Duquesne Light

NUCLEAR CONSTRUCTION DIVISION PROCEDURE

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TITLE

ASME SECTION XI
INTEGRATED PRESERVICE
INSPECTION PROGRAM

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1.0 PURPOSE AND SCOPE

The purpose of this document is to provide the Preservice Inspection (PSI) Program for piping systems, components, and supports installed at Beaver Valley Power Station - Unit No. 2 (BVPS-2). This Program has been written to meet the requirements specified by the Code of Federal Regulations 10CFR50.55a; 10CFR50 Appendix J; and DLC Positions to applicable USNRC Regulatory Guides specified herein. It also incorporates BVPS-2 Final Safety Analysis Report (FSAR) commitments for PSI.

2.0 APPLICABILITY

This integrated PSI Program is applicable to BVPS-2 during the Design/Construction Phase.

3.0 REFERENCES

3.1 Code of Federal Regulations

a. Title 10, Section 50.55a, "Codes and Standards" (Current)

b. Title 10, Section 10CFR50, Appendix J, "Primary Reactor Containment Leakage Testing for Water-Cooled Power Reactors" (Current)

3.2 BVPS-2 FSAR

a. Section 3.2.2, "System Quality Group Classifications" (Amendment 5)
b. Section 3.6, "Protection Against Dynamic Effects Associated with the Postulated Rupture of Piping" (Amendment 4)
c. Section 5.2.4, "Inservice Inspection and Testing of Reactor Coolant Pressure Boundary" (Amendment 2)
d. Section 5.3.1.3, "Special Methods for Nondestructive Examination" regarding Reactor Vessel NDE (Amendment 3)
e. Section 5.4.1.5.2, "Fabrication and Inspection" regarding Reactor Coolant Pump Flywheel NDE (Amendment 2)
f. Section 5.4.2.2, "Steam Generator Inservice Inspection" (Amendment 3)
g. Section 6.6, "Inservice Inspection of ASME Code Class 2 and 3 Components" (Amendment 5)

3.3 USNRC Regulatory Guides

a. R.G. 1.14, "Reactor Coolant Pump Flywheel Integrity" (Rev. 1) and BVPS-2 Licensing Position to R.G. 1.14, Rev. 1

b. R.G. 1.83, "Inservice Inspection of Pressurized Water Reactor Steam Generator Tubes" (Rev. 1) and BVPS-2 Licensing Position to R.G. 1.83, Rev. 1

c. R.G. 1.147, "Inservice Inspection Code Case Acceptability, ASME Section XI, Division 1 (Rev. 2) and BVPS-2 Licensing Position to R.G. 1.147, Rev. 2

d. R.G. 1.150, "Ultrasonic Testing of Reactor Vessel Welds During Preservice and Inservice Examinations" (Rev. 1) and BVPS-2 Licensing Position to R.G. 1.150, Rev. 1

3.4 ASME Section XI Code, "Rules for Inservice Inspection of Nuclear Power Plant Components"

a. PSI Basis Code (80W80)
b. Table IWF-2500-1 (80W81) and IWA-2300 (80W81)
c. IWC-1220; Table IWC-2520, CF and CG

3.5 Duquesne Light Company Procedures/Plans

a. NCDP 1.13, "Preservice and Inservice Inspection Programs" (Rev. 0)
b. NCDP 2.13.1, "ASME Section XI Repair and Replacement Plan" (Rev. 1)
c. NCDP 2.13.2, "ASME Section XI Preservice Inspection Plan for Class 3 Pressure Retaining Components" (Rev. 0)
d. NCDP 2.13.3, "ASME Section XI Preservice Inspection Plan for Component Supports" (Rev. 0)
e. NCDP 2.13.4, "ASME Section XI Preservice Inspection Plan for Snubbers" (Rev. 0)
f. DLC Specification No. NDS-0064, "Preservice Eddy Current Inspection of the BVPS Unit 2 Steam Generators" (Rev. 0)
g. NDE/ADMIN-6, "ASME Section XI Preservice Inspection Site Quality Control Plan"
h. OSUM Chapter 24, "ASME Section XI Pump and Valve Test Plan"
i. DLC Design and Construction Quality Assurance Program, Appendix C

3.6 Other Project Procedures/Plans

a. Westinghouse Plan: DMW-PSI-100, "Beaver Valley Unit No. 2 Preservice Examination Program Plan (EPP)
b. Westinghouse Procedure: DMW-ISI-101, "Preservice and Inservice Inspection Documentation"
c. Westinghouse Procedure: DMW-ISI-154, "Preservice and Inservice Examination in Reactor Vessel"
d. Westinghouse Procedure: DMW-ISI-47, "Manual Ultrasonic Examination of Welds in Vessels"
e. Westinghouse Procedure: DMW-ISI-206, "Manual Ultrasonic Examination of Welds"
f. Westinghouse Procedure: DMW-ISI-147, "Manual Ultrasonic Examination of Welds in Reactor Vessel"

4.0 DEFINITIONS

The definitions identified in ASME Section XI, Subsubarticle IWA-2110 are invoked by this PSI Program.

5.0 ORGANIZATION AND RESPONSIBILITIES

5.1 Responsibilities

5.1.1 Quality Assurance (QA) Manager

The QA Manager is responsible to the Nuclear Group Vice President for the overall administration of the PSI Program during the Design/Construction Phase, including the assignment of the PSI Program director.

5.1.2 PSI Program director

The PSI Program director is responsible for overall direction and coordination of the PSI Program during the Design/Construction Phase, including establishing assurance of compatibility of the PSI Program with the ISI functions.

5.1.3 PSI Site supervisor

The Site supervisor is responsible to the PSI Program director for on-site coordination with interfacing organizations during the development and implementation of the PSI Program during the Design/Construction Phase.

5.1.4 Engineering Department, Nuclear Construction Division (NCD)

The NCD Engineering Department, through the Engineering Manager, is responsible for the technical support in the preparation of the PSI program. Included in these responsibilities are: assignment of Engineering personnel to the PSI Program Team, coordination of Technical Consulting Services, technical approval of Repair/Replacement Plan activities, and technical interface with DLC Licensing for submittals of PSI Program documents to the NRC.

5.1.5 PSI Program Team

The PSI Program Team, chaired by the PSI Program director, is comprised of a working group of representatives from DLC organizations involved in the development and implementation of the PSI Program. These representatives include: the Site supervisor, QA, Site Quality Control (SQC), Start-Up, and Engineering.

5.2 Organization

5.2.1 The PSI Program Functional Organization is shown in Figure 2.13-1. Included in this figure are interfacing organization and major functional responsibilities.

5.2.2 The PSI Program Document Matrix, shown in Figure 2.13-2 identifies program plans, procedures (by type), and organizations responsible for development and implementation of these plans and procedures.

6.0 PRESERVICE INSPECTION PROGRAM

6.1 General Requirements and Basis for PSI Program

6.1.1 Definition of Owner's Intent

In accordance with the requirements set forth in 10CFR50.55a, BVPS-2 must comply with requirements of the 1971 Edition of Section XI, with addenda through Winter 1972. In order to comply with more recent codes and addenda, Duquesne Light Company (DLC) has elected to comply with the 1980 Edition of Section XI, with addenda through Winter 1980 (80W80); hereafter referred to as the "Code" or "Section XI".

10CFR50.55a allows use of the 1980 Edition of Section XI, with addenda through Winter 1981 (80W81). However, since the 80W80 code has already been committed to by the BVPS-2 FSAR and other plant documents, DLC has elected to utilize the 80W80 code and addenda as the PSI Basis document for the overall Section XI Program. R.G. 1.147, Rev. 2 may be utilized by DLC as applicable (Reference 3.3.c).

6.1.2 System Boundaries Subject to Inspection

The boundaries of Code Class 1, 2, and 3 systems subject to inspection by the Rules of Section XI are defined in accordance with the BVPS-2 FSAR (Reference 3.2.a). Safety classes of components in the fluid system boundaries are included in Table 3.2.1 of the FSAR. The system flow diagrams, as well as piping system isometric drawings, identify these class breaks. Flow diagrams are contained in the FSAR. Unless otherwise noted, Quality Group A is equivalent to Class 1, Group B is equivalent to Class 2, and Group C is equivalent to Class 3.

In accordance with IWA-2200, the preservice examinations of Class 1, 2, and 3 components will conform with those invoked by IWB, IWC, and IWD-2500 of Section XI. Class 1, 2, and 3 component supports identified as ASME Section III, Subsection NF will be examined in accordance IWF-2500 and Section 6.7 of this Program. Non-NF component supports which were designed and fabricated to the "code in effect" prior to 71W73 ASME III will be examined in accordance with Section 6.7 of this Program.

6.1.3 Pump Testing

Class 1, 2, and 3 pumps will be tested in accordance with Section 6.8 of this Program.

6.1.4 Valve Testing

Class 1, 2, and 3 valves will be tested in accordance with Section 6.9 of this Program.

6.1.5 Accessibility

Provisions for accessibility to perform PSI examinations are in accordance with Section XI, IWA-1500. Any accessibility limitations will be identified as they are encountered by specific relief request.

6.1.6 Examination Procedures

Preservice inspection on BVPS-2 will be performed using procedures which comply with the requirements of IWA-1400(d), (e), (h), (i), (m), (o), and IWA-2200. Written procedures prepared by outside or Contractor NDE organizations require review and approval by DLC prior to use. Volumetric, surface, and visual methods of examination are generic terms, each permitting a selection of techniques and procedures as allowed by Section XI.

6.1.6.1 Visual Examination

Visual examinations required by Section XI will be performed using procedures which satisfy IWA-2210. Direct visual methods will be used to the extent practical. However, remote visual examinations may be used.

6.1.6.2 Surface Examination

Surface examinations required by Section XI will be performed using techniques which comply with the requirements of IWA-2220.

6.1.6.3 Volumetric Examination

A. Volumetric examinations required by Section XI will be performed in accordance with IWA-2230 using manual ultrasonic (UT) techniques in most cases. Required volumetric examination of reactor vessel welds will be performed using an automated UT device (Reference 3.6.c), with limited usage of manual ultrasonic examination (Reference 3.6.f). Refer to Paragraph 6.1.11.1 of this procedure for limitations applying to ultrasonic examinations.

B. Steam generator tubing will be examined using the eddy current method (Reference 3.5.f)

6.1.6.4 Alternative and Supplemental Examinations

A. General

In accordance with IWA-2240, alternative examination methods, a combination of methods, or newly developed techniques may be substituted for the methods specified in Section XI, provided the Authorized Nuclear Inservice Inspector (ANII) concurs that the results are demonstrated to be equivalent or superior to those of the specified method.

Visual examinations that detect surface flaws shall be supplemented by either surface or volumetric examinations for Class 1, as allowed by IWb-3200. When further evaluation of results is necessary, other NDE methods may be employed to supplement the required examinations.

6.1.7 Personnel Qualification

Personnel performing nondestructive examination (NDE) operations shall be qualified in accordance with IWA-2300 of Section XI. Outside organizations and other personnel available within DLC may be qualified to later Editions/Addenda of Section XI and may be utilized to perform NDE for BVPS-2. DLC recognizes the existence of the 80W81 Section XI invoking certification of NDE personnel to the 1980 Edition of SNT-TC-1A (versus the 1975 Edition invoked by the above) and will accept certification of personnel to this later code.

For those NDE methods (e.g. VT-1) not covered by SNT-TC-1A documents, training and qualification shall be of comparable levels of competency by utilization of comparable examinations on the particular method involved. Other NDE personnel qualification (e.g. VT-2, VT-3, VT-4, and Test Functions) will be performed in accordance with the DLC Site Quality Control Training Manual through the DLC NDE/ADMIN-6, "ASME Section XI Preservice Inspection Site Quality Control Plan" (Reference 3.5.g), hereafter referred to as the SQC Plan.

6.1.8 Recording/Characterization of Indications

All recordable indications will be recorded and investigated by a Level II or Level III examiner.

Flaw indications will be characterized in accordance with IWA-3300.

In accordance with the requirements of IWA-1400(h), IWA-6220, and IWB-3112, indications are to be recorded in terms of location, size, shape, orientation, and distribution within the component. This recording requirement also applies to ultrasonic indications of geometric or metallurgical origin determined in accordance with IWB-3514.5.

6.1.9 Evaluation and Reporting of Results

6.1.9.1 Flaw indications detected during PSI will be evaluated in accordance with IWB-3000. Supplemental examinations may be used to assist in determination of location, size, shape, and orientation of a flaw indication. Results of all examinations will be noted as Reportable Indication (RI), No Reportable Indication (NRI), or No Indication (NI), as defined in the SQC Plan (Reference 3.5.g).

6.1.9.2 If the disposition of a flaw indication identifies a defect which requires repair or replacement of the component containing the defect, such activities will be performed under a Plan (described in Paragraph 6.3) regarding Repairs and Replacements, after which it will be re-examined. The disposition of all defects, their repair, and the re-examination results shall be subject to review by the ANII.

6.1.10 Calibration

6.1.10.1 Instrumentation/Equipment

Instrumentation/equipment calibration shall be defined in the applicable DLC approved procedure(s).

6.1.10.2 Calibration Standards/Calibration Blocks

Calibration standards/calibration blocks shall comply with the appropriate Code Article to the extent practicable. When DLC encounters problems in Code Compliance regarding material availability or physical size, etc., the actual or as-built calibration standard will be demonstrated acceptable in accordance with IWA-2240. Calibration standards shall be maintained by DLC.

6.1.11 Exemptions and Limitations

The following exemptions from, and limitations to examination requirements are applicable to Class 1, 2, and 3 components, and their supports:

6.1.11.1 Limitation on UT Examination of Austenitic Materials

Material properties (e.g. grain structures) may limit capabilities to ultrasonically examine austenitic stainless steel materials. Results of NRC sponsored studies on UT inspectability may be used to assess the scope and extent of the problem. Limitations to examinations employed will be noted in the record of examinations.

6.1.11.2 Personnel Qualifications

Inspection personnel qualifications to SNT-TC-1A, 1980 are allowed in lieu of SNT-TC-1A, 1975 qualifications required by this Code.

6.1.12 Hydrostatic Testing

An ASME Section XI Preservice hydrostatic test is not required in accordance with IWA-5215. All components will have undergone an ASME III system hydrostatic test when the system has been certified by N-5 Data Report.

The visual examination requirements for ASME Section XI (VT-2) are met by the hydrostatic test and accompanying visual examination performed in accordance with ASME Section III.

6.2 QUALITY ASSURANCE

The PSI Program will be in compliance with the requirements of the DLC Design and Construction Quality Assurance Program, Appendix C (Reference 3.5.i), which complies with Appendix B of 10CFR50.

6.3 REPAIR AND REPLACEMENT PLAN

6.3.1 The Repair and Replacement Plan will be in accordance with DLC Procedure NCDP 2.13.1 (Reference 3.5.b) which implements Section XI, IWA-4000 and IWA-7000.

6.3.2 This Plan establishes the criteria, functions, assignment, and responsibilities of DLC organizations, interfacing other site outside organizations, and personnel involved in repair and replacement performed to the requirements of ASME Section XI during the Design/Construction Phase.

6.3.3 This Plan includes repair and replacement of any piping system and associated supports which have been fully certified on an N-5 Data Report and for any component and associated supports constructed to ASME Section III, Class 1, 2, 3, MC, and Code "N" or "NV" stamped.

6.4 REQUIREMENTS FOR CLASS 1 COMPONENTS

6.4.1 General Requirements for Class 1 Components

The preservice examinations of Class 1 components will be performed in accordance with IWB-2200 and IWB-2500 and will be those examinations identified in Table IWB-2500-1. Specific examinations under each examination category are identified by an item number which directly correlates to Table IWB-2500-1. Specific equipment to be examined is listed in DMW-PSI-100, "Beaver Valley Unit No. 2 Preservice Examination Program Plan (EPP)" (Reference 3.6.a), hereafter referred to as the EPP. In accordance with IWB-2100, the examinations shall be witnessed or otherwise verified by the ANII.

6.4.2 Exemptions and Limitations

Components will be exempted in accordance with IWB-1220 from volumetric and surface examination requirements identified in IWB-2500.

In Table IWB-2500-1, Categories B-L-2 and B-M-2 require a VT-3 examination of internal surfaces for pump casings and valve bodies exceeding 4-inch nominal pipe size. The final manufacturing Quality Assurance data from the Supplier, and/or final site assembly Quality Assurance documents will be acceptable as preservice inspection data for these items per IWB-2200(b). This data will be retrievable from QA Records, and will be included in the PSI Report.

6.4.3 Reactor Vessel Examination

6.4.3.1 The automatic and manual ultrasonic examination of the Reactor Vessel are identified in the EPP and the UT examinations incorporate the DLC Licensing Position on R.G. 1.150, Rev. 1 (Reference 3.3.d). The EPP identifies each UT examination area by Table IWB 2500-1 item number, category, and specific description.

6.4.3.2 Procedure DMW-ISI-154, "Preservice and Inservice Examination in Reactor Vessel" (Reference 3.6.c) describes the equipment, calibration sequence, examination techniques, and specific recording requirements for preservice UT inspection using the remotely operated inspection tool.

6.4.3.3 Procedure DMW-ISI-147, "Manual Ultrasonic Examination of Welds in Reactor Vessel" (Reference 3.6.f) defines requirements for manual UT examination of applicable portions of the Reactor Vessel, identified in the EPP.

6.4.3.4 Surface and visual examination requirements and procedures utilized for the Reactor Vessel are identified in the EPP.

6.4.4 Examination of Pressure Retaining Boundary for Class 1 Pumps, Valves, and Vessels

6.4.4.1 Procedure DMW-ISI-47, "Manual Ultrasonic Examination of Welds in Vessels" (Reference 3.6.d) defines the requirements for manual ultrasonic examination of full penetration longitudinal and circumferential pressure retaining welds in ferritic vessel material (wrought or cast) greater than 2 inches thick. This procedure applies to portions of the Pressurizer and Steam Generator as identified in the EPP.

6.4.4.2 Procedure DMW-ISI-206, "Manual Ultrasonic Examination of Welds" (Reference 3.6.e) defines the requirements for manual ultrasonic examinations of full penetration circumferential and longitudinal butt welds and adjacent base materials of these and fillet or corner welds. It is applicable to such welds in piping systems (.25 inch to 6 inches thick) and vessel material (.25 to 2 inches thick) in ferritic or austenitic steels of either wrought or cast product forms.

6.4.4.3 The EPP identifies the specific applicability of UT examinations for vessels, as well as identifies specific surface examinations for vessels, pumps, and valves.

6.4.5 Class 1 Piping Examination

6.4.5.1 Procedure DMW-ISI-206 (Reference 3.6.e) will be utilized to perform manual UT examinations of Class 1 piping welds as specifically identified in the EPP.

6.4.5.2 The EPP identifies the specific applicability f·· surface examination for Class 1 piping welds.

6.4.6 Bolting Examination

The EPP identifies specific volumetric and surface examinations for bolting (including studs).

6.4.7 Steam Generator Tube Examination

DLC will perform Preservice Inspection on 100% of the steam generator tubing using eddy current techniques. This inspection will be performed after completion of the field hydrostatic test and prior to initial power operation. Steam generator tubing examination will comply with the DLC Position on USNRC Regulatory Guide 1.83, Revision 1. (Reference 3.3.b).

Specific requirements for steam generator tubing eddy current examination will be provided by DLC Specification No. NDS-0064, "Preservice Eddy Current Inspection of the BVPS Unit 2 Steam Generators" (Reference 3.5.f).

6.4.8 Augmented Inspections and Examinations

6.4.8.1 Reactor Coolant Pump Flywheels

Although not part of a pressure boundary, the Reactor Coolant Pump flywheels will receive an inspection in accordance with the DLC Position on USNRC Regulatory Guide 1.14, Revision 1 (Reference 3.3.a). Preservice inspection will consist of an insitu ultrasonic examination of the flywheel. This examination is limited to an interrogation of bore and keyway which will be performed from the flywheel gage holes and the periphery of each flywheel plate. A magnetic particle or liquid penetrant inspection of the machine finished bores and keyways will be performed if the flywheel is disassembled from the motor. The vendor shop records may serve to provide the preservice baseline data record, if available. Volumetric and surface examinations will be performed by procedures identified in the EPP.

6.5 REQUIREMENTS FOR CLASS 2 COMPONENTS

6.5.1 General PSI Requirements for Class 2 Components

The preservice examinations of Class 2 components will be performed in accordance with IWC-2200 and IWC-2500, except for piping welds in the Residual Heat Removal (RHR), Emergency Core Cooling (ECC), and Containment Heat Removal (CHR) Systems. As required by 10CFR50.55a(b)(2)(iv), the piping welds in these systems will be determined by the requirements of Paragraph IWC-1220; and examined to the extent defined in IWC-2100 and Table IWC-2520, Examination Categories C-F and C-G, of the 74S75 Code. Specific examinations under each examination category are identified by an item number in Table IWC-2500-1 (80W80 Code). Specific equipment to be examined is listed in the EPP.

6.5.2 Exemptions and Limitations

Components, except those identified by the Augmented Inspection below, will be exempted in accordance with IWC-1220 of the applicable Code.

6.5.3 Examination of Pressure Retaining Boundary for Class 2 Pumps, Valves, and Vessels

6.5.3.1 Procedure DMW-ISI-47 (Reference 3.6.d) and DMW-ISI-206 (Reference 3.6.e) are applicable for UT Examination of Class 2 Vessels.

6.5.3.2 The EPP identifies the specific applicability for surface examination for pumps, valves, and vessels.

6.5.4 Class 2 Piping Examination

6.5.4.1 Procedure DMW-ISI-206 (Reference 3.6.e) is applicable for UT Examination of Class 2 piping welds.

6.5.4.2 The EPP identifies the specific applicability for surface examination for Class 2 piping welds.

6.5.5 Bolting Examination

The EPP identifies specific volumetric examinations for bolting (including studs).

6.5.6 Augmented Inspections and Examinations

6.5.6.1 In accordance with the requirements of the FSAR (References 3.2.b and 3.2.g), those portions of non-exempt systems identified by Paragraph 6.5.1 above, which are at containment penetrations, will receive a 100% volumetric examination. This inspection will apply to high energy piping components defined as those which are required to operate above 275 psig or above 200°F. The extent of examination will be applicable to those welds inside and outside containment between and including the containment isolation valves. Specific equipment to be examined is listed in the EPP.

6.6 Requirements for Class 3 Components

6.6.1 General PSI Requirements for Class 3 Components

The preservice examinations of Class 3 components will be performed in accordance with IWD-2100 and IWD-2600, and will be those examinations identified in Table IWD-2500-1. Specific examinations under each examination category are identified by an item number in Table IWD-2500-1. Specific equipment to be examined is listed in DLC Procedure NCDP 2.13.2, "ASME Section XI Preservice Inspection Plan for Class 3 Pressure Retaining Components" (Reference 3.5.c) and the examination will be implemented in accordance with the DLC SQC Plan (Reference 3.5.g).

6.6.2 Exemptions and Limitations

Integral attachments of supports and restraints for components will be exempted in accordance with IWD-1220.

6.7 Component Supports

6.7.1 General PSI Requirements for Class 1, 2, and 3 Component Supports

Although the BVPS-2 Plant Design Basis for component supports is not to ASME Section III Subsection NF, some component supports "Code in Effect" are later than W73 Addenda, therefore, both NF and Non-NF applications are addressed in this PSI Program. Both NF and Non-NF supports will receive a preservice examination in accordance with Subsection IWF. At DLC discretion, the Construction Code may be utilized for final acceptance of Non-NF supports.

Supports will receive a preservice examination in accordance with IWF-2500 which invokes the examination categories and methods of examinations listed in Tables IWF 2500-1 and IWF-2500-2. However, for consistency with the Class 1, 2, and 3 tables, examination categories and item numbers will be those shown in Table IWF-2500-1 of the 80W81 Code. Specific equipment to be examined for component supports and snubbers is listed in DLC Procedures NCDP 2.13.3 and 2.13.4 (References 3.5.d and 3.5.e) and the examination will be implemented in the DLC SQC Plan (Reference 3.5.g).

6.7.2 Exemptions and Limitations

6.7.2.1 Component supports (except snubbers) exempt from examination shall be those supports of the Class 1, 2, and 3 components which are exempted by the rules of Section XI, Subsections IWB, IWC, and IWD, respectively.

6.7.2.2 Snubber testing is required in accordance with Article IWF-5000. The final manufacturing Quality Assurance data from the Supplier, and/or final site assembly Quality Assurance documents will be acceptable as Preservice Inspection data in accordance with IWF-5200, as defined in DLC Snubber Plan (Reference 3.5.e).

6.8 PUMP TESTING

6.8.1 PSI Requirements for Pump Testing

Class 1, 2, and 3 pumps will be tested in accordance with IWP-3000 and IWP-4000 of Section XI, and OSUM Chapter 24, "ASME Section XI Pump and Valve Test Plan (Reference 3.5.h) to measure or observe the following:

- Speed
- Inlet Pressure
- Differential Pressure
- Flow Rate
- Vibration Amplitude
- Proper Lubricant Level or Pressure
- Bearing Temperature

Specific pumps to be tested are as referenced in the Pump Portion of this Plan (Reference 3.5.h), as well as the listing of Pump Testing Procedures, methods of Pump Test Data Collection, Pump Data Review, and Records retention and retrieval.

6.8.2 Exemptions and Limitations

Exemptions and limitations identified in the Pump Testing Portion of this Plan are in compliance with IWP-1200.

6.9 VALVE TESTING

6.9.1 PSI Requirements for Valve Testing

Class 1, 2, and 3 valves will be tested in accordance with IWV-3000 and OSUM Chapter 24, "ASME Section XI Pump and Valve Test Plan (Reference 3.5.h) to measure or observe the following:

- Valve Operability (excluding check valves) Testing
- Valve Leak Rate Testing
- Safety Valve and Relief Valve Set Points Testing
- Check Valve Operability Testing

6.9.2 Augumented Valve Testing Requirements

In accordance with 10CFR50, Appendix J, the primary reactor containment shall comply with the containment leakage test requirements as specified in this Appendix. The PSI Program will include Type C testing of valves in accordance with Appendix J, Section III.C.

6.9.3 Specific valves to be tested are as referenced in the valve portion of this Plan (Reference 3.5.h), as well as the listing of valve testing procedures and methods of: Valve Data Collection, Valve Data Review, and Record retention and retrieval.

6.9.4 Exemptions and Limitations

Exemptions and limitations identified in the Valve Testing Portion of this Plan are in compliance with IWV-1200.

6.10 PSI PROGRAM RELIEF REQUESTS

In accordance with the requirements of 10CFR50.55a(g), as clarified by the NRC in "Guidance for Preservice and Inservice Inspection Program and Relief Requests Pursuant to 10CFR50.55a(g)", Relief Requests will be identified during PSI examinations, prepared in accordance with the NRC format (referenced above), and submitted subsequent to the examination. Where Relief Requests are identified prior to the PSI examination, the submittal will be made prior to the examination whenever possible.

7.0 RECORDS AND DATA MANAGEMENT

7.1 Records of the Preservice Inspection Plan; schedules; calibration standards; examination results and reports; and corrective actions required and taken, will be developed and maintained at BVPS-2 in accordance with IWA-6000 of Section XI and ANSI N45.2.9-1974, as identified in DLC PSI specific Plans (References: 3.5.b, 3.5.c, 3.5.d, 3.5.e, 3.5.f, 3.5.g, and 3.5.h).

7.2 The general examination documentation for Class 1 and Class 2 components will be in accordance with the vendor approved documentation program which has been reviewed and approved by DLC.

