National Nuclear Security Administration

Weapon Quality Assurance

Qualification Standard

Reference Guide

AUGUST 2009

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Acronyms	
ACO	advance change order
AER	advance engineering release
ANSI	American National Standards Institute
CCL	commercial calibration laboratory
CEPPC	component evaluation program planning committee
CER	complete engineering release
COI	certification of inspection
CSL	contractor standards laboratory
DA	design agency
DCS	designated calibration source
DER	development engineering release
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
DTER	drawing transfer engineering release
EA	engineering authorization
ECR	engineering change release
EE	engineering evaluation
EER	engineering evaluation release
ESR	evaluation status release
FAQS	functional area qualification standard
FCO	final change order
FPU	first production unit
IER	information engineering release
IP	interproject
IPG	interproject group
JTA	joint test assembly
KCP	Kansas City Plant
KSA	knowledge, skills, and abilities
LANL	Los Alamos National Laboratory
LLC	limited life component
LLNL	Lawrence Livermore National Laboratory
M&O	management and operating
M&TE	measuring and testing equipment
NDT	nondestructive test
NIST	National Institute of Standards and Technology
NMFT	new material flight test
NMLT	new material laboratory test
NMSEP	New Material Stockpile Evaluation Plan
NNSA	National Nuclear Security Administration
NWC	nuclear Weapon complex
OIG	Office of the Inspector General
ORPS	occurrence reporting and processing system

Acronyms	
PA	production agency
PCD	program control document
POC	point of contact
PPD	production program definition
PQ	qualification plan
PRT	production realization team
PSL	Primary Standards Laboratory
QA	quality assurance
QAA	quality assurance agency
QADR	quality assurance defect report
QAIP	quality assurance inspection procedure
QAP	quality assurance program
QAS	quality assurance survey
QER	qualification evaluation release
QIL	quality instruction list
RDG	retirement disposition groups
RDI	retirement disposition instructions
REN	re-evaluation notice
REST	retrofit evaluation system test
S/CI	suspect/counterfeit item
SCP	standards and calibration program
SFI	significant finding investigation
SIER	special instruction engineering release
SNL	Sandia National Laboratories
SO	Secretarial Officer
SQA	software quality assurance
SXN	specification exception notice
SXR	specification exception release
TBP	technical business practice
TQP	Technical Qualification Program
UK	United Kingdom
UU	ultimate user
WEPPC	weapon evaluation program planning committee
WR	war reserve

PURPOSE

The purpose of this reference guide is to provide a document that contains the information required for a Department of Energy (DOE)/National Nuclear Security Administration (NNSA) technical employee to successfully complete the Weapon Quality Assurance Functional Area Qualification Standard (FAQS). Information essential to meeting the qualification requirements is provided; however, some competency statements require extensive knowledge or skill development. Reproducing all the required information for those statements in this document is not practical. In those instances, references are included to guide the candidate to additional resources.

SCOPE

This reference guide addresses the competency statements in the August 2008 edition of DOE-STD-1025-2008, *Weapon Quality Assurance Functional Area Qualification Standard*. The qualification standard contains 28 competency statements within 2 sections.

Please direct questions or comments related to this document to the NNSA Learning and Career Development Department.

Competency statements and supporting knowledge and/or skill statements from the qualification standard are shown in contrasting bold type, while the corresponding information associated with each statement is provided below it.

A comprehensive list of acronyms and abbreviations is found at the beginning of this document. It is recommended that the candidate review the list prior to proceeding with the competencies, as the acronyms and abbreviations may not be further defined within the text unless special emphasis is required.

The competencies and supporting knowledge, skill, and ability (KSA) statements are taken directly from the FAQS. Most corrections to spelling, punctuation, and grammar have been made without remark, and all document-related titles, which variously appear in roman or italic type or set within quotation marks, have been changed to plain text, also mostly without remark. Capitalized terms are found as such in the qualification standard and remain so in this reference guide. When needed for clarification, explanations are enclosed in brackets.

Every effort has been made to provide the most current information and references available as of August 2009. However, the candidate is advised to verify the applicability of the information provided. It is recognized that some personnel may oversee facilities that utilize predecessor documents to those identified. In those cases, such documents should be included in local qualification standards via the Technical Qualification Program (TQP).

In the cases where information about an FAQS topic in a competency or KSA statement is not available in the newest edition of a standard (consensus or industry), an older version is referenced. These references are noted in the text and in the bibliography.

Unless noted otherwise, a specific reference in a competency statement to a regulation, directive, or other industry or consensus standard is the source of the discussion text. Some of the directives referred to have been archived.

TECHNICAL COMPETENCIES

Weapon Quality Assurance Specialist

General Technical

1. Weapon Quality Assurance Specialist shall demonstrate a working level knowledge of geometric dimensions and tolerances.

a. Explain the purpose and use of dimensions and tolerances.

The following is taken fromDOE-STD-1016/2-93.

For any engineering fabrication, construction, or architectural drawing to be of value, exact information concerning the various dimensions and their tolerances must be provided by the drawing. Drawings usually denote dimensions and tolerances per the American National Standards Institute (ANSI) standards. These standards are explained in detail in Dimensioning and Tolerancing, ANSI Y14.5M - 1982.

Dimensions on a drawing can be expressed in one of two ways. In the first method, the drawing is drafted to scale and any measurement is obtained by measuring the drawing and correcting for the scale. In the second method, the actual dimensions of the component are specified on the drawing. The second method is the preferred method because it reduces the chances of error and allows greater accuracy and drawing flexibility. Because even the simplest component has several dimensions that must be stated (and each dimension must have a tolerance), a drawing can quickly become cluttered with dimensions. To reduce this problem, the ANSI standards provide rules and conventions for dimensioning a drawing. The basic rules and conventions must be understood before a dimensioned drawing can be correctly read.

When a drawing is dimensioned, each dimension must have a tolerance. In many cases, the tolerance is not stated, but is set to an implied standard. An example is the blueprint for a house. The measurements are not usually given stated tolerances, but it is implied that the carpenter will build the building to the normal tolerances of his trade (1/8-1/4 inch), and the design and use of the blueprints allow for this kind of error. Another method of expressing tolerances on a drawing is to state in the title block, or in a note, a global tolerance for all measurements on the drawing.

The last method is to state the tolerance for a specified dimension with the measurement. This method is usually used in conjunction with one of the other two tolerancing methods. This type of notation is commonly used for a dimension that requires a higher level of accuracy than the remainder of the drawing.

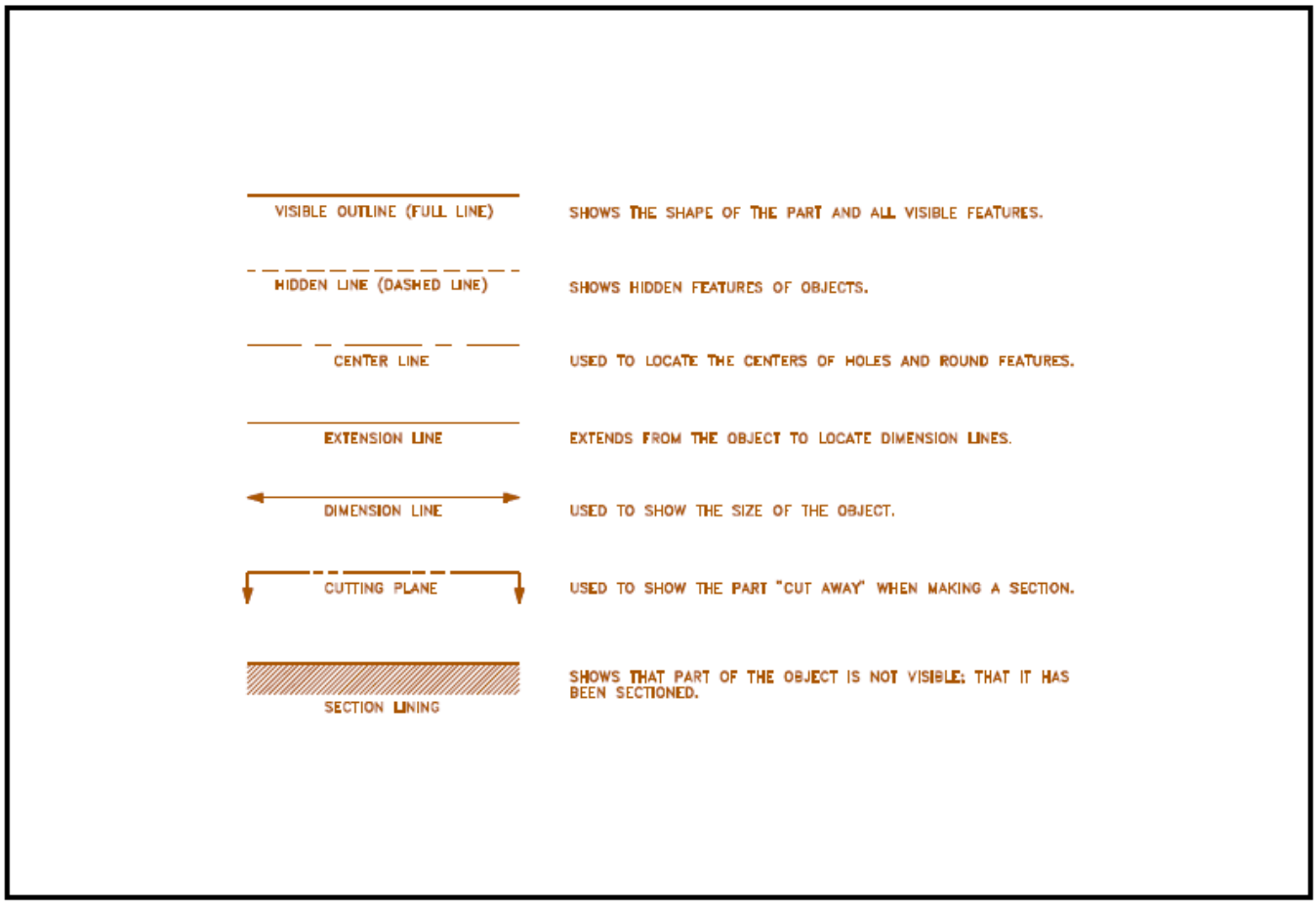
Tolerances are applied to more than just linear dimensions, such as 1 ± 0.1 inches. They can apply to any dimension, including the radius, the degree of out-of-round, the allowable out-of square, the surface condition, or any other parameter that affects the shape and size of the object. These types of tolerances are called geometric tolerances. Geometric tolerances state

the maximum allowable variation of a form or its position from the perfect geometry implied on the drawing. The term geometry refers to various forms, such as a plane, a cylinder, a cone, a square, or a hexagon. Theoretically these are perfect forms, but because it is impossible to produce perfect forms, it may be necessary to specify the amount of variation permitted. These tolerances specify either the diameter or the width of a tolerance zone within which a surface or the axis of a cylinder or a hole must be if the part is to meet the required accuracy for proper function and fit.

b. Demonstrate knowledge and use of the dimensions and tolerances on product drawings and specifications.

The following is taken fromDOE-STD-1016/2-93.

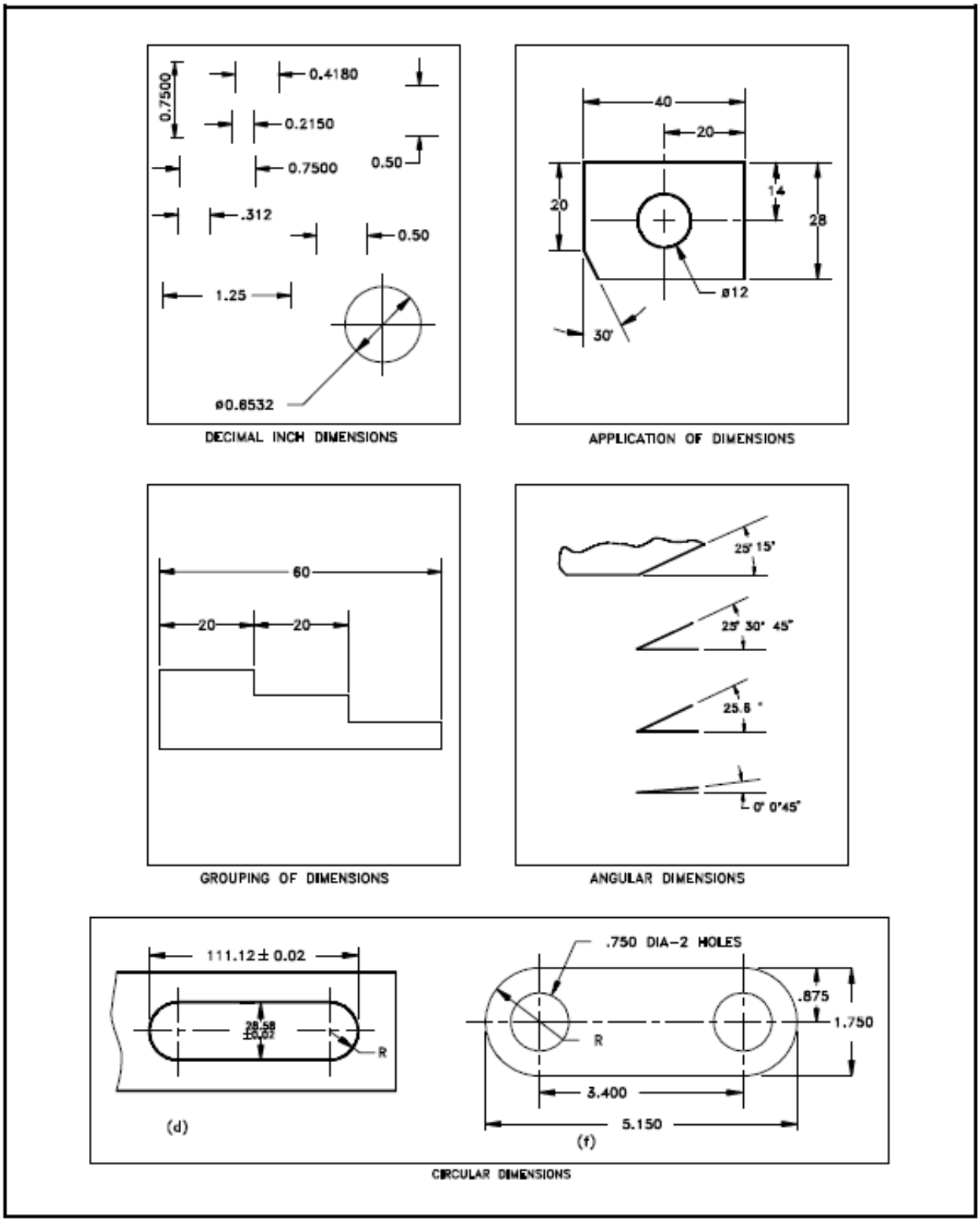
When actual dimensions are specified on a print, the basic line symbols that are illustrated by figure 1 are used.



