Recommended Practice No

SNT-TC-1A

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The American Society for Nondestructive Testing, Inc.

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FOREWORD

This Recommended Practice establishes the general framework for a qualification and certification program. In addition, th document provides recommended educational, experience and training requirements for the different test methods. Supplementary documents include question and answer lists, which may be used in composing examinations for nondestructive testing personnel.

This recommended practice is not intended to be used as a strict specification. It is recognized, however, that contracts require programs, which meet the intent of this document. For such contracts, purchaser and supplier must agree upon acceptability of an employer's program.

The verb "should" has been used throughout this document to emphasize the recommendation presented herein. It is the employer's responsibility to address specific needs and to modify these guidelines as appropriate in a written practice. In th employer's written practice, the verb "shall" is to be used in place of "should" to emphasize the employer's needs.

The 2006 Edition of *SNT-TC-1A* is annotated so that users of the 2001 edition can quickly and easily locate new and updated material. The vertical lines in the margins of this document indicate that information in the text has been modified in some way.

Inquiries related to this recommended practice should be directed to the chair of the *SNT-TC-1A* Interpretation Panel at the following address:

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REVIEW COMMITTEE

Publication and review of this Recommended Practice was under the direction of the *SNT-TC-1A* Review Committee which is a committee of the Methods Division. The Methods Division reports to the Technical & Education Council of the American Society for Nondestructive Testing.

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Personnel Qualification and Certification in Nondestructive Testing

1.0 Scope

1.1 It is recognized that the effectiveness of nondestructive testing (NDT) applications depends upon the capabilities of the personnel who are responsible for, and perform, NDT. This Recommended Practice has been prepared to establish guidelines for the qualification and certification of NDT personnel whose specific jobs require appropriate knowledge of the technical principles underlying the nondestructive tests they perform, witness, monitor, or evaluate.

1.2 This document provides guidelines for the establishment of a qualification and certification program.

1.3 These guidelines have been developed by The American Society for Nondestructive Testing, Inc., to aid employers in recognizing the essential factors to be considered in qualifying personnel engaged in any of the NDT methods listed in Section 3.

1.4 It is recognized that these guidelines may not be appropriate for certain employers' circumstances and/or applications. In developing a written practice as required in Section 5, the employer should review the detailed recommendations presented herein and modify them, as necessary, to meet particular needs.

2.0 Definitions

2.1 Terms included in this document are defined as follows:

2.1.1 **Certification**: written testimony of qualification.

2.1.2 **Certifying Authority**: the person or persons properly designated in the written practice to sign certifications on behalf of the employer.

2.1.3 **Certifying Agency**: the employer of the personnel being certified.

2.1.4 **Closed Book Examination**: an examination administered without access to reference material except for materials supplied with or in the examination (See 8.7).

2.1.5 **Comparable**: being at an equivalent or similar level of NDT responsibility and difficulty as determined by the employer's Level III.

2.1.6 **Documented**: the condition of being in written form.

2.1.7 **Employer**: the corporate, private, or public entity, which employs personnel for wages, salary, fees or other considerations.

2.1.8 **Experience**: work activities accomplished in a specific NDT method under the direction of qualified supervision including the performance of the NDT method and related activities but not including time spent in organized training programs.

2.1.9 **Limited Certification**: nondestructive test methods may be further subdivided into limited disciplines or techniques to meet specific employer's needs; these are Level II certifications, but to a limited scope.

2.1.10 **Nondestructive Testing**: a process that involves the inspection, testing, or evaluation of materials, components and assemblies for materials' discontinuities, properties and machine problems without further impairing or destroying the parts serviceability. Throughout this document the term NDT applies equally to the NDT inspection methods used for material inspection, flaw detection or predictive maintenance (PdM) applications.

2.1.11 **Outside Agency**: a company or individual who provides NDT Level III services and whose qualifications to provide these services have been reviewed by the employer engaging the company or individual.

2.1.12 **Qualification**: demonstrated skill, demonstrated knowledge, documented training, and documented experience required for personnel to properly perform the duties of a specific job.

2.1.13 **Recommended Practice**: a set of guidelines to assist the employer in developing uniform procedures for the qualification and certification of NDT personnel to satisfy the employer's specific requirements.

2.1.14 **Training**: an organized program developed to impart the knowledge and skills necessary for qualification.

2.1.15 **Written Practice**: a written procedure developed by the employer that details the requirements for qualification and certification of their employees.

3.0 Nondestructive Testing Methods

3.1 Qualification and certification of NDT personnel in accordance with this Recommended Practice is applicable to each of the following methods:

Acoustic Emission Testing
Electromagnetic Testing
Laser Testing Methods
Leak Testing
Liquid Penetrant Testing
Magnetic Flux Leakage
Magnetic Particle Testing
Neutron Radiographic Testing
Radiographic Testing
Thermal/Infrared Testing
Ultrasonic Testing
Vibration Analysis
Visual Testing

4.0 Levels of Qualification

4.1 There are three basic levels of qualification. The employer may subdivide these levels for situations where additional levels are deemed necessary for specific skills and responsibilities.

4.2 While in the process of being initially trained, qualified, and certified, an individual should be considered a trainee. A trainee should work with a certified individual. The trainee shall not independently conduct, interpret, evaluate, or report the results of any NDT test.

4.3 The three basic levels of qualification are as follow:

4.3.1 NDT Level I. An NDT Level I individual should be qualified to properly perform specific calibrations, specific NDT, and specific evaluations for acceptance or rejection determinations according to written instructions and to record results. The NDT Level I should receive the necessary instruction and supervision from a certified NDT Level II or III individual.

4.3.2 NDT Level II. An NDT Level II individual should be qualified to set up and calibrate equipment and to interpret and evaluate results with respect to applicable codes, standards, and specifications. The NDT Level II should be thoroughly familiar with the scope and limitations of the methods for which qualified and should exercise assigned responsibility for on-the-job training and guidance of trainees and NDT Level I personnel. The NDT Level II should be able to organize and report the results of NDT tests.

4.3.3 NDT Level III. An NDT Level III individual should be capable of developing, qualifying, and approving procedures, establishing and approving techniques, interpreting codes, standards, specifications, and procedures; and designating the particular NDT methods, techniques, and procedures to be used. The NDT Level III should be responsible for the NDT operations for which qualified and assigned and should be capable of interpreting and evaluating results in terms of existing codes, standards, and specifications. The NDT Level III should have sufficient practical background in applicable materials, fabrication, and product technology to establish techniques and to assist in establishing acceptance criteria when none are otherwise available. The NDT Level III should have general familiarity with other appropriate NDT methods, as demonstrated by an ASNT Level III Basic examination or other means. The NDT Level III, in the methods in which certified, should be capable of training and examining NDT Level I and II personnel for certification in those methods.

5.0 Written Practice

5.1 The employer shall establish a written practice for the control and administration of NDT personnel training, examination, and certification.

5.2 The employer's written practice should describe the responsibility of each level of certification for determining the acceptability of materials or components in accordance with the applicable codes, standards, specifications, and procedures.

5.3 The employer's written practice shall describe the training, experience, and examination requirements for each level of certification.

5.4 The employer's written practice shall be reviewed and approved by the employers NDT Level III.

5.5 The employer's written practice shall be maintained on file.

6.0 Education, Training, and Experience Requirements for Initial Qualification

6.1 Candidates for certification in NDT should have sufficient education, training, and experience to ensure qualification in those NDT methods in which they are being considered for certification. Documentation of prior certification may be used by an employer as evidence of qualification for comparable levels of certification.

6.2 Documented training and/or experience gained in positions and activities comparable to those of Levels I, II, and/or III prior to establishment of the employer's written practice may be considered in satisfying the criteria of Section 6.3.

6.3 To be considered for certification, a candidate should satisfy one of the following criteria for the applicable NDT level:

6.3.1 NDT Levels I and II

Table 6.3.1 A lists the recommended training and experience factors to be considered by the employer in establishing written practices for initial qualification of Level I and Level II individuals.

Table 6.3.1 B lists alternate training and experience factors which may be considered by the employer in establishing written practices for initial qualification of Level I and Level II individuals. (The *SNT-TC-1A* Review Committee plans to remove Table 6.3.1 B with the next revision.)

Table 6.3.1 C lists initial training and experience factors which may be considered by the employer for specific limited applications as defined in the employer's written practice.