8.0 FIGURES AND ATTACHMENTS

8.1 FIGURES

8.1.1 Figure 2.13-1, "Preservice Inspection Program Functional Organization"

8.1.2 Figure 2.13-2, "Preservice Inspection Program Document Matrix"

PRESERVICE INSPECTION PROGRAM
FUNCTIONAL ORGANIZATION

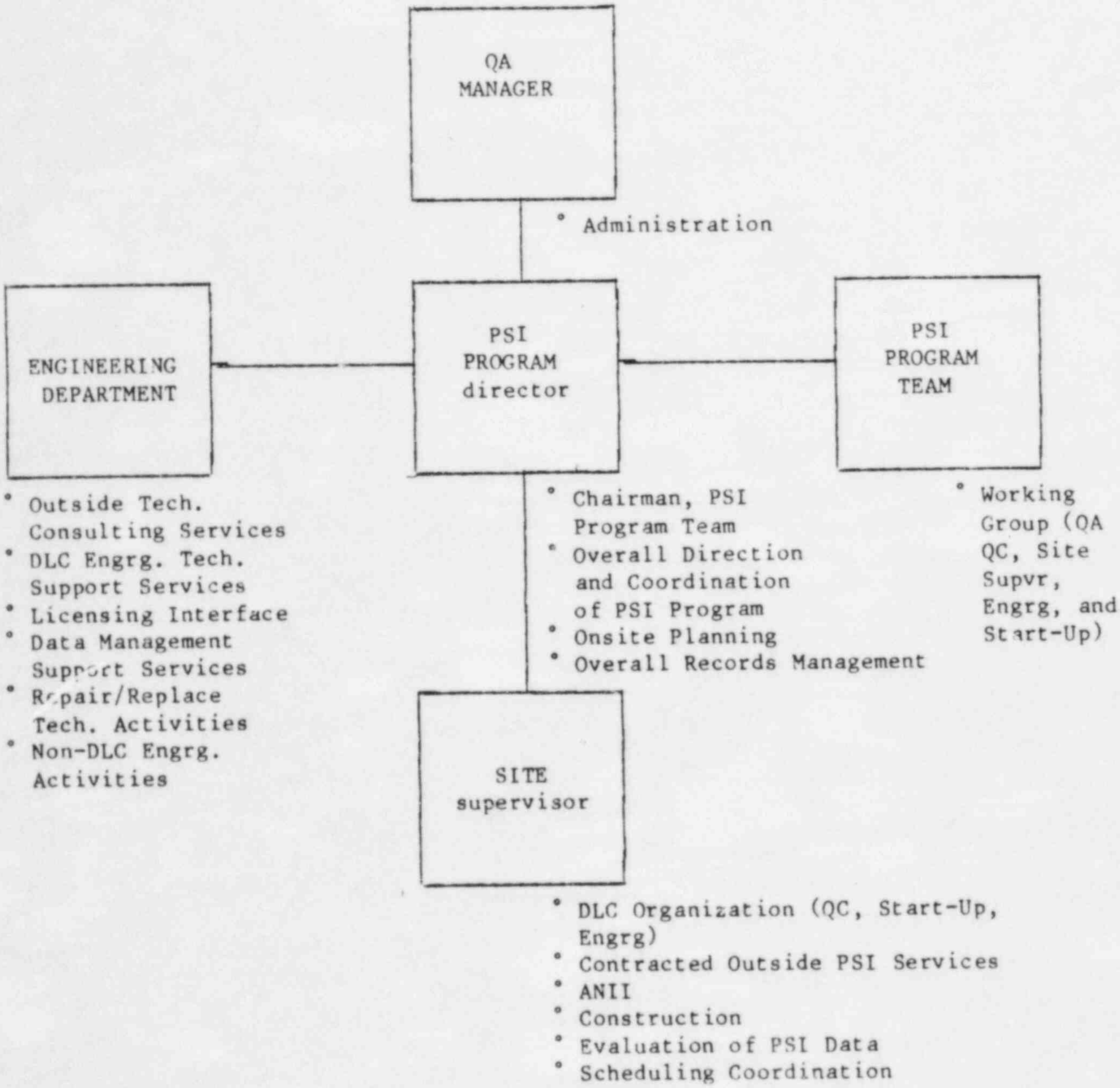
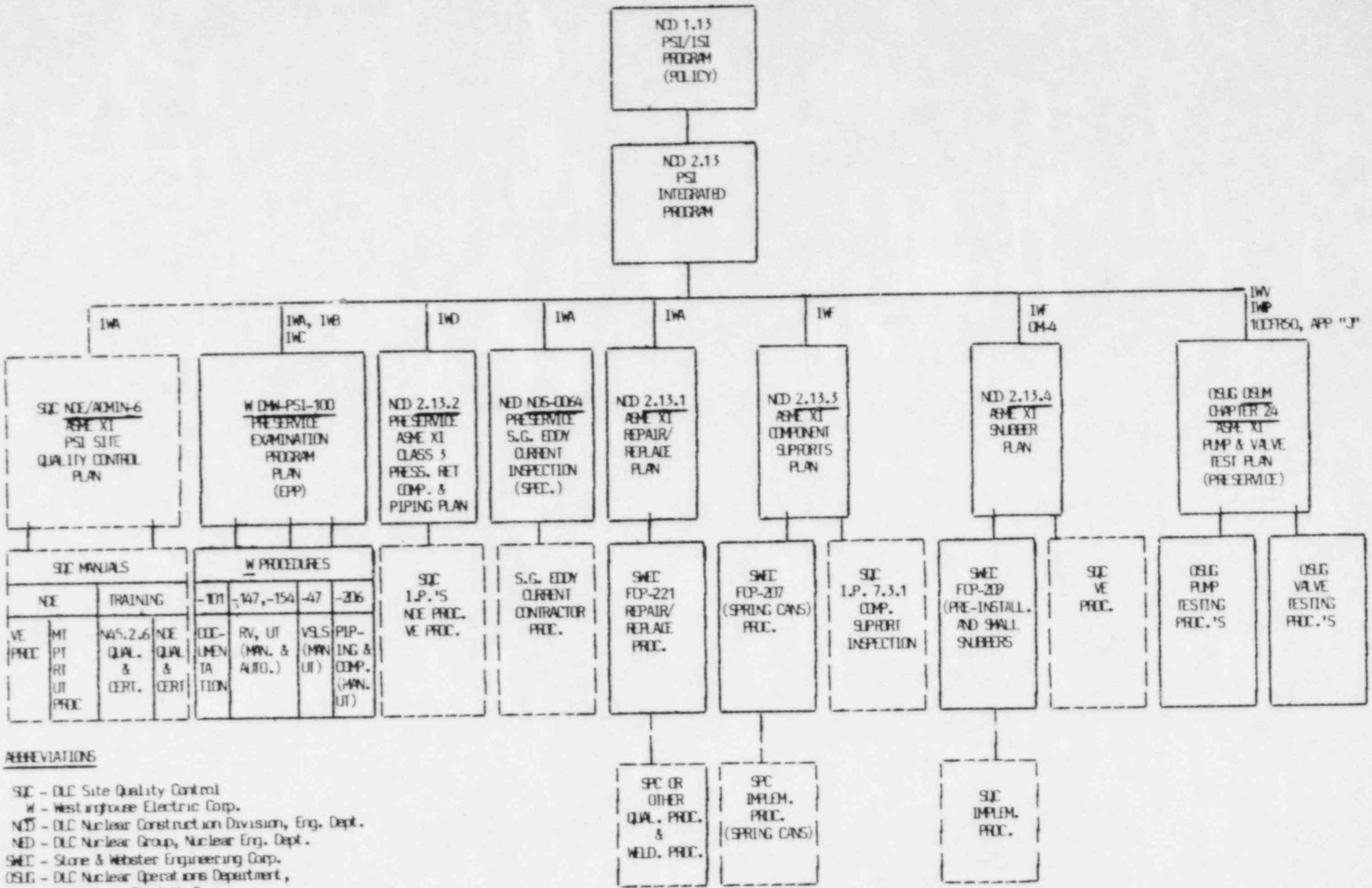


FIGURE 2.13-1
(From Procedure 1.13)

NOTE: Listing under the above organization elements represent functions and interface

PRESERVICE [illegible]CTION PROGRAM
DOC[illegible] MATRIX



ABBREVIATIONS

SQC - DLC Site Quality Control
W - Westinghouse Electric Corp.
NCD - DLC Nuclear Construction Division, Eng. Dept.
NED - DLC Nuclear Group, Nuclear Eng. Dept.
SWEC - Stone & Webster Engineering Corp.
OSUG - DLC Nuclear Operations Department, Operations Start-Up Group
SPC - Schneider Power Corp. (Piping Contractor)
FCP - Field Construction Procedure
I.P. - Inspection Plan

Figure 2.13-2

BEAVER VALLEY UNIT NO. 2

PRESERVICE EXAMINATION PROGRAM PLAN (EPP)

DMW-PSI-100

Reviewed By: R. M. Johnson 6/12/84
PSI Coordinator

Approved By: [signature] 6/22/84
Inspection Service Manager

Reviewed By: [signature] 6/20/84
W Product Assurance

6/22/84

PRESERVICE EXAMINATION PROGRAM PLAN

Scope of Examinations

The ASME Boiler and Pressure Vessel Code Section XI examinations for Class 1 and Class 2 components will be performed in accordance with the attached listing of items. The requirements of the 1980 Edition up to and including Winter 1980 Addenda will be implemented using the following examination procedures.

PROCEDURE NUMBER	TITLE
DMW-ISI-101	Preservice and Inservice Inspection Documentation
DMW-ISI-8	Visual Examination Procedure
DMW-ISI-10	Qualification of Ultrasonic Manual Equipment
DMW-ISI-11	Liquid Penetrant Examination Procedure
DMW-ISI-15	Ultrasonic Examination of Studs, Bolts and Nuts
DMW-ISI-41	Manual Ultrasonic Testing of Reactor Coolant Pump Flywheels
DMW-ISI-47	Manual Ultrasonic Examination of Welds in Vessels
DMW-ISI-70	Magnetic Particle Examinations
DMW-ISI-147	Manual Ultrasonic Examination of Welds in Reactor Vessel
DMW-ISI-154	Preservice and Inservice Examination of Reactor Vessels
DMW-ISI-206	Manual Ultrasonic Examination of Welds

NOTE: The revision number of NDE Procedures will be stated prior to the start of examinations and the revision of each DMW sketch will be noted in the PSI Final Report.

DUQUESNE LIGHT COMPANY

Beaver Valley Nuclear Power Plant Unit No. 2

Preservice Examination Program Plan

All items listed below are to be examined, as indicated, in accordance with the requirements of the 1980 Edition Section XI of the ASME Boiler and Pressure Vessel Code up to and including Winter 1980 Addenda to the extent practical with the access provided and the limitations of component geometry.

PROGRAM ITEM	IWB-2500-1 REFERENCE	AREA TO BE EXAMINED	EXAMINATION PROCEDURE			SKETCH REFERENCE
			Vol	Sur.	Vis.	
		REACTOR VESSEL				
	B1.10	Shell Welds				
1.	B1.11	Circumferential Welds 2,3 and 4	154	--	--	1-1100
2.	B1.12	Longitudinal Welds 6,7,8,9 10,11 and 12	154	--	--	1-1100
	B1.20	Head Welds				
3.	B1.21	Circumferential Weld 5	147	--	--	1-1100
4.	B1.22	Meridional Welds 13,14,15 and 16	147	--	--	1-1100
5.	B1.30	Flange to Vessel Weld 1	154	--	--	1-1100
6.	B1.40	Closure Head to Flange Weld 1	147	70	--	1-1300
	B1.50	Repair Welds				
7.	B1.51	Beltline Region	(1)	--	--	1-1100
8.	B3.90	Outlet Nozzle to Vessel Welds 17,19 and 21	154	--	--	1-1100
9.	B3.90	Inlet Nozzle to Vessel Welds 18,20 and 22	154	--	--	1-1100
10.	B3.100	Outlet Nozzle Inside Radius Section - For welds 17,19 and 21	154	--	--	1-1100
11.	B3.100	Inlet Nozzle Inside Radius Section - For welds 18,20 and 22	154	--	--	1-1100

PROGRAM ITEM	IWB-2500-1 REFERENCE	AREA TO BE EXAMINED	EXAMINATION PROCEDURE Vol.	Sur.	Vis.	SKETCH REFERENCE
		REACTOR VESSEL (cont'd)				
	B4.10	Partial Penetration Welds				
12.	B4.11	Vessel Nozzles	--	--	(2)	--
13.	B4.12	Control Rod Drive Nozzles	--	--	(2)	--
14.	B4.13	Instrumentation Nozzles	--	--	(2)	--
15.	B5.10	Outlet Nozzle to Safe End Butt Weld 1-F1	154/206	11	--	1-4100
16.	B5.10	Outlet Nozzle to Safe End Butt Weld 4-F1	154/206	11	--	1-4200
17.	B5.10	Outlet Nozzle to Safe End Butt Weld 7-F1	154/206	11	--	1-4300
18.	B5.10	Inlet Nozzle to Safe End Butt Weld 3-F4	154/206	11	--	1-4100
19.	B5.10	Inlet Nozzle to Safe End Butt Weld 6-F4	154/206	11	--	1-4200
20.	B5.10	Inlet Nozzle to Safe End Butt Weld 9-F4	154/206	11	--	1-4300
21.	B5.11	Nominal Pipe Size less than 4 inches Nozzle to Safe End Butt Welds	--	(7)	--	--
22.	B5.12	Nozzle to Safe End Socket welds	--	(10)	--	--
23.	B6.10	Closure Head Nuts 1 thru 58	--	70	--	1-1400
24.	B6.20	Closure Head Studs, in place	(12)	--	--	--
25.	B6.30	Closure Head Studs (when removed) 1 thru 58	15	70	--	1-1400
26.	B6.40	Threads in Flange 1 thru 58	154	--	--	1-1100
27.	B6.50	Closure Head Washers 1 thru 58	--	--	8	1-1400
28.	B7.10	Bolts, Studs and Nuts	--	--	(7)	--

PROGRAM ITEM	IWB-2500-1 REFERENCE	AREA TO BE EXAMINED	EXAMINATION PROCEDURE Vol.	Sur.	Vis.	SKETCH REFERENCE
		REACTOR VESSEL (cont'd)				
29.	B7.80	Conoseal Bolting Assemblies 47,49,51 and 53	--	--	8	1-1300
30.	B8.10	Integrally Welded Attachments (Not applicable: See Items 8 & 9)	--	--	--	1-1100
31.	B13.10	Vessel Interior	--	--	8	1-1200
32.	B13.30	Core Support Structures	--	--	8	1-1200
33.	B14.10	Control Rod Drive Mechanism Welds 42 thru 65	--	11	--	1-1300
34.	B15.10	Pressure Retaining Boundary	--	--	(3)	--
35.	B15.11	Pressure Retaining Boundary	--	--	(2)	--
		PRESSURIZER				
	B2.10	Shell to Head Welds				
36.	B2.11	Circumferential Welds 1,3,5 and 7	47	--	--	1-2100
37.	B2.12	Longitudinal Welds 2,4 and 6	47	--	--	1-2100
	B2.20	Head Welds				
38.	B2.21	Circumferential Welds	(10)	--	--	1-2100
39.	B2.22	Meridional Welds	(10)	--	--	1-2100
40.	B3.110	Nozzle to Vessel Welds 9 thru 15	47	--	--	1-2100
41.	B3.120	Nozzle Inside Radius Section for welds 9 thru 15	(9)	--	8	1-2100
42.	B4.20	Heater Penetration Welds	--	--	(2)	--
43.	B5.20	14" Pressurizer Surge Nozzle to Safe End Butt Weld F3	206	11	--	1-4500
44.	B5.20	6" Pressurizer Safety Nozzle to Safe End Butt Weld	206	11	--	1-4501

PROGRAM ITEM	IWB-2500-1 REFERENCE	AREA TO BE EXAMINED	EXAMINATION PROCEDURE Vol.	Sur.	Vis.	SKETCH REFERENCE
		PRESSURIZER (cont'd)				
45.	B5.20	6" Pressurizer Safety Nozzle to Safe End Butt Weld	206	11	--	1-4502
46.	B5.20	6" Pressurizer Safety Nozzle to Safe End Butt Weld	206	11	--	1-4503
47.	B5.20	6" Pressurizer Relief Nozzle to Safe End Butt Weld	206	11	--	1-4504
48.	B5.20	4" Pressurizer Spray Nozzle to Safe End Butt Weld	206	11	--	1-4505
49.	B5.21	Nominal Pipe Size less than 4 inches nozzle to Safe End Butt Welds	--	(7)	--	1-2100
50.	B5.22	Nozzle to Safe End Socket Welds	--	(10)	--	1-2100
51.	B6.60	Bolts and Studs	(7)	--	--	1-2100
52.	B6.70	Flange Surface, when connection disassembled	--	--	(7)	1-2100
53.	B6.80	Nuts, Bushings and Washers	--	--	(7)	1-2100
54.	B7.20	Manway Bolts B1 thru B16	--	--	8	1-2100
55.	B8.20	Integrally Welded Support Skirt Weld 8	206	70	--	1-2100
56.	B15.20	Pressure Retaining Boundary	--	--	(3)	--
57.	B15.21	Pressure Retaining Boundary	--	--	(2)	--
		STEAM GENERATORS 1,2 and 3				
	B2.30	Head Welds				
58.	B2.31	Circumferential Welds	(10)	--	--	1-3100
59.	B2.32	Meridional Welds	(10)	--	--	1-3100

PROGRAM ITEM	IWB-2500-1 REFERENCE	AREA TO BE EXAMINED	EXAMINATION PROCEDURE Vol.	Sur.	Vis.	SKETCH REFERENCE
		STEAM GENERATORS 1,2 and 3 (cont'd)				
60.	B2.40	Channel Head to Tubesheet Welds 1-1, 2-1 and 3-1	47	--	--	1-3100
61.	B3.130	Nozzle to Vessel Welds	(10)	--	--	1-3100
62.	B3.140	Nozzle Inside Radius Section 1A,1B,2A,2B,3A and 3B	(9)	--	8	1-3100
63.	B5.30	Nozzle to Safe End Butt Welds 1-F4 and 2-F1	206	11	--	1-4100
64.	B5.30	Nozzle to Safe End Butt Welds 4-F4 and 5-F1	206	11	--	1-4200
65.	B5.30	Nozzle to Safe End Butt Welds 7-F4 and 8-F1	206	11	--	1-4300
66.	B5.31	Nominal Pipe size less than 4 inches nozzle to safe end Butt Welds	--	(7)	--	1-3100
67.	B5.32	Nozzle to Safe End socket welds	--	(10)	--	1-3100
68.	B6.90	Bolts and Studs	(7)	--	--	1-3100
69.	B6.100	Flange Surface, when connection disassembled	--	--	(7)	1-3100
70.	B6.110	Nuts, Bushings and Washers	--	--	(7)	1-3100
71.	B7.30	Manway Bolting1-B1 thru 1-B32; 2-B1 thru 2-B32 and 3-B1 thru 3-B32	--	--	8	1-3100
72.	B8.30	Integrally Welded Vessel Supports	--	(10)	--	1-3100
73.	B15.30	Pressure Retaining Boundary	--	--	(3)	--
74.	B15.31	Pressure Retaining Boundary	--	--	(2)	--
75.	B16.10	Steam Generator Tubing in Straight Tube design	(10)	--	--	--

PROGRAM ITEM	IWB-2500-1 REFERENCE	AREA TO BE EXAMINED	EXAMINATION PROCEDURE Vol.	Sur.	Vis.	SKETCH REFERENCE
		STEAM GENERATORS 1,2 and 3 (cont'd)				
76.	B16.20	Steam Generator Tubing in U Tube Design	(4)	--	--	--
		PIPING				
77.	B5.50	Nominal Pipe Size greater than 4 inches Dissimilar Metal Butt Welds	(10)	(10)	--	--
78.	B5.51	Nominal Pipe Size less than 4 inches Dissimilar Metal Butt Welds	--	(10)	--	--
79.	B5.52	Dissimilar Metal Socket Welds	--	(10)	--	--
80.	B6.150	Bolts and Studs	(7)	--	--	--
81.	B6.160	Flange Surface, when connection disassembled	--	--	(7)	--
82.	B6.170	Nuts, Bushings and Washers	--	--	(7)	--
83.	B7.50	Bolts, Studs and Nuts	--	--	8	1-4700
	B9.10	Pressure Retaining Welds Nominal Pipe Size greater than or equal to 4 inches				
84.	B9.11	Circumferential Welds	206	11	--	1-4100 to 1-4600
85.	B9.12	Longitudinal Welds	206	11	--	1-4100 to 1-4600
	B9.20	Pressure Retaining Welds Nominal Pipe Size less than 4 inches				
86.	B9.21	Circumferential Welds	--	11	--	1-4100 to 1-4600
87.	B9.22	Longitudinal Welds	--	11	--	1-4100 to 1-4600

PROGRAM ITEM	IWB-2500-1 REFERENCE	AREA TO BE EXAMINED	EXAMINATION PROCEDURE Vol.	Sur.	Vis.	SKETCH REFERENCE
		PIPING (cont'd)				
	B9.30	Branch Pipe Connection Welds				
88.	B9.31	Nominal Pipe Size Greater than or equal to 4 inches	206	11	--	1-4100 to 1-4600
89.	B9.32	Nomina' Pipe Size less than 4 inches	--	11	--	1-4100 to 1-4600
90.	B9.40	Socket Welds	--	11	--	1-4100 to 1-4600
91.	B10.10	Integrally Welded Attachments	--	11	--	1-4810
92.	B15.50	Pressure Retaining Boundary	--	--	(3)	--
93.	B15.51	Pressure Retaining Boundary	--	--	(2)	--
		REACTOR COOLANT PUMPS 1,2 and 3				
94.	B6.180	Main Flange Bolting 1-B1 thru 1-B24; 2-B1 thru 2-B24 and 3-B1 thru 3-B24	15	--	--	1-5100
95.	B6.190	Flange Surfaces when connection disassembled for Main Flange Bolting 1-B1 thru 1-B24; 2-B1 thru 2-B24 and 3-B1 thru 3-B24	--	--	(6)	1-5100
96.	B6.200	Nuts, Bushings and Washers for Main Flange Bolting 1-B1 thru 1-B24, 2-B1 thru 2-B24 and 3-B1 thru 3-B24	--	--	(6)	1-5100
97.	B7.60	No. 1 Seal Housing Bolts 1-B1 thru 1-B12; 2-B1 thru 2-B12 and 3-B1 thru 3-B12	--	--	(6)	1-5100
98.	B10.20	Integrally Welded Attachments	--	(10)	--	1-5100

PROGRAM ITEM	IWB-2500-1 REFERENCE	AREA TO BE EXAMINED	EXAMINATION PROCEDURE			SKETCH REFERENCE
			Vol.	Sur.	Vis.	
		REACTOR COOLANT PUMPS 1,2 and 3 (cont'd)				
99.	B12.10	Pump Casing Welds 1-1, 2-1 and 3-1	(11)	--	--	1-5100
100.	B12.20	Pump Casings 1, 2 and 3	--	--	(6)	1-5100
101.	B15.60	Pressure Retaining Boundary	--	--	(3)	--
102.	B15.61	Pressure Retaining Boundary	--	--	(2)	--
103.	N/A	Pump Motor Flywheels 1, 2 and 3	41	70	8	1-5100
		VALVES				
104.	B6.210	Bolts and Studs	15	--	--	1-6100
105.	B6.220	Flange Surfaces when connection disassembled	--	--	(6)	1-6100
106.	B6.230	Nuts, Bushings and Washers	--	--	(6)	1-6100
107.	B7.70	Bolts, Studs and Nuts	--	--	8	1-6300
108.	B10.30	Integrally Welded Attachments	--	11	--	1-4810
109.	B12.30	Valve Body Welds on Valves less than 4 inch nominal pipe size	--	(10)	--	--
110.	B12.31	Valve Body Welds in Valves equal to or greater than 4 inch nominal pipe size	(10)	--	--	--
111.	B12.40	Valve Bodies exceeding 4 inch nominal pipe size	--	--	(6)	1-6200
112.	B15.70	Pressure Retaining Boundary	--	--	(3)	--
113.	B15.71	Pressure Retaining Boundary	--	--	(2)	--

PROGRAM ITEM	IWC-2500-1 REFERENCE	AREA TO BE EXAMINED	EXAMINATION PROCEDURE Vol.	Sur.	Vis.	SKETCH REFERENCE
		STEAM GENERATORS 1,2 and 3				
114.	C1.10	Circumferential Shell Weld 1-3	47	--	--	2-1100
115.	C1.10	Circumferential Shell Weld 2-5	47	--	--	2-1100
116.	C1.10	Circumferential Shell Weld 2-6	47	--	--	2-1100
117.	C1.20	Circumferential Head Weld 3-8	47	--	--	2-1100
118.	C1.30	Tubesheet to Shell Weld 1-2	47	--	--	2-1100
119.	C2.10	Nozzle in Vessel Welds less than or equal to 1/2 inches nominal thickness	--	(7)	--	2-1100
	C2.20	Nozzles in Vessel Welds greater than 1/2 inches nominal thickness				
120.	C2.21	Feedwater Nozzle to Shell Weld 2-9	47	70	--	2-1100
121.	C2.21	Mainsteam Nozzle to Head Weld 3-10	47	70	--	2-1100
122.	C2.22	Feedwater Nozzle Inside Radius Section of Weld 2-9	(9)	--	8	2-1100
123.	C2.22	Mainsteam Nozzle Inside Radius Section of Weld 3-10	(9)	--	8	2-1100
124.	C3.10	Integrally Welded Attachments	--	(10)	--	2-1100
125.	C4.10	Bolts and Studs	(7)	--	--	2-1100
126.	C7.10	Pressure Retaining Components	--	--	(5)	--
127.	C7.11	Pressure Retaining Components	--	--	(2)	--

PROGRAM ITEM	IWC-2500-1 REFERENCE	AREA TO BE EXAMINED	EXAMINATION PROCEDURE Vol.	Sur.	Vis.	SKETCH REFERENCE
		EXCESS LETDOWN HEAT EXCHANGER				
128.	C1.10	Circumferential Shell Welds	(10)	--	--	2-1110
129.	C1.20	Circumferential Head Weld 1	206	--	--	2-1110
130.	C1.30	Tubesheet to Shell Welds	(10)	--	--	2-1110
131.	C2.10	Nozzle in Vessel Welds	--	(7)	--	2-1110
	C2.20	Nozzle in Vessel Welds				
132.	C2.21	Nozzle to Shell Welds	(7)	(7)	--	2-1110
133.	C2.22	Nozzle Inside Radius Section	(7)	--	--	2-1110
134.	C3.10	Integrally Welded Attachments	--	(10)	--	2-1110
135.	C4.10	Bolts and Studs	(7)	--	--	2-1110
136.	C7.10	Pressure Retaining Components	--	--	(5)	--
137.	C7.11	Pressure Retaining Components	--	--	(2)	--
		RESIDUAL HEAT EXCHANGERS 1A & 1B				
138.	C1.10	Circumferential Shell Weld 1A-1	206	--	--	2-1120
139.	C1.20	Circumferential Head Weld 1B-2	206	--	--	2-1120
140.	C1.30	Tubesheet to Shell Welds	(10)	--	--	2-1120
141.	C2.10	Nozzle in Vessel Welds	--	(7)	--	2-1120
	C2.20	Nozzle in Vessel Welds greater than 1/2 inches nominal thickness				
142.	C2.21	Nozzle to Shell Welds 1A-3 and 1B-4	206	11	--	2-1120
143.	C2.22	Nozzle Inside radius section	(7)	--	--	2-1120

PROGRAM ITEM	IWC-2500-1 REFERENCE	AREA TO BE EXAMINED	EXAMINATION PROCEDURE Vol.	Sur.	Vis.	SKETCH REFERENCE
		RESIDUAL HEAT EXCHANGERS 1A & 1B				
144.	C3.10	Integrally Welded Attachments	--	(7)	--	2-1120
145.	C4.10	Bolts and Studs	(7)	--	--	2-1120
146.	C7.10	Pressure Retaining Components	--	--	(5)	--
147.	C7.11	Pressure Retaining Components	--	--	(2)	--
		SEAL WATER HEAT EXCHANGER				
148.	C1.10	Circumferential Shell Weld 1	(8)	11	--	2-1130
149.	C1.20	Circumferential Head Weld 2	(8)	11	--	2-1130
150.	C1.30	Tubesheet to Shell Welds	(10)	--	--	2-1130
151.	C2.10	Nozzle in Vessel Welds	--	(7)	--	2-1130
	C2.20	Nozzle in Vessel Welds				
152.	C2.21	Nozzle to Shell Welds	(7)	(7)	--	2-1130
153.	C2.22	Nozzle Inside Radius Section	(7)	--	--	2-1130
154.	C3.10	Integrally Welded Attachments	--	(7)	--	2-1130
155.	C4.10	Bolts and Studs	(7)	--	--	2-1130
156.	C7.10	Pressure Retaining Components	--	--	(5)	--
157.	C7.11	Pressure Retaining Components	--	--	(2)	--
		NON REGENERATIVE LETDOWN HEAT EXCHANGER				
158.	C1.10	Circumferential Shell Weld	(10)	--	--	2-1140
159.	C1.20	Circumferential Head Weld 1	206	--	--	2-1140
160.	C'.30	Tubesheet to Shell Weld	(10)	--	--	2-1140

PROGRAM ITEM	IWC-2500-1 REFERENCE	AREA TO BE EXAMINED	EXAMINATION PROCEDURE Vol.	Sur.	Vis.	SKETCH REFERENCE
		NON REGENERATIVE LETDOWN HEAT EXCHANGER				
161.	C2.10	Nozzle in Vessel Welds	--	(7)	--	2-1140
	C2.20	Nozzle in Vessel Welds				
162.	C2.21	Nozzle to Shell Welds	(7)	(7)	--	2-1140
163.	C2.22	Nozzle Inside Radius Section	(7)	--	--	2-1140
164.	C3.10	Integrally Welded Attachments 1WS & 2WS	--	11	--	2-1140
165.	C4.10	Bolts and Studs	(7)	--	--	2-1140
166.	C7.10	Pressure Retaining Components	--	--	(5)	--
167.	C7.11	Pressure Retaining Components	--	--	(2)	--
		REGENERATIVE HEAT EXCHANGER				
168.	C1.10	Circumferential Shell Welds 2,3,6,7,10 and 11	206	--	--	2-1150
169.	C1.20	Circumferential Head Welds 1,4,5,8,9 and 12	206	--	--	2-1150
170.	C1.30	Tubesheet to Shell Welds	(10)	--	--	2-1150
171.	C2.10	Nozzle in Vessel Welds	--	(7)	--	2-1150
	C2.20	Nozzle in Vessel Welds				
172.	C2.21	Nozzle to Shell Welds	(7)	(7)	--	2-1150
173.	C2.22	Nozzle Inside Radius Section	(7)	--	--	2-1150
174.	C3.10	Integrally Welded Attachments	--	(10)	--	2-1150
175.	C4.10	Bolts and Studs	(10)	--	--	2-1150
176.	C7.10	Pressure Retaining Components	--	--	(5)	--
177.	C7.11	Pressure Retaining Components	--	--	(2)	--

PROGRAM ITEM	IWC-2500-1 REFERENCE	AREA TO BE EXAMINED	EXAMINATION PROCEDURE Vol.	Sur.	Vis.	SKETCH REFERENCE
		RECIRCULATION SPRAY COOLERS 1A,1B,1C & 1D				
178	C1.10	Circumferential Shell Welds	(10)	--	--	2-1160
179	C1.20	Circumferential Head Welds	(10)	--	--	2-1160
180	C1.30	Tubesheet to Shell Welds 1A-1 and 1A-11	206	--	--	2-1160
181	C2.10	Nozzle in Vessel Welds 1A-12 and 1A-13	--	11	--	2-1160
	C2.20	Nozzle in Vessel Welds				
182	C2.21	Nozzle to Shell Welds	(7)	(7)	--	2-1160
183	C2.22	Nozzle Inside Radius Section	(7)	--	--	2-1160
184	C3.10	Integrally Welded Attachments 1A-1WS thru 1A-10WS	--	11	--	2-1160
185	C4.10	Bolts and Studs	(10)	--	--	2-1160
186	C7.10	Pressure Retaining Components	--	--	(5)	--
187	C7.11	Pressure Retaining Components	--	--	(2)	--
		VOLUME CONTROL TANK				
188	C1.10	Circumferential Shell Welds	(10)	--	--	2-1200
189	C1.20	Circumferential Head Welds 1 and 2	206	--	--	2-1200
190	C1.30	Tubesheet to Shell Welds	(10)	--	--	2-1200
191	C2.10 C2.20	Nozzle in Vessel Welds Nozzle in Vessel Welds	--	(7)	--	2-1200
192	C2.21	Nozzle to Shell Welds	(7)	--	--	2-1200
193	C2.22	Nozzle Inside Radius Section	(7)	--	--	2-1200
194	C3.10	Integrally Welded Attachments	--	(7)	--	2-1200

