CP&L
Carolina Power & Light Company

MAY 0 8 1986

SERIAL: NLS-86-158

Director of Nuclear Reactor Regulation
Attention: Mr. Dan Muller, Director
BWR Project Directorate #2
Division of BWR Licensing
United States Nuclear Regulatory Commission
Washington, DC 20555

BRUNSWICK STEAM ELECTRIC PLANT, UNIT NO. 2
DOCKET NO. 50-324/LICENSE NO. DPR-62
IGSCC INSPECTION RESULTS - BRUNSWICK-2 RELOAD 6

Dear Mr. Muller:

By letter dated November 1, 1985, Carolina Power & Light Company (CP&L) apprised your staff of the Company's plans for performing mitigative actions and examinations for IGSCC on Brunswick Unit 2 during the Reload 6 outage. These mitigative actions and inspections are complete. This letter contains descriptions of : 1) the Induction Heating Stress Improvement (IHSI) that has been performed on Recirculation System welds, 2) the Reactor Water Cleanup (RWCU) System piping replacement program, 3) the IGSCC examination program, and 4) the weld-overlay repairs performed during the current refueling outage. A summary of the susceptible weld population describing mitigative actions applied and repairs is included as Table 1. In addition, this letter includes the basis for continued operation of Unit 2 until the next refueling outage presently scheduled to begin in January 1988.

Mitigative Actions

IHSI was performed on 65 recirculation system weld joints as indicated in Table 1. The IHSI was performed by IHI, Inc., of Yokohama, Japan, in accordance with IHI procedures. IHSI is not specifically addressed by codes, standards, or regulations. The time-temperature recordings were made in accordance with ASME Boiler and Pressure Vessel Code, Section III, Division 1, NB-4622.2 and capacitive discharge welding requirements for thermocouple settings were made in accordance with NB-4311.2 and NB-4311.3.

The entire Class 1, 6-inch RWCU System piping was replaced from the RHR System tie-in to the outboard primary containment isolation valve, 2-G31-F004. The piping was replaced with nuclear grade stainless steel piping. The RWCU primary containment penetration X-14 (suction side) was modified to eliminate the inaccessible weld inherent with the original flued head penetration design at Brunswick.

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Examination Program

Ultrasonic (UT) examinations were performed by General Electric Company (GE). The UT examinations performed during the Reload 6 outage are divided into the following categories:

1) Five weld overlay repairs made prior to the present refueling outage.

2) Re-examination and re-evaluation of the eleven flawed unrepaired welds listed in Table 2.

3) Inconel butter welds as recommended by IE Notice 84-41.

4) Welds subjected to IHSI and other examinations required by Generic Letter 84-11.

The UT personnel were qualified in accordance with Generic Letter 84-11 and the fall 1985 EPRI requalification program. The examinations incorporated the use of the fully-automated GE "SMART UT" System where geometrically feasible. The SMART UT System utilizes the Ultra Image III computer-driven data acquisition system with the ALARA remote scanning device. The scanner is capable of positioning a transducer at any location circumferentially, axially, and at any angle to the weld centerline. Manual exams supplemented the SMART UT exams where geometrical limitations existed.

The sizing of IGSCC indications was performed using 2 to 5 MHz refracted-longitudinal transducers. The sizing methods used were those taught at EPRI including Satellite Pulse Observation Technique (SPOT), Pulse Arrival Time Technique (PATT), and 70° creeping wave technique.

The five existing weld overlay repairs listed in Table 3 were upgraded to meet full structural design requirements by addition of weld metal. The upgraded overlay surfaces were finished to meet or exceed EPRI surface finish requirements. These upgraded weld overlay repairs were examined using 2.25 MHz creeping waves for the overlay weld metal, 0° 4.0 MHz straight beam for the overlay to pipe bond and 2.25 MHz 60° refracted longitudinal wave for the base material. The techniques used were those recommended by EPRI's weld overlay training program.

The eleven flawed unrepaired welds listed in Table 2 were re-examined and re-evaluated. Ten of the eleven welds were examined by "SMART UT" and manually sized. Weld 2-B32-RECIRC-28"-A-8 was examined manually due to elbow-valve configuration. Welds 2-B32-RECIRC-28"-A-14, 2-B32-RECIRC-28"-B-9, and 2-E11-RHR-20"-SUCT-A-2 were determined to have geometry indications not attributable to IGSCC and, therefore, not subject to repair. The remaining eight welds were confirmed to have IGSCC and were repaired by weld overlay.

