Designation: C1490 – 14 (Reapproved 2023)

Standard Guide for the Selection, Training and Qualification of Nondestructive Assay (NDA) Personnel[1]

This standard is issued under the fixed designation C1490; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide contains good practices for the selection, training, qualification, and professional development of personnel performing analysis, calibration, physical measurements, or data review using nondestructive assay equipment, methods, results, or techniques. The guide also covers NDA personnel involved with NDA equipment setup, selection, diagnosis, troubleshooting, or repair. General guidelines for the selection, training, and qualification of NDA auditors are included as well, but at a lower level of detail due to the variability of the personnel's responsibilities performing this functions. Selection, training, and qualification programs based on this guide are intended to provide assurance that NDA personnel are suitably qualified and experienced personnel (SQEP) to perform their jobs competently. This guide presents a series of options but does not recommend a specific course of action.

This standard guide does not address the qualifications per se of an NDA Manager. However, it is expected that the NDA Manager is familiar with NDA techniques, and can make informed decisions on the acceptability of the assay results. If an NDA Manager does not have adequate technical qualifications in the NDA field, they are recommended to undergo training to gain familiarity in this area.

An NDA Manager with no relevant NDA experience should have access to a Senior NDA Professional who will give guidance for all technical decisions such as applicability and limitation of methods, reasonableness of results, needed upgrades and advantageous development investments.

1.2 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C1030 Test Method for Determination of Plutonium Isotopic Composition by Gamma-Ray Spectrometry

C1133 Test Method for Nondestructive Assay of Special Nuclear Material in Low-Density Scrap and Waste by Segmented Passive Gamma-Ray Scanning

C1207 Test Method for Nondestructive Assay of Plutonium in Scrap and Waste by Passive Neutron Coincidence Counting

C1221 Test Method for Nondestructive Analysis of Special Nuclear Materials in Homogeneous Solutions by Gamma-Ray Spectrometry

C1268 Test Method for Quantitative Determination of ^{241}Am in Plutonium by Gamma-Ray Spectrometry

C1316 Test Method for Nondestructive Assay of Nuclear Material in Scrap and Waste by Passive-Active Neutron Counting Using ^{252}Cf Shuffler

C1455 Test Method for Nondestructive Assay of Special Nuclear Material Holdup Using Gamma-Ray Spectroscopic Methods

C1458 Test Method for Nondestructive Assay of Plutonium, Tritium and ^{241}Am by Calorimetric Assay

C1493 Test Method for Non-Destructive Assay of Nuclear Material in Waste by Passive and Active Neutron Counting Using a Differential Die-Away System

C1500 Test Method for Nondestructive Assay of Plutonium by Passive Neutron Multiplicity Counting

C1514 Test Method for Measurement of ^{235}U Fraction Using Enrichment Meter Principle

C1592 Guide for Making Quality Nondestructive Assay Measurements

C1673 Terminology of C26.10 Nondestructive Assay Methods

C1718 Test Method for Nondestructive Assay of Radioactive Material by Tomographic Gamma Scanning

C1726 Guide for Use of Modeling for Passive Gamma Measurements

[1] This guide is under the jurisdiction of ASTM Committee C26 on Nuclear Fuel Cycle and is the direct responsibility of Subcommittee C26.10 on Non Destructive Assay.

Current edition approved Jan. 1, 2023. Published January 2023. Originally approved in 2001. Last previous edition approved in 2014 as C1490–14. DOI: 10.1520/C1490-14R23.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

3. Terminology

3.1 Refer to Terminology C1673 for definitions used in this test method.

4. Significance and Use

4.1 The process of selection, training and qualification of personnel involved with NDA measurements is one of the quality assurance elements for an overall quality NDA measurement program.

4.2 This guide describes an approach to selection, qualification, and training of personnel that is to be used in conjunction with other NDA Quality Assurance (QA) program elements. The selection, qualification and training processes can vary and this guide provides one such approach.

4.3 The qualification activities described in this guide assume that NDA personnel are already proficient in general facility operations and safety procedures. The training and activities that developed this proficiency are not covered in this guide.

4.4 This guide describes a basic approach and principles for the qualification of NDA professionals and technical specialists and operators. A different approach may be adopted by the management organization based on its particular organization and facility specifics. However, if a variation of the approach of this guide is applied, the resulting selection, training, and qualification programs must meet the requirements of the facility quality assurance program and should provide all the applicable functions of Section 5.