PROGRAM ITEM	IWC-2500-1 REFERENCE	AREA TO BE EXAMINED	EXAMINATION PROCEDURE Vol.	Sur.	Vis.	SKETCH REFERENCE
		VOLUME CONTROL TANK (cont'd)				
195	C4.10	Bolts and Studs	(7)	--	--	2-1200
196	C7.10	Pressure Retaining Components	--	--	(5)	--
197	C7.11	Pressure Retaining Components	--	--	(2)	--
		ACCUMULATOR TANKS 1A, 1B AND 1C				
198	C1.10	Circumferential Shell Welds	(10)	--	--	2-1210
199	C1.20	Circumferential Head Welds 1A-1, 1A-2, 1A-3 and 1A-4	206	--	--	2-1210
200	C1.30	Tubesheet to Shell Welds	(10)	--	--	2-1210
201	C2.10	Nozzle in Vessel Welds	--	--	--	2-1210
	C2.20	Nozzle in Vessel Welds greater than 1/2 inches nominal thickness				
202	C2.21	Nozzle to Head Weld 1A-5	206	70	--	2-1210
203	C2.22	Nozzle Inside Radius Section	(7)	--	--	2-1210
204	C3.10	Integrally Welded Attachment	--	(7)	--	2-1210
205	C4.10	Bolts and Studs	(7)	--	--	2-1210
206	C7.10	Pressure Retaining Components	--	--	(5)	--
207	C7.11	Pressure Retaining Components	--	--	(2)	--
		SEAL WATER INJECTION FILTERS 4A & 4B				
208	C1.10	Circumferential Shell Weld 4A-1	206	--	--	2-1300
209	C1.20	Circumferential Head Weld 4A-2	206	--	--	2-1300
210	C1.30	Tubesheet to Shell Welds	(10)	--	--	2-1300
211	C2.10	Nozzle in Vessel Welds	--	(7)	--	2-1300

PROGRAM ITEM	IWC-2500-1 REFERENCE		AREA TO BE EXAMINED	EXAMINATION PROCEDURE Vol.	Sur.	Vis.	SKETCH REFERENCE
			SEAL WATER INJECTION FILTERS 4A & 4B (cont'd)				
	C2.20		Nozzle in Vessel Welds				
212		C2.21	Nozzle to Shell Welds	(7)	(7)	--	2-1300
213		C2.22	Nozzle Inside Radius Section	(7)	--	--	2-1300
214	C3.10		Integrally Welded Attachments	--	(7)	--	2-1300
215	C4.10		Bolts and Studs	(7)	--	--	2-1300
216	C7.10		Pressure Retaining Components	--	--	(5)	--
217		C7.11	Pressure Retaining Components	--	--	(2)	--
			REACTOR COOLANT FILTER				
218	C1.10		Circumferential Shell Welds 1 and 2	(8)	11	--	2-1310
219	C1.20		Circumferential Head Weld 3	(8)	11	--	2-1310
220	C1.30		Tubesheet to Shell Welds	(10)	--	--	2-1310
221	C2.10		Nozzle in Vessel Welds	--	(7)	--	2-1310
	C2.20		Nozzle in Vessel Welds				
222		C2.21	Nozzle to Shell Welds	(7)	(7)	--	2-1310
223		C2.22	Nozzle Inside Radius Section	(7)	--	--	2-1310
224	C3.10		Integrally Welded Attachment 1WS	--	11	--	2-1310
225	C4.10		Bolts and Studs	(7)	--	--	2-1310
226	C7.10		Pressure Retaining Components	--	--	(5)	--
227		C7.11	Pressure Retaining Components	--	--	(2)	--
			SEAL WATER RETURN FILTER				
228	C1.10		Circumferential Shell Welds 1 and 2	206	--	--	2-1320

PROGRAM ITEM	IWC-2500-1 REFERENCE	AREA TO BE EXAMINED	EXAMINATION PROCEDURE			SKETCH REFERENCE
			Vol.	Sur.	Vis.	
		SEAL WATER RETURN FILTER (cont'd)				
229	C1.20	Circumferential Head Weld 3	206	--	--	2-1320
230	C1.30	Tubesheet to Shell Welds	(10)	--	--	2-1320
231	C2.10	Nozzle in Vessel Welds	--	(7)	--	2-1320
	C2.20	Nozzle in Vessel Welds				
232	C2.21	Nozzle to Shell Welds	(7)	(7)	--	2-1320
233	C2.22	Nozzle Inside Radius Section	(7)	--	--	2-1320
234	C3.10	Integrally Welded Attachments 1WS	--	11	--	2-1320
235	C4.10	Bolts and Studs	(7)	--	--	2-1320
236	C7.10	Pressure Retaining Components	--	--	(5)	--
237	C7.11	Pressure Retaining Components	--	--	(2)	--
		PIPING				
238	C3.40	Integrally Welded Attachments	--	11/70	--	2-2710
239	C4.20	Bolts and Studs	15	--	--	2-2600
	C5.10	Piping less than or equal to 1/2 inches nominal wall thickness				
240	C5.11	Circumferential Welds	--	11/70	--	2-2100 to 2-2555
241	C5.12	Longitudinal Welds	--	11/70	--	2-2100 to 2-2555
	C5.20	Piping greater than 1/2 inches nominal Wall Thickness				
242	C5.21	Circumferential Welds	206	11/70	--	2-2100 to 2-2555
243	C5.22	Longitudinal Welds	206	11/70	--	2-2100 to 2-2555
	C5.30	Pipe Branch Connections				

PROGRAM ITEM	IWC-2500-1 REFERENCE	AREA TO BE EXAMINED	EXAMINATION PROCEDURE Vol.	Sur.	Vis.	SKETCH REFERENCE
		PIPING (cont'd)				
244	C5.31	Circumferential Welds	--	11/70	--	2-2100 to 2-2555
245	C5.32	Longitudinal Welds	--	11/70		2-2100 to 2-2555
246	C7.20	Pressure Retaining Components	--	--	(5)	--
247	C7.21	Pressure Retaining Components	--	--	(2)	--
		RESIDUAL HEAT REMOVAL PUMPS 1A & 1B				
248	C3.70	Integrally Welded Attachments 1A-1WS, 1A-2WS & 1A-3WS	--	11	--	2-3100
249	C4.30	Bolts and Studs	(7)	--	--	2-3100
250	C6.10	Pump Casing Welds	--	(10)	--	2-3100
251	C7.30	Pressure Retaining Components	--	--	(5)	--
252	C7.31	Pressure Retaining Components	--	--	(2)	--
		CHARGING PUMPS 1A, 1B & 1C				
253	C3.70	Integrally Welded Attachments 1A-1WS, 1A-2WS, 1A-3WS & 1A-4WS	--	11	--	2-3110
254	C4.30	Bolts and Studs	(7)	--	--	2-3110
255	C6.10	Pump Casing Welds	--	(10)	--	2-3110
256	C7.30	Pressure Retaining Components	--	--	(5)	--
257	C7.31	Pressure Retaining Components	--	--	(2)	--
		REACTOR COOLANT PUMPS 1, 2 & 3				
258	C3.70	Integrally Welded Attachments	--	(10)	--	2-3120
259	C4.30	Bolts and Studs	(7)	--	--	2-3120
260	C6.10	Pump Casing Welds	--	(10)	--	2-3120

PROGRAM ITEM	IWC-2500-1 REFERENCE		AREA TO BE EXAMINED	EXAMINATION PROCEDURE Vol.	Sur.	Vis.	SKETCH REFERENCE
			REACTOR COOLANT PUMPS 1, 2 & 3 (cont'd)				
261	C7.30		Pressure Retaining Components	--	--	(5)	--
262		C7.31	Pressure Retaining Components	--	--	(2)	--
			LOW HEAD SAFETY INJECTION PUMPS 1A & 1B				
263	C3.70		Integrally Welded Attachments	--	(10)	--	2-3130
264	C4.30		Bolts and Studs	(7)	--	--	2-3130
265	C6.10		Pump Casing Welds	--	(10)	--	2-3130
266	C7.30		Pressure Retaining Components	--	--	(5)	--
267		C7.31	Pressure Retaining Components	--	--	(2)	--
			RECIRCULATION SPRAY PUMPS 1A, 1B, 1C & 1D				
268	C3.70		Integrally Welded Attachments	--	11	--	2-3140
269	C4.30		Bolts and Studs	15	--	--	2-3140
270	C6.10		Pump Casing Welds	--	11	--	2-3140
271	C7.30		Pressure Retaining Components	--	--	(5)	--
272		C7.31	Pressure Retaining Components	--	--	(2)	--
			VALVES				
273	C3.100		Integrally Welded Attachments	--	11	--	2-2710
274	C4.40		Bolts and Studs	15	--	--	2-4100
275	C6.20		Valve Body Welds	--	(10)	--	--
276	C7.40		Pressure Retaining Components	--	--	(5)	--
277		C7.41	Pressure Retaining Components	--	--	(2)	--

PROGRAM ITEM	IWF-2500-2 REFERENCE	AREA TO BE EXAMINED	EXAMINATION PROCEDURE Vol.	Sur.	Vis.	SKETCH REFERENCE
278	F-1	Examine 100% of supports by VT-3 as applicable	--	--	8	General
279	F-2	Examine 100% of supports by VT-3 as applicable	--	--	8	General
280	F-3	Examine 100% of supports by VT-3 as applicable	--	--	8	General

GENERAL NOTES

(1) Examine 100% during preservice inspection in conjunction with item B1.10.
(2) Examined by other than Westinghouse Inspection Services during system hydrostatic tests.
(3) Not applicable to PSI. Examined after refueling outages only.
(4) Examined by other than Westinghouse Inspection Services.
(5) Examined by other than Westinghouse Inspection Services in conjunction with system hydrostatic test.
(6) Examined by other than Westinghouse Inspection Services - Shop examination data to be used for baseline information.
(7) Component items do not meet code requirement size for examination in this category.
(8) Ultrasonic examination not feasible due to material thickness. Surface examination done as a substitute.
(9) Relief requested: no method of manual ultrasonic examination feasible at this time. Visual examination done as substitute where access is available.
(10) There are no items in this category for this component.
(11) Volumetric examination performed by other than Westinghouse Inspection Services - Shop examination data to be used for baseline information.
(12) Reactor Vessel Studs are removed for examination, as per item 25.

EXAMINATION PROCEDURES:

Asterisks (*) noted on the left hand margin of these Class 1 & 2 procedures identify deviations from the ASME Code and use of an alternative method. The deviations are explained in another document.

Nuclear Services Integration Division	INSPECTION SERVICES NONDESTRUCTIVE EXAMINATION PROCEDURE	PROCEDURE NUMBER DMW-ISI-154, Rev. 0

TITLE

PRESERVICE AND INSERVICE INSPECTION OF REACTOR VESSELS

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EFFECTIVE DATE	June 13, 1984		REVISED DATE	

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PRESERVICE AND INSERVICE INSPECTION OF REACTOR VESSELS

1.0 PURPOSE

1.1 This document describes the equipment, calibration sequence, examination techniques, and recording requirements for preservice and inservice inspection of the Beaver Valley Unit II reactor vessel with the remotely operated inspection tool. All operations described herein are intended to satisfy volumetric examination requirements of the 1980 Edition of Section XI of the ASME Boiler and Pressure Vessel Code including Addenda through Winter 1980 and the Westinghouse position on USNRC Regulatory Guide 1.150. The Beaver Valley Unit 2 Examination Program Plant (EPP) is considered part of this procedure and should be used as applicable.

2.0 SCOPE

2.1 This document provides general requirements for straight and angle beam immersion ultrasonic examinations of pressure retaining carbon and low alloy steel welds, nozzle safe end welds, heat affected zones, specified base material, and weld repairs to base material which exceed 10% of the nominal wall thickness in the reactor vessel beltline regions.

2.2 Specific calibration and examination requirements, i.e., areas selected for examination, extent of examination, search unit sizes, angles, calibration standards, and water path distances, are defined in the plant specific Examination Program Plan.

3.0 EQUIPMENT

3.1 Examinations shall be performed using pulse-echo and/or transmit-receive techniques with immersion water path coupling using the equipment listed below.

3.1.1 Sonic Multichannel Time - Amplitude Ultrasonic System, consisting of the following modules and interconnects:

Pulser/Preamps	Mark VI Mainframe/CRT
Mark VI Receiver	Mark VI Interface
System Controller	Hardcopy Controller
Gate Monitor	Two Tektronix 613 Storage Scopes
Data Display	Tektronix 4613 Hardcopy Printer
Power Supply Module	Serial Data Link
RG-174 Cable, 23 ft.	
Four Tektronix 2213 Auxiliary Displays	

3.1.2 Westinghouse Computer System Model 2500

3.1.3 Westinghouse MK-1 Electronic Block Simulator (EBS)

3.1.4 Ultrasonic Transducers
2.25 MHz, 1.50 inches diameter
2.25 MHz, 0.75 inches diameter
1.0 MHz, 1.50 inches diameter
1.0 MHz, 0.75 inches diameter
5.0 MHz, 0.50 inches x 1.00 inches rectangular

3.1.5 Transducer array plates and transducer mounting assemblies

3.1.6 Calibration tank and manipulator

3.1.7 Calibration block

3.1.8 Mechanical Transfer Standard (MTS)

3.1.9 Spherical "Home" Target

3.2 Other transducers, calibration standards, and/or equipment may be used for special applications or where metallurgical characteristics or geometry preclude effective use of the equipment described above. These parameters shall be defined in the Examination Program Plan.

4.0 PERSONNEL REQUIREMENTS

4.1 Ultrasonic test operators performing activities per this procedure shall be qualified and certified Level II or Level III per W PA 10.1 or equivalent procedure based on SNT-TC-1A, as supplemented by the requirements of Section XI. Individuals qualified and certified Level I or Level I Trainees per W PA 10.1 or equivalent procedure as described above may perform these activities under direct supervision of a Level II or Level III. All recordable indications shall be evaluated by a Level II or Level III individual.

5.0 INSTRUMENT PERFORMANCE CHECKS

5.1 Instrument screen height linearity and amplitude control linearity shall be verified prior to the performance of any system calibrations and at the beginning and end of the examination period or every three months, whichever is less. The same EBS signal response(s) shall be used for the initial determination and subsequent field checks.

5.2 The ultrasonic instrument shall be verified as having a linear vertical presentation within ± 5% of the full screen height for at least 80% of the calibrated screen height in accordance with the following steps.

5.2.1 Utilizing the EBS and any given channel of the Sonic System obtain two EBS pulses on the CRT.

5.2.2 Adjust the EBS controls and the receiver gain control to set the first indication to 80% full screen height (FSH) and the second indication at 40% FSH.

5.2.3 Without changing the EBS controls, adjust the receiver gain to sequentially set the larger indication from 100% to 10% FSH in 10% increments. Record the smaller indication amplitude at each setting. Estimate the readings to the nearest 1% FSH.

5.2.4 The reading must be 50% of the larger amplitude, within ± 5% FSH.

5.2.5 Record all data and instrument settings on the appropriate data sheet.

5.3 The accuracy of the amplitude control of the ultrasonic system shall be verified as being within ± 20% of the nominal amplitude ratio over its useful range in accordance with the following steps.

5.3.1 Utilizing the EBS and any given channel of the Sonic System obtain an EBS pulse on the CRT.

5.3.2 Adjust the receiver gain to set the indication to 80% FSH. Record the receiver gain setting.

5.3.3 Decrease the receiver gain by 6dB and record the signal amplitude.

5.3.4 Decrease the receiver gain again by 6dB and record the signal amplitude. Decrease the receiver gain by an additional 6dB and record the signal amplitude.

5.3.5 Adjust the receiver gain to set the indication to 40% FSH. Record the receiver gain setting.

5.3.6 Increase the receiver gain by 6dB and record the signal amplitude.

5.3.7 Adjust the receiver gain to set the indication to 20% FSH. Record the receiver gain setting.

5.3.8 Increase the receiver gain by 12dB and record the signal amplitude.

5.3.9 Adjust the receiver gain to set the indication to 10% FSH. Record the receiver gain setting.

5.3.10 Increase the receiver gain by 18dB and record the signal amplitude.

5.3.11 Recorded readings must be within the following limits:

Indication Set at % of FSH	dB Control Change	Indication Limits % FSH
80%	-6dB	32 to 48%
80%	-12dB	16 to 24%
80%	-18dB	8 to 12%
40%	+6dB	64 to 96%
20%	+12dB	64 to 96%
10%	+18dB	64 to 96%

5.3.12 Record all data and instrument settings on the appropriate data sheet.

5.4 Verification of performance of instrument performance checks shall be documented. Documentation shall include the date, time, and the initials of the operator.

5.5 A photographic record of the RF pulse waveform shall be obtained for each transducer, before and after each vessel examination per paragraph 6.13.

6.0 SYSTEM CALIBRATION

6.1 Calibration Requirements - General

System calibration shall be performed at the Westinghouse Waltz Mill Site.

6.1.1 Calibration shall include the complete ultrasonic system using responses from reflectors in the basic calibration block(s). The ultrasonic system is defined as the ultrasonic instrument, cables, transducer, couplant, and any other apparatus, instrument or circuit between the instrument and the calibration block surface.

6.1.2 Basic calibration blocks used for calibration of the ultrasonic system shall be defined by the plant specific Examination Program Plan and shall meet the following requirements.

6.1.2.1 The material from which the block(s) are fabricated shall be from one of the following:

(a) a nozzle dropout from the reactor vessel
(b) a prolongation from the reactor vessel
(c) material of the same general material specification, product form, and heat treatment as one of the materials being joined.

6.1.2.2 Where the component material is clad, the block(s) shall be clad to the component clad nominal thickness. Deposition of the cladding may be by an automatic or manual technique so long as the method represents, to the extent practical, the method used on the reactor vessel.

6.1.2.3 The calibration block shall receive at least the minimum tempering temperature treatment required by the material specification and a post weld heat treatment of at least two hours.

6.1.3 The block(s) shall be placed in the calibration tank and carefully leveled and aligned. The zero degree index of the manipulator shall be defined.

6.1.4 Each calibration shall be performed from the calibration block surface, clad or unclad, corresponding to the surface of the component from which the examination will be performed. The calibration block, surface, reference reflectors, and scan directions used during calibration shall be defined on the calibration data sheets, If, for any reason, it is necessary to change any of the calibration parameters from those recommended in the Examination Program Plan, the changes shall be documented and reasons for those changes shall be transmitted to the NSID Inspection Services coordinator.

6.1.5 During calibration the search unit centerline shall be at least 1-1/2 inches from the nearest side of the basic calibration block.

6.1.6 The water temperature for calibration shall be within 25°F of the water temperature during scanning. Devices for this measurement are not considered MTE equipment.

6.1.7 Transducers shall be calibrated in fixtures which provide the angle of incidence specified in the examination Program Plan. Upon completion of the calibration sequence the transducer/fixture assembly shall be mounted on the array plate at the specified location. The orientation of the transducer with respect to the fixture shall not be changed. Bubbles shall not be present on the transducer face or the calibration block entry surface during the calibration sequence.

6.1.8 A calibration data sheet packet shall be completed for each transducer/inspection channel combination used to examine each volume required by the plant specific Examination Program Plan. All data will be fully recorded such that the operating parameters can be verified in the field. Calibration and examination data sheets are attached as Figures 1 through 4.

6.1.9 Measurements of beam spread shall be made for each transducer used during the inspection program. These measurements shall be performed per paragraph 6.11. These data will be included in the calibration data described in paragraph 6.1.8.

6.1.10 The artificial waterpath selector shall be set at the transit time equal to the waterpath of the transducer (inspection channel 0) used to synchronize the interface gating function for a given calibration package.

6.2 Calibration for Straight Beam Examination of Vertical and Circumferential Welds

System calibration for each straight beam inspection channel/transducer combination used for examination of vertical and circumferential welds, including safe end welds and the flange-to-upper shell weld from the shell side, shall be performed as described below.

6.2.1 Attach the transducer to the appropriate fixture for the required incident angle and mount the assembly on the manipulator in the calibration tank.

6.2.2 Position the transducer to direct the sound beam toward the appropriate surface of the calibration block and adjust for the required waterpath.

6.2.3 Adjust the instrument delay such that the lower left corner of the initial pulse starts at the 0 gradicule on the CRT.

6.2.3.1 Adjust the instrument range to the maximum achievable sweep range where the initial pulse and entry surface reflection are displayed on the CRT screen. Record the transit time to the entry surface reflection.

6.2.3.2 Since the gate position controls of the ultrasonic system are calibrated directly in units of time, the gate can be moved to coincide with the entry surface reflection and travel time in microseconds can be read directly from the digital display. All transit time measurements can be made in this manner.

6.2.3.3 Determine the sound velocity and measure the water temperature. Record these values.

$$V = \frac{\text{Round Trip Distance}}{\text{Travel Time}}$$

6.2.4 Adjust the instrument delay such that the lower left corner of the entry surface reflection starts at the 0 gradicule on the CRT.

6.2.4.1 Adjust the instrument range such that metal travel between the entry surface reflection and block back surface reflection occupies 60% to 90% of the full sweep length.

6.2.4.2 Record the transit time between the entry surface reflection and the back surface reflection.

6.2.4.3 Calculate the sound velocity in the calibration block and record this value.

6.2.4.4 Adjust the selected gate controls to include all metal travel between the entry surface reflection and the back surface reflection.

6.2.5 Set the trace and gate baselines to zero percent of scale.

6.2.6 Position the transducer to obtain the maximum response from the side drilled hole which exhibits the highest amplitude. Adjust the preamplifier gain control to set the indication amplitude to 40% $\pm$ 1dB of full screen height. Mark the peak of the indication on the screen. Record instrument settings, indication amplitude, and the transit time from the entry surface reflection to the indication.

6.2.7 Without changing instrument settings move the transducer to obtain the maximum responses from the remaining calibration holes. Mark the peak of the indications on the screen. Record the indication amplitudes and transit times from the water/steel interface to the indications.

6.2.8 Draw a line through the maximum response points on the CRT screen. The curve may be extrapolated at either end for a distance of one-quarter the thickness of the calibration block. This line represents the basic calibration distance amplitude curve (DAC).

6.2.9 Adjust the EBS pulse train to follow the DAC over the entire gate length. Record the EBS control settings.

6.2.10 The electronic DAC module function shall then be initiated.

6.2.10.1 Adjust the electronic DAC controls so all EBS pulses are nominally 40% FSH.

6.2.10.2 Adjust the monitor gate threshold to the position where a 16% FSH alarm level is realized and set for positive trigger.

6.2.10.3 Disable the EBS, scan the block, and observe the responses from each applicable calibration reflector. The amplitude of each should be at 40% FSH $\pm$ 1dB. If not, review steps 6.2.1 through 6.2.10.3.

6.2.10.4 Decrease the receiver gain by 6dB. Switch the system to the cycle mode and scan the transducer assembly over the calibration block at or greater than the specified examination speed. The gate alarm shall actuate when the peak response from each hole is detected. If the alarm is not observed for one or more of the holes, investigate to identify the test system parameter(s) (e.g., alarm count, repetition rate, alarm level, etc.) which may require adjustment and make corrections, if necessary.

6.2.10.5 Increase the receiver gain by 6dB and record all pertinent calibration data on the calibration data sheets.

6.2.11 Move DEC Delay 1 to a position past the end of the gated sweep, i.e. where the DEC will not influence the MTS response amplitudes. Position the transducer to obtain the peak responses from at least three cylindrical reflectors in the MTS which fall within the gated sweep length. Record the reflector identification, indication amplitude, and transit time to the indication from the initial pulse.

Reflectors selected for this step shall provide transit times representative of those for the primary reflectors in the basic calibration block where practical.

6.3 Calibration for Angle Beam Examination of Vertical and Circumferential Vessel Welds

System calibration for each angle beam inspection channel/transducer combination used for examination of vertical and circumferential vessel welds, including the flange-to-upper shell weld from the shell side, shall be performed as described below.

6.3.1 Attach the transducer to the appropriate fixture for the required incident angle and mount the assembly on the manipulator in the calibration tank.

6.3.2 Position the transducer to direct the sound beam toward the appropriate surface of the calibration block and adjust for the required waterpath.

6.3.3 Position the transducer to obtain a maximum response from the square notch on the opposite surface or the block corner and adjust the instrument delay such that the lower left corner of the initial pulse starts at the 0 gradicule on the CRT.

6.3.3.1 Adjust the instrument range to the maximum achievable sweep range where the initial pulse and entry surface reflection are displayed on the CRT screen. Record the transit time to the entry surface reflection.

6.3.3.2 Since the gate position controls of the ultrasonic system are calibrated directly in units of time, the gate can be moved to coincide with the entry surface reflection and travel time in microseconds can be read directly from the digital display. All transit time measurements can be made in this manner.

6.3.3.3 Determine the sound velocity and measure the water temperature. Record these values.

$$V = \frac{\text{Round Trip Distance}}{\text{Travel Time}}$$

6.3.4 Adjust the instrument delay such that the lower left corner of the entry surface reflection starts at the 0 gradicule on the CRT.

6.3.4.1 Adjust the instrument range such that metal travel between the entry surface reflection and the notch response or the block corner response occupies 50% to 80% of the full sweep length.

6.3.4.2 Record the transit time between the entry surface reflection and the notch response or block corner response.

6.3.4.3 Calculate the sound velocity in the calibration block and record this value.

6.3.4.4 Position the transducer to obtain the maximum response from the 3/4T hole after the beam has bounced from the opposite surface (5/8 node response) and adjust the selected gate controls to include all metal travel between the entry surface reflection and this indication.

6.3.5 Set the trace and gate baselines to zero percent of scale.

6.3.6 Position the transducer to obtain the maximum response from the side drilled hole which exhibits the highest amplitude. Adjust the preamplifier gain control to set the indication amplitude to 80% ± 1dB of full screen height. Mark the peak of the indication on the screen. Record instrument settings, indication amplitude, and the transit time from the entry surface reflection to the indication.

6.3.7 Without changing instrument settings move the transducer to obtain the maximum responses from the other calibration holes including the 5/8 node response from the 3/4T hole. Mark the peaks of the indications on the screen. Record indication amplitudes and transit times from the water/steel interface to the indications. If the 5/8 node response from the 3/4T hole is not readily discernable, the DAC curve amplitude point shall be determined by calculating the dB difference between the 1/2T and 3/4T reflector amplitudes, decreasing the 3/4 T reflector amplitude by two times that difference, and marking the resulting amplitude at the point on the sweep that represents the transit time to the 5/8 node position.

6.3.8 Draw a line through the maximum response points on the CRT screen. The curve may be extrapolated at either end for a distance of one-quarter the thickness of the calibration block. This line represents the basic calibration distance amplitude curve (DAC).

6.3.9 Without changing the instrument settings position the transducer to obtain a maximum response from the square notch on the opposite surface, if applicable. Record the indication amplitude and transit time from the water/steel interface to the indication.

6.3.10 Adjust the EBS pulse train to follow the DAC over the entire gate length. Record the EBS control settings.

6.3.11 The electronic DAC module function shall then be initiated.

6.3.11.1 Adjust the electronic DAC controls so all EBS pulses at transit times from the entry surface reflection to and including the response from the 1/4T hole are nominally 80% FSH and those at transit times in excess of the 1/4T hole to the end of the gate are nominally 40% FSH.

6.3.11.2 Adjust the monitor gate threshold to the position where a 16% FSH alarm level is realized and set for positive trigger.

6.3.11.3 Disable the EBS, scan the block, and observe the responses from each applicable calibration reflector. The amplitude of the 1/4T hole should be at 80% FSH ± 1dB and the amplitudes of the 1/2T, 3/4T, and 5/8 node response from the 3/4T hole should be at 40% FSH ± 1dB. If not, review steps 6.3.1 through 6.3.11.3.

6.3.11.4 Decrease the receiver gain by 6dB. Switch the system to the cycle mode and scan the transducer assembly over the calibration block at or greater than the specified examination speed. The gate alarm shall actuate when the peak amplitude from each hole is detected. Decrease the receiver gain by an additional 8dB and once again scan over the block at or higher than the specified examination speed. The alarm should actuate when the peak amplitude from the 1/4T hole is detected. If the alarm is not observed for one or more of the holes, investigate to identify the test system parameter(s) (e.g., alarm count, repetition rate, alarm level, etc.) which may require adjustment and make corrections, if necessary.

6.3.11.5 Increase the receiver gain by 14dB and record all pertinent calibration data on the calibration data sheets.

6.3.12 Move DEC Delay 1 to a position past the end of the gated sweep, i.e. where the DEC will not influence the MTS response amplitudes. Position the transducer to obtain the peak responses from at least three cylindrical reflectors in the MTS which fall within the gated sweep length. Record the reflector identification, indication amplitude, and transit time to the indication from the initial pulse.

Reflectors selected for this step shall provide transit times representative of those for the primary reflectors in the basic calibration block where practical.

6.4 Calibration for Examination of the Flange-to-Upper Shell Weld From the Flange Seal Surface

System calibration for each inspection channel/transducer combination used for examination of the flange-to-upper shell weld from the flange seal surface shall be performed as described below.

6.4.1 Attach the transducer to the appropriate fixture for the required incident angle and mount the assembly on the manipulator in the calibration tank.

6.4.2 Position the transducer to direct the sound beam toward the appropriate surface of the calibration block and adjust for the required waterpath.

6.4.3 Adjust the instrument delay such that the lower left corner of the initial pulse starts at the 0 gradicule on the CRT.

6.4.3.1 Adjust the instrument range to the maximum achievable sweep range where the initial pulse and entry surface reflection are displayed on the CRT screen. Record the transit time to the entry surface reflection.

6.4.3.2 Since the gate position controls of the ultrasonic system are calibrated directly in units of time, the gate can be moved to coincide with the entry surface reflection and travel time in microseconds can be read directly from the digital display. All transit time measurements can be made in this manner.

6.4.3.3 Determine the sound velocity and measure the water temperature. Record these values.

$$V = \frac{\text{Round Trip Distance}}{\text{Travel Time}}$$

6.4.4 Adjust the instrument delay such that the lower left corner of the entry surface reflection starts at the 0 gradicule on the CRT.