6.3.2 NDT Level III

6.3.2.1 Have graduated from a minimum four-year college or university curriculum with a degree in engineering or science, plus one additional year of experience beyond the level II requirements in NDT in an assignment comparable to that of an NDT Level II in the applicable NDT method(s), or:

6.3.2.2 Have completed with passing grades at least two years of engineering or science study at a university, college, or technical school, plus two additional years of experience beyond the level II requirements in NDT in an assignment at least comparable to that of NDT Level II in the applicable NDT method(s), or:

6.3.2.3 Have four years experience beyond the level II requirements in NDT in an assignment at least comparable to that of an NDT Level II in the applicable NDT method(s).

The above Level III requirements may be partially replaced by experience as a certified NDT Level II or by assignments at least comparable to NDT Level II as defined in the employer's written practice.

7.0 Training Programs

7.1 Personnel being considered for initial certification should complete sufficient organized training to become thoroughly familiar with the principles and practices of the specified NDT method related to the level of certification desired and applicable to the processes to be used and the products to be tested.

7.2 The training program should include sufficient examinations to ensure understanding of the necessary information.

7.3 Recommended training course outlines and references for NDT Levels I, II, and III personnel, which may be used as technical source material, are contained in *ANSI/ASNT CP-105 – Topical Outlines for Qualification of Nondestructive Testing Personnel*.

7.4 The employer who purchases outside training services is responsible for assuring that such services meet the requirements of the employer's written practice.

8.0 Examinations

8.1 Administration and Grading

8.1.1 An NDT Level III shall be responsible for the administration and grading of examinations specified in Section 8.3 through 8.8 for NDT Level I, II, or other Level III personnel. The administration and grading of examinations may be delegated to a qualified representative of the NDT Level III and so recorded. A qualified representative of the employer may perform the actual administration and grading of Level III examinations specified in 8.8.

8.1.2 For Level I and II personnel, a composite grade should be determined by simple averaging of the results of the general, specific, and practical examinations described below. For Level III personnel the composite grade should be determined by simple averaging of the results of the basic, method, and specific examinations described below.

8.1.3 Examinations administered for qualification should result in a passing composite grade of at least 80 percent, with no individual examination having a passing grade less than 70 percent.

8.1.4 When an examination is administered and graded for the employer by an outside agency and the outside agency issues grades of pass or fail only, on a certified report, then the employer may accept the pass grade as 80 percent for that particular examination.

8.1.5 The employer who purchases outside services is responsible for ensuring that the examination services meet the requirements of the employer's written practice.

8.2 Vision Examinations

8.2.1 Near-Vision Acuity. The examination should ensure natural or corrected near-distance acuity in at least one eye such that the applicant is capable of reading a minimum of Jaeger Number 2 or equivalent type and size letter at the distance designated on the chart but not less than 12 inches (30.5 cm) on a standard Jaeger test chart. The ability to perceive an Ortho-Rater minimum of 8 or similar test pattern is also acceptable. This should be administered annually.

8.2.2 Color Contrast Differentiation. The examination should demonstrate the capability of distinguishing and differentiating contrast among colors or shades of gray used in the method as determined by the employer. This should be conducted upon initial certification and at five-year intervals thereafter.

8.3 General (Written - for NDT Levels I and II)

8.3.1 The general examinations should address the basic principles of the applicable method.

8.3.2 In preparing the examinations, the NDT Level III should select or devise appropriate questions covering the applicable method to the degree required by the employer's written practice.

8.3.3 See the Appendix for example questions.

8.3.4 The minimum number of questions that should be given is as follows:

Test Method	Limited Certifications	Number of Level I Questions	Number of Level II Questions
Acoustic Emission Testing		40	40
Electromagnetic Testing		40	40
1. Alternating Current Field Measurement		40	40
2. Eddy Current		40	40
3. Flux Leakage Testing		40	40
4. Remote Field Testing		40	40
Laser Testing		30	30
Leak Testing		20	20
Liquid Penetrant Testing		40	40
Magnetic Flux Leakage		20	20
Magnetic Particle Testing		40	40
Neutron Radiographic Testing		40	40
Radiographic Testing		40	40
	Film Interpreter (from trainee)	N/A	40
	Film Interpreter (from Level I)	N/A	20
	Digital Radioscopy	N/A	30
Thermal/Infrared Testing		40	40
Ultrasonic Testing		40	40
	Digital Thickness Measurement	N/A	20
	A-Scan Thickness Measurement	N/A	30
Vibration Analysis		40	40
Visual Testing		40	40

N/A: Not Allowed

8.4 Specific (Written - for NDT Levels I and II)

8.4.1 The specific examination should address the equipment, operating procedures, and NDT techniques that the individual may encounter during specific assignments to the degree required by the employer's written practice.

8.4.2 The specific examination should also cover the specifications or codes and acceptance criteria used in the employer's NDT procedures.

8.4.3 The minimum number of questions that should be given is as follows:

Test Methods and Techniques	Limited Certification	Number of Level I Questions	Number of Level II Questions
Acoustic Emission Testing		20	20
Electromagnetic Testing			
1. Alternating Current Field Measurement		20	20
2. Eddy Current		20	20
3. Flux Leakage Testing		20	20
4. Remote Field Testing		20	20
Laser Testing			
1. Profilometry		20	20
2. Holography/Shearography		20	20
Leak Testing			
1. Bubble Test		15	15
2. Absolute Pressure Leak Test (Pressure Change)		15	15
3. Halogen Diode Leak Test		15	15
4. Mass Spectrometer Leak Test		20	40
Liquid Penetrant Testing		20	20
Magnetic Flux Leakage		20	15
Magnetic Particle Testing		20	20
Neutron Radiographic Testing		15	15
Radiographic Testing		20	20
	Film Interpreter (from trainee)	N/A	20
	Film Interpreter (from Level I)	N/A	15
	Digital Radioscopy	N/A	20
Thermal/Infrared Testing		20	20
Ultrasonic Testing		20	20
	Digital Thickness Testing	N/A	10
	A-Scan Thickness Testing	N/A	15
Vibration Analysis		20	60
Visual Testing		20	20

N/A: Not Allowed

8.5 Practical (for NDT Level I and II)

8.5.1 The candidate should demonstrate familiarity with and ability to operate the necessary NDT equipment, record, and analyze the resultant information to the degree required.

8.5.2 At least one flawed specimen or component should be tested and the results of the NDT analyzed by the candidate.

8.5.3 The description of the specimen, the NDT procedure, including check points, and the results of the examination should be documented.

8.5.4 NDT Level I Practical Examination. Proficiency should be demonstrated in performing the applicable NDT on one or more specimens or machine problems approved by the NDT Level III and in evaluating the results to the degree of responsibility as described in the employer's written practice. At least ten (10) different checkpoints requiring an understanding of test variables and the employer's procedural requirements should be included in this practical examination.

8.5.5 NDT Level II Practical Examination. Proficiency should be demonstrated in selecting and performing the applicable NDT technique within the method and interpreting and evaluating the results on one or more specimens or machine problems approved by the NDT Level III. At least ten (10) different checkpoints requiring an understanding of NDT variables and the employer's procedural requirements should be included in this practical examination.

8.6 Sample questions for general examinations are presented in the separate question booklets that can be obtained from ASNT Headquarters. These questions are intended as examples only and should not be used verbatim for qualification examinations. The following is a list of the booklets:

Test Method	Question Booklets
Acoustic Emission Testing	G
Electromagnetic Testing	E
1. Alternating Current Field Measurement	EA*
2. Eddy Current	EE*
3. Flux Leakage	EF*
4. Remote Field Testing	ER*
Laser Testing	
1. Profilometry	LP*
2. Holography/Shearography	LH*
Leak Testing	
1. Bubble Test	HB
2. Pressure Change Measurement	HP
3. Halogen Diode Leak Test	HH
4. Mass Spectrometer Test	HM
Liquid Penetrant Testing	D
Magnetic Flux Leakage Testing	MF*
Magnetic Particle Testing	B
Neutron Radiographic Testing	F
Radiographic Testing	A
Thermal/Infrared Testing	J*
Ultrasonic Testing	C
Vibration Analysis	K*
Visual Testing	I

* In course of preparation

8.7 Additional Written, Specific and Practical Examination Criteria

8.7.1 Level I, II, and III Written Examinations

8.7.1.1 All Level I, II, and III written examinations should be closed-book except that necessary data, such as graphs, tables, specifications, procedures, codes, etc., may be provided with or in the examination. Questions utilizing such reference materials should require an understanding of the information rather than merely locating the appropriate answer. All questions used for Level I and Level II examinations should be approved by the responsible Level III.

8.7.1.2 A valid endorsement on an ACCP Level II certificate fulfills the corresponding examination criteria described in paragraphs 8.3 and 8.5 for each applicable NDT method.