Source: DOE-HDBK-1016/2-93

Figure 1. Types of dimensioning lines

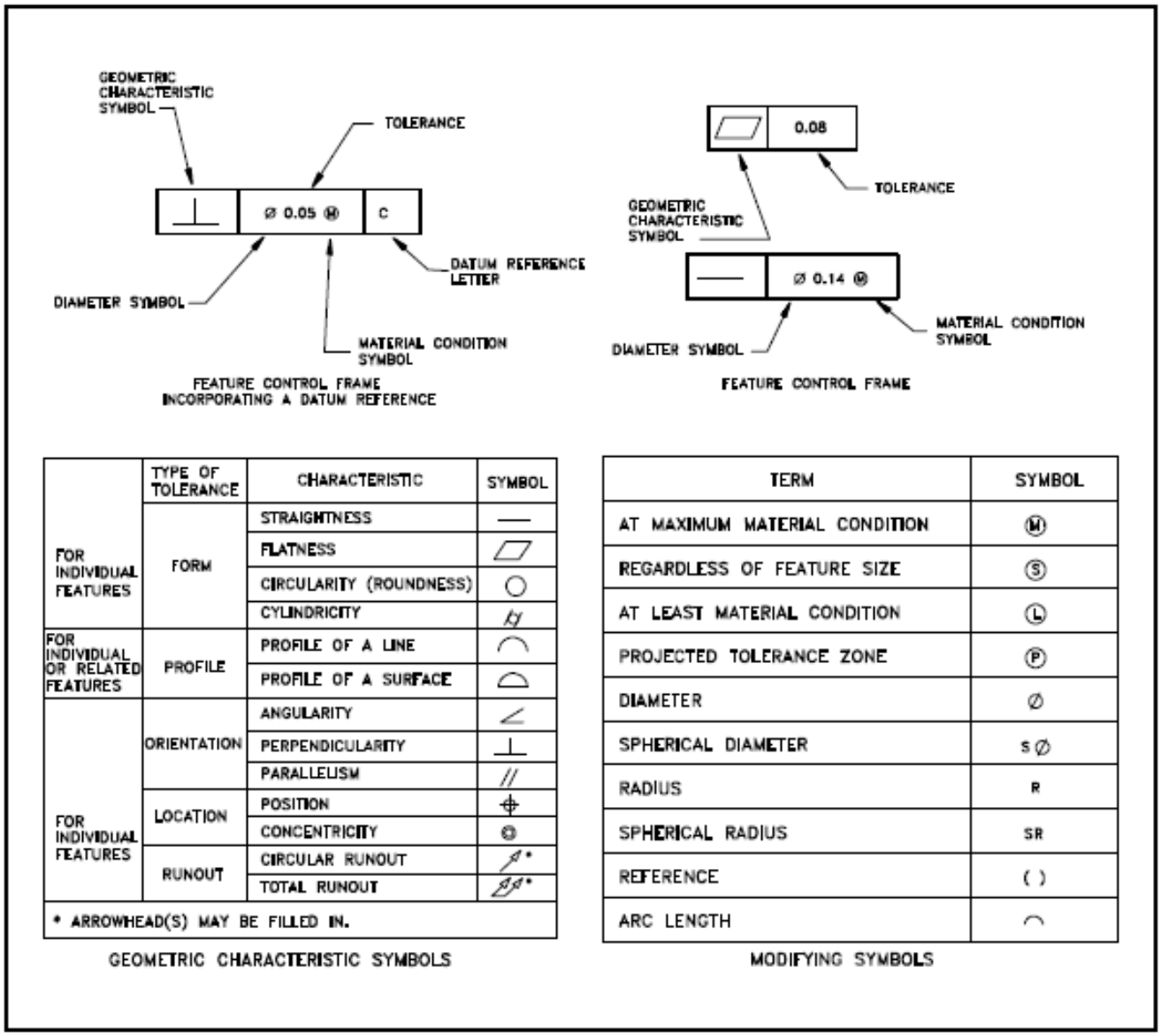
Figure 2 provides examples of the various methods used on drawings to indicate linear, circular, and angular dimensions.



Source: DOE-HDBK-1016/2-93

Figure 2. Example of dimensioning notation

The methods of indicating geometric tolerances by means of geometric characteristic symbols are shown in figure 3. Examples of tolerance symbology are shown in figure 4.



	TYPE OF TOLERANCE	CHARACTERISTIC	SYMBOL
FOR INDIVIDUAL FEATURES	FORM	STRAIGHTNESS	—
		FLATNESS	▱
		CIRCULARITY (ROUNDNESS)	○
		CYLINDRICITY	⌭
FOR INDIVIDUAL OR RELATED FEATURES	PROFILE	PROFILE OF A LINE	⌒
		PROFILE OF A SURFACE	⌓
FOR INDIVIDUAL FEATURES	ORIENTATION	ANGULARITY	∠
		PERPENDICULARITY	⊥
		PARALLELISM	//
	LOCATION	POSITION	⌖
		CONCENTRICITY	◎
	RUNOUT	CIRCULAR RUNOUT	↗*
		TOTAL RUNOUT	⌰*
* ARROWHEAD(S) MAY BE FILLED IN.			

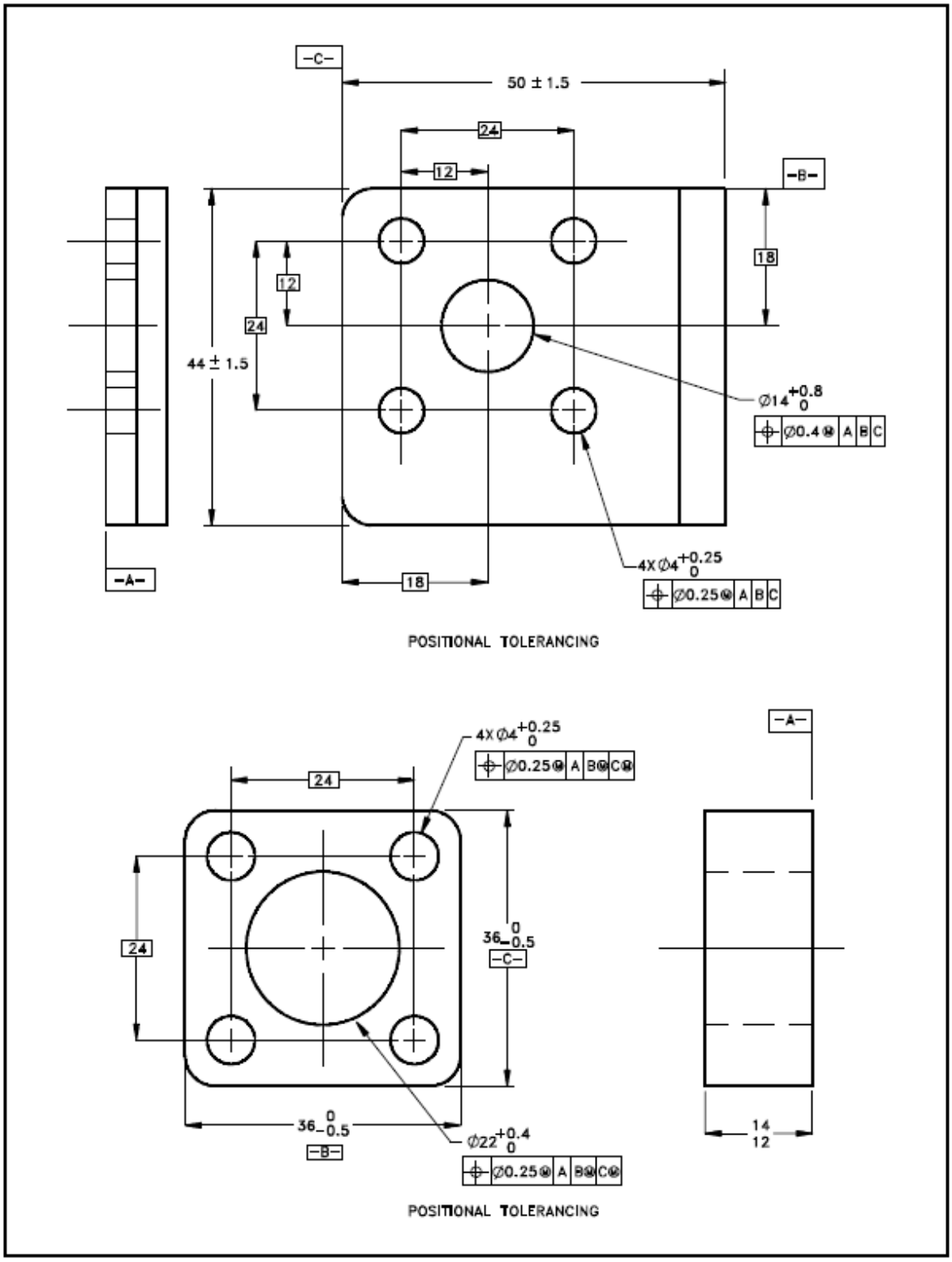
GEOMETRIC CHARACTERISTIC SYMBOLS

TERM	SYMBOL
AT MAXIMUM MATERIAL CONDITION	Ⓜ
REGARDLESS OF FEATURE SIZE	Ⓢ
AT LEAST MATERIAL CONDITION	Ⓛ
PROJECTED TOLERANCE ZONE	Ⓟ
DIAMETER	Ø
SPHERICAL DIAMETER	SØ
RADIUS	R
SPHERICAL RADIUS	SR
REFERENCE	( )
ARC LENGTH	⌒

MODIFYING SYMBOLS

Source: DOE-HDBK-1016/2-93

Figure 3. Symbology used in tolerancing drawings

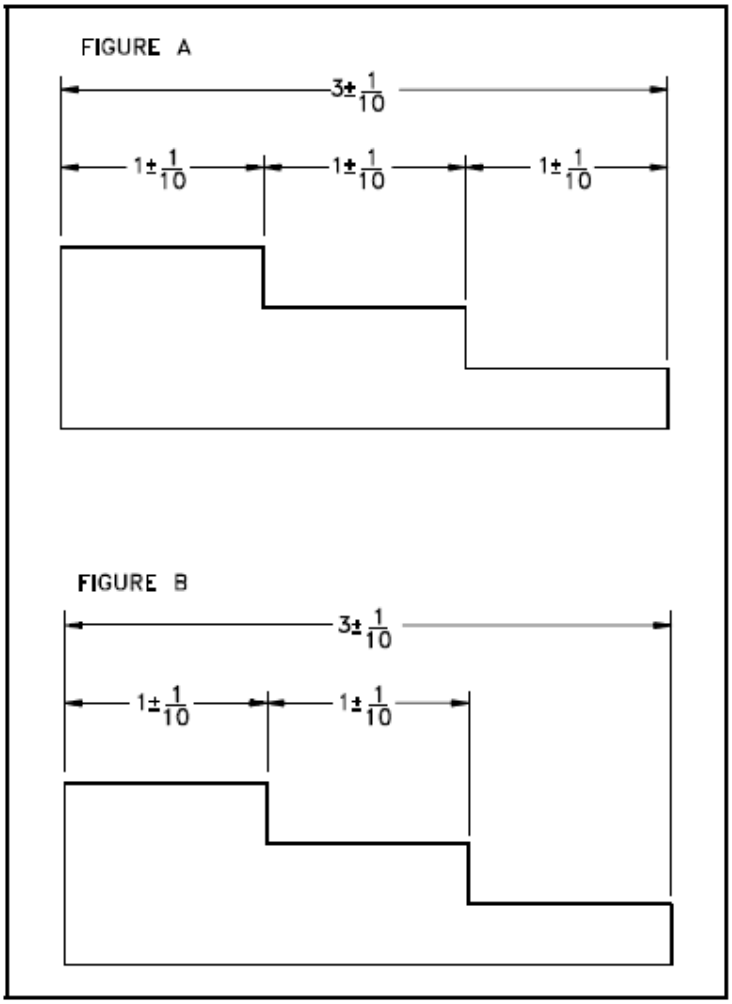


Source: DOE-HDBK-1016/2-93

Figure 4. Examples of tolerance symbology

Because tolerances allow a part or the placement of a part or feature to vary or have a range, all of an object's dimensions can not be specified. This allows the unspecified, and therefore nontoleranced, dimension to absorb the errors in the critical dimensions. As illustrated in Figure 5 (A) for example, all of the internal dimensions plus each dimension's maximum tolerance adds up to more than the specified overall dimension and its maximum tolerance. In this case the length of each step plus its maximum tolerance is 1 1/10 inches, for a maximum object length of 3 3/10 inches. However the drawing also specifies that the total length of the object cannot exceed 3 1/10 inches. A drawing dimensioned in this manner is not correct, and one of the following changes must be made if the part is to be correctly manufactured.

To prevent this type of conflict, the designer must either specify different tolerances for each of the dimensions so that the length of each smaller dimension plus its maximum error adds up to a value within the overall dimension plus its tolerance, or leave one of the dimensions off, as illustrated in figure 5 (B) (the preferred method).



Source: DOE-HDBK-1016/2-93

Figure 5. Example of tolerancing

2. Weapon Quality Assurance Specialist shall demonstrate a working level knowledge of testing and inspection methods and processes used in weapons certification activities.

a. Discuss the types and applications of nondestructive/destructive testing.

Nondestructive Testing

The following is taken from the Nondestructive Testing Encyclopedia.

Nondestructive tests (NDT) are noninvasive techniques to determine the integrity of a material, component, or structure or quantitatively measure some characteristic of an object. In contrast to destructive testing, NDT is an assessment without doing harm, stress or destroying the test object. The destruction of the test object usually makes destructive testing more costly and it is also inappropriate in many circumstances.

Table 1 displays popular NDT methods, their applications, and limitations.

