Single Manager for Conventional Ammunition (SMCA)

Review Guide

Measurement System Evaluation (MSE) Requirements

http://www.pica.army.mil/PicatinnyPublic/organizations/ardec/orgchart/quality.html

30 June 2014

MSE Review Guide
FOR REFERENCE & GUIDANCE PURPOSES ONLY

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An MSE Review Guide is available to assist Contractors on the ARDEC Public Website in the application of the MSE Clause. The MSE Review Guide's content, in its entirety, is provided solely for REFERENCE and GUIDANCE PURPOSES ONLY - it is not, nor is it intended to be, contractually binding. Accordingly, the information contained within the MSE Review Guide is expressly not, nor shall it be construed to be, incorporated either directly or by reference into the terms of the MSE Clause itself nor into the terms and conditions of any underlying contract which contains the MSE Clause.

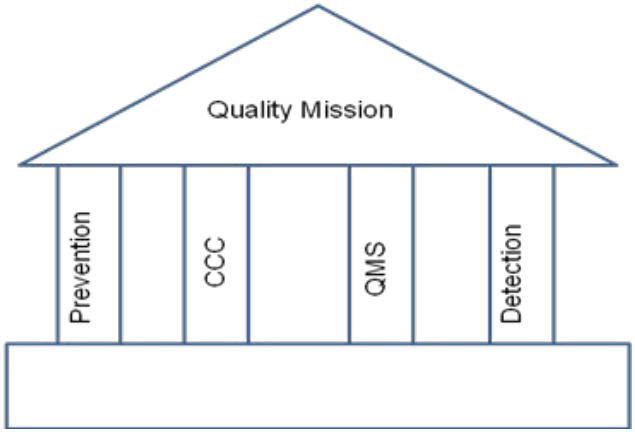
Background

The Measurement System Evaluation (MSE) clause was developed by the Single Manager for Conventional Ammunition (SMCA) and Military Services as a tool for use in ammunition acquisition and, when applicable, in conjunction with other supplier quality requirements.

MSE was established to replace the three current Acceptance Inspection Equipment (AIE) clauses:

1. Army/Joint Munitions Command
2. Navy/Air Force/Joint Munitions Command
3. ARDEC

The MSE clause was designed with continuous improvement in mind to complement the four pillars of supplier quality which are:



- Prevention – Process Capability, Control & Improvement (PCCI)
- Critical Characteristic Control (CCC) – Detection, prevention & continuous improvement for safety critical characteristics
- Quality Management System (QMS) – Framework for continuous improvement
- Detection – Measurement System Evaluation (MSE)

The MSE clause does not create any new AIE requirements but serves to highlight and emphasize requirements that have been in existence in Technical Data Packages and contracts all along. AIE requirements have been spread out across a variety of different documents such as MIL-A-70625A (*Automated Acceptance Inspection Equipment Design, Testing and Approval of,* 21 April

1989), MIL-A-48078A (*Ammunition Standard Quality Assurance Provisions, General Specifications For*, dated 16 December 1988), and the Critical Characteristics Clause. The MSE clause, along with its corresponding MSE Contract Data Requirements List (CDRL), Measurement System Analysis (MSA) CDRL, MSE Data Item Description (DID), and MSE Review Guide consolidates all AIE requirements into one location.

Other areas of MSE, such as calibration systems, MSA, and use of process control systems for acceptance of product are also addressed. The MSE clause and associated information seek to utilize best industry practices for:

1. Prove-out methodologies/requirements pertaining to AIE, Automated Acceptance Inspection Equipment (AAIE), and Process Control Systems.
2. DID, CDRLs, and review guide that provide clarity to contractors on AIE submissions and the Government on how to review those submissions, within the associated time lines.
3. Applicability of MSE requirements to Performance Based or Commercial Off-the-Shelf (COTS) acquisition.
4. Appropriate references to latest commercial industry standards.
5. Storage, handling, and environmental conditions associated with inspection systems.
6. Government Furnished Equipment (GFE) requirements from Navy/Air Force/JMC clause.

Requirements that adequately address modern measurement systems for inspection (and process control when used for acceptance), and a robust methodology to evaluate these systems is projected to enhance the reliability for acceptance of conforming product. Consequently, there will a smoother review and approval process for AIE submissions due to improved synchronization between Government and contractor expectations. The guide will assist personnel responsible for interpreting and executing the requirements of the contract.

To reiterate, MSE requirements are intended to be uniform, integrated requirements for the SMCA or other procuring agencies to aid suppliers in accomplishing their AIE work while encouraging them to utilize commercial best practices. The MSE clause supports and reinforces the expectations of MIL-A-70625A and MIL-STD-1916 *(DOD Preferred Method For Acceptance Of Product, paragraph 4.4,* 1 April 1996).

Introduction

The purpose of this Review Guide is to assist personnel involved in the review, design, or selection of AIE utilized for inspection of characteristics identified in Government Technical Data Packages (TDPs).

The MSE Review Guide is meant to be an aid for:

- Applying the MSE clause.
- Developing AIE submissions.
- Reviewing AIE submissions.

The document is formatted in a fashion where a clause paragraph is followed by a discussion of what is intended by the paragraph and what should be contained in an AIE submission to address that particular clause requirement. Paragraphs of the clause are included in the review guide but are not substitutes for the actual requirements included in a solicitation, purchase order or contract.

There are a variety of approaches/methods/tools that can be utilized to comply with requirements. The goal in developing the review guide is to provide guidance of the MSE requirements.

The Integrated Product Team (IPT) will consist of Government, Contractor and sub-Contractor representatives, as appropriate.

It is recommended that the Contractor participate in Government partnering through IPTs during the analysis. This will facilitate review of the AIE submissions and allow for open discussion of the manufacturing, inspection and material handling processes.

Contracts & Statement of Requirements – COCOs, GOCOs & GOGOs

The term Contractor is used throughout this document to denote the entity with a Government contract or Government Owned, Government Operated (GOGO) activity responsible for preparation and submission of AIE design for approval. The normal method of transmission of MSE requirements for Contractor Owned, Contractor Operated (COCO) and Government Owned, Contractor Operated (GOCO) facilities is via a contractual instrument. The method of transmission of MSE requirements at a GOGO is through a Statement of Requirements (SOR) via a Production Work Directive.

Paragraph (a) Definitions

(a) **Definitions**. This paragraph defines specific terms utilized throughout the rest of the clause and in the accompanying Contract Data Requirements List (CDRL) and Data Item Description (DID) (DI-QCIC-81960). This aids in clarifying the MSE requirements to Government and contractor personnel.

(1) **Acceptance Inspection Equipment (AIE)**. All equipment (includes AAIE defined below), special and standard, including dimensional gages, measuring equipment, test fixtures, electronic and physical test equipment, and other test equipment used for examination and test of a product to determine conformance to the Technical Data Package (TDP) which may include drawings and specifications (e.g., Detail, Performance, Weapon specifications, and QAPs).

(2) **Automated Acceptance Inspection Equipment (AAIE)**. AIE in which the inspection and acceptance determination of the product is performed, in whole or in part, in an automatic manner.

(3) **Contractor Inspection Equipment**. Government-approved equipment utilized by the contractor to perform examination and tests to assure conformance to contract requirements.

(4) **Commercial Inspection Equipment**. Industry-developed inspection equipment of universal application, without limitations to a specific part or item, which is advertised or cataloged as available to the trade or to the public on an unrestricted basis at an established price. Examples follow:

(i) **Standard Test Equipment**. Multiusage equipment that is specific to a function rather than to an item. It includes such items as hardness testers, tensile strength testers, meters, weighing devices, standard gear testers, ohmmeters, voltmeters, and oscilloscopes.

(ii) **Standard Measuring Equipment (SME)**. Multipurpose equipment and standards used for performing measurements. It includes such items as micrometers, rulers, tapes, height gages, and protractors, etc. Standards include visual inspection equipment such as scratch and dig standards, surface finish comparator, color standards (FED-STD-595), etc.

(5) **Nondestructive Testing**. The development and application of technical methods to examine materials or components in ways that do not impair future usefulness and serviceability in order to detect, locate, measure and evaluate flaws; to assess integrity, properties and composition; and to measure geometrical characteristics. NDT includes Radiography/Radioscopic, Ultrasonic, Eddy Current, Magnetic Particle, and Liquid Penetrant.

(6) **Measurement System Analysis (MSA)**. Per ASTM E2782 (Standard Guide for MSA), paragraph 3.1.7, MSA is any of a number of specialized methods useful for studying a measurement system and its properties.

Discussion:

Paragraph “(a) Definitions” of the clause is used to define commonly used terms in MSE.

During MSE Industry Day of 10-11 December 2013, the Supplier Quality Initiative (SQI) Working Group (WG) was tasked to expand on the definition of AAIE. The definition of AAIE was extracted from MIL-A-70625A and is repeated here for convenience:

> **Automated Acceptance Inspection Equipment (AAIE)**. AIE in which the inspection and acceptance determination of the product is performed, in whole or in part, in an automatic manner.

The concern focused on what is meant by “in whole” or “in part” in the definition. MIL-A-70625A does not elaborate on what is meant by “in whole” or “in part.” As the definition is written, it implies that the “acceptance determination” of the product can be performed completely (in whole) or partially (in part) by the AAIE. In fact, the definition could be refined to mean, “AIE in which the inspection and acceptance determination of the product is performed in an automatic manner.” Hence, the definition of AAIE as presented in MIL-A-70625 will be updated accordingly in a future continuous improvement effort.

After speaking to the original author of MIL-A-70625, the words “in whole” or “in part” dealt with the amount of automation of the accompanying Material Handling System (MHS) to the AAIE. That is, the MHS can be completely (in whole) or partially (in part) automated. “In whole” would mean that the MHS has the capability to identify and segregate “good” from “bad” product while “in part” means the MHS would involve some kind of human intervention. However, the “inspection and acceptance determination of the product” by the AAIE is independent of the MHS.

Paragraph (b) Scope

(b) **Scope**. This clause establishes requirements for design, supply, performance, and maintenance of AIE used for product inspection and acceptance. In addition, this clause establishes requirements for the preparation, submission, and approval of AIE documentation.

Discussion:

Each sentence of paragraph "(b) Scope" of the clause is discussed and elaborated on below.

First sentence: This clause establishes requirements for design, supply, performance, and maintenance of AIE used for product inspection and acceptance.

- The MSE clause outlines the requirements that need to be satisfied when an AIE is designed for inspection of desired TDP characteristics.
- "**Supply**" of AIE refers to the act of the Government providing the AIE designs or actual gages to the contractor for use, or the contractor providing its AIE designs to the Government for review and approval prior to fabricating the corresponding inspection equipment. Procedures for development of AIE documentation to be submitted to the Government for review and approval shall be in accordance with CDRL (DI-QCIC-81960). Any AIE hardware/software that is produced prior to Government approval of the submitted gage package will be at the contractor's own risk.
- "**Performance**" of AIE refers to the inspection equipment functioning as required (accurate, reliable, and repeatable) where there are no "false accepts" while a small number of "false rejects" are permitted per Gage Tolerancing Policy ASME Y14.43, "Absolute Tolerancing (Pessimistic Tolerancing)". See clause paragraph (d)(2).
- "**Maintenance**" of AIE refers to keeping all inspection equipment properly maintained and calibrated per ISO 10012 or ANSI/NCSL Z540.3. See clause paragraph (j).

Second sentence: In addition, this clause establishes requirements for the preparation, submission, and approval of AIE documentation.

- The MSE DID outlines in detail how the contractor is to prepare, what to include and how to submit its AIE package to the Government for review and approval.
- The MSE DID also outlines requirements for Go-No Go/Functional gages, Standard Measuring Equipment (SME), Special Inspection Equipment/Methods, Coordinate Measuring Machines (CMMs), Tool Control (TC), Non-Destructive Testing (NDT), Automated Acceptance Inspection Equipment (AAIE) & Complex Designs, Destructive, Environmental, and Functional Test Equipment, and Measurement Systems Analysis (MSA).

NOTE 1

Measurement systems that will be utilized for product inspection and acceptance shall complement the requirements of an ISO 9001-2008 or equivalent Quality Management System (QMS) as well as all contract quality requirements.

For example, ISO 9001-2008 Paragraph 7.6 incorporates *"Control of monitoring and measuring equipment"* as one of its elements. Thus, it is appropriate for the Contractor to maintain an effective AIE system that operates within the ISO requirements to provide evidence of conformity of product to TDP and/or contract quality requirements.

Where necessary to ensure valid results, measuring equipment shall (see paragraph 7.6, ISO 9001:2008)

a. be calibrated or verified, or both, at specified intervals, or prior to use, against measurement standards traceable to international or national measurement standards; where no such standards exist, the basis used for calibration or verification shall be recorded (see ISO 9001:2008 4.2.4);
b. be adjusted or re-adjusted as necessary;
c. have identification in order to determine its calibration status;
d. be safeguarded from adjustments that would invalidate the measurement result;
e. be protected from damage and deterioration during handling, maintenance and storage.

The above excerpt is taken from ISO 9001:2008, Section 7.6 on page 11, with the permission of ANSI on behalf of ISO.

NOTE 2

- The contractor is responsible for the design, calibration, and maintenance of AIE and to make it available to Government personnel for verification and acceptance inspection purposes.
- AIE should be designed to maximize simplicity of operation, and reliability, while minimizing requirements for maintenance, calibration, and special operator skills.

Paragraph (c) AIE

(c) **AIE**. The contractor shall provide all AIE necessary to ensure conformance of components and end-items to contract requirements. AIE shall include inspection, measuring, and test equipment whether Government furnished or contractor furnished (including commercially acquired) along with the necessary specifications and procedures for their use (see ISO 10012, paragraph 6.2.1). The AIE shall not create or conceal defects on the product being inspected. All AIE documentation shall contain sufficient information to permit evaluation of the AIE's ability to test, verify, and/or measure the applicable characteristics or parameters (see DI-QCIC-81960).

Discussion:

Each sentence of paragraph "(c) AIE" of the clause is discussed and elaborated on below.

First sentence: The Contractor shall provide all AIE necessary to ensure conformance of components and end-items to contract requirements.

Acceptance Inspection Equipment and Automated Acceptance Inspection Equipment are defined as follows in paragraph (a) the MSE Clause:

(a)(1) **Acceptance Inspection Equipment (AIE)**. All equipment (includes AAIE defined below), special and standard, including dimensional gages, measuring equipment, test fixtures, electronic and physical test equipment, and other test equipment used for examination and test of a product to determine conformance to the Technical Data Package (TDP) which may include drawings and specifications (e.g., Detail, Performance, Weapon specifications, and QAPs).