6.4.4.1 Adjust the instrument range such that metal travel between the entry surface reflection and the reflection from the reference hole at the longest test metal distance occupies 60% to 90% of the full sweep length.

6.4.4.2 Record the transit time between the entry surface reflection and the reflection from the reference hole.

6.4.4.3 Calculate the sound velocity in the calibration block and record this value.

6.4.4.4 Adjust the selected gate controls to include all metal travel including the weld and specified adjacent base material on the shell and flange sides of the weld.

6.4.5 Set the trace and gate baselines to zero percent of scale.

6.4.6 Position the transducer to obtain the maximum response from the side drilled hole which exhibits the highest amplitude. Adjust the preamplifier gain control to set the indication amplitude to 80% ± 1dB of full screen height. Mark the peak of the indication on the screen. Record instrument settings, indication amplitude, and the transit time from the entry surface reflection to the indication.

6.4.7 Without changing instrument settings move the transducer to obtain the maximum responses from the remaining calibration holes. Mark the peak of the indications on the screen. Record the indication amplitudes and transit times from the water/steel interface to the indications.

6.4.8 Draw a line through the maximum response points on the CRT screen. The curve may be extrapolated at either end for a distance of one-quarter the thickness of the calibration block. This line represents the basic calibration distance amplitude curve (DAC).

6.4.9 Adjust the EBS pulse train to follow the DAC over the entire gate length. Record the EBS control settings.

6.4.10 The electronic DAC module function shall then be initiated.

6.4.10.1 Adjust the electronic DAC controls so all EBS pulses are nominally 80% FSH.

6.4.10.2 Adjust the monitor gate threshold to the position where a 16% FSH alarm level is realized and set for positive trigger.

6.4.10.3 Disable the EBS, scan the block, and observe the responses from each applicable calibration reflector. The amplitude of each should be at 80% FSH ± 1dB. If not, review steps 6.4.1 through 6.4.10.3.

6.4.10.4 Decrease the receiver gain by 14dB. Switch the system to the cycle mode and scan the transducer assembly over the calibration block at or greater than the specified examination speed. The gate alarm shall actuate when the peak response from each hole is detected. If the alarm is not observed for one or more of the holes, investigate to identify the test system parameter(s) (e.g., alarm count, repetition rate, alarm level, etc.) which may require adjustment and make corrections, if necessary.

6.4.10.5 Increase the receiver gain by 14dB and record all pertinent calibration data on the calibration data sheets.

6.4.11 Move DEC Delay 1 to a position past the end of the gated sweep, i.e. where the DEC will not influence the MTS response amplitudes. Position the transducer to obtain the peak responses from at least three cylindrical reflectors in the MTS which fall within the gated sweep length. Record the reflector identification, indication amplitude, and transit time to the indication from the initial pulse.

Reflectors selected for this step shall provide transit times representative of those for the primary reflectors in the basic calibration block where practical.

6.5 Calibration for Examination of Nozzle-to-Shell Welds from the Nozzle Bore

System calibration for each inspection channel/transducer combination used for examination of nozzle-to-shell welds from the nozzle bore shall be performed as described below.

6.5.1 Attach the transducer to the appropriate fixture for the required incident angle and mount the assembly to the manipulator in the calibration tank.

6.5.2 Position the transducer to direct the sound beam toward the appropriate surface of the calibration block and adjust for the required waterpath.

6.5.3 Adjust the instrument delay such that the lower left corner of the initial pulse starts at the 0 gradicule on the CRT.

6.5.3.1 Adjust the instrument range to the maximum achievable sweep range where the initial pulse and entry surface reflection are displayed on the CRT screen. Record the transit time to the entry surface reflection.

6.5.3.2 Since the gate position controls of the ultrasonic system are calibrated directly in units of time, the gate can be moved to coincide with the entry surface reflection and travel time in microseconds can be read directly from the digital display. All transit time measurements can be made in this manner.

6.5.3.3 Determine the sound velocity and measure the water temperature. Record these values.

$$V = \frac{\text{Round Trip Distance}}{\text{Travel Time}}$$

6.5.4 Adjust the instrument delay such that the lower left corner of the entry surface reflection starts at the 0 gradicule on the CRT.

6.5.4.1 Adjust the instrument range such that metal travel between the entry surface reflection and the reflection from the reference hole at the longest test metal distance occupies 60% to 90% of the full sweep length.

6.5.4.2 Record the transit time between the entry surface reflection and the reflection from the reference hole.

6.5.4.3 Calculate the sound velocity in the calibration block and record this value.

6.5.4.4 Adjust the selected gate controls to include all metal travel which will include the entire nozzle, the weld, and specified adjacent base material on the shell side of the weld. Consult the Examination Program Plan to verify that this gate length will monitor the required examination volume.

6.5.5 Set the trace and gate baselines to zero percent of scale.

6.5.6 Position the transducer to obtain the maximum response from the side drilled hole which exhibits the highest amplitude. Adjust the preamplifier gain control to set the indication amplitude to 80% (± 1dB) of full screen height. Mark the peak of the indication on the screen. Record instrument settings, indication amplitude, and the transit time from the entry surface reflection to the indication.

6.5.7 Without changing instrument settings move the transducer to obtain the maximum responses from the remaining calibration holes. Mark the peak of the indications on the screen. Record the indication amplitudes and transit times from the water/steel interface to the indications.

6.5.8 Draw a line through the maximum response points on the CRT screen. The curve may be extrapolated at either end for a distance of one-quarter the thickness of the calibration block. This line represents the basic calibration distance amplitude curve (DAC).

6.5.9 Adjust the EBS pulse train to follow the DAC over the entire gate length. Record the EBS control settings.

6.5.10 The electronic DAC module function shall then be initiated.

6.5.10.1 Adjust the electronic DAC controls so all EBS pulses are nominally 80% FSH.

6.5.10.2 Adjust the monitor gate threshold to the position where a 16% FSH alarm level is realized and set for positive trigger.

6.5.10.3 Disable the EBS, scan the block, and observe the responses from each applicable calibration reflector. The amplitude of each should be at 80% FSH $\pm$ 1dB. If not, review steps 6.5.1 through 6.5.10.3.

6.5.10.4 Decrease the receiver gain by 14dB. Switch the system to the cycle mode and scan the transducer assembly over the calibration block at or greater than the specified examination speed. The gate alarm shall actuate when the peak response from each hole is detected. If the alarm is not observed for one or more of the holes, investigate to identify the test system parameter(s) (e.g., alarm count, repetition rate, alarm level, etc.) which may require adjustment and make corrections, if necessary.

6.5.10.5 Increase the receiver gain by 14dB and record all pertinent calibration data on the calibration data sheets.

6.5.11 Move DEC Delay 1 to a position past the end of the gated sweep, i.e. where the DEC will not influence the MTS response amplitudes. Position the transducer to obtain the peak responses from at least three cylindrical reflectors in the MTS which fall within the gated sweep length. Record the reflector identification, indication amplitude, and transit time to the indication from the initial pulse.

Reflectors selected for this step shall provide transit times representative of those for the primary reflectors in the basic calibration block where practical.

6.6 Calibration for Examination of Nozzle Radii and Protrusions

System calibration for each angle beam inspection channel/transducer combination used for nozzle radius and protrusion examination shall be performed as described below.

6.6.1 Attach the transducer to the appropriate fixture for the required incident angle and mount the assembly on the manipulator in the calibration tank.

6.6.2 Position the transducer to direct the sound beam toward the appropriate surface of the calibration block and adjust for the required waterpath.

6.6.3 Position the transducer to obtain a maximum response from the side drilled hole at the longest test metal distance and adjust the instrument delay such that the lower left corner of the initial pulse starts at the 0 gradicule on the CRT.

6.6.3.1 Adjust the instrument range to the maximum achievable sweep range where the initial pulse and entry surface reflection are displayed on the CRT screen. Record the transit time to the entry surface reflection.

6.6.3.2 Since the gate position controls of the ultrasonic system are calibrated directly in units of time, the gate can be moved to coincide with the entry surface reflection and travel time in microseconds can be read directly from the digital display. All transit time measurements can be made in this manner.

6.6.3.3 Determine the sound velocity and measure the water temperature. Record these values.

$$V = \frac{\text{Round Trip Distance}}{\text{Travel Time}}$$

6.6. . Adjust the instrument delay such that the lower left corner of the entry surface reflection starts at the 0 gradicule on the CRT.

6.6.4.1 Adjust the instrument range such that metal travel between the entry surface reflection and the response from the reference hole at the longest test metal distance occupies 60% to 90% of the full sweep length.

6.6.4.2 Record the transit time between the entry surface reflection and the side drilled hole response.

6.6.4.3 Calculate the sound velocity in the calibration block and record this value.

6.6.4.4 Adjust the selected gate controls to include all metal travel between the entry surface reflection and the response from the specified side drilled hole at the longest test metal distance.

6.6.5 Set the trace and gate baselines to zero percent of scale.

6.6.6 Position the transducer to obtain the maximum response from the drilled hole which exhibits the highest amplitude. Adjust the preamplifier gain control to set the indication amplitude to 80% ± 1dB of full screen height. Mark the peak of the indication on the screen. Record instrument settings, indication amplitude, and the transit time from the entry surface reflection to the indication.

6.6.7 Without changing instrument settings move the transducer to obtain the maximum responses from the other calibration hole. Mark the peak of this indication on the screen. Record the indication amplitude and transit time from the water/steel interface to the indication.

6.6.8 Draw a line through the maximum response points on the CRT screen. The curve may be extended at either end for a distance equivalent to one-quarter the depth of the deepest hole. This line represents the basic calibration distance amplitude curve (DAC).

6.6.9 Adjust the EBS pulse train to follow the DAC over the entire gate length. Record the EBS control settings.

6.6.10 The electronic DAC module function shall then be initiated.

6.6.10.1 Adjust the electronic DAC controls so all EBS pulses are nominally 80% FSH.

6.6.10.2 Adjust the monitor gate threshold to the position where a 16% alarm level is realized FSH and set for positive trigger.

6.6.10.3 Disable the EBS, scan the block, and observe the responses from each applicable calibration reflector. The amplitude of each should be 80% FSH ± 1dB. If not, review steps 6.6.1 through 6.6.10.3.

6.6.10.4 Decrease the receiver gain by 14dB. Switch the system to the cycle mode and scan the transducer assembly over the calibration block at or greater than the specified examination speed. The gate alarm shall actuate when the peak response from each hole is detected. If the alarm is not observed for one or more of the holes, investigate to identify the test system parameter(s) (e.g., alarm count, repetition rate, alarm level, etc.) which may require adjustment and make corrections, if necessary.

6.6.10.5 Increase the receiver gain by 14dB and record all pertinent calibration data on the calibration data sheets.

6.6.11 Move DEC Delay 1 to a position past the end of the gated sweep, i.e. where the DEC will not influence the MTS response amplitudes. Position the transducer to obtain the peak responses from at least three cylindrical reflectors in the MTS which fall within the gated sweep length. Record the reflector identification, indication amplitude, and transit time to the indication from the initial pulse.

Reflectors selected for this step shall provide transit times representative of those for the primary reflectors in the basic calibration block where practical.

6.7 Calibration for Angle Beam Examination of Nozzle-to-Safe End Welds

System calibration for each angle beam inspection channel/transducer combination used for safe end inspection shall be performed as described below. When the calibration block is a mockup of the bimetallic weld, calibration shall be from the side of the weld, carbon steel or stainless steel, corresponding to the side of the weld from which the examination will be performed.

6.7.1 Attach the transducer to the appropriate fixture for the required incident angle and mount the assembly to the manipulator in the calibration tank.

6.7.2 Position the transducer to direct the sound beam toward the appropriate surface of the calibration block and adjust for the required waterpath.

6.7.3 Position the transducer to obtain a maximum response from the side drilled hole at the longest test metal distance and adjust the instrument delay such that the lower left corner of the initial pulse starts at the 0 gradicule on the CRT.

6.7.3.1 Adjust the instrument range to the maximum achievable sweep range where the initial pulse and entry surface reflection are displayed on the CRT screen. Record the transit time to the entry surface reflection.

6.7.3.2 Since the gate position controls of the ultrasonic system are calibrated directly in units of time, the gate can be moved to coincide with the entry surface reflection and travel time in microseconds can be read directly from the digital display. All transit time measurements can be made in this manner.

6.7.3.3 Determine the sound velocity and measure the water temperature. Record these values.

$$V = \frac{\text{Round Trip Distance}}{\text{Travel Time}}$$

6.7.4 Adjust the instrument delay such that the lower left corner of the entry surface reflection starts at the 0 gradicule on the CRT.

6.7.4.1 Adjust the instrument range such that metal travel between the entry surface reflection and the response from the side drilled hole at the longest test distance occupies 50% to 70% of the full sweep length.

6.7.4.2 Record the transit time between the entry surface reflection and the response from the drilled hole at the longest test distance.

6.7.4.3 Calculate the sound velocity in the calibration block and record this value.

6.7.4.4 Adjust the selected gate controls to include all metal travel from the entry surface reflection to the equivalent of 1/4T past the 3/4T hole as a minimum.

6.7.5 Set the trace and gate baselines to zero percent of scale.

6.7.6 Position the transducer to obtain the maximum response from the side drilled hole which exhibits the highest amplitude. Adjust the preamplifier gain control to set the indication amplitude to 40% $\pm$ 1dB of full screen height. Mark the peak of the indication on the screen. Record instrument settings, indication amplitude, and the transit time from the entry surface reflection to the indication.

6.7.7 Without changing instrument settings move the transducer to obtain the maximum responses from the other calibration holes. Mark the peaks of these indications on the screen. Record the indication amplitudes and transit time from the water/steel interface to the indications.

6.7.8 Draw a line through the maximum response points on the CRT screen. The curve may be extrapolated at either end for a distance of one-quarter the thickness of the calibration block. This line represents the basic calibration distance amplitude curve (DAC).

6.7.9 Adjust the EBS pulse train to follow the DAC over the entire gate length. Record the EBS control settings.

6.7.10 The electronic DAC module function shall then be initiated.

6.7.10.1 Adjust the electronic DAC controls so all EBS pulses are nominally 40% FSH.

6.7.10.2 Adjust the monitor gate threshold to the position where a 16% FSH alarm level is realized and set for positive trigger.

6.7.10.3 Disable the EBS, scan the block, and observe the responses from each applicable calibration reflector. The amplitude of each should be 40% FSH ± 1dB. If not, review steps 6.7.1 through 6.7.10.3.

6.7.10.4 Decrease the receiver gain by 6dB. Switch the system to the cycle mode and scan the transducer assembly over the calibration block at or greater than the specified examination speed. The gate alarm shall actuate when the peak response from each hole is detected. If the alarm is not observed for one or more of the holes, investigate to identify the test system parameter(s) (e.g., alarm count, repetition rate, alarm level, etc.) which may require adjustment and make corrections, if necessary.

6.7.10.5 Increase the receiver gain by 6dB and record all pertinent calibration data on the calibration data sheets.

6.7.11 Move DEC Delay 1 to a position past the end of the gated sweep, i.e. where the DEC will not influence the MTS response amplitudes. Position the transducer to obtain the peak responses from at least three cylindrical reflectors in the MTS which fall within the gated sweep length. Record the reflector identification, indication amplitude, and transit time to the indication from the initial pulse.

Reflectors selected for this step shall provide transit times representative of those for the primary reflectors in the basic calibration block where practical.

6.8 Calibration for Examination of Reactor Vessel Flange Ligaments

System calibration for each straight beam inspection channel/ transducer combination used for flange ligament inspection shall be performed as described below.

6.8.1 Attach the transducer to the appropriate fixture for the required incident angle and mount the assembly to the manipulator in the calibration tank.

6.8.2 Position the transducer to direct the sound beam toward the appropriate surface of the calibration block and adjust for the required waterpath.

6.8.3 Adjust the instrument delay such that the lower left corner of the initial pulse starts at the 0 gradicule on the CRT.

6.8.3.1 Adjust the instrument range control to the maximum achievable sweep range where the initial pulse and entry surface reflection are displayed on the CRT screen. Record the transit time to the entry surface reflection.

6.8.3.2 Since the gate position controls of the ultrasonic system are calibrated directly in units of time, the gate can be moved to coincide with the entry surface reflection and travel time in microseconds can be read directly from the digital display. All transit time measurements can be made in this manner.

6.8.3.3 Determine the sound velocity and measure the water temperature. Record these values.

$$V = \frac{\text{Round Trip Distance}}{\text{Travel Time}}$$

6.8.4 Adjust the instrument delay such that the lower left corner of the entry surface reflection starts at the 0 gradicule on the CRT.

6.8.4.1 Adjust the instrument range such that metal travel between the entry surface reflection and the reflection from the applicable reference hole at the longest test metal distance occupies 60% to 90% of the full sweep length.

6.8.4.2 Record the transit time between the entry surface reflection and the reflection from the reference hole.

6.8.4.3 Calculate the sound velocity in the calibration block and record this value.

6.8.4.4 Adjust the selected gate controls to include all metal travel between the water/steel interface and the far limit of the inspection volume as defined in the Examination Program Plan. This distance shall be the equivalent of one stud hole diameter, as a minimum.

6.8.5 Set the trace and gate baselines to zero percent of scale.

6.8.6 Position the transducer to obtain the maximum response from the side drilled hole which exhibits the highest amplitude. Adjust the preamplifier gain control to set the indication amplitude to 40% (± 1dB) of full screen height. Mark the peak of the indication on the screen. Record instrument settings, indication amplitude, and transit time from the entry surface reflection to the indication.

6.8.7 Without changing instrument settings move the transducer to obtain the maximum responses from the remaining calibration holes. Mark the peak of the indications on the screen. Record the indication amplitudes and transit times from the water/steel interface to the indications.

6.8.8 Draw a line through the maximum response points on the CRT screen. The curve may be extrapolated at either end for a distance of one-quarter the thickness of the calibration block. This line represents the basic calibration distance amplitude curve (DAC).

6.8.9 Adjust the EBS pulse train to follow the DAC over the entire gate length. Record the EBS control settings.

6.8.10 The electronic DAC module function shall then be initiated.

6.8.10.1 Adjust the electronic DAC controls so all EBS pulses are nominally 40% FSH.

6.8.10.2 Adjust the monitor gate threshold to the position where a 16% FSH alarm level is realized and set for positive trigger.

6.8.10.3 Disable the EBS, scan the block, and observe the responses from each applicable calibration reflector. The amplitude of each should be at 40% FSH ± 1dB. If not, review steps 6.8.1 through 6.8.10.3.

6.8.10.4 Decrease the receiver gain by 6dB. Switch the system to the cycle mode and scan the transducer assembly over the calibration block at or greater than the specified examination speed. The gate alarm shall actuate when the peak response from each hole is detected. If the alarm is not observed for one or more of the holes, investigate to identify the test system parameter(s) (e.g., alarm count, repetition rate, alarm level, etc.) which may require adjustment and make corrections, if necessary.

6.8.10.5 Increase the receiver gain by 6dB and record all pertinent calibration data on the calibration data sheets.

6.8.11 Move DEC Delay 1 to a position past the end of the gated sweep, i.e. where the DEC will not influence the MTS response amplitudes. Position the transducer to obtain the peak responses from at least three cylindrical reflectors in the MTS which fall within the gated sweep length. Record the reflector identification, indication amplitude, and transit time to the indication from the initial pulse.

Reflectors selected for this step shall provide transit times representative of those for the primary reflectors in the basic calibration block where practical.

6.9 Calibration for Full Node Angle Beam Examination of Vertical and Circumferential Vessel Welds

System calibration for each inspection channel/transducer combination used for full node angle beam examination of the volume of material near the vessel inside diameter shall be performed as described below.

6.9.1 Attach the transducer to the appropriate fixture for the required incident angle and mount the assembly on the manipulator in the calibration tank.

6.9.2 Position the transducer to direct the sound toward the appropriate surface of the calibration block at the required waterpath. Record the transit time from the initial pulse to the entry surface reflection.

6.9.3 Position the transducer to obtain a maximum full node response from the square notch on the entry surface of the block.

6.9.4 Adjust the instrument delay such that the lower left corner of the entry surface reflection starts at the 0 gradicule on the CRT.

6.9.4.1 Adjust the instrument range such that metal travel between the entry surface reflection and the notch response occupies 50% to 80% of the full sweep length.

6.9.4.2 Record the transit time between the entry surface reflection and the notch response.

6.9.4.3 Adjust the selected gate controls to include all metal travel between the 7/8 node and 1 1/8 node responses from the 1/4T hole.

6.9.5 Set the trace and gate baselines to zero percent of scale.

6.9.6 Adjust the preamplifier gain control to set the notch full node response indication to 40% ± 1dB of full screen height. Mark the peak of the indication on the screen.

Record instrument settings, indication amplitude, and transit time from the entry surface reflection to the indication.

6.9.7 Draw a horizontal line through the maximum response point on the CRT and extend it to include the entire gate length. This line represents the basic calibration distance amplitude curve (DAC).

6.9.8 Adjust the EBS pulse train to follow the DAC over the entire gate length. Record the EBS control settings.

6.9.9 Adjust the monitor gate threshold to the position where a 16% FSH alarm level is realized and set for positive trigger.

6.9.9.1 Disable the EBS, scan the block, and observe the response from the notch. The amplitude should be at 40% FSH ± 1dB. If not, review steps 6.9.1 through 6.9.9.1.

6.9.9.2 Decrease the receiver gain by 6dB. Switch the system to the cycle mode and scan the transducer over the calibration block at or greater than the examination speed. The gate alarm should actuate when the peak response from the notch is detected. If the alarm is not observed for the notch investigate to identify the test system parameter(s) (e.g., alarm count, repetition rate, alarm level, etc.) which may require adjustment and make corrections, if necessary.

6.9.9.3 Increase the receiver gain by 6dB and record all pertinent calibration data on the calibration data sheets.

6.9.10 Move DEC Delay 1 to a position past the end of the gated sweep, i.e. where the DEC will not influence the responses from the MTS reflectors. Position the transducer to obtain the peak responses from at least three cylindrical reflectors in the MTS which fall within the gated sweep length. Record the reflector identification, indication amplitude, and transit time to the indication from the initial pulse.

Reflectors selected for this step shall provide transit times representative of those for the primary reflectors in the basic calibration block where practical.

6.10 Calibration for Near Surface Examinations

System calibration for each inspection channel/transducer combination used for near surface examination of volumes of material near the vessel inside diameter shall be performed as described below.

6.10.1 Transducers used for these examinations shall be dual-element, transmit-receive, 2.25 MHz units of the type Ultran WKSI-2.25 WRV, WPSI-2.25 WRV, or equivalent. The nominal waterpath shall be 6.0 inches and the nominal incident angle shall be 12.5° unless otherwise specified.

6.10.2 Attach the transducer to the appropriate fixture for the required incident angle and mount the assembly on the manipulator in the calibration tank.

6.10.3 Position the transducer to direct the sound beam toward the appropriate surface of the calibration block at the required waterpath. Record the transit time from the initial pulse to the entry surface reflection.

NOTE

It may be necessary to increase the gain and/or use one search unit element in the pulse-echo mode to obtain a discernable entry surface reflection.

6.10.4 Position the transducer to obtain a maximum response from the 1/8-inch diameter side drilled hole located 3/4-inch in depth from the entry surface.

6.10.5 Adjust the instrument delay such that the lower left corner of the entry surface reflection starts at the 0 gradicule on the CRT.

6.10.5.1 Adjust the instrument range such that metal travel between the entry surface reflection and the response from the 1/8" diameter side drilled hole at 3/4-inch depth occupies 50% to 75% of the full sweep range.

6.10.5.2 Record the transit time between the entry surface reflection and the hole response.

6.10.5.3 Adjust the selected gate controls to include as a minimum all metal travel from the lower left corner of the entry surface reflection to at least 10 microseconds past the response from the 1/8-inch diameter hole at 3/4-inch depth.

6.10.6 Set the trace and gate baselines to zero percent of scale.

6.10.7 Adjust the preamplifier gain control to set the indication from the 1/8-inch diameter hole at 3/4-inch depth to 80% $\pm$ 1dB of full screen height. Mark the peak of the indication on the screen.

6.10.8 Without changing instrument settings move the transducer to obtain maximum responses from the two remaining calibration holes and the square notch on the entry surface of the block.

6.10.9 Record instrument settings, indication amplitudes (i.e., 100% FSH + 6dB), and transit times from the water/steel interface (see Note Paragraph 6.10.3) to the indications.

6.10.10 Draw a horizontal line through the response from the 3/4 inch deep hole on the CRT screen. The curve shall be extrapolated at either end to cover the entire gate length as set in Paragraph 6.10.5.3.

6.10.11 Adjust the EBS pulse train to follow the DAC over the entire gate length. Record the EBS control settings.

6.10.12 Adjust the monitor gate threshold to the position where a 40% FSH alarm level is realized and set for positive trigger.

6.10.12.1 Disable the EBS, scan the block, and observe the response from the 1/8 inch diameter side drilled hole at 3/4 inch depth. The amplitude should be at 80% FSH ± 1dB. If not, review steps 6.10.2 through 6.10.12.1.

6.10.12.2 Decrease the receiver gain by 6dB. Switch the system to the cycle mode and scan the transducer over the calibration block at or greater than the examination speed. The gate alarm shall actuate when the peak response from the 3/4 inch deep 1/8 inch diameter side drilled hole is detected. If the alarm is not observed, investigate to identify the test system parameter(s) (e.g., alarm count, repetition rate, etc.) which may require adjustment and make corrections, if necessary.

6.10.12.3 Increase the receiver gain by 6 dB and record all pertinent calibration data on the calibration data sheets.

6.10.13 Move DEC Delay 1 to a position past the end of the gated sweep, i.e. where the DEC will not influence the MTS response amplitudes. Position the transducer to obtain the peak responses from at least three cylindrical reflectors in the MTS which fall within the gated sweep length. Record the reflector identification, indication amplitude, and transit time to the indication from the initial pulse.

Reflectors selected for this step shall provide transit times representative of the transducer focal distance, approximately nine inches in water.

6.10.14 Examinations shall be performed with the receiver gain at a level where the general noise level from the cladding is 25% of full screen height. The resulting receiver gain setting shall be recorded on the UT System Controller Data Sheet and identified as "scanning sensitivity". All mapping of indications shall be at this level. Field system calibration shall be verified at the receiver gain recorded per paragraph 6.10.12.3.

6.11 Beam Spread Measurements

Beam spread measurements shall be made for each transducer used during the inspection program. Data will be recorded on the appropriate calibration data sheet.

6.11.1 Establish the location of the scribe line on the reference block as a zero reference point.

6.11.2 Position the transducer to obtain the maximum indication amplitude from the applicable calibration hole at the nearest test distance in the appropriate basic calibration block. Record the manipulator carriage location with respect to the zero reference point and the transit time to the indication.

6.11.3 Move the transducer toward the reference hole until the indication amplitude drops to 50% of its peak amplitude. Record the manipulator carriage location with respect to the zero reference point and the transit time to the indication. Move the transducer toward the reference hole until the indication amplitude drops to 20% of its peak amplitude and record data defined above.

6.11.4 Move the transducer away from the reference hole until the indication amplitude passes through maximum and again drops to 50% of its peak amplitude. Record the manipulator carriage location with respect to the zero reference point and the transit time to the indication. Move the transducer away from the reference hole until the indication amplitude drops to 20% of its peak amplitude and record data defined above.

6.11.5 Repeat these measurements on the other applicable calibration holes.

6.12 Field System Calibration

On site the system calibration shall be established and verified with the EBS per Paragraph 6.12.1 at the beginning and end of each scan routine, with any change of equipment, or every four hours, whichever is less. Calibration shall be established and verified on the MTS cylindrical reflector array per paragraph 6.12.2 at the beginning and end of each series of examinations, with any change of equipment, or each week the system is in use, whichever is less.

6.12.1 Enable the EBS and observe the pulse train.

6.12.1.1 If any point on the DAC curve has decreased by 20% or 2dB of its original amplitude, calibration shall be re-established and all areas since the previous acceptable calibration or check reexamined.

6.12.1.2 If any point on the DAC curve has increased by 20% or 2dB of its original amplitude, calibration shall be re-established and all reportable indications since the previous acceptable calibration or check reevaluated.

6.12.2 Disable the EBS function and position the transducer array such that it is directed toward the cylindrical reflector array mounted on the tool 0° leg. Each applicable transducer/inspection channel should be checked as follows:

6.12.2.1 Move DEC Delay 1 to a position past the end of the gated sweep, i.e. where the DEC will not influence the MTS responses from the MTS reflectors. Position the transducer to obtain the peak responses from each cylindrical reflector in the MTS array used during initial system calibration at the specified waterpaths. Record the reflector identification, indication amplitude, and transit time to the indication from the initial pulse in microseconds.

6.12.2.2 The recorded values should be compared to the data obtained during the initial calibration at Waltz Mill.

6.12.2.2.1 If the response from any reflector has decreased by 20% or 2dB of its original amplitude, calibration shall be reestablished and all areas since the previous acceptable calibration or check reexamined.

6.12.2.2.2 If the response from any reflector has increased by 20% or 2dB of its original amplitude, calibration shall be reestablished and all reportable indications since the previous acceptable calibration or check reevaluated.

6.12.2.2.3 If the response from any reflector in the gated sweep length has moved on the sweep line more than 10% of the sweep reading, correct the sweep range calibration and note the correction in the examination record. If recordable reflectors are noted on the data sheets, those data sheets shall be voided, the new calibration shall be recorded, and areas relative to the voided data re-examined.

6.12.3 Reposition DEC Delay 1 to the delay position established during system calibration.

6.12.4 Verification of the performance of all calibration checks shall be documented. Documentation shall include the date, time, and initials of the operator. See Figure 5. In addition, the operator shall document calibration verification at the beginning and end of a weld scan via signature on the computer data printout.

6.13 Transducer RF Waveforms

Photographic records of transducer RF waveforms shall be collected as follows. These records shall be made at the reactor site.

6.13.1 Position the transducer to obtain the peak response from an appropriate reference reflector.

6.13.2 Display the RF waveform on a calibrated oscilloscope.

6.13.3 Adjust the oscilloscope sweep controls to clearly display the waveform.

6.13.4 Adjust the oscilloscope veritical display so the amplitude of the response is two to four centimeters.

6.13.5 Photograph the displayed waveform and record all pertinent data on the Transducer RF Waveform Data Sheet, Figure 6.