Table 1. NDT methods

NDT Method	Applications	Limitations
Liquid Penetrant	▪ Used on nonporous materials ▪ Can be applied to welds, tubing, brazing, castings, billets, forgings, aluminum parts, turbine blades and disks, gears	▪ Need access to test surface ▪ Defects must be surface breaking ▪ Decontamination and precleaning of test surface may be needed ▪ Vapor hazard ▪ Very tight and shallow defects difficult to find ▪ Depth of flaw not indicated
Magnetic Particle	▪ Ferromagnetic materials ▪ Surface and slightly subsurface flaws can be detected ▪ Can be applied to welds, tubing, bars, castings, billets, forgings, extrusions, engine components, shafts and gears	▪ Detection of flaws are limited by field strength and direction ▪ Needs clean and relatively smooth surface ▪ Some holding fixtures are required for some magnetizing techniques ▪ Test piece may need demagnetization which can be difficult for some shapes and magnetizations ▪ Depth of flaw not indicated
Eddy Current	▪ Metals, alloys, and electroconductors ▪ Sorting materials ▪ Surface and slightly subsurface	▪ Requires customized probe ▪ Although non-contacting, it requires close proximity of probe to part

NDT Method	Applications	Limitations
	flaws can be detected ▪ Used on tubing, wire, bearings, rails, nonmetal coatings, aircraft components, turbine blades and disks, automotive transmission shafts	▪ \low penetration ▪ False indications due to uncontrolled parametric variables
Ultrasonics	▪ Metals, nonmetals, and composites ▪ Surface and slightly subsurface flaws can be detected ▪ Can be applied to welds, tubing, joints, castings, billets, forgings, shafts, structural components, concrete, pressure vessels, aircraft and engine components ▪ Used to determine thickness and mechanical properties ▪ Monitoring service wear and deterioration	▪ Usually contacting, either direct or with intervening medium required ▪ Special probes are required for applications' ▪ Sensitivity limited by frequency used and some materials cause significant scattering ▪ Scattering by test material structure can cause false indications ▪ Not easily applied to very thin materials
Radiography Neutron	▪ Metals, nonmetals, composites, and mixed materials ▪ Used on pyrotechnics, resins, plastics, organic material, honeycomb structures, radioactive material, high density materials, and materials containing hydrogen	▪ Access for placing test piece between source and detectors ▪ Size of neutron source housing is very large (reactors) for reasonable source strengths ▪ Collimating, filtering, or otherwise modifying beam is difficult ▪ Radiation hazards ▪ Cracks must be oriented parallel to beam for detection sensitivity decreases with increasing thickness
Radiography X-ray	▪ Metals, nonmetals, composites, and mixed materials ▪ Used on all shapes and forms; castings, welds, electronic assemblies, aerospace, marine and automotive components	▪ Access to both sides of test piece needed ▪ Voltage, focal spot size and exposure time is critical ▪ Radiation hazards ▪ Cracks must be oriented parallel to beam for detection ▪ Sensitivity decreases with increasing thickness
Radiography Gamma	▪ Usually used on dense or thick material ▪ Used on all shapes and forms; castings, welds, electronic assemblies, aerospace, marine and automotive components ▪ Used where thickness or access limits x-ray generators	▪ Radiation hazards ▪ Cracks must be oriented parallel to beam for detection ▪ Sensitivity decreases with increasing thickness ▪ Access to both sides of test piece needed ▪ Not as sensitive as X-rays

Source: Nondestructive Testing Encyclopedia

The following definitions are taken from Integrated Publishing, Construction: Destructive Testing.

Destructive Testing

The most common types of destructive testing are known as free bend, guided bend, nick-break, impact, fillet welded joint, etching, and tensile testing. The primary disadvantage of destructive testing is that an actual section of a weldment must be destroyed to evaluate the weld. This type of testing is usually used in the certification process of the welder. Some of the testing requires elaborate equipment that is not available for use in the field. Three tests that may be performed in the field without elaborate equipment are the free-bend test, the guided-bend test, and the nick-break test.

Free-Bend Test

The free-bend test is designed to measure the ductility of the weld deposit and the heat-affected area adjacent to the weld. Also it is used to determine the percentage of elongation of the weld metal. Ductility is that property of a metal that allows it to be drawn out or hammered thin.

Guided-Bend Test

The guided-bend test is used to determine the quality of weld metal at the face and root of a welded joint. This test is made in a specially designed jig. The test specimen is placed across the supports of the die. A plunger, operated from above by hydraulic pressure, forces the specimen into the die. To fulfill the requirements of this test, the specimen must be bent 180 degrees—the capacity of the jig. No cracks should appear on the surface greater than 1/8 inch.

Nick-Break Test

The nick-break test is useful for determining the internal quality of the weld metal. This test reveals various internal defects (if present), such as slag inclusions, gas pockets, lack of fusion, and oxidized or burned metal.

Impact Test

The impact test is used to check the ability of a weld to absorb energy under impact without fracturing. This is a dynamic test in which a test specimen is broken by a single blow, and the energy used in breaking the piece is measured in foot-pounds. This test compares the toughness of the weld metal with the base metal. It is useful in finding if any of the mechanical properties of the base metal were destroyed by the welding process.

Fillet-Welded Joint Test

The fillet-welded joint test is used to check the soundness of a fillet weld. Soundness refers to the degree of freedom a weld has from defects found by visual inspection of any exposed welding surface. These defects include penetrations, gas pockets, and inclusions.

Etching Test

The etching test is used to determine the soundness of a weld and also make visible the boundary between the base metal and the weld metal

Tensile Strength Test

The tensile strength test may be defined as the resistance to longitudinal stress or pull and is measured in pounds per square inch of cross section. Testing for tensile strength involves placing a weld sample in a tensile testing machine and pulling on the test sample until it breaks.

b. Discuss a typical lot sample selection method for destructive testing.

The following is taken from Kowalewski, Milton, J., *Quality and Statistics: Total Quality Management, American Society for Testing and Materials.*

EPRI NP-7218, *Guideline for Sampling in the Commercial-Grade Item Acceptance Process,* recognizes that different sampling approaches are needed for destructive tests and inspections. The guideline emphasizes that the use of small representative sample sizes is an accepted practice used in material testing standards and equipment qualification testing.

The guideline, however, also emphasizes that there should be sufficient justification to permit the use of the small sample sizes. The selection factors should again be used to determine if a small sample size is permissible. A number of upfront activities can be performed to provide technical justification for small sample sizes.

Some of the selection factors that should be considered to justify a small sample size when a destructive test or inspection is necessary follows:

- Lot formation based on a product manufacturer's heat number, production lot number, or batch number. This type of lot formation essentially assures the lot is homogenous and sample results will be representative of the lot. When this type of lot formation exists, only one destructive test or inspection sample is considered necessary. When destructive tests/inspections are required, upfront planning should be performed to determine if production traceability can be obtained
- If the supplier has a record of providing a consistently conforming, product, a small sample size can be justified.
- If the lot is from a single product manufacturer, the successful verification of other nondestructive critical characteristics provides additional confidence in the destructive test or inspection results from a small sample.
- If there is a correlation between a nondestructive test and destructive test. Where a correlation exists, successful results from testing the nondestructive test characteristic can justify only a small sample size for the destructive test.
- A satisfactory item performance history often provides evidence the supplier has been providing items meeting the destructive test or inspection acceptance requirements.
- The item is produced to a national standard that specifies the critical characteristic's acceptance requirements.

- The cost effectiveness of the test/inspection considering the consequences if a defect is not detected, is low

Because of the necessity to consider the selection factors, a specific destructive test/inspection sampling plan is not provided. The guideline emphasizes the need to justify the basis for the small sample size selected. Special research and upfront efforts should be performed to provide the proper technical justification for the sample size specified.

c. Describe the use of test data and reporting

The following is taken from SAND99-8240.

In the early days of the stockpile evaluation program, a reliability number (based primarily on lab test results through the end of production) and a statistical confidence limit (based strictly on quantities of a single type of stockpile laboratory test) were reported. The mid sixties brought recognition of the importance of a diversified testing program in detecting defects and the role of engineering judgment in determining what data are relevant. Test program diversification greatly enhanced our ability to detect stockpile defects but also increased the challenge of assessment because of the need to combine data obtained from widely varying sources and taken under a variety of conditions. Adequate recent test data are needed to substantiate the continued validity of reliability assessments based mostly on tests performed early in the life of the weapon.

3. Weapon Quality Assurance Specialist shall demonstrate a working level knowledge of a nonconformance and the Suspect/Counterfeit Item Program identified in DOE Order 414.1C, *Quality Assurance*, and DOE/NNSA *Weapon Quality Policy (QC-1)*.

a. Discuss the purpose of a nonconformance and the Suspect/Counterfeit Item Program.

Nonconformance

The following is taken from DOE/NNSA QC-1.

Whenever a weapon program requirement of any type is not met, a nonconforming condition exists. Nonconforming conditions include, but are not limited, to nonconforming operations, activities, procedures, software, and items (including material and product). When a potential or actual nonconformance is identified, the situation shall be evaluated and appropriate action shall be taken. A process shall be documented to prescribe actions to address potential and actual nonconforming conditions. Procedures shall be established and maintained that define processes for identifying, investigating, and dispositioning nonconforming conditions. These procedures shall clearly define the level and qualification of personnel authorized to disposition nonconformances. Personnel performing evaluations to determine disposition of a nonconformance shall have demonstrated competence in the specific area they are evaluating, have an adequate understanding of the requirements, and have access to pertinent background information.

Procedures shall be established and maintained to ensure that weapon program items that do not conform to requirements are prevented from inadvertent use or shipment. Control of nonconforming items shall provide for the identification, documentation, evaluation, preservation, segregation, and disposition of the item, as well as notification to the organization(s) concerned. Nonconforming items shall be identified by legible marking, tagging, or other methods on the item or on the container or package containing the item. Marking shall be durable and not detrimental to the material. Nonconforming items shall be segregated, when practical, by placing them in a clearly identified and designated hold area until properly dispositioned. When segregation is impractical or impossible due to physical conditions such as size, weight, or access or other limitations, other precautions shall be employed to preclude inadvertent use of a nonconforming item.

The following is taken from DOE G 414.1-3.

The nonconformance and suspect/counterfeit item program (S/CI) gives us the requirements and guidance to control or eliminate the hazards posed by S/CIs, which can lead to unexpected equipment failures and undue risks to the DOE/NNSA mission, the environment, and personnel.

b. Describe the process and/or procedures used to implement nonconformance requirements.

The following is taken from DOE/NNSA QC-1.

Procedures shall be established and maintained to ensure that weapon program items that do not conform to requirements are prevented from inadvertent use or shipment. Control of nonconforming items shall provide for the identification, documentation, evaluation, preservation, segregation, and disposition of the item, as well as notification to the organization(s) concerned.

Nonconforming items shall be identified by legible marking, tagging, or other methods on the item or on the container or package containing the item. When a nonconforming item is identified, an evaluation shall be performed to determine if any other previously produced item is also nonconforming. There shall be timely disposition of any nonconforming item.

c. Describe the requirements and method for reporting nonconforming material delivered between NNSA agencies.

The following is taken from DOE/NNSA QC-1.

Material shipped from one contractor’s responsibility to another will be provided as government-furnished material. NNSA shall be notified when a nonconforming condition involving government-furnished material is suspected or discovered. NNSA shall report the information regarding the suspect or nonconforming condition to the contractor that supplied

the material. Once material is accepted by NNSA, it is under NNSA management control. Any item or material accepted by NNSA that is deemed to have failed or is otherwise found unsuitable for use or designated for different use shall be clearly identified to preclude use or re-entry into the stockpile material flow without NNSA approval. Procedures shall be established and maintained to ensure that weapon program items that do not conform to requirements are prevented from inadvertent use or shipment.

The following is taken from DOE G 414.1-3.

10 CFR 830, Subpart A and DOE O 414.1C require that processes for the prevention of quality problems (i.e., S/CIs) be established and implemented. The quality assurance (QA) requirements further state that items, services, and processes that do not meet requirements be identified, controlled, and corrected. DOE M 231.1-1A requires prompt reporting of all S/CIs, regardless of their location/application, to the cognizant DOE operations office manager and program manager by means of the Occurrence Reporting and Processing Systems (ORPS), and the local Office of the Inspector General (OIG). The use of ORPS and the S/CI notification process will facilitate the contractor's reporting obligation. Reporting an S/CI to ORPS does not substitute for reporting to the OIG. Prompt reporting of S/CI in ORPS contributes to improvement of safety, regulatory compliance, and reliability. The S/CI information reported in ORPS is also used by Program Offices, other DOE contractors, EH, OIG, and where appropriate by external agencies to prevent the spread of potentially hazardous items. For this reason, information reported should be sufficient to alert other organizations of an S/CI and potential safety or performance problems associated with the items.

d. Describe the purpose for the disposition of nonconforming and suspect material/items.

The following is taken from DOE G 414.1-3.

DOE/NNSA is committed to effective controls for the prevention, detection, and disposition of S/CIs to mitigate any potential safety threat in the DOE/NNSA complex. According to the requirements of DOE O 414.1C, the principal objectives of S/CI controls are as follows:

- Ensure that items intended for application in safety systems and mission critical facilities comply with design and procurement documents.
- Maintain current, accurate information on S/CIs and associated suppliers using all available sources within the Government and industry and disseminate relevant information on S/CIs to field organizations and contractors.
- Identify, control, and disposition S/CIs that create potential hazards in safety systems and applications.

- Report discoveries of and disseminate information about S/CIs to field organizations, contractors, and government agencies.
- Train and inform managers, supervisors, and workers of S/CI controls and indicators, including prevention, detection, and disposition of S/CIs.

These controls should also include obtaining contractual remedies from suppliers of S/CIs.

4. Weapon Quality Assurance Specialist shall demonstrate a working level knowledge of Software Quality Assurance (SQA).

a. Discuss the requirements for SQA specific to DOE/NNSA Weapon Quality Policy (QC-1).

The following is taken from DOE/NNSA QC-1.

A software quality assurance (SQA) process shall be established to provide assurance that software will satisfy customer requirements. The process shall apply to software that is purchased, developed under contract, or developed by NNSA or its contractors. The SQA process shall address applicable elements of QC-1.

SQA activities shall be commensurate with the complexity and the risk associated with failure of the software to meet established requirements. A documented risk-based and graded approach shall be used to balance cost, risk, and program flexibility.

The SQA process shall use a software life-cycle management methodology based upon a consensus SQA standard or an equivalency rigorous contractor-specific standard that addresses software development from beginning to end and the flow of activities and iterations for the software life cycle. Software life-cycle stages may include:

- concept,
- requirements,
- design,
- implementation,
- operation,
- maintenance, and
- retirement.

Software configuration management shall ensure: a software baseline is established no later than the completion of the software validation process, and changes subsequent to the baseline are traceable to software requirements, approved, documented, and added to the baseline so that the baseline defines the most recently approved software configuration. Software verification and validation activities shall be controlled, documented, and demonstrate requirements are met.

b. Identify the procedure/process used by the M&O contractor for SQA development, testing, use control, and error reporting and correction.

The following descriptions are taken from DOE G 414.1-4.

Development

During software design and implementation the software is developed, documented, reviewed, and controlled. The software design elements should identify the operating system, function, interfaces, performance requirements, installation considerations, design inputs, and design constraints. The software design should be complete and sufficient to meet the software requirements. The design activities and documentation should be adequate to fully describe how the software will interface with other system components and how the software will function internally. Data structure requirements and layouts may be necessary to fully understand the internal operations of the software.

