ASME NQA.TR-2020

Evolution of Quality Assurance Principles and Requirements in the U.S. Nuclear Industry

AN ASME TECHNICAL REPORT

The American Society of Mechanical Engineers

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FOREWORD

This Technical Report provides a historical summary of the principles, practices, and requirements of quality assurance standards across the nuclear industry from 1954 to the present. It details the origins of nuclear quality assurance techniques such as quality control and inspection requirements during World War II, and the subsequent nuclear vessel codes and standards that emerged in the early 1960s. The purposes of and benefits derived from these early engineering efforts are provided with their historical context. This Technical Report provides a thorough timeline of the evolution of quality assurance across the nuclear industry (primarily in the United States) and a discussion of today's practices to ensure high integrity in the design, operation, and decommission of U.S. nuclear facilities.

Merritt E. (Gene) Langston — a long-time member of the ASME NQA Standards Committee and industry historian — was the principal author of the original 2005 draft of this Technical Report. Mr. Langston coauthored quality assurance requirements of the U.S. Nuclear Regulatory Commission (NRC) regulation 10 C.F.R 50, Appendix B, Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants; the U.S. Atomic Energy Commission Reactor Development and Technology (AEC RDT) document F2-2T, Quality Assurance Program Requirements, and U.S. Department of Energy (DOE) Order 5700.6, Quality Assurance. He was a charter member of the former ASME N45.3 Subcommittee and a former member of the ASME Committee on NQA. Subsequent contributors to this Technical Report include staff from the NRC and the DOE, and members of ASME Codes and Standards Committees.

ASME NQA Standards Committee is committed to maintaining this Technical Report to benefit the entire nuclear industry. It will help provide young professionals and "newcomer nations" to nuclear power with the historical foundations for the principles, practices, and requirements used to ensure the safe and reliable use of nuclear energy.

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Nuclear Quality Assurance

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Proposing Revisions. Revisions are made periodically to the Technical Report to incorporate changes that appear necessary or desirable, as demonstrated by the experience gained from the application of the Technical Report. Approved revisions will be published periodically.

The Committee welcomes proposals for revisions to this Technical Report. Such proposals should be as specific as possible, citing the paragraph number(s), the proposed wording, and a detailed description of the reasons for the proposal, including any pertinent documentation.

Attending Committee Meetings. The NQA Standards Committee regularly holds meetings and/or telephone conferences that are open to the public. Persons wishing to attend any meeting and/or telephone conference should contact the Secretary of the NQA Standards Committee.

EXECUTIVE SUMMARY

This Technical Report provides an accounting of the continuing evolution of quality assurance principles, practices, and requirements for nuclear facility applications in the United States since 1954. Sections 1 through 5 describe how nuclear quality assurance (NQA) and its documentation have evolved along four separate yet interrelated paths, as follows:

(a) standards and directives from the U.S. Atomic Energy Commission (AEC), then the Energy Research and Development Administration (ERDA), then the Department of Energy (DOE)

(b) regulations and regulatory guides first from AEC and subsequently from the U.S. Nuclear Regulatory Commission (NRC)

(c) ANSI N45.2 and subsequently ASME NQA-1 and related standards

(d) ASME Boiler and Pressure Vessel Code (BPVC), Section III

These first five Sections track the evolution of early AEC quality control and acceptance inspection requirements and practices for nuclear weapons production from the 1950s; the AEC quality assurance requirements for government-owned reactor and technology development programs from the 1960s; the AEC licensing regulations for designing, constructing, and operating commercial nuclear power plants and fuel-reprocessing plants from the 1970s; the development of the American Society of Mechanical Engineers' (ASME) national consensus standards for nuclear facilities from the 1970s; the ASME code quality assurance criteria from the 1960s; and the management system and performance-based approach, also from the 1970s to date. Section 6 outlines ASME NQA management issues the ASME NQA Committee vision.