8.7.2 Level I and II Specific Examinations

The employer may delete the specific examination if the candidate has a valid ACCP Level II certificate in the method and if documented experience exists to permit such.

8.7.3 Practical Examinations

Successful completion of an ACCP Level II general hands-on practical examination may be considered as fulfilling the requirements of paragraph 8.5.

8.8 NDT/PdM Level III Examinations

8.8.1 Basic Examinations

8.8.1.1 NDT Basic Examination (required only once when more than one method examination is taken). The minimum number of questions that should be given is as follows:

8.8.1.1.1 Fifteen (15) questions relating to understanding the *SNT-TC-1A* document.

8.8.1.1.2 Twenty (20) questions relating to applicable materials, fabrication, and product technology.

8.8.1.1.3 Twenty (20) questions that are similar to published Level II questions for other appropriate NDT methods.

8.8.1.2 PdM Basic Examination (required only once when more than one method examination is taken). The minimum number of questions that should be given is as follows:

8.8.1.2.1 Fifteen (15) questions relating to understanding the *SNT-TC-1A* document.

8.8.1.2.2 Twenty (20) questions relating to applicable machinery technology.

8.8.1.2.3 Thirty (30) questions that are similar to published Level II questions for other appropriate PdM methods.

8.8.2 Method Examination (for each method).

8.8.2.1 Thirty (30) questions relating to fundamentals and principles that are similar to published ASNT Level III questions for each method, and

8.8.2.2 Fifteen (15) questions relating to application and establishment of techniques and procedures that are similar to the published ASNT Level III questions for each method, and

8.8.2.3 Twenty (20) questions relating to capability for interpreting codes, standards, and specifications relating to the method.

8.8.3 Specific Examination (for each method).

8.8.3.1 Twenty (20) questions relating to specifications, equipment, techniques, and procedures applicable to the employer's product(s) and methods employed and to the administration of the employer's written practice.

8.8.3.2 The employer may delete the specific examination if the candidate has a valid ASNT NDT Level III or ACCP Professional Level III certificate in the method and if documented evidence of experience exists, including the preparation of NDT procedures to codes, standards, or specifications and the evaluation of test results.

8.8.4 A valid endorsement on an ASNT NDT Level III certificate fulfills the examination criteria described in 8.8.1 and 8.8.2 for each applicable NDT method.

8.8.5 A valid endorsement of an ACCP Professional Level III certificate fulfills the examination criteria described in 8.8.1 and 8.8.2 for each applicable NDT method.

8.9 Reexamination

Those failing to attain the required grades should wait at least thirty (30) days or receive suitable additional training as determined by the NDT Level III before reexamination.

9.0 Certification

9.1 Certification of all levels of NDT personnel is the responsibility of the employer.

9.2 Certification of NDT personnel shall be based on demonstration of satisfactory qualification in accordance with Sections 6, 7, and 8, as described in the employer's written practice.

9.3 At the option of the employer, an outside agency may be engaged to provide NDT Level III services. In such instances, the responsibility of certification of the employees shall be retained by the employer.

9.4 Personnel certification records shall be maintained on file by the employer for the duration specified in the employers written practice and should include the following:

9.4.1 Name of certified individual.

9.4.2 Level of certification and NDT method.

9.4.3 Educational background and experience of certified individuals.

9.4.4 Statement indicating satisfactory completion of training in accordance with the employer's written practice.

9.4.5 Results of the vision examinations prescribed in 8.2 for the current certification period.

9.4.6 Current examination copy(ies) or evidence of successful completion of examinations.

9.4.7 Other suitable evidence of satisfactory qualifications when such qualifications are used in lieu of the specific examination prescribed in 8.8.3.2 or as prescribed in the employer's written practice.

9.4.8 Composite grade(s) or suitable evidence of grades.

9.4.9 Signature of the Level III that verified qualifications of candidate for certification.

9.4.10 Dates of certification and/or recertification and the dates of assignments to NDT.

9.4.11 Certification expiration date.

9.4.12 Signature of employer's certifying authority.

10. Technical Performance Evaluation

10.1 NDT personnel may be reexamined any time at the discretion of the employer and have their certificates extended or revoked.

10.2 Periodically, as defined in the employers written practice, the technical performance of Level I and II personnel should be evaluated and documented by a NDT Level III. The evaluation and documentation should follow the format and guidelines described in section 8.5.

11.0 Interrupted Service

11.1 The employer's written practice should include rules covering the types and duration of interrupted service that requires reexamination and recertification.

11.2 The written practice should specify the requirements for reexamination and/or recertification for the interrupted service.

12.0 Recertification

12.1 All levels of NDT personnel shall be recertified periodically in accordance with one of the following criteria:

12.1.1 Evidence of continuing satisfactory technical performance.

12.1.2 Reexamination in those portions of the examinations in Section 8 deemed necessary by the employer's NDT Level III.

12.2 Recommended maximum recertification intervals are 5 years for all certification levels.

13.0 Termination

13.1 The employer's certification shall be deemed revoked when employment is terminated.

13.2 A Level I, Level II, or Level III whose certification has been terminated may be certified to the former NDT level by a new employer based on examination, as described in Section 8, provided all of the following conditions are met to the new employer's satisfaction:

13.2.1 The employee has proof of prior certification.

13.2.2 The employee was working in the capacity to which certified within six (6) months of termination.

13.2.3 The employee is being recertified within six (6) months of termination.

13.2.4 Prior to being examined for certification, employees not meeting the above requirements should receive additional training as deemed appropriate by the NDT Level III.

14.0 Reinstatement

14.1 A Level I, Level II, or Level III whose certification has been terminated may be reinstated to the former NDT level, without a new examination, provided all of the following conditions are met:

14.1.1 The employer has maintained the personnel certification records required in section 9.4.

14.1.2 The employee's certification did not expire during termination.

14.1.3 The employee is being reinstated within six (6) months of termination.

Table 6.3.1 A: Recommended Initial Training and Experience Levels

Examination Method	Level	Technique	High School Graduate or Equivalent	Completion with a passing grade of at least 2 years of engineering or science study at a university college or technical school	Minimum Required Work Experience in Method (hours)	Total Hours in NDT
Acoustic Emission	I		40	32	210	400
	II		40	40	630	1200
Electromagnetic	I	AC Field Measurement	40	24	210	400
	II		40	40	630	1200
	I	Eddy Current	40	24	210	400
	II		40	40	630	1200
	I	Flux Leakage	40	24	210	400
	II		40	40	630	1200
	I	Remote Field	40	24	210	400
	II		40	40	630	1200
Laser Methods	I	Profilometry	8	4	70	130
	II		24	12	140	260
	I	Holography/ Shearography	40	36	210	400
	II		40	36	630	1200
Leak Testing	I	Bubble Testing	2	2	3	4
	II		4	2	35	65
	I	Pressure Change	24	16	105	200
	II		16	12	280	520
	I	Halogen Diode	12	8	105	200
	II		8	6	280	520
	I	Mass Spectrometer	40	28	280	520
	II		24	16	420	800
Liquid Penetrant	I		4	4	70	130
	II		8	4	140	270
Magnetic Flux Leakage	I		16	12	70	130
	II		12	8	210	400
Magnetic Particle	I		12	8	70	130
	II		8	4	210	400
Neutron Radiography	I		28	20	420	800
	II		40	40	1680	2400
Radiography	I		40	30	210	400
	II		40	35	630	1200
Thermal/Infrared	I		32	32	210	400
	II		34	32	1260	1800
Ultrasonics	I		40	30	210	400
	II		40	40	630	1200
Vibration Analysis	I		24	24	420	800
	II		72	48	1680	2400
Visual	I		8	4	70	130
	II		16	8	140	270

Notes:

1.0 For Level II certification, the experience shall consist of time at Level I or equivalent. If a person is being qualified directly to Level II with no time at Level I, the required experience shall consist of the sum of the times required for Level I and Level II and the required training shall consist of the sum of the hours required for Level I and Level II.

2.0 For Level III certification, the required experience shall consist of the sum of the time required for Level I and Level II, plus the additional time required in 6.3.2 as applicable. The required formal training shall consist of the Level I and Level II training, plus any additional formal training as defined in the employer's written practice.

3.0 Listed training hours may be adjusted as described in the employer's written practice depending on the candidate's actual education level, e.g. grammar school, college graduate in engineering, etc.

4.0 Training shall be outlined in the employer's written practice. Magnetic Particle training hours may be counted towards Magnetic Flux Leakage training hours as defined in employer's written practice.