Custom developed software will require more formality in the documentation and review of the design than configurable or utility calculations. Simple process flows, relationships between data elements, interfaces with external components, and basic database table structures may be all that are needed for configurable or utility calculations, whereas for custom developed software, complete functional and logical designs of the software components, the input and output data, and pseudo code may be required to fully understand the safety software design. The software design description may be combined with the documentation of the software requirements or software source code.

During implementation, static analysis, clean room inspections, and reviews are common techniques to ensure the implementation remains consistent with the design and does not add complexity or functions which could decrease the safe operation of the software. Many tools exist to evaluate the complexity and other attributes of the source code design structure.

Walkthroughs and more formal inspections, such as Fagan inspections, can be used to identify defects in source code, as well as design descriptions and other software development process outputs.

Testing

The software developer should perform unit testing prior to system level verification and validation techniques, including acceptance testing. Developer testing can be very structured and formal, using automated tools or less formal methods. In addition to unit testing, functional, structural, timing (performance testing), stress, security, and human-factors testing are useful testing methods.

These methods can be applied using a graded or tailored approach to ensure the known risks are mitigated appropriately. Other techniques, such as error seeding; equivalence class testing; branch and path testing; statistical-based, boundary value testing; and code coverage analysis may all be beneficial testing techniques to ensure robust and reliable software.

Error Reporting and Correction

Coupled with the configuration management of the software system, the problem reporting and corrective action process should address the appropriate requirements of the QAP corrective action system. The reporting and corrective action system will cover (1) methods for documenting, evaluating, and correcting software problems; (2) an evaluation process for determining whether a reported problem is indeed a defect or an error; and (3) the roles and

responsibilities for disposition of the problem reports, including notification to the originator of the results of the evaluation. If the noted problem is indeed an error, the problem reporting and corrective action system should correlate the error with the appropriate software engineering elements; identify the potential impacts and risks to past, present, and future developmental and operational activities; and support the development of mitigation strategies. After an error has been noted, all users should be apprised to ascertain any impacts upon safety basis decisions.

Procurement documents should identify the requirements for suppliers to report problems to the supplier, any required supplier response, and the method for the purchasers to report problems to the supplier.

Maintaining a robust problem reporting and corrective action process is obviously vital to maintaining a reliable and vital safety software system. This problem reporting and corrective action system need not be separate from the other problem reporting and corrective action processes if the existing process adequately addresses the items in this work activity.

This work activity should be fully implemented for all Level A and B software types (custom developed, acquired, configurable, and commercial design and analysis) and for Level C custom developed. This formal implementation should include documentation and tracking to closure of any problems reported for the software and authorization to perform the corrective action. A graded approach that reduces the formality of documenting problem reports and approving corrective actions taken may be applied for Level A and B utility calculation safety software and all Level C software applications except custom developed. This less formal implementation may include interoffice communications describing the problem identified and the corrective actions planned.

5. Weapon Quality Assurance Specialist shall demonstrate a working level knowledge of metrology and calibration used in the weapons program from the following documents:

- **DOE/NNSA 56XB, Nuclear Weapon Development and Production Manual**
- **Primary Standards Laboratory Memorandum**
- **DOE/NNSA Weapon Quality Policy (QC-1)**

a. Describe the purpose of instrument and equipment calibration.

The following is taken from DOE/NNSA QC-1.

A standards and calibration program shall be established and documented to ensure measurement standards and measuring and test equipment are controlled, calibrated, and maintained to achieve the capability required for the intended use. Selection of measuring and test equipment shall be based on the type, range, accuracy, and uncertainty needed to accomplish the required measurements for determining conformance to requirements. The calibration method and frequency of calibration for measuring and test equipment shall be defined, based on the type of equipment, stability characteristics, required accuracy, intended use, and other conditions affecting capability. Calibration procedures shall identify

- the type item to be calibrated;
- parameters or quantities and ranges to be determined;
- apparatus and equipment needed, including technical performance requirements;
- reference standards and reference materials required;
- environmental conditions required and any stabilization period needed;
- calibration steps, including the method for determining uncertainty;
- criteria and/or requirements for calibration approval/rejection; and
- data to be recorded and reported.

Calibration shall be against certified equipment having known valid relationships to nationally recognized standards. If no nationally recognized standards exist, the basis for calibration shall be documented. A certificate of calibration shall be prepared and issued for each calibration that identifies the following:

- the item calibrated,
- calibration date,
- calibration expiration criteria,
- calibration procedure used,
- person performing the calibration,
- standards and/or reference materials used or statement of traceability,
- accuracy and uncertainty with any limiting conditions, and
- the person approving the calibration.

Measurement standards and measuring and test equipment shall be properly handled and stored and marked or otherwise identified to indicate calibration status.

When measurement standards or measuring and test equipment are found to be out-of-tolerance, an evaluation commensurate with the significance of the condition shall be made and documented including the validity of previous inspection or test results and the acceptability of items previously inspected or tested. Measurement standards or measuring and test equipment with expired calibration or suspected or found to be out-of-tolerance shall be controlled to prevent incorrect use until they have been recalibrated.

Records shall be maintained to document calibration and the capability of measuring and test equipment to satisfactorily perform the intended function. Records shall be maintained to establish traceability between product and measuring and test equipment used for its test or inspection.

b. Describe the function the Primary Standards Laboratory performs on behalf of NNSA.

The following is taken from SNL, Primary Standards Laboratory.

The Primary Standards Laboratory (PSL) develops and maintains primary standards traceable to national standards and calibrates and certifies customer reference standards. The PSL provides technical guidance, support, and consultation; develops precision measurement techniques; provides oversight, including technical surveys and measurement audits; and

anticipates future measurement needs of the nuclear Weapon complex and other Department of Energy programs.

The following is taken from DOE SD 56XB.

The Primary Standards Laboratory:

- coordinates a system-wide standards and calibration program (SCP) for DOE/NNSA and its contractors by providing technical guidance, training, and consultation.
- prepares PSL memoranda for review and approval by NA-121.3.
- provides a research and development program in the area of measurement technology to enable the timely provision of new measurement standards and measuring and testing equipment (M&TE) for a properly balanced program and measurement compatibility.
- develops and maintains primary standards. When no recognized national standard is available, the PSL shall document the use of consensus standards.
- provides certification of reference standards, when they are within their capacity and capability, to contractor standards laboratory (CSL)s.
- assists the CSL in obtaining sources of outside calibration or specifying standards for which National Institute of Standards and Technology (NIST) or PSL do not have capability.
- provides technical oversight of DOE/NNSA nuclear weapon contractors by:
    - performing and reporting to the local Secretarial Officer (SO) technical survey results of DOE/NNSA nuclear weapon contractor's SCP including CSL, commercial calibration laboratory (CCL), and designated calibration source (DCS) programs;
    - periodically attending CSL surveys of current and potential CCLs and DCSs;
    - conducting and reporting the results of proficiency testing shall be reported to NA-121.3 and appropriate site office(s);
    - reviewing the program used for the approval and oversight of CCLs and DCSs and providing written approval to CSL;
    - coordinating technical surveys and corresponding official correspondence, as well as written reports with the local SO;
    - providing immediate feedback to the appropriate site office when any deficiencies are identified during a technical survey;
    - maintaining a current list of PSL- and CSL-approved DCSs and CCLs, which include—name, address, point of contact (POC), phone number, metrology parameter, range, uncertainty, and expiration information.
    - publish annually and update semi-annually a survey schedule covering a complete PSL audit cycle of the nuclear weapon complex (NWC) SCP.

c. Discuss the measurements and control of calibrated instruments used in weapon production.

The following is taken from References: SNL, Primary Standards Laboratory Memorandum.

All calibrated instruments must have a calibration certificate that meets the requirements of NNSA Supplemental Directive 56XB and the PSL memorandum, before it is used, for traceability. In addition the certified standard or instrument shall have an appropriate calibration label, which provides the information required of all standards.

Where referenced values and associated uncertainties are provided by the calibration source, the calibration certificate for the instrument or reference standard shall meet the requirements of NNSA Supplemental Directive 56XB and include the following:

- The measured values or a reference to a report containing the measured values. If an adjustment to the measured values has been performed by the CSL, the reason for the adjustment and the method used shall be noted on the cover certificate. In this case the as-found value(s) shall be retained on file.
- The certification uncertainty assigned to the measured values. The certification uncertainty shall be expanded from that of the report to cover behavior of the instrument/standard throughout the certification interval and include factors such as drift, usage, shipping; etc., as appropriate.
- Date of CSL certification, and expiration date or criteria.
- Identification of the person who performed the data analysis, if that person is different from the person who certifies the certificate. In cases of a measurement assurance program or similar data collection system, identification of the metrologist who operated the program or system.
- Any applicable restrictions and/or special instructions, as appropriate.
- Certification signature.
- If the calibration certificate issued by the approved calibration source meets the requirements of a, b, c, e and f, above, it may be used by the CSL. However, if either a calibration report or the raw measurements data are supplied by the approved calibration source, then the CSL shall generate a cover calibration certificate that meets the requirements of the PSL memorandum, sections 5.1.2.3(a) through (f). The cover certificate will often be a separate document; however, where no ambiguity will result, certification may be accomplished by clearly identifiable additions to the report from the calibration source.

It is a responsibility of the CSL that obtained the calibration to periodically assure that an adequate repeatability of values is obtained when equipment is recalibrated by checking new values against historically obtained values for the instrument or standard. If re-adjustment of some function of the instrument or standard is required, the as-found value relative to the previous as-left value is the value used to determine the repeatability.

6. Weapon Quality Assurance Specialist shall demonstrate a working level knowledge of process control and statistical sampling methods for product inspection.

a. Discuss examples of process control used in weapon production processes.

The following is taken from DOE SD 56XB.

The program control document (PCD) for weapon production is comprised of the planning schedule, the authorization schedule, and the directive schedule. Table 2 describes the PCD.

Table 2. Production control document

Document Name	Purpose	Notes
PCD Includes:	Implements current production and retirement directive from defense programs and provides programming and administrative guidance for Weapon production and retirement.	Issued as three documents as production program progresses through phase 3 through 7.
Planning Schedule	Contains preliminary information about Phases 3, 4, 5, and 6 and estimated dates for release of product for procurement, production, and delivery. States planned total quantities and monthly delivery rates currently anticipated.	During Phase 3, issued yearly to provide planning information to the Production Agencies (PAs) and Design Agencies (DAs).
Authorization Schedule	Places program in Phase 4. Authorizes tooling, material procurement, and fabrication of components necessary to support requirements for authorized procurement period.	Issued to DAs and PAs when sufficient engineering information warrants placing program in phase 4. Cancels and supersedes planning schedule.
Directive Schedule	Establishes firm first-production delivery dates. Confirms or extends authorized procurement period. Defines weapon-protected period. Schedules all factory retrofits. Schedules as line orders retirement and disposal of war-reserve and stockpile reportable components.	Issued six months before first production unit of war reserve. Cancels and supersedes authorization schedule. Completed orders are retained as part of this schedule.

Source: DOE SD 56XB

b. Discuss the statistical sample methods applicable to product acceptance used by the Quality Assurance Procedures Manual.

The following is taken from NNSA *Weapons Quality Procedures Manual*.

Sampling plans establish the basis for verification inspections. Sampling is performed to verify the original inspection measurements and the original inspection procedures are valid. Sampling requires only a moderate level of assurance (e.g., 80 percent) of identifying a moderate level of nonconformance (e.g., 20 percent) to assure against generic inspection problems. A random sample must be used.

Table 3A defines a sample rate for a moderate level of assurance and is used unless an excessive number of defects have been observed and/or the assessments designated in the quality assurance activities plan have not been performed. Table 3B defines a higher sample rate and may be used for new products or production processes, or when it is justified, based on the quality history and impact to form, fit, or function.

A nonconforming sample unit found during audit sampling is evidence that contractor inspection processes may be inadequate. In addition to issuing a quality assurance defect

report (QADR) for the nonconforming product, a finding should be made requiring the contractor to correct their inspection process. It may be necessary to either intensify the sampling rate (by moving to Table 4) or to increase the frequency of verification inspections to assure the corrective action has eliminated the root cause of the problem.

Table 3. Sampling Rate for 80% Assurance of Detecting a 20% or Higher Nonconformance Rate

A. 80% Assurance of detecting a 20% or high nonconformance rate	
Submittal Size	**Sample Size**
1-3	All
4-7	4
8-9	5
10-19	6
20-119	7
120 and higher	8
B. Sampling Rate for 90% Assurance of Detecting a 10% or Higher	
Submittal Size	**Sample Size**
1-8	All
9-13	9
14-15	10
16	11
17-18	12
19	13
20-26	14
27-29	15
30-38	16
39-48	17
49-59	18
60-79	19
80-129	20
130-279	21
280 and higher	22

Source: Weapons Quality Procedures Manual

7. Weapon Quality Assurance Specialist shall demonstrate a working level knowledge of NNSA product acceptance.

a. Describe the use of the Quality Instruction List (QIL)

The following is taken from NNSA *Weapons Quality Procedures Manual*.

A Quality Instruction List (QIL) specifies the products required to be submitted for verification inspection. It is also used as the index of effective issues of active quality

assurance inspection procedures (QAIPs). QILs are updated and issued promptly to the contractor as QAIPs are revised, added, or removed or are issued annually when no changes have occurred. site offices may make temporary changes to their QILs; these must be dated and initialed or otherwise controlled to ensure there no unauthorized changes.

b. Describe the use of the Certification of Inspection (COI)

The following is taken from NNSA *Weapons Quality Procedures Manual*.

The Certificate of Inspection (COI), or equivalent approved by the site office, is the official document used:

- by contractors to identify and certify that submitted material meets design requirements,
- for contractors to submit specified material to the NNSA (or to the contractor's inspection group, if delegated), and
- for site offices to indicate inspection results and disposition of submitted material.

c. Describe the verification inspection process including Quality Assurance Inspection Procedures (QAIPs), where the requirements come from, reviewing certification documentation, reviewing drawings, performance of verification inspection, etc.

The following is taken from DOE G 414.1-2A.

Design verification is a documented process for ensuring that the design and the resulting items will comply with the project requirements. Design verification methods include, but are not limited to, design reviews, alternate calculations, qualification testing, and peer review of experimental design. When appropriate, the verification process may include consideration of previous verifications of similar designs or verifications of similar features of other designs.

Design verification should be performed by technically knowledgeable persons separate from those who performed the design. Interim verifications may occur at predetermined stages of design development. The extent of design verifications should be based on a graded approach depending on the designed product's complexity and importance to safety and project success.