At the onset of nuclear power generation in the United States, AEC regulators and nuclear utility owners were primarily concerned with ensuring safe plant operation without due regard to formal management controls that were essential for ensuring quality in achieving both safe and reliable operation of these complex facilities. Untoward problems during commercial nuclear facility design and construction phases eventually caused AEC regulators and nuclear utility plant owners to realize the importance and interrelationship of NQA to nuclear safety. Similarly, problems in AEC-owned reactor and test facilities led to the development of quality assurance standards and practices.

Early NQA activities were focused on the design of commercial nuclear power facilities. This focus then shifted to construction activities. Current NQA activities have also included the operations and maintenance of existing facilities.

Anticipating a revitalized U.S. nuclear power plant industry and associated fuel reprocessing, design, construction, and operation, the ASME NQA Committee envisions an additional section documenting

- a broader adoption by the nuclear industry of ASME NQA-1 standards
- a growing application of the standards to DOE reactor and non-reactor nuclear facilities
- a more timely endorsement by the NRC of successive versions of the standards beyond 1994

NOTE: At its April 2004 meeting, the ASME NQA Committee approved a task proposal notice enabling development of an historical and tutorial document on the origins, purposes, and benefits to be derived from the principles, practices, and requirements of quality assurance standards for nuclear facilities from 1954 to today. This Technical Report is not a part of ASME NQA-1.

PREFACE[1]

Nuclear quality assurance had its origin in the quality control and inspection practices of World War II. Quality control and inspection requirements were exercised through statistical process control techniques. These techniques were embedded in the early military and industrial products and nuclear weapons production standards. Quality assurance emerged as an adjunct engineering practice.

Early engineering efforts to design and construct components for nuclear power plants evolved through nuclear code cases arising from non-nuclear boiler and pressure vessel codes and standards. In 1963 and 1974, the first nuclear vessel codes emerged and became, collectively, the foundation standard for extension to other pressure-retaining nuclear components rules. With the initial edition of the nuclear vessel code, Section III of the ASME BPVC, ASME provided a tutorial guide that was extremely helpful for orienting new people to the principles and practices underlying the rules and procedures that governed nuclear component design and fabrication. Later, as the body of experience and understanding grew and the nuclear component codes matured, this guidance was no longer essential and thus no longer promulgated.

In 1962, Vice Admiral Hyman G. Rickover, the recognized father of naval nuclear propulsion, spoke of a "cultural lag" in nuclear power plant management and manufacturing.[2] He said industry practices were not geared to the higher standards imposed by the new power reactor technology. He laid out the following three principles for improving quality management:

(a) More effective management and engineering attention must be given to routine and conventional aspects of nuclear power.

(b) Specifications must be clearly understood, respected, and enforced by manufacturers as well as customers.

(c) More effective use must be made of quality assurance program requirements.

An exponential growth in the nuclear power plant market began in 1965. This growth followed the successful demonstration of commercial nuclear power at the Shippingport, PA, nuclear plant. At that time, 8 reactors with a combined capacity of 4,870 megawatts electrical (MWe) were on order. In the first 8 months of 1966, 15 more reactors with a total capacity of 11,800 MWe were ordered. By November 1966, there were 52 civilian power reactors with a total capacity of 26,890 MWe on order. The AEC predicted an increase in capacity of from 80,000 total MWe to 110,000 total MWe by 1980. Plant capacity had increased in size from several hundred megawatts electrical to 1,100 MWe, including multiple units at some sites, such as Commonwealth Edison's Dresden, IL, generating station. Also, plants were being located in proximity to largely populated metropolitan areas.

This rapid growth in nuclear power plant orders and construction in the 1960s eventually raised considerable concern among the members of the U.S. Congress, the AEC commissioners and their inspectors, and senior utility industry officials. These concerns focused on the following questions:

– Did the nuclear industry have sufficient numbers of skilled people to staff these very large and technically challenging projects without compromising the high-quality standards necessary to protect public and worker safety?

– Conversely, did the AEC have sufficient staff to inspect, evaluate, and oversee licensee applications and construction permits for nuclear power plants?

AEC Commissioner James Ramey and Reactor Development and Technology (RDT) Director Milton Shaw spoke on numerous occasions about the need for quality assurance in nuclear reactor design and development projects and facility construction.

