertheless, you may publicize the fact that your quality program for such product has been adjudged by the

Department of Defense as conforming with MIL-Q-9858A.

"Acknowledgement of this communication is requested."

C. CRITERIA FOR EVALUATION.

(1) Does the contractor have a quality program which assures compliance with the requirements of the contract?

(2) Is the program documented and is such documentation available for Government review?

1.3 Summary. An effective and economical quality program, planned and developed in consonance with the contractor's other administrative and technical programs, is required by this specification. Design of the program shall be based upon consideration of the technical and manufacturing aspects of production and related engineering design and materials. The program shall assure adequate quality throughout all areas of contract performance; for example, design, development, fabrication, processing, assembly, inspection, test, maintenance, packaging, shipping, storage and site installation.

All supplies and services under the contract, whether manufactured or performed within the contractor's plant or at any other source, shall be controlled at all points necessary to assure conformance to contractual requirements. The program shall provide for the prevention and ready detection of discrepancies and for timely and positive corrective action. The contractor shall make objective evidence of quality conformance readily available to the Government Representative. Instructions and records for quality must be controlled.

The authority and responsibility of those in charge of the design, production, testing, and inspection of quality shall be clearly stated. The program shall facilitate determinations of the effects of quality deficiencies and quality costs on price. Facilities and standards such as drawings, engineering changes, measuring equipment and the like which are necessary for the creation of the required quality shall be effectively managed.

The program shall include an effective control of purchased materials and subcontracted work. Manufacturing, fabrication and assembly work conducted within the contractor's plant shall be controlled completely. The quality program shall also include effective execution of responsibilities shared jointly with the Government or related to Government functions, such as control of Government property and Government source inspection.

A./B. REVIEW AND APPLICATION OF REQUIREMENT. Contractors generally recognize that most functions of management affect product quality in some manner and to some degree, and that it is essential to identify, and to assign responsibility for, inter-related quality activities. Among the characteristics of an effective quality program are delegation of authority, responsibility and accountability for decisions affecting quality in a clear and precise manner which assures the proper functioning of the quality program.

Contractors also recognize that the quality programs must be responsive to changing needs. Accordingly, contractors ordinarily provide for the continuous acquisition of current data on the status of quality.

Some contractors require early reporting of properly identified quality failures. Such failures are priced using appropriate cost records to emphasize their cost. Many contractors attempt to balance the cost of failures with the cost of control, shifting effort and resources as necessary to achieve optimum results. The cost of preventive actions usually is much less than the cost of failures and after-the-fact corrective action.

Close collaboration and coordination with DoD contract and administrative personnel is a mark of successful DoD suppliers. This cooperation properly extends to subcontractors and vendors.

C. CRITERIA FOR EVALUATION. Since this is a summary, no criteria for evaluation are necessary.

1.4 Relation to Other Contract Requirements. This specification and any procedure or document executed in implementation

thereof, shall be in addition to and not in derogation of other contract requirements. The quality program requirements set forth in this specification shall be satisfied in addition to all detail requirements contained in the statement of work or in other parts of the Contract. The contractor is responsible for compliance with all provisions of the contract and for furnishing specified supplies and services which meet all the requirements of the contract. If any inconsistency exists between the contract schedule or its general provisions and this specification, the contract schedule and the general provisions shall control. The contractor's quality program shall be planned and used in a manner to support reliability effectively.

A. REVIEW OF REQUIREMENT. The requirements of MIL-Q-9858A are not intended to cancel or conflict with any other requirements of a contract. Thus, MIL-Q-9858A does not relieve a contractor of any of his contractual responsibility. If there is an apparent conflict between the requirements of the contract and MIL-Q-9858A, the contract requirements shall prevail.

Reliability is often an important contract requirement. The quality program must support the achievement of required reliability by assuring that material is manufactured as designed by a manufacturing process which does not detract from the reliability designed into the product.

B. APPLICATION. Contractors usually review with care all of the technical requirements of a contract to make certain that all are effectively covered by their quality programs. Though many requirements may be standard from contract to contract and from specification to specification and can be dealt with by a standard response, most contractors insist on a total and thorough review because special or new contract clauses relating to quality (reliability, maintainability, incentives, etc.) may be included. Even in follow-on contracts for supplies previously furnished, contractors may find specifications requiring compliance to new or different requirements.

Contracts for complex supplies frequently reference many component parts specifica-

tions, and specifications for such characteristics as reliability, maintainability or interchangeability—all of which are elements of, or affect, quality. When contracts and specifications contain reliability requirements, contractors design their quality program to measure and assure compliance. Many suppliers combine their reliability and quality efforts. They often integrate reliability testing, instructions, records and similar reliability aspects into the quality program.

C. CRITERIA FOR EVALUATION

(1) Does MIL-Q-9858A conflict with any of the other requirements of the contract, or are any features of the quality program superseded by other specifications?

(2) Is the quality program adequately planned to support reliability requirements?

1.5 Relation to MIL-I-45208. This specification contains requirements in excess of those in specification MIL-I-45208, Inspection System Requirements, inasmuch as total conformance to contract requirements is obtained best by controlling work operations, manufacturing processes as well as inspections and tests.

A./B. REVIEW AND APPLICATION OF REQUIREMENT. This handbook is not directly related to the requirements established in MIL-I-45208A and discussed in H-51, "Evaluation of a Contractor's Inspection System." However, specifications MIL-Q-9858A and MIL-I-45208A and their respective handbooks are complementary. The Government wants contractors to have effective yet economical programs for quality and inspection. Therefore, both MIL-I-45208A and MIL-Q-9858A were developed simultaneously to permit the use of the former, less comprehensive specification whenever appropriate.

Again it is emphasized that MIL-Q-9858A applies to complex services or supplies, where effective control of quality demands control of work operations, this is, where control of inspection and testing only is not sufficient.

C. CRITERIA FOR EVALUATION

(1) Since this paragraph of MIL-Q-9858A does not contain requirements, no evaluation is necessary.

2. SUPERSEDING, SUPPLEMENTATION AND ORDERING

2.1 Applicable Documents. The following documents of the issue in effect on date of the solicitation form a part of this specification to the extent specified herein.

SPECIFICATIONS

MILITARY

MIL-I-45208 — Inspection System Requirements

MIL-C-45662 — Calibration System Requirements

2.2 Amendments and Revisions. Whenever this specification is amended or revised subsequent to its contractually effective date, the contractor may follow or authorize his subcontractors to follow the amended or revised document provided no increase in price or fee is required. The contractor shall not be required to follow the amended or revised document except as a change in contract. If the contractor elects to follow the amended or revised document, he shall notify the Contracting Officer in writing of this election. When the contractor elects to follow the provisions of an amendment or revision, he must follow them in full.

2.3 Ordering Government Documents. Copies of specifications, standards and drawings required by contractors in connection with specific procurements may be obtained from the procuring agency, or as otherwise directed by the Contracting Officer.

The above paragraphs of MIL-Q-9858A are self-explanatory and do not require elaboration.

3. QUALITY PROGRAM MANAGEMENT

3.1 Organization. Effective management for quality shall be clearly prescribed by the contractor. Personnel performing quality functions shall have sufficient, well-defined responsibility, authority and the organiza-

tional freedom to identify and evaluate quality problems and to initiate, recommend or provide solutions. Management regularly shall review the status and adequacy of the quality program. The term "quality program requirements" as used herein identifies the collective requirements of this specification. It does not mean that the fulfillment of the requirements of this specification is the responsibility of any single contractor's organization, function or person.

A. REVIEW OF REQUIREMENT. To establish a quality program which fulfills the requirements of MIL-Q-9858A, contractors must identify the functions and activities that directly affect quality and assign specific authority and responsibility for these functions. The assignment is made in terms of decisions and actions to identified elements at all levels of the organization. The mere preparation of organization charts or handbooks is not enough.

MIL-Q-9858A explicitly requires contractors to satisfy certain quality program requirements, but does not specify an organizational arrangement of any kind for meeting these requirements.

B. APPLICATION. Although practically all contractors now have quality control and/or inspection departments which are focal points for quality matters, these departments cannot satisfy all of the quality program requirements of MIL-Q-9858A. Many other departments of a contractor's organization contribute to the quality efforts. Their actions, together with those of the quality and/or inspection departments, constitute the quality programs to which MIL-Q-9858A applies. These facts, however, do not preclude assignment of responsibility for coordination and management of the implementation of MIL-Q-9858A to a particular organizational component (e.g., Quality Control Department).

C. CRITERIA FOR EVALUATION

(1) Does the established program identify the organizational element responsible for each of the various quality efforts?

(2) Do the personnel performing the quality functions have sufficient authority, responsibility, and freedom of action to identify and evaluate quality problems and initiate, recommend, or provide solutions?

(3) Does management regularly review the status and adequacy of the quality program?

3.2 Initial Quality Planning. The contractor, during the earliest practical phase of contract performance, shall conduct a complete review of the requirements of the contract to identify and make timely provision for the special controls, processes, test equipments, fixtures, tooling and skills required for assuring product quality. This initial planning will recognize the need and provide for research, when necessary, to update inspection and testing techniques, instrumentation and correlation of inspection and test results with manufacturing methods and processes. This planning will also provide appropriate review and action to assure compatibility of manufacturing, inspection, testing and documentation.

A. REVIEW OF REQUIREMENT. Initial quality planning should take place as early as possible, preferably prior to the start of contract performance. The contractor's quality program is not complete unless it is planned and developed in conjunction with all other functions such as research and development, production, engineering, and subcontracting.

One of the main objectives of initial planning is to identify any special or unusual requirements. When such requirements are found, there is frequently a need for study, planning and programming to provide appropriate operations, processes, and techniques. The planning must be timely and provide for operational review to assure compatibility between the quality program requirements and affected manufacturing operations, processes and techniques.

B. APPLICATION. There have been instances of late completion and overruns on contracts because of unforeseen problems arising from requirements with which contractors were unfamiliar. Sometimes military requirements

are so advanced that the chances of success depend greatly on the use and adaptation of recent "breakthroughs" in technology. Failure to recognize and plan for such requirements endangers timely and successful performance of the contract.

It is important, therefore, for contractors to review requirements to identify needs for advanced technology in design, engineering, testing, inspection and manufacturing. Such a review should take place at the earliest possible time.

A review for unique requirements entails a complete examination of all contract requirements, including work statements, exhibits, references and the like. The object is to identify those requirements that are unusual by reason of newness, unfamiliarity, lack of experience, or absence of precedents. What is common and ordinary in one industry may be unusual in another. Old familiar products and processes may be adapted to new, unknown applications. Ordinary applications may take on new aspects because of use in new environments. For instance, the use of paper as a material might present new problems to the textile industry. Ceramic cylinder inserts in aluminum engine blocks may create unusual design, foundry, manufacturing, testing and servicing problems for an established engine manufacturer.

As each new special requirement is identified, the means for testing and proving successful compliance with the unique requirement must be considered. Existing inspection practices often are not adequate. For example, if the use of a laser or maser was necessary for compliance with a technical requirement, research might be needed to devise effective tests for the optical and electronic functions involved.