Organizations rely on verified design output to support other work, such as procurement, manufacture, construction, testing, or experiments. When the verification cannot be achieved in time for these activities, unverified portions of the design should be identified and controlled. Design verifications should be completed before relying on the SSC to perform its function.

d. Describe stamping activities (i.e., which stamps are used for what)

The following is taken from NNSA, *Weapons Quality Procedures Manual*.

Diamond Stamp—indicates the material is mark quality based on application of NNSA or delegated contractor product acceptance activities. It is applied to all weapons and weapon-

related material that was verified by inspection and all products of a production lot that was verified based on statistical sampling.

Star Stamp is applied to all weapon assemblies (including Types); base and military spares for shipment to DoD, joint test assemblies, and all ultimate user (UU) packages, except those for the United Kingdom (UK).

Circle T Stamp indicates conditional acceptance and is used when it is necessary to accept material as suitable for next assembly. It is applied to the material and its packaging. Use of the Circle T stamp should only be considered as a last resort, and only when there is potential impact to the delivery schedule.

Interproject Stamp is applied to all packages containing NNSA-accepted material that is to be shipped to the next NNSA facility for further processing. The IP Stamp indicates that material has been accepted by the government.

Acceptance Required Stamp is applied to material that has been reworked, reprocessed, or repaired after acceptance and must be resubmitted. This includes items returned from other NNSA sites or DoD and material that is determined to require inspection and/or testing.

Evaluation Use Only Stamp is used on weapon-related material, Mark Quality and non-Mark Quality that is selected or diverted for evaluation or other engineering purposes.

United Kingdom Stamp is used when material accepted for ultimate user (UU) shipment is to the UK and is diamond-stamped and over stamped with a UK stamp.

e. Describe source acceptance.

The following is taken from NNSA, *Weapons Quality Procedures Manual*.

When the site office requires submittal of weapons and weapon-related material manufactured by vendors for NNSA acceptance, the contractor may request approval for acceptance to be performed at the vendor location and provide a justification.

site offices may approve source inspection requests that meet one or more of the following criteria:

- The product is permanently sealed or assembled at the source, which precludes performing the required verification inspection at the NNSA contractor,
- The time for processing a specific item is critical, and significant time is saved by direct shipment from the source to the using NNSA contractor,
- Source verification inspection and acceptance will save substantial shipping costs,
- The cost of duplicating gauges or test equipment required for acceptance at the NNSA contractor is prohibitive, or
- Vendor acceptance equipment is acceptable and no NNSA equipment is available.

f. Describe the process for rejection of submitted material using a Quality Assurance Defect Report (QADR).

The following is taken from NNSA, *Weapons Quality Procedures Manual*.

Disposition of Defective Units and Corrective Action:

- The site office:
  - Originates a Quality Assurance Defect Report (QADR) (see NA-10, appendix 4-F) to report defects, including incidentals, observed during verification inspection of submitted material. When activities have been delegated, the contractor may use their own process, as long as required information is documented and submitted to the site office, if required.
  - May:
    - Permit the contractor to correct incidental and easily remedied defects and allow the inspection to resume. The defect must still be noted on the QADR.
    - Reject material if the Quality organization determines the number of incidental defects is excessive.

  - Forwards a QADR to the contractor to require a Corrective Action Report that identifies the root cause and the appropriate action(s). A corrective action response for incidental defects is required only when requested by the site office.

- Contractors:
  - Prepare corrective actions in response to QADRs.
  - Identify rejected and resubmitted material as a resubmittal in the Remarks section of the COI, specifying the individual units that were rejected.
  - Ensure any changes made to the COI are authorized, controlled, and explained in the Remarks section.
  - Retain records of COIs and QADRs for any submitted material.

- The QADR is closed out after contractor corrective action(s) are reviewed, verified, and accepted by the site office.
- If a resubmitted unit is not selected as a sample, that unit only requires inspection to assure correction of the defects found during the initial verification inspection or conformance to applicable deviations. Also, confirm that any reworking has not affected other characteristics.

  NOTE: A defective unit may indicate problems with contractor inspection processes. It may be necessary to use a more conservative sampling plan until there is confidence that the problems have been resolved (see NA-1, appendix 4-B).

- The Site Office:
  - Maintains a summary log that records submittals for each QAIP configuration.
  - Separate logs for QAIP material produced by different suppliers.
  - Develop instructions for establishing new logs when existing QAIPs are combined or divided. If a unit (or lot) is resubmitted after correction of defect(s), the PA should identify it as a prior submittal and identify the specific defective

unit in the remarks section of the COI. If the resubmitted unit is not selected as a sample, the QAA need only inspect it for correction of the defects found during verification inspection or for conformance to applicable deviations; the QAA ensures that reworking of the unit has not affected other characteristics.

8. Weapon Quality Assurance Specialist shall demonstrate a working level knowledge of product specification/design agency requirements (drawings).

a. Describe the applicable production specifications used in weapon production.

The following is taken from DOE SD 56XB.

Preparation of the definitions and documents provided in table 4 require source information be sent directly to the Kansas City Plant (KCP). This information includes weapon system drawings, flow charts, material lists, change orders, and engineering releases.

Table 4. Documents included in the production program definition

Definition and Document Name	Purpose	Notes
Weapon Program Description ("A" Document)	Describes weapon program in prose, illustrations, flow charts, and interproject (IP) group summaries for new production and retrofit.	Initial issue at the beginning of Phase 4.
Production Program Definition (PPD) Dataset Weapon Support Definition (formerly known as the "PPD-B-Doc")	Describes IP group definitions that are directive for new production, and factory retrofit or field retrofit kits when required.	Initial issue at the beginning of Phase 4.
Rebuild Support Definition (formerly known as the "PPD-C-Doc")	Describes IP group definitions required to rebuild Weapon to war reserve (WR) status after surveillance testing.	Initial issue finalized at rebuild support conference scheduled 12 months prior to the first production unit (FPU).
Evaluation Support Definition (formerly known as the "PPD-E-Doc")	Describes unique products and special test hardware to conduct laboratory testing of Weapon.	Only specially designed items included. Submitted to the Office of Nuclear Weapon Surety and Quality (NA-121) at least 12 months before FPU.
Retirement Disposition Instruction ("D" Document)	A disposition plan for all of the material of a weapon.	Released before FPU.
Limited Life Component Support Definition (PPD-AB-LLC)	Describes limited life components (LLC), Kit definitions (LLC, Alteration, and Group X Kit), and PA roles in the manufacturing and shipment of components.	Updated annually.

Source: DOE SD 56XB

The following is taken from DOE SD 56XB.

Weapon Program Description ("A" Document)

The A document shall contain a description of the weapon, its subsystems, and its components.

The document shall consist of narrative portion to include, but is not limited to:

- A general description of the weapon system, its applications, and its capabilities

- A statement giving the designed stockpile life of the weapon and the length of the weapon protected period
- a description of major components and their functions
- a description of the weapon system's safety considerations, features, and components
- an explanation of the fuzing and firing system and operational sequence
- the maintenance and limited life exchange concepts
- a description of the joint test assembly (JTA) and TYPE Weapon

The document shall consist of an illustration portion to include but is not limited to:

- a cutaway illustration detailing the major internal and external components of the weapon; however, cutaway details of the physics package and the active protective system are not revealed
- a configuration table indicating the major components of the WR, TYPE, and JTA Weapon
- flow charts for the above-mentioned Weapon to indicate production and assembly responsibility for the major components

The A document shall also include a statement delineating the weapon system development and production responsibilities of the DOE/NNSA and the U.S. Department of Defense (DoD) and statements establishing divisions of responsibility between the DAs for design and development of the weapon and its components.

PPD Dataset
Weapon Support Definition (within the PPD Dataset)

The weapon support definition shall be distributed at the beginning of Phase 4 and shall be maintained as a current document throughout the stockpile life of the weapon.

This document shall contain complete and current definitions of the WR, TYPE, and JTA Weapon and identifies the components for building those configurations.

The weapon support definition shall be presented at the ship entity level for each PA IP group (IPG).

This format includes a separate IPG for each production-to-using-agency group.

IPG listings are in drawing number or part number sequence and include nomenclature, the responsible DA, and the quantity required for each assembly.

IPGs are included for DoD-manufactured parts delivered to a DOE/NNSA plant for assembly with DOE/NNSA materials.

The end item for the UU is listed in a Pantex-to-UU IPG.

Rebuild Support Definition (within the PPD Dataset)

General Requirements

The initial rebuild support definition shall be finalized at a rebuild support conference called by NA-122 and the KCP one year before the FPU.

The definition shall be revised as required thereafter.

The rebuild support definition shall define the IP part relationships for rebuild support requirements during the stockpile protected period of the weapon. The definition includes:

- nonnuclear and nuclear rebuild material
- PCD issue number and date which is the reference for definition preparation

The PCD rebuild schedule determines the fiscal year used for defining rebuild support requirements.

Reprocessable returned material is a projection based on historical data and, therefore, should be provisioned accordingly.

Specific Requirements

The delivering PA shall be fiscally responsible for the production of scheduled material.

PAs shall produce all material scheduled for use after the end of the WR weapon new build period by following the normal course of WR production. The actual timing of such production is left to the discretion of the PA. Such material is generally not held in inventory by the PA but is completed and shipped to a contractor for the next higher assembly and finally to Pantex for storage and inventory control.

Shelf life material listed in the rebuild support definition is exempt from the provisions of the previous paragraph. Pantex and the first-order PA for limited life material must coordinate closely to ensure shipping dates occur as close to rebuild dates as practical.

PAs do not normally produce for spares those components made of fissionable material. However, if stockpile protection and a significant cost savings can be achieved by producing and storing these components for use as rebuild material, approval is requested from NA-122 to prebuild these components.

Evaluation Support Definition (within the PPD Dataset)

The evaluation support definition is submitted to NA-122 at least one year prior to FPU.

The evaluation support definition reflects all evaluation support material required during the stockpile life of the weapon. The definition includes:

- a test configuration and description table, as necessary
- IPG items required for each test, and
- PCD issue and date, which is the reference for the definition preparation.

Retirement Disposition Instruction (“D” Document)

Retirement disposition instructions (RDIs) are instructions for Pantex on disposal of all of the components of a nuclear weapon when that individual weapon is retired. RDIs are effective

when there are no competing requirements for the residual components, e.g., open base or military spares orders or approved requests from DAs.

Each RDI is subdivided into a series of retirement disposition groups (RDGs). Weapon components in each RDI are clustered by RDG. In general, all weapon components are available for diversion to support competing requirements after approval by NA-122.

The draft RDI is presented, reviewed, updated, and agreed upon by the attendees at the RDI/provisioning meeting. After the meeting, the KCP provides NA-122 with a ready to approve version. The original issue of an RDI for a particular weapon program is published before FPU. Subsequent issues are published as appropriate. The RDI is canceled after the last weapon in the program has been dismantled and its components disposed.

Limited Life Component Support Definition (PPD-AB-LLC)

The PPD-AB-LLC is updated annually.
The PPD-AB-LLC shall consist of three sections.

- Section 1 contains a summary table of stockpiled weapon configurations and related LLC and Group X kits, kit-packaging specifications, limited life components contained in the kits, and the projected life of the components.
- Section 2 contains five categories of limited life component exchange information for each weapon program: (1) a brief summary of the weapon program and applicable limited life component exchange comments, (2) a summary table of the weapon program (same as Section 1), (3) a part listing for each LLC kit showing PA responsibility, (4) Group X kit part configurations, and (5) LLC photographs and specifications.
- Section 3 contains a listing of IP group definitions for each PA involved in supporting the LLC exchange program, showing the LLC kit part manufacturing and shipping responsibility.

b. Describe the engineering authorizations identified in the technical business practices (TBPs).

The following is taken from NWC, TBP-404.

The objective of the engineering authorization system is to provide a configuration control and record management tools.

The engineering authorization (EA) system is a key element of the configuration management process. Engineers use the EA system to authorize actions that affect product definition and related product. Seventeen EAs grouped into five release categories comprise the EA system. The categories are administrative release, definition release, evaluation release, change release, and exception release.

Administrative Releases

Administrative releases support administrative activities by specifying maintenance instructions for product definition, justification for limiting procurement sources or general information/agreements about a program, project, product, or product definition.

Drawing Transfer Engineering Release (DTER)

DTERS are used to transfer product definition to a PA that has been delegated the responsibility for maintenance of the product definition. During the support step, the DTER is used to return product definition back to the DA. In this case, DA approval is not required

on the DTER. The DTER may be used to authorize a PA to originate a drawing; if so, the DTER may pre-assign a drawing number and title, however, the cage code of the drawing remains assigned to the DA.

Information Engineering Release (IER)

IERs are used as an administrative release to document general information not covered in other EAs when it is desirable to take advantage of the configuration control and records management features of the EA system. Statements in the body of the IER explain the nature of the information released.

Special Instruction Engineering Release/B-Item

Special instruction engineering release/B-item is used when it is necessary to document limited-source justification for products (i.e., B-Items) in accordance with TBP-601.

Definition Releases

Definition releases support development, production, and surveillance activities by authorizing the issuance of product definition as well as recording the release of product and surveillance definition. With respect to the product definition, EAs authorize development, pre-production, production actions, or surveillance activities.

Advance Engineering Release (AER)

AERs use is mandatory when the product realization team (PRT) determines it must issue an advance authorization. The PRT uses the AER to release the listed minimum product definition and/or authorizes PA to request funding to prepare for production as specified in the AER. The DA is responsible for determining when product development is advanced enough to use the AER. Coordination between the design and production agencies' engineering and program management groups is necessary to plan the scope and timing of the actions. The release may authorize preparation of product definition (drawings and specifications) for DA review and sign-off. The AER may be issued to authorize procurement of long-lead-time components. The AER may include supplementary information such as materials to be furnished by the DA, hazardous material in the product, available tooling and equipment, available acceptance equipment, the need for engineering evaluation (EE) of preproduction activities such as vendor qualification, material certification, and suggested sources of supply.

Complete Engineering Release (CER)

A CER is a mandatory EA used by the DA to release product definition to a PA to facilitate quantity production. The product definition shall be released by CER only once unless the mission assignment has changed. For multiple-use applications, it is not a requirement to CER the product definition again. When releasing product definition by CER, all subordinate product definition, except as described in the note below, shall also be released by CER. The DA shall issue CERs as soon as practical to facilitate EE. All CERs for product definition involved in an EE shall be released prior to completion of the EE and release of the qualification evaluation release (QER). The CER shall state all part numbers and/or control

numbers and issues of the product definition in existence at the time of release. Unless otherwise specified, the issue stated is the minimum issue authorized for product acceptance.