At a meeting of the American Nuclear Society (ANS) in 1966, Commissioner Ramey defined quality assurance as comprising "all actions necessary to provide adequate confidence that a product or facility will operate satisfactorily in service."[3]

This definition was consistent with the U.S. Department of Defense (DOD) military specification MIL-STD-109, which defined quality assurance as "a planned and systematic pattern of all activities necessary to provide adequate confidence that the item or product conforms to established technical requirements."[4]

[1] This Preface was contributed by Joe Anderson, former Chair of the ASME N45-2 Subcommittee and former member of the ASME NQA Committee and Applications Subcommittee.

[2] Address by Vice Admiral Hyman. G. Rickover, "The Never-Ending Challenge," 44th Annual National Metals Congress, New York, NY, October 29, 1962.

[3] Address by AEC Commissioner James T. Ramey, "Quality Assurance as a Matter of Public Policy in the Safety of Atomic Power Plants," 1966 Winter Meeting of the American Nuclear Society, Pittsburgh, PA, November 2, 1966.

[4] Reference to MIL-STD-109 definition of "quality assurance" was contributed by Robert Hartstern, former member, ASME NQA Committee.

In 1968, Commissioner Ramey addressed the American Power Conference expressing his concerns about insufficiently experienced organizations causing errors and omissions resulting in startup problems and delays in nuclear power plant construction. He emphasized that these problems and delays demanded management leadership and urgent attention by the nuclear utilities.[5] He referred to his 1966 definition of quality assurance and the practices necessary for an effective quality assurance program.

Commissioner Ramey's concerns, when coupled with other unplanned events, led eventually to the development of AEC regulation on nuclear quality assurance, known as Appendix B to Title 10 of the Code of Federal Regulation, Part 50 (10 C.F.R. 50). In response to Appendix B, the ASME-sponsored American National Standards N45 Committee formed a quality assurance subcommittee to develop standards for implementing quality assurance standards. This subcommittee subsequently became the ASME Nuclear Quality Assurance (NQA) Committee. Since their inception, these ASME standards committees have carefully preserved the early definition and the enlightened concepts of nuclear quality assurance.

Throughout the late 1960s and 1970s, as nuclear power plant construction projects continued to grow in size and numbers, groups of people were trained to conform their programs to ANSI N45.2 and later to ASME NQA-1. As we know now, the nuclear industry designed, constructed, and successfully operated over 100 nuclear power plants; however, no new plants have been ordered for over 20 years. During the late 1960s and 1970s, many of the skilled workers in the U.S. nuclear industry who managed, designed, and constructed these plants moved to other careers, retired, or were nearing retirement. Today, the nuclear industry is approaching the same situation it initially faced in the early 1960s: a lack of knowledgeable and skilled management, technical, and quality assurance professionals. A tremendous amount of accumulated experience and best practices have been developed, documented, and codified over the past 70 years. This knowledge must not be lost to the future designers, constructors, and operators of nuclear power generation facilities.

With the prospect emerging again for new nuclear power plant orders and a new cycle of growth in the nuclear power industry, the ASME NQA Committee believes it is appropriate and timely to prepare an historical record of events for the next generation of managers, technical specialists, and nuclear quality assurance professionals. The ASME NQA Committee intends that this Technical Report will be used to acquaint newly involved management, technical, and quality assurance professional with the what, how, and why of the principles, practices, and requirements that have been defined and documented in ASME NQA-1 and other standards, as well as with some of the key quality management issues.

ACRONYMS

The following acronyms are used in this Technical Report:

Acronym	Definition	Acronym	Definition
ACRS	Advisory Committee for Reactor Safeguards	FFTF	Fast Flux Test Facility
AEC	U.S. Atomic Energy Commission	GOCO	Government-owned, contractor-operated
AIChE	American Institute of Chemical Engineers	IEEE	Institute of Electrical and Electronics Engineers
AL	Albuquerque Operations Office	MWe	Megawatts electrical
ANS	American Nuclear Society	NASA	National Aeronautics and Space Administration
ANSI	American National Standards Institute	NFPQT	Nuclear Facility Personnel Qualification and Training Committee
ASLB	Atomic Safety and Licensing Board	NNSA	National Nuclear Security Administration
ASME	The American Society of Mechanical Engineers	NQA	Nuclear quality assurance
BPVC	Boiler and Pressure Vessel Code	NRC	U.S. Nuclear Regulatory Commission
C.F.R.	Code of Federal Regulations	NSMB	Nuclear Standards Management Board
CP	Construction permit	OMB	Office of Management and Budget
CRD	Contractor requirements document	PAAA	Price Anderson Amendments Act
DNFSB	Defense Nuclear Facilities Safety Board	QC	Quality control
DOD	U.S. Department of Defense	RDT	Reactor development and technology
DOE	U.S. Department of Energy	SFO	Santa Fe Operations Office
DP	Defense Program	SNAP	Space Nuclear Auxiliary Power
DRS	AEC Division of Reactor Standards		
ERDA	Energy Research and Development Administration		

[5] Address by AEC Commissioner James T. Ramey, "Quality Assurance — An Essential for Safe and Economic Nuclear Power," American Power Conference, Chicago, IL, April 23, 1968.

TIME LINE

The following chronology traces significant events and reactions in the evolution of AEC, ERDA, DOE, ASME, and other related NQA standards and directives from 1954 to today:

1954

The Atomic Energy Act of 1954 amended the Atomic Energy Act of 1946, defined the AEC function, and established the AEC in Germantown, MD, and Washington, DC, encompassing both regulatory and developmental functions.

AEC Santa Fe Operations Office issued QC-1, Weapon Quality Policy, prescribing nuclear weapons production quality control and inspection practices.

1956

Dresden 1 and Indian Point 1 [Note (1)] received the first AEC construction permits (CPs) under 10 C.F.R. 50, with no specified quality assurance program criteria or requirements.

1963

ASME issued ASME BPVC, Section III, with no specified quality assurance requirements.

1965–1967

AEC developed a proposed Appendix A to 10 C.F.R. 50 covering nuclear power plant design criteria. Criterion 1, Quality Standards and Records, required the following:
(a) quality standards
(b) a quality assurance program
(c) quality records for structures, systems, and components important to safety

1966

The Fermi 1 [Note (1)] incident resulted from unauthorized design changes causing partial reactor core meltdown. Also, AEC reported ten reactors that had been in operation for approximately 2½ years were then closed.

1967

During its review of the CPs for Turkey Point 3 and 4 [Note (1)], the ACRS asked about but did not pursue methods of quality control.

ASME published ASME BPVC, Section III, Appendix IX, containing 15 quality assurance criteria and requiring ASME review and approval.

During its review of the CPs for Browns Ferry 1 and 2 [Note (1)], ACRS found a lesser commitment to quality assurance. ACRS was concerned because these were the first reactors to exceed 1,000 MWe.

The AEC regulatory function moved to Bethesda, MD, while the development function stayed in Germantown, MD.

1968

ASLB suspended public hearings on a Commonwealth Edison application to design and construct a nuclear power plant because the license applicant did not have a quality assurance program for the plant and the AEC did not have criteria for evaluating the adequacy of the applicant's quality assurance program.

1969

The AEC RDT Division developed and issued a comprehensive quality assurance program standard, AEC RDT F2-2T, for its GOCO reactors and test facilities.

AEC regulatory department proposed for public comment 18 quality assurance criteria as Appendix B to 10 C.F.R. 50 for licensing nuclear power plants.

Representatives of the AEC and the nuclear industry met to begin developing N45.2 standards on quality assurance program requirements and guidance for nuclear power plants.

1970

Following an extensive public comment period and a trial use at Surry [Note (1)], the AEC issued 18 quality assurance criteria for nuclear power plants as 10 C.F.R. 50, Appendix B, thereby expanding upon Criterion 1 of 10 C.F.R. 50, Appendix A.