Examinations of inconel butter welds as recommended by IE Notice 84-41, were performed on selected welds using 31° to 70° refracted longitudinal dual 1.0 - 2.25 MHz transducers with SMART UT. A "mock-up" calibration block, representative of materials and configuration of welds, was utilized. The initial inspection sample consisted of two 12-inch inlet nozzles and one 28-inch suction nozzle. The initial inspection sample is denoted by astericks in Table 4. A small axial IGSCC indication was detected in weld 2-B32-RECIRC-28"-A-1. The inconel butter of nozzle weld 2-B32-RECIRC-28"-B-1 was then examined and was found to have a small axial indication as well. These indications were sized using a 45° and 60° refracted longitudinal 1.0 MHz search unit. Indication sizes are shown on Table 5. By use of a 45° shear wave, the indications were

confirmed not to penetrate into the nozzle material. A fracture mechanics analysis, performed by General Electric Company, determined that continued operation for an additional fuel cycle without repair is justifiable. This analysis is included as Attachment 2. The examination was expanded to include the remaining inlet nozzle inconel butters shown in Table 4 and did not yield additional indications.

A selected weld sample was examined prior to IHSI based on Unit 1 experience. A post-IHSI examination was performed on each weld. Those welds with indications were overlayed and then re-examined. The remaining joints that did not receive IHSI or overlay were also examined. UT examinations were performed on 100 percent of the susceptible weld population.

Examinations were performed in accordance with Generic Letter 84-11 using a 2.25 MHz, single element, 45° shear wave transducer. Scanning was performed in eight directions (where geometry permitted); two perpendicular, two parallel, and four tangential. A minimum overlap of 50 percent was used in lieu of the ASME code required 10 percent. Thirty welds were found to have IGSCC indications. Through wall leaks were found visually on three 4" by-pass weldolet to pipe configurations. The leaks were not detectable by UT because of the forging geometry and were determined by liquid penetrant examinations to be on the forging side. The remaining by-pass weldolet was overlayed as a preventative measure. Thirty-four new overlay repairs were performed and are listed in Table 1. The new overlay repairs were examined by the same technique as the five existing overlays. The Unit 2 overlays meet or exceed the EPRI-recommended surface finish requirements.

Disposition of Indications

Indications were present in seven 28-inch pipe weld joints. These seven joints were repaired with leakage barrier overlays. Full structural weld overlay repairs were applied to pipe weld joints less than 28-inches in diameter. The full structural overlay design is based on an assumed 360° through-wall crack. All overlay designs applied at Brunswick satisfy the requirements of the revised IWB-3640, ASME Code Section XI and Generic Letter 84-11. A complete design report, performed by NUTECH, on the weld overlay repairs is included as Attachment 1.

One shallow axial indication was found in each of the 28-inch suction nozzle inconel weld butters. General Electric Company performed a fracture mechanics analysis of these indications and determined that continued operation for an additional fuel cycle without repair is justifiable. The ASME Code Section XI safety margins will be maintained throughout this period. In addition, substantial leak-before-break margin against pipe as well as nozzle failure is assumed. The fracture mechanics analysis is included as Attachment 2.

Summary of Susceptible Weld Population

The susceptible weld population at Brunswick Unit 2 consists of 107 welds. The current status of this weld population with respect to mitigative actions and repairs is summarized below:

Mitigation/Repair	No. of Weld Joints
IHSI	58
Weld Overlay Repair	32
IHSI & Weld Overlay Repair	7
Solution Anneal	8
Unmitigated	2
Total	107

Table 1 provides a detailed breakdown of the mitigations and repairs performed on each susceptible weld joint.

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The following special surveillance measures have been implemented at the Brunswick Plant:

1) As required by the Technical Specifications, plant shutdown shall be initiated for inspection and corrective action shall be taken when any leakage detection system indicates, within any period of 24 hours, an increase in the rate of unidentified leakage in excess of 2 gpm. For sump level monitoring systems with fixed-measurement interval method, the level shall be monitored at 4-hour intervals or less.