(a)(2) **Automated Acceptance Inspection Equipment (AAIE)**. AIE in which the inspection and acceptance determination of the product is performed, in whole or in part, in an automatic manner.

AAIE is a subset of AIE. It is the Contractor's responsibility to ensure all AIE documentation submitted to the Government for review and approval contain all relevant information that will "*ensure conformance of components and end-items to contract requirements*".

Second sentence: AIE shall include inspection, measuring, and test equipment whether Government furnished or Contractor furnished (including commercially acquired) along with the necessary specifications and procedures for their use (see ISO 10012, paragraph 6.2.1).

The AIE submitted to the Government for review and approval may consist of the following as defined in the MSE Clause:

1) **(a)(3) Contractor Inspection Equipment**. Government-approved equipment utilized by the contractor to perform examination and tests to assure conformance to contract requirements.

   There are times when a characteristic being inspected may require a unique piece of AIE to be designed and produced by the contractor.

2) **(a)(4) Commercial Inspection Equipment**. Industry-developed inspection equipment of universal application, without limitations to a specific part or item, which is advertised or cataloged as available to the trade or to the public on an unrestricted basis at an established price.

   Examples would include Coordinate Measuring Machines (CMMs) or Conventional Radiographic Inspection Systems.

   (a)(4)(i) Standard Test Equipment. Multiusage equipment that is specific to a function rather than to an item. It includes such items as hardness testers, tensile strength testers, meters, weighing devices, standard gear testers, ohmmeters, voltmeters, and oscilloscopes.
   (a)(4)(ii) Standard Measuring Equipment (SME). Multipurpose equipment and standards used for performing measurements. It includes such items as micrometers, rulers, tapes, height gages, and protractors, etc. Standards include visual inspection equipment such as scratch and dig standards, surface finish comparator, color standards (FED-STD-595), etc.

3) **Government designs or Government furnished gages**. It is important for the contractor to include Government furnished gages or designs as part of the AIE submission. The Government needs to maintain records of what

inspection equipment is being used to inspect each characteristic.

All AIE submitted must be accompanied by any corresponding specifications and detailed procedures for use. See ISO 10012, paragraph 6.2.1.

Third sentence: The AIE shall not create or conceal defects on the product being inspected.

This may sound straight forward, but there have been occasions where the AIE has actually created or concealed defects from view on the product being inspected. This is unacceptable. The contractor is to take precautions to prevent the product from being damaged by the AIE and to ensure all defects are revealed.

Fourth sentence: All AIE documentation shall contain sufficient information to permit evaluation of the AIE's ability to test, verify, and/or measure the applicable characteristics or parameters (see DI-QCIC-81960).

The AIE documentation submitted to the Government is to contain all information necessary to enable Government personnel to properly evaluate the ability of the AIE to test, verify, and/or measure the applicable characteristics or parameters. This may include logical flow charts and other additional data that explains the logic/algorithm used by the AIE to make a determination. In addition, Government AIE reviewers may request to contact the contractor's personnel responsible for preparing and submitting the AIE package to discuss areas that need further clarification and detail. Once again, it is encouraged for Government and contractor personnel to work cooperatively reviewing an AAIE package submission. This will accelerate the AIE review process.

NOTE

During MSE Industry Day of 10-11 December 2013, suppliers inquired what is meant by words such as "necessary" and "sufficient" in the clause language and how detailed AIE submissions should be.

The clause language is consistent with language used in commercial standards such as ISO 10012. The team agreed to reference paragraph 6.2.1 of ISO 10012 in the clause paragraph, included below for convenience:

INTERNATIONAL STANDARD
ISO 10012 First edition 2003-04-15
Measurement management systems — Requirements for measurement processes and measuring equipment

6.2.1 Procedures

Measurement management system procedures shall be documented to the extent necessary and validated to ensure the proper implementation, their consistency of application, and the validity of measurement results.

New procedures or changes to documented procedures shall be authorized and controlled. Procedures shall be current, available and provided when required.

Guidance

Technical procedures may be based on published standard measurement practices, or on customers' or equipment manufacturers' written instructions.

In addition, the team explained that the DID and inspection requirements within the rest of the MSE clause address what information is needed for AIE submissions.

Paragraph (d) AIE Designs & Government Furnished Gages

(d) **AIE Designs & Government Furnished Gages**. AIE designs are of two types – Government designs (see (d)(1)) and contractor designs (see (d)(2)). When applicable, Government designs or Government furnished gages are designated in the TDP/contract; responsibility for all other AIE is assigned to the contractor. The designs, associated inspection procedures, and theory of operation shall have the level of detail to demonstrate capability of the proposed AIE to perform the required inspection.

(1) **Government AIE Designs**. Government AIE designs may consist of detailed drawings necessary for the fabrication and use of the AIE. Unless otherwise specified, the contractor may submit alternate or modified contractor designs of Government AIE designs.

(2) **Contractor AIE Designs**. Contractor AIE design drawings shall meet the requirements of ASME Y14.100, ASME Y14.5 and ASME Y14.43 and may include commercial inspection equipment. ["Commercial inspection equipment" is defined as shown in paragraph (a)(4) above. It shall be fully described by catalog listings or other means which provide sufficient information to permit identification and evaluation by the Government and may include illustrations and engineering data.] Designs shall be submitted for any special fixture(s) to be used. Unless otherwise specified, Gage Tolerancing Policy shall be in accordance with ASME Y14.43, "Absolute Tolerancing (Pessimistic Tolerancing)."

(3) **Visual Inspection**. Visual inspection standards used for the acceptance/rejection of product shall be submitted for approval.

Discussion:

Various AIE designs are employed to inspect technical data package (TDP) requirements. Most designs are contractor designs; however Government designs, which may include source and vendor item control drawings (see ASME Y14.24), exist for particular programs. AIE submissions should have inspection procedures and theory of operation with a level of detail to demonstrate capability of the proposed AIE to perform the required inspection. This may include drawings, work instructions, operation manuals, etc. Government-provided designs have the necessary information for fabrication and use

of the AIE. Contractor designs require compliance to ASME Y14.100, ASME Y14.5, and ASME Y14.43. Commercial inspection equipment, as noted in catalogs and description sheets, is also employed as AIE. For acceptance purposes, AIE designs should be in accordance with ASME Y14.43's Absolute Tolerancing Policy AKA Pessimistic Tolerancing. The definition for Absolute Tolerancing from ASME Y14.43 is as follows:

> **4.3.1 Absolute Tolerancing (Pessimistic Tolerancing).** Absolute tolerancing (pessimistic tolerancing) is a policy of tolerancing gages that ensures complete random assemblability of parts by applying gagemakers' tolerances, wear allowances, measurement uncertainties, and form controls, all within the workpiece limits of size and geometric control. Gage tolerances add material to the gaging element, beginning at the limit [e.g., MMC or virtual condition (MMC concept) of the feature being gaged]. Gages produced under this policy will accept most part features that are within tolerance, reject all part features not within tolerance, and reject a small percentage of borderline part features that are technically within tolerance.

Government Furnished Equipment (GFE) will be provided as necessary. These consist of gages to be used to inspect for specific TDP requirements. For example, the Navy provides interface gages for inspection of some of their characteristics. See paragraph (o).

All submitted Contractor designs and commercial equipment should provide enough detail to demonstrate the AIE's ability to accurately inspect the desired characteristic(s).

Various methods of visual inspection are used for acceptance of product. When visual inspection is used, visual standards are established and submitted to the Government for review and approval. For example, pictures or hardware standards can contain the defect criteria for visual comparison purposes.

Paragraph (e) AIE Package Submittals

(e) **AIE Package Submittals**. The contractor shall prepare the AIE package submittal in accordance with DI-QCIC-81960 in the applicable Contract Data Requirements List (CDRL – DD Form 1423). In addition, the contractor shall adhere to the following requirements:

(1) **Designs for Approval**. Contractor designs and/or the submission for the use of Government designs shall be approved by the Government. Partial submission of AIE designs is permissible in order to expedite the approval process; however, the response date for design review will be based on the date of the final complete submission of designs.
(2) **Correspondence in English**. The contractor shall ensure all AIE correspondence and documentation are submitted in English.
(3) **Units of Measurement**. The units of measurement within the AIE package submittal shall be consistent with the requirements of the Technical Data Package (TDP).
(4) **AIE Flow Down**. The contractor shall flow down AIE requirements to sub-contractors at any tier who are performing acceptance inspections.

Discussion:

Designs for Approval

Contractor designs and/or the submission for the use of Government designs shall be approved by the Government. Partial submission of AIE designs is permissible in order to expedite the approval process; however, the response date for design review will be based on the date of the final complete submission of designs.

The contractor may use their own AIE designs or Government AIE designs for inspection of product. However, if Government AIE designs are to be used, these must be formally submitted by the contractor for approval.

Correspondence in English

All AIE correspondence issued to the United States Government shall be made in the English language. However, the Contractor is free to submit the correspondence in the

original language along with an English translation in the event translation problems arise.

The objective is to maintain documentation control and avoid potential problems that can occur when translating technical procedures, operation instructions, etc. into English that may affect the original intent of the writings.

Units of measurement

All units of measurements that are applicable to AIE submissions shall be made in accordance with the Technical Data Package (TDP). Government TDPs may be in accordance with the English or Metric systems of measurements. It is the Contractor's responsibility to convert the units of measurement so they can be consistent with those called out in the TDP.

The objective is to avoid potential problems that can occur when converting units of measurement that may affect the accept/reject decision making process when reviewing the AIE submissions.

AIE Flow Down

It is the Prime Contractor's responsibility to flow down all AIE requirements to sub-Contractors, gather all applicable AIE from sub-Contractors, and to prepare the AIE package and submit it to the Government for review and approval. The prime contractor can facilitate Government communications with sub-Contractors on a case by case basis for the purposes of clarification of AIE submissions.

Most importantly, AIE requirements apply where inspections are being conducted for the defined Critical, Major, Minor characteristics or special tests.

Paragraph (f) Characteristics for Inspection

(f) **Characteristics for Inspection**. AIE documentation for Critical, Special, and Major characteristic inspections shall be submitted to the Government for approval in accordance with (IAW) the CDRL (DI-QCIC-81960). AIE for Minor characteristic inspections shall be submitted to the Government for approval IAW CDRL (DI-QCIC-81960) and as required below:

(1) ☐ Listed Minor (characteristics displayed on specifications and/or drawings)
(2) ☐ Government selected list (as attached or as provided herein)
(3) ☐ Not submitted

Discussion:

The contractor will provide the AIE documentation corresponding to all Critical, Special, and Major characteristics as listed in the item's TDP specification and/or drawings. The proposed AIE will be submitted for approval per the CDRL. AIE documentation used for Minor characteristic inspections shall also be submitted for approval as required by the selected option:

- (f)(1) AIE documentation will be submitted for inspection of all minor characteristics listed in the TDP drawings and/or specifications. NOTE: This may include 200 series listed minors from specifications or minors called out in drawings
- (f)(2) AIE documentation will be submitted for inspection of those minor characteristics (see note above) selected by the Government.
- (f)(3) This option does not require AIE documentation to be submitted for approval.

Unlisted characteristics are not applicable to this clause.

Paragraph (g) Automated Acceptance Inspection Equipment

(g) **Automated Acceptance Inspection Equipment**. The AAIE shall accept only conforming material. All characteristics requiring AAIE per the TDP shall utilize inspection equipment with a minimum demonstrated reliability of 99.8% at a 90% confidence level to detect non-conforming material unless otherwise specified below.

(1) Reliability of _____% at a _____% Confidence Level for Critical/Special Characteristics
(2) Reliability of _____% at a _____% Confidence Level for Major Characteristics
(3) For inspection of major and minor characteristics where contractor utilizes AAIE when it is not required by the TDP, the AAIE package shall be submitted to the Government for approval. If the Minor characteristic is not listed in paragraph (f)(2) or not required for submittal in paragraph (f)(3), then the AAIE requirements (e.g., verification, calibration, prove-out, etc.) of the inspection shall still be performed.
(4) All AAIE packages submitted to the Government for approval shall be in accordance with MIL-A-70625 (*Automated Acceptance Inspection Equipment Design, Testing and Approval of*). Furthermore, the contractor shall be responsible for producing the acceptance and rejection verification standards/masters representative of the characteristics the AAIE is designed to inspect. The verification standards and frequency of use require Government approval prior to use. When verification standards are used for the VL-VII “sampling plan” per MIL-STD-1916 paragraph 4.4, verification standards and frequency of use shall require Government approval prior to use.
(5) If the AAIE accepts a critical characteristic “reject” standard the contractor shall notify the Government and act in accordance with paragraph (f) of the Critical Characteristic Control Clause. In addition, if the AAIE accepts a major and/or minor characteristic “reject” standard the contractor shall act in accordance with paragraph 8.3 of ISO 10012 or paragraph 5.2.3 of ANSI/NCSL Z540.3.
(6) All AAIE shall be required to pass a Government-approved Acceptance (Prove-Out) Test. The contractor shall conduct this test per the approved test plan and shall submit a test analysis report for approval. See applicable CDRL (DI-QCIC-81960). This test shall be performed at the contractor’s facilities whose manufacturing system has had the AAIE fully integrated and calibrated as per paragraph (j) of this clause. The contractor shall allow Government personnel access to this facility and unobstructed monitoring of this test.
(7) The contractor shall notify the Government prior to a modification and/or relocation of the Government-approved AAIE. The modified AAIE designs shall be submitted for approval. The modified and/or relocated AAIE shall require submission of the acceptance test plan (prove-out) and results for review and approval prior to use. The modified and/or relocated AAIE shall be in accordance with paragraphs (g)(1) – (g)(6).

Discussion:

Paragraph (a)(2) of the clause defines Automated Acceptance Inspection Equipment (AAIE) as "AIE equipment in which the inspection and acceptance determination of the product is performed, in whole or in part, in an automatic manner."

AAIE can be used to inspect any product characteristic as directed by TDPs. Nevertheless, AAIE is mostly used for inspecting critical and major characteristics and automatically accepting or rejecting the product accordingly. Since the accept/reject decision is made in an automatic manner without human intervention then it is extremely important for the AAIE to be properly proved-out.

The first sentence of the MSE clause states, "**The AAIE shall accept only conforming material**." This refers to the actual Automated Acceptance Inspection Equipment (AAIE). The intent of the sentence is to convey the idea that the Government expects the AAIE to work as required when in use by accepting only conforming material and never accepting nonconforming material or rejection verification standards. There have been instances where the submitted AAIE designs were functional in theory and on paper, but the actual AAIE system did not perform as desired during the Government-approved prove-out test or when integrated with the actual production line.