5.0 If an individual is currently certified in an ET technique and a full course format was used to meet the initial qualifications in that technique, the minimum training hours to qualify in another ET technique at the same level may be reduced up to 40 percent if so defined in the employer's written practice. If an individual is certified in an ET technique, the minimum experience to qualify for another ET technique at the same level or to the next level may be reduced by up to 50 percent if so defined in the employer's written practice.

Table 6.3.1 B: Alternate Initial Training and Experience Levels

The intent is to eliminate this table during the next revision.

Examination Method	Level	Technique	High school graduate or equivalent	Completion with a passing grade of at least 2 years of engineering or science study at a university college or technical school	Experience Level (months)
Acoustic Emission	I		40	32	3
	II		40	40	9
Electromagnetic	I	AC Field Measurement	40	24	3
	II		40	40	9
	I	Eddy Current	40	24	3
	II		40	40	9
	I	Flux Leakage	40	24	3
	II		40	40	9
	I	Remote Field	40	24	3
	II		40	40	9
Laser Methods	I	Profilometry	8	4	1
	II		24	12	2
	I	Holography/ Shearography	40	36	3
	II		40	36	9
Leak Testing	I	Bubble Testing	2	2	2 hours
	II		4	2	0.5
	I	Pressure Change	24	16	1.5
	II		16	12	4
	I	Halogen Diode	12	8	1.5
	II		8	6	4
	I	Mass Spectrometer	40	28	4
	II		24	16	6
Liquid Penetrant	I		4	4	1
	II		8	4	2
Magnetic Flux Leakage	I		16	12	1
	II		12	8	3
Magnetic Particle	I		12	8	1
	II		8	4	3
Neutron Radiography	I		28	20	6
	II		40	40	24
Radiography	I		40	30	3
	II		40	35	9
Thermal/Infrared	I		32	30	3
	II		34	32	18
Ultrasonics	I		40	30	3
	II		40	40	9
Vibration Analysis	I		24	24	6
	II		72	48	24
Visual	I		8	4	1
	II		16	8	2

Notes:

1.0 For Level II certification, the experience shall consist of time at Level I or equivalent. If a person is being qualified directly to Level II with no time at Level I, the required experience shall consist of the sum of the times required for Level I and Level II and the required training shall consist of the sum of the hours required for Level I and Level II.

2.0 For Level III certification, the required experience shall consist of the sum of the time required for Level I and Level II, plus an additional 12 months. The required formal training shall consist of the Level I and Level II training, plus any additional formal training as defined in the employer's written practice.

3.0Listed training hours may be adjusted as described in the employer's written practice depending on the candidate's actual education level, e.g. grammar school, college graduate in engineering, etc.

4.0 Initial experience may be gained simultaneously in two or more methods if the:

4.1 candidate spends a minimum of 25% of work time on each method for which certification is sought, and

4.2 remainder of the work time claimed as experience is spent in NDT-related activities defined in the employer's written practice.

5.0 Training shall be outlined in the employer's written practice.

6.0 If an individual is currently certified in an ET technique and a full course format was used to meet the initial qualifications in that technique, the minimum training hours to qualify in another ET technique at the same level may be reduced up to 40 percent if so defined in the employer's written practice. If an individual is certified in one ET technique, the minimum experience to qualify for another ET technique at the same level or to the next level may be reduced by up to 50 percent if so defined in the employer's written practice.

Table 6.3.1 C: Initial Training and Experience Levels For Level II Limited Certifications

Examination Method	Limited Certification	Technicians Starting Point	Formal Training	Minimum Required Work Experience in Method (Hours)
Radiography	Film Interpretation	Trainee	18	22
	Film Interpretation	Level I	2	22
	Digital Radioscopy	Trainee	32	175
Ultrasonics	Digital Thickness	Trainee	8	40
	A-Scan Thickness	Trainee	24	175

NON-RADIOGRAPHERS
Interpretation of Radiographs – total = 22 hours
Artifacts – 2 hours
Castings – 6 hours
Weldments – 14 hours

RADIOGRAPHERS (Certified RT Level I)
Refresher instruction – 2 hours (geometrical unsharpness, radiographic sensitivity, radiographic contrast, film contrast, subject contrast, definition, exposure techniques, manufacturing processes and associated discontinuities, & standards, code and procedures)
Interpretation of radiographs – 22 hours

BASIC EXAMINATION

General Level III Requirements

The Basic Examination will cover three (3) main topical areas:

1.0 Personnel Qualification and Certification Programs
- 1.1 *SNT-TC-1A*
- 1.2 *ANSI/ASNT-CP-189*
- 1.3 ASNT Level III Program

2.0 General familiarity with other NDT Methods.

3.0 General knowledge of materials, fabrication, and product technology.

Separate Method examinations will be given to cover each of the following NDT Methods:

Acoustic Emission Testing
Electromagnetic Testing
Laser Methods
Leak Testing
Liquid Penetrant Testing
Magnetic Flux Leakage
Magnetic Particle Testing
Neutron Radiographic Testing
Radiographic Testing
Thermal/Infrared Testing
Ultrasonic Testing
Visual Testing

Each of the Method examinations is divided into three main topical areas:

1. Method fundamentals and principles,
2. General knowledge of techniques within the Methods,
3. General interpretation of codes, standards, and specifications relating to the Method.

The Basic examination and one or more Method examinations must be taken and passed to qualify for an ASNT Level III Certificate. The endorsements on the ASNT Certificate will list the various Methods, which the applicant passed.

The following topical outlines further subdivide the main topical areas of both Basic and Method examinations, cite literature references, and have sample questions typical of those in the examinations.

Recommended Practice No. SNT-TC-1A

1.0 Scope
2.0 Definitions
3.0 Nondestructive Testing Methods
4.0 Levels of Qualification
5.0 Written Practice
6.0 Education, Training, and Experience
7.0 Training Programs
8.0 Examinations
9.0 Certification
10.0 Termination

ASNT Standard ANSI/ASNT-CP-189

1.0 Scope
2.0 Definitions
3.0 Levels of Qualification
4.0 Qualification Requirements
5.0 Qualification and Certification
6.0 Examinations
7.0 Expiration, Suspension, Revocation, and Reinstatement of Employee's Certification
8.0 Employer Recertification
9.0 Records

10.0 Referenced Publications
- 10.1 ASNT Level III Certification Program
- 10.2 ASNT Document Numbers
- 10.3 CP-3-89
- 10.4 CP-4-86
- 10.5 CP-5-87
- 10.6 CP-6-86

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* Available from The American Society for Nondestructive Testing, Columbus, OH.

Basics of Common NDT Methods

1.0 Acoustic Emission Testing
- 1.1 Fundamentals
  - 1.1.1 Principles/theory of acoustic emission testing
  - 1.1.2 Sources of acoustic emissions
  - 1.1.3 Equipment and material
- 1.2 Proper selection of acoustic emission technique
  - 1.2.1 Instrumentation and signal processing
    - 1.2.1.1 Cables (types)
    - 1.2.1.2 Signal conditioning
    - 1.2.1.3 Signal detection
    - 1.2.1.4 Noise discrimination
    - 1.2.1.5 Electronic technique
    - 1.2.1.6 Attenuation materials
    - 1.2.1.7 Data filtering techniques
- 1.3 Interpretation and evaluation of test results

2.0 Electromagnetic Testing
- 2.1 Fundamentals
  - 2.1.1 Electromagnetic field generation
  - 2.1.2 Properties of eddy current
  - 2.1.3 Effects of varying frequency
  - 2.1.4 Phase discrimination
- 2.2 Electromagnetic testing
  - 2.2.1 Sensors
  - 2.2.2 Basic types of equipment; types of read out
  - 2.2.3 Reference standards
  - 2.2.4 Applications and test result interpretation
    - 2.2.4.1 Flaw detection
    - 2.2.4.2 Conductivity and permeability sorting
    - 2.2.4.3 Thickness gaging
    - 2.2.4.4 Process control

3.0 Leak Testing
- 3.1 Fundamentals
  - 3.1.1 Bubble detection
  - 3.1.2 Pressure change
  - 3.1.3 Halogen diode detector
  - 3.1.4 Mass spectrometer

3.2 Leak testing
- 3.2.1 Systems factors
  - 3.2.1.1 Relative sensitivity
  - 3.2.1.2 Evacuated systems
  - 3.2.1.3 Pressurized systems; ambient fluids, tracer fluids
  - 3.2.1.4 Locating leaks
  - 3.2.1.5 Calibration
- 3.2.2 Test result interpretation
- 3.2.3 Essentials of safety
- 3.2.4 Test equipment
- 3.2.5 Applications
  - 3.2.5.1 Piping and pressure vessels
  - 3.2.5.2 Evacuated systems
  - 3.2.5.3 Low pressure fluid containment vessels, pipes, and tubing
  - 3.2.5.4 Hermetic seals
  - 3.2.5.5 Electrical and electronic components