2) At least one of the leakage measurement instruments associated with each sump shall be operable and the outage time for inoperable instruments shall be limited to 24 hours. Otherwise, an orderly shutdown will be immediately initiated.

3) A visual examination for leakage of the reactor coolant piping shall be performed during each plant outage in which the containment is deinerted provided that such an inspection has not been made in the previous 92 days. The examination shall be performed consistent with the requirements of IWA-5241 and IWA-5242 of the 1980 Edition of Section XI of the ASME Boiler and Pressure Vessel Code. The system boundary subject to this examination shall contain the susceptible welds inside the primary containment.

These special surveillance measures are consistent with those given in Attachment 1 to Generic Letter 84-11 and CP&L's ALARA Program.

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CP&L has completed IHSI on 65 susceptible weld joints and has replaced the 6-inch, Class 1, Reactor Water Cleanup System piping with nuclear grade materials. Of a susceptible weld population of 107 welds, 105 of these welds have been mitigated by either IHSI, weld overlay repair, or solution annealing. The two unmitigated weld joints are the 4-inch decontamination ports attached to the 28-inch suction piping.

UT examinations were performed on 100 percent of the susceptible stainless steel weld population using the fully automated GE SMART UT System where geometrically feasible. Full structural overlays were applied to piping weld joints less than 28 inches in diameter with indications. Five existing weld overlays were upgraded to full structural requirements. Leak barrier overlays were applied to the seven 28-inch pipe weld joints with indications. The piping weld joints with indications have been repaired by weld overlay.

Five existing weld overlays were upgraded to full structural requirements. The overlay surface finishes meet the requirements for surface finish recommended by EPRI.

One shallow axial indication found in each of the 28-inch suction nozzle inconel butters has been analyzed by GE and found to meet the ASME Code Section XI safety margins for at least one additional 18-month fuel cycle.

Examination of seven recirculation inlet nozzle inconel butters did not reveal any indications.

As a result of the mitigative actions taken, the state of the art inspections performed on 100 percent of the susceptible weld population, and enhanced surveillance requirements for drywell leakage detection, CP&L believes that start-up and continued operation of Brunswick Unit 2 until the next refueling outage (presently scheduled for January 1988) is justified and will not adversely affect the health and safety of the public.

As inspection plan for the next refueling outage will be submitted 30 days prior to the start of that outage. Should you have any questions regarding this submittal, please contact Mr. S. D. Floyd at (919) 836-6901.

Yours very truly,

S. R. Zimmerman
Manager
Nuclear Licensing Section

SRZ/MAT/pgp (3839MAT)

Attachments

cc: Mr. W. H. Ruland (NRC-BNP)
Dr. J. Nelson Grace (NRC-RII)
Mr. E. D. Sylvester (NRC)