1971	AEC issued 10 C.F.R. 50, Appendix A.
	AEC expanded 10 C.F.R. 50, Appendix B, to apply the 18 quality assurance criteria to fuel-reprocessing plants as well as to nuclear power plants.
	ANSI N45.2-1971 was issued. Supplementary ANSI N45.2 standards (referred to as daughter standards) were issued in subsequent years.
1972	ANS published ANS 3.2-1972 for administrative controls during nuclear power plant operation.
1974	The Energy Reorganization Act of 1974 abolished the AEC and established separate agencies: the NRC and the ERDA.
	Due to some organizational issues at LaSalle and Midland [Note (1)], the AEC and then the NRC proposed an amendment to Criterion 1, Organization, of 10 C.F.R. 50, Appendix B, with regard to permissible organizational relationships; the Criterion 1 amendment was approved and issued early in 1975.
1975	ASME established the ASME Committee on Nuclear Quality Assurance to continue developing, coordinating, consolidating, and restructuring nuclear quality assurance standards.
	Browns Ferry [Note (1)] fire occurred.
1977	ASME NQA Committee issued ANSI/ASME N45.2-1977 on quality assurance program requirements for nuclear facilities.
	ERDA was abolished with the creation of the U.S. Department of Energy.
1978	ANSI N46-2 Committee issued Revision 1 of ANSI N46.2-1978, Quality Assurance Program Requirements for Post-Reactor Nuclear Fuel Cycle Facilities, which was subsequently withdrawn.
1979	Three Mile Island Unit 2 [Note (1)] suffered severe operational casualty due to minor maintenance errors and a stuck pressure relief valve, leading to a loss of crew operational awareness and resulting in major core damage.
	ASME NQA Committee issued ANSI/ASME NQA-1–1979 on quality assurance requirements for nuclear facilities.
1981	DOE issued DOE Order (O) 5700.6, Quality Assurance, in response to deficiencies observed by the DOE Inspector General in DOE nuclear facilities. This Order was superseded by DOE O 5700.6A in 1981, DOE O 5700.6B in 1986, and DOE O 5700.6C in 1991, which was superseded by DOE O 414.1 in 1998.
1983	ASME NQA Committee issued ANSI/ASME NQA-1–1983.
	ASME BPVC, Section III, adopted ANSI/ASME NQA-1–1979 edition.
	ASME NQA Committee incorporated seven ANSI/ASME N45.2 daughter standards as Parts of ANSI/ASME NQA-2–1983.
1985	NRC endorsed ASME NQA-1–1983 in Revision 3 of NRC Regulatory Guide 1.28.
1986	ASME NQA Committee issued ASME NQA-1–1986 with minor editorial changes to the 1983 edition, with several positions.

1989 ASME NQA Committee issued ASME NQA-1–1989 on quality assurance requirements for nuclear facilities.

1991 NRC endorsed ASME NQA-1 and ASME NQA-2 in NUREG-0800.

DOE published a proposed Nuclear Safety Management Rule under 10 C.F.R. 830 and § 830.120 on quality assurance. DOE also issued DOE O 5700.6C, introducing ten performance-based quality assurance criteria, including the concept of quality improvement. These ten criteria were used in the proposed Rule.

1994 DOE published the Nuclear Safety Management Rule, 10 C.F.R. 830 and § 830.120. The Rule provided for civil and criminal penalties similar to the NRC rules for commercial nuclear facilities.

ASME NQA Committee issued ASME NQA-1–1994, Quality Assurance Requirements for Nuclear Facility Applications.

1997 ASME NQA Committee issued ASME NQA-1–1997 with continued restructuring and removal of redundant text.

1998 DOE O 414.1 was issued in November 1998. This Order was superseded by DOE O 414.1A in May 1999 and by DOE O 414.1B in April 2004.

2000 ASME NQA Committee issued ASME NQA-1–2000 with minor revisions to the 1997 edition.

2001 DOE revised the Nuclear Safety Management Rule to include safety basis requirements and minor changes to the quality assurance rule, clarifying its applicability to nuclear weapons and radiological facilities.

2004 ASME NQA Committee issued ASME NQA-1–2004, which contained numerous revisions to the 2000 edition.

DOE/NNSA issued Revision 10 of QC-1 on DOE weapon quality policy.