6.13.6 Photographic records of transducer RF waveforms collected after reactor vessel examinations should be made using the same reflector, electronics, waterpath and instrument settings as used prior to the examinations when practical.

7.0 EXAMINATION REQUIREMENTS

7.1 The following activities shall have been completed prior to the performance of any in-field ultrasonic examination of a reactor vessel using the remotely operated inspection tool.

7.1.1 The reactor vessel Examination Program Plan identifying specific plant inspection parameters such as search unit incident angles, calibration standards, water paths, scan lengths, scan locations, and scan increments shall have been prepared.

7.1.2 The ultrasonic equipment shall have been calibrated for all examinations required by the Examination Program Plan and all data recorded in accordance with paragraph 6.0 of this procedure.

7.1.3 The reactor vessel inspection tool shall have been assembled in the configuration on the arrangement drawing applicable to the specific vessel being examined as listed in the Examination Program Plan.

7.1.4 Prior to placing the inspection tool on the reactor vessel, the following tests and checks shall be performed to demonstrate the tool is fully operational and to assure the tool can be safely set on the reactor vessel.

7.1.4.1 Establish "home" position and record all resolver readings and other relevant data. Mechanically measure the distance from the face of transducer zero (TR0) or transducer twenty (TR20) to the spherical target and record this value.

7.1.4.2 Test to ensure that all drives are functional both in manual and computer control.

7.1.4.3 Visually verify that all appropriate hardware is properly secured by lockwire or other suitable means.

7.1.4.4 Check each transducer and associated pulser/amplifier channel by tapping on the face of the transducer and observing the initial pulse.

7.1.4.5 Cavity water clarity shall be adequate to assure visibility of the vessel flange, keyways, and/or core barrel seating surface.

7.1.4.6 Verify that no specimen capsules are installed where the inspection tool legs will seat.

7.1.5 The calibration settings of each transducer/instrumentation system shall be checked using the data previously entered in the Electronic Block Simultor (EBS) with the Sonic system control settings as defined on the Calibration Data Sheets for each examination to be performed.

7.1.6 Once the inspection tool is set on the reactor vessel the tool home position shall be verified by monitoring the TRO or TR20 straight beam inspection channel and positioning the search unit to obtain a peaked response from the spherical target without changing waterpath from that set mechanically in 7.1.4.1. Contact the control room every two days, obtain the refueling water temperature, and record this value on a form similar to the one shown in Figure 7. If the temperature is not within ± 25°F of that used during calibration, advise the control room to notify when temperature is within this range. Alternately, water temperature may be measured directly with a thermometer, not considered MTE equipment. Mercury thermometers are not acceptable for this application.

7.1.7 Calculate the water velocity, record this value, and compare with that determined during system calibration.

7.1.8 Check the instrument calibration and system calibration.

7.2 Prior to initiating a scan per the Examination Program Plan, the flange area shall be subject to preliminary scans while monitoring the TRO or TR20 inspection channel to determine that the tool is properly centered, level, and that water paths (compensated for difference in water velocity, if necessary) correspond with those used during calibration.

7.3 The area to be examined shall be subject to a preliminary scan while monitoring the TRO inspection channel to determine the thickness of the examination area. Ultrasonic thickness readings for each applicable exam catagory shall be recorded on a form similar to the one shown in Figure 8. Use this information to verify that all gates have been set properly. If gating adjustments are necessary at any time during the examination they shall be documented. See Figure 9.

7.4 Each area of the reactor vessel identified in the Examination Program Plan shall be scanned in accordance with the requirements of the Examination Program Plan.

7.4.1 The computer "home" routine shall be used to determine the actual reference position for the nine axes of tool movement at least once each day. When a computer "home" is achieved, a peaked response from the spherical target should be observed on the TRO or TR20 inspection channel and the axes resolver readings shall be noted and compared with those original values recorded per paragraph 7.1.4.1.

7.5 During scanning the following parameters shall be maintained unless otherwise specified in the Examination Program Plan.

7.5.1 Scanning shall be conducted at the calibration sensitivity.

7.5.2 The rate of search unit movement shall be 5 inches per second maximum.

7.5.3 Scan increments shall be three-quarter inches maximum for 1-1/2 inch diameter transducers and three-eighth inches maximum for 3/4 inch diameter transducers.

7.5.4 The required examination volume for welds shall include the weld, both heat affected zones, and one-half the weld thickness of adjacent base material on both sides of the weld.

7.6 The following paragraphs provide general scanning requirements for each area of the reactor vessel. Specific requirements are provided in the Examination Program Plan.

7.6.1 Base Metal Examination

When specified in the Examination Program Plan, the base metal through which angle beams will pass shall be completely scanned by straight beam to detect laminar reflectors where practical.

7.6.1.1 Sensitivity shall be established at a location free of indications by adjusting the first back surface reflection to 80% FSH.

7.6.1.2 Set the back wall gate to monitor the back surface reflection and alarm when the echo amplitude drops to 16% FSH.

7.6.1.3 Alternately, the base metal examination may be conducted as an extension of straight beam examination in accordance with paragraph 7.6.2.1 provided the sensitivity is at least that required in paragraph 7.6.1.1 and the gating and alarm requirements of paragraph 7.6.1.2 are employed.

7.6.2 Vertical and Circumferential Vessel Welds

The extent of each reactor vessel vertical and/or circumferential weld identified in the Examination Program Plan shall be examined in accordance with the following requirements where practical.

7.6.2.1 The entire weld, both heat affected zones, and specified adjacent base material are examined from the vessel ID by longitudinal waves at 0°.

7.6.2.2 The entire weld, both heat affected zones, and specified adjacent base material are examined from the vessel ID by transverse waves at two angles, the difference between which shall be at least 10°, in two opposite directions parallel to the weld and two opposite directions perpendicular to the weld. For purposes of minimum required coverage, adjacent base material need not be examined with both angle beams in both directions. Any combination of two angle beams will satisfy this requirement.

7.6.3 Reactor Vessel Flange-to-Upper Shell Weld

The extent of the reactor vessel flange-to-upper shell weld identified in the Examination Program Plan shall be examined in accordance with the following requirements where practical.

7.6.3.1 The reactor vessel flange-to-upper shell weld, both heat affected zones, and specified adjacent base material are examined from the vessel flange seal surface using longitudinal waves at angles as defined in the Examination Program Plan.

7.6.3.2 When the core barrel is removed the flange-to-upper shell weld may be examined from the vessel ID in accordance with Paragraph 7.6.2, except angle beam scanning perpendicular to the weld will be performed from the vessel shell side only.

7.6.4 Reactor Vessel Nozzle-to-Shell Welds

The extent of each reactor vessel nozzle-to-shell weld identified in the Examination Program Plan shall be examined in accordance with the following requirements where practical.

7.6.4.1 The reactor vessel nozzle-to-shell weld, both heat affected zones, and specified adjacent base material are examined from the nozzle bore using angles and modes as defined in the Examination Program Plan.

NOTE

RHR flow should be off or reduced to the extent possible during this examination. Water clarity shall be such that the nozzle opening is clearly visible from the operating deck.

7.6.5 Nozzle Radius and Protrusion

The extent of each nozzle radius or protrusion identified in the Examination Program Plan shall be examined in accordance with the following requirements where practical.

7.6.5.1 The entire area defined by the Examination Program Plan is examined from the nozzle ID by transverse waves in both circumferential directions.

NOTE

RHR flow should be off or reduced to the extent possible during this examination. Water clarity shall be such that the nozzle opening is clearly visible from the operating deck.

7.6.6 Nozzle-to-Safe Ends Welds

The extent of each reactor vessel nozzle-to-safe end weld identified in the Examination Program Plan shall be examined in accordance with the following requirements where practical.

7.6.6.1 The entire weld, both heat affected zones, and specified adjacent base material are examined from the nozzle bore by longitudinal waves at 0°.

7.6.6.2 The entire weld, both heat affected zones, and specified adjacent base material are examined from the nozzle bore by angled longitudinal waves in two directions parallel to the weld and two directions perpendicular to the weld.

NOTE

RHR flow should be off or reduced to the extent possible during this examination. Water clarity shall be such that the nozzle opening is clearly visible from the operating deck.

7.6.7 Reactor Vessel Flange Ligaments

The extent of the threaded ligaments in the reactor vessel flange identified in the Examination Program Plan shall be examined in accordance with the following requirements where practical.

7.6.7.1 The ligaments between threaded stud holes are examined from the top of the flange using longitudinal waves at 0°.

7.6.8 Full Node Angle Beam Examination of Vertical and Circumferential Vessel Welds

When full node angle beam examinations are specified, the extent of each reactor vessel vertical and/or circumferential weld identified in the Examination Program Plan shall be examined in accordance with the following requirements where practical.

7.6.8.1 The volume of material including the weld, both heat affected zones, and specified adjacent base material within 1/8T of the vessel ID shall be examined in two directions parallel to the weld and two directions transverse to the weld.

7.6.9 Near Surface Examinations of Vertical and Circumferential Vessel Welds

When near surface examinations are specified, the extent of each reactor vessel vertical and circumferential weld identified in the Examination Program Plan shall be examined in accordance with the following requirements where practical.

7.6.9.1 The volume of material including the weld, both heat affected zones, and specified adjacent base material within one inch of the vessel ID shall be examined in two directions parallel to the weld and two directions transverse to the weld.

7.6.9.2 Refer to paragraph 6.10.14 for examination sensitivity adjustment based on clad noise.

8.0 INTERPRETATION AND INVESTIGATION

8.1 The Level II or Level III examiner shall interpret indications in accordance with criteria listed below such that he can assess their being valid or not valid.

8.1.1 The interpretation and investigation level is 50% of the primary reference DAC for:

8.1.1.1 All indications detected during straight beam examinations of vertical and circumferential welds.

8.1.1.2 Indications detected during angle beam examinations of vertical and circumferential welds at transit times representing 25 percent and greater of the vessel through-wall thickness measured from the inner surface.

8.1.1.3 Indications detected during examinations of the flange-to-upper shell weld from the seal surface at locations representing 25 percent and greater of the vessel through-wall thickness measured from the inner surface.

8.1.1.4 Indications detected during examinations of nozzle-to-shell welds from nozzle bores at locations representing 25 percent and greater of the vessel through-wall thickness measured from the inner surface.

8.1.1.5 All indications detected during straight and angle beam examinations of nozzle-to-safe end welds.

8.1.1.6 All indications detected during examinations of reactor vessel flange ligaments.

8.1.1.7 All indications detected during full node angle beam examinations of vertical and circumferential welds.

8.1.1.8 All indications detected during near surface examinations.

8.1.2 The interpretation and investigation level is 20% of the primary reference DAC for:

8.1.2.1 Indications detected during angle beam examinations of vertical and circumferential welds at transit times which represent the inner 25 percent of the vessel through-wall thickness measured from the inner surface.

8.1.2.2 Indications detected during examinations of the flange-to-upper shell weld from the seal surface at locations which are within 25 percent of the vessel through-wall thickness measured from the inner surface.

8.1.2.3 Indications detected during examinations of nozzle-to-shell welds from nozzle bores at locations which are within 25 percent of the vessel through-wall thickness measured from the inner surface.

8.1.2.4 All indications detected during examinations of nozzle radii and protrusions.

8.1.3 The interpretation and investigation levels for the base material examination are defined as follows:

8.1.3.1 All areas where indications are equal to exceed the amplitude of the remaining back reflection.

8.1.3.2 All areas that produce a continuous total loss of back reflection accompanied by a continuous indication in a singular plane.

8.2 Valid indications are the result of flaw reflectors such as cracks, lack of penetration, lack of fusion, inclusions, slag and porosity. All other indications are considered not valid, including those due to: scanning noise, grain structure, beam redirection, loss of interface gating, spurious noise from electrical sources, clad interface, straight beam back surface, mode conversion and geometric reflectors.

8.3 Valid indications meeting the criteria of paragraphs 8.1 and 8.2 shall be investigated by the examiner in terms of the recording requirements in paragraph 9.0.

8.4 Other transducers, search units, frequencies, techniques, etc., may be used to aid interpretation and investigation.

9.0 RECORDING REQUIREMENTS

9.1 All indications shall be identified as valid or non-valid on the data printout. Valid indications having amplitudes which equal or exceed the appropriate interpretation and investigation level within the OD and ID boundaries of the area being examined shall be recorded per the additional requirements of Paragraph 9.4. Valid indications having amplitudes less than the appropriate interpretation and investigation level need only have peak amplitudes noted on the data printout.

9.2 The "Flaw Detect" data acquisition system provides the following information.

9.2.1 A digital readout defining the location of each of the nine axis of tool motion.

9.2.2 Identity of the inspection channel.

9.2.3 The number of indications exceeding the primary reference level.

9.2.4 A digital readout in microseconds of the transit time to the indication(s) referenced from the channel 0 interface position.

9.2.5 The indication amplitude(s) in percent of FSH.

9.3 For examinations of nozzle-to-shell welds from the nozzle bore, "A" scan data will be permanently recorded on videotape for review and interpretation in lieu of use of the "Flaw Detect" data acquisition system. The Sonic Mark VI display or an auxiliary scope may be used. Operation of the system is described as follows:

9.3.1 Adjust the Sonic Mark VI delay and range controls such that the artificial interface marker, set at the transit time defined during system calibration, falls on the first major screen division (10% of sweep length) and the end of the gate set, as a minimum, at the length defined during system calibration, falls on the ninth major screen division (90% of sweep length).

9.3.2 Calculate the Sonic Mark VI horizontal sweep calibration in usec/div at those sweep settings.

9.3.3 If "A" scan data will be recorded from an auxiliary scope in lieu of the Sonic Mark VI, paragraphs 9.3.3.1 through 9.3.3.4 are applicable.

9.3.3.1 Establish an EBS pulse train to start at the sweep location described for the artificial interface and end at the sweep location described for the end of the gate.

9.3.3.2 Calibrate the sweep of the auxiliary "A" scan oscilloscope as follows. Adjust the sweep delay and range controls of the auxiliary "A" scan oscilloscope until the EBS signals described in 9.3.3 are at identical sweep locations as on the Sonic Mark VI. After this adjustment is made, tape down the horizontal fine adjustment knob. The horizontal sweep calibration (usec/div) of the auxiliary "A" scan oscilloscope is then the same as that determined for the Sonic Mark VI in paragraph 9.3.2.

9.3.3.3 Calibrate the vertical scale of the auxiliary "A" scan oscilloscope as follows. Adjust the EBS attenuation controls to obtain a 100% full screen height response for one EBS pulse on the Sonic Mark VI. View this same EBS pulse on the auxiliary "A" scan oscilloscope and adjust the vertical scale such that the amplitude is also 100% of full screen height. After this adjustment is made, tape down the vertical fine adjustment knob.

9.3.3.4 Check the vertical linearity of the auxiliary "A" scan oscilloscope per paragraph 5.2.

9.3.4 Field calibration checks with the EBS shall be recorded at the beginning and end of each nozzle examination.

9.3.5 The following information, as a minimum, shall be prominently displayed on the recording.

9.3.5.1 Plant identification.

9.3.5.2 Nozzle identification.

9.3.5.3 Transducer/channel identification.

9.3.5.4 Artificial interface transit time and sweep position on the auxiliary display.

9.3.5.5 Gate delay and length. Specify the gate end sweep position on the auxiliary display.

9.3.5.6 Sweep calibration in usec/div.

9.3.6 "A" scan, tool position, and timing information shall be permanently recorded for scans of nozzle-to-shell welds from the nozzle bores performed per paragraph 7.6.4.

9.4 The following additional information shall be generated and recorded on an indication data sheet, Figure 10, for each valid indication recorded in terms of a distance-amplitude-curve per paragraphs 8.1.1 and 8.1.2. Prior to recording indications with a particular transducer/inspection channel, calibration and instrument linearity shall have been verified within the periods specified.

9.4.1 Maximum indication amplitude in percent of the DAC calibration curve, search unit location as defined by the nine axis of tool motion, and transit time from the water/steel interface to the indication.

9.4.2 Jog the search unit toward the reflector. Where a 20% DAC interpretation and investigation level is specified, record the search unit location as defined by the nine axes of tool motion and transit time from the water/steel interface to the indication for positions where the indication amplitude drops to 100% DAC, half-maximum amplitude (for indications with peak amplitudes exceeding 100% DAC), 50% DAC, and 20% DAC. Where a 50% DAC interpretation and investigation level is specified, this information shall be recorded for the 100% DAC, half-maximum amplitude (for indications with peak amplitudes exceeding 100% DAC), and 50% DAC positions only.

9.4.3 Jog the search unit away from the reflector. Where a 20% DAC interpretation and investigation level is specified, record the search unit location as defined by the nine axes of tool motion and transit time from the water/steel interface to the indication for positions where the indication amplitude drops to 100% DAC, half-maximum amplitude (for indications with peak amplitues exceeding 100% DAC), 50% DAC,and 20% DAC. Where a 50% DAC interpretation and investigation level is specified, this information shall be recorded for the 100% DAC, half-maximum amplitude (for indications with peak amplitudes exceeding 100% DAC), and 50% DAC positions only.

9.4.4 Jog the search unit back to the area of maximum amplitude and peak the indication. Where a 20% DAC interpretation and investigation level is specified, the length of the reflector shall be determined by scanning along the reflector's major dimension and recording search unit locations as defined by the nine axes of tool motion where the indication amplitude drops to 100%, 50%, and 20% of the DAC curve. Where a 50% DAC interpretation and investigation level is specified, this information shall be recorded for the 100% and 50% DAC positions only.

9.5 Valid indications identified during the base material examination per paragraph 8.1.3 shall be recorded on the data printout in terms of transit time to the indication, peak indication amplitude, and length and width measurements taken from the points at which indication and backwall amplitudes are equal.

9.5.1 Areas identified per paragraph 8.1.3.1 shall be investigated to determine if and to what extent they interfere with angle beam examinations. Where reflectors do interfere, the angle beam technique(s) shall be reviewed toward achieving at least the minimum required coverage of the volume to be examined, and modified to the extent necessary and practical to accomplish this.

9.5.2 Areas identified per paragraph 8.1.3.2 shall be investigated in terms of the appropriate acceptance criteria for laminar reflectors.

9.6 Disassembly of the inspection tool shall not commence until all recorded indications have been assessed in terms of the applicable code criteria, and results are recorded on an indication analysis table similar to that shown in Figure 11.

10.0 EXAMINATION RECORDS

The following information shall be provided to document the examinations.

10.1 The test procedure

10.2 Description of the test system

10.3 Calibration records

10.4 Identification and location of extent of areas examined

10.5 Record of all indications recorded

10.6 Record of all evaluations of indications

10.7 Personnel certifications

10.8 Dates and times of examinations

10.9 Basic calibration block identification

10.10 Couplant

10.11 Surface condition and surfaces from which examinations were performed.

Illustrative Only

WESTINGHOUSE N.S.I.D. INSPECTION SERVICES REACTOR VESSEL U.T. EXAMINATION	PLANT	UNIT	
	OUTAGE	PROCEDURE ISI	REV

LINEARITY

BEFORE [ ] CALIBRATION [ ] EXAMINATION

CHANNEL NO.	PREAMP GAIN	E.B.S. ATTENUATION COARSE	E.B.S. ATTENUATION FINE	EXAMINER	DATE/TIME

AMPLITUDE CONTROL LINEARITY				
REFERENCE AMPLITUDE	dB CHANGE	AMPLITUDE AFTER CHANGE	LIMITS	RECEIVER GAIN
80% FSH	-6 dB		32-48	
80% FSH	-12 dB		16-24	
80% FSH	-18 dB		8-12	
40% FSH	+6 dB		64-96	
20% FSH	+12 dB		64-96	
10% FSH	+18 dB		64-96	

VERTICAL LINEARITY (% F.S.H.)										
FIRST PULSE	10	20	30	40	50	60	70	80	90	100
SECOND PULSE								40		

AFTER [ ] CALIBRATION [ ] EXAMINATION

CHANNEL NO. (SAME AS ABOVE)	PREAMP GAIN (SAME AS ABOVE)	E.B.S. ATTENUATION COARSE	E.B.S. ATTENUATION FINE	EXAMINER	DATE/TIME

AMPLITUDE CONTROL LINEARITY				
REFERENCE AMPLITUDE	dB CHANGE	AMPLITUDE AFTER CHANGE	LIMITS	RECEIVER GAIN
80% FSH	-6 dB		32-48	
80% FSH	-12 dB		16-24	
80% FSH	-18 dB		8-12	
40% FSH	+6 dB		64-96	
[illegible]	+12 dB		[illegible]	
[illegible]	+18 dB		[illegible]	

VERTICAL LINEARITY (% F.S.H.)										
FIRST PULSE	10	20	30	40	50	60	70	80	90	100
SECOND PULSE								40		

EXT

REFER:

SCREEN HEIGHT AND AMPLITUDE CONTROL LINEARITY
DATA SHEET
FIGURE 1

Illustrative Only

WESTINGHOUSE N.S.I.D. INSPECTION SERVICES REACTOR VESSEL U.T. EXAMINATION	PLANT	UNIT	SKETCH 1-1100
	WELD(S)	PACKAGE NO	OUTAGE
	EXAMINER	DATE	PROCEDURE ISI REV

SONIC SYSTEM CONTROLS

CRT

SWEEP DELAY
COURSE ______ FINE ______
SWEEP RANGE
COURSE ______ FINE ______
MODE ___NORM___
SYNC ___DELAY___

RECEIVER

DB COARSE ______
DB GAIN ______
FREQUENCY ______
FILTER ______
DISPLAY ______
CLIPPER ___OFF___

ALARM GATES

BACK GATE
THRESHOLD ______
WIDTH ______
ATTENUATION ______

MONITOR GATE
THRESHOLD ______
ALARM COUNT ______

SYSTEM CONTROLLER

CLOCK ___INT/EXT___ REP. RATE ______ PULSES/SCAN ______ ARTIFICIAL I. F. ______

CHANNEL NO	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
PULSER NO																
PREAMP NO																
PREAMP GAIN																
DEC GATE NO																
DEC DELAY 1																
DEC DELAY 2																
DEC DELAY 3																
DEC DELAY 4																
DEC SLOPE 1																
DEC SLOPE 2																
DEC SLOPE 3																
DEC SLOPE 4																
GATE DELAY																
GATE [illegible]																
GAT[illegible]	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
[illegible]																

[illegible]

UT SYSTEM CONTROLLER DATA SHEET
FIGURE 2

Illustrative Only

WESTINGHOUSE N.S.I.D. INSPECTION SERVICES REACTOR VESSEL U.T. EXAMINATION	PLANT	UNIT	SKETCH 1-1100
	WELD(S)	PACKAGE NO.	OUTAGE
	EXAMINER	DATE	PROCEDURE ISI REV

(1) CHANNEL NO.	(2) TRANSDUCER	TRANSDUCER SERIAL NO.	SIZE (DIA.)	FREQUENCY (MHZ)	INCIDENT ANGLE	REFRACTED ANGLE	WATER PATH	CALIBRATION BLOCK ID	CABLE LENGTH

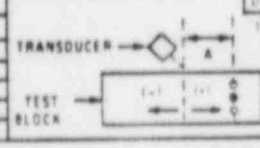
DISTANCE – AMPLITUDE CALIBRATION

(3) REFLECTOR LOCATION	SIGNAL AMPLITUDE	TOTAL TRANSIT TIME	TRANSIT TIME FROM IF TO % OF PEAK					DISTANCE A (SEE FIGURE BELOW)				
			-20%	-50%	100%	+50%	+20%	-20%	-50%	100%	+50%	+20%
IF												
NOTCH												

WATER TEMPERATURE	CALIBRATION	METAL VELOCITY (in / μ second)
WATER VELOCITY (in / μ second)	CALIBRATION	

CALCULATED METAL DISTANCE	
REFLECTOR	CALCULATION

DISTANCE A (ENTRY POINTS)



E.B.S. INFORMATION

SERIAL DATA LINK FREQUENCY PULSE DELAY PULSE PERIOD ATTENUATION COARSE / FINE

GAIN

PULSE ADDRESS NO.	0	1	2	3	4	5	6	7	8	9	A	B	C	D	[illegible]	[illegible]
PULSER [illegible] SETTING																

NOTES

(1) SEE THE DATA SHEET ENTITLED SONIC SYSTEM CONTROLS FOR THE INSTRUMENT SETTINGS
(2) SEE THE SKETCH OF THE TRANSDUCER ARRAY PLATE FOR THE TRANSDUCER POSITION
(3) [illegible] THE CALIBRATION BLOCK FOR INFORMATION ON THE [illegible] AND [illegible] HOLES

REMARKS [illegible]

[illegible]

ULTRASONIC CALIBRATION DATA SHEET

FIGURE 3

Illustrative Only

WESTINGHOUSE N.S.I.D. INSPECTION SERVICES REACTOR VESSEL U.T. EXAMINATION	PLANT	UNIT	SKETCH 1-1100
	WELD(S)	PACKAGE NO	OUTAGE
	TRANSDUCER	CHANNEL NO	PROCEDURE ISI REV

VERIFICATION OF TRANSDUCER CALIBRATION

				CALIBRATION		DISTANCE AMPLITUDE CALIBRATION SETTINGS (SETTINGS FOR EXAMINATION)		
REFLECTOR ID	CALCULATED WATER PATH (INCHES)	TRANSIT TIME (μ SECONDS)	AMPLITUDE (% F.S.H.)	PREAMP GAIN	RECEIVER GAIN	PREAMP GAIN	RECEIVER GAIN	DEC DELAY NO. 1
				EXAMINER				
				DATE	TIME	TYPE OF REFLECTOR(S)		
						WATER VELOCITY		IN/μSECOND

				BEFORE EXAM		
REFLECTOR ID	CALCULATED WATER PATH (INCHES)	TRANSIT TIME (μ SECONDS)	AMPLITUDE (% F.S.H.)	PREAMP GAIN (SAME AS ABOVE)	RECEIVER GAIN (SAME AS ABOVE)	WATER VELOCITY IN/μSECOND
						REMARKS
				EXAMINER		
				DATE	TIME	

				AFTER EXAM		
REFLECTOR ID	CALCULATED WATER PATH (INCHES)	TRANSMIT TIME (μ SECONDS)	AMPLITUDE (% F.S.H.)	PREAMP GAIN (SAME AS ABOVE)	RECEIVER GAIN (SAME AS ABOVE)	WATER VELOCITY IN/μSECOND
						REMARKS
				EXAMINER		
				DATE	TIME	

MTS CALIBRATION DATA SHEET
FIGURE 4

Illustrative Only

WESTINGHOUSE N.S.I.D. INSPECTION SERVICES REACTOR VESSEL U.T. EXAMINATION	PLANT	UNIT	SKETCH 1-1100
	WELD(S)	PACKAGE NO	OUTAGE
	TRANSDUCER(S)		PROCEDURE ISI REV

EXAM LOG

WELDS	CALIBRATION VERIFICATION (DATE/TIME)		SIGNATURE OF EXAMINER	REMARKS
	BEFORE EXAM	AFTER EXAM		

FIELD CALIBRATION VERIFICATION DATA SHEET

FIGURE 5

Illustrative Only

WESTINGHOUSE N.S.I.D. INSPECTION SERVICES REACTOR VESSEL U.T. EXAMINATION	PLANT	UNIT
	OUTAGE	PROCEDURE ISI- REV

TRANSDUCER RF WAVEFORM

TRANSDUCER INFORMATION MANUFACTURER ____ FREQUENCY ____ MHz ACTIVE ELEMENT DIMENSION ____ CONNECTOR TYPE ____ UHF SERIAL NUMBER ____ **SONIC MARK III DATA** SERIAL NUMBER ____ RECEIVER GAIN COARSE ____ RECEIVER GAIN FINE ____ FREQUENCY ____ FILTER ____ DISPLAY ____ CLIPPER ____ OFF	**PRE EXAM** **MONITOR OSCILLOSCOPE** MANUFACTURER ____ MODEL NUMBER ____ SERIAL NUMBER ____ VERTICAL SCALE ____ /DIV. HORIZONTAL SCALE ____ µSEC/DIV CALIBRATION DATE ____ CALIBRATION VALID UNTIL ____ PERFORMED BY ____ DATE ____	PHOTO PRE EXAM
PROGRAM DATA CHANNEL ____ PULSER ____ PREAMP ____ PREAMP GAIN ____ **TEST DATA** TARGET ____ ____ WATERPATH ____	**POST EXAM** **MONITOR OSCILLOSCOPE** MANUFACTURER ____ MODEL NUMBER ____ SERIAL NUMBER ____ VERTICAL SCALE ____ /DIV HORIZONTAL SCALE ____ µSEC/DIV CALIBRATION DATE ____ CALIBRATION VALID UNTIL ____ PERFORMED BY ____ DATE ____	PHOTO POST EXAM

9224-2

TRANSDUCER WAVEFORM DATA SHEET
FIGURE 6

Illustrative Only

REACTOR VESSEL WATER TEMPERATURE

The following information shall be recorded every 2 days during the examination

SITE: ______________________

Date	Time	Water Temperature	Temperature Information Source	Person Recording Information

REACTOR VESSEL WATER TEMPERATURE
FIGURE 7

Illustrative Only

REACTOR VESSEL THICKNESS READINGS

AREA	TRANSIT TIME	THICKNESS	LEVEL II	DATE
Upper Shell				
Intermediate Shell				
Lower Shell				
Bottom Head				
Outlet Nozzle Safe End				
Inlet Nozzle Safe End				

REACTOR VESSEL THICKNESS MEASUREMENTS
FIGURE 8

Illustrative Only

WESTINGHOUSE N.S.I.D. INSPECTION SERVICES REACTOR VESSEL U.T. EXAMINATION	PLANT	UNIT	SKETCH 1:1100
	WELD(S)	PACKAGE NO	OUTAGE
	EXAMINER	DATE/TIME	PROCEDURE ISI REV

ACTUAL I.F. POSITIONS AND GATE CORRECTIONS (IN μ SECONDS)