Development Engineering Release (DER)

A DER is used to release a specific issue of product definition or engineering information, and authorize specific PA actions related to design and development, or fabrication of development hardware for DA use. The release may authorize preparation of product definition (drawings and specifications) for design reviews or for DA review and sign-off. In this case, the six-digit base drawing numbers and part titles are assigned by the release.

Information Engineering Release

An information engineering release is used to release only specific support drawings and documents as defined in TBP-301.

Special Instruction Engineering Release (SIER)

An SIER is used to specify special engineering instructions against a specific item of product or acceptance equipment and authorized specific actions by the PA or provides information regarding the fabrication, reprocessing, testing, use, packaging, etc., of the item. Affected product should be listed by serial number or otherwise limited through the use of lot number(s) or the quantity produced (or accepted) during a certain time period. SIERs are not used to specify or change product definition, except for reprocessing as described in TBP-703.

Evaluation Releases

Evaluation releases support evaluation activities by specifying engineering evaluation requirements, interim evaluation status release (ESR), QERs, and by notifying that a re-evaluation (REN) may be needed. For additional information pertaining to the use of evaluation releases, see TBP-101.

Engineering Evaluation Release (EER)

An EER is used to document the concurrent qualification plan for product and/or processes when the plan is not already specified in a qualification plan (PQ) drawing. During definition and development activities, the EER is used to define initial evaluation activities. During delivery, support, surveillance, and dismantlement activities, it may be used to specify the qualification plans for initial or re-evaluations as appropriate. For traceability purposes, when the EER or PQ exists, it shall be referenced in all related QERs.

Evaluation Status Release (ESR)

An ESR is used to document status of the first three stages of the concurrent qualification process described in TBP-PRP and TBP-100.

Qualification Evaluation Release (QER)

A QER is a mandatory EA that is used to document status of the final stage of the concurrent qualification process. If the status of the engineering evaluation is “Acceptable” or

"Conditional," the QER authorizes use of the listed product or process. A QER shall be released prior to acceptance of the initial production run or initiation of surveillance or dismantlement activities. For traceability purposes, when the EER or PQ exists, it shall be referenced in all related QERs.

Re-Evaluation Notice (REN)

A REN is used to notify affected agencies that a condition exists that may require an engineering re-evaluation for a product and/or process and may include a recommendation as to whether or not a re-evaluation is needed. The decision to conduct a re-evaluation shall be resolved within 30 days and the resulting decision to conduct a re-evaluation or not is documented by issuing a revision of the initial REN. If a re-evaluation is needed the qualification or engineering evaluation plan is released as an EER or PQ within 30 days of the revision of the REN. For traceability purposes, the REN shall reference the QER, and if a re-evaluation is necessary the EER or PQ shall reference the REN.

Change Releases

A change release supports change activities by specifying changes or requesting changes to product definition. Rejected change requests are also documented. The EA system requires the issuance of a change release to authorize changes to product definition previously released by a definition release. For additional information pertaining to the use of change releases, see TBP-401.

Advance Change Order (ACO)

An ACO is a mandatory EA used to specify a change to product definition /or process before the changes are incorporated into a new issue of the product definition through out the entire life cycle of the product. Changes shall be incorporated into product definition within 90 days of ACO release, unless otherwise stated in the ACO. Until all changes are incorporated, any additional ACOs against the product definition shall include the unincorporated changes as "plus changes" in the description of change field of the ACO.

Final Change Order (FCO)

A FCO is a mandatory EA used to specify a change to product definition when the changes are incorporated into the product definition and the product definition is released in tandem.

Engineering Change Request (ECR)

An ECR is used by a PA or DA to formally request changes to product definition. It is reviewed by the DA and accepted or rejected within 60 days. The decision to accept or reject the ECR is documented in a revision of the ECR. If the ECR is accepted, the requested change is released as an ACO or FCO. For traceability purposes the ACO or FCO and revised ECR shall cross-reference each other. An ECR is a mandatory EA when the change affects a nuclear explosive safety (Pentagon S) feature. The ECR shall be reviewed and the proposed changes approved by the nuclear explosive representative at the DA in order to release the ACO or FCO.

Exception Releases

Exception releases support the nonconformance activities by identifying product that has deviated from its production or surveillance requirements, describing the deviation, specifying the corrective action, and providing disposition instruction for the deviated product. For additional information pertaining to the use of exception releases, see TBP-702.

Specification Exception Notice (SXN)

AN SXN is prepared and released by a PA to notify a DA of a product nonconformance and to request DA approval to use the nonconforming product. The decision to accept or reject the SXN is documented in a revision of the SXN. If accepted, the SXN is followed up by a SXR and references the SXN number. If requesting a deviation for use of a nonconforming feature, the SXN is a mandatory EA if the nonconforming feature is controlled by a requirement specified in an interface control drawing (Pentagon I) or the nonconformance affects a nuclear explosive safety (Pentagon S) feature.

Specification Exception Release (SXR)

An SXR is a mandatory EA used to authorize the use of a nonconforming product. The SXR authorizes use of a specific quantity of product that does not conform to its production or surveillance requirements, and after engineering assessment it is determined that the nonconforming product does not adversely affects safety, operability, reliability, interchangeability, assembly, storage life, completeness of assembly, or the ultimate use. An SXR can be approved as either “Unrestricted” “Restricted” use. The SXR is an optional EA during the development activities, if the product is not intended to be used as WR.

c. Discuss the applicability of product specification use in verification inspection.

The following is taken from NNSA, *Weapons Quality Procedures Manual*.

Unless delegated, site offices develop, revise, and maintain Quality Assurance Inspection Procedures (QAIPs). If this has been delegated, the contractor may use procedures that are equivalent to a QAIP and that meet the requirements on NA-1, appendix 4-B.

QAIPs prescribe the minimum inspection requirements necessary to determine product acceptability, and are generated using a Design Agency (DA)-specified, -reviewed, and -approved product definition. Draft QAIPs are coordinated through the responsible DA, as appropriate.

QAIP-prescribed inspection characteristics usually require hands-on inspection of the product. The QAIP may also require observing the contractor product inspection and/or an examination of contractor-performed inspection data in lieu of the site office inspection.

QAIPs may be prepared for:

- a single part type or for a family of similar part types, and
- subassembly levels (stage QAIPs) to incorporate critical characteristics that cannot be inspected at the final configuration.

A QAIP may be written to address new production, reacceptance, or both. QAIPs for reacceptance should be written only when it is known that reacceptance activities will be performed and when specifications have been written that define the acceptability criteria for used material. Unless conditions warrant a separate QAIP, reacceptance requirements should be included with new production requirements in a single QAIP.

The appropriate sampling plan is selected for both lot and continuous production based on the practical formation of submitted material and the use of the most effective acceptance method. Changes are made by reissuing the entire QAIP.

d. Demonstrate ability to identify applicable product specifications and drawings.

The requirements for this competency vary from site to site. The local Qualifying Official will evaluate the completion of this competency.

9. Weapon Quality Assurance Specialist shall demonstrate a working level knowledge of the NNSA quality assurance policy and other regulatory requirements contained in the following documents:

- **10 CFR 830, Subpart A, *Quality Assurance***
- **DOE Order 414.1C, *Quality Assurance***
- **DOE/NNSA 56XB, Nuclear Weapon Development and Production Manual**
- **DOE/NNSA Weapon Quality Policy (QC-1)**
- **DOE/NNSA Technical Business Practices**
- **DOE/NNSA Quality Assurance Procedures Manual**

a. Explain the hierarchy of NNSA and regulatory documents used in the Weapon Quality Assurance Program.

The following is taken from DOE O 414.1C.

The hierarchy of NNSA and regulatory documents used in the Weapon Quality Assurance Program begins with 10 CFR 830, the Nuclear Regulatory Commission, and then other Federal agencies.

b. Explain the purpose of each of the documents listed above.

10 CFR 830

10 CFR 830, Subpart A, Quality Assurance establishes quality assurance for contractors conducting activities, including providing items or services, that affect, or may affect, nuclear safety of DOE nuclear facilities.

DOE O 414.1C

The purpose of this Order is:

- to ensure that DOE/NNSA, products and services meet or exceed customers' expectations.
- to achieve QA for all work based on the following principles.

- that quality is assured and maintained through a single, integrated, effective QA program (i.e., management system).
- that management support for planning, organization, resources, direction, and control is essential to QA.
- that performance and quality improvement require thorough, rigorous assessment and corrective action.
- that workers are responsible for achieving and maintaining quality.
- that environmental, safety, and health risks and impacts associated with work processes can be minimized while maximizing reliability and performance of work products.

- to establish quality process requirements to be implemented under a QA program (QAP) for the control of suspect/counterfeit items (S/CIs), safety issue corrective actions, and safety software.

DOE/NNSA 56XB

DOE/NNSA 56XB establishes the DOE/NNSA requirements for the research, development, production, refurbishment, repair, and retirement/disposal of nuclear Weapon, to include stockpile support and transportation activities.

DOE/NNSA QC-1

DOE/NNSA QC-1 prescribes the basic quality principles and requirements for nuclear Weapon research, design, development, procurement, production, dismantlement, maintenance, stockpile evaluation, and disassembly/disposal.

DOE/NNSA TBPs

The TBP system goal is to provide the NWC community with a minimum set of standardized business methods to manage and promote innovation, agility, efficiency, safety, and performance.

DOE/NNSA QAPM

This procedure establishes the minimum operating principles and responsibilities of the QAAs.

c. Discuss the responsibilities of the NNSA, production agencies, and design agencies for acceptance of weapons related product per the Quality Assurance Program Manual.

The following is taken from the NNSA, *Weapons Quality Procedures Manual*.

When the site office requires submittal of weapons and weapon-related material manufactured by vendors for NNSA acceptance, the contractor may request approval for acceptance to be performed at the vendor location and provide a justification.

Site offices may approve source inspection requests that meet one or more of the following criteria:

- The product is permanently sealed or assembled at the source, which precludes performing the required verification inspection at the NNSA contractor,
- The time for processing a specific item is critical, and significant time is saved by direct shipment from the source to the using NNSA contractor,
- Source verification inspection and acceptance will save substantial shipping costs,
- The cost of duplicating gauges or test equipment required for acceptance at the NNSA contractor is prohibitive, or
- Vendor acceptance equipment is acceptable and no NNSA equipment is available.

Management, Assessment, and Oversight

10. Weapon Quality Assurance Specialist shall demonstrate a working level knowledge of how to oversee the effective implementation of quality assurance criteria as contained in the following documents:
- **DOE/NNSA Weapon Quality Policy (QC-1)**
- **DOE/NNSA Quality Assurance Procedures Manual (QAPM)**

a. Discuss the Weapon Assurance Specialist's role in effective oversight.

The following is taken from DOE-STD-1025-2008.

The Specialist role may vary at different NNSA sites. Site specific position descriptions will provide additional details. The following is a partial list of the WQA Specialist's responsibilities
- Performs the functions of monitoring, inspection, analysis and investigation of complex electrical, electronic, mechanical, electro-mechanical, and nuclear components, subassemblies, and assemblies associated with the manufacture of nuclear weapons and other non-nuclear components as applicable.
- Conducts QASs and oversight activities of contractor operations.
- Performs verification acceptance of product manufactured by the DOE Weapons Complex.
- Investigates quality and manufacturing problems and ensures corrective actions are appropriate for the identification and control of product and process deficiencies
- Conducts other activities as defined in the QAP Manual.

b. Describe process(es) used to conduct oversight.

The following is taken from DOE/NNSA QC-1.

Processes to detect and prevent quality problems shall be established and implemented. Items, services, and processes that do not meet established requirements shall be identified, controlled, and corrected according to the importance of the problem and the work affected.

Correction shall include identifying the causes of problems and working to prevent recurrence. Item characteristics, process implementation, and other quality-related information shall be reviewed and the data analyzed to identify items, services, and processes needing improvement.

The objective of a quality management system is to prevent errors and nonconformance, reduce variability, and build quality into products and processes. Fundamental methods such as design of experiments, prototyping, process capability studies, Pareto analyses, and statistical process controls may be used to

- characterize processes,
- simplify processes,
- mistake-proof processes,
- continually reduce product and process variability
- identify and minimize the number of unstable or error-prone processes, and
- provide early feedback of engineering and manufacturing data to determine the need for product or process changes.

Special processes shall be identified and procedures, processes, and controls implemented to ensure a high level of confidence in the control of product variability and to minimize nonconformances.

Special-process equipment and procedures shall be qualified and controlled. When the outcome of a special process is dependent upon the skill of the person performing the process, that person shall be certified to written procedure. Evidence of qualification of equipment and procedures and certification of personnel shall be maintained.

11. Weapon Quality Assurance Specialist shall demonstrate a working level knowledge of assessment requirements, principles and techniques as defined in the following documents.

- **DOE/NNSA Quality Assurance Procedures Manual**
- **DOE/NNSA Weapon Quality Policy (QC-1)**
- **DOE Order 414.1C, *Quality Assurance***
- **DOE Guide 414.1-1B, Management and Independent Assessment Guide for use with 10 CFR 830, Subpart A and DOE Order 414.1C**

a. Describe the different types and purpose of assessments.

The following is taken from DOE G 414.1-1B.

Assessments are tools for improvement. DOE's QA Rule and QA Order establish distinct requirements for management and independent assessments. DOE O 226.1A refers to contractor self-assessment programs that include line and independent evaluations. In this context, the assessments are those that a contractor conducts on its own ES&H performance. Management and independent assessments satisfy the requirements of DOE O 226.1A.

contractors should clearly describe in writing how their self-assessment programs satisfy the requirements for management and/or independent assessment.

Management and Independent Assessments may be performed on the same functions or organizations; however, each has a specific focus defined by the QA Rule and QA Order as described below. For some organizations, the only difference between Management and Independent Assessments may be the actual performer of the assessment.

It is essential to clearly define the criteria and/or objectives intended for the assessment through the assessment planning process and in the criteria review and approach documents.

Management Assessment

Managers perform management assessments to comply with the QA Rule and QA Order and to improve performance. In general, the purpose of this type of assessment is to identify the improvements. Management assessments look at the total picture:

- how well the management systems and processes meet the customer's requirements;
- compliance with standards and requirements;
- meeting the expectations for safely performing work;
- clarity of the organizational mission, goals, and objectives; and
- identifying and correcting problems that hinder the organization from achieving its objectives.

The emphasis of management assessment is on issues that affect performance, strategic planning, personnel qualification and training, staffing and skills mix, communication, cost control, organizational interfaces, and mission objectives.