TABLE 1

NONCONFORMING CLASS 1 WELD JOINTS AT BSEP UNIT NO. 2

WELD ID AND PIPE SIZE	WELD JOINT DESCRIPTION	SOLUTION ANNEAL	IHSI	INDICATIONS	WELD OVERLAY DATE DESIGN	NOTES
2-B32-28"-A-2	SS Safe End to SS Pipe	N	Y	N		
2-B32-28"-A-3	SS Pipe to SS Elbow	N	Y	N		
2-B32-28"-A-4	SS Elbow to SS Pipe	N	N	Y	DEC 85 LB	NOV 83 Analysis
2-B32-28"-A-5	SS Pipe to SS Tee	N	Y	N		
2-B32-28"-A-6	SS Tee to SS Pipe	N	Y	N		
2-B32-28"-A-7	SS Pipe to SS Elbow	N	Y	N		
2-B32-28"-A-8	SS Elbow to SS Valve	N	N	Y	DEC 85 LB	NOV 83 Analysis
2-B32-28"-A-9	SS Valve to SS Pipe	N	Y	N		
2-B32-28"-A-10	SS Pipe to SS Elbow	N	Y	N		
2-B32-28"-A-11	SS Elbow to SS Pump	N	Y	N		
2-B32-28"-A-12	SS Pump to SS Pipe	N	Y	N		
2-B32-28"-A-13	SS Pipe to SS Valve	N	N	Y	DEC 85 LB	NOV 83 Analysis
2-B32-28"-A-14	SS Valve to SS Elbow	N	Y	N		1.
2-B32-28"-A-15	SS Elbow to SS Pipe	N	Y	N		
2-B32-28"-A-16	SS Pipe to SS Tee	N	Y	N		
2-B32-28"-A-17	SS Tee to SS Cross	N	Y	N		
2-B32-28"-A-18	SS Cross to SS Reducer	N	Y	N		
2-B32-28"-B-2	SS Safe End to SS Pipe	N	Y	N		
2-B32-28"-B-3	SS Pipe to SS Elbow	N	N	Y	DEC 85 LB	NOV 83 Analysis
2-B32-28"-B-4	SS Elbow to SS Pipe	N	N	Y	DEC 85 LB	NOV 83 Analysis
2-B32-28"-B-5	SS Pipe to SS Tee	N	Y	Y	DEC 85 LB	NOV 83 Analysis
2-B32-28"-B-6	SS Tee to SS Pipe	N	Y	N		
2-B32-28"-B-7	SS Pipe to SS Elbow	N	Y	N		
2-B32-28"-B-8	SS Elbow to SS Valve	N	Y	N		
2-B32-28"-B-9	SS Valve to SS Pipe	N	Y	N		1.
2-B32-28"-B-10	SS Pipe to SS Elbow	N	Y	N		
2-B32-28"-B-11	SS Elbow to SS Pump	N	Y	Y	DEC 85 LB	
2-B32-28"-B-12	SS Pump to SS Pipe	N	Y	N		
2-B32-28"-B-13	SS Pipe to SS Valve	N	Y	N		
2-B32-28"-B-14	SS Valve to SS Elbow	N	Y	N		

(3839MAT/pgp)

TABLE 1 (CONT'D)

NONCONFORMING CLASS 1 WELD JOINTS AT BSEP UNIT NO. 2

WELD ID AND PIPE SIZE	WELD JOINT DESCRIPTION	SOLUTION ANNEAL	IHSI	INDICATIONS	WELD OVERLAY DATE DESIGN	NOTES
2-B32-28"-B-15	SS Elbow to SS Pipe	N	Y	N		
2-B32-28"-B-16	SS Pipe to SS Tee	N	Y	N		
2-B32-28"-B-17	SS Tee to SS Cross	N	Y	N		
2-B32-28"-B-18	SS Cross to SS Reducer	N	Y	N		
2-B32-22"-AM-1	SS Valve to SS Pipe	N	Y	N		
2-B32-22"-AM-2	SS Pipe to SS Valve	N	Y	N		
2-B32-22"-AM-3	SS Valve to SS Pipe	N	Y	N		
2-B32-22"-AM-4	SS Pipe to SS Pipe	N	Y	N		
2-B32-22"-AM-5	SS Pipe to SS Cross	N	N	Y	DEC 85 FS	NOV 83 Analysis
2-B32-22"-AM-6	SS Cross to SS Pipe	N	Y	N		
2-B32-22"-BM-1	SS Cap to SS Pipe	N	N	Y	DEC 85 FS	NOV 83 Analysis
2-B32-22"-BM-2	SS Pipe to SS Cross	N	Y	N		
2-B32-22"-BM-3	SS Cross to SS Pipe	N	Y	N		
2-B32-22"-BM-4	SS Pipe to SS Valve	N	Y	N		
2-B32-12"-AR-A-1	SS Sweepolet to SS Pipe	N	Y	N		
2-B32-12"-AR-A-2	SS Pipe to SS Elbow	N	N	Y	DEC 85 FS	
2-B32-12"-AR-A-3	SS Elbow to SS Pipe	N	N	Y	DEC 85 FS	
2-B32-12"-AR-A-4	SS Pipe to SS Safe End	N	Y	N		
2-B32-12"-AR-B-1	SS Sweepolet to SS Pipe	N	Y	N		
2-B32-12"-AR-B-2	SS Pipe to SS Elbow	N	N	Y	DEC 85 FS	
2-B32-12"-AR-B-3	SS Elbow to SS Pipe	N	N	Y	DEC 85 FS	
2-B32-12"-AR-B-4	SS Pipe to SS Safe End	N	Y	N		
2-B32-12"-AR-C-1	SS Sweepolet to SS Pipe	N	Y	Y	DEC 85 FS	
2-B32-12"-AR-C-2	SS Pipe to SS Elbow	N	N	Y	DEC 85 FS	
2-B32-12"-AR-C-3	SS Elbow to SS Pipe	N	N	Y	DEC 85 FS	
2-B32-12"-AR-C-4	SS Pipe to SS Safe End	N	N	Y	DEC 85 FS	
2-B32-12"-AR-D-1	SS Sweepolet to SS Pipe	N	Y	Y	DEC 85 FS	
2-B32-12"-AR-D-2	SS Pipe to SS Elbow	N	Y	N		
2-B32-12"-AR-D-3	SS Elbow to SS Pipe	N	Y	N		
2-B32-12"-AR-D-4	SS Pipe to Safe End	N	N	Y	DEC 85 FS	