TRANSDUCER ID	INTERFACE POSITION (ON CRT)	GATE DELAY POSITION	GATE WIDTH POSITION	TOTAL METAL TRAVEL	REMARKS

8/174

EXAMINATION PARAMETER RECORDS SHEET
FIGURE 9

Illustrative Only

WESTINGHOUSE N.S.I.D. INSPECTION SERVICES REACTOR VESSEL U.T. EXAMINATION	PLANT/UNIT	CAL PACKAGE NO	SKETCH
	WELD/SCAN I.D.	TRANSDUCER/CHANNEL	OUTAGE
	EXAMINER (Level II)	DATE	PROCEDURE (S) REV

REFLECTOR SIZING DATA

POSITION ON PRINT OUT

PAGE NO. ON PRINT OUT INDICATION I.D. NO DEPTH RADIUS ALPHA

MEASUREMENT DATA

MEASURED WATER PATH ______ µSEC LONGITUDINAL METAL VELOCITY ________ IN/µSEC 0° BEAM WATER PATH ______ µSEC
PEAK REFLECTOR AMPLITUDE (% DAC) __________ SHEAR METAL VELOCITY ________ IN/µSEC 0° BEAM METAL PATH ______ µSEC

LENGTH MEASUREMENT

LENGTH AXIS ______ ______ COUNTS PER __________

AMPLITUDE	20% DAC	50% DAC	50% PEAK	100% DAC	PEAK	100% DAC	50% PEAK	50% DAC	20% DAC
COUNTS									

WIDTH MEASUREMENT(S)

WIDTH AXIS ______ ______ COUNTS PER __________

LENGTH POSITION NO. 1 __________ COUNTS

AMPLITUDE	20% DAC	50% DAC	50% PEAK	100% DAC	PEAK	100% DAC	50% PEAK	50% DAC	20% DAC
WIDTH COUNTS									
METAL PATH									

LENGTH POSITION NO. 2 __________ COUNTS

AMPLITUDE	20% DAC	50% DAC	50% PEAK	100% DAC	PEAK	100% DAC	50% PEAK	50% DAC	20% DAC
WIDTH COUNTS									
METAL PATH									

LENGTH POSITION NO. 3 __________ COUNTS

AMPLITUDE	20% DAC	50% DAC	50% PEAK	100% DAC	PEAK	100% DAC	50% PEAK	50% DAC	20% DAC
WIDTH COUNTS									
METAL PATH									

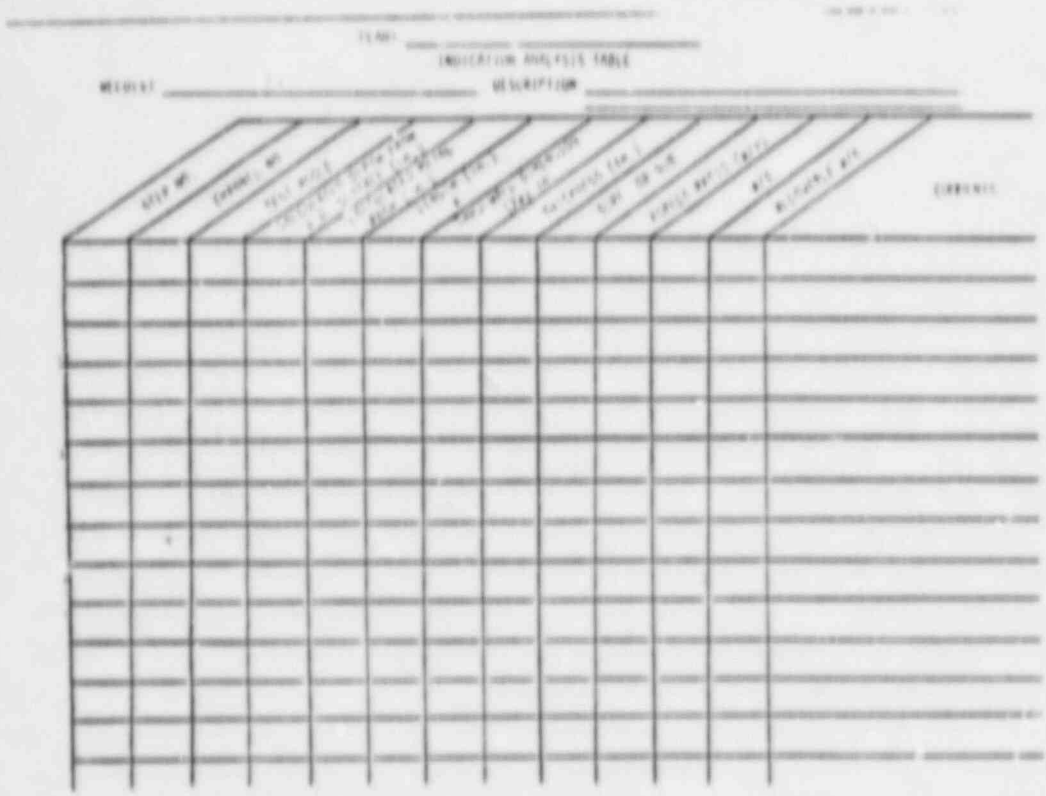
NOTE: USE START POINT FOR REFERENCE. THE COMPUTER PRINT OUT IS CALCULATED FROM THE CENTERLINE OF ℄ AXIS PROJECTED ONTO THE SURFACE. PLATE OFFSET VALUES MUST BE CONSIDERED WHEN DETERMINING THE BEAM ENTRY POINT.

REMARKS

INDICATION DATA SHEET

FIGURE 10

Illustrative Only



ULTRASONIC INDICATION DATA SHEET
FIGURE 11

Nuclear Services Integration Division	INSPECTION SERVICES NONDESTRUCTIVE EXAMINATION PROCEDURE	PROCEDURE NUMBER DMW-ISI-147 Rev. 0

T I T L E

MANUAL ULTRASONIC EXAMINATION

OF

WELDS IN REACTOR VESSELS

Prepared By: B. J. Lefebvre

Approved By: D. C. Adamonis, Manager
Inspection Service

EFFECTIVE DATE	June 27, 1984		REVISED DATE

MANUAL ULTRASONIC EXAMINATION OF WELDS IN REACTOR VESSELS

1.0 SCOPE

1.1 This procedure defines requirements for manual ultrasonic examination of full penetration longitudinal and circumferential pressure retaining welds in ferritic reactor vessel material that is greater than 2 inches thick.

1.2 This procedure satisfies the requirements of the 1980 Edition of Section XI of the ASME Boiler and Pressure Vessel Code with addenda through the Winter, 1980 and the Duquesne Light Company Position on USNRC Regulatory Guide 1.150. Technical contents are based on the ASME Code, including Section XI, IWA-2240, when dictated due to Code omissions and to implement upgraded technology or good practice.

1.3 Procedure DMW-ISI-101, "Preservice and Inservice Examination Documentation"; Procedure DMW-ISI-10, "Qualification of Ultrasonic Manual Equipment"; and the Beaver Valley Unit 2 Examination Program Plan (EPP) are considered part of this procedure. The specific scope of the examinations that are to be performed on all welds and/or areas of systems and components shall be as defined in the Beaver Valley Unit 2 EPP.

2.0 GENERAL REQUIREMENTS

2.1 Personnel performing examinations per this procedure shall be certified to at least Level II for ultrasonic examinations in accordance with Westinghouse procedure PA 10.1 or approved equivalent procedures based on SNT-TC-1A as modified by requirements in the 1980 Edition of Section XI of the ASME Boiler and Pressure Vessel Code with Addenda through the Winter, 1980. Personnel certified as any NDE level for ultrasonic examinations may be employed as assistants.

2.2 Ultrasonic flaw detection instruments shall be of the pulse echo type with an A-scan presentation and shall be qualified to the requirements of DMW-ISI-10 before and after examining all applicable reactor vessel welds.

2.3 Piezoelectric transducers shall have a maximum surface area of one square inch. The nominal frequency shall be 2.25 MHz. The transducers shall be capable of producing satisfactory calibrations at nominal refracted beam angles of 0° (longitudinal wave) and 45° and 60° (transverse wave). Other transducers may be used for supplemental investigations and where metallurgical characteristics preclude use of the transducers specified above. If it is necessary to change either or both the 45° and 60° angles, two other angles shall be used. The angular difference between the two angles shall be at least 10°. The maximum refracted angle shall not exceed 70°.

2.4 The couplant used during the examinations shall be a suitable liquid, semi-liquid, or paste, such as Echogel, Exosen, Sonotrace, Trim, Ultragel, or glycerine. The couplant shall contain no more than 1% by weight of residual sulphur and halogens.

2.5 The item to be examined, including the required extent of adjacent volume to be examined, shall be defined in the Beaver Valley Unit 2 EPP. This information shall be provided to the examiner assigned to conduct the examination. The required volume shall be examined to the maximum extent practical. The extent of the required volume that cannot be examined during the preservice examination shall be noted in the report of recorded examination in accordance with DMW-ISI-101.

2.6 The transducer scan surfaces, including the weld crown, shall be essentially free of dirt, spatter, paint, coatings and irregularities that would impair the smooth, uninterrupt contact of the search unit with the entry surface or the effective coupling of the sound beam into the material being examined.

2.6.1 The preparation of examination surfaces along with examination area access support (e.g., scaffolds, lighting, etc.) when requested by the examiner, shall be the responsibility of the utility.

2.7 Each pass or scan of the transducer shall overlap at least 10% of the transducer (piezoelectric element) dimension perpendicular to the direction of scan.

2.8 The rate of search unit movement shall not exceed six inches per second.

2.9 Scanning shall be performed at a gain setting at least two times (+ 6 dB) the reference level. When this is not feasible, the cause or reason shall be documented.

2.10 The basic calibration block containing the basic calibration reflectors used to establish a primary reference response of the examination system and to construct a distance-amplitude correction curve shall satisfy the requirements of the 1980 Edition of the ASME Boiler and Pressure Vessel Code with addenda through the Winter of 1980. Calibration blocks and a listing of the weld or groups of welds for which they are individually applicable shall be identified in the EPP.

3.0 SYSTEM CALIBRATION-GENERAL REQUIREMENTS

3.1 Prior to performing examinations, the complete examination system shall be calibrated on the applicable calibration block(s) for the examinations to be performed. The examination system is defined as the ultrasonic instrument (and battery pack, if applicable); cable(s); transducer(s); couplant; any other apparatus, instrument, or circuit employed between the instrument and the calibration block surface. Once calibration has been established, any change to any part of the examination system will require verification of the original calibration. See paragraphs 6.2 and 6.3.

3.2 The centerline of search units shall be at least 1-1/2 inches from the nearest side of the block when calibrating on standard reference blocks. The front of the search unit shall be oriented approximately parallel to the major axis of the reference reflector (sound beam perpendicular to major axis of reflector). The sound beam shall not be directed into the corner formed by the hole and the side of the block. Staggered holes shall be utilized for straight beam calibration and in-line holes for angle beam calibration.

3.3 The temperature difference between the surface of the calibration block and the surface of the item to be examined shall not exceed 25°F.

3.4 Each calibration shall be performed from the surface (clad or unclad) corresponding to the surface of the component from which the examination will be performed.

3.5 The ultrasonic instrument shall provide linear vertical presentation within $\pm$ 5% of the full screen height for at least 80% of the calibrated screen height (base line to maximum calibrated screen point(s)). The instrument screen height/linearity shall be verified per paragraph 2.2 before and after examining all applicable reactor vessel welds.

3.6 The ultrasonic instrument shall utilize an amplitude control, accurate over its useful range to $\pm$ 20% of the nominal amplitude ratio, to allow measurement of indications beyond the linear range of the vertical display on the screen. The instrument amplitude control linearity shall be verified per paragraph 2.2 before and after examining all applicable reactor vessel welds.

* 3.7 Any controls which affect the instrument linearity (e.g., reject, or clipping) shall be in the off or minimum position for linearity checks, calibrations, and examinations. Once adjustment of filters is established during system calibration, they shall remain fixed for the period of the examinations for which the calibration is applicable.

3.8 Photographic records of RF pulse waveforms shall be obtained for each transducer, before and after examining all applicable reactor vessel welds. Photographic records of transducer RF waveforms shall be collected as follows.

3.8.1 Position the transducer to obtain the peak response from an appropriate reflector, e.g. backwall.

3.8.2 Display the RF waveform on a calibrated oscilloscope.

3.8.3 Adjust the oscilloscope sweep controls to clearly display the waveform.

3.8.4 Adjust the oscilloscope vertical display so the amplitude of the response is two to four centimeters.

3.8.5 Photograph the displayed waveform and record all pertinent data. See Figure 1.

3.8.6 Photographic records of transducer RF waveforms collected after reactor vessel examinations should be made using the same reflector, electronics, and instrument settings as used prior to the examinations when practical.

3.9 Documentation of general calibration data shall be in accordance with DMW-ISI-101.

* Denotes where IWA-2240 is involked as referenced in 1.2.

4.0 STRAIGHT BEAM CALIBRATION

4.1 Sweep range shall be calibrated to provide linear spacing of the appropriate reflectors:

4.1.1 Position the search unit to obtain the maximum response from the 1/4 T side-drilled hole. Position the left edge of the 1/4 T hole indication to 20% of the sweep length.

4.1.2 Position the search unit to obtain the maximum response from the 3/4 T hole. Position the left edge of the 3/4 T hole indication to 60% of the sweep length.

4.1.3 The delay and range controls shall be adjusted until the indication from the 1/4 T hole starts at 20% of the sweep length and the indication from the 3/4 T hole starts at 60% of the sweep length.

4.2 The distance-amplitude correction (DAC) curve shall be established in the following manner:

4.2.1 Position the search unit to obtain the maximum response from the calibration hole that produces the highest amplitude signal.

4.2.2 Adjust the instrument sensitivity to obtain an 80% full screen height indication from the hole. The location of the peak amplitude of the indication shall be marked on the screen of the test instrument. The sensitivity established in this step is referred to as the reference sensitivity.

4.2.3 With the search unit at this peaked signal location, the system vertical linearity will be re-verified by decreasing the instrument sensitivity by 6 dB, and then by an additional 6 dB. The resulting signal decreases shall be within 32% to 48% full screen height and 16% to 24% full screen height, respectively.

4.2.4 Position the search unit to obtain the maximum response from another calibration hole and the peak indication location shall be marked on the instrument screen.

4.2.5 Position the search unit to obtain the maximum response from the third calibration hole and the peak indication location shall be marked on the instrument screen.

4.2.6 The three marked points on the instrument screen shall be connected by a smooth curve which is extended through the full thickness to be examined to form the distance-amplitude correction curve.

4.3 Documentation of data obtained during straight beam calibration shall be in accordance with DMW-ISI-101.

5.0 ANGLE BEAM CALIBRATION

5.1 Sweep range shall be calibrated to allow display of the maximum thickness required to be examined within 80% of the sweep length. The sweep shall be calibrated as follows to provide linear spacing of the appropriate reflectors.

5.1.1 Position the search unit for the maximum response from the 1/4 T side-drilled hole in the applicable calibration block. The left edge of the indication from the 1/4 T hole shall be positioned to 20% of the sweep length.

5.1.2 Position the search unit to obtain the maximum response from the 3/4 T hole. The left edge of the hole shall be positioned to 60% of the sweep length.

5.1.3 The delay and range controls shall be adjusted until the 1/4 T and 3/4 T hole reflections start at 20% and 60% of the sweep length, respectively.

5.1.4 The search unit will then be positioned to obtain the maximum response from the square notch on the opposite surface. The indication will appear near 80% of the sweep length.

5.1.5 When the above calibration has been completed, two divisions on the sweep will equal 1/4 T of the calibration block T and the full sweep range will equal 1 1/4 T.

5.1.6 When conditions require examination of a volume that exceeds 1 1/4 T (5/8 node), sweep range and reflector positions specified in 5.1.1 thru 5.1.5 shall be altered as necessary to ensure that at least the volume required to be examined is displayed on 100% of the sweep length.

5.2 Distance - amplitude correction (primary reference level) shall be established as follows:

5.2.1 Position the search unit to obtain the maximum response from the side drilled hole that produces the highest amplitude indication and the instrument sensitivity shall be set to produce an 80% full screen height signal from the hole. The sensitivity established in this step is referred to as the reference sensitivity.

5.2.2 With the search unit at this peaked signal location, the system vertical linearity will be re-verified by decreasing the instrument sensitivity by 6 dB, and then by an additional 6 dB. The resulting signal decrease shall be within 32% to 48% full screen height and 16% to 24% full screen height respectively.

5.2.3 The examination system gain shall be returned to the reference sensitivity level and the peak indication amplitude will be determined from the remaining side-drilled holes at the 1/8, 1/4, 3/8, and 5/8 node locations. When it is not possible to obtain a meaningful signal at the 5/8 node location, the following alternate technique shall be used:

* (a) The dB difference in amplitude between the 1/2 T and 3/4 T positions shall be determined.

(b) Decrease the 3/4 T calibrated reflector amplitude by 2 x the value determined in (a) and read the resulting amplitude of this signal to the nearest 1% of full screen height.

(c) Mark the resulting amplitude in (b) at the appropriate sweep location that represents the 5/8 node location.

A distance-amplitude correction curve shall be constructed by connecting the peaked points on the screen to form a curved line.

5.2.4 The search unit shall then be positioned to obtain the peak amplitude from the notch on the opposite surface of the block and the location of the peak shall be marked on the instrument screen.

5.2.5 Reference points at 50% and 20% DAC of the distance-amplitude curve shall be established on the screen by decreasing each DAC curve reference point by 6 dB and then by an additional 8 dB. The resulting 50% and 20% DAC points shall be connected by curved lines drawn on the screen. To minimize screen clutter, a line connecting the 50% points may be omitted, provided the individual points are clearly visible. When investigating indications to the 50% DAC level, a line connecting applicable 50% DAC reference points must be visualized or the reference sensitivity may be increased 6 dB and the 100% DAC curve may be used to represent the 50% DAC level.

5.3 Data for determining transducer beam spread (scribe/ref. line data) shall be obtained as follows:

(a) Position the search unit to obtain a peaked indication from the 1/4 T hole. Measure the distance from the transducer exit point to the scribe line on the calibration block.

(b) Move the search unit toward the 1/4 T hole until the signal amplitude is 50% of the maximum amplitude. Measure the distance from the transducer exit point to the scribe line on the calibration block. Move the search unit toward the 1/4 T hole until the signal amplitude is 20% of the maximum amplitude. Measure the distance from the transducer exit point to the scribe line on the calibration block.

(c) Move the search unit away from the 1/4 T hole until the signal amplitude is again 50% of the maximum amplitude. Measure the distance from the transducer exit point to the scribe line on the calibration block. Move the search unit toward the 1/2 T hole until the signal amplitude is 20% of the maximum amplitude. Measure the distance from the transducer exit point to the scribe line on the calibration block.

(d) Repeat steps (a), (b), and (c) for the 1/2 T and 3/4 T holes.

5.4 Documentation of data obtained during angle beam calibration shall be in accordance with DMW-ISI-101.

6.0 SYSTEM CALIBRATION VERIFICATION

6.1 Calibration shall be performed prior to the use of the system in the thickness range to be examined. Calibration verification shall be performed on at least two of the basic calibration reflectors at the end of examinations for which they are applicable, or every 4 hours during the examination, whichever is less, and when Level II examination personnel are changed.

6.2 If any point on the DAC curve has moved on the sweep line more than 10% of the sweep division reading, the sweep range calibration shall be corrected and the corrections shall be noted in the examination documentation. If any recordable reflectors have been noted on data sheets after the previously acceptable sweep range calibration, the questionable data shall be voided, the new calibration shall be documented, and areas relative to the voided data shall be re-examined.

6.3 If any point on the DAC curve has decreased 20% or 2 dB of its original amplitude, all data generated since the last calibration or calibration verification shall be marked void. A new calibration shall be performed and documented and the voided examination areas shall be reexamined. If any point on the DAC curve has increased more than 20% or 2 dB of its original amplitude, all recordable indications noted since the last acceptable calibration or calibration verification shall be reexamined using the corrected calibration data and their corrected recorded values shall be noted on the data sheets.

7.0 STRAIGHT BEAM EXAMINATION FOR LAMINAR REFLECTORS (BASE METAL EXAMINATION)

7.1 Prior to the initial angle beam examination, the base metal through which the angle beams will travel shall be scanned with a straight beam search unit to detect laminar reflectors which might affect the interpretation of angle beam results and to detect laminar reflectors for acceptance. This examination is to be performed only during the preservice examination.

7.2 Scanning for laminar reflectors shall be performed at a gain setting that gives an initial back surface reflection of nominally 80% of full screen height at an indication-free location of the component to be tested. The back reflection indication shall be positioned to 80% of the sweep length.

* 7.3 Alternatively, straight beam examinations for laminar reflectors may be conducted as an extension of the straight beam examination for planar reflectors (Ref. 4.0 and 8.5) if the planar reflector examination sensitivity is at least equal to that required in 7.2. If laminar indications are detected by the alternate method, the indications shall be investigated at the sensitivity required in 7.2 and recorded in accordance with 7.5.

7.4 Areas containing laminar indications that causes either or both of the following shall be recorded:

(a) All areas where the indications are equal to or greater than the remaining back reflection.

(b) All areas where one or more discontinuties produce a continuous total loss of back reflection accompanied by continuous indications in the same plane.

7.5 The boundary of each area producing recordable laminar indications shall be recorded at increments not exceeding 1 inch. The plotting shall be such that a plan view showing the size, shape, and location of the area relative to the circumferential zero reference, weld centerline, and appropriate component surface is generated. The sweep location of indications which equal or exceed the criteria in 7.4 shall be recorded along with an identification of the criteria (7.4a or 7.4b) that was exceeded.

7.6 Information recorded in 7.5 shall be used to determine if the lamination will interfere with the angle beam tests. An indication determined to be non-interfering shall be recorded as a GENERAL INDICATION. Indications determined to be interfering shall be recorded as an EXAMINATION LIMITATION.

7.7 Where reflectors do interfere with angle beam examinations, the angle beam technique (including beam angle and sweep range) shall be reviewed and modified to the extent practical to achieve at least the minimum required coverage of the volume required to be examined.

7.8 Documentation of data obtained during straight beam examinations for laminar reflectors shall be in accordance with DMW-ISI-101.

8.0 EXAMINATION OF VESSEL WELDS

8.1 Examinations shall be conducted at a gain setting at least two times (+ 6 dB) the reference level. When this is not feasible, the cause or reason shall be documented.

8.2 The rate of search unit movement shall not exceed six inches per second.

8.3 Each pass or scan of the transducer shall overlap at least 10% of the transducer (piezoelectric element) dimension perpendicular to the direction of the scan.

8.4 The temperature of the examination surface shall be determined and related to the calibration block temperature. Record the temperature difference in terms of plus or minus degrees. The temperature difference between the calibration block and the surface of the item to be examined shall not exceed 25°F.

8.5 The volume of weld and adjacent base material that is to be examined shall be described in the Beaver Valley Unit 2 EPP. The volumes defined shall be scanned by straight and angle beam techniques. Two angle beams having nominal angles of 45 and 60 degrees with respect to a line drawn perpendicular to the examination surface will normally be used. Other pairs of angles may be used as long as the measured difference between the angles is at least 10 degrees.

8.6 Scanning of the examination volume shall be performed from both sides of the weld on the same surface. Where component configuration or adjacent parts of the component are such that scanning from both sides of the weld is not feasible, such limitations shall be included in the report of the examination.

8.7 The examination volume shall be scanned with angle beam search units directed both at right angles to the weld axis and along the weld axis. Each examination shall be performed in two directions, i.e., approaching the weld from opposite directions and parallel to the weld from opposite directions. Scanning directions shall be identified by numbers as described in DMW-ISI-101.

8.8 The angle beam search units shall be aimed at right angles to the weld axis with the search unit manipulated so that the ultrasonic sound wave passes through all the weld metal when scanning for reflectors oriented parallel to the weld. The adjacent base metal need not be examined with both angle beams from both directions. Any combination of two angle beams will satisfy this requirement.

8.9 When scanning for reflectors oriented transverse to longitudinal and circumferential welds, the search units shall be aimed parallel to the axis of the weld. The search unit shall be manipulated so that the ultrasonic sound wave passes through all the required examination volume. Scanning shall be done in two directions 180 degrees to each other to the extent possible.

9.0 INTERPRETATION AND INVESTIGATION

9.1 The examiner shall interpret all indications that exceed 20% of the primary reference DAC such that he can assess their source and cause in terms of their being either valid or non-valid. Indications or reflectors from or near the root of welds and clad surfaces may require other aids. See paragraph 9.3.

9.1.1 Valid indications are reflectors caused by flaws, such as cracks, lack of penetration or fusion, inclusions and porosity. All other indications are considered non-valid, including those due to: scanning noise, grain structure, beam redirection, internal liquid levels, clad interface, straight beam back surface and geometric reflectors.

9.2 Reflector indications that exceed 20% of primary reference DAC shall be investigated by the examiner, in terms of the recording requirements of paragraph 10.0.

9.3 Other transducers, search units, frequencies, techniques, etc., may be used to aid interpretation and investigation.

9.3.1 If such aids necessitate use of any control that cannot be positively returned to its calibrated position, (such as a potentiometer control on sweep, damping, uncalibrated gain, etc.) primary reference calibration shall be verified before use and, re-established prior to continuing examinations.

10.0 RECORDING INDICATIONS

10.1 Prior to recording reflector indications that require dimensioning, complete primary reference calibration, including linearity check shall be verified. Scribe/Ref. line data shall be verified.

10.2 Reflector indications which provide a response equal to or greater than 20% of the primary reference DAC and are at sweep locations representing the inner 25% of the component through-wall thickness measured from the inner surface shall be considered as--recordable indications and noted as RI.

10.2.1 For each such indication, peak amplitude, sweep position, search unit location and direction, beam angle, and measured thickness shall be recorded.

10.2.2 Indications interpreted as non-valid need not be dimensioned, but shall be described with respect to the distance over which the indication is observed and the operators interpretation of the cause.

10.2.3 Indications interpreted as valid shall also be dimensioned to record, as a minimum, sweep positions and search unit locations representing minimum and maximum 50% DAC points, parallel and perpendicular to the length axis of the indication and sweep positions and search unit locations representing minimum and maximum 20% DAC points, parallel and perpendicular to the length axis of the indication. For indications that exceed DAC, the minimum and maximum 100% points shall also be noted.

10.3 Reflector indications which provide a response equal to or greater than 50% of primary reference DAC and are at sweep locations representing 25% and greater of the component through-wall thickness measured from the inner surface, shall be considered as--recordable indication--and noted as RI.

10.3.1 For each such indication; peak amplitude, sweep position, search unit location and direction, beam angle, and measured thickness shall be recorded.

* 10.3.2 Indications interpreted as non-valid need not be dimensioned, but shall be described with respect to the distance over which the indication is observed and the operators interpretation of the cause.

* 10.3.3 Indications interpreted as valid shall also be dimensioned to record, as a minimum, sweep positions and search unit locations representing minimum and maximum 50% DAC points, parallel and perpendicular to the length axis of the indication. For indications that exceed DAC, the minimum and maximum 100% points shall also be noted.

10.4 Valid reflector indications which provide a response between 20% and 50% of primary reference DAC and are at sweep positions representing 25% and greater of the component through-wall thickness measured from the inner surface shall be considered as--non-recordable indication--and noted as NRI.

10.4.1 For preservice examination only, each such indication shall be noted on an RI data sheet. As a minimum, peak amplitude, sweep position, search unit location and direction, beam angle, and measured thickness shall be noted.

10.5 The absence of valid indications shall be considered as--no indication--and noted as NI.

11.0 <u>POST CLEANING</u>

11.1 Examined areas shall be dry-wiped to remove excess wet couplant.

12.0 EXAMINATION RESULTS AND DOCUMENTATION

12.1 All data relative to examinations shall be recorded in accordance with DMW-ISI-101.

ILLUSTRATIVE ONLY

WESTINGHOUSE NUCLEAR SERVICES INTEGRATION DIVISION
TRANSDUCER RF WAVEFORM DATA SHEET

UTILITY ____________ PLANT ____________

☐ PRE-INSPECTION ☐ POST INSPECTION

TRANSDUCER DATA

Manufacturer ____________
Style ____________
Frequency ____________
Active Element Dimension ____________
Connector Type ____________
Focal Type ____________
Serial Number ____________

TEST DATA

Target ____________
____
Waterpath ____________
Refracted Angle ____________

PULSER/RECEIVER DATA

Manufacturer ____________
Model Number ____________
Serial Number ____________
Receiver Gain ____________
Receiver Attenuation ____________
Filter ____________
Damping ____________
Repetition Rate ____________
Energy ____________
Frequency ____________

MONITOR OSCILLOSCOPE

Manufacturer ____________
Model Number ____________
Serial Number ____________
Vertical Scale ____________ /div.
Horizontal Scale ____________ usec/div.
Calibration Date ____________
Calibration Valid Until ____________

Performed by ____________
Date ____________

TRANSDUCER RF WAVEFORM DATA SHEET
FIGURE 1

Nuclear Services Integration Division	INSPECTION SERVICES NONDESTRUCTIVE EXAMINATION PROCEDURE	PROCEDURE NUMBER DMW-ISI-47, Rev. 0

TITLE

MANUAL ULTRASONIC EXAMINATION OF WELDS IN VESSELS

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APPROVED BY: D. C. Adamonis, Manager
Inspection Service

EFFECTIVE DATE	June 13, 1984		REVISED DATE	

MANUAL ULTRASONIC EXAMINATION OF WELDS IN VESSELS

1.0 SCOPE

1.1 This procedure defines requirements for manual ultrasonic examination of full penetration longitudinal and circumferential pressure retaining welds in ferritic vessel material (wrought or cast) greater than 2 inches thick.

1.2 This procedure satisfies the requirements of the 1980 Edition of Section XI of the ASME Boiler and Pressure Vessel Code with addenda through the Winter, 1980. Technical contents are based on the ASME Code, including Section XI, IWA-2240, when dictated due to Code omissions and to implement upgraded technology or good practice.

1.3 Procedure DMW-ISI-101, "Preservice and Inservice Examination Documentation"; Procedure DMW-ISI-10, "Qualification of Ultrasonic Manual Equipment"; and the Beaver Valley Unit 2 Examination Program Plan (EPP) are considered part of this procedure. The specific scope of the examinations that are to be performed on all welds and/or areas of systems and components shall be defined in the Beaver Valley Unit 2 EPP.