Management assessment is a periodic introspective self-analysis to determine whether the organization's activities are properly focused on achieving desired results. This includes reviewing the processes, systems, and programs that are important to the organization's mission and objectives. Results of management as well as independent assessments can be used, in addition to formulating approaches and corrective actions for improvements, to develop plans for the subsequent management assessments. Additionally, independent assessment results may also be used as the basis for determining the focus and frequency of management assessments. It should be noted that effective management assessments could result in less frequent independent assessments, and independent assessment findings could affect the frequency and rigor of management assessments. In general, management and independent assessments are complementary; however, management assessments are generally performed at a greater frequency and cover a broader spectrum than independent assessments.

Independent Assessment

An independent assessment may be an audit, surveillance, "for cause" review or inspection conducted by individuals within the organization or company but independent from the work or process being evaluated, or by individuals from an external organization or company. In general, the purpose of this assessment is to perform the following:

- evaluate compliance with standards and requirements;
- evaluate the performance of work;
- measure the quality of the item or service;
- examine process effectiveness/adequacy; and
- promote improvement.

The organization or staff performing independent assessments should have sufficient authority and freedom from the line organization to carry out its responsibilities. Individuals

should be technically qualified and knowledgeable in assessment techniques and in the areas being assessed.

Independent assessments evaluate the performance of work processes with regard to requirements, compliance, and expectations for safely performing the work and achieving the goals of the organization. The focus of independent assessments should be the items and services produced and their associated processes. Thus, management receives an objective view of the assessed activity. Independent assessments are typically performed less frequently than management assessments but go into greater depth.

Management is responsible for developing and implementing a coherent plan that balances management and independent assessments and other forms of feedback and improvement to satisfy the requirements of the QA Rule and QA Order.

b. Demonstrate knowledge of performance methods/techniques.

The following is taken from DOE G 414.1-1B.

Organizational Activity Levels

To develop a comprehensive assessment program that optimizes the application of each assessment type, it may be helpful to visualize the organization as having three interlinked levels of activity (figure 6). This is not meant to imply a hierarchy of assessments. For this discussion, these levels are referred to as “process,” “system,” and “program.”

Figure 6. Interlinked levels of assessment activity

Management and independent assessments can be applied at all three levels, but examine different aspects of each level.

A process is a collection of steps or actions that yield some intermediate outcome.

A system is made up of two or more processes that may operate independently or interdependently to yield a complete product or service.

A program is the most complex level, and consists of multiple interdependent systems that often require several interfaces to provide the desired product or service.

Process Level Assessments

Process level assessments involve the examination of work controls, and verification that they are being implemented effectively, and should assess the effectiveness of the processes from a quality and customer satisfaction perspective. This level of assessment is critical for ensuring that the worker, the public, and the environment are protected from harm.

At the process level, assessments are performed to verify compliance with procedures and process objectives or criteria, and to ensure that work-control documents (e.g., procedures, instructions, radiation surveys, permits, and safety checklists) accurately reflect tasks and their associated hazards.

System Level Assessments

System level assessments focus on whether the appropriate leadership and support systems are in place to enable the implementation of work processes, and may range from informal daily performance oversight to formal periodic evaluations using established protocols. System level assessments are performed to ensure that human and material resources are being properly applied to achieve an organization's mission and objectives. The collection of "processes" that have been assembled to form an effective "system" is also evaluated.

At the system level, assessments are performed to determine whether all the necessary elements and interfaces are addressed, and to ensure that the system is capable of consistently meeting requirements and customer expectations. For example, a management assessment of the work control system might identify cost and resource allocation issues that affect the system. Some of the elements within the work control systems that might be assessed are:

- planning the work;
- identifying hazards associated with the work;
- identifying hazard controls;
- scheduling and performing work;
- verifying/testing completed work;
- critiquing work processes and results; and
- documenting the work performed.

Program Level Assessments

Program level assessments are used to determine whether the overall organizational programs are properly established and implemented, and are used to evaluate complex organizations from several perspectives. They usually examine the integration of the systems designed to achieve organizational goals and customer expectations (with an emphasis on environment, safety, and health factors).

At the program level for example, a maintenance management program, which relies on the work control system, would use results from the process (i.e., work control documents) and system level assessments to determine the effectiveness of the entire maintenance program. This program level assessment could be performed as either a management assessment or an independent assessment.

Assessing for Compliance and Performance

There are two different methods commonly used for accomplishing assessments. These are usually known as compliance assessment and performance-based assessment. While each method has distinct characteristics, a good assessment will usually gauge, at some level, effectiveness of the processes, systems, and programs in meeting the mission and objectives of the organization. In practice, an assessment is likely to include both compliance and performance based methods.

Compliance Assessments

Compliance assessments focus on verifying compliance with requirements through the implementation of procedures, and begin with a determination of the contractual and regulatory requirements governing the assessed organization. Assessors should become familiar with requirements and procedures and then verify that requirements flow down to implementing documents such as procedures, whose implementation is in turn verified.

Assessing for compliance alone may not adequately identify higher-level systemic or programmatic problems or determine the effectiveness of the program. For example, an organization may have written procedures that appear to implement the requirements, however, in practice the intent of those requirements may not be fully achieved because of variables such as poorly executed procedures.

Performance-Based Assessments

Performance-based assessments take a different approach by focusing first on the adequacy of the process that produced a product or service, and then on the product itself. If problems are found in the product or work processes, the assessor evaluates the methods and procedures used to implement the applicable requirements in an effort to find the failure that led to the problems.

The assessor is expected to determine whether a non-compliance or series of non-compliances with procedures could result in a failure to satisfy top-level requirements. Results of prior compliance assessments may help the assessor in determining the focus areas for planning performance-based assessments.

In performance-based assessments, great emphasis is placed on getting the full story on a problem before coming to a conclusion. If an assessor sees a problem with the execution of a welding process, the next step should determine the extent of the problem. Is it limited to one welder? Is it limited to one process? Can the problem be traced to the qualification program for the welder or to the qualification program for the welding process? Or is there a problem with the weld material itself, indicating a problem such as engineering or procurement?

While the assessor should be familiar with requirements and procedures, in performance-based assessments the assessor's experience and knowledge play an integral part in determining whether requirements are satisfied. Therefore, participants in performance-based assessments should be technically competent in the areas they are assessing. For example, if an assessor is evaluating a welding process, the assessor relies heavily on his or her knowledge of welding codes, welding processes, and metallurgy, rather than just verifying simple procedure compliance.

Performance-based assessments usually provide the most useful information to management; however, it requires a much higher level of competence on the part of the assessment team. Results of performance-based assessments may provide useful insight for management's pursuit of excellence.

Mandatory Performance Activities

These are performance-based competencies. The Qualifying Official will evaluate the completion of these competencies.

12. Participate in a minimum of one product specification/design agency requirements (drawings) review.

13. Participate in product acceptance activities using a QAIP or a survey.

14. Perform a minimum of one QAS 4 survey.

Note: The number of activities needed to satisfy this competency will be determined at the site level.

Weapon Quality Assurance Engineer/Scientist

1. Weapon Quality Assurance Engineers/Scientists shall demonstrate a working level knowledge of product specification/Design Agency requirements (drawings).

Note: Information regarding the KSAs in this competency is available in competency 8 of the first section of this guide.

a. Describe the applicable production specifications used in weapon production.

b. Describe the engineering authorizations identified in the TBPs.

c. Discuss the applicability of product specification use in verification inspection.

2. Weapon Quality Assurance Engineers/Scientists shall demonstrate a working level knowledge of process control and statistical sampling methods for product inspection.

Note: Information regarding the KSAs in this competency is available in competency 6 of the first section of this guide.

a. Discuss examples of process control used in weapon production processes.

b. Discuss the statistical sample methods applicable to product acceptance used by the Quality Assurance Procedures Manual.

3. Weapon Quality Assurance Engineers/Scientists shall demonstrate a working level knowledge of the DOE/NNSA 56XB, *Nuclear Weapon Development and Production Manual and Technical Business Procedures* used to evaluate product and production quality and to qualify product and production methods, processes, and equipment.

a. Describe the requirements of the weapons program evaluation and qualification process.

The following is taken from DOE SD 56XB.

The product realization process uses concurrent engineering in a systematic team approach and concurrent qualification to assure that the goals and objectives of the project are met.

The PRT is a multi-disciplinary team that is used as a mechanism to achieve concurrency. Each participating organization contributes to the concurrent engineering process consistent with the defined design or production mission. A PRT will be designated for all weapon development projects. When the size or complexity of a project demands differentiation of tasks, sub-PRTs can be formed.

The following four process steps define the product realization process:

- Definition (Define customer requirements and develop a conceptual design.)
- Development (Finalize the design and fabrication requirements.)
- Delivery (Produce and deliver the product to the customer.)
- Support (Provide support from initial delivery through disposition.)

b. Discuss the methods for evaluation and qualification of product (e.g., destructive and non-destructive).

The following information is taken from DOE SD 56XB.

Investment and Management Process for Stockpile Evaluation Technology and Transformation

The objective of surveillance technology and transformation investment is to meet the goals of the 150-Day Study and achieve a responsive capability for predictive and cost-effective stockpile evaluation. A multi-year investment plan will be developed and maintained by NA-122.1 and implemented for improved diagnostics and methods to be deployed for surveillance testing and assessment. The investment plan will be reviewed by the Southwestern Pennsylvania Industrial Resources Center and will recommend technical priorities covering all stockpile evaluation activities for new diagnostic deployment including enhanced surveillance, core surveillance, and other programs. A weapon evaluation program planning committee (WEPPC), component evaluation program planning committee (CEPPC), or DA will identify the requirements for the new diagnostic and methods. A product realization team (PRT) or equivalent will be formed for each diagnostic project involving multiple sites and/or program elements. The PRT will ensure proper integration and coordination for project implementation through the development, procurement, installation, qualification, and startup of the diagnostic. The PRT will develop and maintain an integrated project plan and will provide the necessary input for the investment plan.

The central purpose of the WEPPC is to develop the most cost-effective evaluation program for the weapon to meet the testing, assessment, and certification needs of the national laboratories, NNSA, and the DoD. NA-122 NNSA and the national laboratories will follow the process set forth in the August 9, 2005, NA-122 memorandum "Weapon Evaluation Program Planning Committee (WEPPC) and Component Evaluation Program Planning Committee (CEPPC) Process."

WEPPCs and CEPPCs

WEPPCs and CEPPCs shall be composed of members from NNSA and technical experts from the design agency, including systems, and component engineering disciplines. It is the responsibility of WEPPCs and CEPPCs to develop the specific evaluation plans for all systems and applicable component elements. Each committee will review the system's or component's basic performance, reliability, and safety requirements as defined in the military characteristics/stockpile-to-target-sequence documents, and define the underlying component characteristics needed to meet these requirements to develop a surveillance plan.

Each system's WEPPC, will be responsible for determining weapon specific sampling rationale for the active and inactive stockpile, including applicable safety testing, Weapon undergoing Life Extension Programs, Weapon with limited populations or small builds, and Weapon awaiting dismantlement.

In order to assess the stockpile, plan for modernizations, alterations, and modifications and provide the DoD with reliability assessments, the NNSA performs testing on a selected number of Weapon each year. The DOE has an established sampling rationale for determining the number of samples to pull and what testing to perform. The NNSA-approved sampling rationale for the United States nuclear stockpile consists of new material and stockpile Weapon testing.

New Material Sampling

New material testing applies to new weapon systems and stockpile systems that undergo extensive retrofit. Since retrofit units are not entirely new material Weapon, they are referred to as retrofit evaluation system test (REST) units.

For REST programs, WEPPCs/CEPPCs should determine the percentage of a new material program by considering the following:

- How many components are being changed or added? Are there large numbers of Commercial off-the-Shelf parts being used?
- Is there new technology or added capability that the NWC has never designed or built before?
- How many NWC production and design agencies are involved?
- What is the impact of the change on compatibility with the DoD delivery system?
- What is the complexity of teardown and reassembly?
- Who is doing the change (Pantex, SNL, military)?
- How many different field locations?
- How many different teams are doing the change?
- What is the quality control over the process (NNSA at Pantex, Military Liaison in field, none)?
- How long will it take to do the changes?
- Is the production a continuous or interrupted process?
- Are there new production processes being planned or have current production processes been exercised recently?

A total of $NT^{1/2}$ units are selected during T years of production. N is the 90/95 sample quantity based on total system production plus the number of units rebuilt during the production period About twice as many samples are selected from the first year's production as from any subsequent year. Additional samples are added as necessary to assure that at least six units are tested in any 12-month period. About one sixth of the new material sample Weapon are normally scheduled for flight-testing.

Sample Weapon are selected during production for testing in flight or laboratory. Laboratory testing typically includes both system and component testing. New material samples are pulled from new production Weapon and rebuilt Weapon that have been previously sampled.

NA-122, in coordination with Sandia National Laboratories, systems evaluation engineer, randomly selects Weapon for new material laboratory test (NMLT) and new material flight test (NMFT) by using the SAMSEL computer program. SAMSEL generates a list of sequence numbers that are used to forecast the monthly NMLT and NMFT pulls. This information is incorporated into the PCD. NA-122 transmits the sequence numbers for NMLT and NMFT sample selections to the Pantex site office. If the total production quantity or the length of the production period changes significantly, then the sequence numbers may be adjusted along with a corresponding change to the PCD.

Stockpile Sampling

NNSA supports a defensible reliability assessment while a weapon is in stockpile. Stockpile testing on Weapon that have been in the stockpile for at least one year begins approximately two years after the start of production, and continues throughout stockpile life, typically until two years before retirement. As with new material testing, stockpile testing consists of conducting the same kinds of tests as in new material testing. The WEPPC for each system will review the type of testing that is done on that weapon and modify the testing as required for changes in purpose, lifetime, retirement, etc.

The DoD is notified of the DOE sample selections at the beginning of each fiscal year for the next fiscal year and one to two years in advance. The DOE normally begins stockpile testing approximately two years after production is started during test cycle 3, although flight-testing of stockpile material may be conducted earlier if requested by the DoD.

Stockpile sampling continues until, but not during, the last two years before complete retirement. Starting in cycle 3 and continuing for the duration of the program, sampling is conducted annually at one-half of the 90/90 sampling rate. Normally, eight samples are tested in the laboratory and two to four samples are flight tested per year per system, unless program complexities require additional flight units to evaluate all aspects of performance. Laboratory and flight test quantities could vary based on program requirements.

Stockpile samples are used for both laboratory and flight-testing. The sample normally consists of Weapon randomly selected by the DoD for flight-testing and NNSA for lab testing. Authorization for new material and stockpile testing on each specific weapon system is accomplished through the approved weapon program New Material Stockpile Evaluation Plan (NMSEP). The details of the specific laboratory and flight tests required during each cycle are included in the NMSEP and the B-series documents prepared by SNL for each weapon system.