The second sentence of introductory paragraph (g) reads:

> **All characteristics requiring AAIE per the TDP shall utilize inspection equipment with a minimum demonstrated reliability of 99.8% at a 90% confidence level to detect non-conforming material unless otherwise specified below.**

This translates into an AAIE correctly identifying a "reject" standard 1151 times. This is also mentioned in the *Review Guide for Critical Characteristics Control (CCC) Plan and Critical Plan of Action (CPOA)*.

> **NOTE 1**: The use of variable data analysis or a "K factor," as used in the CCCP/CPOA review guide, are not applicable to reduce the prove-out quantity of non-conformances, e.g., the default requirement of 99.8% reliability at a 90% confidence level still requires the AAIE to properly identify a nonconformance 1151 times. A "K factor" may be used to demonstrate reliability as part of other contractual requirements, e.g., CCCP, but only after the

AAIE prove-out has been successfully completed. The accuracy of the inspection equipment does not guarantee that the AAIE, when integrated into the manufacturing system, will function properly.

Clause paragraphs (g)(1) and **(g)(2)** of the MSE Clause provide the program offices with the necessary flexibility, up-front, to fill in the desired reliability and confidence levels for the AAIEs associated with their particular programs if the default (minimum demonstrated reliability of 99.8% at a 90% confidence level) is not desired. Reliability and confidence level requirements are intended to assure that only conforming material is presented to the Government for acceptance. They are NOT intended to imply that the Government is willing to accept any non-conforming material.

The reliability of the AAIE needs to be monitored on a continual basis to ensure non-conforming product is never accepted. MIL-A-70625 is the AAIE standard. Other Government specifications such as MIL-A-48078 (maximum error rate of 1/500) and contractual requirements such as the Critical Characteristics Control Clause (Six Sigma) also stress the importance of system reliability.

Clause paragraph (g)(3) is a new sub-paragraph that was created as a result of MSE Industry Day during 10-11 December 2013. It was added to address what to do if a contractor uses AAIE, as a continuous improvement effort, for inspection of Major or Minor characteristics although it is not required per the TDP. The AAIE package will still need to be submitted to the Government for review and approval. In these situations, it is not the intent of the Government to discourage continuous improvement efforts or application of LEAN production practices. Standard calibration, process control, and Measurement System Analysis (MSA) still apply. However, the MSE clause does not stipulate default reliabilities in such cases. Best practices of ISO 10012, ANSI Z540.3, and ASTM E2782-11 still apply.

Clause paragraph (g)(4) states that all AAIE submitted to the Government for approval shall be in accordance with MIL-A-70625 (*Automated Acceptance Inspection Equipment Design, Testing and Approval of*). If the contractor proposes alternate methods to achieve compliance with MIL-A-70625, then these shall be submitted to the Government for review and approval.

Additionally, paragraph (g)(4) requires the contractor to produce the acceptance and rejection verification

standards/masters that will represent the characteristics the AAIE is designed to inspect. Effective standards are designed to include "borderline" conforming and non-conforming product. The Government will be given assurances of the sensitivity of the AAIE to properly identify and segregate good product from bad. It is these standards that will be used to "prove-out" the AAIE in a Government approved acceptance test to determine if the minimum reliability and confidence level requirements can be met.

> **NOTE 2**: Ideally the verification standards should be fabricated from actual product created by the contractor's manufacturing processes.
>
> **NOTE 3**: Additional configurations of standards may be required during prove-out to ensure the AAIE is capable of detecting the specified non-conformances in multiple configurations of the product or for other technically based reasons. For example, the specification lists three different critical defects. Therefore, three individual reject standards will be required to represent each critical defect independently. Additional standards may be required to represent two critical defects present at once, or all three critical defects present at once, or different combinations of the critical defects, etc. The need for additional standards shall be determined on a case by case basis depending on the technicality of the defects or the inspection methodology.
>
> **NOTE 4**: Additional standards or production parts may be required in order to conduct AAIE accuracy testing. These parts shall be capable of withstanding repeated measurements without degrading. There shall be sufficient parts that represent the expected range of measurement values the AAIE was designed to inspect.

Proper planning for the design, production, testing and implementation of standards shall be incorporated into the contractor's program schedule. To ensure adequate data is collected, the standards and their frequency of use should be described to the Government in AIE submissions IAW with DI-QCIC-81960. The contractor shall recalibrate the calibration / verification standards and/or AIE as required.

Paragraph 4.4 (displayed below for convenience) of MIL-STD-1916 requires, "for each Critical Characteristic to implement an AAIE

or a failsafe manufacturing operation and apply sampling plan VL-VII to verify the performance of the screening operation."

> *4.4 **Critical characteristics**. Unless otherwise specified in the contract or product specifications, the contractor is required for each critical characteristic to implement an automated screening or a fail safe manufacturing operation and apply sampling plan VL-VII to verify the performance of the screening operation. The occurrence of one or more critical nonconformances requires corrective action as specified in paragraph 4.5.*

If the AAIE is inspecting for critical characteristics, then the performance of the accept/reject decision making operation must be verified using a MIL-STD-1916 VL-VII sampling plan during production – all contractors shall plan accordingly. The VL-VII sampling plan does not alleviate the contractor from following all approved calibration and verification requirements per paragraph (j) of the clause. The verification of the critical characteristic could entail use of a second AAIE, which requires Government approval. However, contractor-proposed provisions (MIL—STD-1916, paragraphs 4.1 & 5.1) may be used in lieu of the VL-VII with Government approval. Keep in mind that all calibration/verification standards and their frequency of use during production to verify the AAIE, as well as the inspection method(s) and equipment used to perform the VL-VII inspection, require Government approval prior to use.

Clause paragraph (g)(5) addresses the issue of what a contractor is to do if their AAIE incorrectly accepts a critical defect master, which is designed to simulate actual defective product. If such a scenario occurs, the contractor is to follow the directions of paragraph (f) of the SMCA Critical Characteristic Control Clause, which has been copied and pasted below for convenience.

ES6550
CRITICAL CHARACTERISTICS (SIX SIGMA)
52.246-4553
May 2010

(f) In the event that a critical non-conformance is found anywhere in the production process, the contractor, as part of its CCC Plan, shall have procedures in place to ensure:

(1) The non-conformance is positively identified and segregated to ensure that nonconforming product does not inadvertently remain in or reenter the production process. This control shall be accomplished without affecting or impairing subsequent non-conformance analysis. Final disposition of non-conforming product shall be documented and audited for traceability.

(2) The operation that produced the non-conforming component or assembly and any other operations incorporating suspect components or assemblies are immediately stopped. (See para h. for exceptions)

(3) The government (PCO) is immediately notified of the critical non-conformance (electronic mail)(DI-SAFT-80970A).

(4) Any suspect material is identified, segregated and suspended from any further processing and shipment.

(5) An investigation is conducted to determine the root cause of the non-conformance and the required corrective actions. An evaluation shall also be conducted with regard to suspect material to ensure that no additional critical non-conformances are present. A report of this investigation shall be submitted to the government (DI-SAFT-80970A). The use of the DID report shall not delay notification to the government as required in f(3) above.

(6) A request to restart manufacturing or to use any suspect material associated with the critical non-conformance is submitted to the government (DI-SAFT-80970A). Restart of production shall not occur until authorized by the PCO, unless previously addressed in the approved CCC Plan. The Government will respond to a restart request within 3 working days. All objective evidence of the investigations to date shall be available for review at the time of restart. Suspect material shall not be used without PCO approval.

(7) The procuring activity reserves the right to refuse acceptance of any suspect material until the root cause or reasonably likely cause of the critical non-conformance has been identified, corrective action has been fully implemented and sufficient evidence has been provided to exclude non-conforming material from the conforming population.

Furthermore, paragraph 8.3 of ISO 10012 and paragraph 5.2.3 of ANSI Z540.3-2006 are referenced that detail actions to take if the AAIE is found to be suspect, e.g. accept nonconforming product such as a critical defect master. These paragraphs have also been copied and pasted below for convenience.

INTERNATIONAL STANDARD
ISO 10012 First edition 2003-04-15
Measurement management systems — Requirements for measurement processes and measuring equipment

8.3 Control of nonconformities

8.3.1 Nonconforming measurement management systems
The metrological function shall ensure the detection of any nonconformities, and shall take immediate action.

Guidance

Nonconforming elements should be identified to prevent inadvertent use.

Interim actions (e.g. workaround plans) may be used until the corrective actions have been implemented.

8.3.2 Nonconforming measurement processes

Any measurement process known to give, or suspected of producing, incorrect measurement results shall be suitably identified and shall not be used until appropriate actions have been taken.

If a nonconforming measurement process is identified, the process user shall determine the potential consequences, make the necessary correction, and take the necessary corrective action.

A measurement process modified due to a nonconformity shall be validated before use.

ANSI/NCSL Z540.3-2006
American National Standard for Calibration – Requirements for the Calibration of Measuring and Test Equipment
NCSL International

5.2.3 **Nonconforming measuring and test equipment**

Measuring and test equipment that are included in the calibration system and suspected or known:

a) to have been damaged, overloaded, or mishandled;
b) to have malfunctioned in such a way that may invalidate its intended use;
c) to produce incorrect measurement results;
d) to have been used beyond its designated calibration interval without an authorized temporary extension;
e) to have damaged, broken, bypassed, or missing seals or adjustment access controls; or 1
f) to have been exposed to influencing quantities that can adversely affect its intended use;

shall be removed from service and identified by prominent labeling or marking. Such equipment shall not be returned to service until the reasons for its nonconformity have been investigated and resolved, and it has been recalibrated.

NOTE 5: When verification standards are used during the verification process in production and the AAIE accepts a critical characteristic “reject” standard, the Government shall be notified.

According to **clause paragraph (g)(6)**, all AAIE is required to pass a Government-approved Acceptance (Prove-Out) Test. Prove-out tests per MIL-A-70625 include evaluations of the AAIE for accuracy, reliability, repeatability, and fail-safe. Accuracy testing involves repeated measurements of masters or standards with known values to evaluate the AAIE's accuracy and the influence of external elements. Reliability tests typically include cycling of "borderline" accept/reject standards intermixed with conforming product over a simulated production run. Repeatability tests include running the defect masters through the AAIE system in series. Fail safe testing includes examining the automated system operation during potentially problematic circumstances, e.g. emergency shutdown, varied start up procedures, loss of air pressure, incomplete inspection cycle, etc. to ensure all product is properly inspected and handled when a non-conformance is discovered.

The contractor will submit a prove-out test plan as part of the AIE submission package (DI-QCIC-81960). The Government is at liberty to recommend modifications to the prove-out test plan as appropriate. After approval of the proposed prove-out test plan, Government personnel shall be granted permission to freely participate in and monitor the prove-out test to validate if the AAIE system reliability meets the contractual requirement(s). This test shall be performed at the contractor's facilities where the manufacturing system and the AAIE have been fully integrated, as appropriate, and calibrated per paragraph (j) of the clause. MIL-A-70625 has the necessary information for design, implementation, and prove-out of AAIE. However, any reliability requirement stipulated in the contractual MSE clause supersedes the minimum reliability requirements established in MIL-A-70625 or MIL-A-48078. Finally, following the prove-out test the contractor shall submit a test analysis report of the test to the Government for review and approval.

It is recommended the contractor conduct a preliminary internal prove-out test prior to scheduling the official Government prove-out test. In this fashion, if there are any bugs or problems that occur, these can be quickly resolved. In addition, it will provide the Government with the added confidence that the contractor is truly ready for the official prove-out test.

Please see the "Examples" section of this paragraph below which outlines in more detail the various factors to consider when conducting AAIE prove-outs.

Clause paragraph (g)(7) is a sub-paragraph that was created as a result of MSE Industry Day during 10-11 December 2014. It was added to address actions to take in the event Automated Acceptance Inspection Equipment is changed and/or moved after it has already been reviewed, proved-out, and approved by the Government.

If contractors decide to make changes to Government approved AAIE that will not affect fit, form, or function, or if they decide to move the Government approved AAIE to a new location, they are to notify the Government of their intention prior to bringing it to fruition. This does not, in any way, interfere with contractors' internal policies. Contractors are at liberty to change and relocate their AAIE. However, the Government needs to know that the AAIE is no longer being used as originally approved. Hence, the Government must assess if the changes and/or relocation could have negatively affected the inspection equipment in such a way that it could accept nonconforming product. The Government also needs to keep track of the AAIE being used for documentation control purposes per the requirements of the clause, CDRL, and DID.

The Government has observed scenarios where approved AAIE that has been moved by a mere few inches has suddenly become suspect in accepting poor product. The relocation of the AAIE contributed to the inspection equipment being out of calibration. Thus, another acceptance test (prove-out) may have been required.

Nevertheless, if contractors decide to go through with changes and/or relocation to the Government approved AAIE they are NOT permitted to use it for acceptance of product until it is demonstrated to the Government that it meets the requirements of the clause.

One way contractors can assure the Government that modifications and/or relocation of their approved AAIE has not compromised its acceptance/rejection determination capability is for them to perform an acceptance test (prove-out) under Government observation. Essentially, paragraphs (g)(1) – (g)(6) are to be satisfied including submission of the AAIE information per the CDRL(s) and DID.

Example(s)

Examples of factors to consider during AAIE prove-out testing

Factor 1: Accuracy Testing – See MIL-A-70625 for guidance.

Factor 2: Repeatability Testing – See MIL-A-70625 for guidance.

Factor 3: Reliability Testing – See MIL-A-70625 for guidance.

Paragraph (g) of the MSE clause states that "Unless otherwise specified all AAIE shall have a minimum reliability of 99.8% at a 90% lower confidence level." This translates into an AAIE correctly identifying a "reject" standard 1151 times. See formula below.

Sample Size Calculator for Minimum Desired Reliability

n = CHIINV(1-Conf, 2*(x+1))/((1-Rel)*2)

Inputs:	
x	0
Conf	0.9
Rel	0.998000
1 - Rel	0.002000

n
1,151

Where
n = Sample size
x = Number of defects
Conf = Confidence level
Rel = Reliability

- The prove-out test plan for reliability testing will ensure that a mixture of acceptable and non-conforming standards/product gets cycled through the AAIE system. The mixture will include at least 10% acceptance standards/product randomly intermixed amongst the required 1151 minimum rejection quantity. The acceptance standards/product shall be in addition to the required defect quantity.

Factor 4: Failsafe Testing – See MIL-A-70625 for guidance.

- Fail safe testing includes examining the automated system operation during potentially problematic circumstances, e.g. emergency shutdown, varied start up procedures, loss of air pressure, incomplete inspection cycle, etc. to ensure all product is properly inspected and handled once a non-conformance is discovered.