Solutions to the problems of unique requirements are often unusual. The integration of these unusual new functions into the quality program must be carefully planned so that they are compatible. For instance, metrology and calibration systems need to be flexible enough to include many diverse manufacturing and testing requirements, particularly for aerospace applications.

C. CRITERIA FOR EVALUATION

(1) Does the contractor conduct a complete review to identify and provide for special or unusual contract requirements?

(2) Does the contractor perform initial quality planning as early as possible?

(3) Does planning require the research needed for developing all the advanced or new testing and inspection techniques required?

(4) Has action been taken to make the controls for special requirements compatible throughout manufacturing, inspection and testing?

3.3 Work Instructions. The quality program shall assure that all work affecting quality (including such things as purchasing, handling, machining, assembling, fabricating, processing, inspection, testing, modification, installation, and any other treatment of product, facilities, standards or equipment from the ordering of materials to dispatch of shipments) shall be prescribed in clear and complete documented instructions of a type appropriate to the circumstances. Such instructions shall provide the criteria for performing the work functions and they shall be compatible with acceptance criteria for workmanship. The instructions are intended also to serve for supervising, inspecting and managing work. The preparation and maintenance of and compliance with work instructions shall be monitored as a function of the quality program.

A. REVIEW OF REQUIREMENT. Documented work instructions are necessary for work which affects product quality. Instructions must be clear, concise and appropriate to the nature of the work and the circumstances under which the work is to be done. The instructions also must establish quantitative or qualitative means for determining that each work operation has been done satisfactorily. These quantitative or qualitative criteria must also be suitable for use with related inspections or tests, because work instructions serve operating personnel, supervisors, inspectors, managers, and in some instances, customers.

The contractor is required to review and assure compliance with his prescribed work instructions.

B. APPLICATION. Work instructions have different names in different plants and sometimes even in different departments of the same plant. Among the names used are Production Control Books, Production Control Releases, Job Tickets, Manufacturing Control Sheets and Work Tickets. Regardless of name, each job operation is usually identified with a number that is one of a sequence indicating previous and subsequent work operations. The instructions ordinarily tell how a job will be done, the order in which actions are accomplished, set-up information, speeds and feeds, associated drawings and specifications, and other pertinent information.

The work of many departments affect quality. For example, inferior packaging can lead to damage during transportation. Thus, shipping department work affects quality. Stock rooms also affect quality by issuance of the correct bars, rods, and shapes in the proper alloy of steel, aluminum or other metal. Technical writing is a work operation that has an impact on quality. Though there are many and diverse work operations, only a small number of them constitute inspection or testing. All work operations affecting quality must be covered by effective work instructions.

It is of prime importance that the events that make possible the fabrication of a product follow a systematic, unvarying sequence of work operations. For this reason, work instructions are necessary, regardless of whether a contractor's facilities and organization are considered "small" or "large." Of course, for large enterprises documented work instructions are an absolute necessity for communication purposes because of the large number of people involved. However, smaller organizations have no less need for appropriately documented work instructions to assure exact product replication.

Work instructions must be kept current and complete. The problems involved in controlling drawing use in the shop are also

encountered in controlling work instructions. At times work is attempted using drawings alone without work instructions. Sometimes changes are developed on the shop floor and not entered in the instructions. At other times an attempt is made to use an unsuitable general instruction on new work operations. Often, changes in machines, tools, work locations or conditions are not reflected properly in the work instructions.

Dimensions and tolerances are quantitative criteria for a work operation and are usually specified in a work instruction by reference to a drawing. Comparison standards such as surface finish blocks, color cards, cloth swatches, macrographs or sectioned samples often serve as the qualitative criteria provided in work instructions. Often a qualitative work standard is nothing more than a written description.

Just as drawings are used by designers, engineers, customers, machine operators and many others, so work instructions are used by inspectors, supervisors and managers, as well as by production personnel. Supervisors or others responsible for quality improvement often find in the work instructions manufacturing details that need to be changed. Whenever a drawing is changed, a work instruction change is likely; on the other hand, many work instruction changes do not require drawing changes.

Since work instructions are so numerous and varied, have such wide use, and are subject to much change, it is necessary that contractors continually review work instruction systems to assure that they provide accurate, complete instructions and require worker compliance.

C. CRITERIA FOR EVALUATION

(1) Are documented work instructions available and used for all work operations which affect quality?

(2) Are such work instructions complete and appropriate?

(3) Are standards available for each work operation?

(4) Are work instructions compatible with associated inspection and testing?

(5) Do supervisors, managers and inspectors make proper use of work instruction?

(6) Are work instructions reviewed on a systematic basis for accuracy, completeness and worker compliance?

3.4 Records. The contractor shall maintain and use any records or data essential to the economical and effective operation of his quality program. These records shall be available for review by the Government Representative and copies of individual records shall be furnished him upon request. Records are considered one of the principal forms of objective evidence of quality. The quality program shall assure that records are complete and reliable. Inspection and testing records shall, as a minimum, indicate the nature of the observations together with the number of observations made and the number and type of deficiencies made and the number and type of deficiencies found. Also, records for monitoring work performance and for inspection and testing shall indicate the acceptability of work or products and the action taken in connection with deficiencies. The quality program shall provide for the analysis and use of records as a basis for management action.

A. REVIEW OF REQUIREMENT. The contractor is responsible for controlling and assuring quality and for providing objective evidence that this control and assurance do, in fact, exist. The essentiality of proper record keeping to contractor quality programs cannot be overemphasized; thus the requirement in MIL-Q-9858A for complete and reliable records wherever essential to an effective and economical quality program.

It is the responsibility of the Government to review a contractor's records to the extent necessary to assure compliance with quality program requirements. This review ordinarily consists of the following actions: (a) checking the contractor's record keeping policies, systems, and procedures, (b) inventory of the contractor's record forms, (c) evaluation of specific records for currency, completeness, accuracy and pertinency, and (d) verification of the records by means of independent examinations (e.g., inspection

and tests) of products and appropriate calibration of test and measuring equipment.

As a minimum, inspection and test records must indicate the number of type of deficiencies found, the actions taken concerning them, and the nature and number of observations made. In addition, these records should indicate the percentage of items passing inspection or test and the quantities of acceptable and rejected items.

Records must be made of work accomplished, compliance or noncompliance with work instructions, and of actions taken to remedy noncompliance.

The design, maintenance and use of records should be accomplished in a systematic manner to assure that the records can be readily analyzed to indicate the state of the over-all quality program. Management decisions must reflect the use and analysis of these records.

B. APPLICATION. Records of sub contractor quality assurance programs, of engineering approvals, of customer returns and cost records pertinent to acceptance of nonconforming materials are examples of the records required for an effective quality program.

Government Representatives ordinarily review and use records at the places where the contractor keeps them. If tests records are maintained in a laboratory office, for example, the Government should expect to use them there. Similarly, microfilmed records should be examined at the film storage site, if viewers are available. As for copies of records, the Government should not request them routinely, but only when needed for a definite purpose.

Financial audits are used to verify the accuracy and completeness of fiscal records, and assure their validity as a basis for financial management. Quality management can obtain the same assurance by carefully validating the records used to make decisions, report achievements and identify problems. Contractor inspection alone does not suffice. The Government also needs to sample contractor record keeping practices.

It is conceivable that a minimum of record keeping might suffice—with automated in-

spection, for instance. A coordinated system of record keeping should reduce recording activity substantially. Information may be recorded on individual forms that supplement one another, or information may be combined on a minimum of forms containing the optimum amount of related information.

To establish and maintain a satisfactory quality program, the results of many kinds of work operations must be recorded. For instance, the adjustment set points on a speed governor, or the amount or volume of material added to a manufacturing process, may need to be recorded. Frequently, logbook records for complicated assembly operations, such as those used in the manufacture of aircraft, guidance systems, or engines, must contain a complete record of the inspection of each assembly operation. Where the same worker is responsible for a variety of dissimilar work operations, inspecting and recording his compliance with work instructions, often is necessary to properly protect quality.

The value of any failure or rejection record is increased tremendously if it can help prevent repetition of the same error which caused the defects. Such prevention is best achieved by having the failure record show (1) the cause of the error, (2) how the error was corrected and (3) the action necessary to prevent a recurrence. Many factories record such information on job tickets and rejection tags.

It is difficult to consolidate individual item logbook data into a record which permits a broad scale judgment of the quality of whole groups of a specific item. For instance, the logbook record tells very completely the quality of one engine, vehicle or aircraft. However, it is very difficult to tell from logbooks the prevalent quality of a whole year's production of engines, vehicles or aircraft. Because few contractors manage production and quality control on a one-item-at-a-time basis, it is necessary to collate, tabulate, and consolidate all similar or identical quality or deficiency information. From this properly organized and consolidated data a supervisor or manager can evaluate the general quality of precisely identified aspects of the

product and its individual parts. This consolidation is facilitated if the records and reports pertinent to a product are indexed by company part number.

Many producers allocate resources and concentrate corrective efforts on the basis of part number tabulation reports. Management frequently follows a practice of concentrated supervisory action to improve the quality of the most deficient parts, processes or departments in each month. Specialists from design, production and industrial engineering may be assigned to concentrate on improving the quality of these specific areas of deficiency. Management by intuition, rather than by analysis of tabulated records, is not acceptable.

CRITERIA FOR EVALUATION

- (1) Are there records of all essential activities?
- (2) Are records available to Government personnel, and furnished when required?
- (3) Are there effective means for assuring the currency, completeness and accuracy of records?
- (4) Do inspection records include only the number and kind of defectives? Is other essential data recorded? How and where?
- (5) Do inspection records and work instruction compliance records indicate the quantitative degree of acceptance or rejection of product or work effort?
- (6) If rejection is recorded, do records show resulting action?
- (7) Do management actions reflect the analyses and use of records?

3.5 Corrective Action. The quality program shall detect promptly and correct assignable conditions adverse to quality. Design, purchasing, manufacturing, testing or other operations which could result in or have resulted in defective supplies, services, facilities, technical data, standards or other elements of contract performance which could create excessive losses or costs must be identified and changed as a result of the quality program. Corrective action will extend to the performance of all suppliers and

vendors and will be responsive to data and product forwarded from users. Corrective action shall include as a minimum:

- (a) Analysis of data and examination of product scrapped or reworked to determine extent and causes;
- (b) Analysis of trends in processes or performance of work to prevent nonconforming product; and

(c) Introduction of required improvements and corrections, an initial review of the adequacy of such measures and monitoring of the effectiveness of corrective action taken.

A. REVIEW OF REQUIREMENT. Prompt, effective corrective action is essential to a quality program. Segregating defective material from acceptable material is not enough; the cause of the defects must be found and corrected. Occasionally the cause of infrequent or non-repetitive defects cannot be determined and the only action possible is to reject the defective items.

Incorrect ways of working or noncompliance with work instructions are frequent causes of defects. Sometimes inferior design is the cause. As need dictates, correction requires (a) changing unsatisfactory work methods and designs, or (b) enforcing compliance with satisfactory work methods and designs.

It is imperative that the contractor make effective use of all data regarding defects, whether the data comes from using activities or is generated by his own operation. Data from users may concern defects caused by the prime contractor or by his suppliers. In either case, the contractor is responsible for assuring that corrective action is taken.