The goal of the NMSEP is to conduct a variety of tests in sufficient number to ensure that any significant defectiveness or aging trends with a stockpiled weapon will be detected in time to avert serious stockpile degradation. Selection of Weapon, and the designation of tests, does not guarantee that significant problems will be detected and/or recognized. It does provide a probability that the problems will be contained at least once within the quantity of Weapon sampled.

A variety of tests are necessary to address all aspects of weapon performance under all use conditions, and to provide maximum realism in all testing. Testing at the highest system or subsystem level possible is emphasized although as Weapon age, it may be desirable to increase the number of samples that see component or material testing. The absence of observed problems may be an indication that no serious problems exist in the stockpile detectable by the testing being performed. The appearance of problems in tested Weapon facilitates the action necessary to accommodate or eliminate the adverse effects of the problems.

c. Discuss how production processes/methods and equipment are evaluated and qualified.

The following is taken from NWC TBP-701.

As soon as product design information is available, the design engineer initiates planning conferences to discuss the electrical, chemical, testing, and mechanical measurement requirements at each level of assembly. The conferences also address whether or not the measurements will be performed with DA-controlled acceptance equipment. Engineers in the reliability, quality, product data systems development, and nuclear explosive safety organizations, along with other related departments, should be asked to participate. The production engineer and tester and/or gage engineers should also be invited. Planning for DA-controlled acceptance equipment may also take place at the Conceptual Design Review, see TBP-403.

Preparation, review, and approval of DA-controlled acceptance equipment designs and procedures shall be as follows:

Design Initiation

After establishing product inspection and test requirements, the DA releases one or more AERs. The AER identifies the requirements that are to be tested by specified acceptance equipment and authorizes the PA to prepare acceptance equipment design proposals.

Design Proposals

The PA prepares acceptance equipment design proposals. Proposals may recommend using existing DA- or PA-designed equipment, or commercial or contractor equipment, or may propose that new equipment be provided. Proposals shall contain technical detail consistent with the performance complexity of the product being tested. Design and fabrication time scales and cost estimates shall be included. Acceptance equipment proposals prepared by the PA are normally presented at the equipment conceptual design review; see TBP-403.

Design Reviews

Depending on equipment complexity, one or more design reviews shall occur before acceptance equipment fabrication begins. Often three reviews are held: conceptual design review, technical design review, and final design review. The PA arranges design and production review conferences at the appropriate times. When the Design Agency designs acceptance equipment that will be used by a PA, the production agency is invited to participate in design reviews. See TBP-403.

Members of the acceptance equipment evaluation team are also invited to participate in design reviews. For acceptance equipment that will be used in a NEA, a nuclear explosive safety representative from each applicable DA must be a member of this team, review the drawings, and participate in design reviews.

d. Demonstrate ability to locate and explain evaluation and qualification documentation.

The following is taken from DOE SD 56XB.

NA-122, with NA-121 concurrence, authenticates and distributes the Weapon reliability report by the end of the scheduled publication month. NA-122 must concur in writing before each Weapon System Stockpile Evaluation Progress Report (cycle report) can be finalized and formally distributed.

Design Agencies

Annual Stockpile Evaluation Program Reports--Each year, within 3 months of the conclusion of an annual weapon cycle, the national laboratories report the consolidated results of stockpile evaluation activities for that weapon reported by the testing sites within the preceding cycle months. Due to the sequential flow of activities, parent unit and component evaluations from the same cycle usually span subsequent years before being fully completed. Once all evaluations of a laboratory's cycle components are finally completed and reported, the laboratory in the next Annual Cycle Report will include a summary of the evaluation results of that cycle.

Sandia National Laboratories

SNL, with input from Los Alamos National Laboratory (LANL) and Lawrence Livermore National Laboratory (LLNL), issues a quarterly summary of ongoing significant finding investigations (SFI) by the fifteenth day of the month following the end of each quarter. The report includes activities and results for the previous quarter.

SNL prepares the Weapon reliability report in accordance with approved NNSA policy and methodology and with input from the nuclear DAs and other engineering and reliability groups within SNL. They provide NA-122.1 with a coordinated draft of this report by the 21st day of the month before the month of publication. SNL publishes the report in May and November, after approval by NA-122.1, with NA-121.3 concurrence. Included in the report is the status of the reliability of all active fielded nuclear warheads or bombs and the quantity of laboratory and flight tests that make up the database used to generate the reliability assessments. Addenda are issued when required by significant changes to the reliability of any system.

SNL's reliability department is responsible for preparing and issuing the reliability profile report.

SNL has responsibility for development and maintenance of the Stockpile Surveillance Program Data Management System. The data management system will combine all current and future NMSEP data into a single host system that will facilitate data management, evaluation, and correlation of information from various sources.

SNL's Weapon Evaluation Test Laboratory maintains a database that contains information on tests conducted for each weapon.

Los Alamos National Laboratory and Lawrence Livermore National Laboratory

LANL and LLNL provide updated information, as necessary, to SNL for inclusion in the quarterly SFI report.

LANL and LLNL report on various evaluation activities for their respective components to SNL for the cycle reports consistent with required publication dates.

LANL and LLNL are responsible for providing inputs to the findings database as necessary to maintain the currency of the master data bank.

LANL and LLNL provide input to SNL for inclusion into the semi-annual reliability report.

Production Agencies

Production agencies will provide the results of individual cycle evaluations as required by national laboratory specifications and drawings. At the conclusion of all disassembly and inspection evaluation activities for a cycle, Pantex will submit to the national laboratories a consolidated package of all the individual evaluation reports for parent units, JTAs, testbeds, and components. Other production agencies will provide consolidated cycle evaluation packages when requested by a national laboratory.

4. Weapon Quality Assurance Engineers/Scientists shall demonstrate a working level knowledge of a nonconformance and the Suspect/Counterfeit Item Program identified in:

- **DOE Order 414.1C, *Quality Assurance***
- **DOE/NNSA Weapon Quality Policy (QC-1)**

Note: Information regarding the KSAs in this competency is available in competency 3 of the first section of this guide.

a. Discuss the purpose of the nonconformance and the Suspect/Counterfeit Item Program.

b. Explain the process requirements for nonconforming material.

c. Describe the requirements and method for reporting nonconforming material delivered between NNSA agencies.

d. Describe the purpose for the disposition of nonconforming and suspect material/items.

5. Weapon Quality Assurance Engineers/Scientists shall demonstrate a working level knowledge of metrology and calibration used in the weapons program from the following documents:

- **DOE/NNSA 56XB, Nuclear Weapon Development and Production Manual**
- **Primary Standards Laboratory Memorandum**
- **DOE/NNSA Weapon Quality Policy (QC-1)**

Note: Information regarding the KSAs in this competency is available in competency 5 of the first section of this guide.

a. Describe the purpose of instrument and equipment calibration.

b. Describe the function the Primary Standards Laboratory performs on behalf of NNSA.

c. Discuss the measurements and control of calibrated instruments used in weapon production.

6. Weapon Quality Assurance Engineers/Scientists shall demonstrate a working level knowledge of SQA.

Note: Information regarding the KSAs in this competency is available in competency 4 of the first section of this guide.

a. Discuss the requirements for software quality assurance specific to DOE/NNSA *Weapon Quality Policy (QC-1)*.

b. Identify the procedure/process used by the M&O contractor for SQA development, testing, use control, and error reporting and correction.

7. Weapon Quality Assurance Engineers/Scientists shall demonstrate a working level knowledge of geometric dimensions and tolerances.

Note: Information regarding the KSAs in this competency is available in competency 1 of the first section of this guide.

a. Explain the purpose and use of dimensions and tolerances.

b. Demonstrate knowledge and use of the dimensions and tolerances on product drawings and specifications.

8. Weapon Quality Assurance Engineers/Scientists shall demonstrate a working level knowledge of Federal product acceptance.

Note: Information regarding the KSAs in this competency is available in competency 7 of the first section of this guide.

a. **Describe the use of the Quality Instruction List (QIL)**

b. **Describe the use of the Certification of Inspection (COI)**

c. **Describe the verification inspection process including Quality Assurance Inspection Procedures (QAIPs), where the requirements come from, reviewing certification documentation, reviewing drawings, performance of verification inspection, etc.**

d. **Describe stamping activities (which stamps are used for what)**

e. **Describe source acceptance**

f. **Describe the process for rejection of submitted material using a Quality Assurance Defect Report (QADR)**

9. **Weapon Quality Assurance Engineers/Scientists shall demonstrate a working level knowledge of the NNSA quality assurance policy and other regulatory requirements contained in the following documents:**
   - **10 CFR 830, Subpart A, *Quality Assurance***
   - **DOE Order 414.1C, *Quality Assurance***
   - **DOE/NNSA 56XB, Nuclear Weapon Development and Production Manual**
   - **DOE/NNSA Weapon Quality Policy (QC-1)**
   - **DOE/NNSA Technical Business Practices**
   - **DOE/NNSA Quality Assurance Procedures Manual (QAPM)**

   Note: Information regarding the KSAs in this competency is available in competency 9 of the first section of this guide.

   a. **Explain the hierarchy of NNSA and regulatory documents used in the Weapon Quality Assurance Program**

   b. **Explain the purpose of each of the documents listed above.**

   c. **Discuss the responsibilities of the NNSA, production agencies, and design agencies for acceptance of weapon related product per the Quality Assurance Program Manual.**

10. **Weapon Quality Assurance Engineers/Scientists shall demonstrate a working level knowledge of assessment requirements, principles, and techniques as defined by the following documents.**
    - **DOE/NNSA Quality Assurance Procedures Manual**
    - **DOE/NNSA Weapon Quality Policy (QC-1)**
    - **DOE Order 414.1C, Quality Assurance**
    - **DOE Guide 414.1-1B, Management and Independent Assessment Guide for use with 10 CFR 830, Subpart A and DOE Order 414.1C**

    Note: Information regarding the KSAs in this competency is available in competency 11 of the first section of this guide.

a. Describe the different types and purpose of assessments

b. Demonstrate knowledge of performance methods/techniques

11. Weapon Quality Assurance Engineers/Scientists shall demonstrate a working level knowledge of how to oversee the effective implementation of QA criteria as contained in the following documents:

- **DOE/NNSA Weapon Quality Policy (QC-1)**
- **DOE/NNSA Quality Assurance Procedures Manual (QAPM)**

a. Discuss the Weapon Quality Assurance Specialist's role in effective oversight

The following information is taken from DOE-STD-1025-2008.

The WQA Specialist role may vary at different NNSA sites. Site specific position descriptions provide additional details. The following is a partial list of the WQA Specialist's responsibilities

- Performs the functions of monitoring, inspection, analysis, and investigation of complex electrical, electronic, mechanical, electro-mechanical, and nuclear components, subassemblies, and assemblies associated with the manufacture of nuclear weapons and other non-nuclear components as applicable.
- Conducts QASs and oversight activities of contractor operations.
- Performs verification acceptance of product manufactured by the DOE Weapons Complex.
- Investigates quality and manufacturing problems and ensures corrective actions are appropriate for the identification and control of product and process deficiencies
- Conducts other activities as defined in the QAP Manual.

b. Discuss the Weapon Quality Assurance Engineer/Scientist's role in effective oversight.

The following is taken from DOE-STD-1025-2008.

The following is a partial list of the WQA Engineer/Scientist's responsibilities:

- Monitors nuclear weapons and non-nuclear components assembly and surveillance activities of the Management and Operating (M&O) contractor to assure that the production processes and quality control operations for nuclear weapon assemblies, subassemblies, and components (nuclear and non-nuclear) are adequate and result in acceptable product quality.
- Provides production support and weapons program (nuclear and non-nuclear) direction to M&O contractor contracting officer representatives when appropriate.
- Ensures surveys and technical studies conducted by Weapon Quality staff adequately cover the contractor production processes and quality control operations for assigned weapons activities.
- Ensures assigned weapons activities comply with Weapon Quality policies, procedures, specifications and other requirements and that these policies, procedures, specifications and other requirements are adequate.

- Schedules and conducts QAS surveys on assigned weapons activities (nuclear and non-nuclear) that require engineering judgment and expertise to interpret policies, procedures and specifications and other requirements assuring that the life cycle processes and quality control operations for nuclear weapon assemblies, subassemblies, and components (nuclear and non-nuclear) are adequate and result in acceptable product quality. Reviews QAS criteria checklists, survey guidelines, and non-nuclear verification instructions for assigned weapons activities.
- Initiates, responds, and provides technical and status information on assigned weapons activities (nuclear and non-nuclear) by interfacing with DOE/NNSA Headquarters, Service Center/site offices, on-site DOE/NNSA personnel, design/production agency, and site contractor technical personnel. Provides policy guidance or interpretation in situations where guidelines exist and do not exist to contractor personnel.
- May perform the responsibilities of a Weapon Quality Specialist as applicable.

c. Describe process(es) used to conduct oversight

The following is taken from DOE/NNSA QC-1.

Processes to detect and prevent quality problems shall be established and implemented. Items, services, and processes that do not meet established requirements shall be identified, controlled, and corrected according to the importance of the problem and the work affected.

Correction shall include identifying the causes of problems and working to prevent recurrence. Item characteristics, process implementation, and other quality-related information shall be reviewed and the data analyzed to identify items, services, and processes needing improvement.

The objective of a quality management system is to prevent errors and nonconformance, reduce variability, and build quality into products and processes. Fundamental methods such as design of experiments, prototyping, process capability studies, Pareto analyses, and statistical process controls may be used to

- characterize processes,
- simplify processes,
- mistake-proof processes,
- continually reduce product and process variability
- identify and minimize the number of unstable or error-prone processes, and
- provide early feedback of engineering and manufacturing data to determine the need for product or process changes.

Special processes shall be identified and procedures, processes, and controls implemented to ensure a high level of confidence in the control of product variability and to minimize nonconformances.

Special-process equipment and procedures shall be qualified and controlled. When the outcome of a special process is dependent upon the skill of the person performing the

process, that person shall be certified to written procedure. Evidence of qualification of equipment and procedures and certification of personnel shall be maintained.

Mandatory Performance Activities

Note: The number of activities needed to satisfy this competency will be determined at the site level.

12. Participate in a minimum of one product specification and design agency drawing review.

13. Participate in product acceptance activities using a QAIP or a survey.

14. Participate/Perform at least one QAS 1.0, 3.0 and 4.0 Survey.

These are performance-based competencies. The Qualifying Official will evaluate the completion of these competencies.

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DOE Guide 414.1-2A, *Quality Assurance Management System Guide for Use with 10 CFR 830 Subpart A, Quality Assurance Requirements, and DOE O 414.1C, Quality Assurance*, June 17, 2005.

DOE Guide 414.1-3, *Suspect/Counterfeit Items Guide for Use with 10 CFR 830 Subpart A, Quality Assurance Requirements, and DOE O 414.1B, Quality Assurance*, November 3, 2004.

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