



**UNIVERSITY OF  
ULTRASONICS™**

***DRAFT***

***Performance Demonstration  
Qualification (PDQ) Test Protocol  
for Phased Array  
UT Qualification***

**DEVELOPED BY:**



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## 1. PURPOSE

The Test Protocol for the PDQ Program is presented to provide a description of the Performance Demonstration Examination Program for Advanced UT Examinations, i.e., Phased Array. Other methods of UT may be used to take the PDQ Examination, e.g., AUT, TOFD, etc. The PDQ Test Protocol is intended to provide a brief overview for each Test Candidate regarding test administration and candidate preparation. The information contained in this procedure is subject to change, therefore, all candidates will receive an additional orientation by the PDQ Administrator prior to the start of each qualification session.

## 2. PDQ Testing Protocol

The Phased Array Test Candidate Examinations are scheduled to be completed during a two (2) and ½ day, eight-hour workday (8 AM to 5 PM). The Test Candidate may elect to bring lunch for a one-hour lunch break.

**Only one Test Candidate may leave the testing area at a time.** A defined security plan will be established during testing (including lunch and bathroom breaks) to prevent test sample compromise.

The following projected time schedule is provided for candidate reference. The actual practical examination times identified below can be affected as a result of candidate readiness. It is strongly recommended that candidate's become familiar with the PDQ Examination, specifically the data collection, reporting forms and examination procedure to increase efficiency.

- 8:00 – 8:30                      Test Protocol Review
- 8:30 – 12:00                  PDQ Examination
- 12:00 – 12:30                Lunch Break – In Room (optional)
- 1:00 – 5:00                    PDQ Examination

Each Test Candidate will be given a unique test set consisting of 8 qualification test specimens. Candidates must work independently and are not allowed to discuss specimen or examination information during or after the demonstration. In general, there will be no single sample time limit established, however, if a sample requires sharing between 2 candidates, sample time limit provisions may be established.

All paperwork must be completed and turned into the monitor by end of day. Time extensions will not be authorized. Candidates that fail to complete the examination in the allotted time will be considered unsuccessful.

## 3. **There are three (3) primary areas of PDQ Qualification:**

- |                    |   |
|--------------------|---|
| 1. <b>Basic</b>    | <b>Phased Array Equipment Operability</b> |
| 2. <b>Advanced</b> | <b>Weld Inspection</b>                    |
| 3. <b>Advanced</b> | <b>Crack Sizing</b>                       |

Note: A successful completion of the Advanced PDQ Qualifications will automatically qualify the Test Candidate for the Basic.

For the Advanced PDQ Examinations (Weld Inspection and Crack Sizing), the following will apply for data collection:

1. Non-Encoded
2. Encoded

Note: The method of data collection shall be clearly outlined in the Test Candidates Phased Array Procedure. This qualification parameter will be documented on the Test Candidate’s PDQ Certificate.

**4. SPECIMEN PRESENTATION**

Flaw location and “True” specimen identification shall be concealed to maintain a “blind test”. Test specimens will be given a unique number identifier. The PDQ Test Specimens are divided into grading units. Each grading unit will be considered as either flawed or unflawed. There will only be one defect type in each grading unit. The number of flawed and/or unflawed grading units and specific grading unit length will not be made available to the candidates. There will be no disclosure of particular specimen results or candidate viewing of unmasked specimens during or after the performance demonstration.

**5. THE PDQ TEST SET AND TEST SPECIMEN DESIGN**

Each candidate will be supplied a list defining the test specimens that make up their test set. Each test set will be comprised with the following samples (1 of each):

8 inch Diameter Pipe	1 - Carbon Steel 24 inches weld length	1 - Stainless Steel 24 inches weld length
16 inch Diameter Pipe	1 - Carbon Steel 15 inches weld length	1 - Stainless Steel 15 inches weld length
24 inch Diameter Pipe	2 - Carbon Steel 30 inches weld length	NA
½ inch Plate	1 - Carbon Steel 15 inches weld length	NA
1 inch Plate	1 - Carbon Steel 15 inches weld length	NA

Test Sample Dimensions:

<u>Pipe Diameter/Thickness</u>	<u>Bevel Type</u>	<u>Bevel Angle</u>
8 inch / .500 inch thick	Single Vee	37.5 degrees
16 inch/ .750 thick	Single Vee	37.5 degrees
24 inch/ 1.00 thick	Single Vee	37.5 degrees

<u>Plate/Thickness</u>	<u>Bevel Type</u>	<u>Bevel Angle</u>
½ inch thick	Single Vee	37.5 degrees
1 inch thick	Double Vee	30.0 degrees

## 6. Potential Flaw Mechanism's

The following flaw types may be included in each test specimen. The number of flaws in each test specimen may vary for each test set. At least one Test Specimen may be unflawed along the entire length.

### Planar Flaws-Surface Connected

Lack of Penetration-LOP  
Inside Diameter Crack-IDC  
Outside Diameter Crack-ODC  
Transverse Crack

### Volumetric Flaws- Not Surface Connected

Lack of Fusion-LOF  
Slag  
Porosity  
Mid-Wall Crack-MDC

Definitions and descriptions of each flaw type are outline in the Addendum to this PDQ Test Protocol.

## 7. TEST SAMPLE GEOMETRY

1. The Test Specimen may contain counterbore geometry
2. The Test Specimen may contain ID or OD mismatch
3. The Test Specimen weld crown reinforcement and weld root geometry will be in the “as-welded” condition and may be offset from sample centerline.

## 8. GRADING CRITERIA

Candidate performance will be evaluated in the following five categories:

- A. Detection - The detection portion of the test is applied to initially evaluate a candidate's data report. If the candidate does not detect an intended flaw, no further evaluation is required. The candidate will be required to detect approximately of 80% of the flaws in the test set. Sufficient data must be provided in order for the monitor to determine if the candidate actually detected the flaw.
- B. Flaw Characterization - Once a flaw is detected, the candidate's must characterize the flaw to determine the type of flaw as shown above. See Addendum 1. Characterization criteria will be weighted heavily on the location of the reported flaw (surface connected or volumetric). The candidate must correctly characterize approximately 80% of the detected flaws.
- C. Flaw Length Sizing - The length of the flaw shall be measured using a 6 dB drop method. The flaw length accuracy will be at .75 RMS.
- D. Flaw Positioning - Reported flaws must also be positioned correctly with respect to the weld centerline (upstream/downstream). Evaluations will include the flaws approximate relationship to the weld centerline. Cross sectional plotting of flaw indications on the indication data sheets may be required in order to determine the location of the flaw. The candidate must correctly position approximately 80% of the detected flaws.
- E. False Call - A false call is defined as reporting a flaw within a non-flawed grading unit. Candidates will not know the location of unflawed grading units. The candidate must correctly evaluate the unflawed Grading Units and not report more than approximately 20 % False Calls units in order to be successful.

There is a maximum error allowance for each grading category. Unsatisfactory performance in any category will result in test failure.

The PDQ Test results for each category will be provided to the Test Candidate to assist unsuccessful candidates for future preparation.

Over sizing of flaw length may result in false calls in the adjoining grading units.

#### **9. TEST SPECIMEN RE-EXAMINATION**

The candidate may re-look any specimen during **“the day”** of the examination for those test specimen examined for that day, provided they are within the time limits of the test. Re-examination of Test Samples on subsequent days is not allowed.

#### **10. PERFORMANCE DEMONSTRATION RE-EXAMINATION**

Any unsuccessful candidate must wait 30 days and show evidence of at least 8 hours of retraining on the appropriate Phased Array System. Re-Examination will be administered with the same rules and guidelines as the original test. After the second unsuccessful attempt the Test Candidate must wait 6 months and document Phased Array field training experience (OJT) in which to take the Re-Test for the PDQ Examination.

#### **11. TEST RESULTS**

Test results will be provided to the test Candidate within 2 to 3 weeks after the examination. Test paperwork will be reviewed at the end of the session for completeness and legibility. All grading will be done post session and filed. The Test Results will be forwarded from to either the individual candidate or their organization.

#### **12. THE TEST CANDIDATES PHASED ARRAY EXAMINATION PROCEDURE**

The Test Candidate shall bring to the PDQ Examination a copy of the Phased Array Procedure. The essential variables will be reviewed by the Test Administrator.