2005 DOE O 414.1C superseded DOE O 414.1B. DOE O 414.1C contained requirements for safety software.

DOE published Action Plan based on lessons learned from the Columbia Space Shuttle accident and Davis–Besse [Note (1)] reactor pressure-vessel head corrosion event.

2008 ASME NQA Committee issued ASME NQA-1–2008 with the new work-practice requirements on commercial grade dedication in Subpart 2.14.

DOE Office of Environmental Management issued EM-QA-001, Quality Assurance Program, which required consideration of all Parts of ASME NQA-1.

2009 ASME NQA Committee issued the ASME NQA-1a–2009 addenda linking Subpart 2.14 on commercial grade dedication and Subpart 2.7 on acquired software and safety functions.

2010 NRC endorsed ASME NQA-1–2008 and the ASME NQA-1a–2009 addenda with the issuance of Revision 4 of NRC Regulatory 1.28.

2011 ASME NQA Committee issued the ASME NQA-1b–2011 addenda, which included revision of para. 100 titles in Part I from "Basic" to "General" and the beginning of the Part II revisions.

DOE issued DOE O 414.1D, which superseded DOE O 414.1C. The revision required the use of ASME NQA-1–2008 with ASME NQA-1a–2009 for activities passing Critical Decision Phase 1 (CD-1).

2012 ASME NQA Committee issued ASME NQA-1–2012. The edition contained numerous revisions to Part II Subparts; the addition of Subpart 2.22 on management assessments within the DOE; and revision and restructuring to the Subparts of Parts III and IV [notably the addition of guidance on commercial grade dedication of software (3.2-2.14), and the redesignation of the research and development guide as Subpart 4.2.1 (previously Subpart 4.2)].

2013 DOE/NNSA issued NAP-24 on DOE weapon quality policy that superseded QC-1 Revision 10. NAP-24 described the minimum quality requirements for the NNSA and NNSA contractors and subcontractors responsible for activities specific to phases 1 through 7 of the weapon life cycle. Requirements were aimed at ensuring customer requirements are met during all seven phases of weapon and weapon-related product realization — from concept definition to disposal.

DOE/NNSA issued NAP 24A, a revision of NAP-24, NNSA Weapon Quality Policy. NAP-24A added content that replaced the NNSA Office of Defense Programs (NA-10) Weapon Quality Assurance Procedures Manual and incorporated new NNSA Nuclear Enterprise Assurance policies.

2015 ASME NQA Committee issued ASME NQA-1–2015. In this edition, the committee continued its efforts to enhance the understanding and usability of the Standard (e.g., Parts II, III, and IV). Of particular note were the consolidation of the majority of software requirements in Subpart 2.7, and guidance on the relationship between the software requirements and guidance. An initial set of process flow diagrams for the software requirements of ASME NQA-1a–2009 was included to assist in the implementation of ASME NQA-1–2008 with the 2009 addenda. A guide on the peer-review process was also developed and included in this edition.

2017 ASME NQA Committee issued ASME NQA-1–2017. The edition was revised to address requirements and guidance for use of electronic quality assurance records and supplier accreditation for calibration and testing services. Guidance for control of nonconforming items was revised, and minor changes were made to the graded approach for applying ASME NQA-1 to research and development projects. Additionally, the full set of process flow diagrams for the software requirements of ASME NQA-1a–2009 was completed to better assist in the implementation of ASME NQA-1–2008 with the 2009 addenda.

NOTE: (1) This time lime uses the following abbreviations for U.S. nuclear sites:

Browns Ferry 1 and 2	=	Browns Ferry Nuclear Plant, Units 1 and 2, Athens, AL
Davis–Besse	=	Davis–Besse Nuclear Power Station, Oak Harbor, OH
Dresden 1	=	Dresden Generating Station, Unit 1, Dresden, IL
Fermi 1	=	Enrico Fermi Atomic Power Plant, Unit 1, Newport, MI
Indian Point 1	=	Indian Point Energy Center, Unit 1, Buchanan, NY
LaSalle	=	LaSalle County Generating Station, Marseilles, IL
Midland	=	Midland Nuclear Power Plant, Midland, MI
Surry	=	Surry Nuclear Power Station, Surry, VA
Three Mile Island Unit 2	=	Three Mile Island Nuclear Generating Station, Unit 2, Middletown, PA
Turkey Point 3 and 4	=	Turkey Point Nuclear Generating Station, Units 3 and 4, Homestead, FL