B. APPLICATION. Many contractors have specific methods for detecting and correcting defects. They attempt to detect defective material as early as possible to save the cost of further spoiled material and wasted work. In addition, the desire to maximize production efficiency motivates manufacturers to establish effective methods for rapidly determining and correcting the causes of recurrent defects.

First piece inspection, inspection by machine operators and other production line workers, inspection after each work operation or a small group of work operations, roving inspectors and many other inspection arrangements are used by contractors to determine recurring defects. Sometimes statistical in-process control methods are used to indicate or predict the need for correction of defects. Rejection tags and stamps are devices commonly used to identify products needing corrective action and to initiate such action.

Once defects are found, contractors normally use the services of the responsible manufacturing or design personnel to determine and correct the cause. Engineering, production control, purchasing, or any other function found to have caused the defect is charged with the responsibility for devising and implementing corrective measures. The interests of both the contractor and the Government demand close attention to the effectiveness of corrective actions. Likewise, both the contractor and the Government must monitor "fixes" carefully to be certain of their continued effectiveness. Records of specific recurring defects are essential to the diagnosis of the causes of defects and removal of these causes by corrective action.

Although the major focus of attention in quality program activities is on "hardware", or the output of production lines, other areas which require close attention are processes, methods and manufacturing facilities which may be substandard and inefficient. Deficiencies in these potential sources of difficulty should be corrected before they cause defects in the "hardware".

Since most contractors depend to some extent on subcontractors and vendors for raw materials, parts, and subassemblies applicable to their products, they extend quality assurance to suppliers. Where a contractor finds items or services of the suppliers to be defective, he is responsible to see that corrective action is taken, even to the extent of changing his supplier.

C. CRITERIA FOR EVALUATION

(1) Does the program provide for prompt detection of inferior quality and for correction of its assignable causes?

(2) Is adequate action taken to correct the causes of defects in products and facilities? In functions, e.g., design, purchasing, testing?

(3) Are analyses made to identify trends towards product deficiencies?

(4) Is corrective action taken to arrest unfavorable trends before deficiencies occur?

(5) Does corrective action extend to suppliers' products?

(6) Is corrective action taken in response to user data?

(7) Are data analysis and product examination conducted on scrap or rework to determine extent and causes of defects?

(8) When corrections are made, is their effectiveness reviewed and are they monitored later?

3.6 Costs Related to Quality. The contractor shall maintain and use quality cost data as a management element of the quality program. These data shall serve the purpose of identifying the cost of both the prevention and correction of noneconforming supplies (e. g., labor and material involved in material spoilage caused by defective work, correction of defective work and for quality control exercised by the contractor at subcontractor's or vendor's facilities). The specific quality cost data to be maintained and used will be determined by the contractor. These data shall, on request, be identified and made available for "on site" review by the Government Representative.

A. REVIEW OF REQUIREMENT. The purpose of recording and maintaining cost information related to quality is to facilitate sound decision making by contractors regarding their quality programs. The contractor determines the cost data needed and how it is recorded and used.

The cost of preventing and correcting defects is a significant part of total quality costs. Cost data is highly useful in assessing the effectiveness of manufacturing, inspec-

tion and other types of work operations, such as the recording of quality data. Cost information concerning engineering changes, price adjustments for defective material, reinspection of defective material and similar costs also are useful in managing quality programs.

Contractors will make cost data available for "on site" review by the Government QA Representative when requested. "Make available" means the cost data will be shown, not given. "On site" means that the Government QA Representative examines the data on the spot. He does not make copies nor does he carry the data away nor reveal it to anyone else. The sole purpose of the examination of such data by the QA Representative is to assure that such data are being used in managing the quality program.

B. APPLICATION. Procedures for recording quality program costs range from the very simple to the highly complex. In the past, measurement of such costs has not been the subject of intensive study by either the Government or industry; however, many contractors in recent years have designed and implemented highly efficient systems for measuring and controlling quality program costs.

Effective implementation of paragraph 3.6 of MIL-Q-9858A in the interest of both industry and the Government is to a decisive degree a function of the initiative and alertness of management in adopting new techniques for quality costing as these techniques appear increasingly in the literature of the quality assurance field.

C. CRITERIA FOR EVALUATION

(1) Has the contractor determined the specific quality cost data that he needs?

(2) Are the data (in (1)) being collected?

(3) Do the data identify the cost of prevention or correction of defects, or both?

(4) Are the cost data used in managing quality?

(5) Are cost data available for "on site" review by the Government QA Representative?

4. FACILITIES AND STANDARDS

4.1 Drawings, Documentation and Changes.

A procedure shall be maintained that concerns itself with the adequacy, the completeness and the currentness of drawings and with the control of changes in design. With respect to the currentness of drawings and changes, the contractor shall assure that requirements for the effectivity point of changes are met and that obsolete drawings and change requirements are removed from all points of issue and use. Some means of recording the effective points shall be employed and be available to the Government.

With respect to design drawings and design specifications, a procedure shall be maintained that shall provide for the evaluation of their engineering adequacy and an evaluation of the adequacy of proposed changes. The evaluation shall encompass both the adequacy in relation to standard engineering and design practices and the adequacy with respect to the design and purpose of the product to which the drawing relates.

With respect to supplemental specifications, process instructions, production engineering instructions, industrial engineering instructions and work instructions relating to a particular design, the contractor shall be responsible for a review of their adequacy, currentness and completeness. The quality program must provide complete coverage of all information necessary to produce an article in complete conformity with requirements of the design.

The quality program shall assure that there is complete compliance with contract requirements for proposing, approving, and effecting of engineering changes. The quality program shall provide for monitoring effectively compliance with contractual engineering changes requiring approval by Government design authority. The quality program shall provide for monitoring effectively the drawing changes of lesser importance not requiring approval by Government design authorities.

Delivery of correct drawings and change information to the Government in connection

with data acquisition shall be an integral part of the quality program. This includes full compliance with contract requirements concerning rights and data both proprietary and other. The quality program's responsibility for drawings and changes extend to the drawings and changes provided by the subcontractors and vendors for the contract.

A. REVIEW OF REQUIREMENT. Paragraph 4.1 requires that a contractor's quality program assure current, complete engineering documentation. Approved drawing changes must be initiated at the time scheduled in appropriate orders. Obsolete drawings must be removed from all locations where they mistakenly could be used. The initiation of drawing changes and removal of obsolete drawings must be recorded by the contractor and these records must be available to the Government.

The engineering adequacy of the designs delineated and defined in drawings, specifications and change documentation shall be subject to a verification procedure. Engineering adequacy may be judged in two principal ways. First, the content of the drawing, specification or change order can be checked for compliance with sound application of the engineering practices involved. Second, the content of the engineering documentation can be checked for design validity relative to the specific item and its application.

Other quality-related documentation exists besides drawings, specifications, and change orders and notices. All such supplementary or complementary documentation must be provided on request—none is so unimportant that it may be ignored. Such documents also must be complete, current and adequate. Among the various types of work covered by the supplementary documents are fabrication, service, inspection, tests, preservation, packaging, identification and the like. Supplementary documentation is referred to by many titles, such as "process instructions," "production engineering instructions," "industrial engineering instructions," "work instructions," and "job tickets."

Different types and classes of changes require approval by different authorities. Some changes must be approved by Government authorities who are not resident in the plant. Others require only the approval of on-site Government authorities. Contractors may need to approve certain changes made by their suppliers, that is, vendors or subcontractors. The contractor must establish an acceptable method for processing Class I change proposals and approvals. In addition, arrangements should be made with the appropriate local Government representative to assure his review of all Class II Changes to assure proper classification. Finally, the contractor must develop requirements for his suppliers to satisfy in controlling changes to purchased material.

The quality program should assure contractor compliance with the Government's contract requirements for the acquisition of drawings or other data. Compliance with delivery schedules for required data is particularly important. The contractor is responsible for arranging with his suppliers for the acquisition of all data necessary to fulfill the contract.

B. APPLICATION. The control of engineering changes and of drawings is so closely related that many manufacturers combine both in a single operation. Production control requires many documents which supplement drawings, such as process specifications, job orders, work orders, and in-plant procedures for accomplishing work.

Ordinarily, the format, dimensional and tolerance accuracy and the degree of design disclosure of drawings are controlled by drawing checkers and supervisors who review the work of the draftsmen. The drafting department frequently is responsible for establishing precise tolerances on drawings since project engineers frequently specify only a general tolerance.

Drawings normally are used in engineering departments, production control departments, purchasing departments and in such shop floor areas as machining, fabrication and assembly. Assurance that everyone is using correct and current drawings can best

be obtained by using procedures which provide for immediate recall of obsolete drawings and issuance of revised or new ones.

Even more important than having the correct drawing in the right place at the proper time is having drawings that are up to standard: drawings that contain the correct delineation, tolerances, and notes that are essential for manufacturing acceptable parts or items. Each drawing must convey a complete design, suitable in all respects for the specific object depicted and its particular purpose. Since design engineers are subject to human failings and have varying capabilities, many contractors provide checks and balances to assure design adequacy from each engineer or designer creating drawings. Frequently, supervisory engineers review the work of project engineers to make certain that drawings are accurate and of sufficiently high quality to give a workable and satisfactory design. Accurate drawings are of paramount importance to effective design and manufacturing efforts.

Production control department engineers and technicians prepare many of the supplemental instructions necessary for manufacture. Checks and balances similar to the aforementioned are used to assure quality work by the personnel who prepare supplemental instructions.

Other departments, for example the company laboratory and metallurgical department, may furnish additional supplements to drawings, such as notes calling out protective coatings or heat treatments. Normally, the work from all such sources should be reviewed to assure its completeness and accuracy.

In some firms, engineering changes are processed by departments other than those responsible for initiating and implementing the changes. In other firms, engineering changes are processed by the group responsible for the original design. Frequently major and minor types of engineering changes are handled by different groups. Regardless of the department held responsible, it is imperative that all engineering changes be adequately controlled.

For DoD work the Government requires prior approval of some or all engineering changes. The extent to which the Government will control each type of engineering change is specified in the contract. Any contractor's change control system must satisfy the Government's change approval requirements.

Contractors usually assign to one particular organization the responsibility for on-time delivery of the drawings and other technical data required by the contract. In some companies this is handled by a technical documentation or publications department; in others, by the engineering department; in others, the contractor order department; and in yet others, by a contract compliance department.

Drawings are one of a contractor's most valuable assets. Therefore, most contractors take appropriate steps to safeguard their rights in engineering data. In recognition of these facts, Government policy is to acquire rights to only those drawings whose acquisition is provided for contractually. Contractors also must adhere to contract provisions for the delivery of data. Contractors should assure that all supplementary documents, such as a company's own work instructions and specifications for special processing, are retained or disclosed strictly in accordance with the contract. At the outset of contract negotiations, it should be determined to what extent the contract calls for such supplementary data.

C. CRITERIA FOR EVALUATION.

- (1) Is there a procedure for assuring the engineering adequacy of drawings?
- (2) Is there a procedure to insure currentness and completeness of drawings?
- (3) Has all the supplemental documentation necessary to produce articles in conformance with design been provided?
- (4) Does the program assure compliance with contract requirements for proposing, approving and implementing engineering changes?