- Failsafe testing shall be conducted for new AAIE or when AAIE has not been used for an extended period of time.

- **SYSTEM ON/OFF –** The AAIE should be shut off and restarted at the main power source prior to, during and after the process of inspecting product/standards. This "On/Off" test will be repeated until a sufficient number of product/standards have been automatically inspected. Each time the system is turned on any product that was in any stage (e.g., prior to, during or after inspection) of being inspected should be rejected.

- **EMERGENCY STOP** – Repeat all tests for "System on/off" using the emergency stop button. The emergency stop will be triggered prior to, during and after the process of inspecting product/standards. This "Emergency Stop" test will be repeated until a sufficient number of product/standards have been automatically inspected. Each time the system is turned on any product/standards that was in any stage (e.g., prior to, during or after inspection) of being inspected should be rejected.

- **SYSTEM PRESSURE VARIANCE** – This would include incrementally decreasing or increasing the system pressure back to operating pressure, as applicable. The intent is to simulate a gradual and gross system pressure loss or spike and how this affects the decision making ability of the AAIE.

  NOTE: IPT representatives participating in the testing may request additional tests to any one of the prove-out plans based on observations made during the prove-out to assess compliance to MSE requirements.

Paragraph (h) Measurement System Analysis (MSA)

(h) **Measurement System Analysis (MSA)**. The contractor is responsible to ensure all AIE is, at a minimum, stable, repeatable, and reproducible for all characteristics. Refer to ASTM E2782 and/or AIAG MSA for guidance. The contractor shall provide objective evidence, including the MSA assessment plan, associated data, and analysis, which demonstrates the AIE is, at a minimum, stable, repeatable, and reproducible for the following characteristics (MSA CDRL):

Specification	Paragraph No.	Drawing	Characteristic

Approval of submitted MSA(s) must be granted before the corresponding AIE can be used or continue to be used for acceptance of product. If at any time following approval of the AIE and MSA the AIE is disapproved, then the MSA shall be disapproved. After the resubmitted AIE is approved, the MSA shall be conducted on the approved AIE and resubmitted for approval.

Discussion:

Organizations such as the Automotive Industry Action Group (AIAG) and ASTM provide guidance on best methods and practices for conducting MSAs. The intent here is to provide basic guidelines within the scope of the MSE clause, including some examples of the minimum information needed to assess the suitability of the inspection equipment being used to accept product for the Government.

Paragraph (a)(6) of the clause defines Measurement System Analysis (MSA) as any of a number of specialized methods useful for studying a measurement system and its properties. This definition was extracted from ASTM E2782 (Standard Guide for MSA), paragraph 3.1.7.

For all characteristics identified in the table, the contractor is responsible to ensure that the AIE is maintained at a stable condition throughout the life-cycle of the AIE. The inspection

function of the AIE is to remain repeatable and reproducible for all characteristics identified.

In order to verify and validate that the AIE is capable, stable, repeatable, and reproducible, the contractor shall have the MSA assessment plan in place. The plan shall include objective evidence by collecting associated data and conducting statistical or other types of analysis, as required. Each characteristic may need a separate MSA assessment plan.

The AIE is not approved for Government use without an approved MSA. If at any time following approval of the AIE and MSA the AIE is disapproved, then the MSA shall be disapproved. After the resubmitted AIE is approved, the MSA shall be conducted on the approved AIE and resubmitted for approval.

Paragraph (i) Robust AIE System

(i) **Robust AIE System**. The contractor shall ensure the AIE and its use is not negatively affected by any manufacturing/inspection environmental stimuli including, but not limited to production rate, noise, temperature, humidity, and vibration.

Discussion:

It is the contractor's responsibility to ensure the AIE method of inspection for each characteristic works as desired within the contractor's manufacturing/inspection facilities. Contractors should know and understand all factors within their facilities that may negatively affect their AIE. Factors may include production rate, noise, temperature, humidity, and vibration.

In order to conduct the inspection properly all variables that can adversely affect the accuracy of the inspection results must be controlled to the maximum extent possible. The Government assumes that the operator of the AIE will exercise reasonable care in the use of the equipment. The accuracy of the inspection equipment should not depend on a particular operator skill or talent.

Paragraph (j) AIE Calibration and Verification

(j) **AIE Calibration and Verification**. The calibration system shall be in accordance with ISO 10012 or ANSI/NCSL Z540.3. All AIE shall be subjected to scheduled calibration intervals to ensure that the equipment will accept only conforming product and reject all non-conforming product for the duration of the approved calibration period. AIE shall be subjected to periodic verification to ensure that the equipment will continue to accept and reject product with the same consistency as it did at the time of its previous calibration.

Discussion:

Inspection equipment undergoes changes in form and function due to wear, corrosion, occasional abuse, etc. All equipment must be checked and calibrated periodically to ensure proper performance. Because of the potential cost associated with improper performance of inspection equipment and the possibility of accepting nonconforming parts, it is important to establish an effective calibration system to monitor periodically the accuracy of each item of inspection equipment in use.

The contractor’s calibration system shall be IAW ISO 10012 or ANSI/NCSL Z540.3. These documents help establish an effective measurement management system to manage the risk that measuring equipment and measurement processes could produce incorrect results. This measurement management system will provide scheduled calibration intervals, periodic (at times random) verification for repeatability, accuracy, processing, and stability. Calibration intervals should be based on data and best practices. Recording and analyzing the resulting data helps characterize the short and long-term behavior of specific devices. The accuracy requirements of the particular application, inherent stability of the AIE, and environmental factors of use, should be used to determine appropriate calibration intervals.

NOTE

Calibration is done on a less frequent basis while verification is done more frequently. For example, a piece of AAIE may have verifications standards cycled through it three times per day but may be calibrated once every 3 months. See MIL-A-70625A paragraphs 3.3.2 and 3.3.3.

Hard gages, such as profile and alignment gages, are also periodically verified via wear and limit gages to ensure these have not been worn beyond their useful life. Records of the results of calibration and verification shall be maintained.

See ISO 9001:2008 4.2.4, copied and pasted below for convenience.

INTERNATIONAL STANDARD
ISO 9001
Fourth edition
2008-11-15
Corrected version
2009-07-15
Quality management systems — Requirements

4.2.4 Control of records

Records established to provide evidence of conformity to requirements and of the effective operation of the quality management system shall be controlled.

The organization shall establish a documented procedure to define the controls needed for the identification, storage, protection, retrieval, retention and disposition of records.

Records shall remain legible, readily identifiable and retrievable.

Paragraph (k) Non-Destructive Testing (NDT)

(k) **Non-Destructive Testing (NDT)**. Contractor shall submit detailed plans for qualifying and certifying NDT personnel and plans for qualification and ongoing use of NDT methods used for inspecting product. If re-qualification of NDT personnel and/or NDT methods is required, then the applicable plans shall be submitted.

(1) Personnel performing NDT examinations shall be qualified and certified in accordance with the standard practices prescribed by NAS 410 (NAS Certification & Qualification of NDT Personnel), ANSI/ASNT-CP-189 (ASNT Standard for Qualification and Certification of NDT Personnel), or SNT-TC-1A (Recommended Practice for Personnel Qualification and Certification in NDT), and additional procedures that may be identified by the Government. Acceptance of product using NDT shall be performed by personnel at a level of qualification consistent with that defined in the applicable standard.

(2) The NDT method(s) shall be applied in accordance with ASTM E 543 (Standard Specification for Agencies Performing Nondestructive Testing) and the current nationally recognized standard practices appropriate to the NDT method(s) employed, such as ASTM E-1742 (Standard Practice for Radiographic Examination) and SAE-AMS-STD-2154 (Inspection, Ultrasonic, Wrought Metals, Process For). Each application technique shall identify the standard(s) utilized. Non-destructive testing includes, but is not limited to, the following types of testing: Radiography/Radioscopic, Ultrasonic, Eddy Current, Magnetic Particle, and Liquid Penetrant.

Discussion:

1. Personnel need to be certified to verify that they are qualified to make decisions to accept product. The standards listed are the three US standards. Other countries use other standards, e.g., EN 473 for Europe. They are generally similar, and in some cases equivalent

(EN 473 is reconciled with NAS 410 with each revision). The intent is to enforce the US standards.

2. ASTM E 543 references the other main method standards, so calling out that standard pulls the others in as appropriate. The listing above for the RT and UT method should be taken as examples rather than as comprehensive, as there are many other standards that are also applicable based on the method.

Armaments items must be designed and produced to have a high inherent level of safety and reliability. Ammunition is a particularly dangerous product, and it cannot be functionally tested prior to acceptance. Therefore, extensive use is made of radiography and other types of nondestructive testing (NDT) during the manufacture of armaments products to assure their safety and integrity. The following are examples of NDT inspection methods that are currently used to inspect for critical defects.

Example(s)

1. Eddy Current

Eddy current inspection is one of several Non Destructive Test (NDT) methods that use the principal of “electromagnetism” as the basis for conducting examinations. Eddy currents are induced electrical currents that flow in a circular path. The name is derived from the “eddies” which are formed when a liquid or gas flows in a circular path around obstacles when conditions are right.

Eddy currents are created through a process called electromagnetic induction. When alternating currents are applied to a conductor, such as a copper wire or cartridge case, a magnetic field develops in and around the conductor. This magnetic field expands as the alternating current rises to the maximum and collapses as the current is reduced to zero. If another electrical conductor is brought into close proximity to this changing magnetic field, current will be induced in this second conductor.

Eddy current testing is performed by bringing a part near a test coil that is excited with radio frequency (RF) energy. The RF wave induces a local eddy current in a conductive material. The eddy current flow is dependent upon the local

geometry and electrical and mechanical properties. By carefully analyzing the loading on the drive coil or the pick-up voltage on one or more sensing coils, the local nature of the part can be determined. This enables reliable detection of defects and accurate coating measurement. In general, eddy current is used to inspect a relatively small area and the probe design and test parameters must be established with a good understanding of the flaw that is to be detected.

Eddy current can be used for:

a. Crack detection
b. Material thickness measurements
c. Coating thickness measurements
d. Conductivity measurements to determine heat damage, case depth and heat treatment.

Advantages are:

a. Sensitive to minute cracks and perforations
b. Detects surface and sub-surface defects
c. Immediate feedback
d. No contact to part
e. Can be used for complex shapes and sizes.

Limitations are:

a. Can only be used for conductive material
b. Surface must be accessible to the probe
c. Higher level of skill and training required than for other inspection methods
d. Depth of penetration is limited.
e. Cannot detect flaws such as delaminations that lie parallel to the probe coil winding

2. Ultrasound

In the ultrasonic method, beams of high-frequency acoustic energy are sent into the material under test in order to detect surface and subsurface flaws, or to measure the thickness of a material or the distance to a flaw. The ultrasonic beam will travel through a material until it hits an interface or discontinuity, such as a flaw, which interrupts the beam and reflects some of the acoustic energy. The amount of energy reflected depends on the shape, size, and orientation of the flaw or interface.

Most ultrasonic evaluations are performed at frequencies between 1 and 25 MHz. Short pulses of ultrasonic energy are sent into the material from the ultrasonic transducer. This energy travels through the material at a specific velocity, which depends on the properties of the material and the mode of propagation of the ultrasonic wave. This provides the basis for the two commonly used ultrasonic measurement parameters: namely, the amplitude of the energy reflected from the interface or flaw, and the time required (time of flight) for the ultrasonic beam to reach it.

Ultrasonic waves are generated from electrical pulses, usually between 50 to 5000 pulses per second, sent to the transducer element within the search unit or probe. The transducer element is made of a piezoelectric material which converts electrical energy into mechanical energy, and search units vary in the element material and thickness, surface area, shape, as well as the type of backing material. Acoustic lenses can be used to focus the ultrasonic energy.

Ultrasonics can be used for:

a. Crack, flaw and void detection
b. Material thickness measurements
c. Coating thickness measurements
d. Delaminations and disbonds

Advantages of Ultrasonics are:

a. Sensitive to minute cracks and flaws
b. Detects surface and sub-surface defects
c. Immediate feedback
d. Superior penetrating power
e. Can be used on metals and composites

Disadvantages of Ultrasonics are:

a. Parts that are rough, irregular in shape, small or thin are hard to inspect.
b. Surface must be accessible to the probe and a liquid or gel couplant is needed to transfer ultrasound into the part under test.
c. Higher level of skill and training required than for some of the other inspection methods.
d. Reference standards are required, both for calibration and characterizing flaws.

3. Radiography

Radiography is the use of x-ray or gamma radiation to inspect items. Basically, a photographic image is produced by passing penetrating radiation through an item being inspected and producing a shadow of the internal material or components. The variation in the intensity of the radiation after it has passed through the test object is then recorded as an image using photographic film or an electronic recording medium. The types of radiation used vary but primarily involve x-rays or gamma rays. (Radiography using neutrons is sometimes used for special applications, but it has not yet gained widespread acceptance due to high cost, low throughput, and the need for extra safety precautions.) Gamma radiography is predominantly used in the field via the use of a gamma camera which contains a sealed radioactive source (i.e. iridium-192, cesium-137 or cobalt-60). Advantages include portability and no requirement for electrical power to image items. Gamma rays have also been used in powder level gauges to measure the level of propellant inside cartridge cases. X-ray radiography involves electronically generating x-rays from an x-ray tube or linear accelerator. There are stationary as well as portable x-ray systems in use. Advantages in comparison to gamma radiography include better definition and contrast in images, greater safety (x-ray sources can be turned on and off), and no licensing requirements involving the U.S. Nuclear Regulatory Commission (NRC).

The following are advantages of Industrial Radiographic Inspection when compared to other testing methods:

1. It is a nondestructive test method.
2. It reveals the internal condition of the material.
3. It is applicable to most materials.
4. Data displayed as an image facilitates intuitive interpretation.
5. Contact with the object being inspected is not required; there are no contact probes or coupling medium.
6. Parts that are rough or irregular in shape can be readily examined.
7. It discloses fabrication and assembly errors.
8. It reveals structural discontinuities.
9. It provides a permanent visual representation of the object.
10. Evaluation does not have to occur at the point of inspection.

The uses for industrial radiography include checking structural materials, castings and weld integrity in the construction of buildings, bridges, power stations, pressure vessels, automotive assemblies, pipelines, and oil drilling platforms. It is also used in routine in-service inspection of materials and components for the aircraft/aerospace and shipbuilding industries. For the armament and munitions industries, it is used to qualify various critical weapon components such as barrels, receivers, and breechblocks. It is also used to qualify the quality of the munitions prior to being accepted by the Government. As mentioned in the discussion above, the inherently dangerous nature of ammunition and the fact that it cannot be functionally tested prior to use, radiography and other types of nondestructive testing are essential to assuring its safety and integrity.

