

OYSTER CREEK  
CYCLE 13R OUTAGE  
IGSCC ACTIVITIES

TR-084  
Rev. 1

AUTHOR

*R. T. DeV...* 1/31/92  
R. T. DeV...h, Engineer Sr. I

APPROVALS

*W. Connor* 1/31/92  
W. Connor - Mgr, Nuc. Chem. Materials Eng.

#### ABSTRACT

This report describes the Oyster Creek 13R outage inspection, evaluation and repair activities related to the BWR Intergranular Stress Corrosion Cracking (IGSCC) issue. We examined 92 butt welds within the scope of the GPU 13R Inspection Plan [3]. An additional 40 butt welds were examined as a result of IGSCC detection within the shutdown cooling and Core Spray Systems. All four of the nonconforming weldments within the Shutdown Cooling System and the Core Spray System were repaired with full structural weld overlays. Two nonconforming weldments from prior outages within the Recirculation System were dispositioned "use-as-is."

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## 1.0 INTRODUCTION

### 1.1 Purpose

This report describes the IGSCC augmented inspection program and results of examinations performed during the Cycle 13R outage. Described are the examination methods, personnel qualifications, extent of examinations and results.

This program is in response to Generic Letter 88-01[1] and provides assurance that Oyster Creek is not experiencing a major IGSCC problem.

### 1.2 Scope

The systems examined and their weld categories were in compliance with the GPUN examination plan as depicted in Tables 1 - 14[3]. A total of 92 butt welds were examined within the initial scope. 57 additional 40 butt welds were examined as a result of IGSCC detection. Of these, four indications were found; one was in the shutdown cooling system and three were in the core spray system. The weld examination expansion criteria applied is provided with in Section 5.3 of the GPUN Examination Plan [3].

## 2.0 IGSCC EXAMINATION AND RESULTS

### 2.1 Examination Methods

Manual and automated UT examination procedures were qualified at the EPRI NDE Center. These procedures rely on the 45 degree shear wave examination as the primary detection technique.

Geometric considerations of the weld bead width related to base material thickness in some cases required the use of manual 60 degree shear wave as a supplemental detection examination. Sizing after verification of IGSCC was performed by manual UT. Various EPRI-taught and industry-accepted techniques were utilized. The equipment utilized for the automated UT detection examination was the GE-SMART system. The ALARA I Scanner (track and arm) with UT Transducer Skewing capabilities allowed accurate location determination by use of X, Y and Z coordinates.

The OD and ID clad safe ends were initially examined using the GE-SMART system. Refracted longitudinal waves were used rather than 45° shear waves because of the need to enhance the tip-diffracted and reflection signals from flaws extending through the ID cladding into the base metal. A corner trap signal could be obscured by the clad interface. The process was qualified on a mockup which duplicated the as-built configuration based on our records.

The data acquisition system was the Ultra Image III. The data output from this system was a floppy disc, video cassette recording of the "A" scan, and computer printout of essential variables supplemented by hand written calibration and data sheets.

Examination of structural weld overlays was performed using manual UT techniques and were demonstrated to be effective in detecting IGSCC in the overlay and in the outer 25% of the original pipe wall.

## 2.2 Personnel Qualifications

UT was performed by personnel qualified to the NRC/EPRI/BWROG Coordination Plan for Training and Qualification Activities of NDE personnel.

## 2.3 GPUN Review

EPRI-qualified GPUN personnel and GPUN-approved contractors who were also EPRI-qualified performed reviews of all procedures, personnel certifications, data packages, and concurred with all data analysis performed by the Contractor.

## 2.4 Non-Conforming Examination Results

### 2.4.1 Shutdown Cooling and Core Spray System Welds

Four welds contained indications having the UT signal characteristics of IGSCC as follows: one 14-inch diameter shutdown cooling system weld (NU-3-5) and three 8-inch diameter Core Spray System welds (NZ-3-43, NZ-3-95).

### 2.4.2 Recirculation System Welds

Two Recirculation welds (NG-C-9A and NG-D-18) were previously examined in prior outages and dispositioned "use-as-is" based on a ASME Section XI, IWB-3640 evaluation. The weld examination details are provided in Table 1. Prior outage inspection results were provided previously in Topical Report 059, Rev. 0, submitted by GPUN letter 5000-89-1833 dated October 30, 1989.