(5) Is there appropriate monitoring of changes requiring approval by "off-site" Government design authorities?

(6) Is there appropriate monitoring of changes requiring approval by local "on-site" Government authorities?

(7) Is there appropriate monitoring by the contractor of all changes not requiring Government approval?

(8) Does the program clearly delineate and cover the contractor's responsibility for controlling and recording design and other changes originating with suppliers?

(9) Does the contractor monitor all supplier changes which require his approval?

(10) Does the program assure "on-time" delivery of the data prescribed by the contract?

(11) Is there complete contract compliance concerning rights in data?

(12) Does the program adequately cover the contractor's responsibility for providing required rights in data covering items that originate with his suppliers?

4.2 Measuring and Testing Equipment. The contractor shall provide and maintain gages and other measuring and testing devices necessary to assure that supplies conform to technical requirements. These devices shall be calibrated against certified measurement standards which have known valid relationships to national standards at established periods to assure continued accuracy. The objective is to assure that inspection and test equipment is adjusted, replaced or repaired before it becomes inaccurate. The calibration of measuring and testing equipment shall be in conformity with military specification MIL-C-45662. In addition, the contractor shall insure the use of only such subcontractor and vendor sources that depend upon calibration systems which effectively control the accuracy of measuring and testing equipment.

A. REVIEW OF REQUIREMENT. Gages and other measuring and test devices which can assess the quality, performance, dimensions and other technical requirements of products

are an essential element of the quality program specified by MIL-Q-9858A. These devices must be inspected and calibrated on a regularly scheduled basis to prevent inaccuracies or at least to detect them as early as possible. Such devices often need to be repaired, replaced, or calibrated. The inspection and calibration practices covering measuring and testing equipment are prescribed in detail in specification MIL-C-45662A. MIL-Q-9858A requires compliance with this specification.

In selecting suppliers, the contractor must give preference to those that systematically and effectively control the accuracy of the test and measuring equipment required in the performance of their contracts.

B. APPLICATION. Most contractors recognize the necessity of carefully and continually checking test and inspection equipment to assure that the necessary degree of accuracy is being maintained. A comprehensive calibration system, such as that required by MIL-C-45662A, is necessary. The system should assure the direct or indirect traceability of contractor calibration standards through an unbroken chain of calibrations to the National Reference Standards. The frequency of calibration is determined on the basis of the type, purpose, usage rate and degree of accuracy of the equipment involved. Contractor and Government personnel may obtain additional information about specification MIL-C-45662A in handbook MIL-HDBK-52.

Gage identification is also extremely important. In addition to numbering every gage, color codes, labels and the like are frequently employed to give a quick visual indication of the gage's accuracy and the date this accuracy was last verified.

To effectively control this equipment, contractors should establish such things as gage-wear policies and keep accurate records on each piece of equipment. Obsolete or inaccurate equipment should be carefully segregated or discarded to prevent its use. When employee-owned testing and measuring equipment is used, it often is serviced by the

contractor's calibration system to assess and maintain its accuracy.

The limits of accuracy required for modern weaponry often are so narrow that contractors must calibrate testing and measuring equipment under controlled environmental conditions, usually at established calibration laboratories. Both industry and Government standards exist which describe the conditions to be maintained in these controlled laboratories.

C. CRITERIA FOR EVALUATION.

(1) Are the gages, testing and measuring equipment necessary to assure that products meet technical requirements available and used?

(2) Is this test and measuring equipment properly maintained?

(3) Are these devices inspected on a regular basis to determine that they are of the required accuracy?

(4) Is there continuous control of these devices to prevent their use when they become inaccurate, and to correct, repair or replace them?

(5) Does the program comply with MIL-C-45662A, "Calibration System Requirements"?

(6) Are the required certified measurement standards available and used?

(7) Is the certification of these standards traceable to the National Bureau of Standards that are recognized as absolute by the National Bureau of Standards?

(8) Does the contractor require his suppliers to have a system which assures the accuracy of their test and measuring equipment?

4.3 Production Tooling Used as Media of Inspection. When production jigs, fixtures, tooling masters, templates, patterns and such other devices are used as media of inspection, they shall be proved for accuracy prior to release for use. These devices shall be proved again for accuracy at intervals formally established in a manner to cause their timely adjustment, replacement or repair prior to becoming inaccurate.

A./B. REVIEW AND APPLICATION OF REQUIREMENT. Sometimes contractors elect to use production tooling for inspection and gaging. In such cases, they should take special precautions to assure accuracy. This involves both proof of accuracy before release for use as well as checking at regular, formally established intervals thereafter to prevent inaccuracy. Some equipment used for special manufacturing operations contains automatic gaging controls which are considered a part of a contractor's product quality control system.

The aforementioned practices are acceptable if carefully controlled and monitored to assure continued accuracy.

C. CRITERIA FOR EVALUATION.

(1) Is all tooling which is used as inspection equipment proved for accuracy prior to use?

(2) Is such tooling re-inspected at intervals established in a manner which assures the adjustment, replacement or repair of the tooling before it becomes inaccurate?

4.4 Use of Contractor's Inspection Equipment. The contractor's gages, measuring and testing devices shall be made available for use by the Government when required to determine conformance with contract requirements. If conditions warrant, contractor's personnel shall be made available for operation of such devices and for verification of their accuracy and condition.

A. REVIEW OF REQUIREMENT. The contractor is responsible for manufacturing acceptable products. To prove product acceptability, the contractor must have the capability, both in personnel and equipment, to measure, test and inspect. For technical and economic reasons, it frequently is desirable for Government and contractor personnel to jointly use contractor inspection equipment. Therefore, the contractor shall permit the Government to use such equipment, or to witness contractor use of this equipment, to verify inspection accuracy and product quality. However, if required, the contractor must supply operators for inspection equipment being used exclusively for Government verification.

B. APPLICATION. The Government normally does not provide its inspectors in the field with gages or measuring and testing devices. The more complex test equipment is so expensive or requires such special facilities that it would be highly uneconomical for the Government to provide it at all contractors' plants. Therefore, contractors make their testing and measuring equipment available to the Government. Sometimes it is necessary to have contractor personnel operate the more specialized equipment for required Government inspections.

In some instances Government use of contractor testing and measuring equipment proves to be a "bottle-neck" to production operations. Therefore, most contractors plan for the Government's use of their equipment and allow sufficient time and provide sufficient equipment so that any joint use does not delay production.

Many contractors choose to protect the performance of their complex and specialized equipment by offering to operate it for the Government. In some cases, however, the manner of operating such testing equipment can give false results. Under these conditions the Government QA Representative may wish to operate the equipment himself. When this occurs, the contractor may wish to instruct the Government QA Representative in the operation of the more specialized testing and measuring equipment.

Contractors rightfully expect Government QA Representatives to avoid unnecessary production delays because of Government inspection and testing. Thus Government QA Representatives sometimes accomplish their inspection by witnessing a company inspection rather than conducting a separate one. However, this is not always required and often is not practical or desirable.

C. CRITERIA FOR EVALUATION.

(1) Does the contractor make his inspection equipment or facilities available to the Government QA Representative for verification of the contractor's results?

(2) Does the contractor provide personnel to perform this inspection, if warranted?

4.5 Advanced Metrology Requirements. The quality program shall include timely identification and report to the Contracting Officer of any precision measurement need exceeding the known state of the art.

A. REVIEW OF REQUIREMENT. New and unprecedented military requirements may involve "breakthroughs" in technology. Sometimes it is possible to manufacture correctly functioning hardware without being able to make all of the necessary measurements. However, contractors are still obligated to make all of the measurements required by their contract. If the contractor finds he cannot do this because of a lack of technical know-how, equipment or other resources, he must advise his Contracting Officer at the earliest opportunity.

B. APPLICATION. In producing today's modern weapon systems contractors may be faced with precision measurement requirements beyond their ability to perform. Normally contractors attempt to meet such requirements by acquiring additional measuring capability.

However, contracts may require measurement capability that is beyond the state-of-the-art. Contractors who have their own precision measurement capability usually are familiar with the latest advances in metrology and quickly recognize, and question, any demand for such high orders of measurement. Conversely, producers who depend primarily on outside sources for precision measurements usually do not recognize excessive requirements as quickly. Regardless of knowledge and capability, however, every contractor is responsible for meeting stated contract measurement requirements. Therefore, if any contractual measurement requirement appears to be unrealistic or in advance of the state-of-the-art, contractors should press for a waiver or change of the measurement requirement.

Some contractors consider a measurement requirement to be in advance of the state-of-the-art only if not known to the science of measurement; other consider a requirement excessive if it cannot be met by industry. Uncertainties about any measurement re-

quirement should be cleared up before completion of negotiations and signing a contract. However, it is not always practicable. In any event, such problems should be resolved as soon as possible after they are recognized.

C. CRITERIA FOR EVALUATION.

(1) Has the contractor reviewed the request for proposal or contract to determine whether or not there are any unusual precision measurement requirements?

(2) Has the contractor notified the Contracting Officer of his inability to perform any required precision measurement?

5. CONTROL OF PURCHASES

5.1 Responsibility. The contractor is responsible for assuring that all supplies and services procured from his suppliers (subcontractors and vendors) conform to the contract requirements. The selection of sources and the nature and extent of control exercised by the contractor shall be dependent upon the type of supplies, his supplier's demonstrated capability to perform, and the quality evidence made available. To assure an adequate and economical control of such material, the contractor shall utilize to the fullest extent objective evidence of quality furnished by his suppliers. When the Government elects to perform inspection at a supplier's plant, such inspection shall not be used by contractors as evidence of effective control of quality by such suppliers. The inclusion of a product on the Qualified Products List only signifies that at one time the manufacturer made a product which met specification requirements. It does not relieve the contractor of his responsibility for furnishing supplies that meet all specification requirements or for the performance of specified inspections and tests for such material. The effectiveness and integrity of the control of quality by his suppliers shall be assessed and reviewed by the contractor at intervals consistent with the complexity and quantity of product. Inspection of products upon delivery to the contractor shall be used for assessment and review to the extent nec-

essary for adequate assurance of quality. Test reports, inspection records, certificates and other suitable evidence relating to the supplier's control of quality should be used in the contractor's assessment and review. The contractor's responsibility for the control of purchases includes the establishment of a procedure for (1) the selection of qualified suppliers, (2) the transmission of applicable design and quality requirements in the Government contracts and associated technical requirements, (3) the evaluation of the adequacy of procured items, and (4) effective provisions for early information feedback and correction of nonconformances.

A. REVIEW OF REQUIREMENT. It is not enough for a contractor to control the quality of parts which he makes in his own plant. He also is required by MIL-Q-9858A to assure control of the quality of parts furnished by his suppliers. Thus a contractor should choose subcontractors and vendors who can maintain adequate quality. Furthermore, a contractor must develop and use effective methods for communicating applicable Government requirements to his suppliers.

There are many ways to assure quality in purchased products. Selecting suppliers with a reputation for quality is a good start. Inspection at the supplier's plant, receiving inspection, examination of supplier test and inspection records and a variety of other techniques are used by contractors to select suppliers and assure control of their quality. Of course, contractor effort alone is inadequate—suppliers also must possess the motivation, knowledge, and capability to control quality.