2.0 GENERAL REQUIREMENTS

2.1 Personnel performing examinations per this procedure shall be certified to at least Level II for ultrasonic examinations in accordance with Westinghouse procedure PA 10.1 approved or equivalent procedures based on SNT-TC-1A as modified by requirements in the 1980 Edition of Section XI of the ASME Boiler and Pressure Vessel Code with Addenda through the Winter, 1980. Personnel certified as any NDE level for ultrasonic examinations may be employed as assistants.

2.2 Ultrasonic flaw detection instruments shall be of the pulse echo type with an A-scan presentation and shall be qualified to the requirements of DMW-ISI-10 at the beginning of each period of extended use. Qualifications may be valid for a period not to exceed three months.

2.3 Piezoelectric transducers shall have a maximum surface area of one square inch. The nominal frequency shall be 2.25 MHz. The transducers shall be capable of producing satisfactory calibrations at nominal refracted beam angles of 0° (longitudinal wave) and 45° and 60° (transverse wave). Other transducers may be used for supplemental investigations and where metallurgical characteristics preclude use of the transducers specified above. If it is necessary to change either or both the 45° and 60° angles, two other angles shall be used. The angular difference between the two angles shall be at least 10°. The maximum refracted angle shall not exceed 70°.

2.4 The couplant used during the examinations shall be a suitable liquid, semi-liquid, or paste, such as Echogel, Exosen, Sonotrace, Trim, Ultragel, or glycerine. The couplant shall contain no more than 1% by weight of residual sulphur and halogens.

2.5 The item to be examined, including the required extent of adjacent volume to be examined, shall be defined in the Beaver Valley Unit 2 EPP. This information shall be provided to the examiner assigned to conduct the examination. The required volume shall be examined to the maximum extent practical. The extent of the required volume that cannot be examined during the preservice examination shall be noted in the report of recorded examination in accordance with DMW-ISI-101.

2.6 The transducer scan surfaces, including the weld crown, shall be essentially free of dirt, spatter, paint, coatings and irregularities that would impair the smooth, uninterrupt contact of the search unit with the entry surface or the effective coupling of the sound beam into the material being examined.

2.6.1 The preparation of examination surfaces along with examination area access support (e.g., scaffolds, lighting, etc.) when requested by the examiner, shall be the responsibility of the utility.

2.7 Each pass or scan of the transducer shall overlap at least 10% of the transducer (piezoelectric element) dimension perpendicular to the direction of scan.

2.8 The rate of search unit movement shall not exceed six inches per second.

2.9 Scanning shall be performed at a gain setting at least two times (+ 6 dB) the reference level. When this is not feasible, the cause or reason shall be documented.

2.10 The basic calibration block containing the basic calibration reflectors used to establish a primary reference response of the examination system and to construct a distance-amplitude correction curve shall satisfy the requirements of the 1980 Edition of the ASME Boiler and Pressure Vessel Code with addenda through the Winter of 1980. Calibration blocks and a listing of the weld or groups of welds for which they are individually applicable shall be identified in the EPP.

3.0 SYSTEM CALIBRATION- GENERAL REQUIREMENTS

3.1 Prior to performing examinations, the complete examination system shall be calibrated on the applicable calibration block(s) for the examinations to be performed. The examination system is defined as the ultrasonic instrument (and battery pack, if applicable); cable(s); transducer(s); couplant; any other apparatus, instrument, or circuit employed between the instrument and the calibration block surface. Once calibration has been established, any change to any part of the examination system will require verification of the original calibration. See paragraphs 6.2 and 6.3.

3.2 The centerline of search units shall be at least 1-1/2 inches from the nearest side of the block when calibrating on standard reference blocks. The front of the search unit shall be oriented approximately parallel to the major axis of the reference reflector (sound beam perpendicular to major axis of reflector). The sound beam shall not be directed into the corner formed by the hole and the side of the block. Staggered holes shall be utilized for straight beam calibration and in-line holes for angle beam calibration.

3.3 The temperature difference between the surface of the calibration block and the surface of the item to be examined shall not exceed 25°F.

3.4 Each calibration shall be performed from the surface (clad or unclad) corresponding to the surface of the component from which the examination will be performed.

3.5 The ultrasonic instrument shall provide linear vertical presentation within ± 5% of the full screen height for at least 80% of the calibrated screen height (base line to maximum calibrated screen point(s)). The instrument screen height/linearity shall be verified per DMW-ISI-10. See paragraph 2.2.

3.6 The ultrasonic instrument shall utilize an amplitude control, accurate over its useful range to ± 20% of the nominal amplitude ratio, to allow measurement of indications beyond the linear range of the vertical display on the screen. The instrument amplitude control linearity shall be verified per DMW-ISI-10. See paragraph 2.2.

* 3.7 Any controls which affect the instrument linearity (e.g.; reject, or clipping) shall be in the off or minimum position for linearity checks, calibrations, and examinations. Once adjustment of filters is established during system calibration, they shall remain fixed for the period of the examinations for which the calibration is applicable.

3.8 Documentation of general calibration data shall be in accordance with DMW-ISI-101.

4.0 STRAIGHT BEAM CALIBRATION

4.1 Sweep range shall be calibrated to provide linear spacing of the appropriate reflectors:

4.1.1 Position the search unit to obtain the maximum response from the 1/4 T side-drilled hole. Position the left edge of the 1/4 T hole indication to 20% of the sweep length.

4.1.2 Position the search unit to obtain the maximum response from the 3/4 T hole. Position the left edge of the 3/4 T hole indication to 60% of the sweep length.

4.1.3 The delay and range controls shall be adjusted until the indication from the 1/4 T hole starts at 20% of the sweep length and the indication from the 3/4 T hole starts at 60% of the sweep length.

4.2 The distance-amplitude correction (DAC) curve shall be established in the following manner:

* Denotes where IWA-2240 is involked as referenced in 1.2.

4.2.1 Position the search unit to obtain the maximum response from the calibration hole that produces the highest amplitude signal.

4.2.2 Adjust the instrument sensitivity to obtain an 80% full screen height indication from the hole. The location of the peak amplitude of the indication shall be marked on the screen of the test instrument. The sensitivity established in this step shall be referred to as the reference sensitivity.

4.2.3 With the search unit at this peaked signal location, the system vertical linearity will be re-verified by decreasing the instrument sensitivity by 6 dB, and then by an additional 6 dB. The resulting signal decreases shall be within 32% to 48% full screen height and 16% to 24% full screen height, respectively.

4.2.4 Position the search unit to obtain the maximum response from another calibration hole and the peak indication location shall be marked on the instrument screen.

4.2.5 Position the search unit to obtain the maximum response from the third calibration hole and the peak indication location shall be marked on the instrument screen.

4.2.6 The three marked points on the instrument screen shall be connected by a smooth curve which is extended through the full thickness to be examined to form the distance-amplitude correction curve.

4.3 Documentation of data obtained during straight beam calibration shall be in accordance with DMW-ISI-101.

5.0 ANGLE BEAM CALIBRATION

5.1 Sweep range shall be calibrated to allow display of the maximum thickness required to be examined within 80% of the sweep length. The sweep shall be calibrated as follows to provide linear spacing of the appropriate reflectors.

5.1.1 Position the search unit for the maximum response from the 1/4 T side-drilled hole in the applicable calibration block. The left edge of the indication from the 1/4 T hole shall be positioned to 20% of the sweep length.

5.1.2 Position the search unit to obtain the maximum response from the 3/4 T hole. The left edge of the hole shall be positioned to 60% of the sweep length.

5.1.3 The delay and range controls shall be adjusted until the 1/4 T and 3/4 T hole reflections start at 20% and 60% of the sweep length, respectively.

5.1.4 The search unit will then be positioned to obtain the maximum response from the square notch on the opposite surface. The indication will appear near 80% of the sweep length.

5.1.5 When the above calibration has been completed, two divisions on the sweep will equal 1/4 T of the calibration block T and the full sweep range will equal 1 1/4 T.

5.1.6 When test conditions require examination of a volume that exceeds 1 1/4 T (5/8 node), sweep range and reflector positions specified in 4.1.1 thru 4.1.5 shall be altered as necessary to ensure that at least the volume required to be examined is displayed on 100% of the sweep length.

5.2 Distance - amplitude correction (primary reference level) shall be established as follows:

5.2.1 Position the search unit to obtain the maximum response from the side drilled hole that produces the highest amplitude indication and the instrument sensitivity shall be set to produce an 80% full screen height signal from the hole. The sensitivity established in this step shall be referred to as the reference sensitivity.

5.2.2 With the search unit at this peaked signal location, the system vertical linearity will be re-verified by decreasing the instrument sensitivity by 6 dB, and then by an additional 6 dB. The resulting signal decrease shall be within 32% to 48% full screen height and 16% to 24% full screen height respectively.

5.2.3 The examination system gain shall be returned to the reference sensitivity level and the peak indication amplitude will be determined from the remaining side-drilled holes at the 1/8, 1/4, 3/8, and 5/8 node locations. When it is not possible to obtain a meaningful signal at the 5/8 node location, the following alternate technique shall be used:

(a) The dB difference in amplitude between the 1/2 T and 3/4 T positions shall be determined.

(b) Decrease the 3/4 T calibrated reflector amplitude by 2 x the value determined in (a) and read the resulting amplitude of this signal to the nearest 1% of full screen height.

(c) Mark the resulting amplitude in (b) at the appropriate sweep location that represents the 5/8 node location.

A distance-amplitude correction curve shall be constructed by connecting the peaked points on the screen to form a curved line.

5.2.4 The search unit shall then be positioned to obtain the peak amplitude from the notch on the opposite surface of the block and the location of the peak shall be marked on the instrument screen.

5.2.5 Reference points at 50% and 20% DAC of the distance-amplitude curve shall be established on the screen by decreasing each DAC curve reference point by 6 dB and then by an additional 8 dB. The resulting 50% and 20% DAC points shall be connected by curved lines drawn on the screen. To minimize screen clutter, a line connecting the 50% points may be omitted, provided the individual points are clearly visible. When investigating indications to the 50% DAC level, a line connecting applicable 50% DAC reference points must be visualized or the reference sensitivity may be increased 6 dB and the 100% DAC curve may be used to represent the 50% DAC level.

5.3 Data for determining transducer beam spread (scribe/ref. line data) shall be obtained as follows:

(a) Position the search unit to obtain a peaked indication from the 1/4 T hole. Measure the distance from the transducer exit point to the scribe line on the calibration block.

(b) Move the search unit toward the 1/4 T hole until the signal amplitude is one-half the maximum amplitude. Measure the distance from the transducer exit point to the scribe line on the calibration block.

(c) Move the search unit away from the 1/4 T hole until the signal amplitude is again one half the maximum amplitude. Measure the distance from the transducer exit point to the scribe line on the calibration block.

(d) Repeat steps (a), (b), and (c) for the 1/2 T and 3/4 T holes.

5.4 Documentation of data obtained during angle beam calibration shall be in accordance with DMW-ISI-101.

6.0 SYSTEM CALIBRATION VERIFICATION

6.1 Calibration shall be performed prior to the use of the system in the thickness range to be examined. Calibration verification shall be performed on at least two of the basic calibration reflectors at the end of examinations for which they are applicable, or every 4 hours during the examination, whichever is less, and when Level II examination personnel are changed.

6.2 If any point on the DAC curve has moved on the sweep line more than 10% of the sweep division reading, the sweep range calibration shall be corrected and the corrections shall be noted in the examination documentation. If any recordable reflectors have been noted on data sheets after the previously acceptable sweep range calibration, the questionable data shall be voided, the new calibration shall be documented, and areas relative to the voided data shall be re-examined.

6.3 If any point on the DAC curve has decreased 20% or 2 dB of its original amplitude, all data generated since the last calibration or calibration verification shall be marked void. A new calibration shall be performed and documented and the voided examination areas shall be reexamined. If any point on the DAC curve has increased more than 20% or 2 dB of its original amplitude, all recordable indications noted since the last acceptable calibration or calibration verification shall be reexamined using the corrected calibration data and their corrected recorded values shall be noted on the data sheets.

7.0 STRAIGHT BEAM EXAMINATION FOR LAMINAR REFLECTORS (BASE METAL EXAMINATION)

7.1 Prior to the initial angle beam examination, the base metal through which the angle beams will travel shall be scanned with a straight beam search unit to detect laminar reflectors which might affect the interpretation of angle beam results and to detect laminar reflectors for acceptance. This examination is to be performed only during the preservice examination.

7.2 Scanning for laminar reflectors shall be performed at a gain setting that gives an initial back surface reflection of nominally 80% of full screen height at an indication-free location of the component to be tested. The back reflection indication shall be positioned to 80% of the sweep length.

* 7.3 Alternatively, straight beam examinations for laminar reflectors may be conducted as an extension of the straight beam examination for planar reflectors (Ref. 4.0 and 8.5) if the planar reflector examination sensitivity is at least equal to that required in 7.2. If laminar indications are detected by the alternate method, the indications shall be investigated at the sensitivity required in 7.2 and recorded in accordance with 7.5.

7.4 Areas containing laminar indications that causes either or both of the following shall be recorded:

(a) All areas where the indications are equal to or greater than the remaining back reflection.

(b) All areas where one or more discontinuties produce a continuous total loss of back reflection accompanied by continuous indications in the same plane.

7.5 The boundary of each area producing recordable laminar indications shall be recorded at increments not exceeding 1 inch. The plotting shall be such that a plan view showing the size, shape, and location of the area relative to the circumferential zero reference, weld centerline, and appropriate component surface is generated. The sweep location of indications which equal or exceed the criteria in 7.4 shall be recorded along with an identification of the criteria (7.4a or 7.4b) that was exceeded.

7.6 Information recorded in 7.5 shall be used to determine if the lamination will interfere with the angle beam tests. An indication determined to be non-interfering shall be recorded as a GENERAL INDICATION. Indications determined to be interfering shall be recorded as an EXAMINATION LIMITATION.

7.7 Where reflectors do interfere with angle beam examinations, the angle beam technique (including beam angle and sweep range) shall be reviewed and modified to the extent practical to achieve at least the minimum required coverage of the volume required to be examined.

7.8 Documentation of data obtained during straight beam examinations for laminar reflectors shall be in accordance with DMW-ISI-101.

8.0 EXAMINATION OF VESSEL WELDS

8.1 Examinations shall be conducted at a gain setting at least two times (+ 6 dB) the reference level. When this is not feasible, the cause or reason shall be documented.

8.2 The rate of search unit movement shall not exceed six inches per second.

8.3 Each pass or scan of the transducer shall overlap at least 10% of the transducer (piezoelectric element) dimension perpendicular to the direction of the scan.

8.4 The temperature of the examination surface shall be determined and related to the calibration block temperature. Record the temperature difference in terms of plus or minus degrees. The temperature difference between the calibration block and the surface of the item to be examined shall not exceed 25°F.

8.5 The volume of weld and adjacent base material that is to be examined shall be described in the Beaver Valley Unit 2 EPP. The volumes defined shall be scanned by straight and angle beam techniques. Two angle beams having nominal angles of 45 and 60 degrees with respect to a line drawn perpendicular to the examination surface will normally be used. Other pairs of angles may be used as long as the measured difference between the angles is at least 10 degrees.

8.6 Scanning of the examination volume shall be performed from both sides of the weld on the same surface. Where component configuration or adjacent parts of the component are such that scanning from both sides of the weld is not feasible, such limitations shall be included in the report of the examination.

8.7 The examination volume shall be scanned with angle beam search units directed both at right angles to the weld axis and along the weld axis. Each examination shall be performed in two directions, i.e., approaching the weld from opposite directions and parallel to the weld from opposite directions. Scanning directions shall be identified by numbers as described in DMW-ISI-101.

8.8 The angle beam search units shall be aimed at right angles to the weld axis with the search unit manipulated so that the ultrasonic sound wave passes through all the weld metal when scanning for reflectors oriented parallel to the weld. The adjacent base metal need not be examined with both angle beams from both directions. Any combination of two angle beams will satisfy this requirement.

8.9 When scanning for reflectors oriented transverse to longitudinal and circumferential welds, the search units shall be aimed parallel to the axis of the weld. The search unit shall be manipulated so that the ultrasonic sound wave passes through all the required examination volume. Scanning shall be done in two directions 180 degrees to each other to the extent possible.

9.0 INTERPRETATION AND INVESTIGATION

9.1 The examiner shall interpret all indications that exceed 20% of the primary reference DAC such that he can assess their source and cause in terms of their being either valid or non-valid. Indications or reflectors from or near the root of welds and clad surfaces may require other aids. See paragraph 9.3.

9.1.1 Valid indications are reflectors caused by flaws, such as cracks, lack of penetration or fusion, inclusions and porosity. All other indications are considered non-valid, including those due to: scanning noise, grain structure, beam redirection, internal liquid levels, clad interface, straight beam back surface and geometric reflectors.

9.2 Reflector indications that exceed 20% of primary reference DAC shall be investigated by the examiner, in terms of the recording requirements of paragraph 10.0.

9.3 Other transducers, search units, frequencies, techniques, etc., may be used to aid interpretation and investigation.

9.3.1 If such aids necessitate use of any control that cannot be positively returned to its calibrated position, (such as a potentiometer control on sweep, damping, uncalibrated gain, etc.) primary reference calibration shall be verified before use and, re-established prior to continuing examinations.

10.0 RECORDING INDICATIONS

10.1 Prior to recording reflector indications that require dimensioning, complete primary reference calibration, including linearity check shall be verified. Scribe/Ref. line data shall be verified.

10.2 Reflector indications which provide a response equal to or greater than 50% of primary reference DAC, and surface indications (other than clad interface) that equal or exceed the amplitude obtained from the notch reflector, shall be considered as--recordable indication--and noted as RI.

10.2.1 For each such indication; peak amplitude, sweep position, search unit location and direction, beam angle, and measured thickness shall be recorded.

* 10.2.2 Indications interpreted as non-valid need not be dimensioned, but shall be described with respect to the

distance over which the indication is observed and the operators interpretation of the cause.

* 10.2.3 Indications interpreted as valid shall also be dimensioned to record, as a minimum, sweep positions and search unit locations representing minimum and maximum 50% DAC points, parallel and perpendicular to the length axis of the indication. For indications that exceed DAC, the minimum and maximum 100% points shall also be noted.

10.3 Valid reflector indications which provide a response between 20% and 50% of primary reference DAC shall be considered as--non-recordable indication--and noted as NRI.

10.3.1 For preservice examination only, each such indication shall be noted on an RI data sheet. As a minimum, peak amplitude, sweep position, search unit location and direction, beam angle, and measured thickness shall be noted.

10.4 The absence of valid indications shall be considered as--no indication--and noted as NI.

11.0 <u>POST CLEANING</u>

11.1 Examined areas shall be dry-wiped to remove excess wet couplant.

12.0 <u>EXAMINATION RESULTS AND DOCUMENTATION</u>

12.1 All data relative to examinations shall be recorded in accordance with DMW-ISI-101.

Nuclear Services Integration Division	INSPECTION SERVICES NONDESTRUCTIVE EXAMINATION PROCEDURE	PROCEDURE NUMBER DMW-ISI-206, Rev. 0

TITLE

MANUAL ULTRASONIC EXAMINATION OF WELDS

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Inspection Service

EFFECTIVE DATE	June 13, 1984		REVISED DATE

MANUAL ULTRASONIC EXAMINATION OF WELDS

1.0 SCOPE

1.1 This procedure defines requirements for manual ultrasonic examination of full penetration circumferential and longitudinal butt welds, and adjacent base materials of these and fillet or corner welds. It is applicable to such welds in piping systems (.25" to 6" thick) and vessel materials (.25 to 2" thick), in ferritic or austenitic steels of either wrought or cast product forms.

1.2 This procedure satisfies the requirements of the 1980 Edition of Section XI of the ASME Boiler and Pressure Vessel Code with addenda through the Winter, 1980.

Technical contents are based on the ASME Code, including Section XI, IWA-2240, when dictated due to Code omissions and to implement upgraded technology or good practice.

1.3 Procedure DMW-ISI-101, "Preservice and Inservice Examination Documentation"; Procedure DMW-ISI-10, "Qualification of Ultrasonic Manual Equipment"; and the Beaver Valley Unit 2 Examination Program Plan (EPP) are considered part of this procedure. The specific scope of the examinations that are to be performed on all welds and/or areas of systems and components shall be defined in the Beaver Valley Unit 2 EPP.

2.0 GENERAL REQUIREMENTS

2.1 Personnel performing examinations per this procedure shall be certified to at least Level II for ultrasonic examinations in accordance with Westinghouse procedure PA 10.1 or approved equivalent procedures based on SNT-TC-1A as modified by requirements in the 1980 Edition of Section XI of the ASME Boiler and Pressure Vessel Code with Addenda through the Winter, 1980. Personnel certified at any NDE Level for ultrasonic examinations may be employed as assistants.

2.2 Ultrasonic flaw detection instruments shall be of the pulse echo type with an A-Scan presentation and shall be qualified to the requirements of DMW-ISI-10 at the beginning of each period of extended use. Qualifications may be valid for a period not to exceed three months.

2.3 Piezoelectric transducers shall be in accordance with TABLE 1 and shall be capable of providing the applicable calibration as required herein.

2.4 The couplant used during the examinations shall be a suitable liquid, semi-liquid, or paste, such as Echogel, Exosen, Sonotrace, Trim, Ultragel, or glycerine. The couplant shall contain no more than 1% by weight of residual sulphur and halogens.

2.5 The item to be examined, including the required extent of adjacent volume to be examined, shall be defined in the Beaver Valley Unit 2 EPP. This information shall be provided to the examiner assigned to conduct the examination. The required volume shall be examined to the maximum extent practical. The extent of the required volume that cannot be examined during the preservice examination shall be noted in the report of recorded examination in accordance with DMW-ISI-101.

2.6 The transducer scan surfaces, including the weld crown, shall be essentially free of dirt, spatter, paint, coatings and irregularities that impair smooth, uninterrupted contact of the search unit with the entry surface or the effective coupling of the sound beam into the material being examined.

2.6.1 The preparation of examination surfaces along with examination area access support (e.g., scaffolds, lighting, etc.) when requested by the examiner, shall be the responsibility of the utility.

2.7 Each pass or scan of the transducer shall overlap at least 10% of the transducer (piezoelectric element) dimension perpendicular to the direction of scan.

2.8 The rate of search unit movement shall not exceed six inches per second.

2.9 Scanning shall be performed at a gain setting at least two times (+ 6 dB) the reference level. When this is not feasible, the cause or reason shall be documented.

2.10 Generally the examinations conducted in accordance with this procedure will be done from the O.D. surface. When examinations are to be conducted from an I.D. surface, calibration must be accomplished on the I.D. of the appropriate calibration block and noted on the report.

2.11 The basic calibration block containing the basic calibration reflectors used to establish a primary reference response of the examination system and to construct a distance-amplitude correction curve shall satisfy the requirements of the 1980 Edition of the ASME Boiler and Pressure Vessel Code with addenda through the Winter of 1980. Calibration blocks and a listing of the weld or groups of welds for which they are individually applicable shall be identified in the EPP.

3.0 SYSTEM CALIBRATION - GENERAL REQUIREMENTS

3.1 Prior to performing examinations, the complete examination system shall be calibrated on the applicable calibration block(s) for the examinations to be performed. The examination system is defined as the ultrasonic instrument (and battery pack, if applicable); cable(s); transducer(s); couplant; any other apparatus, instrument, or circuit employed between the instrument and the calibration block surface. Once calibration has been established, any change to any part of the examination system will require verification of the original calibration. See paragraphs 6.2 and 6.3.

3.2 The beam of the search unit shall be oriented essentially perpendicular to and directed at the mid-point area of the major axis of calibration reflectors. The calibration reflector indications shall not be improved by reflecting the beam off the edge of the block.

3.3 The temperature difference between the surface of the calibration block and the surface of the item to be examined shall not exceed 25°F.

3.4 Each calibration shall be performed from the surface (clad or unclad) corresponding to the surface of the component from which the examination will be performed.

3.5 The ultrasonic instrument shall provide linear vertical presentation within ±5% of the full screen height for at least 80% of the calibrated screen height (base line to maximum calibrated screen point(s)). The instrument screen height/linearity shall be qualified per DMW-ISI-10. See paragraph 2.2.

3.6 The ultrasonic instrument shall utilize an amplitude control, accurate over its useful range to ±20% of the nominal amplitude ratio, to allow measurement of indications beyond the linear range of the vertical display on the screen. The instrument amplitude control linearity shall be qualified per DMW-ISI-10. See paragraph 2.2.

3.7 Sweep range for angle beam calibration shall be sufficiently long so as to allow examination of the entire required volume by a: full "vee path" from one side of the weld; half "vee path" from each side of the weld; or a combination of such coverage so that the entire volume required to be examined is covered by at least 2 sound beam directions. See Figures 1 thru 4.

3.7.1 A "vee path" is composed of a downward and an upward path or leg of the calibrated sound beam in the material through which it is traveling.

A 1/2 vee path is either a downward or an upward leg. Example: for 1 1/2 V (or 3T) calibration where the volume required to be completely covered by the first 1/2 V from one side and by the last (3rd 1/2 V) from the opposite side, 1/2 Vee path coverage from both sides has been satisfied. A 1 1/2 V is composed of 3 half vees and 2 full vees, one of which is inverted.

3.7.2 Sweep shall be calibrated to provide equally spaced increments of the appropriate reference reflectors. Table 2 specifies specific sweep limitations.

* 3.8 Reference sensitivity shall be established from notch reflectors except, for vessels, castings, 1/2 node techniques, and for austenitic materials greater than 1.7 inches thick, drilled holes may be used. For primary loop reactor coolant piping, sensitivity shall be established from the 3/4 T hole. For pressure boundary base metal adjacent to and underneath integrally welded supports, sensitivity shall be established on an O.D. notch or on holes representing an up-leg.

3.9 Documentation of general calibration data shall be in accordance with DMW-ISI-101.

4.0 STRAIGHT BEAM CALIBRATION

4.1 When calibration blocks containing 1/4 T and 3/4 T holes are used, the sweep range shall be calibrated to provide linear time/distance reference.

4.1.1. Position the search unit to obtain the maximum response from the 1/4 T drilled hole. Position the left edge of the 1/4 T hole indication to 15% of the sweep length.

4.1.2. Position the search unit to obtain the maximum response from tne 3/4 T hole. Position the left edge of the 3/4 T hole indication to 45% of the sweep length.

4.1.3. The delay and range controls shall be adjusted until the indication from the 1/4 T hole starts at 15% of the sweep length and the indication from the 3/4 T hole starts at 45% of the sweep length.

*Indicates where ISW 2240 in invoked as referenced in 1.2
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4.2 When calibration blocks contain a 1/2 T hole only, the sweep range shall be calibrated to provide a linear time/distance reference.

4.2.1 Adjust the sweep rate and range controls so as to position the back surface signal from the block to 50% of full sweep length and the first multiple of the back surface to 100% of sweep.

4.3 The distance-amplitude correction (DAC) curve and vertical linearity shall be accomplished in the following manner:

4.3.1 Position the search unit to obtain the maximum response from the calibration hole that produces the highest amplitude and adjust this signal to 80% full screen height (FSH).

4.3.2 Without moving the search unit from this peaked signal location point, check vertical linearity of the system by decreasing signal amplitude 6dB, and then by an additional 6dB. The resulting signal decrease must be within 32% to 48% FSH and 16% to 24% respectively.

4.3.3 If either signal falls outside of its range, such controls as reject, clipping, damping, filtering, etc., shall be adjusted such that this check can be accomplished satisfactorily. If adjustment of controls fails to provide a satisfactory check, the transducer and/or cable shall be changed and calibration repeated. If the system continues to fall outside of the acceptable range, the instrument shall be changed. Once adjustment of controls that affect linearity is established, they shall remain fixed for the period of the examinations.

4.3.4 Maintain the search unit position and return the signal amplitude to 80% FSH as required in 4.3.1. The location of the peak amplitude of this indication shall be marked on the screen of the instrument. The sensitivity established in this step is referred to as the reference sensitivity. When a 1/2 T hole only is provided, a DAC is not required and further screen markings are not required.

4.3.5 Position the search unit to obtain the maximum response from each of the other calibration holes, if applicable, and mark their peak indications location on the instrument screen.

4.3.6 The points marked on the instrument screen shall be connected by a smooth curve which is extended through the full thickness to be examined to form the distance-amplitude correction curve.

4.4 Documentation of data obtained during straight beam calibration shall be in accordance with DMW-ISI-101.

5.0 ANGLE BEAM CALIBRATION

5.1 Sweep range shall be sufficiently long so as to allow examination of the entire required volume as specified in 3.7. and shall be calibrated to provide a linear time/distance reference.

5.2 When primary reference sensitivity is established from a notch, sweep range shall be calibrated from notch reflector(s). When primary reference sensitivity is established from a hole, sweep range shall be calibrated from hole or notch reflector(s).

5.3 Reference sensitivity shall be established by adjusting the peaked signal from the calibration reflector to 80% of FSH (Full Screen Height).

5.3.1 Without moving the search unit from this peaked signal location point, check vertical linearity of the system by decreasing signal amplitude 6dB, and then by an additional 6dB. The resulting signal decrease must be within 32% to 48% FSH and 16% to 24% FSH respectively.

5.3.2 If either signal falls outside of its' range, such controls as reject, clipping, damping, filtering, etc., shall be adjusted such that this check can be accomplished satisfactorily. If adjustment of controls fails to provide a satisfactory check, the transducer and/or cable shall be changed and calibration repeated. If the system continues to fall outside of the acceptable range, the instrument shall be changed. Once adjustment of controls that affect linearity is established, they shall remain fixed for the period of the examinations.

5.4 Return the primary reference signal to 80% FSH and without changing the gain control, determine the peak indication amplitudes from the remaining reflector positions which cover the examination range. Construct a distance amplitude curve (DAC) on the screen by a curved line connecting each of the peaked points. The DAC may be extrapolated at either end for a distance of 1/2 T.

5.5 Where the primary reference sensitivity is established from a notch reflector, signals from the 1/4 T and 3/4 T holes may be used to establish slope of the DAC when 1/2 node examination is used. Alternatively, the next two notch reflector positions may be used to extrapolate the DAC slope to cover the examination range. Holes shall not be used to establish a DAC for examinations requiring a calibration block of less than .8" thick.