## 3.0 DISPOSITION OF WELDMENTS CONTAINING IGSCC INDICATIONS

### 3.1 Introduction

This section describes the actions taken for disposition of the weldments identified by examination as containing the UT signal characteristics of IGSCC. The two actions described are weld overlay repair and analytical evaluation for continued service without repair.

### 3.2 Weld Overlay Repairs

Shutdown Cooling System Weld Nu-3-5 and Core Spray System Welds NZ-3-43, NZ-3-44 and NZ-3-95 were weld overlay repaired. The overlays were designed assuming that a 360° through-wall crack existed at each location. The resultant minimum design thickness provides adequate margin against plastic collapse when evaluated to the requirements of IWB-3642 of the ASME B&PV Code (1989 Edition) Section XI. The width of the overlays are sufficient to enable ultrasonic examination of the overlay and outer 25% of the pipe wall in accordance with the current, accepted methods. Since the overlays were deposited using the gas tungsten arc method, only primary stresses were included in the design input.

Details of the designs are provided in Table 2, and Reference 4. The overlays were deposited using the GTAW process with 309L & 308L bare wire. The original pipe surface and final overlay surface

were liquid penetrant examined. The measurements to confirm minimum design thickness included the first layer that contained an average ferrite number of 7.5 or higher with no single reading less than 5. Following completion of the overlay welding, each was ultrasonically examined using the current, EPRI-taught, industry-accepted methods as baseline examinations.

### 3.3 Use-As-Is

The indications in Recirculation System Welds NG-D-18 and NG-C-9A were re-evaluated for continued service assuming as-IHSI'd residual stress patterns. The results showed that both were acceptable for continued service without repair when evaluated to the criteria of IWB-3640 of ASME Code (1989 Edition) Section XI, Tables IWB-3641-5 and 6 and NUREG-0313 Rev. 2[2].

## 4.0 REFERENCES

1. "NRC Position on IGSCC in BWR Austenitic Stainless Steel Piping (Generic Letter 88-01)," USNRC, January 25, 1988.
2. "Technical Report on Material Selection and Processing Guidelines for BWR Coolant Pressure Boundary Piping", NUREG-0313 Revision 2, W.S. Hazelton, USNRC.
3. TR-050, Rev. 3, GPUN Response to Generic Letter 88-01 and NUREG 0313, Rev. 2. February, 1991.
4. General Electric Report NE-523-41-0691, Full Structural Weld Overlay Design for the Oyster Creek Shutdown Cooling, and Core Spray System, June 1991.

## 5.0 TABLES

1. IGSCC Indications
2. Weld Overlay Design Parameters

Table 1  
IGSCC INDICATIONS

SYSTEM	PIPE DIA.	WELD NO.	LOCATION	INDICATION DESCRIPTION
Recirculation	26.0"	NG-C-9A	"C" Loop DW Elev 12'	<u>11R Examination</u> (Elbow to pipe configuration) IGSCC indication #1 started at L-14.8", is 2.2" long, and is 18% thru wall. The indication is on the elbow side of the weld. (Circ.)
				<u>12R Examination</u> IGSCC indication #1 starts at L-14.25", is 3.5" long, and is 24% thru wall. The indication is on the elbow side of the weld. (Circ.)
				<u>13R Examination</u> IGSCC indication #1 starts at L-14.80", is 3.00" long, and is 29% thru wall. The indication is on the up stream side of the weld. (Circ.)
				IGSCC indication #2 starts at L-15.80", is 0.63" long, and is 10% thru wall. The indication is on the up stream side of the weld. (Axial)
				IGSCC indication #3 starts at L-14.00", is 0.49" long, and is 10% thru wall. The indication is on the up stream side of the weld. (Axial)
Recirculation	26.0	NG-D-18	"D" Loop DW Elev 30'	<u>12R Examination</u> (Pipe to pipe configuration) IGSCC indication #1 started at L-55.0", is 1.2" long, and is 14% thru wall. The indication is on the up stream side of the weld. (Circ.)
				IGSCC indication #2 starts at L-78.00", is 2.2" long, and is 13% thru wall. The indication is on the up stream side of the weld. (Circ.)
				<u>13R Examination</u> IGSCC indication #1 starts at L-65.40", is 3.00" long, and is 17% thru wall. The indication is on the up stream side of the weld. (Circ.)
				IGSCC indication #2 starts at L-78.50", is 0.60" long and is 13% thru wall. The indication is on the up stream side of the weld. (Circ.)