A detailed Scan Plan shall be prepared by the Test Candidate prior to the PDQ Examination and submitted to the Test Administrator at the beginning of the PDQ Examination.

#### **13. EQUIPMENT REQUIREMENTS**

The Test Candidate or candidate organizations are responsible for supplying **ALL** the equipment needed for each demonstration. **Sharing of equipment will not be allowed during the demonstration.** Below is a recommended list of equipment and supplies that should be considered for use during the demonstration.

1. Ultrasonic Phased Array Instrument
2. Ultrasonic Cables
3. Ultrasonic Phased Array Probes
4. Basic Calibration Blocks

5. Calibration Standards (IIW, Rompas, DSC)
6. Indication Plotting Devices
7. Calculator
8. Pens/Pencils
9. Couplant
10. Rags

#### 14. **REQUIRED PAPERWORK**

**All PDO Examination paperwork** shall be completed and turn into the PDQ Administrator to maintain Test Specimen Security. No other paper or materials will be allowed at the testing station. The following demonstration paperwork will be required as a minimum;

##### Equipment Inventory

Ultrasonic instruments, search units, and other equipment essential to the examination system shall be inventoried and documented on an Equipment Inventory Sheet prior to the start of the qualification test. All non-inventoried equipment shall be stored in an area unrelated to the operation of the examination system. All subsequent inclusions of equipment for qualification purposes shall be documented on the sheet and verified by the PDQ Administrator. An inventory sheet can be completed prior to the demonstration, but will be verified prior to the start of the demonstration. If the make model, frequency, size or shape can not be readily determined the equipment certification should be on hand during the demonstration.

##### Calibration Data Sheet

Calibration data record(s) as required by the test Candidates PA Procedure shall be completed for each test specimen examined. The PDQ Administrator will review all calibration data sheets to ensure that they contain sufficient information to properly document the equipment was used during the demonstration and to document procedure compliance. The calibration data sheet will not be used as a pass-fail criterion, but shall be evaluated to determine correlation between successful and unsuccessful candidates.

##### Indication Data Sheet

For each sample, an indication data sheet shall be completed. The indication data sheet has been designed to properly identify indication start and stop positions (length), characterization, and flaw positioning, e.g., upstream or downstream. The candidate is responsible to ensure that all required data is legibly and denotes the specific flaw type and its length, location and type of flaw is clearly recorded on the PDQ Examination Report Form. See attached.

At the conclusion of the PDQ Examination, the Phased Array Unit Data Storage Card/Device will be turned into the Test Administrator. The Test Administrator shall verify that not data is stored on the internal hard drive.

Prior to the PDQ Examination a computer registry of the Hard Drive will be obtained from the Phased Array unit. At the conclusion of the PDQ Examination, another Hard Drive registry will be obtained to ensure no examination data was inadvertently left on the computer system.

The following will be needed prior beginning the PDQ Phased Array Examination:

- Phased Array Examination Procedure
- Scan Plan Plots or drawings to detail the examination process

These will be reviewed prior to the examination.

## 15. SECURITY

### 1. Session Monitoring

The PDQ Examination will be monitored by the PDQ Test Administrator. Continuous testing area surveillance will be maintained to ensure test security. Entry into and out of the testing area will be restricted. The testing area will be monitored during lunch to allow candidates additional time for testing if they choose not to take a lunch break.

Purses, backpacks, or briefcases will not be allowed at the candidates testing stations. Additionally, no cellular telephones, personal pagers, or laptop computers will be allowed in the testing area. Personal items shall be stored in a location specified by the session monitor and will be secured to prevent theft or loss during testing.

The PDQ Examinations will span over a 2 to 3 day period. The Test Candidates Phased Array Examination Equipment shall not be moved from the testing area. The Test Area will be locked to ensure test security as well as equipment security.

### 2. Test Candidate Expectations

The Test Candidate is expected to follow the test security rules as specified in this guideline. Candidates are not allowed to openly discuss information concerning the test samples or examination results. Any violations of the security rules may be cause for terminating the candidate's test and a failing grade to be posted. The PDQ samples will be rotated and renumber daily.