(3839MAT/pgp)

TABLE 1 (CONT'D)

NONCONFORMING CLASS 1 WELD JOINTS AT BSEP UNIT NO. 2

WELD ID AND PIPE SIZE	WELD JOINT DESCRIPTION	SOLUTION ANNEAL	IHSI	INDICATIONS	WELD OVERLAY DATE	DESIGN	NOTES
2-B32-12"-AR-E-1	SS Sweepolet to SS Pipe	N	Y	N			
2-B32-12"-AR-E-2	SS Pipe to SS Elbow	N	N	Y	DEC 85	FS	
2-B32-12"-AR-E-3	SS Elbow to SS Pipe	N	N	Y	DEC 85	FS	
2-B32-12"-AR-E-4	SS Pipe to SS Safe End	N	N	Y	DEC 85	FS	
2-B32-12"-BR-F-1	SS Sweepolet to SS Pipe	N	Y	N			
2-B32-12"-BR-F-2	SS Pipe to SS Elbow	N	N	Y	DEC 85	FS	
2-B32-12"-BR-F-3	SS Elbow to SS Pipe	N	N	Y	DEC 85	FS	
2-B32-12"-BR-F-4	SS Pipe to SS Safe End	N	Y	Y	DEC 85	FS	
2-B32-12"-BR-G-1	SS Sweepolet to SS Pipe	N	Y	Y	DEC 85	FS	
2-B32-12"-BR-G-2	SS Pipe to SS Elbow	N	N	Y	DEC 85	FS	
2-B32-12"-BR-G-3	SS Elbow to SS Pipe	N	N	Y	DEC 85	FS	
2-B32-12"-BR-G-4	SS Pipe to SS Safe End	N	N	Y	NOV 83	E	Upgraded DEC 85 FS
2-B32-12"-BR-H-1	SS Sweepolet to SS Pipe	N	Y	N			
2-B32-12"-BR-H-2	SS Pipe to SS Elbow	N	N	Y	DEC 85	FS	
2-B32-12"-BR-H-3	SS Elbow to SS Pipe	N	Y	N			
2-B32-12"-BR-H-4	SS Pipe to SS Safe End	N	N	Y	DEC 85	FS	
2-B32-12"-BR-J-1	SS Sweepolet to SS Pipe	N	Y	N			
2-B32-12"-BR-J-2	SS Pipe to SS Elbow	N	N	Y	NOV 83	E	Upgraded DEC 85 FS
2-B32-12"-BR-J-3	SS Elbow to SS Pipe	N	N	Y	NOV 83	E	Upgraded DEC 85 FS
2-B32-12"-BR-J-4	SS Pipe to SS Safe End	N	Y	N			
2-B32-12"-BR-K-1	SS Sweepolet to SS Pipe	N	Y	N			
2-B32-12"-BR-K-2	SS Pipe to SS Elbow	N	N	Y	NOV 83	E	Upgraded DEC 85 FS
2-B32-12"-BR-K-3	SS Elbow to SS Pipe	N	N	Y	NOV 83	E	Upgraded DEC 85 FS
2-B32-12"-BR-K-4	SS Pipe to SS Safe End	N	Y	N			
2-B32-4"-A-BYPASS-1	SS Pipe to SS Weldolet	N	Y	Y	DEC 85	FS	
2-B32-4"-A-BYPASS-11	SS Pipe to SS Weldolet	N	N	Y	DEC 85	FS	
2-B32-4"-B-BYPASS-1	SS Pipe to SS Weldolet	N	N	Y	DEC 85	FS	
2-B32-4"-B-BYPASS-11	SS Pipe to SS Weldolet	N	N	N	DEC 85	FS	
2-B32-28"-A-9BC-1	SS Branch	N	N	N			
2-B32-28"-A-12BC	SS Weldolet	N	Y	N			