Table 1  
IGSCC INDICATIONS

SYSTEM	PIPE DIA.	WELD NO.	LOCATION	INDICATION DESCRIPTION
Recirculation	26.0	NG-D-18	"D" Loop DW Elev 30'	IGSCC indication #3 starts at L-68.40", is 0.40" long, and is 8% thru wall. The indication is on the up stream side of the weld. (Axial)
				IGSCC indication #4 starts at L-70.00", is 0.30" long and is 8% thru wall. The indication is on the up stream side of the weld. (Axial)
Shut Down Cooling	14.0"	NU-3-5	DW Elev 40'	<u>13R Examination</u> (Elbow to pipe configuration) IGSCC indication #1 starts at L-1.70", is 5.20" long, and 29% thru wall. The indication is on the up stream side of the weld. (Circ.)
				IGSCC indication #2 starts at L-8.00", is 1.80" long, and 46% thru wall. The indication is on the up stream side of the weld. (Circ.)
				IGSCC indication #3 starts at L-3.25", is 0.50" long, and 51% thru wall. The indication is on the up stream side of the weld. (Axial)
				IGSCC indication #4 starts at L-8.45", is 0.40" long, and 35% thru wall. The indication is on the up stream side of the weld. (Axial)
				IGSCC indication #5 starts at L-8.65", is 0.35" long, and 40% thru wall. The indication is on the up stream side of the weld. (Axial)
				IGSCC indication #6 starts at L-9.25", is 0.35" long, and 40% thru wall. The indication is on the up stream side of the weld. (Axial)
				IGSCC indication #7 starts at L-9.75", is 0.20" long, and 29% thru wall. The indication is on the up stream side of the weld. (Axial)



Table 1  
IGSCC INDICATIONS

SYSTEM	PIPE DIA.	WELD NO.	LOCATION	INDICATION DESCRIPTION
Core Spray	8.0"	NZ-3-43	DW Elev 73'	<u>I3R Examination</u> (Elbow to pipe configuration) IGSCC indication #1 starts at 11.60", is 0.30" long, and is 22% thru wall. The indication is on the down stream side of the weld. (Axial)
				IGSCC indication #2 starts at 12.90", is 0.30" long, and is 18% thru wall. The indication is on the down stream side of the weld. (Axial)
				IGSCC indication #3 starts at 14.80", is 0.40" long, and is 31% thru wall. The indication is on the down stream side of the weld. (Axial)
				IGSCC indication #4 starts at 15.20", is 0.40" long, and is 22% thru wall. The indication is on the down stream side of the weld. (Axial)
				IGSCC indication #5 starts at 16.60", is 0.30" long, and is 31% thru wall. The indication is on the down stream side of the weld. (Axial)
				IGSCC indication #6 starts at 0.20", is 0.48" long, and is 40% thru wall. The indication is on the down stream side of the weld. (Axial)
Core Spray	8.0"	NZ-3-44	DW Elev 73'	<u>I3R Examination</u> (Pipe to reducer configuration)
				IGSCC indication #1 starts at 0.70", is 0.80" long, and is 19% thru wall. The indication is on the up stream side of the weld. (Circ.)
				IGSCC indication #2 starts at 25.20", is 2.40" long, and is 42% thru wall. The indication is on the down stream side of the weld. (Circ.)

Table 1  
IGSCC INDICATIONS

SYSTEM	PIPE DIA.	WELD NO.	LOCATION	INDICATION DESCRIPTION
Core Spray	8.0"	NZ-3-44 (Cont.)	DW Elev 73'	IGSCC indication #3 starts at 0.70", is 0.44" long, and is 57% thru wall. The indication is on the down stream side of the weld. (Axial)
				IGSCC indication #4 starts at 6.10", is 0.68" long, and is 54% thru wall. The indication is on the down stream side of the weld. (Axial)
				IGSCC indication #5 starts at 7.40", is 0.48" long, and is 42% thru wall. The indication is on the down stream side of the weld. (Axial)
				IGSCC indication #6 starts at 8.60", is 0.48" long, and is 31% thru wall. The indication is on the down stream side of the weld. (Axial)
				IGSCC indication #7 starts at 14.00", is 0.40" long, and is 31% thru wall. The indication is on the down stream side of the weld. (Axial)
				IGSCC indication #8 starts at 18.00", is 0.40" long, and is 25% thru wall. The indication is on the down stream side of the weld. (Axial)
				IGSCC indication #9 starts at 19.00", is 0.48" long, and is 31% thru wall. The indication is on the down stream side of the weld. (Axial)
				IGSCC indication #10 starts at 20.50", is 0.32" long, and is 38% thru wall. The indication is on the down stream side of the weld. (Axial)
				IGSCC indication #11 starts at 21.30", is 0.52" long, and is 35% thru wall. The indication is on the down stream side of the weld. (Axial)
				IGSCC indication #12 starts at 10.80", is 0.40" long, and is 23% thru wall. The indication is on the up stream side of the weld. (Axial)