Radiographic inspection equipment most commonly encountered in the armament and munitions industry varies depending on what item is being inspected. Medium powered x-ray units (320 to 450 kV) up to high energy accelerators (1 to 15 MeV) are used. For instance, grenade bodies, pyrotechnic flares, and most medium caliber munitions can be adequately x-rayed using medium powered x-ray sources. The larger mortar munitions, aerial bombs, tank and artillery munitions are x-rayed using linear accelerators. While film has been used for many years, the ongoing trend is to use a digital imaging medium (also referred to as Digital Radiography, DR) to capture x-ray images. There are several types of DR image acquisition systems. The advantages in using digital panels over film are cost savings in purchasing and developing film, less environmental impact, a wider variety of archival options and image portability.

Qualification & Certification of NDT Personnel:

The proper selection and application of appropriate NDT equipment and the interpretation of results requires knowledge of the physics of the particular energy being employed and of its interactions with the various materials being inspected. In order to have a robust, well thought out nondestructive inspection process, a qualified, well-trained NDT practitioner must be present. Since each munitions item is unique with its own inspection criteria, in most cases one cannot just install some NDT equipment and expect it to generate high quality, useful data for interpretation. The process must be carefully thought out, taking into consideration various factors such as material thickness of the item being inspected, its density,

internal and external geometry, inspection/acceptance criteria, expected throughput rate, and various factors unique to the applicable NDT method.

In order to ensure that NDT methods for armaments items are properly developed and executed, nationally recognized standard practices have been adopted for the qualification and certification of NDT personnel.

These include NAS410 (NAS Certification & Qualification of NDT Personnel), ANSI/ASNT-CP-189 (ASNT Standard for Qualification and Certification of NDT Personnel), and SNT-TC-1A (Recommended Practice for Personnel Qualification and Certification in NDT). The American Society for Nondestructive Testing (ASNT) has a central certification program whereby they can test and certify nondestructive evaluation (NDE) professionals of all disciplines. A Level III certified individual is the most qualified and is capable of selecting and planning an inspection process for a particular product line. A Level III can also qualify new NDE equipment and inspection procedures in accordance with accepted industry best practices and Government contract requirements.

Paragraph (l) Contractor Alternate Inspection Method(s), Modifications and/or Relocation of AIE (Non-Automated) After Government Approval

(l) **Contractor Alternate Inspection Method(s), Modifications and/or Relocation of AIE (Non-Automated) After Government Approval**. If the contractor proposes an alternate inspection method and/or modifies the AIE design(s) affecting hardware, software, or procedures after Government approval the intended change(s) shall be submitted to and approved by the Government prior to implementation. If an AIE is relocated and the relocation risks the integrity of the inspection system, notify the Government to determine information needed to assess impact to AIE. See CDRL (DI-QCIC-81960).

Discussion:

Each sentence of paragraph (l) of the clause is discussed and elaborated on below.

First sentence: If the contractor proposes an alternate inspection method and/or modifies the AIE design(s) affecting hardware, software, or procedures after Government approval the intended change(s) shall be submitted to and approved by the Government prior to implementation.

Let's sub-divide this sentence a little more and analyze it accordingly:

- *If the Contractor proposes an **alternate inspection method**, the intended change (alternate inspection method) shall be submitted to the Government for approval prior to implementation.*
    - This sentence refers to a couple of scenarios. One would be if the contractor decides to utilize its own alternate inspection method(s) in lieu of the Government supplied AIE designs or gages (see clause paragraph (d)). This may include methods that measure variables data in place of attribute data. The contractor can do so with the understanding that the alternate method has to be submitted to the Government in a written proposal for approval prior to implementation.

- Another scenario would be if the contractor discovers it is in their best interests to conduct “Tool Control (TC)” inspection to indirectly inspect certain characteristics in the TDP. TC is used in circumstances where desired characteristics to be inspected are too difficult to inspect directly. Hence, the tool responsible for creating those specific characteristics can be inspected instead, provided it satisfies the criteria outlined in paragraph 3.6.b of DI-QCIC-81960.

- Alternate inspection methods include, but are not limited to different inspection methods from those required in the contract (AAIE or NDT), measurement equipment for statistical process control, tool control, poka-yoke of processes to prevent creation of a defect, etc. Regardless of the equipment or method used for acceptance of product for the required characteristics, it should be submitted to the Government for review and approval. MIL-STD-1916 paragraph 4.1.2 and MIL-HDBK-1916 Section 6 address acceptance by contractor submitted provisions and other methods, repeated below for convenience.

DEPARTMENT OF DEFENSE
TEST METHOD STANDARD

DOD PREFERRED METHODS
FOR ACCEPTANCE OF PRODUCT

MIL-STD-1916
1 April 1996

4.1.2 Requirements and procedures.

a. Contractors currently operating quality systems in accordance with such models as MIL-Q-9858 enhanced with Statistical Process Controls (SPC), ANSI/ASQC Q9004, or others that are deemed satisfactory to the Government representative are qualified to apply for alternate acceptance methods if demonstration of process focus and objective evidence of effectiveness exists.

b. The contractor shall include in his request for approval of an alternate acceptance method an assessment plan to periodically verify process stability, capability, and other conditions under which the alternate acceptance method was developed. The current minimum values of process capability are equivalent to a Cpk of 2.00 for critical characteristics, 1.33 for major characteristics, and 1.00 for minor characteristics. Upon approval of the assessment plan, the contractor may reduce or eliminate inspection sampling when the plan criteria are met or exceeded.

DEPARTMENT OF DEFENSE HANDBOOK – COMPANION DOCUMENT TO MIL-STD-1916 MIL-HDBK-1916 – 10 February 1999

Section 6: ACCEPTANCE BY OTHER METHODS (NEITHER SPC NOR MIL-STD-1916 SAMPLING TABLES)

6.1 General. Although MIL-STD-1916 focuses on statistical process control and acceptance by the AoZ Tables when SPC is not possible, it is recognized that other product acceptance methodologies are also viable. Examples of these other acceptance techniques include Poka-Yoke, calibrated fixtures as a media of inspection, 100% automated inspection, tool control, etc. Any supplier-proposed acceptance plan must demonstrate that it provides customer protection that is equal to or greater than the acceptance provisions of the standard. Effectiveness of the plan should also be periodically demonstrated and verified by the supplier. The acceptability of the supplier-proposed plan is dependent upon the existence of a quality system, the demonstration of its process focus, and the availability of objective evidence of the effectiveness of the proposed plan. (See paragraph 4.1.2 of MIL-STD-1916.)

6.1.1 Poka-Yoke or mistake-proofing. Poka-Yoke is a Japanese term that generally translated means “mistake-proofing” or “fail safing”. Poka-Yoke is an approach that uses techniques or devices that prevent production errors or prevents movement of product with errors to the next step in the production process. Even if an error occurs, Poka-Yoke will prevent nonconformances or halt the process. The types of Poka-Yoke devices are:

a. Source inspection to avoid errors at their source – before they cause nonconformities. An example is an additional locator pin to prevent misalignment of the workpiece.

b. 100% inspection for nonconformities using an inexpensive sensing device such as a limit switch.

c. Immediate action to stop operations when an error is detected, such as an interlocked circuit that automatically shuts down the machine.

If Poka-Yoke is used as an alternate means of acceptance, it must be periodically audited to assure its continued effectiveness.

6.1.2 Calibrated fixtures as a media of inspection. 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.

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.

6.1.3 100% automated inspection. This system must be verified as to the accuracy of the inspection and its fail-safe feature.

- *If the Contractor modifies the **AIE design(s) affecting hardware, software, or procedures** after Government approval, the intended change (corresponding modification(s)) shall be submitted to the Government for approval prior to implementation.*

    - The Government will be notified of any modifications to the AIE designs that affect hardware or software as well as procedures that have already received Government approval for use.
    - Notification will be in the form of a formal written proposal detailing the alternate inspection method(s) and submitted to the Government for review and approval prior to implementation.

Second sentence: If an AIE is relocated and the relocation risks the integrity of the inspection system, notify the Government to determine information needed to assess impact to AIE. See CDRL (DI-QCIC-81960).

- The same reasoning described in paragraph (g)(7) towards Automated Acceptance Inspection Equipment applies towards Non-Automated Acceptance Inspection Equipment.
- If the contractor plans on relocating the Government approved AIE from its originally approved location and moving the AIE presents the possibility that it could compromise the acceptance/rejection determination capability of the inspection equipment, then the Government shall be notified of the relocation plans.

Example 1

Contractor XYZ has a requirement to perform a dimensional inspection to verify an assembly feature. This feature is a major characteristic and per the specification, requires to be sampled at a minimum sample size of VL-IV.

Previously, due to production throughput, the contractor conducted this inspection applying the continuous sampling option from MIL-STD-1916 with a go/no go gage verifying that the assembled item meets the requirements. However, as a part of a LEAN improvement effort, the contractor has automated the production line in a one-piece flow set up (see commercial references for one-piece flow). Due to the change in the production process, pulling a continual quantity from the

production line at the required frequency would disrupt the production process.

An alternate inspection method for acceptance of product is proposed and submitted to the Government for review and approval. The objective evidence provided included a correlation of the assembly forces (press fit operation) from the machinery to the dimensional requirements (with variables dimensional data). This data showed that within a specified set of control limits, the operation produced compliant product consistently, and these limits were continually monitored applying industry standard process control techniques. The alternate method proposed demonstrated that:

1. The operation stopped if the proper forces weren't recorded real time (fail safe).
2. All the data collected showed a strong correlation between the assembly forces and dimensional compliance.
3. Measurement device recording force data was calibrated and on a preventive maintenance schedule. The data also showed that measurements were reproducible and repeatable.

Example 2

During thread pitch gaging the contractor finds the “no-go” ring gage threads onto the part. Due to the “no-go” ring gage’s ability to reject conforming product near its limits the contractor decides to check the thread pitch using the three wire method, which measures the actual pitch size yielding variables data that is then reviewed for conformance to requirements. Both methods comply with the requirement to verify the feature.

After the contractor demonstrated that the alternate three wire method was reliable, repeatable, and reproducible using different operators, the AIE was re-submitted to the Government for review and approval.

NOTE

During MSE Industry Day of 10-11 December 2013, the SQI WG was tasked to clarify paragraph l of the MSE clause.

- This paragraph applies to alternate inspection methods such as tool control and to Non-Automated inspection equipment

that may be changed and/or moved to a new location after it has already been reviewed, proved-out, and approved by the Government. These could include Non-Destructive Testing (NDT) equipment such as ultrasonic and Digital Radiography.

- The same reasoning described in paragraph (g)(7) towards Automated Acceptance Inspection Equipment applies towards Non-Automated Acceptance Inspection Equipment.

Paragraph (m) Responsibility for AIE Package Submittal

(m) **Responsibility for AIE Package Submittal**. The contractor shall submit the AIE design documentation package within contractual timeframes per CDRL (DI-QCIC-81960). The Government will provide approval or disapproval within the timeframe specified in the CDRL. Disapproval of the AIE package will require re-submittal and subsequent Government review in accordance with the CDRL requirements. The AIE package and any required prove-outs must be approved prior to First Article (FA) (if required) or production start-up if FA is not required.

Discussion:

The MSE CDRL provides the number of calendar days, from date of AIE design package receipt, the Government has to provide the contractor with approval or disapproval documentation. Disapprovals should include reason(s) for disapproval.

Incremental submissions of AIE design data can aid in allowing the design activity to expedite approval of the final AIE package and to provide feedback to the contractor, if needed, prior to final submittal.

Recommended timeframes for submittals, re-submittals and review of AIE packages are pre-filled on the DD 1423. The IPT should consider the following in establishing AIE package delivery and review scheduling, and revise as necessary:

1. Projected contract award date.
2. Estimate of lead time required for contractor to design/acquire AIE.
3. Complexity of inspections.
4. Estimated First Article (FA) (if required) or production start-up if FA is not required.
5. Past experiences with similar items that may aid in anticipating problems with AIE approvals.

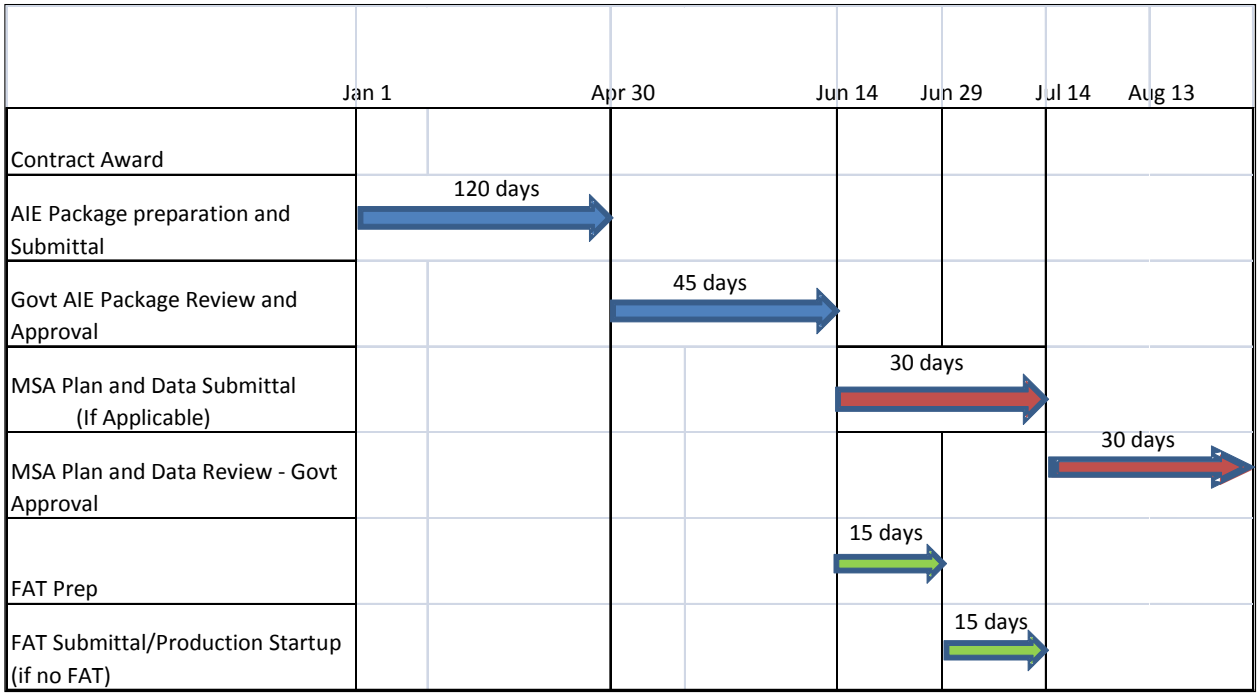
When the contract calls out specific characteristics that require submission of a Measurement System Analysis (MSA) plan and data, the MSA submission will be made in accordance with the MSA CDRL, which will normally require submission within 30 days of AIE package approval. The Government will provide an approval decision within 30 days of the MSA package receipt.