For economic and technical reasons it is essential that contractors make full use of supplier inspection records and test reports as well as all other kinds of accurate quality data. This data must be used for demonstrating that suppliers adequately control quality. Definite documented procedures also must be issued and maintained.

Contractors must not depend upon Government inspection at their suppliers' plants; instead, they must generate their own knowledge and control of supplier quality. How

often a contractor will assess a supplier's quality control depends upon the nature and volume of his purchases from that supplier. In addition, to the degree necessary and possible, receiving inspection should be used to determine the quality of purchases. Further, contractors should establish criteria or standards for qualifying suppliers and avoid suppliers who do not meet the qualifications. Of course, the best evidence of supplier quality comes from the contractor's continuing evaluation of the hardware and services delivered to him by his sources. Any deficiencies which become known to the contractor should be made known immediately to his suppliers and corrected by them.

B. APPLICATION. The completeness with which a contractor controls his purchases determines in large measure the success of this phase of his quality program. For instance, even purchases for research and development usually are rigidly controlled by the purchasing system and subjected to appropriate laboratory analyses and suitable receiving inspections.

Contractors following accepted business practices already comply to a great extent with Paragraph 5 of MIL-Q-9858A. In choosing their suppliers, contractors follow the same practice that the Government follows in choosing between qualified competitors: they award the business to the lowest responsible bidder.

Various methods are used by contractors to assure adequate supplier control of quality. A few of the most frequently used are:

- (a) Contractor evaluation of supplier past performance for the type of purchases involved (vendor rating).
- (b) Contractor inspection at subcontractors' and vendors' plants.
- (c) Review of suppliers' test and inspection records.
- (d) Receiving inspection of suppliers' products.

Subcontracts and purchase orders of many contractors require suppliers to maintain quality records such as inspection and test results. The contractor also may require information about inspections and tests made

by the supplier during manufacturing—actions which the contractor cannot duplicate. Often the contractor will require delivery of such records along with the material they cover. When such records accompany shipments, the contractor knows more about the quality of his purchases. He can use this knowledge to advantage in calculating how much his receiving inspection and laboratory testing can be reduced without impairing quality.

An open, active, comprehensive flow of quality information from supplier to contractor can significantly reduce a contractor's costs. Suppliers who provide such information should have a distinct competitive advantage over suppliers who do not.

Contractors increasingly recognize that they must not depend on Government inspection at subcontractors and vendors. Since they alone are responsible for assuring suppliers' quality, no purpose is served by involving the Government in subcontractor or vendor inspection.

It is the DoD policy to refrain from entering directly into the quality and inspection aspects of contractor-supplier relationships. Neither contractor nor supplier should expect the DoD to take responsibility for establishing any aspect of their quality relationships. Contractor surveys of suppliers are a prime example of a relationship which does not directly involve DoD quality assurance functions.

In defense industries, the relationships between contractors and suppliers consist mainly of practices intended to meet the objectives and requirements of the contractors' contract with DoD. The form of these practices ordinarily is not specified. For instance, MIL-Q-9858A requires a contractor to review the suitability of each supplier's quality efforts, but does not specify the details of the review. The contractor may choose to use liaison inspectors at a supplier's plant as a review method. He may decide that surveys are more appropriate. Independent laboratory inspection may be his choice. Some contractors prefer disassembly and teardown audit inspections. These prac-

tices usually are coupled with a review of each supplier's quality program and inspection system documentation. Regardless, and even though the manner of review is unspecified, the review itself is a mandatory requirement.

Contractors sometimes fail to carry out their responsibility for qualified products. If a supplier is producing an item which requires qualification testing and listing on a Qualified Products List (QPL), the contractor is responsible for assuring that the supplier meets all of these requirements. Other forms of qualification also must be properly covered by the purchasing system. Preproduction testing, reliability life testing, aircraft engine part substantiation testing, and a variety of other special qualifications are examples of contractor responsibilities which must be met through appropriate control of purchases.

Receiving inspection is an essential element of a complete purchasing system. However, technology and economy usually limit the extent of such inspection. Receiving inspection can be minimized by obtaining optimum control of quality at the source. Receiving inspection should complement and supplement source quality control, rather than ignore or duplicate it unnecessarily.

C. CRITERIA FOR EVALUATION.

(1) Does the program assure that products and services furnished by suppliers meet contract requirements?

(2) Does the program provide for the selection of suppliers on the basis of their ability to perform satisfactorily as well as evidence of their capability to produce quality products?

(3) Is objective quality evidence provided by the supplier and is it used to assure effective and economical control of quality?

(4) Does the contractor refrain from using Government source inspection for control of his suppliers?

(5) Does the contractor review his suppliers' quality efforts at intervals consistent

with the complexity and quality of the product?

(6) Does the contractor have complete and effective control of all qualified products, including those of his suppliers?

(7) Does the program provide for sufficient receiving inspection of all supplies and services furnished to the contractor?

(8) Are there adequate procedures for source selection?

(9) Are there adequate procedures for communicating requirements to suppliers?

(10) Are there adequate procedures for evaluating the quality of deliveries?

(11) Are there adequate procedures for providing suppliers with appropriate data regarding unsatisfactory quality?

(12) Are there adequate procedures for assuring that suppliers correct all nonconformances?

5.2 Purchasing Data. The contractor's quality program shall not be acceptable to the Government unless the contractor requires of his subcontractors a quality effort achieving control of the quality of the services and supplies which they provide. The contractor shall assure that all applicable requirements are properly included or referenced in all purchase orders for products ultimately to apply on a Government contract. The purchase order shall contain a complete description of the supplies ordered including, by statement or reference, all applicable requirements for manufacturing, inspecting, testing, packaging, and any requirements for Government or contractor inspections, qualification or approvals. Technical requirements of the following nature must be included by statement or reference as a part of the required clear description: all pertinent drawings, engineering change orders, specifications (including inspection system or quality program requirements); reliability, safety, weight, or other special requirements, unusual test or inspection procedures or equipment and any special revision or model identification. The description of products ordered shall include a requirement for contractor inspection at the sub-

contractor or vendor source when such action is necessary to assure that the contractor's quality program effectively implements the contractor's responsibility for complete assurance of product quality. Requirements shall be included for chemical and physical testing and recording in connection with the purchase of raw materials by his suppliers. The purchase orders must also contain a requirement for such suppliers to notify and obtain approval from the contractor of changes in design of the products. Necessary instructions should be provided when provision is made for direct shipment from the subcontractor to Government activities.

A. REVIEW OF REQUIREMENT. MIL-Q-9858A states that a contractor's quality program is not complete, therefore not acceptable, unless it requires suppliers to have effective control of quality. Suppliers usually devise whatever systems they wish. Sometimes, however, suppliers must design their systems to meet specific contractor requirements.

The Government does not directly specify technical requirements for a contractor's suppliers, but may do so indirectly through specifications in the prime contract which apply to items whether produced by the contractor or his suppliers. Contractors must include such contractual and technical requirements in the subcontracts and purchase orders given to their suppliers. Other information often is needed, and sometimes may be provided by using standard reference documents and standard contract clauses. In addition to drawings, specifications, engineering change identifications and testing requirements, less common requirements such as those for quality control procedures and inspections at the supplier's plant often must be included in subcontracts and purchase orders. A requirement for contractor approval before making significant design changes must be included, as should any special shipping instructions covering direct delivery by the supplier to the Government.

B. APPLICATION. MIL-Q-9858A and MIL-I-45208A require contractors to have effective control of product quality. Those specifica-

tions, H-51 and this handbook are the vehicles for informing contractor and Government personnel of the over-all Government requirements for quality. However, the specifications and handbooks are of little use if a contract does not include all of the design, manufacturing and testing requirements for the specific product involved. Both the general rules for quality and the specific quality characteristics of the product are essential for Government purchasing from contractors and contractor purchasing from suppliers.

The purchaser should tell the seller exactly what he wishes to buy; that is, the quality characteristics, dimensions, design, materials, performance and all other technical features of the product being purchased. Ordinarily, the purchase order and accompanying drawings do this. Sometimes, however, the technical requirements are better known by the seller, and the purchaser wishes to obtain them along with the product, if feasible.

In any case, contractor purchasing control must provide the complete technical detail required to assure the correct manufacture and proper performance of every item purchased.

Many contractors include standard clauses ("boiler plate" or "fine print") on the bottom or reverse side of their purchase order forms. Sometimes standard flyers or even supplements several pages in length are added to each purchase order. These standard clauses in essence are the contractor's general rules for suppliers. They do not vary appreciably from item to item or order to order.

Most contractors use either standard clauses or a separate purchase order entry to tell their suppliers what type of quality program, inspection system or inspection is required. For standard commercial items few if any of the specific requirements of MIL-Q-9858A or MIL-I-45208A are included in the purchase order. Nevertheless, the contractor is responsible for the quality and suitability of all purchases incorporated into products he sells to the Government. Though his knowledge of vendor effective-

ness may be small and difficult to obtain, the contractor's responsibility is undiminished.

For some purchases, the DoD requires the contractor to include on the purchase order a requirement for Government subcontract inspection. Government QA Representatives indicate when such action is necessary and how it shall be done. However, since routine DoD subcontract inspection is no longer authorized, careful cooperation between contractor and Government QA Representatives is more necessary than ever for efficient operation of the contractor's purchasing system. For example, it is highly desirable for Government QA Representatives to advise the contractor in detail about any Government subcontract inspection plans as early in the procurement process as possible, so that the contractor can adjust his purchasing activities accordingly.

Sometimes purchasing control breaks down because a contractor fails to provide his supplier with adequate requirements for the selection and testing of the raw materials used to make the purchased products. This occurs more frequently with vendor than with subcontractor items.

Several classes of changes can apply to purchased material. Generally, any major change in the design or material of a purchased item is not permitted without the contractor's approval. Insignificant changes not affecting form, fit or function may be permitted without prior approval, but only under certain conditions, and almost always subject to the contractor's review. Regardless, all contractual requirements for the control of changes must be followed exactly.

C. CRITERIA FOR EVALUATION.

(1) Does the contractor require his suppliers to have effective control of product quality?

(2) Do the contractors' purchasing documents contain all of an item's specific design, manufacturing and testing requirements?

(3) Do purchasing documents also contain all other routine and special requirements, e.g., routine manufacturing, inspecting, test-

ing and packaging requirements; or quality system, direct shipment or other such special requirements?

(4) Do purchasing documents provide for prime contractor and/or Government source inspection when appropriate?

(5) Are requirements for necessary tests and inspections of raw materials specified in purchasing documents?

(6) Is complete and appropriate control of design changes required of all suppliers?

(7) Are the necessary instructions provided for any required direct shipments from subcontractors' or vendors' plants to the Government?

6. MANUFACTURING CONTROL

6.1 Materials and Materials Control. Supplier's materials and products shall be subjected to inspection upon receipt to the extent necessary to assure conformance to technical requirements. Receiving inspection may be adjusted upon the basis of the quality assurance program exercised by suppliers. Evidence of the suppliers' satisfactory control of quality may be used to adjust the amount and kind of receiving inspection.