4.5 This guide may be used as an aid in the preparation of a Training Implementation Plan (TIP) for the Transuranic Waste Characterization Program (TWCP).

4.6 This guide describes education and expertise guidance for NDA auditors due to the importance and complexity of proper oversight of NDA activities.

5. NDA Roles, Responsibilities, and Duties

5.1 The application and use of NDA techniques includes such diverse activities as data review and analysis; measurement control activities; equipment operation, troubleshooting and repair; all require different levels of education, expertise, and training. Therefore the implementation and continued successful application of an NDA measurement program requires a complex mixture of theory, experience, and professional judgement. For NDA professionals, a wide variety of skills and knowledge areas is required. These knowledge areas include: physics, chemistry, statistics, NDA modeling methods, electronics, engineering, health physics, quality assurance, nuclear safety, and appropriate regulatory requirements. For technical specialists and operators, less emphasis can be put on formal education, but would be compensated for by higher levels of job specific training.

5.2 Based on roles and responsibilities, NDA personnel can be broken into the following categories. These are not necessarily job titles and some facilities may combine one or more levels. The activities exist in a broader organizational context.

5.2.1 *Senior NDA Professional:*

5.2.1.1 *Education*—Advanced degree (M.S. or Ph.D.) in physics, chemistry, or nuclear engineering and five years NDA experience; or fifteen equivalent years of experience in the NDA field.

5.2.1.2 *Expertise*—Expertise in most or all NDA techniques. Recognized nationally as an expert in one or more NDA fields through publications, peer reviewed by other subject matter experts (SMEs), active participation in national NDA conferences or conducting NDA training courses. Knowledge areas cover most of those listed in 5.1. Core expertise in one or more of the following areas, and familiarity with the others: Test Methods C1030, C1133, C1207, C1221, C1268, C1316, C1455, C1458, C1493, C1500, C1514, Guide C1592, Terminology C1673, Test Method C1718, and Guide C1726 are applicable. The senior professional must adhere to t good practices for performing NDA measurements and data analysis to achieve quality results, as described in Guide C1592 (Standard Guide for Making Quality Nond-Destructive Assay Measurements). The senior professional must possess relevant technical knowledge of the physical and chemical properties of the materials being assayed, when available. In-depth knowledge of analysis algorithm's applicability to the assay conditions (and limitations) for the NDA methods used is required. Knowledge of computational codes used for modeling, for example MCNP and MCNPX, may be necessary.

5.2.1.3 *Duties*—Designs NDA measurement programs, including method selection and instrument performance specification. Performs NDA technical oversight over the entire program. Performs initial calibrations, qualifications and certifications for instruments and methods. Provides expert technical data review. Provides consultation on NDA matters to various facility departments and organizations such as nuclear safety, safeguards, nuclear materials control and accountability, waste characterization, waste disposal and production operations. Provides mentoring to other job categories.

5.2.2 *NDA Professional:*

5.2.2.1 *Education*—Undergraduate degree in physical science or engineering and five years NDA experience; or ten equivalent years of experience in the NDA field.

5.2.2.2 *Expertise*—Expertise in one or more NDA techniques. Recognized in NDA field on a local or facility basis. Knowledge areas cover several of those listed in 5.1. Understanding of the NDA methods contained in one or more of the following: Test Methods C1030, C1133, C1207, C1221, C1268, C1316, C1455, C1458, C1493, C1500, C1514, Guide C1592, Terminology C1673, Test Method C1718, and Guide C1726, are essential. The professional must be a practitioner of good practices for performing NDA measurements and data analysis to achieve quality results, as described in Guide C1592 (Standard Guide for Making Quality Nondestructive Assay Measurements).

5.2.2.3 *Duties*—Provides expert technical data review, and NDA measurement oversight. Performs routine instrument qualification, calibration, and validation. Reviews and approves measurement control data. Provides consulting on NDA matters within his or her area of expertise to various facility departments and organizations such as nuclear safety, safeguards, nuclear materials control and accountability, waste

characterization, waste disposal, production operations. Mentors technical specialists and operators.

5.2.3 *NDA Technical Specialist:*

5.2.3.1 *Education*—Undergraduate degree or equivalent with emphasis in the physical sciences and one year NDA experience or a 12–year General Education (High School) and two years NDA experience; or five equivalent years of experience in the NDA field.

