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FMF-OM-907 Eddy-Current Bond Testing

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EBR-II FUEL MANUFACTURING FACILITY OPERATIONS MANUAL

REVIEW AND APPROVAL

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CONTENTS

		Page
1.	INTRODUCTION	2
2.	EQUIPMENT	3
3.	OPERATION PROCEDURES	5
4.	MAINTENANCE	11

1. INTRODUCTION

The eddy-current bond tester is used to assess the quality of sodium bond. The device is capable of detecting voids in the sodium-to-metal bonds. The device induces a current to flow in the sodium annulus and measures the resistance to the flow of that induced current. A chart trace is produced which is read by the operator technician for indications of bond defects.

2. EQUIPMENT

The eddy-current bond tester consists of: (1) an eddy-current differential coil and yoke, (2) eddy current detector (with CRT) and 2-channel strip chart recorder, (3) control box and (4) an element driving mechanism. A bond test standard is used to monitor the sensitivity of the eddy-current detector.

2.1 Eddy-Current Differential Coil

The eddy-current differential coil has multiple windings and is used as the testing probe. The presence of a uniform conducting material within the coil will produce a fixed signal. However, when defects enter the coil the differences in conductivity will produce voltage changes which are translated to a recorder.

2.2 Eddy-Current Detector

The eddy-current instrument generates the test signal and processes the indications. The sodium bond defect signals are analyzed by the detector and transmitted to the chart drive.

2.3 Fuel Element Driving Mechanism

The drive mechanism moves the fuel element through the test coil. A gripping device is mounted on a motor-driven ball screw. The end of the element is inserted through the test coil into the gripping device. When the gripper starts up, it pulls the element through the test coil. As the end fitting approaches the test coil, the gripping device contacts an adjustable limit switch and its direction of travel is reversed. At the end of its downward travel, the element is again stopped by a limit switch. The coil, gripper, ball screw, motor and limit switches are all supported on a steel frame.

2.4 Control Box

The control box contains the required switches to energize the equipment and to operate the drive mechanism functions.

2.5 Bond Test Standard

The sensitivity of the bond testing machine is maintained at a constant level by means of standards. The standards are dummy elements in which the sodium annulus is simulated by means of a brass sleeve. When the element is run through the bond tester, a trace will be produced. When the bond tester is capable of reproducing the master trace, both in feature location and feature amplitude, the bond tester is at its reference sensitivity. The master traces are set up and maintained in a separate file. A copy of these traces are also kept at the bond test location for the operator technicians use.

3. OPERATION PROCEDURES

3.1 Operator Qualification

Bond testing of fuel elements shall be performed only by qualified personnel who may be assisted by one or more trainees. Qualification shall consist of a demonstration of knowledge and understanding of: (1) the bond testing procedure, (2) the bond testing equipment, (3) the acceptance criteria, and (4) the recordkeeping requirements.

3.2 Precautions

3.2.1 The rules for material transfer on criticality control per EB-CHCS-A09 shall be observed at all times.

3.2.2 Fuel elements shall be handled with clean white nylon or polyethylene gloves at all times.

3.2.3 The limit switch on the bond tester driver mechanism shall be adjusted in the proper element location.

3.2.4 The element catch basket should be in position to save a dropped element from damage.

3.2.5 When the detector is left in the energized mode the CRT intensity should be turned down so the spot is not visible. Leaving intensity up will cause CRT screen damage and failure.

3.2.6 To stop the chart drive during non-normal operations move chart drive (pen/pen chart) switch to the "pen" position.

3.2.7 If spot on the CRT screen drifts during element testing, reset the balance on the detector amp unit.

3.2.8 The control box contains a "STOP" switch which will stop drive mechanism in case of need to discontinue drive travel.

3.3 Startup Procedures

3.3.1 Energize "Power On" at Control Box and coil.

3.3.2 Energize "Power On" "CRT." Warmup on "CRT" should be at least five minutes.

3.3.3 Set up recorder, (1) Set chart drive to 10 in. per minute, (2) Set continuation switch to "CAL," (3) and set (Pen/Pen Chart) switch to "Pen."

3.3.4 Zero/Center recorder pen on chart drive.

3.3.5 Set deviation switch on chart recorder per desired location per standard used.

3.3.6 Set up (1) Phase control to number required by standard used, (2) Gain control to number required by standard used, (3) Plug to Horizontal (H) output, (4) Bal/Diff. ABS set to outward position, (5) Disp On set to inward position, and (6) volts per division set to number one.

3.3.7 Set up Frequency Driver to frequency requirements for type of standard used and/or as established by the Responsible Engineer.

3.3.8 Insert element standard into the drive gripper and energize control box "Start." Allow drive to travel through the upward and downward motions and see if the standard recorded the proper number of chart deviation increments. If not - problems may exist and the assistance of the Responsible Engineer and I&C technician may be necessary. "Resolve before proceeding."