Section 1
AEC and DOE Quality Assurance Requirements and Rules

1.1 SCOPE

This Section describes the evolution of nuclear quality assurance from early quality control and inspection requirements for AEC nuclear weapons production and naval reactors programs; to the more comprehensive quality assurance program requirements for nuclear weapons production and AEC/DOE reactor development and technology activities; to the series of DOE quality assurance directives.

1.2 AEC WEAPON QUALITY POLICY, QC-1 AND NAP-24

AEC quality management policy for nuclear weapons complex activities was first documented in the AEC's Santa Fe Operations Office (SFO) Weapon Quality Policy, QC-1. Issued in April 1954, QC-1 predated MIL-Q-9858A,[1] the widely used DOD specification for military quality assurance programs that was issued in 1959.

The initial edition of QC-1 included the following quality control and inspection principals and requirements:

(a) specification and drawing control
(b) quality control procedures
(c) control of inspection gauging and test equipment
(d) production tooling accuracy
(e) in-process inspection and records
(f) control of special processes
(g) SFO/DOE source inspection
(h) raw material and deviation control

QC-1 prescribed general principles and practices for AEC–SFO acceptance inspection of nuclear weapons systems and auxiliary equipment from prime contractors. It required weapons program prime contractors to establish and implement quality control systems to ensure, among other things, that nuclear weapons materials met minimum quality standards. SFO expected these principles and requirements to be applied also to ordnance plants operated by DOD on the behalf of SFO and to arsenals that performed work for the SFO under agreements with DOD.

In 1982, the DOE Assistant Secretary for Military Applications defined,[2] and in 1989 redefined[3] in greater detail, the quality assurance policy for the DOE nuclear weapons complex. This policy required the execution and maintenance of procedures that

– provided control, through plans and actions, over activities affecting quality to an extent consistent with defined programmatic or organizational objectives
– had objective, measurable means to ensure their effectiveness, which were required to be used by management for regular assessments
– emphasized continuous improvement in all activities, including both support and operational organizations
– applied appropriate elements of recognized standards

QC-1 was revised numerous times from its initial issue in 1954 through 2004. In 2013, QC-1, Revision 10, was replaced by National Nuclear Security Administration (NNSA) Policy Letter NAP-24. QC-1 and NAP-24A addressed changes and additional DOE weapon quality policy and quality assurance requirements. Thus, for example, QC-1, Revision 6, issued in 1992, added quality system requirements for training of manufacturing, inspection, and test personnel, and for quality improvement, error prevention versus detection, and nonconformance costs.

The highly classified nature of most DOE Defense Program (DP) weapons production activities governed by QC-1 led to some external criticism that DP lacked a viable quality assurance effort that complied with DOE quality assurance directives. DP quality management policy in the 1980s exempted the DOE nuclear weapons program from complying with DOE quality assurance orders on the basis of equivalency. Then, in 1992, in a memorandum to DOE field office managers,[4] the Assistant Secretary for Defense Programs declared that DP would comply with DOE O 5700.6C (see para. 1.5.2), with certain exemptions for classified weapons production work. The Assistant Secretary decided that it would be to DP's

[1] DOD Military Specification MIL-Q-9858 was issued in April 1959 and superseded by MIL-Q-9858A in December 1963. MIL-Q-9858A was canceled in 1996.

[2] DOE Assistant Secretary for Military Applications, Quality Assurance Policy, November 20, 1982.

[3] DOE Assistant Secretary for Military Applications, Quality Assurance Policy, July 7, 1989.

[4] DOE Defense Programs Memorandum, Implementation of Department of Energy Order 5700.6C, "Quality Assurance," was issued February 27, 1992. It was canceled in 1998 and replaced by the DOE O 414.1 series.