5.2.3.2 *Expertise*—Knowledgeable in one or more NDA techniques. Knowledge areas may cover one or more of those listed in 5.1.

5.2.3.3 *Duties*—Independent technical data review; instrument calibration, and validation. Performs measurement control activities, instrument operation. Provides first response to instrument problems, upset conditions. Performs troubleshooting.

5.2.4 *NDA Qualified Instrument Operator:*

5.2.4.1 *Education*—a 12–year general education (high school) or equivalent technical training, or two years of experience in the nuclear facility field.

5.2.4.2 *Expertise*—Trained and qualified in operation of one or more NDA instruments.

5.2.4.3 *Duties*—Operation of NDA instrument. Recording of NDA data and other duties as qualified and assigned.

5.3 The hierarchy described above is only one set of possible tiers. Other tiered hierarchies providing equivalent functions are equally valid. The important consideration is the increasing level of required expertise and independence of action with increasing job level function. Based on site-specific practices and policies, the four levels presented above may be collapsed or expanded and the duties listed may move to other tiers in the hierarchy.

5.4 In addition to the NDA personnel described above, the services of other specialists are often required. These include statisticians to help establish measurement uncertainties, control limits, etc. Also, personnel trained in the maintenance and repair of electronic and mechanical systems may be required. In all cases, the value of the services provided by these specialists is enhanced if they have a basic understanding of NDA methods and instruments.

5.5 *Roles, Responsibilities, and Duties of NDA Auditors:*

5.5.1 *NDA Auditor:*

5.5.1.1 *Education*—Undergraduate degree or equivalent with emphasis in the physical sciences and two years experience in the nuclear facility field; or an under graduate degree in an unrelated field and four years experience in the nuclear facility field.

5.5.1.2 *Expertise*—Trained and qualified nuclear facility auditor. Demonstrated basic physics knowledge relevant to detection of neutrons and gamma rays. Familiarity with the NDA methods contained in those of the following that apply to personnel being audited: Test Methods C1030, C1133, C1207, C1221, C1268, C1316, C1455, C1458, C1493, C1500, C1514, Guide C1592, Terminology C1673, Test Method C1718, and Guide C1726; and the good practices for performing NDA measurements and data analysis to achieve quality results, as described in Guide C1592 (Standard Guide for Making Nondestructive Assay Measurements) is necessary.

5.5.1.3 *Duties*—Audits of NDA measurement process, application, results, and compliance typically related to, radioactive waste, safeguards or nuclear criticality.

6. Selection

6.1 The selection of NDA personnel should be a careful and thoughtful process that recognizes the responsibilities that are unique to the NDA position. The selection process should include an evaluation of the NDA candidate's technical skills, as well as the individual's experience and past performance relative to the position requirements.

6.2 The attributes, characteristics, and skills used as criteria for selecting NDA candidates or trainees should include demonstrated qualities such as: judgment, motivation, integrity, communication skills, teamwork skills, diagnostic skills, analytical ability, and strong technical competence.

6.3 The NDA organization should have a selection process for initial hiring and promoting of personnel. This process may involve a selection test, in addition to interviews. Selection should be based on the ability to meet position qualification criteria with reasonable amounts of training.

7. Training

7.1 A training program should be established to develop and enhance the skills, knowledge, and abilities of NDA trainees to perform their job assignments. The program should consist of a combination of classroom-type and on-the-job training (OJT) and should include laboratory training (for those facilities that have laboratory facilities), as it applies to the NDA position.

7.2 Full implementation of an NDA training program requires a long-term commitment from both the NDA personnel and management. Training activities should be carefully managed to produce effective results.

7.3 Each NDA organization should assess its training needs to develop a facility-specific training program. It is important to implement a systematic method to update training program content to incorporate facility modifications, operating experiences, procedure changes, and changes in job requirements.

7.4 The complete training program for NDA personnel may include courses offered by national laboratories, commercial vendors, universities, and other centers of excellence. The necessity for this type of training will depend on the roles and responsibilities of the NDA personnel.

7.5 Table 1 contains a list of training categories that are necessary for effective NDA application. Each training category includes a list of academic components for that training area. Table 1 is not intended to be comprehensive for all situations. Site-specific training plans shall be evaluated against the training categories listed in Table 1 and any academic content exclusion must be justified (for example, a site only stores sealed items so holdup measurements are never performed).

7.5.1 Different job responsibilities require different levels of understanding and mastery of the contents listed in Table 1.