5.6 For primary loop RC piping, the slope of the DAC shall be established with the peaked signal from the 1/4 T hole set to 80% FSH and connecting the resulting peaks from the 1/2 T and 3/4 T holes with a curved line. With the peaked signal from the 3/4 T hole adjusted to 80% FSH reference sensitivity, the DAC curve shall be drawn as a line parallel to the line established above. The line shall extend through the 80% reference point and through a vertical line of the screen that represents a minimum of 1 1/4 T or 100% of sweep.

5.7 Reference points at 50% and 20% of DAC shall also be established on the screen by decreasing each DAC curve reference point by 6dB and then by an additional 8dB. The resulting 50% and 20% points shall be connected by curved lines drawn on the screen. To minimize screen clutter, lines connecting 50% points may be deleted, provided the points are clearly defined and are separated by not more than approximately one major screen division. When investigating indications which may or are required to be recorded at the 50% DAC level, a line connecting the applicable adjacent points must be considered or, alternatively, 2X reference sensitivity may be used, with the 100% DAC curve then reresenting the 50% DAC line.

5.8 Documentation of data obtained during straight beam calibration shall be in accordance with DMW-ISI-101.

6.0 SYSTEM CALIBRATION VERIFICATION

6.1 Calibration shall be performed prior to the use of the system in the thickness range to be examined. Calibration verification shall be performed on at least two of the basic calibration reflectors at the end of examinations for which they are applicable, or every 4 hours during the examination, whichever is less, and when examination personnel performing the examination are changed.

6.2 If any point on the DAC curve has moved on the sweep line more than 10% of the sweep division reading, the sweep range calibration shall be corrected and the corrections shall be noted in the examination documentation. If any recordable reflectors have been noted on data sheets after the previously acceptable sweep range calibration, the questionable data shall be voided, the new calibration shall be documented, and areas relative to the voided data shall be re-examined.

6.3 If any point on the DAC curve has decreased 20% or 2 dB of its original amplitude, all data generated since the last calibration or calibration verification shall be marked void. A new calibration shall be performed and documented and the voided examination areas shall be reexamined. If any point on the DAC curve has increased more than 20% or 2 dB of its original amplitude, all recordable indications noted since the last acceptable calibration or calibration verification shall be reexamined using the corrected calibration data and their corrected recorded values shall be noted on the data sheets.

7.0 EXAMINATION

7.1 Examinations shall be conducted at a gain setting at least two times (+ 6 dB) the reference level. When this is not feasible, the cause or reason shall be documented.

7.2 The rate of search unit movement shall not exceed six inches per second.

7.3 Each pass or scan of the transducer shall overlap at least 10% of the transducer (piezoelectric element) dimension perpendicular to the direction of the scan.

7.4 The temperature of the examination surface shall be determined and related to the calibration block temperature. Record the temperature difference in tems of plus or minus degrees. The temperature difference between the calibration block and the surface of the item to be examined shall not exceed 25°F.

7.5 Prior to the initial angle beam examination, the base metal through which the angle beams will travel shall be scanned with a straight beam search unit to detect laminar reflectors which might affect the interpretation of angle beam results and to detect laminar reflectors for acceptance. This examination is to be performed only during the preservice examination for welds in vessels and welds in piping made from plate material.

7.5.1 Scanning for laminar reflectors shall be performed at a gain setting that gives an initial back surface reflection of nominally 80% of full screen height at an indication-free location on the component.

7.5.2 Alternatively, straight beam examinations for laminar reflectors may be conducted as an extension of the straight beam examination for planar reflectors (Ref. 4.0 and 2.6) if the planar reflector examinatin sensitivity is at least equal to that required in 7.5.1. If laminar indicatins are detected by the alternate method, the indications shall be investigated at the sensitivity required in 7.5.1 and recorded in accordance with 7.5.4.

7.5.3. Areas containing laminar indications that causes either or both of the following shall be recorded:

(a) All areas where the indications are equal to or greater than the remaining back reflection.

(b) All areas where one or more discontinuties produce a continuous total loss of back reflection accompanied by continuous indications in the same plane.

7.5.4 The boundary of each area producing recordable laminar indications shall be recorded at increments not exceeding 1 inch. The plotting shall be such that a plan view showing the size, shape, and location of the area relative to the circumferential zero reference, weld centerline, and appropriate component surface is generated. The sweep location of indications which equal or exceed the criteria in 7.5.3 shall be recorded along with an identification of the criteria 7.5.3 (a) or 7.5.3 (b) that was exceeded.

7.5.5 Information recorded in 7.5.4 shall be used to determine if the lamination will interfere with the angle beam tests. An indication determined to be non-interfering shall be recorded as a GENERAL INDICATION. Indications determined to be interfering shall be recorded as an EXAMINATION LIMITATION.

7.5.6 Where reflectors do interfere with angle beam examinations, the angle beam technique (including beam angle and sweep range) shall be reviewed and modified to the extent practical to achieve at least the minimum required coverage of the volume required to be examined.

7.5.7 Documentation of data obtained during straight beam examinations for laminar reflectors shall be in accordance with DMW-ISI-101.

7.6 Examination of Vessel Welds

7.6.1 The volume of weld and adjacent base material that is to be examined shall be described in the Beaver Valley Unit 2 EPP. The volumes defined shall be scanned by straight and angle beam techniques. Angle beams having nominal angles of 45 or 60 degrees with respect to a line drawn perpendicular to the examination surface will normally be used.

7.6.2 The examination shall be performed from two sides of the weld where practicable or as a minimum from one side of the weld. Welds that cannot be examined from at least one side using the angle beam technique shall be examined by another volumetric method.

7.6.3 The examination volume shall be scanned with angle beam search units directed both at right angles to the weld axis and along the weld axis. Each examination shall be performed in two directions, i.e., approaching the weld from opposite directions and parallel to the weld from opposite directions. Scanning directions shall be identified by numbers as described in DMW-ISI-101.

7.6.4 The angle beam search unit shall be aimed at right angles to the weld axis with the search unit manipulated so that the ultrasonic sound wave passes through all the weld metal when scanning for reflectors oriented parallel to the weld.

7.6.5 When scanning for reflectors oriented transverse to longitudinal and circumferential welds, the search unit shall be aimed parallel to the axis of the weld. The search unit shall be manipulated so that the ultrasonic sound wave passes through all the required examination volume. Scanning shall be done in two directions 180 degrees to each other to the extent possible.

7.6.6 Documentation of data obtained during angle beam examinatins shall be in accordance with DMW-ISI-101.

7.7 Examination of Pipe Welds

7.7.1 The identification of areas to be examined, a description of the reference system to be used, the scan directions, and description of calibration blocks to be used shall be included in the Beaver Valley Unit 2 EPP.

7.7.2 The search unit and beam angles specified in Table 1 for piping examinations shall be capable of detecting the calibration reflectors in the applicable calibration block over the required angle beam path. Other angles may be used for evaluation of indications or where wall thickness or geometric configurations preclude use of the normal angle.

7.7.3 The angle beam examination for reflectors parallel to the weld shall be performed by at least a full-V path from one side or at least a one-half V path from two sides of the weld where practical (Examination is limited to 1/2 V-Path for primary loop RC Piping). The scan pattern shall start with the search unit transmitting an angle beam perpendicular to and towards the weld. The search unit shall be moved towards and away from the weld such that a necessary amount of the beam path passes through the maximum accesible volume of weld and base metal to be examined. Concurrent with this scan, the search unit shall be angled right and left and progressively indexed along the length of the weld such that the whole scan pattern follows a "saw-tooth" pattern. The "pitch" of the "saw-tooth"shall be such that the beam covers at least 10 percent of the area covered by the previous adjacent pass. The weld and required amount of adjacent base metal is to be fully scanned by this method. When necessary and practicable, examination shall be accomplished from both sides of the weld. This relates to examination directions 2 and 5 in DMW-ISI-101.

7.7.4 The angle beam examination for reflectors transverse to the weld shall be performed on the weld crown on a single scan path to examine the weld root by one-half V path in two directions along the weld.

7.7.5 Documentation of data obtained during straight beam examinations for laminar reflectors shall be in accordance with DMW-ISI-101.

8.0 INTERPRETATION AND INVESTIGATION OF INDICATIONS

8.1 The examiner shall investigate and interpret all indications that exceed 20% of the primary reference DAC curve to determine the source and cause of the indication. Indications from or near the root of welds and clad surfaces may require the use of supplemental transducers, test frequencies, techniques, etc. to obtain additional information. If the use of such supplemental tests necessitates the use of any control that cannot be positively returned to its calibrated position (such as a potentiometer sweep, damping, or uncalibrated gain control), the primary reference calibration shall be verified before continuing normal examinations.

8.2 The examiner shall determine if the indications are valid or non-valid based on his evaluation of test conditions and data. Valid indications are reflectors caused by flaws such as cracks, lack of penetration, lack of fusion, inclusions, and porosity. Non-valid indications are reflectors from sources other than flaws such as scanning noise, grain structure, beam redirection, internal liquid levels, clad interface, and geometric reflectors.

9.0 RECORDING OF INDICATIONS

9.1 Prior to recording indications that require dimensioning, the complete primary reference calibration, including linearity and scribe/reference line checks shall be verified.

9.2 Valid flaw indications that produce a response equal to or exceeding 50% of the primary DAC curve shall be recorded and dimensioned in accordance with DMW-ISI-101 "Preservice and Inservice Examination Documentation." Surface indications caused by the clad interface or back wall reflectors shall not be considered valid flaw indications. All search unit position and locations dimensions shall be recorded to the nearest tenth of an inch. All valid flaw indications requiring dimensioning shall be considered recordable indications and noted as RI.

9.2.1 For each valid flaw indication requiring dimensioning, peak amplitude, sweep position, and search unit location and direction shall be recorded. For indications that exceed the primary DAC curve amplitude, the minimum and maximum 100% DAC points shall also be noted.

9.3 Valid flaw indications that produce a response less than 50% of the primary DAC curve shall be considered a non-recordable indication and noted as NRI. During preservice inspections, non-recordable indications shall be noted on an RI data sheet. As a minimum peak amplitude, sound beam direction, and scanning side thickness shall be noted for NRI reflectors detected during a preservice inspection.

9.4 Non-valid indications that produce a response equal to or in excess of 50% of the primary DAC curve shall be considered non-dimensioning indications and noted as NDI. Non-dimensioning indications shall be noted on an RI data sheet. As a minimum, peak amplitude, indication sweep position, search unit location at peak amplitude, estimated length, sound beam direction, scanning side thickness, and examiner's interpretation of the cause of the reflector shall be noted.

9.5 Non-valid indications that produce a response less than 50% of the primary DAC curve shall be considered as no indication and noted as NI. Evaluation of all recordable indications (RI) shall be performed in accordance with the requirements of the referenced ASME Boiler and Pressure Vessel Code, Section XI, Articles IWA-3000 and IWB-3000 and Appendix III.

10.0 POST EXAMINATION CLEANING

10.1 Examined areas shall be dry-wiped to remove excessive wet couplant.

11.0 EXAMINATION RESULTS AND DOCUMENTATION

11.1 All data relative to calibrations and examinations shall be recorded in accordance with DMW-ISI-101, "Preservice and Inservice Examination Documentation".

TABLE 1

ANGLE BEAM EXAMINATION

NOMINAL MATERIAL THICKNESS	TRANSDUCER (1) MAX. SIZE	MINIMUM FREQ. MHz	NOMINAL ANGLE
.250" to .750"	1/4"	2.25	45°S & 60°S
.751" to 1.000"	1/2"	2.25	45°S & 60°S
1.001" to 1.200"	3/4"	2.25	45°S & 60°S
1.201" and Greater	1"	2.25	45°S & 60°S
Main Coolant Piping			
Forged	1"	1.0	41°L/45°S
Centrifugally Cast	1"	1.0	41°L

STRAIGHT BEAM EXAMINATION

	SIZE MIN.	SIZE MAX.	MAX. FEQ. MHz
Main Coolant Piping	1"	1.25"	2.25
All Other to 12" Dia.	1.4"	1/2"	5.0
12" Dia. and greater	1.4"	1"	5.0

NOTES:

(1) Other transducers may be used where metallurgical characteristic or geometry impede effective use of the above listed angle beams or frequencies. Size is the element viewed from the side and shall not be increased.

TABLE 2

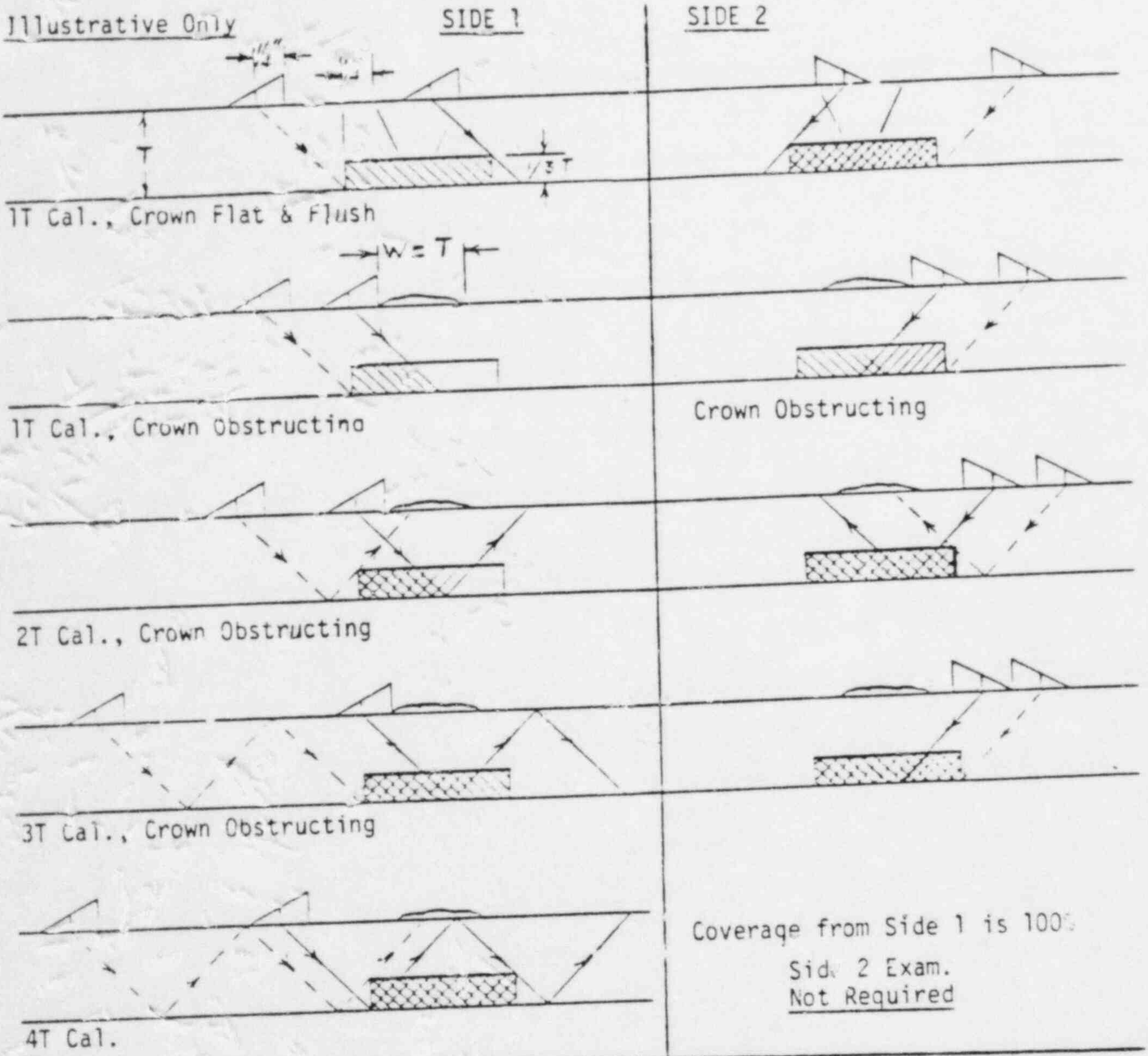
1/4 T = 1/8 Node = 1/8V	1 1/4 T = 5/8 Node = 5/8 V
1/2 T = 2/8 Node = 1/4 V	1 1/2 T = 6/8 Node = 3/4 V
3/4 T = 3/8 Node = 1/4 V	1 3/4 T = 7/8 Node = 7/8 V
1 T = 4/8 Node = 1/2 V	2 T = 8/8 Node = 1 V
	ETC.

SWEEP RANGE CALIBRATION

FOR SWP. RANGE CAL. OF:	LAST LEG % SWP. LOCATION(1) MIN	MAX
1 T	50	75
2 T	50	75
3 T	50	75
4 T	50	75

(1) Applicable for "T" calibration point from notch reflector, or last "T" point as extrapolated or extended from calibration hole reflectors. Maximum last leg location indicated is based on piping calibration block at minimum "T" and of volume to be examined at maximum "T". Last leg positions indicated above may be changed if thickness of calibration block and the examination area are determined to be other than this basis. Calculate for maximum last leg position as follows:

$$100 + \frac{\text{EXAM. VOL. "T"}}{\text{CAL. BLOCK "T"}} = \text{MAX. \%SWP. LOCATION FOR LAST LEG.}$$

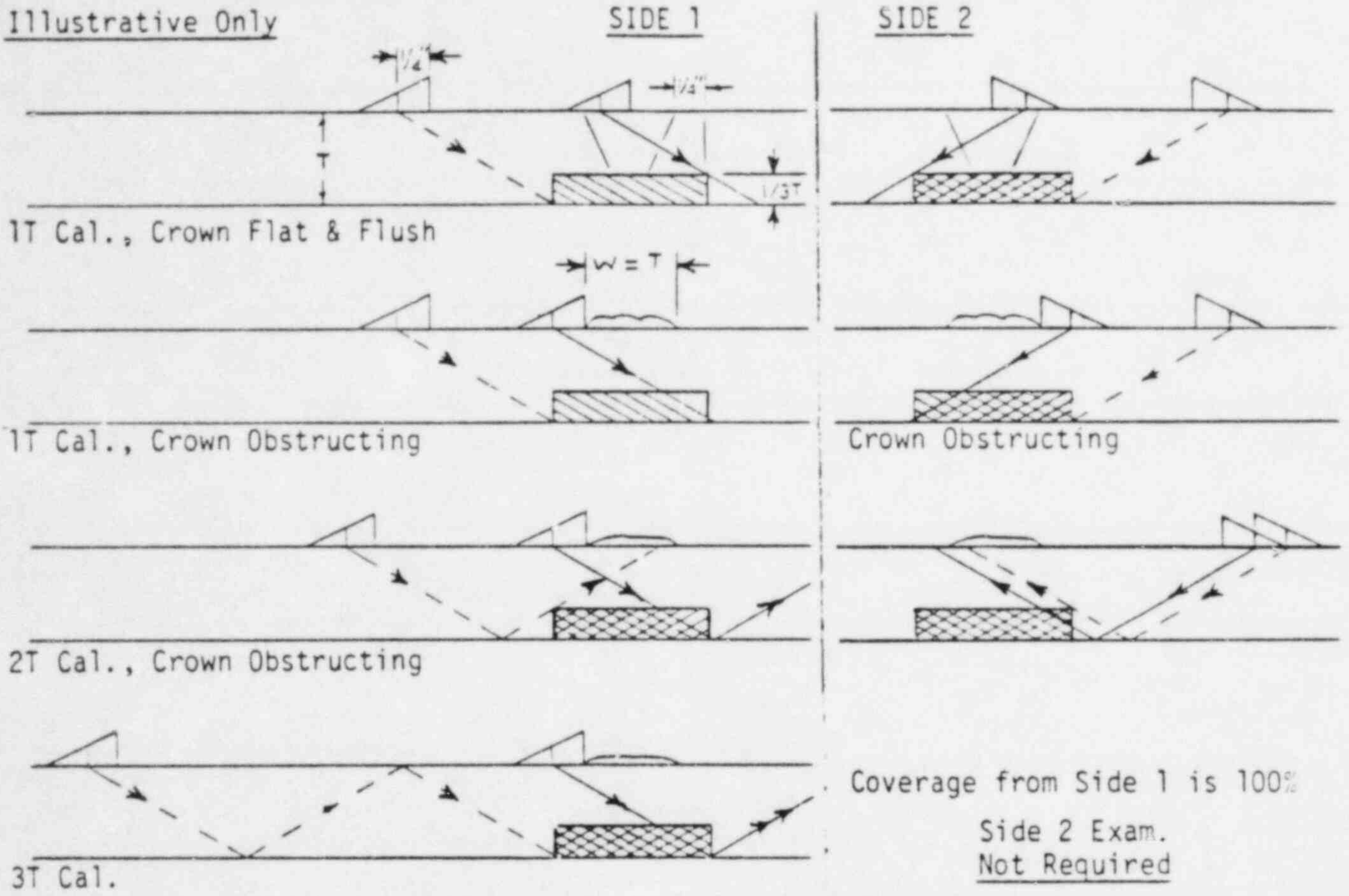


Broken beam = Exam. start. Solid beam = Exam. completion or maximum access.

All Beam Angles - 45°

See Figure 2 for Commentary

FIGURE 1



Broken beam = Exam. start. Solid beam = Exam. completion or maximum access.

ALL BEAM ANGLES-60°

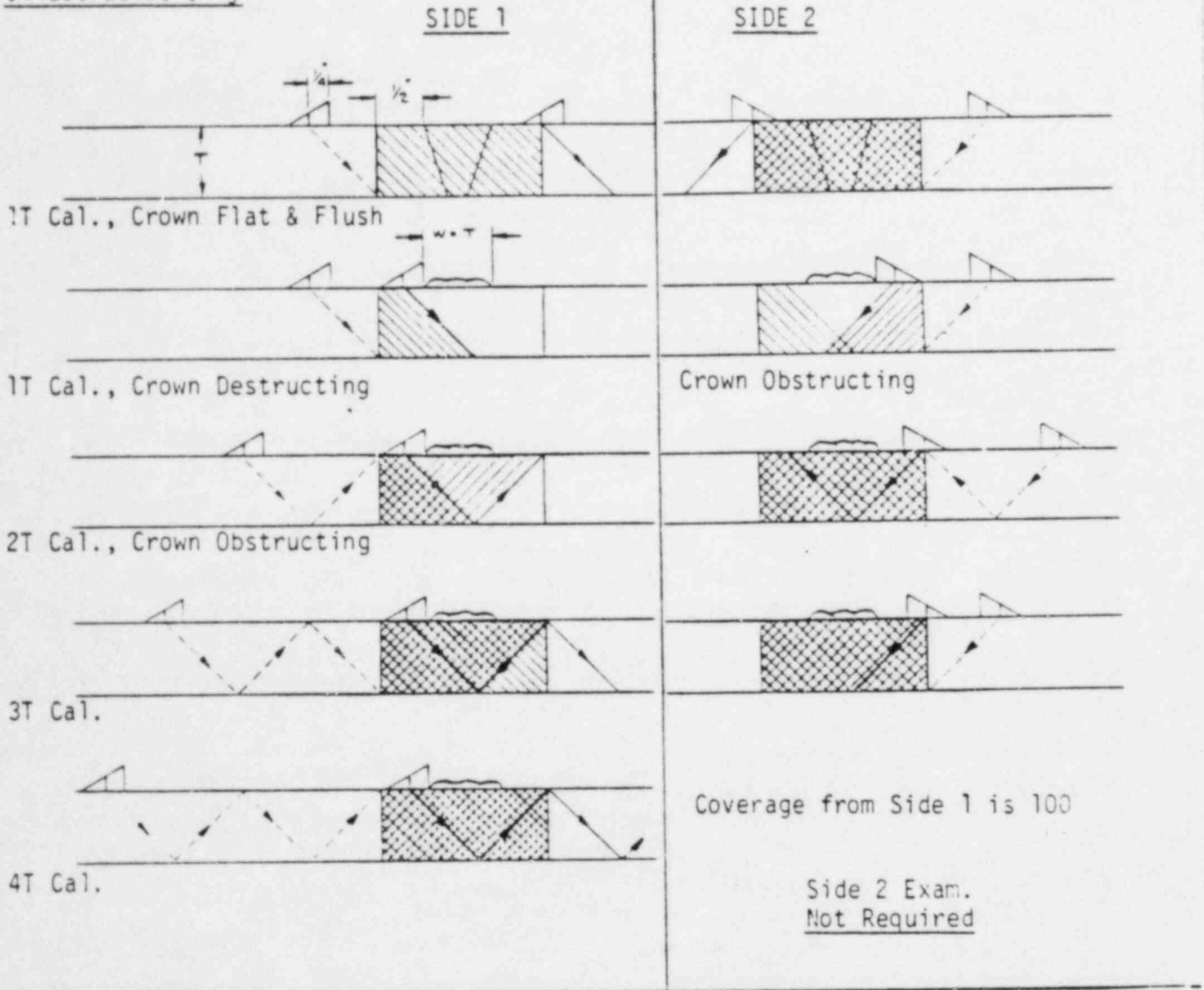
Figures and views illustrate extent of examination volume coverage that is obtained based on parameters depicted. Actual parameters exisiting for or during each examination alter significantly the depicted coverage.
Key parameters depicted are:
1. Search unit is essentially minimum size
2. Nominal beam angle (in the part) is achieved and maintained
3. Beam has zero spread
4. Beams reflect from parallel planes equal to T at I.D. and crown areas
5. Width of obstructing crown is equal to T
6. Scan access is available on both sides.

Where weld crown is not obstructing, 2T cal. range or greater can satisfy required coverage from one side.

Cal. range and transducer or angle shall be such that examination and data required (see 2.5) can be satisfied. Maximum extent of required coverage achieved during examination is, that volume that has been "cross-hatched" by calibrated beams, as perceived solely by the examiner.

FIGURE 2

Illustrative Only

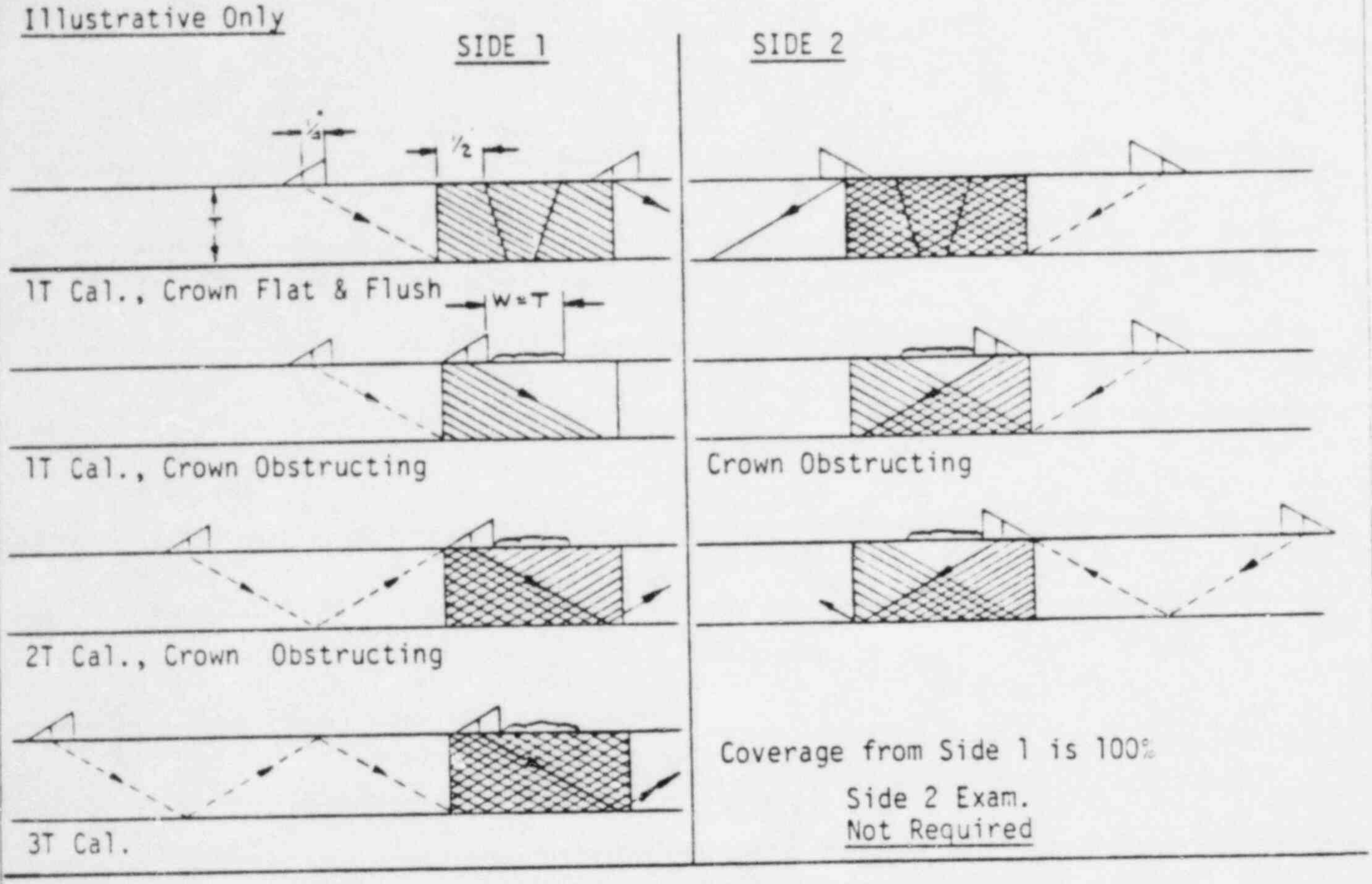


Broken beam = Exam. start. Solid beam = Exam. completion or maximum access.

All Beam Angles - 45°

See Figure 2 for Commentary

FIGURE 3



Broken beam = Exam. start. Solid beam = Exam. completion or maximum access.

ALL BEAM ANGLES-60°

Figures and views illustrate extent of examination volume coverage that is obtained based on parameters depicted. Actual parameters exisiting for or during each examination alter significantly the depicted coverage.

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5. Width of obstructing crown is equal to T
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Where weld crown is not obstructing, 2T cal. range or greater can satisfy required coverage from one side.

Cal. range and transducer or angle shall be such that examination and data required (see 2.5) can be satisfied. Maximum extent of required coverage achieved during examination is, that volume that has been "cross-hatched" by calibrated beams, as perceived solely by the examiner.

FIGURE 4