The quality program shall assure that raw materials to be used in fabrication or processing of products conform to the applicable physical, chemical, and other technical requirements. Laboratory testing shall be employed as necessary. Suppliers shall be required by the contractors' quality program to exercise equivalent control of the raw materials utilized in the production of the parts and items which they supply to the contractor. Raw material awaiting testing must be separately identified or segregated from already tested and approved material but can be released for initial production, providing that identification and control is maintained. Material tested and approved must be kept identified until such time as its identity is necessarily obliterated by processing. Controls will be established to prevent the inadvertent use of material failing to pass tests.

A. REVIEW OF REQUIREMENT. Contractor receiving inspection is considered essential for

effective control of the quality of purchased supplies. However, the amount and extent of receiving inspection varies. If a supplier has effective quality control, the contractor can safely reduce his receiving inspection. It should be apparent, however, that a contractor's knowledge of supplier quality stems primarily from proven performance and the records the supplier furnishes.

Raw material quality must be adequately controlled, frequently by acceptance testing in the laboratory. Tested and approved materials must not be mixed with untested or rejected materials. Methods for identifying tested, approved material and untested or disapproved material, plus effective controls for keeping them separated, are required and must extend as far as possible into the production sequence.

B. APPLICATION. Though contractor assembly or processing of some incoming items automatically provides at least a partial inspection, many contractors have receiving departments which directly and routinely inspect incoming material. The extent, of course, to which this is done depends on the availability of inspection equipment and personnel as well as on the degree to which an incoming product has been assembled.

A basic prerequisite of efficient receiving inspection is complete identification of each incoming item plus full knowledge of the requirements for the item, its quality history and its intended use. Thus, receiving departments usually have complete copies of all purchase orders and pertinent specifications. In addition, most inspectors have ready access to contractor and Government libraries and to files of industry and military specifications and standards. Copies of pertinent drawings often are located in receiving departments or can be requisitioned by these departments.

Supplier test results accompanying each shipment can permit contractors to substitute sample testing for 100% testing. The better a contractor's knowledge of supplier inspection systems or quality programs, the more accurate his adjustments of receiving inspection. The use of traveling inspectors

who check the inspection activity of suppliers can help contractors establish economical and effective control of the quality of incoming material.

Contractors usually detect flaws in raw materials by appropriate laboratory tests. Because the mechanical properties and composition of metals, the chemical composition of fluids, and the physical and chemical properties of a host of other raw materials usually cannot be determined once manufacturing or processing begins, most contractors analyze and test raw materials as soon as possible after receipt.

An important responsibility of contractors is the identification and segregation of material. Identifying stocks of raw material and keeping untested, uninspected material separate from that already tested must be done very carefully—the inadvertent release to production of wrong or defective raw material can be disastrous.

C. CRITERIA FOR EVALUATION.

(1) Does the contractor inspect suppliers' material to the extent necessary upon receipt?

(2) Does the contractor adjust the extent of receiving inspection on the basis of objective data?

(3) Does the contractor assure that raw materials conform to the applicable physical, chemical and other technical requirements, using laboratory analyses as necessary?

(4) Does the contractor require his suppliers to exercise an equivalent control of raw materials ((3) above)?

(5) Are tested, approved raw materials identified and carefully segregated from those not tested or approved?

(6) Does the contractor have effective controls for preventing the use of nonconforming raw materials?

6.2 Production Processing and Fabrication. The contractor's quality program must assure that all machining, wiring, batching, shaping and all basic production operations of any type together with all processing and fabricating of any type is accomplished un-

der controlled conditions. Controlled conditions include documented work instructions, adequate production equipment, and any special working environment. Documented work instructions are considered to be the criteria for much of the production, processing and fabrication work. These instructions are the criteria for acceptable or unacceptable "workmanship". The quality program will effectively monitor the issuance of and compliance with all of these work instructions.

Physical examination, measurement or tests of the material or products processed is necessary for each work operation and must also be conducted under controlled conditions. If physical inspection of processed material is impossible or disadvantageous, indirect control by monitoring processing methods, equipment and personnel shall be provided. Both physical inspection and process monitoring shall be provided when control is inadequate without both, or when contract or specification requires both.

Inspection and monitoring of processed material or products shall be accomplished in any suitable systematic manner selected by the contractor. Methods of inspection and monitoring shall be corrected any time their unsuitability with reasonable evidence is demonstrated. Adherence to selected methods for inspection and monitoring shall be complete and continuous. Corrective measures shall be taken when noncompliance occurs.

Inspection by machine operators, automated inspection gages, moving line or lot sampling, setup or first piece approval, production line inspection station, inspection or test department, roving inspectors—any other type of inspection—shall be employed in any combination desired by the contractor which will adequately and efficiently protect product quality and the integrity of processing.

Criteria for approval and rejection shall be provided for all inspection of product and monitoring of methods, equipment, and personnel. Means for identifying approved and rejected product shall be provided.

Certain chemical, metallurgical, biological, sonic, electronic, and radiological processes are of so complex and specialized a nature

that much more than the ordinary detailing of work documentation is required. In effect, such processing may require an entire work specification as contrasted with the normal work operation instructions established in normal plant-wide standard production control issuances such as job operation routing books and the like. For these special processes, the contractors' quality program shall assure that the process control procedures or specifications are adequate and that processing environments and the certifying, inspection, authorization and monitoring of such processes to the special degree necessary for these ultraprecise and super-complex work functions are provided.

A. REVIEW OF REQUIREMENT. As part of a contractor's quality program, production and manufacturing operations must be systematically controlled and documented in appropriate work instructions. Only the manner of doing the work specified in these instructions, without deviation, is acceptable. As drawings indicate the configuration, dimensions and special processes to be applied to work, other forms of work instructions establish the level of workmanship required. Systematic, controlled inspection is usually required for each work operation. The result of several work operations may be inspected at one time, if desired, after the work is completed.

When direct inspection of operations is impractical, equipment settings, operator performance and other conditions of manufacture are evaluated instead. Sometimes both direct and indirect inspection of work operations are required for technical or contractual reasons.

The manner of conducting inspections is at the option of the contractor unless a specific procedure is required by the contract either directly or by reference to specifications and standards. When an optional inspection method proves inaccurate or ineffective, it must be corrected.

Contractors should establish criteria for judging the effectiveness of their inspection efforts. This is often more difficult for proc-

ess inspection than for product inspection—nevertheless, it is required for both.

Highly complex or precise manufacturing processes ordinarily cannot be controlled by the usual sheet or card type work instruction. Comprehensive specifications must be prepared for such processes. A book-type specification often is needed to provide all the detailed instructions required to assure the success of special manufacturing processes, including effective inspection of the output. A contractor's quality program must provide the detailed data and tight control needed to implement these special processes satisfactorily.

B. APPLICATION. Producers of complex products are generally aware that production control must be highly disciplined to be effective. Omission of any operations or processes from control invites inferior quality. Ineffective, incomplete or intermittent control is almost as bad and usually leads to costly and unnecessary defects. Men, machines, materials and methods all require disciplined control. Most contractors recognize this fact and apply it to all of their production.

Adequate communication is indispensable to effective control. Contractors must tell production personnel exactly what is required of them. The contractor should communicate "what is needed," usually by means of drawings and specifications. "How to do it" must also be communicated, ordinarily through the medium of work instructions which contain more detailed information than drawings or specifications.

Many manufacturers include a variety of detailed information in work instructions. These usually are designed and issued by a production control department. A systematic approach is used in instructions to tell "how" to do the work. Machines, tools, rates, speeds and feeds, and the sequence of operations to be used are stated. Essential environmental conditions, such as cleanliness, temperature and humidity, and safety precautions and other pertinent features of the work also are specified.

Achievement of a single product characteristic may require many work operations.

For instance, degreasing, chemical cleaning, surface treatment, priming, and painting may all be necessary to achieve a desired painted surface. Work control in such a case calls for detailed instructions for operation and checking of every stage and type of work necessary to prepare and paint the item.

Even so-called basic work operations may be prone to defects. For example, in chemical cleaning, too short an immersion time may leave parts dirty, while too long a time can cause corrosion or erosion damage. In priming and painting, coverage can be spotty, with "holidays" or paint furrowing or "tear-dropping." Work instructions usually should include descriptions or references to samples of adequate and inadequate work, so that workers know what is acceptable and unacceptable. Blindly following prescribed instructions is not enough to guarantee acceptable results. The results must be examined critically and compared with satisfactory standard samples. Fortunately, this approach is almost universal in American industry; mass production has made it an economic necessity.

Other parts of this handbook discuss the monitoring and control applied to the work of design engineers and engineering change authorities to assure satisfactory, high quality engineering. Similarly, control and review is required of the activities of production or industrial engineers and their assistants who prepare work instructions.

The work involved in inspection is as important as that involved with manufacturing. Most manufacturing inspections are carried out in the producer's plant. Usually, contractors conduct inspections as soon as possible after each production operation in order to keep defective material from continuing on through the production process. This prevents the needless waste of expending labor and material on items which are already defective.

Sometimes direct inspection of hardware is impractical; or is inadequate without an inspection of the work operations and processes used to manufacture the hardware. For example, inspections of both the welding

process and the welded product often are necessary to assure that the product is of adequate quality. Similarly, it may be necessary to inspect the potting of an electronic component as well as the final potted product.

Some processes and work operations are highly complex. Heat treatment, chemical milling and x-ray inspection are good examples. Such processes may require detailed book-type specifications rather than one- or two-page work instructions. Many producers have well-organized systems for the preparation, issuance, and enforcement of such instructions. The instructions often are included as standard references in purchase orders placed with suppliers.

C. CRITERIA FOR EVALUATION.

(1) Are all production processes accomplished under controlled conditions?

(2) Does control include documented work instructions, adequate production equipment, and appropriate working environments?

(3) Do the work instructions provide criteria for determining whether production, processing and fabrication work is acceptable or unacceptable?

(4) Does the quality program monitor both the issuance of work instructions and compliance with them?

(5) Are physical examinations, measurements or tests of materials and products provided for each work operation?

(6) When direct inspection of material is not advisable, does the program provide for indirect control by the inspection of processes?

(7) Are both physical and process inspections used when either alone is inadequate, or when required by the contract?

(8) Is the inspection and monitoring of processed material accomplished systematically?

(9) Are unsuitable inspection or monitoring methods corrected promptly?

(10) Is conformance with documented inspection methods complete and continuous,

and are corrective measures taken when non-compliance occurs?

(11) Are approval and rejection criteria provided for all inspections and monitoring actions?

(12) Are approved and rejected products properly identified?

(13) For highly specialized and complex processes, does the quality program assure that appropriate, more detailed work instructions are provided?

(14) Does the quality program assure provision of the proper processing environment, as well as the necessary degree of certification, inspection, authorization and monitoring, for such specialized and complex processes?

6.3 Completed Item Inspection and Testing. The quality program shall assure that there is a system for final inspection and test of completed products. Such testing shall provide a measure of the overall quality of the completed product and shall be performed so that it simulates, to a sufficient degree, product end use and functioning. Such simulation frequently involves appropriate life and endurance tests and qualification testing. Final inspection and testing shall provide for reporting to designers any unusual difficulties, deficiencies or questionable conditions. When modifications, repairs or replacements are required after final inspection or testing, there shall be reinspection and retesting of any characteristics affected.