4.0 Liquid Penetrant Testing

4.1 Fundamentals
- 4.1.1 Interaction of penetrants and discontinuity openings
- 4.1.2 Fluorescence and contrast

4.2 Liquid penetrant tenting
- 4.2.1 Penetrant processes
- 4.2.2 Test equipment and systems factors
- 4.2.3 Test result interpretation; discontinuity indications
- 4.2.4 Applications
  - 4.2.4.1 Castings
  - 4.2.4.2 Welds
  - 4.2.4.3 Wrought metals
  - 4.2.4.4 Machined parts
  - 4.2.4.5 Leaks
  - 4.2.4.6 Field inspections

5.0 Magnetic Particle Testing

5.1 Fundamentals
- 5.1.1 Magnetic field principles
- 5.1.2 Magnetization by means of electric current
- 5.1.3 Demagnetization

5.2 Magnetic particle inspection
- 5.2.1 Basic types of equipment and inspection materials
- 5.2.2 Test results interpretation; discontinuity indications
- 5.2.3 Applications
  - 5.2.3.1 Welds
  - 5.2.3.2 Castings
  - 5.2.3.3 Wrought metals
  - 5.2.3.4 Machined parts
  - 5.2.3.5 Field applications

6.0 Neutron Radiographic Testing

6.1 Fundamentals
- 6.1.1 Sources
  - 6.1.1.1 X-ray
  - 6.1.1.2 Isotopic
  - 6.1.1.3 Neutron
- 6.1.2 Detectors
  - 6.1.2.1 Imaging
  - 6.1.2.2 Nonimaging
- 6.1.3 Nature of penetrating radiation and interactions with matter
- 6.1.4 Essentials of safety

6.2 Neutron radiographic testing
- 6.2.1 Basic imaging considerations
- 6.2.2 Test result interpretation; discontinuity indications
- 6.2.3 Systems factors (source/test object/detector interactions)
- 6.2.4 Applications
  - 6.2.4.1 Explosives and pyrotechnic devices
  - 6.2.4.2 Assembled components
  - 6.2.4.3 Bonded components
  - 6.2.4.4 Corrosion detection
  - 6.2.4.5 Nonmetallic materials

7.0 Radiographic Testing

7.1 Fundamentals
- 7.1.1 Sources
  - 7.1.1.1 Castings
  - 7.1.1.2 Welds
  - 7.1.1.3 Assemblies
  - 7.1.1.4 Electronic components
  - 7.1.1.5 Field inspections
- 7.1.2 Detectors
  - 7.1.2.1 Imaging
  - 7.1.2.2 Nonimaging
- 7.1.3 Nature of penetrating radiation and interactions with matter
- 7.1.4 Essentials of safety

7.2 Radiographic testing
- 7.2.1 Basic imaging considerations
- 7.2.2 Test result interpretation; discontinuity indications
- 7.2.3 Systems factors (source/test object/detector interactions)
- 7.2.4 Applications
  - 7.2.4.1 Castings
  - 7.2.4.2 Welds
  - 7.2.4.3 Assemblies
  - 7.2.4.4 Electronic components
  - 7.2.4.5 Field inspections

8.0 Thermal/Infrared Testing

8.1 Fundamentals
- 8.1.1 Principles and theory of thermal/infrared testing
- 8.1.2 Temperature measurement principles
- 8.1.3 Proper selection of thermal/infrared technique

8.2 Equipment/materials
- 8.2.1 Temperature measurement equipment
- 8.2.2 Heat flux indicators
- 8.2.3 Non-contact devices

8.3 Applications
- 8.3.1 Contact temperature indicators
- 8.3.2 Non-contact pyrometers
- 8.3.3 Line-scanners
- 8.3.4 Thermal imaging
- 8.3.5 Heat flux indicators
- 8.3.6 Exothermic or endothermic investigations
- 8.3.7 Friction investigations
- 8.3.8 Fluid flow investigations
- 8.3.9 Thermal resistance investigations
- 8.3.10 Thermal capacitance investigations

8.4 Interpretation and evaluation

9.0 Ultrasonic Testing
- 9.1 Fundamentals
  - 9.1.1 Ultrasonic sound beams
    - 9.1.1.1 Wave travel modes
    - 9.1.1.2 Refraction, reflection, scattering, and attenuation
  - 9.1.2 Transducers and sound beam coupling
- 9.2 Ultrasonic testing
  - 9.2.1 Basic types of equipment
  - 9.2.2 Reference standards
  - 9.2.3 Test result interpretation; discontinuity indications
  - 9.2.4 System factors
  - 9.2.5 Applications
    - 9.2.5.1 Flaw detection
    - 9.2.5.2 Thickness measurement
    - 9.2.5.3 Bond evaluation
    - 9.2.5.4 Process control
    - 9.2.5.5 Field inspection

10.0 Visual Testing
- 10.1 Fundamentals
  - 10.1.1 Principles and theory of visual testing
  - 10.1.2 Selection of correct visual technique
  - 10.1.3 Equipment and materials
- 10.2 Specific applications
  - 10.2.1 Metal joining processes
  - 10.2.2 Pressure vessels
  - 10.2.3 Pumps
  - 10.2.4 Valves
  - 10.2.5 Bolting
  - 10.2.6 Castings
  - 10.2.7 Forgings
  - 10.2.8 Extrusions
  - 10.2.9 Microcircuits
- 10.3 Interpretation and evaluation
  - 10.3.1 Codes and standards
  - 10.3.2 Environmental factors

Basic Materials, Fabrication and Product Technology

1.0 Fundamentals of Material Technology
- 1.1 Properties of materials
  - 1.1.1 Strength and elastic properties
  - 1.1.2 Physical properties
  - 1.1.3 Material properties testing
- 1.2 Origin of discontinuities and failure modes
  - 1.2.1 Inherent discontinuities
  - 1.2.2 Process-induced discontinuities
  - 1.2.3 Service-induced discontinuities
  - 1.2.4 Failures in metallic materials
  - 1.2.5 Failures in nonmetallic materials
- 1.3 Statistical nature of detecting and characterizing discontinuities

2.0 Fundamentals of Fabrication and Product Technology
- 2.1 Raw materials processing
- 2.2 Metals processing
  - 2.2.1 Primary metals
    - 2.2.1.1 Metal ingot production
    - 2.2.1.2 Wrought primary metals

2.2.2 Castings
- 2.2.2.1 Green sand molded
- 2.2.2.2 Metal molded
- 2.2.2.3 Investment molded

2.2.3 Welding
- 2.2.3.1 Common processes
- 2.2.3.2 Hard-surfacing
- 2.2.3.3 Solid State

2.2.4 Brazing

2.2.5 Soldering

2.2.6 Machining and material removal
- 2.2.6.1 Turning, boring, and drilling
- 2.2.6.2 Milling
- 2.2.6.3 Grinding
- 2.2.6.4 Electrochemical
- 2.2.6.5 Chemical
- 2.2.6.6 Gears and bearings

2.2.7 Forming
- 2.2.7.1 Cold-working processes
- 2.2.7.2 Hot-working processes

2.2.8 Powdered metal processes

2.2.9 Heat treatment

2.2.10 Surface finishing and corrosion protection
- 2.2.10.1 Shot peening and grit blasting
- 2.2.10.2 Painting
- 2.2.10.3 Plating
- 2.2.10.4 Chemical conversion coatings

2.2.11 Adhesive joining

2.3 Nonmetals and composite materials processing
- 2.3.1 Basic materials processing and process control
- 2.3.2 Nonmetals and composites fabrication
- 2.3.3 Adhesive joining

2.4 Dimensional metrology
- 2.4.1 Fundamental units and standards
- 2.4.2 Gaging
- 2.4.3 Interferometry

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PdM Basic Examination
Predictive Maintenance (PdM) Examination Specification

The PdM Basic Examination, composed of 90 questions, will cover three main topical areas:

1.0 Personnel Qualification and Certification Programs – 40 questions
- 1.1 *SNT-TC-1A*
- 1.2 *ANSI/ASNT-CP-189*
- 1.3 ASNT Level III Programs

2.0 General familiarity with other PdM Methods – 30 questions

3.0 General knowledge of machinery – 20 questions

The PdM Basic examination and one or more PdM Method examinations (either Thermal/Infrared Testing or Vibration Analysis) must be taken and passed to qualify for an ASNT PdM Level III Certificate. The endorsements on the ASNT Certificate will list the various Methods, which the applicant passed.