(3839MAT/pgp)

TABLE 1 (CONT'D)

NONCONFORMING CLASS 1 WELD JOINTS AT BSEP UNIT NO. 2

WELD ID AND PIPE SIZE	WELD JOINT DESCRIPTION	SOLUTION ANNEAL	IHSI	INDICATIONS	WELD OVERLAY DATE DESIGN	NOTES
2-B32-28"-A-15BC-1	SS Weldolet	N	Y	N		
2-B32-28"-B-9BC	SS Branch	N	N	N		
2-B32-28"-B-12BC-1	SS Weldolet	N	Y	N		
2-B32-28"-B-15BC-1	SS Weldolet	N	Y	N		
2-B32-22"-AM-3BC-A	SS Sweepolet	Y	N	N		
2-B32-22"-AM-3BC-B	SS Sweepolet	Y	N	N		
2-B32-22"-AM-5BC-A	SS Sweepolet	Y	N	N		
2-B32-22"-AM-5BC-B	SS Sweepolet	Y	N	N		
2-B32-22"-BM-1BC-A	SS Sweepolet	Y	N	N		
2-B32-22"-BM-1BC-B	SS Sweepolet	Y	N	N		
2-B32-22"-BM-3BC-A	SS Sweepolet	Y	N	N		
2-B32-22"-BM-3BC-B	SS Sweepolet	Y	N	N		
2-E11-RHR-20"-A-SUCT-1	SS Tee to SS Pipe	N	Y	N		
2-E11-RHR-20"-A-SUCT-1BC	SS Sweepolet	N	Y	N		
2-E11-RHR-20"-A-SUCT-2	SS Pipe to CS Valve	N	Y	N		1.
2-E11-RHR-24"-A-DISCH-12	SS Tee to CS Valve	N	Y	N		
2-E11-RHR-24"-B-DISCH-12	SS Tee to CS Valve	N	Y	N		

NOTES:
- Y - Yes
- N - No
- LB - Leak Barrier Overlay Design
- E - Engineered Overlay Design
- FS - Full Structural Overlay Design
- 1. - Indications detected during NOV 83 RF5 Outage. Determined to be geometry and not IGSCC during DEC 85 RF6 Outage.

TABLE 2

FLAWED UNREPAIRED WELDS
AT START OF RELOAD 6 OUTAGE

2-B32-28"-A-4
2-B32-28"-A-8
2-B32-28"-A-13
2-B32-28"-A-14
2-B32-28"-B-3
2-B32-28"-B-4
2-B32-28"-B-5
2-B32-28"-B-9
2-B32-22"-AM-5
2-B32-22"-BM-1
2-E11-RHR-20"-A-SUCT-2

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TABLE 3

FIVE EXISTING WELD OVERLAY
REPAIRS UPGRADED TO FULL STRUCTURAL

2-B32-12"-BR-G-4
2-B32-12"-BR-J-2
2-B32-12"-BR-J-3
2-B32-12"-BR-K-2
2-B32-12"-BR-K-3

TABLE 4

INCONEL BUTTER EXAMINATIONS

* 2-B32-RECIRC-12"-AR-A5
2-B32-RECIRC-12"-AR-B5
2-B32-RECIRC-12"-AR-C5
2-B32-RECIRC-12"-AR-E5
2-B32-RECIRC-12"-BR-F5
* 2-B32-RECIRC-12"-BR-G5
2-B32-RECIRC-12"-BR-H5
* 2-B32-RECIRC-28"-A1
2-B32-RECIRC-28"-B1

* Original Weld Sample

TABLE 5

INCONEL BUTTER INDICATIONS

	2-B32-RECIRC-28"	
Weld	A-1	B-1
Distance From Reference	0"	10.1"
Length	0.300"	0.250"
Through Wall Depth	0.250"	0.250"
Side	UP/Nozzle	UP/Nozzle
Orientation	Axial	Axial

ATTACHMENT 1

TO SERIAL: NLS-86-158

(3839MAT/pgp)