A. REVIEW OF REQUIREMENT. Even though inspections are made throughout the manufacturing process, Paragraph 6.3 requires final inspection and testing of completed items to give an over-all measure of each item's conformance to end product specifications. Sufficiently thorough testing must be done to assure that completed products will perform as intended during use. Life, environment, endurance, use and qualification tests may be required. Deficiencies or deviations from established design requirements shall be reported. When any inspected item is reworked, repaired or modified, it must be reinspected or retested.

B. APPLICATION. Many contractors attempt to design tests to simulate conditions of intended use of the product. Frequently, great effort is expended to make test environments similar to those expected to be encountered in use. One type of test that may approximate actual end use is endurance or life testing. This type of testing is intended to indicate whether a product which demonstrates satisfactory performance when new is likely to do so after prolonged use. Life testing generally is destructive and is therefore applied only to small samples.

Many problems are encountered in trying to simulate conditions encountered in actual use for testing purposes. Even when properly done, such testing may be very expensive. Inadequate testing, however, is more expensive: thus many contractors employ their best engineering and design talent for the planning of simulative tests. Many producers find that failure mode analysis is helpful in planning or improving final tests.

Contractors usually find that final testing is a useful source of information for improving both manufacturing methods and products.

C. CRITERIA FOR EVALUATION.

(1) Are completed items given a final inspection and test which indicates over-all quality?

(2) Does the final testing adequately simulate performance in use?

(3) Are inspection and test problems or deficiencies promptly reported to designers?

(4) Is there reinspection and retest of all items which are reworked, repaired, or modified, after initial end product testing?

6.4 Handling, Storage and Delivery. The quality program shall provide for adequate work and inspection instructions for handling, storage, preservation, packaging, and shipping to protect the quality of products and prevent damage, loss, deterioration, degradation, or substitution of products. With respect to handling, the quality program shall require and monitor the use of procedures to prevent handling damage to articles.

Handling procedures of this type include the use of special crates, boxes, containers, transportation vehicles and any other facilities for materials handling. Means shall be provided for any necessary protection against deterioration or damage to products in storage. Periodic inspection for the prevention and results of such deterioration or damage shall be provided. Products subject to deterioration or corrosion during fabrication or interim storage shall be cleaned and preserved by methods which will protect against such deterioration or corrosion. When necessary, packaging designing and packaging shall include means for accommodating and maintaining critical environments within packages, e.g., moisture content levels, gas pressure. The quality program shall assure that when such packaging environments must be maintained, packages are labeled to indicate this condition. The quality program shall monitor shipping work to assure that products shipped are accompanied with required shipping and technical documents and that compliance with Interstate Commerce Commission rules and other applicable shipping regulations is effected to assure safe arrival and identification at destination. In compliance with contractual requirements, the quality program shall include monitoring provisions for protection of the quality of products during transit.

A. REVIEW OF REQUIREMENT. Documented work instructions are necessary for both the operation and the inspection of the shipping function. The material handling aspect of shipping requires monitored work instructions. Methods used to clean, preserve, and protect items must be compatible with the intended use of the items, yet protect the items against damage or deterioration in storage. Special requirements, such as a controlled storage environment, must also be carefully devised, maintained, and monitored to assure full protection of quality. Labeling which clearly indicates special handling and storage requirements is imperative. Loading practices must conform with the requirements of common carriers and with specified Government (e.g., Interstate Commerce Commission,

U. S. Post Office) or industry regulations. Contractual requirements for the identification and movement of shipments must be met. The contractor's quality program must establish effective practices for protecting quality during shipping and must monitor compliance. In addition, all handling, storage, and delivery requirements must be covered by documented work instructions.

B. APPLICATION. Control of supplies during handling, storage, and delivery is a important aspect of satisfactory quality programs. Manufacturers and users of products which are subject to damage and deterioration when improperly handled and stored carefully plan their preservation, packaging, packing and storage efforts. They conduct regularly scheduled inspections of all stored material. In many cases, the date of manufacture or receipt of the material is marked on incoming materials so that they can be used in order of receipt and thus spend minimum time in storage.

Shipping and storage control departments usually develop documented work and inspection instructions for handling, storing, preserving, packaging, packing, marking, and shipping materials to prevent damage, loss, deterioration, substitution, degradation, or any other quality defects.

C. CRITERIA FOR EVALUATION.

(1) Are adequate work and inspection instructions prepared and implemented for the handling, storage and delivery of material?

(2) Are handling, storage and delivery procedures monitored in accordance with established quality program requirements?

(3) Are there procedures and regular schedules for the inspection of products in storage, and are these procedures adequate to prevent deterioration or damage?

(4) Is there a procedure to assure that items which can deteriorate or corrode during fabrication or interim storage are properly cleaned and preserved?

(5) Are all required critical environments maintained within packaging?

(6) Is all material to be stored or shipped properly identified and labeled?

(7) Are all shipments prepared and transported in compliance with contractual requirements and applicable Government and carrier regulations?

(8) Is quality protected and monitored during transit?

6.5 Nonconforming Material. The contractor shall establish and maintain an effective and positive system for controlling nonconforming material, including procedures for its identification, segregation, and disposition. Repair or rework of nonconforming material shall be in accordance with documented procedures acceptable to the Government. The acceptance of nonconforming supplies is a prerogative of and shall be as prescribed by the Government and may involve a monetary adjustment. All nonconforming supplies shall be positively identified to prevent unauthorized use, shipment and intermingling with conforming supplies. Holding areas or procedures mutually agreeable to the contractor and the Government Representative shall be provided by the contractor. The contractor shall make known to the Government upon request the data associated with the costs and losses in connection with scrap and with rework necessary to reprocess nonconforming material to make it conform completely.

A. REVIEW OF REQUIREMENT. Since most production processes inevitably yield some defective products, methods for preventing further regular processing, completion or delivery of such products are essential and must be established by the contractor. Segregation or disposal of defective products is also necessary. Effective segregation and disposal requires proper identification of the withheld, repaired, or unapproved status of defective products at all times prior to Government inspection approval. Segregation can be achieved by clearly marking defective material and removing it, when appropriate, from the production lines to special holding area. Defective material can be disposed by reworking, repairing or scrapping. The contractor is required to disclose scrapping and

rework costs and losses when requested to do so by the Government.

Sometimes superficially nonconforming items may be accepted by the Government, but always under controlled and prescribed conditions. If the degree of nonconformance is serious, a written waiver or contract change notice is necessary before such material can be accepted. In any situation involving Government acceptance of nonconforming material, the contractor shall follow the procedures prescribed or agreed to by the Government. A price reduction often is required to compensate for the Government's acceptance of items of a quality which does not conform completely to applicable specifications.

B. APPLICATION. When seeking Government acceptance of nonconforming material, a contractor must furnish the Government with all pertinent information about the material and its nonconformance so that the Government can render a decision on his request and determine if a price reduction is warranted.

It is generally recognized that the repetitive acceptance of nonconforming material degrades production efficiency. Ordinarily, the Government requires contractors to correct the causes of recurrent defects.

Most contractors voluntarily keep complete and accurate records of nonconforming supplies. Government inspectors responsible for accepting such supplies should insist on complete records. The exact nature and extent of each deficiency, as well as any repair or rework, must be recorded. The contractor and Government personnel responsible for assuring that the acceptance of any nonconforming product meets all contractual and other applicable requirements use such records extensively. The records kept by suppliers are carefully categorized and are referred to in connection with corrective action and future production of the items involved.

To preserve the benefits and prevent the ills caused by the acceptance of nonconforming supplies, most producers carefully analyze acceptance trends and attempt to improve their performance.

For repair or rework of nonconforming

supplies, contractors prepare all necessary work instructions, procedures and drawings. These must be documented to the Government's satisfaction. Welding of a defective casting is an example of a repair requiring appropriate documentation.

When a contract requires the establishment and maintenance of a Material Review Board for decisions regarding disposal of nonconforming supplies, the Government prescribes the composition of the Board and its related procedures. Even when not contractually required, some contractors use a material review committee on their own initiative. In these cases, the procedures used and the membership of the group are decided by the contractor but the Government requires that these procedures be documented.

C. CRITERIA FOR EVALUATION.

(1) Does the contractor have an effective system for controlling nonconforming material?

(2) Does the contractor properly identify, segregate and dispose of nonconforming material?

(3) Are the procedures for repair and rework of nonconforming material documented and acceptable to the Government?

(4) Are scrap and rework cost and loss data maintained and available to the Government for review?

(5) Do repair and rework activities comply with documented procedures?

(6) Are holding areas adequate for the detention and storage of nonconforming material?

6.6 Statistical Quality Control and Analysis. In addition to statistical methods required by the contract, statistical planning, analysis, tests and quality control procedures may be utilized whenever such procedures are suitable to maintain the required control of quality. Sampling plans may be used when tests are destructive, or when the records, inherent characteristics of the product or the noncritical application of the product, indicate that a reduction in inspection or testing can be achieved without jeopardizing quality. The contractor may employ sam-

pling inspection in accordance with applicable military standards and sampling plans (e.g., from MIL-STD-105, MIL-STD-414, or Handbooks H 106, 107 and 108). If the contractor uses other sampling plans, they shall be subject to review by the cognizant Government Representative. Any sampling plan used shall provide valid confidence and quality levels.

A. REVIEW OF REQUIREMENT. In addition to any statistical quality control techniques required by a contract, contractors may use such other statistical quality control techniques they wish as long as the techniques assure the required control of quality.

Sampling inspection has proven very useful, especially for destructive testing or for non-critical tests, where a reduction in inspection will not jeopardize required quality. Sometimes the sampling plans used are those contained in military standards or handbooks. Other sampling plans may also be used, but are subject to Government review. However, any sampling technique used must assure required quality with appropriate confidence.

B. APPLICATION. Two of the most frequently used types of sampling plans are "attributes sampling" and "variables sampling." Attributes sampling is used to inspect items on a good/no good basis; how good or how bad is not determined. An example of this type of sampling is the use of "go" and "no go" gages. Variables sampling determines how good or bad an item is by making and analyzing actual measurements. This method is used if the nature of the product warrants it. With variables sampling, fewer observations are necessary for a given degree of assurance.

Statistical process control or control sampling is used to determine whether a process is in or out of control. Machine control and heat treating control are examples of this method. Statistical process control procedures permit contractors to determine and analyze the causes of significant variations in manufacturing operations.

Some contractors find it advantageous to design their own sampling plans. Usually a

qualified mathematician or statistician develops such plans to assure that they are valid and effective. The Government must have such assurance; thus MIL-Q-9858A requires that the derivation, confidence level, protection and all other features of contractor-designed sampling be made known to the responsible Government authority upon request.

Prudent contractors guard against two great dangers to effective sampling: inadequate knowledge and improper use. They make certain they know completely the limitation and protection afforded by all sampling plans used. They also enforce to the letter all of the conditions, such as population size, sample randomness, homogeneity, order and ranking, which are required to assure effective sampling.