1.0 Personnel Qualification and Certification Programs

1.1 *Recommended Practice No. SNT-TC-1A*
- 1.1.1 Scope
- 1.1.2 Definitions
- 1.1.3 Nondestructive testing methods
- 1.1.4 Levels of qualification
- 1.1.5 Written practice
- 1.1.6 Education, training, and experience
- 1.1.7 Training programs
- 1.1.8 Examinations
- 1.1.9 Certification
- 1.1.10 Termination

1.2 *ASNT Standard ANSI/ASNT-CP-189*
- 1.2.1 Scope
- 1.2.2 Definitions
- 1.2.3 Levels of qualification
- 1.2.4 Qualification requirements
- 1.2.5 Qualification and certification
- 1.2.6 Examinations
- 1.2.7 Expiration, suspension, revocation, and reinstatement of employee's certification
- 1.2.8 Employer recertification
- 1.2.9 Records
- 1.2.10 Referenced publications

1.3 ASNT Level III Certification Programs

2.0 Basics of Common PdM Methods (presuming 30 questions)
- 2.1 Infrared Testing – 7 questions
- 2.2 Vibration Analysis – 7 questions
- 2.3 Oil/Lube Analysis – 7 questions
- 2.4 Motor Circuit Analysis – 3 questions
- 2.5 Alignment – 2 questions
- 2.6 Thermal Testing – 2 questions
- 2.7 System Performance – 2 questions

3.0 Machinery Technology (presuming 20 questions)
- 3.1 Machine Design – 7 questions
  - 3.1.1 Lube Systems
- 3.2 Electrical Components – 5 questions
- 3.3 Maintenance Concerns – 3 questions
  - 3.3.1 Millwright Concerns
- 3.4 Machine Components – 3 questions
- 3.5 Engineering Mechanics – 2 questions

APPENDIX
Example Questions
Level I and Level II

The purpose of this appendix is to provide a guideline for the preparation of the General, Level I and Level II written exami nations. Extensive examples of representative questions for degree of difficulty, type, etc., are provided in separate question booklets, which can be obtained from ASNT Headquarters. These questions are intended as examples only and should not b used verbatim for qualification examinations.

Note: All questions and answers should be referenced to a recognized source.

Acoustic Emission Testing Method

Level I

1. A qualitative description of the sustained signal level produced by rapidly occurring acoustic emission events is the accepted definition for:
   - a. burst emission.
   - b. acoustic emission signature.
   - c. acoustic emission signal.
   - d. continuous emission.
   - e. none of the above.

2. Attenuation of a wave is best defined by which statement?
   - a. A decrease in frequency with distance traveled.
   - b. A decrease in amplitude with distance traveled.
   - c. A decrease in wave speed with distance traveled.
   - d. A change in direction as a function of time.

3. The number of times the acoustic emission signal exceeds a preset threshold during any selected portion of a test is called the:
   - a. acoustic emission response.
   - b. acoustic emission count.
   - c. acoustic emission count rate.
   - d. acoustic emission energy.
   - e. none of the above.

Level II

1. When detecting impulsive acoustic emission signals on large objects, the peak of the signals normally decreases with increasing distance from the source. This alteration, dependent on distance, must be explained by:
   - a. absorption: i.e., the elastic pulse gradually converts into heat.
   - b. dispersion: i.e., the pulse gradually spreads out in time because the different waves involved travel with different velocities.
   - c. the geometric factors: i.e., the energy in the pulse is distributed into ever-larger volumes.
   - d. all of the above.

2. Which of the following factors will tend to produce *low-amplitude* acoustic emission response during a tensile test?
   - a. low temperature
   - b. high strain rate
   - c. plastic deformation
   - d. crack propagation

3. The Kaiser effect is:
   - a. valid only when testing composites.
   - b. a physical law of nature that is never violated.
   - c. not applicable when an rms recording is being made.
   - d. the absence of detectable acoustic emission until previously applied stress levels are exceeded.

Electromagnetic Testing Method
Eddy Current Testing Method

Level I

1. The impedance of an eddy current test coil will increase if the:
   a. test frequency increases.
   b. inductive reactance of the coil decreases.
   c. inductance of the coil decreases.
   d. resistance of the coil decreases.

2. Which of the following test frequencies would produce eddy currents with the largest depth of penetration?
   a. 100 Hz
   b. 10 kHz
   c. 1 MHz
   d. 10 MHz

3. To generate measurable eddy currents in a test specimen, the specimen must be:
   a. a conductor.
   b. an insulator.
   c. either a conductor or an insulator.
   d. a ferromagnetic material.

Level II

1. The fill factor when a 1.26 cm (0.5 in.) diameter bar is inserted in a 2.54 cm (1 in.) diameter coil is:
   a. 0.5 (50 percent).
   b. 0.75 (75 percent).
   c. 1.0 (100 percent).
   d. 0.25 (25 percent).

2. If the characteristic frequency (f_g) of a material is 125 Hz, the test frequency required to give an f/f_g ratio of 10 would be:
   a. 1.25 Hz.
   b. 12.5 Hz.
   c. 1.25 kHz.
   d. 12.5 kHz.

3. For age-hardened aluminum and titanium alloys, changes in hardness are indicated by changes in:
   a. retentivity.
   b. permeability.
   c. conductivity.
   d. magnetostriction.

Flux Leakage Testing Method

Level I

1. Flux leakage inspection can normally be applied to:
   a. ferromagnetic and nonmagnetic material.
   b. nonmagnetic materials only.
   c. ferromagnetic materials only.
   d. nonconductors only.

2. The ratio B/H is equivalent to a material's:
   a. field strength.
   b. reluctance.
   c. permittivity.
   d. permeability.
   e. relative permeability.

3. In the flux leakage examination of tubular products, which of the following discontinuities can be detected?
   a. longitudinally oriented
   b. transversely oriented
   c. slivers
   d. all of the above

Level II

1. The highest sensitivity of a Hall generator is obtained when the direction of the magnetic field in relation to the largest surface of the Hall probe is:
   a. parallel.
   b. at an angle of 45 degrees.
   c. at an angle of 30 or 60 degrees.
   d. perpendicular.
   e. none of the above

2. What particular type of defect is not indicated by flux leakage techniques?
   a. overlap
   b. grain-boundary crack
   c. slag inclusion with crack
   d. surface contamination
   e. longitudinal seam

3. In the examination of tubular products where the flux sensor measures the leakage field at the outside surface of the tube:
   a. outside-diameter discontinuities are detected.
   b. both outside-diameter and inside-diameter discontinuities may be detected.
   c. both outside-diameter and inside-diameter discontinuities can be detected but generally cannot be distinguished from each other.
   d. both outside-diameter and inside-diameter discontinuities can be detected and generally can be distinguished from each other.

Leak Testing Method
Bubble Leak Testing Method

Level I

1. Before performing a vacuum box leak test, which of the following should be checked for required calibration?
   a. leak-detector solution
   b. evacuation device or equipment
   c. lighting equipment
   d. pressure (or vacuum) gage

2. Which factor can most affect the sensitivity attainable by a pressure bubble leak test?
   a. operator alertness and technique
   b. size and shape of the test specimen
   c. time of day testing is performed
   d. number of test technicians

3. The letters "psia" mean:
   a. pressure referred to National Institute of Standards and Technology's absolute pressure.
   b. pascals per square inch absolute.
   c. pressure standard in absolute units.
   d. pounds per square inch absolute.

Level II

1. Which of the following directly determines the size of the bubble formation when testing using the bubble test method?
    a. method of application of bubble solution
    b. ambient temperature and barometric pressure
    c. amount of leakage from a defect or leak
    d. size of the test specimen

2. When a vacuum gage is marked with a range of 0-30 with the notation "vacuum" on the face, the units of measurement are:
    a. inches of mercury.
    b. pounds per square inch.
    c. centimeters of vacuum.
    d. feet of water.

3. The type of leaks that are most likely to go undetected during a bubble leak test are:
    a. very small leaks and very large leaks.
    b. leaks occurring at welded joints.
    c. corner-configuration joints.
    d. all of the above.

Halogen Diode Detector Leak Testing Method

Level I

1. Good operating practice dictates that the period of time to allow for warm-up of the halogen diode detector prior to calibrating is:
    a. 30 minutes.
    b. 15 minutes.
    c. 1 hour.
    d. as recommended by the manufacturer.