Example

If the IPT anticipates a Contract Award Date of 1 January, with an FAT date of 180 calendar days after award, the CDRL pre-fills (120 calendar days for AIE package Submittal, 45 calendar days for Government review) result in an extremely tight timeframe for accomplishing AIE prove-out, and adequate allowance for FAT preparation (120 calendar days + 45 calendar days = 165 calendar days, allowing only 15 days to FAT). This is assuming the AIE package is approved on initial submittal. See Table 1 below.

This demonstrates the importance of planning for realistic submittal requirements that are consistent with customer requirements and allow for unexpected situations. Contractors and reviewers should consider the submittal and review timeframes as maximums, and earlier submission and response will assure minimal impact on contract delivery. Any required MSA submittal should be made within 30 days of contractor receipt of AIE package approval, with Government review and approval timeframe being 30 days.

Table 1 – Example of AIE and MSA Submission Timeframes



Paragraph (n) Government's Right to Disapprove AIE

(n) **Government's Right to Disapprove AIE**. The Government reserves the right to revoke approval of any AIE that is not satisfying the required acceptance criteria at any time during the performance of this contract. See CDRL (DI-QCIC-81960).

Discussion:

AIE may be found capable of accepting non-conforming material. This can be detected during verification, calibration or the result of mishandling/abuse. If AIE that is produced to the approved designs is found to accept non-conforming material, the calibration, methodology of use, and physical condition should be verified. If calibration, methodology, and physical condition all meet approved design criteria, the AIE should be re-evaluated to assure a previously unconsidered failure mode was not overlooked in the AIE design that allowed acceptance of non-conforming material. Any AIE found to be capable of accepting non-conforming material should be removed from use immediately pending completion of a failure investigation and corrective action. As stated in the MSE Clause, the government reserves the right to revoke approval if the AIE is suspected of allowing acceptance of non-conforming material or if process data indicates the design is not sufficiently robust to withstand full rate production use.

Example 1

1. An AIE gage used for acceptance of an outside diameter of a part is found to be accepting non-conforming material. This gage should be immediately removed from use and submitted for calibration with all suspect material being segregated for screening. If the gage is re-calibrated, found to be conforming to design criteria, and verified as accepting only conforming material, the gage can be returned to service and AIE design approval is not impacted.

Example 2

During routine cycling of verification defect "standards", a piece of AAIE is found to be performing in accordance with approved design criteria; however, during production, acceptance of non-conforming material is discovered. Investigation reveals that the production process is inducing a previously undetected failure mode that the current AAIE design is not capable of

detecting. For example, it's possible that after the inspection and manufacturing systems are integrated the AAIE will now accept bad product and/or reject good product. This could happen due to environmental conditions that result as a consequence of combining the inspection and manufacturing systems. For example, vibration, airflow in the room, etc., could negatively affect the AAIE. In this situation, the government has the right to revoke approval of the AAIE design and require correction and resubmittal. Note that if the AAIE is inspecting a critical characteristic, the inspection system reliability may be impacted. Corresponding changes to the Critical Characteristic Control Plan (CCCP) may then be needed.

Example 3

During routine cycling of verification defect "standards," a piece of AAIE is found to be performing in accordance with approved design criteria; however during production, acceptance of non-conforming material is discovered. Investigation reveals that unexpected wear of a positioning apparatus in the AAIE creates the possibility of acceptance of non-conformances. Conclusion is that the AAIE system design is not sufficiently robust to withstand the required production rate. The Government has the right to revoke the AAIE design approval, requiring that the contractor make changes to the AAIE design and submit for approval/prove-out. Note that if the AAIE is inspecting a critical characteristic, the inspection system reliability may be impacted. Corresponding changes to the Critical Characteristic Control Plan (CCCP) may then be needed.

Paragraph (o) Navy Furnished Gages

(o) **Navy Furnished Gages**. When gages are listed in paragraph (o)(9) below, the Navy Special Interface Gage (NSIG) Requirement paragraphs (o)(1) – (o)(8) shall be satisfied.

(1) The NSIG(s) are provided for verification of selected interface dimensions and do not constitute sole acceptance criteria of production items or relieve the contractor of meeting all drawing/specification requirements under the contract.

(2) The contractor is responsible for contacting the Naval Surface Warfare Center (NSWC), Corona Division at least 45 days prior to FAT (if required) or production, for the delivery of NSIG(s).

(3) NSIG(s) will be forwarded to the contractor for joint use by the Government and the contractor. Government furnished NSIG(s) shall not be used by the contractor(s) or subcontractor(s) as in-process or working gage(s).

(4) For production items that fail to be accepted by the applicable NSIG(s), an alternate inspection method may be submitted for approval.

(5) The contractor may substitute contractor designed and built AIE for the NSIG(s) noted in paragraph (o)(9) below. However, the designs require Government (Navy) approval and the contractor AIE hardware requires Government (Navy) certification. AIE designs shall be submitted in accordance with CDRL (DI-QCIC-81960).

(6) The Government (Navy) shall not be responsible for discrepancies or delays in production items resulting through misuse, damage or excessive wear to the NSIG(s).

(7) Calibration and repair of the NSIG(s) shall only be performed as authorized by the NSWC Corona Division. Repair is at no cost to the contractor unless repair is required due to damage to the gages resulting from contractor fault or negligence. Damaged, worn, or otherwise unserviceable NSIG(s) shall be brought to the immediate attention of the CAO and NSWC Corona Division. The contractor shall not make any adjustments, alterations or add permanent markings to NSIG(s) hardware unless specified by the NSIG operating instructions or authorized by the NSWC Corona Division.

(8) Within 45 calendar days after final acceptance of all production items, the NSIG(s) shall be shipped to NSWC Corona Division, ATTN: Receiving Officer, Bldg 575, Gage Laboratory, 1999 Fourth St., Norco, CA 92860-1915. The following shipping and marking specifications are applicable:

(i) Shipping, MIL-STD-2073, "DOD Standard Practice for Military Packaging"
(ii) Marking, MIL-STD-129, "Marking for Shipment and Storage".

(9) The following NSIG(s) shall be provided and are mandatory for use except as noted by paragraph (o)(5) above.

Drawing	Rev	Characteristic	NSIG No.	Qty	Dimensions	Weight	Value

Discussion:

Navy Special Interface Gages (NSIGs) are provided to contractors to assess specific characteristics on Navy-managed Technical Data Packages (TDPs). Should a contractor design and build their own AIE to substitute any NSIG for the characteristics noted in the clause, Government review and approval would be required in accordance with the clause, CDRL (DI-QCIC-81960).

The Naval Surface Warfare Center (NSWC), Corona Division (NSWC Corona), who is responsible for management of Navy NSIGs, uses its precision measurement capabilities, traceable to the National Institute of Standards and Technology (NIST) to ensure the form, fit, and functional requirements of physical interchangeability and mechanical interoperability for gages. Interchangeability is a critical element of product quality with far-reaching implications for the safety, performance and cost of weapons systems. The purpose of interchangeability is to ensure that weapon components work together seamlessly, without selective assembly or modifications. The Interface Assessment Division ensures the interchangeability of weapon systems and sub-systems, solving problems before they happen in combat. Ensuring interchangeability through interface control is essential for successful deployment of battlefield weapons systems. The Gage Certification Laboratory is responsible for the Special Interface Gage Program that supports and provides certification of interface gages and tooling, master tooling and other associated tooling requiring dimensional certification. Certified gages are shipped daily to front-line field units and deployed ships.

The Government-provided NSIGs constitute a part of the AIE for a system; however, these do not constitute sole acceptance. It is the contractor’s responsibility to request the NSIG gage(s) listed in paragraph (o) from NSWC, Corona Division prior to needing the NSIG gage(s). It may take up to 45 days for delivery of the NSIG gage(s). All AIE (whether contractor designed, Government designed, or NSIG) must effectively evaluate all required characteristics of the TDP. Alternate inspection methods must be submitted in accordance with this clause to the Government for review and approval. Damage, misuse or excessive wear due to handling of NSIGs by contractors is not the Government’s responsibility. All measurement systems should be managed in accordance with the requirements of this clause regardless of ownership.

Example

A bullet interfaces with a barrel; to ensure all bullets will fit, the Government may provide interface gages which would simulate the barrel interface features. Another example is a Bomb lug gage which checks the distance between the lug holes to ensure the bomb lug spacing is correct and the bomb will align with the bomb rack without interference.

Drawing	Rev	Characteristic	NSIG No.	Qty	Dimensions	Weight	Value
1234	A	2X1.5" hole	456	1	1'X2'X3'	5 lbs	$2000

The table in the clause is filled out by the Government and notes which drawings and characteristics will require a NSIG. Additional information on the various fields in the table above is as follows:

- ***Drawing No.*** *– The Government drawing number.*
- ***Rev*** *– The revision of the Government drawing.*
- ***Characteristic*** *– The drawing feature the NSIG will inspect.*
- ***NSIG NO.*** *– This is the number assigned to the gage by the Navy.*
- ***QTY*** *– Quantity of NSIGs provided. More than one NSIG may be provided for a particular drawing or characteristic. Contractors should ensure they maintain proper tracking and traceability of any NSIG provided to them as a part of management of their measurement system.*
- ***Dimensions*** *– Dimensions of the box that will contain the NSIG*
- ***Weight*** *– Weight of the box that will contain the NSIG*
- ***Value*** *– Cost of the NSIG*

Note

When an interface gage is specified it is recommended the contractor request the gage within 45 days of needing it. Some gages have a calibration frequency such that if it is requested too early it may need to be sent back to the Gage Lab for recalibration before it is used. The gage lab typically has two sets of gages so arrangements should be made to ensure there is always a calibrated gage to use for final acceptance.

References

1) AMC Regulation Number 702-2, *Quality Assurance – Inspection, Equipment Design, Supply, and Maintenance*, 27 May 1966
2) MIL-A-70625A, *Automated Acceptance Inspection Equipment Design, Testing and Approval of*, 21 April 1989
3) MIL-A-48078A, *Ammunition, Standard Quality Assurance Provisions, General Specifications for*, 16 December 1988
4) MIL-STD-1916, *DoD Preferred Methods for Acceptance of Product*, 01 April 1996
5) MIL-HDBK-1916, *Companion Document to MIL-STD-1916*, 20 April 2004
6) MIL-HDBK-204A, *MILITARY HANDBOOK – Design of Inspection Equipment for Dimensional Characteristics*, 30 November 1990
7) Critical Characteristic Clause Review Guide dated 08 March 2006
8) Lean Six Sigma Green Belt Project, *Guidelines & Procedures for Performing a Prove Out of an Automated Inspection System for a Critical Defect*, 14 April 2008
9) ISO 9001:2008(E) Fourth Edition, *Quality management systems – Requirements,* 15 November 2008
10) Data Item Description, *OT-90-12009 – Acceptance Inspection Equipment Design Documentation,* 15 December 1989
11) Data Item Description, *DI-QCIC-80906 – Calibration System Description,* 06 October 1989
12) Data Item Description, *DI-QCIC-80278B – Calibration and Measurements Requirements Summary (CMRS),* 13 April 2007
13) Data Item Description, *DI-SESS-81004D – Special Inspection Equipment (SIE) Drawings/Models and Associated Lists,* 05 November 2009
14) Data Item Description, *DI-RELI-80322 – Quality Conformance Inspection and Test Procedures,* 20 February 1987
15) Data Item Description, *DI-QCIC-81006 – Special Inspection Equipment Descriptive Documentation,* 11 September 1989
16) Data Item Description, *DI-QCIC-80798B – Calibration Certificate,* 28 March 2005
17) Data Item Description, *DI-DRPR-81004A – Special Inspection Equipment (SIE) Drawings and Associated Lists,* 21 May 1997
18) MIL-STD-963B, *Department of Defense Standard Practice – Data Item Descriptions,* 31 August 1997
19) ASME Y14.43-2011, *Dimensioning and Tolerancing Principles for Gages and Fixtures [Revision of ASME Y14.43-2003 (R2008)]*, 28 January 2003
20) ASME B89.4.10360.2-2008, *Acceptance Test and Reverification Test for Coordinate Measuring Machines*

(CMMs) – Part 2: CMMs Used for Measuring Linear Dimensions, 11 July 2008
21) ASTM E2782-11, *Standard Guide for Measurement System Analysis*, 15 November 2011
22) ASME Y14.100-2004 (Revision of ASME Y14.100-2000), *Engineering Drawing Practices*, 06 September 2005
23) ASME Y14.5-2009, *Dimensioning and Tolerancing*, 27 March 2009
24) ISO 10012-2003, Measurement Management Systems – *Requirements for Measurement Processes and Measuring Equipment*, 15 April 2003
25) ANSI NCSL Z540.3-2006, *American National Standard for Calibration – Requirements for the Calibration of Measuring and Test Equipment*, 03 August 2006
26) National Aerospace Standard (NAS) 410, *NAS Certification & Qualification of Nondestructive Test Personnel*, May 1996
27) ANSI ASNT CP-189-2011, *ASNT Standard 2011 Edition For Qualification and Certification of Nondestructive Testing Personnel*, 01 June 2011
28) SNT-TC-1A 2011 edition, *Personnel Qualification and Certification in Nondestructive Testing*, 2011
29) ASTM-E-543-09, *Standard Specification for Agencies Performing Nondestructive Testing*, 01 June 2009
30) ASTM E 1742-06, *Standard Practice for Radiographic Examination*, 01 July 2006
31) SAE-AMS-STD-2154, Aerospace material Specification, October 2012
32) MIL-STD-2073-1E, *DoD Standard Practice for Military Packaging*, 07 January 2011

ATTACHMENT 1 – MSE Contract Data Requirements List (CDRL) Example

CONTRACT DATA REQUIREMENTS LIST

Form Approved
CMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 110 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 222202-2302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503. Please DO NOT RETURN your form to either of these addresses. Send completed form to the Government Issuing Contracting Officer for the Contract. PR No. listed in Block E.