Contractors often find it difficult to perform sampling in accordance with all required conditions. Sometimes supposed shortcuts are used through ignorance or a false sense of economy. It is most important to note that invalid sampling is worse than cursory inspection because it may indicate a level of product quality which does not exist in fact.

C. CRITERIA FOR EVALUATION.

(1) Are contractor-designed sampling plans available for review by the Government Representative?

(2) Do contractor-developed sampling plans provide valid confidence and quality levels?

(3) Does the contractor know the degree of protection afforded by his sampling and does he enforce all of the conditions required for its valid use?

6.7 Indication of Inspection Status. The contractor shall maintain a positive system for identifying the inspection status of products. Identification may be accomplished by means of stamps, tags, routing cards, move tickets, tote box cards or other normal control devices. Such controls shall be of a design distinctly different from Government inspection identification.

A. REVIEW OF REQUIREMENT. There must be a positive way of knowing at all times whether a product has (1) not been inspected, (2) been inspected and approved or (3) been inspected and rejected. These conditions can be identified in a variety of ways. In the absence of a contractual requirement, MIL-Q-9858A permits contractors to select any method for indicating inspection status, provided only that it cannot be mistaken for Government identification.

B. APPLICATION. Many manufacturers engaged solely in commercial production maintain a system for positive identification of inspection status. When such manufacturers become Government contractors, they need not change their method of identification unless it can be mistaken for that of the Government.

Most contractors prefer inspection stamps to other identification methods, both because of their permanence and because they can applied directly to products. Material handlers know what to do with parts by the presence or absence of inspection stamps and, of course, by the nature of the stamp. Stamping also simplifies required part segregation.

In addition to showing inspection status, stamps are sometimes used to indicate completion of a work operation or process, or a requirement for special handling. Examples are stamps indicating the completion of heat treatment, or stamps assigning a part to the Material Review Board for action.

Some contractors find serially numbered stamps assigned on an individual basis useful in achieving better quality control because they identify each inspector's work. Other suppliers do not. The DoD no longer makes general use of numbered stamps for inspection purposes.

C. CRITERIA FOR EVALUATION.

(1) Does the contractor have an effective system for identifying the inspection status of products?

(2) Is the contractor's inspection status identification distinctly different from that of the Government?

7. COORDINATED GOVERNMENT/CONTRACTOR ACTIONS

7.1 Government Inspection at Subcontractor or Vendor Facilities. The Government reserves the right to inspect at source supplies or services not manufactured or performed with the contractor's facility. Government inspection shall not constitute acceptance; nor shall it in any way replace contractor inspection or otherwise relieve the contractor of his responsibility to furnish an acceptable end item. The purpose of this inspection is to assist the Government Representative at the contractor's facility to determine the conformance of supplies or services with contract requirements. Such inspection can only be requested by or under authorization of the Government Representative. When Government inspection is required, the contractor shall add to his purchasing document the following statement:

"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."

When, under authorization of the Government Representative, copies of the purchasing document are to be furnished directly by the subcontractor or vendor to the Government Representative at his facility rather than through Government channels, the contractor shall add to his purchasing document a statement substantially as follows:

"On receipt of this order, promptly furnish a copy to the Government Representative who normally services your plant, or if none, to the nearest Army, Navy, Air Force, or Defense Supply Agency inspection office. In the event the representative or office cannot be located, our purchasing agent should be notified immediately."

All documents and referenced data for purchases applying to a Government contract

shall be available for review by the Government Representative to determine compliance with the requirements for the control of such purchases. Copies of purchasing documents required for Government purposes shall be furnished in accordance with the instructions of the Government Representative. The contractor shall make available to the Government Representative reports of any nonconformance found on Government source inspected supplies and shall (when requested) require the supplier to coordinate with his Government Representative on corrective action.

A. REVIEW OF REQUIREMENT. A contractor is solely and exclusively responsible for the quality of all material he delivers to the Government regardless of the source of the product. Therefore, though the Government may conduct inspections at suppliers' plants, the prime contractor's responsibility remains unchanged.

Only the Government Representative can authorize Government inspection at suppliers' facilities. When such inspection is required, MIL-Q-9858A provides appropriate clauses for the contractor to use in his purchase documents.

Contractors must make all purchase orders or subcontracts for materials used in fulfillment of Government contracts available to the Government Representative for review. In addition, reports on any defective Government inspected material received must be made available to the Government Representative.

B. APPLICATION. In the past, Government source inspection was routinely designated using lists of items. Recent DoD subcontract inspection policy renders such lists obsolete and forbids routine requests.

Many contractors who have had experience with current DoD policy encourage the Government Representative to request source inspection as early in the purchasing cycle as possible. This gives the Government Representative time to review thoroughly the technical requirements contained in the purchase order. It also permits him to assess the quality history of all material to be source-

inspected. This permits the Government Representative to include the specific characteristics of each item to be inspected on source-inspection requests.

Such reviews assure that the contractor and the Government clearly understand which items will be source-inspected. The reviews also assure that the contractor, his suppliers and the Government Representatives fully understand the purpose, authority and degree of inspection the Government will perform. The extent of Government source-inspection, of course, is limited to that specified in the purchasing documents covering suppliers' items.

C. CRITERIA FOR EVALUATION.

(1) Do contractor purchasing documents require Government source-inspection of suppliers only when the Government so requests?

(2) Does the contractor use the clauses of Paragraph 7.1 of MIL-Q-9858A in his purchasing documents when source-inspection is required?

(3) Are copies of applicable purchasing documents provided to the Government Representative at suppliers' plants?

7.2 Government Property.

7.2.1 Government-furnished Material. When material is furnished by the Government, the contractor's procedures shall include at least the following:

(a) Examination upon receipt, consistent with practicability to detect damage in transit;

(b) Inspection for completeness and proper type;

(c) Periodic inspection and precautions to assure adequate storage conditions and to guard against damage from handling and deterioration during storage;

(d) Functional testing, either prior to or after installation, or both, as required by contract to determine satisfactory operation;

(e) Identification and protection from improper use or disposition; and

(f) Verification of quantity.

7.2.2 Damaged Government-furnished Material. The contractor shall report to the Government Representative any Government-furnished material found damaged, malfunctioning, or otherwise unsuitable for use. In the event of damage or malfunctioning during or after installation, the contractor shall determine and record probable cause and necessity for withholding material from use.

7.2.3. Bailed Property. The contractor shall, as required by the terms of the Bailment Agreement, establish procedures for the adequate storage, maintenance and inspection of bailed Government property. Records of all inspections and maintenance performed on bailed property shall be maintained. These procedures and records shall be subject to review by the Government Representative.

A./B. REVIEW AND APPLICATION OF REQUIREMENT. "Government Furnished Material" (GFM) is material owned by the Government and furnished directly to contractors for their use in meeting the requirements of their contracts. This material usually is similar in nature to the material contractors obtain from suppliers; that is, material which is incorporated into the products to be delivered to the Government by the contractor. Production, maintenance or service contracts can include provisions for GFM. Unless otherwise stated, GFM is acceptable as tendered and therefore does not require extensive receiving inspection. However, to avoid using or installing any GFM which is defective because of shipping damage or other reasons, contractors are required to maintain suitable quality control over GFM. This control normally shall include:

(a) Examination of GFM upon receipt to detect any shipping damage. This usually will be limited to visual inspection. In most cases, disassembly or testing is neither required nor desirable.

(b) Inspection to make certain that the GFM is of the correct type and is complete.

(c) Periodic inspection during storage to detect any signs of deterioration; to assure

compliance with reinspection requirements and limitations on time in storage; to assure maintenance of proper conditions; and to determine the current status of the GFM.

(d) Functional testing before or after installation, or both, as required by the contract and applicable specifications. Only qualified personnel may perform such tests.

(e) Appropriate identification and safeguarding of the GFM to prevent any unwarranted use or improper disposal.

(f) Examination to verify the quantity received.

Contractors must report all unsuitable GFM to the authorized Government Representative. If unsuitability is found during or after installation, the contractor must determine the probable cause and determine if it is necessary to avoid use of the material. This information shall be reported to the Government Representative.

Bailed Property refers primarily to equipment provided to the contractor for a special purpose and not for incorporation into deliverable products. Machine tools and production equipment are examples. The appropriate contract clauses or bailment agreement require the contractor to take proper care of such bailed property. The contractor must provide storage facilities and protective measures for bailed property, consistent with its nature, value, and use. At a minimum, the contractor's quality program must assure the following for all bailed property:

(a) Performance of an initial inspection immediately upon receipt, to detect any shipping or other damage and to determine that the equipment is complete and of the proper type,

(b) Maintenance of suitable records of initial and periodic inspection,

(c) Provision of adequate storage facilities and protective measures, and

(d) Maintenance of the property in good repair and condition.

The contractor's quality program procedures for the storage, maintenance, and inspection of bailed property are subject to review by the Government Representative.

C. CRITERIA FOR EVALUATION.

(1) Does the contractor examine GFM upon receipt for damage, quantity, completeness, and type?

(2) Are there precautions and inspections during storage against damage and deterioration?

(3) Is functional testing performed before or after installation, or both, as required by the specification or contract?

(4) Is all GFM properly identified and protected from unauthorized use or disposition?

(5) Does the contractor record and report to the Government any damage, malfunction, or deterioration of GFM prior to, during, and after installation?

(6) Does the contractor adequately store and maintain bailed property?

(7) Does the contractor inspect bailed property periodically?

(8) Are records of all inspections and maintenance work on bailed property maintained and available for review by the Government Representative?

8. NOTES

(The following information is provided solely for guidance in using this specification. It has no contractual significance.)

8.1 Intended Use. This specification will apply to complex supplies, components, equipments and systems for which the requirements of MIL-I-45208 are inadequate to provide needed quality assurance. In such cases, total conformance to contract requirements cannot be obtained effectively and economically solely by controlling inspection and testing. Therefore, it is essential to control work operations and manufacturing processes as well as inspections and tests. The purpose of this control is not only to

assure that particular units of hardware conform to contractual requirements, but also to assure interface compatibility among these units of hardware when they collectively comprise major equipments, sub-systems and systems.

Paragraph 8 of MIL-Q-9858A is, in essence, a summary of this handbook's discussion of Section 1 of the specification. Two points of that discussion bear repeating:

1. The contract and only the contract states which specification—MIL-Q-9858A or MIL-I-45208A—must be followed by the contractor as a minimum.

2. MIL-Q-9858A is intended primarily for the manufacture of complex equipment; MIL-I-45208A primarily for simple items.

8.2 Exemptions. This specification will not be applicable to types of supplies for which MIL-I-45208 applies. The following do not normally require the application of this specification:

(a) Personal services, and

(b) Research and development studies of a theoretical nature which do not require fabrication of articles.

A./B. REVIEW AND APPLICATION OF REQUIREMENT. Three classes of contracts are exempted from the application of MIL-Q-9858A. They are contracts for which specification MIL-I-45208A is sufficient, contracts for personal services, and contracts for research studies. Of course, small purchases which do not require even application of MIL-I-45208A will certainly not involve application of MIL-Q-9858A.

8.3 Order Data. Procurement documents should specify the title, number and date of this specification.

The above paragraph of MIL-Q-9858A is self-explanatory and no additional coverage is required.