2. While adjusting a reservoir-type variable-halogen standard leak, the operator accidentally vents the gas from the only standard leak available. Which of the following actions would quickly resolve the problem?
    a. Replace the standard leak.
    b. Replace the cylinder in the standard leak.
    c. Recharge the standard leak.
    d. Send the standard leak to the manufacturer for recharging.

3. While performing a halogen-diode detector test, the leak detector becomes difficult to zero, and the pointer on the leak rate meter repeatedly swings up scale. The most likely cause of the problem could be the use of too high a sensitivity range, a shorted element, an excessive heater voltage, or:
    a. poor airflow.
    b. a sensing element that is too new.
    c. a high halogen background.
    d. a faulty leak-rate meter.

Level II

1. Most leaks detected during a halogen sniffer test could have been detected and usually can be verified by:
    a. a bubble leak test.
    b. an ultrasonic examination.
    c. a visual examination.
    d. a pressure change test.

2. The presence of small traces of halogen vapors in the halogen diode detector:
   a. increases the emission of negative ions.
   b. decreases the emission of positive ions.
   c. increases the emission of positive ions.
   d. decreases the emission of negative ions.

3. A halogen standard leak of a certain size produces a known signal on a halogen leak detector. To receive this same intensity signal on the instrument during the test of an object containing a 2 percent by volume halogen-air mixture, the size of the leak in the object causing the signal would theoretically have to be at least _____ times larger than the standard leak.
   a. 20
   b. 50
   c. 40
   d. 10

Mass Spectrometer Leak Testing Method

Level I

1. The sensitivity of a mass spectrometer leak detection system is the mass flow rate of tracer gas:
   a. that gives a maximum measurable signal.
   b. that gives a minimum measurable signal.
   c. at standard temperature and pressure.
   d. in a leak.

2. The diffusion pump and mechanical fore pump in a mass spectrometer leak detection system:
   a. use the same type of oil.
   b. use different types of oil.
   c. operate using the same motor.
   d. use the same principle of operation.

3. The helium mass spectrometer detector-probe pressure-test technique is:
   a. a quantitative test.
   b. a qualitative test.
   c. a semiautomatic test.
   d. none of the above.

Level II

1. A torr is defined as:
   a. 14.7 psia.
   b. 1 mm of Hg.
   c. 1/760 of a standard atmosphere.
   d. 760 mm of Hg.

2. When conducting helium mass spectrometer test of a vacuum vessel in the pressure range of 10^{-4} to 10^{-8} mm Hg, which type gage could be used to measure the pressure?
   a. alphatron gage
   b. thermionic ionization gage
   c. pirani gage
   d. thermocouple gage

3. Helium standard leaks in the range of 10^{-6} to 10^{-10} atm. cc/s are known in general terms as:
   a. reservoir standard leaks.
   b. capillary standard leaks.
   c. permeation standard leaks.
   d. adjustable standard leaks.

Pressure Change Measurement Leak Testing Method

Level I

1. A pressure of 66.0 psig, in terms of absolute pressure at sea level and standard temperature, would be approximately:
   a. 96.0 psia.
   b. 80.7 psia.
   c. 51.3 psia.
   d. 36.0 psia.

2. When conducting a long-duration pressure change test, it is necessary to measure absolute pressure or gage pressure plus barometric pressure because the barometric pressure will:
   a. always fall.
   b. always rise.
   c. remain constant.
   d. tend to vary.

3. Which one of the following is the correct relationship for converting temperature in degrees Rankin (°R) to temperature in degrees Kelvin (K)?
   a. K = (5/9) °R
   b. K = (5/9) °R + 273
   c. K = 460 + °R
   d. K = 273 °R

Level II

1. When a system's internal dry bulb's internal temperature and, in turn, total pressure, increase during a pressure change leakage-rate test, the water vapor pressure in the system under test would normally:
   a. increase.
   b. remain the same.
   c. decrease.
   d. oscillate.

2. For a pneumatically pressurized constant-volume system at an internal temperature of 27 °C, what approximate percentage change in the system absolute pressure can be expected for a system internal temperature change of 1 °C?
   a. 3 percent
   b. 6 percent
   c. 0.3 percent
   d. 10 percent

3. One set of internal dry bulb temperature data for a pressure change leakage rate test is:
   $(T_1 + T_2 + T_3)/3 = 71.87$ °F
   $(T_4 + T_5)/2 = 72.32$ °F
   $(T_6 + T_7)/2 = 72.68$ °F
   $(T_8 + T_9 + T_{10})/3 = 73.07$ °F

   For each of these four sections of this system, the respective weighting factors are 0.27, 0.18, 0.22, and 0.33. The mean absolute dry bulb temperature of system air for this test data point is:
   a. 532.53 °R.
   b. 345.53 K.
   c. 532.48 °R.
   d. 532.48 K.

Liquid Penetrant Testing Method

Level I

1. Which of the following is generally the more acceptable method for cleaning parts prior to penetrant testing?
   a. sand blasting
   b. wire brushing
   c. grinding
   d. vapor degreasing

2. The term used to define the tendency of certain liquids to penetrate into small openings such as cracks or fissures is
   a. saturation.
   b. capillary action.
   c. blotting.
   d. wetting agent.

3. Which of the following is the most commonly used method for removing non-water-washable visible dye penetrant from the surface of a test specimen?
   a. dipping in a solvent
   b. spraying
   c. hand wiping
   d. blowing

Level II

1. When conducting a penetrant test, spherical indications on the surface of a part could be indicative of:
   a. fatigue cracks.
   b. porosity.
   c. weld laps.
   d. hot tears.

2. A commonly used method of checking on the overall performance of a penetrant material system is by:
   a. determining the viscosity of the penetrant.
   b. measuring the wettability of the penetrant.
   c. comparing two sections of artificially cracked specimens.
   d. all of the above.

3. Which of the following is a discontinuity that might be found in a forging?
   a. shrinkage crack
   b. lap
   c. hot tear
   d. lamination

Magnetic Particle Testing Method

Level I

1. Which type of current has a "skin effect?"
   a. alternating current
   b. direct current
   c. half-wave rectified
   d. full-wave rectified

2. The best type of magnetic field to use to inspect a tubular product for surface defects along its length is a:
   a. longitudinal field.
   b. circular field.
   c. swinging field.
   d. yoke magnetization.

3. Which of the following is most often used for dry magnetic particle inspection?
   a. full-cycle direct current
   b. half-wave alternating current
   c. high-voltage, low-amperage current
   d. direct current from electrolytic cells

Level II

1. When testing a bar with an L/D ratio of 4 in a 10-turn coil, the required current would be:
   a. 45 000 A.
   b. unknown; more information is needed.
   c. 18 000 A.
   d. 1125 A.

2. Which of these cracks may appear as an irregular, checked, or scattered pattern of fine lines usually caused by local overheating?
   a. fatigue cracks
   b. grinding cracks
   c. crater cracks
   d. HAZ cracks

3. If a copper conductor is placed through a ferrous cylinder and a current is passed through the conductor, then the magnetic field (flux density) in the cylinder will be:
   a. the same intensity and pattern as in the conductor.
   b. greater than in the conductor.
   c. less than in the conductor.
   d. the same regardless of its proximity to the cylinder wall.

Neutron Radiographic Testing Method

Level I

1. Neutron penetration is greatest in which of the following materials?
   a. hydrogenous material
   b. water
   c. lead
   d. boron carbide

2. Gadolinium conversion screens are usually mounted in rigid holders called:
   a. film racks.
   b. cassettes.
   c. emulsifiers.
   d. diaphragms.

3. Which element is commonly used for direct neutron radiography?
   a. Cd
   b. In
   c. Dy
   d. Gd

Level II

1. Which of the following conversion screens has the longest half-life?
   a. dysprosium
   b. indium
   c. cadmium
   d. gadolinium

2. Neutron radiography can be used for inspecting which of the following applications?
   a. presence of explosives in a metal device
   b. presence of foreign materials such as oil
   c. lubricants in metal systems
   d. hydrogen content in metals
   e. all of the above

3. Real-time imaging of thermal neutron radiography can be performed with which of the following detectors?
   a. gadolinium
   b. dysprosium
   c. zinc sulfide + lithium fluoride
   d. europium

Radiographic Testing Method

Level I

1. The most widely used unit of measurement for measuring the rate at which the output of a gamma ray source decay is the:
   a. curie.
   b. roentgen.
   c. half-life.
   d. MeV.