A. Contract Line Item No.	B. Exhibit	C. Category

D. System/Item.	E. Contract/PR NO.	F. Contractor

1. Data Item No	2. Title of Data Item:	3. Subtitle:
	Measurement System Evaluation (MSE)	

4. Authority (Data Acquisition Document No.)	5. Contract Reference	6. Requiring Office
DI-QCIC-81960	Contract Section E MSE Clause	

7. DD 250 Req	9. Dist Statement Required	10. Frequency	12. Date of First Submission	14. Distribution
	N/A	As required	See BLK 16	
8. APP Code		**11. As of Date**	**13. Date of Subsequent Submission**	
A			See BLK 16	

16. REMARKS

BLK 12: The Contractor shall submit a completed AIE package no later than (120*) calendar days after contract award and no later than (60*) calendar days prior to First Article Testing (if First Article Testing is required), production, and/or all acceptance of product under the contract. The Government will furnish disposition within (45*) calendar days of final AIE package receipt.

BLK 13: If further revisions are necessary, the Contractor shall have (30*) calendar days to generate them and the Government shall have (30*) calendar days to review and respond to them. The approved AIE shall be available for First Article Testing (if First Article Testing is required), production, and/or all acceptance of product under the contract.

If Contractor revises a previously Government accepted AIE for this contract, the revised AIE must be submitted to the Government for review and approval. Approval must be granted before AIE is used for acceptance of product. The Government will respond within (30*) calendar days.

The Contractor shall notify the responsible Government technical agency a minimum of (30*) calendar days prior to acceptance (prove out) testing.

An MSE Review Guide is available to assist Contractors on the ARDEC Public Website in the application of the MSE Clause. The MSE Review Guide's content, in its entirety, is provided solely for REFERENCE and GUIDANCE PURPOSES ONLY- it is not, nor is it intended to be, contractually binding. Accordingly, the information contained within the MSE Review Guide is expressly not, nor shall it be construed to be, incorporated either directly or by reference into the terms of the MSE clause itself nor into the terms and conditions of any underlying contract which contains the MSE clause.

* Number of days may be tailored for programmatic purposes taking into account MSA requirements.

a. Addressee	b. Copies		
	Draft	Final	
		Reg	Repro
PCO	1	1	
COR	1	1	
Tech Agency POCs	1	1	
PQM	1	1	
PM	1	1	
DCMA	1	1	
15. **TOTAL**	**6**	**6**	

G. PREPARED BY	H. DATE	I. APPROVED BY	J. DATE

MSE Contract Data Requirements List (CDRL)

The ordering and delivery of data which the Government requires are specified and scheduled through the use of the Contract Data Requirements List (CDRL), DD Form 1423, in conjunction with the appropriate Data Item Description (DID), DD Form 1664.

This section clarifies a few areas of the MSE CDRL (Attachment 1), which specifies that an AIE package is to be prepared and submitted by the contractor to the Government for review and approval within the recommended timelines identified.

In particular, the primary requirement contained in the MSE CDRL requires the Contractor to prepare an AIE package using Data Item Description, DI-QCIC-81960. It is advantageous for the Contractor to begin preparing the AIE package immediately upon successful notification of contract award. When preparing the AIE package, the Contractor shall meet requirements stipulated in the Measurement System Evaluation (MSE) Clause.

Initial submission of the AIE package using an electronic format such as Microsoft Word or other comparable software is due no later than (120*) calendar after contract award and no later than (60*) calendar days prior to First Article Testing (if First Article Testing is required), production, and/or all acceptance of product under the contract, with Government response due within (45*) calendar days of final AIE package receipt from the Contractor.

Contractor revisions to the AIE package, when required, are to be submitted within (30*) calendar days of the response from the Government. The Government response should be within (30*) calendar days from receipt of the AIE package revisions. The approved AIE shall be available for First Article Testing (if First Article Testing is required), production, and/or all acceptance of product under the contract.

If Contractor revises a previously Government accepted AIE for this contract, the revised AIE must be submitted to the Government for review and approval. Approval must be granted before AIE is used for acceptance of product. The Government will respond within (30*) calendar days.

The Contractor shall notify the responsible Government technical agency a minimum of (30*) calendar days prior to acceptance (prove out) testing.

The contractor should incorporate into their schedules the time required to conduct a Measurement System Analysis (MSA) on any characteristics that may be identified in paragraph (h) of the MSE clause in order to satisfy all contractual timeline requirements.

NOTE – CDRL Distribution Requirements

Technical Agency POCs may include the Design and Development Agency as well as customer representatives based on MIPR requirements.

ATTACHMENT 2 – MSA Contract Data Requirements List (CDRL) Example

CONTRACT DATA REQUIREMENTS LIST

Form Approved
CMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 110 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 222202-2302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503. Please DO NOT RETURN your form to either of these addresses. Send completed form to the Government Issuing Contracting Officer for the Contract. PR No. listed in Block E.

A. Contract Line Item No.	B. Exhibit	C. Category

D. System/Item.	E. Contract/PR NO.	F. Contractor

1. Data Item No	3. Title of Data Item:	3. Subtitle:
	Measurement System Analysis (MSA)	

4. Authority (Data Acquisition Document No.)	5. Contract Reference	6. Requiring Office
DI-QCIC-81960	Contract Section E MSE Clause	

7. DD 250 Req	11. Dist Statement Required	12. Frequency	12. Date of First Submission	14. Distribution
	N/A	As required	See BLK 16	
8. APP Code		**11. As of Date**	**13. Date of Subsequent Submission**	
A			As required	

16. REMARKS

Approval of MSA(s) must be granted before the corresponding AIE can be used or continue to be used for acceptance of product.

BLK 12: The Contractor shall submit a completed MSA package, consisting of the Assessment plan, associated data, and analysis, to the Government for approval no later than (30*) calendar days after Government approval of the AIE submission for the list of characteristics identified in paragraph (h) of the Clause. The Government will furnish disposition within (30*) calendar days of final MSA package receipt.

An MSE Review Guide is available to assist Contractors on the ARDEC Public Website in the application of the MSE Clause. The MSE Review Guide's content, in its entirety, is provided solely for REFERENCE and GUIDANCE PURPOSES ONLY- it is not, nor is it intended to be, contractually binding. Accordingly, the information contained within the MSE Review Guide is expressly not, nor shall it be construed to be, incorporated either directly or by reference into the terms of the MSE clause itself nor into the terms and conditions of any underlying contract which contains the MSE clause.

* Number of days may be tailored for programmatic purposes

a. Addressee	b. Copies		
	Draft	Final	
		Reg	Repro
PCO	1	1	
COR	1	1	
Tech Agency POCs	1	1	
PQM	1	1	
PM	1	1	
DCMA	1	1	
15. **TOTAL**	**6**	**6**	

G. PREPARED BY	H. DATE	I. APPROVED BY	J. DATE

MSA Contract Data Requirements List (CDRL)

This section clarifies a few areas of the MSA CDRL (Attachment 2), which specifies that the Contractor shall submit a completed MSA package, consisting of the Assessment plan, associated data, and analysis, to the Government for approval no later than (30*) calendar days after Government approval of the AIE submission for the list of characteristics identified in paragraph (h) of the Clause. The Government will furnish disposition within (30*) calendar days of final MSA package receipt.

Approval of the MSA(s) must be granted before the corresponding AIE can be used or continue to be used for acceptance of product.

NOTE – CDRL Distribution Requirements

Technical Agency POCs may include the Design and Development Agency as well as customer representatives based on MIPR requirements.

ATTACHMENT 3 – DATA ITEM DESCRIPTION (DID)
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DATA ITEM DESCRIPTION
Title: MEASUREMENT SYSTEM EVALUATION (MSE) – MEASUREMENT AND INSPECTION EQUIPMENT SYSTEM DESIGN DOCUMENTATION FOR ACCEPTANCE OF PRODUCT

Number: DI-QCIC-81960
ASMC Number:
DTIC Applicable: N/A
Office of Primary Responsibility: RDAR-QES-E
Applicable Forms: N/A
Approval Date: 25 February 2014
Limitation: N/A
GIDEP Applicable: No

Use/relationship: The Measurement and Inspection Equipment System Design documentation for Acceptance of Product describes the Acceptance Inspection Equipment (AIE), Automated AIE (AAIE), and various measurement systems, used to meet the inspection and test requirements to deliver units and other end products that conform to contract, specification, QAP, and drawing requirements. This documentation is used to evaluate the acceptability of these designs to meet contract requirements.

a. This Data Item Description (DID) contains the format and content preparation instructions for the data product generated by the specific requirement delineated in the contract.

b. This DID is applicable to all AIE as required by the contract.

Requirements:

1. Reference Documents. The applicable documents cited herein, including their approval dates and dates of any applicable amendments, notices, and revisions, shall be as cited in contract documentation.

2. Format. Contractor's format is acceptable.

3. Content. All AIE package shall include the following (as applicable).

3.1 Cover Sheet. Cover sheet information includes the following:

a. Prime contractor name, address, and contact information.
b. Contract number.
c. Nomenclature of item(s) being produced under contract.
d. Applicable drawing(s), specifications, and Quality Assurance Provisions (QAPs).
e. Date and revision of "New" or "Revised" documentation.
f. Sub-component or assembly (if applicable).
g. Subcontractor(s) name, address, and contact information (if applicable).

3.2 Measuring and Inspection Equipment System Design Documentation. Measuring and inspection equipment system design documentation covers a variety of measurement systems and equipment used to evaluate acceptability of units to meet requirements. See ISO 9000 paragraph 3.8.2, Inspection and 3.10.4, Measuring Equipment.

3.3 Master List / Matrix. A detailed Master List or Matrix cross references each characteristic and its inspection requirement from the applicable drawings, specifications, and QAPs with the proposed inspection methods and equipment. The Master List or Matrix information includes the following:

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a. Drawing, specification or QAP number with revision and date of item being inspected.
b. Amendments, Engineering Change Proposals (ECPs), Notices of Revision (NORs), etc.
c. Specification or QAP paragraph number.
d. Drawing, specification, or QAP characteristic letter/number, description, and inspection requirement.
e. Inspection method with AIE identification with description, revision, and date.
f. Clearly indicate any revisions from previous submission(s).

3.4 Go-No Go/Functional Gages. Gage information includes the following:

a. Gage drawing number (design identification) with revision and date.
b. Drawings showing gage dimensions with tolerances.
c. Drawings showing gage material with surface finish and hardness of contacting gage elements.
d. Associated inspection procedures and theory of operation (as required, see ISO 10012).

3.5 Standard Measurement Equipment (SME). SME information includes the following:

a. Manufacturer, model, resolution, and accuracy.
b. Associated inspection procedures and theory of operation (as required, see ISO 10012).

3.6 Special Inspection Equipment/Methods. It includes Coordinate Measuring Machines (CMM), Tool Control (TC), Non-Destructive Testing (NDT), Automated Acceptance Inspection Equipment (AAIE), Destructive, Environmental, and Functional Test Equipment. It also includes inspection equipment that is not commercially available along with the corresponding design drawings.

a. **Coordinate Measuring Machine (CMM)**. CMM information includes the following per ASME B89.4.10360.2-2008:

i. Establishment of the geometry (Datums) and inspection process of the desired characteristic by the CMM. Include the number and location of probe hits to establish geometry (Datums) and any axis necessary to adequately inspect the feature.
ii. Environmental conditions and limits which may influence measurements.
iii. Operating procedures including machine start/warm up cycles, probing system qualification, probe cleaning, and probe calibrations.
iv. Periodic reverification tests in accordance with the user's specification and manufacturer's procedures including repeatability of point coordinates and length measurement and repeatability.
v. Interim checks between periodic reverifications.
vi. Procedure for checking the CMM immediately after a significant event which could impact CMM performance.

b. **Tool Control (TC)**. Tool Control information includes the following:

i. Measurements of form tools (punches, dies, molds, etc.) and correlation data between tool dimension and component dimension.
ii. Inspection frequency and gages used to measure the form tooling.
iii. Process control parameters that affect the component dimension.

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iv. Procedures for tool control inspection including out of tolerance tool control dimension procedures, corrective action plans, and segregation of product since last successful inspection.

c. **Non-Destructive Testing (NDT)**. NDT information includes the following:

i. Written procedures for the qualification and certification of NDT personnel and the certification records for each inspector, as described in NAS410 (NAS Certification & Qualification of NDT Personnel), ANSI/ASNT-CP-189 (ASNT Standard for Qualification and Certification of NDT Personnel), or SNT-TC-1A (Recommended Practice for Personnel Qualification and Certification in NDT), and additional procedures identified by the Government.

ii. Records for other certification standards shall identify the applicable standard and confirm the levels of qualification of individuals responsible for acceptance of product to be consistent with those defined in the standard.

iii. The design documentation, specific application techniques, and operating procedures in accordance with ASTM E 543 (Standard Specification for Agencies Performing Nondestructive Testing) and the applicable nationally recognized standard practice(s) specific to the NDT method(s) employed on the contract, such as ASTM E-1742 (Standard Practice for Radiographic Examination) and SAE-AMS-STD-2154 (Inspection, Ultrasonic, Wrought Metals, Process For).

iv. Documentation on application techniques shall identify the applicable standard(s) utilized.

d. **Automated Acceptance Inspection Equipment (AAIE) & Complex Designs**. For AAE designs that are complex in nature, (e.g., open set-up, computer controlled, numerically controlled, multistation, and acceptance inspection equipment which is part of an integrated production and assembly system) the following information is to be provided:

i. Concept designs (MIL-A-70625A, p. 3, paragraph 3.2.1) includes:
(1) Sketches of the inspecting elements.
(2) Theory of operation including mechanical, electrical, and unique software operating conditions with associated logic flow diagrams.
(3) Description of the calibration and verification programs and standards.
(4) Description of all fail-safe measures that lead to rejection of Unit Under Test (UUT).
(5) A proposed test plan to qualify the accuracy of inspection and correctness of accept or reject decisions and resultant actions.
(6) Manufacturer, model, resolution, and accuracy of any commercial device to be incorporated in the design.
(7) A method for verifying the integrity of the code (e.g., checksum or cyclic redundancy check).

ii. Detailed proposed designs (MIL-A-70625A, p. 4, paragraph 3.2.2) include:

a. After concept approval and before any fabrication:
(1) Drawings of the inspecting elements.
(2) Proposed system operation including mechanical, electrical, and unique software operating conditions with associated logic flow diagrams. Drawings of the calibration or verification standards.
(3) The computer test program to include software version, software design parameters, and flow charts showing acceptance/rejection settings and

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computer generated test stimuli (as differentiated from computer controlled standard test equipment stimuli).
(4) Schematic or block diagram of test and measuring circuits where applicable.
(5) Layout or block diagram showing overall equipment arrangement and interconnection, including the Unit Under Test (UUT).
(6) Details of adapters, cables, holding fixtures and like items as applicable.

b. Before performing the test to qualify the AIE:
(1) Setup, calibration, operation, and verification instructions.
(2) The final test plan.
(3) Computer test program, acceptance/rejection settings and a flow diagram.
(4) Detailed operating instructions indicating application of the AIE and the acceptance/rejection settings.
(5) The calibration program for each item of computer controlled test equipment and a sample printout of an actual test and calibration.
(6) A printout of the work instructions which are displayed for the operator.

iii. Final designs (MIL-A-70625A, p. 6, paragraph 3.2.5) include:

(1) Results of the test including data generated, printout of test results (when normally generated), unique software test results, and calibration results.
(2) Design depicting the equipment as it was tested.
(3) Setup, calibration, operation, and verification procedures
(4) Calibration and verification records.

e. **Destructive, Environmental, and Functional Test Equipment**. For Destructive, Environmental, and Functional (DEF) test equipment, the following information is to be provided:

i. Proposed AIE designs include:
(1) Theory of operation.
(2) Detailed drawings or sketches of the inspecting and testing elements and sufficient detail for supporting elements to facilitate evaluation for adequacy.
(3) Manufacturer, model, resolution, and accuracy of any commercial device to be incorporated in the design along with any modifications in design or use.
(4) Description of the calibration and verification programs and standards.
(5) A proposed test plan to qualify the accuracy of inspection and correctness of accept or reject decisions and resultant actions (as required).
(6) Setup, calibration, operation, and verification procedures and parameters.
(7) Settings, test conditions, calculations, and verification.
(8) Calibration and verification records.

ii. When DEF test equipment consists of AAIE or complex Designs, AIE design submissions shall include the requirements of paragraph 3.6.d above.

f. **Measurement Systems Analysis (MSA)**. MSA is any of a number of specialized methods useful for studying a measurement system and its properties (ASTM E2782, paragraph 3.1.7).