The operator may run the recorder in the pen or pen chart position at this checkpoint.

3.3.9 After the standard checks out properly, set the recorder Pen/Pen chart switch to Pen Chart position.

3.3.10 Run all elements in batch and appropriately mark all traces to element number. Recheck standard after each 25 elements and at end of batch. If the standard doesn't repeat its proper number of deviation increments the entire batch will have to be rerun up to the point that problems occurred.

3.4 Bond Test Procedure

3.4.1 Remove the fuel element from the storage container and place the element in the drive mechanism collet.

3.4.2 While holding the element in place, press START pushbutton on control box. This will start the motor drive, and close the gripper collet.

NOTE: IF AT ANY TIME IT IS NECESSARY TO STOP THE DRIVE MECHANISM, PRESS THE "STOP" PUSH-BUTTON.

3.4.3 When the end of element approaches the coil, a limit switch reverses the motor drive and the pin passes back through the coil.

3.4.4 At the bottom of travel, the motor drive will turn off and the element will be released into the hands of the operator. The recorder chart drive will continue to run.

3.4.5 Replace the fuel element in its original position in the storage container.

3.4.6 Remove the trace from the recorder. Record the fuel element serial number on the recorder trace and place it face down on the table.

3.4.7 Repeat Steps 3.4.1 through 3.4.6 for the remainder of the fuel elements in the storage container.

NOTE: UPON COMPLETION OF EACH 25 ELEMENTS OR AT END OF THE BATCH OF ELEMENTS, RUN THE SAME BOND TEST STANDARD AND COMPARE THE TRACE AGAINST THE MASTER STANDARD TRACE. ALSO, RERUN THE SAME BOND TEST STANDARD IF THE EQUIPMENT IS LEFT UNATTENDED FOR ANY LENGTH OF TIME OR AFTER ANY BREAKS IN THE NORMAL WORK CYCLE.

IF THE TRACE COMPARES, PROCEED WITH EQUIPMENT SHUTDOWN. IF THERE ARE SIGNIFICANT DISCREPANCIES (MORE THAN ONE INCREMENT DRIFT), ALL PREVIOUS ELEMENT BOND TEST TRACES ARE CONSIDERED INVALID AND MUST BE REPEATED AFTER RESTANDARDIZATION. ONE INCREMENT ON CHART DRIFT IS CONSIDERED SIGNIFICANT AND ANY CLOSELY READ TRACES SHOULD BE RERUN AND THE MACHINE RESET TO THE MASTER STANDARD TRACE.

3.4.8 Acceptance Criteria

The trace may show the end of the pin, if not, measurements will be necessary to verify the pin length of 13.5 in. Within this length, check for void or bubble indications in the sodium annulus. For fuel element acceptance, such indications must be less than the amplitude of level indication for the 3/16-in. hole size as set originally by the master bond test standard.

3.5 Shutdown Procedures

3.5.1 Turn down the "CRT" spot intensity when closing down the operation.

3.5.2 Deenergize the "CRT" power switch.

3.5.3 Deenergize the control box power switch.

3.6 Emergency Conditions

3.6.1 In case of a criticality alarm, EVACUATE IMMEDIATELY.

3.6.2 In case of a site evacuation, remove any fuel element in the bond tester, place it in the birdcage, close the birdcage, then evacuate. The main power on-off switch does not need to be turned off. Turn down the "CRT" spot intensity switch.

3.6.3 In case of fire or other emergency, remove any fuel element from the bond tester, place in the birdcage, seal the birdcage, and prepare to assist or evacuate as directed. The main power on-off switch does not need to be turned off.

3.7 Bonding

3.7.1 All fuel elements that do not meet the acceptance criteria after sodium settling shall be separated and bonded.

NOTE: FUEL ELEMENTS CAN ONLY BE BONDED THREE TIMES. THE ACCEPTED FUEL ELEMENTS ARE TO BE HELD IN STORAGE PENDING FINAL DISPOSITION OF THE BONDED FUEL ELEMENTS. THE BOND TEST OPERATION IS NOT COMPLETE UNTIL ALL FUEL ELEMENTS IN THE BATCH ARE FINAL DISPOSITIONED.

3.7.2 Bond test and read the traces of the bonded fuel elements.

3.7.3 If after bonding, the sodium voids still exist, an Inspection/Disposition Report is to be generated by the operator for the unacceptable elements, which will reflect the final disposition of the bonded elements.

NOTE: FUEL ELEMENTS CAN ONLY BE BONDED THREE TIMES.

3.8 Operation Completion

3.8.1 Complete the signoff of the bond testing operation on the PWS for the fuel element batch.

3.8.2 Forward the bond test traces to the Responsible Engineer for retention.

4. MAINTENANCE

The recorder and the high voltage power supply are on two preventative maintenance and calibration programs through the Instrument Shop. Any other system maintenance or calibration shall be done upon request.