Table 1  
IGSCC INDICATIONS

SYSTEM	PIPE DIA.	WELD NO.	LOCATION	INDICATION DESCRIPTION
Core Spray	8.0"	NZ-3-44 (Cont.)	DW Elev 73'	IGSCC indication #13 starts at 11.90", is 0.72" long, and is 34% thru wall. The indication is on the up stream side of the weld. (Axial)
				IGSCC indication #14 starts at 12.70", is 0.20" long, and is 36% thru wall. The indication is on the up stream side of the weld. (Axial)
				IGSCC indication #15 starts at 15.20", is 0.40" long, and is 46% thru wall. The indication is on the up stream side of the weld. (Axial)
				IGSCC indication #16 starts at 16.20", is 0.42" long, and is 25% thru wall. The indication is on the up stream side of the weld. (Axial)
				IGSCC indication #17 starts at 16.90", is 0.40" long, and is 21% thru wall. The indication is on the up stream side of the weld. (Axial)
				IGSCC indication #18 starts at 17.30", is 0.39" long, and is 31% thru wall. The indication is on the up stream side of the weld. (Axial)
				IGSCC indication #19 starts at 17.30", is 0.41" long, and is 34% thru wall. The indication is on the up stream side of the weld. (Axial)
				IGSCC indication #20 starts at 18.20", is 0.40" long, and is 21% thru wall. The indication is on the up stream side of the weld. (Axial)
				IGSCC indication #21 starts at 18.80", is 0.39" long, and is 29% thru wall. The indication is on the up stream side of the weld. (Axial)
				IGSCC indication #22 starts at 19.60", is 0.40" long, and is 40% thru wall. The indication is on the up stream side of the weld. (Axial)

Table 1  
IGSCC INDICATIONS

SYSTEM	PIPE DIA.	WELD NO.	LOCATION	INDICATION DESCRIPTION
Core Spray	8.0"	NE-3-95	DW Elev 73'	<u>13R Examination</u> (Pipe to reducer configuration) IGSCC indication #1 starts at 22.50", is 1.00" long, and is 21% thru wall. The indication is on the down stream side of the weld. (Circ.)
				IGSCC indication #2 starts at 1.55", is 0.32" long, and is 21% thru wall. The indication is on the down stream side of the weld. (Axial)
				IGSCC indication #3 starts at 2.85", is 0.35" long, and is 31% thru wall. The indication is on the down stream side of the weld. (Axial)
				IGSCC indication #4 starts at 25.40", is 0.30" long, and is 52% thru wall. The indication is on the down stream side of the weld. (Axial)
				IGSCC indication #5 starts at 26.50", is 0.25" long, and is 42% thru wall. The indication is on the down stream side of the weld. (Axial)

Table 2  
CIRCUMFERENTIALLY FLAWED OVERLAY REPAIRED WELDS  
PIPE AND FLAW GEOMETRIC DETAILS

WELD NO.	O.D. (1) (in.)	tp (2) (in.)	to (3) (in.)	t (4) (in.)	L (5) Degrees
NU-3-5	14.00	0.76	0.275	1.035	360
NZ-3-43	8.63	0.53	0.239	0.769	360
NZ-3-44	8.63	0.53	0.349	0.879	360
NZ-3-95	8.63	0.53	0.326	0.856	360

NOTES:

1. O.D. = Outside diameter
2. tp = Pipe wall thickness
3. to = Total weld overlay repair thickness
4. t = tp + to
5. L = Evaluation flaw length

ATTACHMENT 2

Oyster Creek  
Cycle 13R Outage  
Weld Overlay Design