There are several basic properties of measurement systems that are widely recognized among practitioners. These are repeatability, reproducibility, linearity, bias, stability,

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consistency, and resolution (ASTM E2782, paragraph 5.4). An MSA is to include these properties, as applicable.

End of DI-QCIC-81960

Data Item Description (DID)

The Data Item Description identifies the content and format requirements for data required from the contractor to be prepared for use by the Government. The DID specifically defines the data content, format, and intended use.

In particular, this DID references Special Inspection Equipment and Methods as well as outlines the recommended content and format requirements for AIE submissions contractors are to provide to the Government for review and approval. Basically, all AIE submissions shall contain documents and information sufficient to allow a complete understanding and evaluation of the proposed equipment.

This section of the review guide helps clarify a few areas of the DID that have not yet been addressed within this review guide.

3.6 Special Inspection Equipment/Methods. It includes Coordinate Measuring Machines (CMM), Tool Control (TC), Non-Destructive Testing (NDT), Automated Acceptance Inspection Equipment (AAIE), Destructive, Environmental, and Functional Test Equipment. It also includes inspection equipment that is not commercially available along with the corresponding design drawings.

3.6(a) Coordinate Measuring Machines (CMMs). For purposes of this review guide, CMMs are categorized as "Special Inspection Equipment" used for the inspection of a variety of characteristics. The following is an example of CMMs as inspection equipment and how these are used.

NOTE

Coordinate measuring machines (CMMS) locate, measure, and determine the size and shape of product features in two and sometimes three mutually perpendicular planes—i.e., along the x-, y-, and sometimes z-axes. These very accurate machines were developed from precision layout machines to satisfy the need for increased inspection rates and high accuracy. The basic elements of a CMM are a staging table, a movable member (the "gage head") that carries a sensing device, and a displacement-measuring device. The movable member operates in guideways that allow smooth and precise travel in the axial directions. In some machines the staging table is mounted in guideways and is

movable in the two horizontal directions, which afford additional flexibility. The product to be inspected is mounted on the staging table, the sensing device is brought into contact with the reference surface, the displacement reading is zeroed, the sensing device is brought into contact with the surface being inspected, and the displacement of the probe is displayed or recorded by a displacement-measuring device. Because CMMS often are manufactured for a specific purpose, the range of maximum dimensions that can be inspected varies from a few inches to 10 ft or more.

Because CMMs measure displacement along all three axes, the operator must ensure that sufficient readings are taken to define the feature being inspected. For example, a minimum of three points is required to define a circle. Thus inspection with a CMM of the diameter of a hole would require at least three “hits” of the sensing device on the surface of the hole. See Figure 1 below. Likewise, there are a minimum number of points required to define completely any other geometric feature. In CMM parlance this is known as the “minimum number of hits” for adequate inspection. The inspection of form or of more complex features, such as runout or true position, requires additional hits.

For example three hits on a hole that has a tolerance of +/- 0.030 may be sufficient; however three hits on a hole that has a tolerance +/- 0.001 may not be sufficient. Six hits on a +/- 0.001 hole would give a more accurate hole diameter because more points of the hole are being calculated. Another example is picking up a datum surface with a CMM. In order to accurately define the surface several hits may need to be taken; however if the CMM table (known flat and calibrated surface) is used as a datum simulator the three highest points would contact the table, only a few points would be necessary. Something to be mindful of are position tolerances checked with a CMM. For instance many times you see features, like holes, checked at one location. For a position the hole should be checked at two locations to establish its axis.

The AIE documentation should describe the location and number of hits to establish the datums and the number of hits and location to measure the feature(s). Because there is no standard for the number/location of hits on a feature/part it is recommended that Final approval be given after Government witness the CMM inspection for classified characteristics. What is an effective number/location of hits to properly inspect the feature should be agreed to by the Government and the Contractor.

Disadvantages of CMMs are that extreme operator care and frequent calibration are required to achieve the stated accuracy. Also inconsistent orientation of the sensing probe through a set of readings can contribute to errors caused by misalignment between the probe and the table, runout in the probe, or perpendicularity errors among the x-, y-, and z-axes.

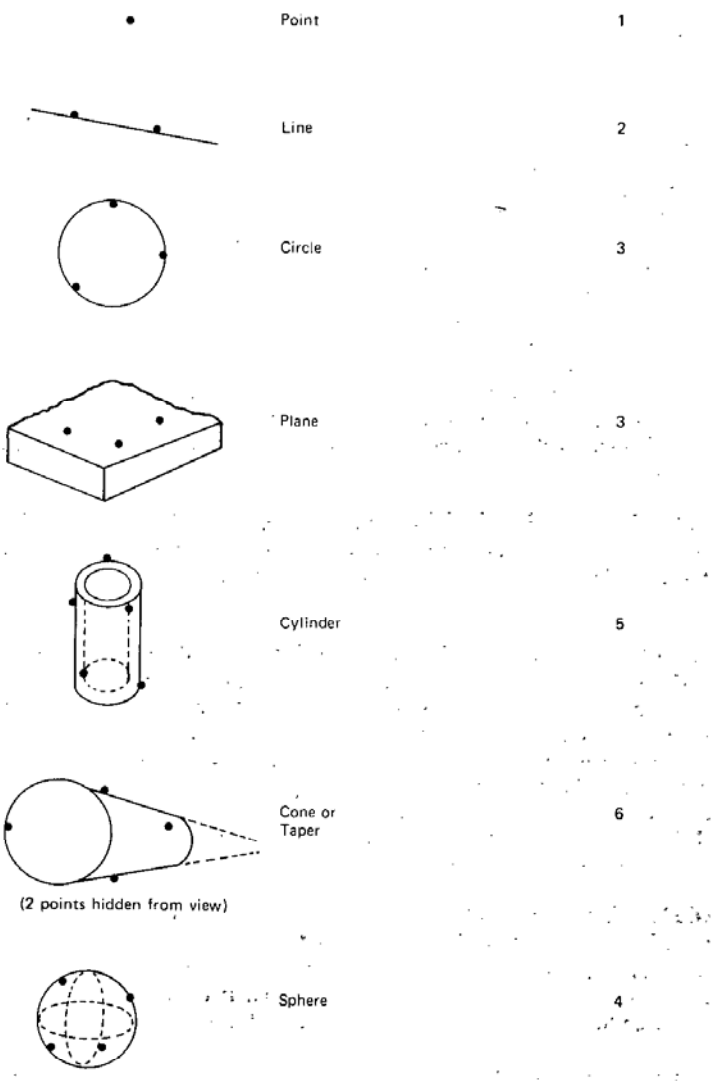

Figure 3-39. Minimum Number of Hits for CMM Inspection

Figure 1 – Minimum Number of Hits for CMM Inspection
(See MIL-HDBK-204A, p. 3-36, Figure 3-39)

Data Item Description (DID)(Continued)

3.6 Special Inspection Equipment/Methods. It includes Coordinate Measuring Machines (CMM), Tool Control (TC), Non-Destructive Testing (NDT), Automated Acceptance Inspection Equipment (AAIE), Destructive, Environmental, and Functional Test Equipment. It also includes inspection equipment that is not commercially available along with the corresponding design drawings.

3.6(b) Tool Control (TC). For purposes of this review guide, TC is categorized as a "Special Inspection Method" used for the inspection of a variety of characteristics. TC is used in circumstances where the desired characteristic to be inspected is too difficult to inspect directly.

When Tool Control is used the contractor shall provide a plan/procedure for ensuring, at a minimum, the following:

1. Measurements of form tools (punches, dies, molds, etc.) may be substituted provided the Contractor has established correlation between the tool dimension and the component dimension prior to substitution.
2. When correlation has been determined, inspection of the form tool dimensions will be permitted.
3. Inspection frequency and gages used to measure the form tooling shall be submitted for approval. Process controls/parameters shall be submitted if they affect the component dimension.
4. Procedures to be followed when an out of tolerance tool control dimension is discovered. Procedures shall contain actions to correct the tool problem and reject all material produced since the last successful tool inspection.

Example

A punch die is designed and manufactured to simultaneously punch out a pattern consisting of several holes that are dimensioned for "true position" in a manner that is pre-set in the die and cannot be adjusted/changed without completely re-tooling the die. Since the true position of the holes cannot change, design documentation and measurement of the die can be submitted for approval as a means of acceptance for the true position.

Data Item Description (DID)(Continued)

3.6 Special Inspection Equipment/Methods. It includes Coordinate Measuring Machines (CMM), Tool Control (TC), Non-Destructive Testing (NDT), Automated Acceptance Inspection Equipment (AAIE), Destructive, Environmental, and Functional Test Equipment. It also includes inspection equipment that is not commercially available along with the corresponding design drawings.

3.6(e) Destructive, Environmental, and Functional Test Equipment. For purposes of this review guide Destructive, Environmental, and Functional (DEF) test equipment refers to AIE that is used at contractor's proving ground facilities, laboratories, etc. and the AIE information that is to be provided to the Government for review and approval.

Whenever a weapon/ammunition item is tested at a contractor's facilities, documentation corresponding to all AIE that will be used to make an accept/reject decision regarding the item is to be submitted to the Government for review and approval.

Data Item Description (DID)(Continued)

3.6 Special Inspection Equipment/Methods. It includes Coordinate Measuring Machines (CMM), Tool Control (TC), Non-Destructive Testing (NDT), Automated Acceptance Inspection Equipment (AAIE), Destructive, Environmental, and Functional Test Equipment. It also includes inspection equipment that is not commercially available along with the corresponding design drawings.

Inspection Equipment not commercially available. Inspection equipment that is not commercially available includes AIE designed and fabricated exclusively to inspect certain TDP characteristics. The corresponding design drawings shall be submitted for review and approval and shall be maintained.

Figure 2 – AIE Review Process Flow Chart

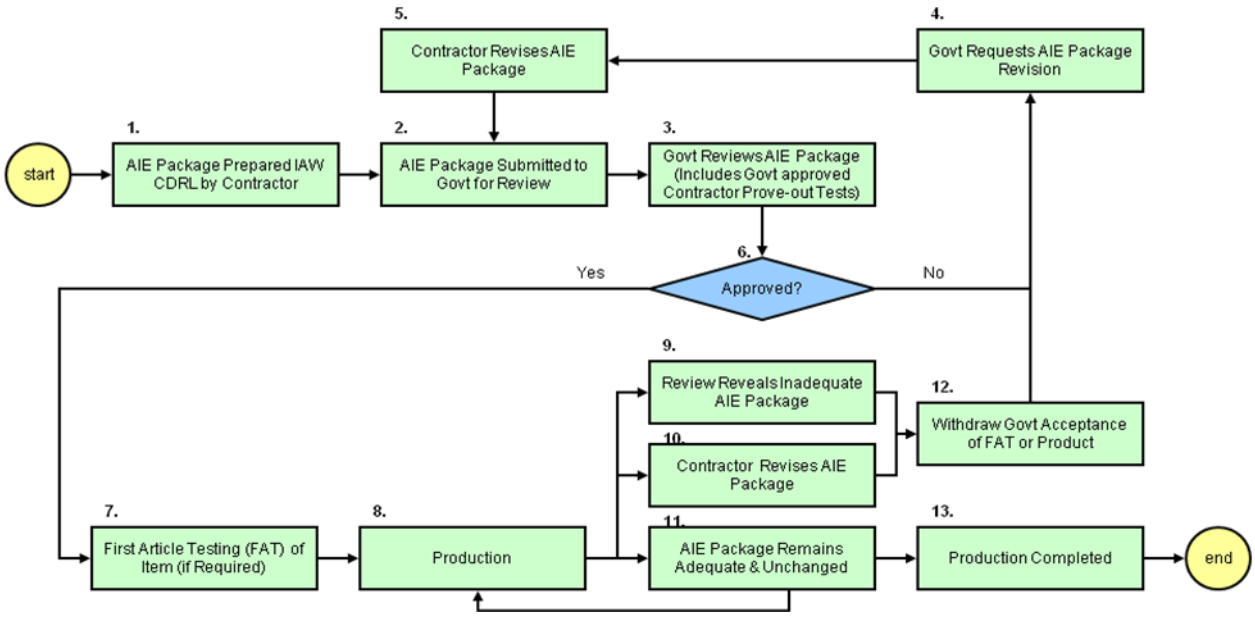

Figure 2 above depicts how the AIE Review Process works:

1. Prior to FAT (if FAT is required) or prior to use for acceptance of production item(s), AIE packages must be prepared by the contractor and submitted to the Government for review and approval.
2. The Government reviews the AIE package and determines whether or not the proposed AIE is acceptable for inspecting the characteristics of item(s) being produced.
3. If approved by the Government, the contractor is allowed to use that exact equipment to inspect item(s) during FAT and/or production.
4. If the AIE package is not approved by the Government, the contractor is allowed to revise the package and resubmit it. Return to Step 2.
5. If there are changes to the approved AIE at any point during the contract, the change must be approved by the Government prior to its implementation. If any of the approved AIE is found to be inadequate, the AIE in question must be corrected and approved by the Government.