2. If an exposure time of 60 seconds were necessary using a 1.2 m (4 ft) source-to-film distance for a particular exposure, what time would be necessary if a 0.61 (2 ft) source-to-film distance is used and all other variables remai the same?
   a. 120 seconds
   b. 30 seconds
   c. 15 seconds
   d. 240 seconds

3. The sharpness of the outline in the image of the radiograph is a measure of:
   a. subject contrast.
   b. radiographic definition.
   c. radiographic contrast.
   d. film contrast.

Level II

1. When radiographing to the 2-2T quality level, an ASTM penetrameter for 6.35 cm (2.5 in.) steel has a thickness of
   a. 1.27 cm (0.5 in.).
   b. 63.5 µm (2.5 X 10^{-3} in.).
   c. 127 µm (5 X 10^{-3} in.).
   d. 1 270 µm 5 X10^{-2} in.).

2. The a; proximate radiographic equivalence factors for steel and copper at 220 kV are 1.0 and 1.4, respectively. If it desirable to radiograph a (1.27 cm) 0.5 in. plate of copper, what thickness of steel would require about the same exposure characteristics?
   a. 1.78 cm (0.7 in.) of steel
   b. 0.89 cm (0.35 in.) of steel
   c. 3.56 cm (1.4 in.) of steel
   d. 2.54 cm (1.0 in.) of steel

3. If a specimen were radiographed at 40 kV and again at 50 kV, with time compensation to give the radiographs the same density, which of the following statements would be true?
   a. The 40 kV exposure would have lower contrast and greater latitude than the 50 kV exposure.
   b. The 40 kV exposure would have higher contrast and greater latitude than the 50 Kv exposure.
   c. The 50 kV exposure would have lower contrast and greater latitude than the 40 kV exposure.
   d. The 50 kV exposure would have higher contrast and greater latitude than the 40 kV exposure.

Thermal/Infrared Testing Method

Questions for the Thermal/Infrared Testing Method were unavailable at the time of this printing.

Ultrasonic Testing Method

Level I

1. The amount of beam divergence from a transducer element is primarily dependent on the:
   a. type of test.
   b. tightness of the transducer element backing in the search unit.
   c. frequency and transducer element size.
   d. refraction.

2. On the area-amplitude ultrasonic standard test blocks, the flat-bottomed holes in the blocks are:
   a. all of the same diameter.
   b. different in diameter, increasing by 1/64 in. (0.39 mm) increments from the No. 1 block to the No. 8 block.
   c. largest in the No. 1 block and smallest in the No. 8 block.
   d. drilled to different depths from the front surface of the test block.

3. On many ultrasonic testing instruments, an operator conducting an immersion test can remove that portion of the screen presentation that represents water distance by adjusting a:
   a. pulse-length control.
   b. reject control.
   c. sweep-delay control.
   d. sweep-length control.

Level II

1. If a contact angle-beam transducer produces a 45 degree shear wave in steel (V_S = 0.323 cm/s), the angle produced by the same transducer in an aluminum specimen (V_S = 0.310 cm/s) would be:
   a. less than 45 degrees.
   b. greater than 45 degrees.
   c. 45 degrees.
   d. more information is required.

2. A discontinuity is located having an orientation such that its long axis is parallel to the sound beam. The indication from such a discontinuity will be:
   a. large in proportion to the length of the discontinuity.
   b. small in proportion to the length of the discontinuity.
   c. representative of the length of the discontinuity.
   d. such that complete loss of back-reflection will result.

3. An ultrasonic longitudinal wave travels in aluminum with a velocity of 635,000 cm/s and has a frequency of 1 MHz. The wavelength of this ultrasonic wave is:
   a. 6.35 ft.
   b. 3.10 in.
   c. 6.35 mm.
   d. 30 000 Å.

Vibration Analysis Testing Method

Level I

1. The vibration amplitude is really a response that is:
   a. inversely proportional to the dynamic resistance in the system.
   b. proportional to the amount of displacement in the signal.
   c. not related at all to the dynamic forces in the system.
   d. meaningless unless it has been initially taken in acceleration units.

2. If a magnetic is attached to an accelerometer, it will:
   a. lower the frequency range capability of the accelerator.
   b. increase the frequency range capability of the accelerator.
   c. not allow the accelerometer to read in acceleration units anymore.
   d. increase the amplitude range of the accelerometer.

3. The enter or store key on a programmable FFT-Analyzer/Data collector should be pressed:
   a. as soon as the accelerator is attached to the mounting surface.
   b. after a pause of 30 seconds from the time the accelerometer is mounted.
   c. after the readings have settled down (usually 3 seconds or longer).
   d. immediately when a display appears on the screen (to save time).

Level II

1. A Lissajous orbit that has a long elliptical (cigar shape) appearance is an indication of:
   a. unbalance.
   b. misalignment.
   c. an oil whirl.
   d. a rub event.

2. The purpose of a Bode or Polar (Nyquist) Flot is to verify the presence of:
   a. an eccentricity.
   b. a defective bearing.
   c. a resonance.
   d. a bent shaft.

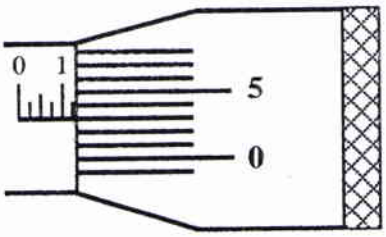
3. The two most common problems that will produce a higher amplitude at 2X RPM than at 1X RPM in a vibration spectrum are:
   a. an eccentric pulley and mechanical looseness (Type A).
   b. offset misalignment and mechanical looseness (Type B).
   c. a shaft bent between its bearings and worn gear teeth.
   d. an unbalanced shaft and mechanical looseness (Type C).

Visual Testing Method

Level I

1. Which of the following is true?
   a. All discontinuities are defects.
   b. Defects that affect the product's usefulness are called discontinuities.
   c. Discontinuities that affect the product's usefulness are called defects.
   d. All discontinuities are unacceptable.

2. The dimension indicated on the sketch of a micrometer is:
   a. 3.25 mm (0.128 in.).
   b. 5.97 mm (0.235 in.).
   c. 3.20 mm (0.126 in.).
   d. 8.33 mm (0.328 in.).



3. As a visual examiner, you shall have your eyes checked at least:
   a. every 3 months.
   b. every 6 months.
   c. every year.
   d. every 3 years.

Level II

1. Handheld magnifiers should fall into which of the following ranges?
   a. 2X to 4X
   b. 5X to 10X
   c. 10X to 20X
   d. 20X to 30X

2. Visual examiners who perform visual exams using borescopes and fiberscopes must be:
   a. color blind.
   b. able to meet far-vision requirements (Snellen 20/30).
   c. competent in their use.
   d. ambidextrous.

3. A narrow field of view produces:
   a. higher magnification and a greater depth of field.
   b. higher magnification and a shorter depth of field.
   c. less magnification and a greater depth of field.
   d. less magnification and a shorter depth of field.

Answers to Example Questions

Acoustic Emission Testing Method

Level I	Level II
1. d	1. d
2. b	2. c
3. b	3. d

Electromagnetic Testing Method
Eddy Current Testing Method

Level I	Level II
1. a	1. d
2. a	2. c
3. a	3. c

Flux Leakage Testing Method

Level I	Level II
1. c	1. d
2. d	2. d
3. d	3. d

Leak Testing Method
Bubble Leak Testing Method

Level I	Level II
1. d	1. c
2. a	2. a
3. d	3. a

Leak Testing Method
Halogen Diode Detector

Level I	Level II
1. d	1. a
2. c	2. c
3. c	3. b

Leak Testing Method
Mass Spectrometer

Level I	Level II
1. b	1. c
2. b	2. b
3. b	3. c

Leak Testing Method
Pressure Change Measurement

Level I	Level II
1. b	1. a
2. d	2. c
3. a	3. a

Liquid Penetrant Testing Method

Level I	Level II
1. d	1. b
2. b	2. c
3. c	3. b

Magnetic Particle Testing Method

Level I	Level II
1. a	1. d
2. b	2. b
3. b	3. b

Neutron Radiographic Testing Method

Level I	Level II
1. c	1. a
2. b	2. e
3. d	3. c

Radiographic Testing Method

Level I	Level II
1. a	1. d
2. c	2. a
3. b	3. c

Thermal/Infrared Testing

(Questions not yet available)

Ultrasonic Testing Method

Level I	Level II
1. c	1. a
2. b	2. b
3. c	3. c

Vibration Analysis Method

Level I	Level II
1. a	1. b
2. a	2. c
3. c	3. b

Visual Testing Method

Level I	Level II
1. c	1. b
2. a	2. c
3. c	3. b