### 3. Additional Security Rules

Additional security measures will be implemented as necessary to ensure the integrity of the testing program. Additional security will be covered in the orientation portion of the demonstration.

### 4. Dispute Resolution

A dispute resolution application form will be available to document unresolved issues and concerns with the qualification program.

## 16. FREQUENTLY ASKED QUESTIONS

### 1. How much weld length is in a typical test set?

A. The approximate length of weld is as follows;

0.50" thick plate

15" Carbon Steel

1.00" thick plate	15" Carbon Steel	
8.0" diameter pipe	24" Carbon Steel	24" Stainless Steel
16.0 diameter pipe (180°)	15" Carbon Steel	15" Stainless Steel
24.0 diameter pipe (180°)	15" Carbon Steel	15" Carbon Steel

**Total** **138 inches**

2. What is a grading unit?

A. The total length of the weld is divided into sections called grading units. Grading units do not have to be of equal length and may not to be equally spaced. A single grading unit consists of both sides of the weld. Grading units are considered unflawed or flawed. **Flawed grading units will contain only one flaw.**

3. What is the minimum size flaw that must be detected?

A. No fixed flaw size value has been established. Identifying flaw size tolerances is difficult because of the different potential flaw types presented. Each sample has been ultrasonically validated to ensure that the flaws meet the reporting threshold identified in the procedure. Flaws sizes are representative of those expected to be found during field applications. The PDQ Examination is designed to test a candidate's ability to perform Basic and Advanced Phased Array Examination operations.

4. Do I have to bring a Phased Array Procedure?

A. Yes, The Phased array Procedure shall meet the minimum requirements for the appropriate code or standard. Calibration reports and equipment inventory records will be used to record the equipment used.

5. Are all of the test sets similar?

A. Yes. All of the samples and test sets have been ultrasonically validated. The test sets do differ from sample to sample in the number and types of flaws that may be in any single sample. Each set is equally challenging and unique to the thicknesses, diameters and materials outline above.

6. What happens if I do not finish the test in the prescribed time?

A. Candidates that fail to complete the examination in the allotted time will be considered unsuccessful. Future attempts will require a complete re-test.

7. Is there anything beneficial I can do prior to the start of testing?

A. Yes. The Test Candidate shall become thoroughly familiar with the Test Protocol. In addition, Scan Plan plots, or computer simulation sketches or drawings **shall** be developed prior to the PDQ Examination and submitted at the beginning of the examination.

B. Additionally, equipment inventory records shall be completed for the Phased Array system used. Calibration records may be completed and documented in advance.

8. Do I have to provide proof of identity?
- A. Yes. A driver's license with picture or an equivalent proof of identification is necessary.
9. Are calibration blocks supplied for the PDQ Examination?
- A. No. All reference and basic calibration blocks will be supplied by the Test Candidate
10. Can I leave the facility during lunch?
- A. No. Once testing has started the security requirements are put in place. Candidates are encouraged to bring lunch.

### *Addendum 1*

#### Planar Flaws-Surface Connected

<b>Lack of Penetration-LOP</b>	A planar flaw at the ID root area due to insufficient weld penetration.
<b>Inside Diameter Crack-IDC</b>	A planar flaw at the ID surface of the plate or pipe component which may be either a single vee or a double vee welded joint.
<b>Outside Diameter Crack-ODC</b>	A planar flaw at the OD surface of the plate or pipe component which may be either a single vee or a double vee welded joint.
<b>Transverse Crack</b>	A planar flaw at the ID surface which is transverse to the length of the of the plate or pipe weld of a single vee or a double vee welded joint.

#### Volumetric Flaws- Not Surface Connected

<b>Lack of Fusion-LOF</b>	An area of non fusion located between the weld beads along the weld joint preparation bevel
<b>Slag</b>	A non-metallic inclusion which is rounded and lies in the area of the mid volume of the weld. This flaw is only characteristic of the carbon steel test samples
<b>Porosity</b>	A group of rounded gas pores which lie in the area of the mid area of the weld volume
<b>Mid Wall Crack-MDC</b>	A planar flaw at the mid-wall volume in a 1 inch thick double vee welded joint of the plate weld sample