JOHNSON CONTROLS - BRANCH 260
812 First State Blvd
Delmarva Branch N28
Wilmington, DE 19804
(302)996-0275

Report of Eddy Current Inspection

Manufacturer: Carrier

Model: 17DA743

Serial: 01588 #6

Location: DUPONT EXPERIMENTAL STATION
RTE. 141 BETWEEN 52 & 202
WILMINGTON, DE 19735

Inspected: January 13, 2014-January 17, 2014

Inspected By: JAYSON C. GREER, LEVEL III
TAI Services, Inc.

Reviewed By: _____
TECHNICAL MANAGER, LEVEL III

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Vessel Information

Manufacturer	Model	Style	Serial Number	Type
Carrier	17DA743	Open Drive	01588 #6	Centrifugal

Condenser	
TestEnd	Opposite Inlet/Outlet
Tube Count	3990
Tube Type	Skip Fin IE
Tube Material	90/10 CuNi
OD	.750
*NWT/Under Fins	.035
*NWT/Bell/Land	.049
#/Type Support	4 Mild Steel
Tube Numbering	Left to Right
Row Numbering	Top to Bottom
Tube Length +- 2	180 Inches

Sub-Cooler	
TestEnd	Opposite Inlet/Outlet
Tube Count	441
Tube Type	Skip Fin IE
Tube Material	90/10 CuNi
OD	.750
*NWT/Under Fins	.035
*NWT/Bell/Land	.049
#/Type Support	9 Mild Steel
Tube Numbering	Left to Right
Row Numbering	Top to Bottom
Tube Length +- 2	180 Inches

Analyst: JAYSON C. GREER, LEVEL III

* Nominal Wall Thickness

Vessel Bay Length Information

Condenser (Length = 180 inches)
S = Intermediate Support

Bay 5	38.00"
Bay 4	35.00"
Bay 3	34.00"
Bay 2	35.00"
Bay 1	38.00"

Sub-Cooler (Length = 180 inches)
S = Intermediate Support

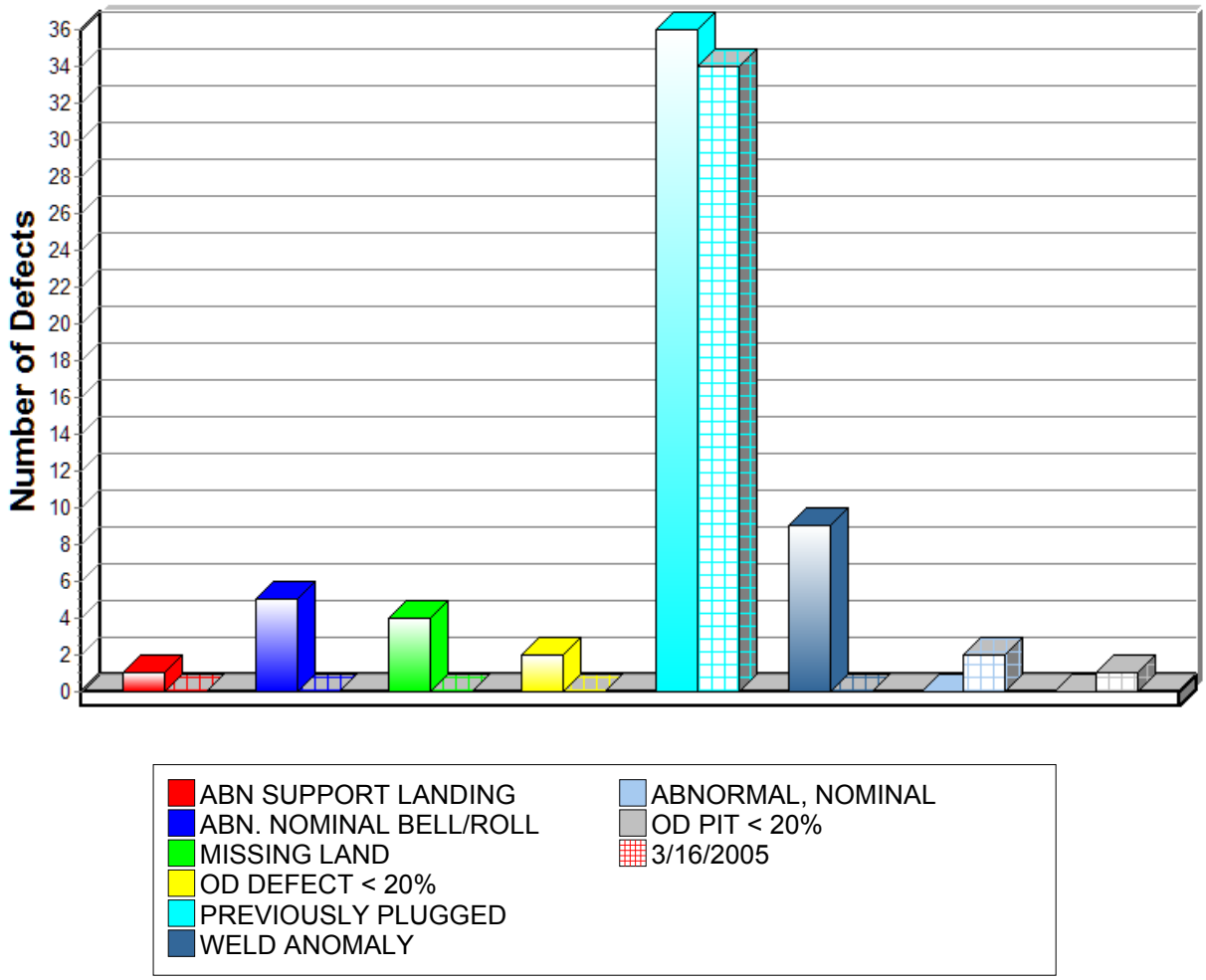
Bay 10	20.00"
Bay 9	17.50"
Bay 8	17.50"
Bay 7	17.50"
Bay 6	17.50"
Bay 5	17.50"
Bay 4	17.50"
Bay 3	17.50"
Bay 2	17.50"
Bay 1	20.00"

Defect Summary/Comparison

Comparison of Tests Performed

1/13/2014 3/16/2005

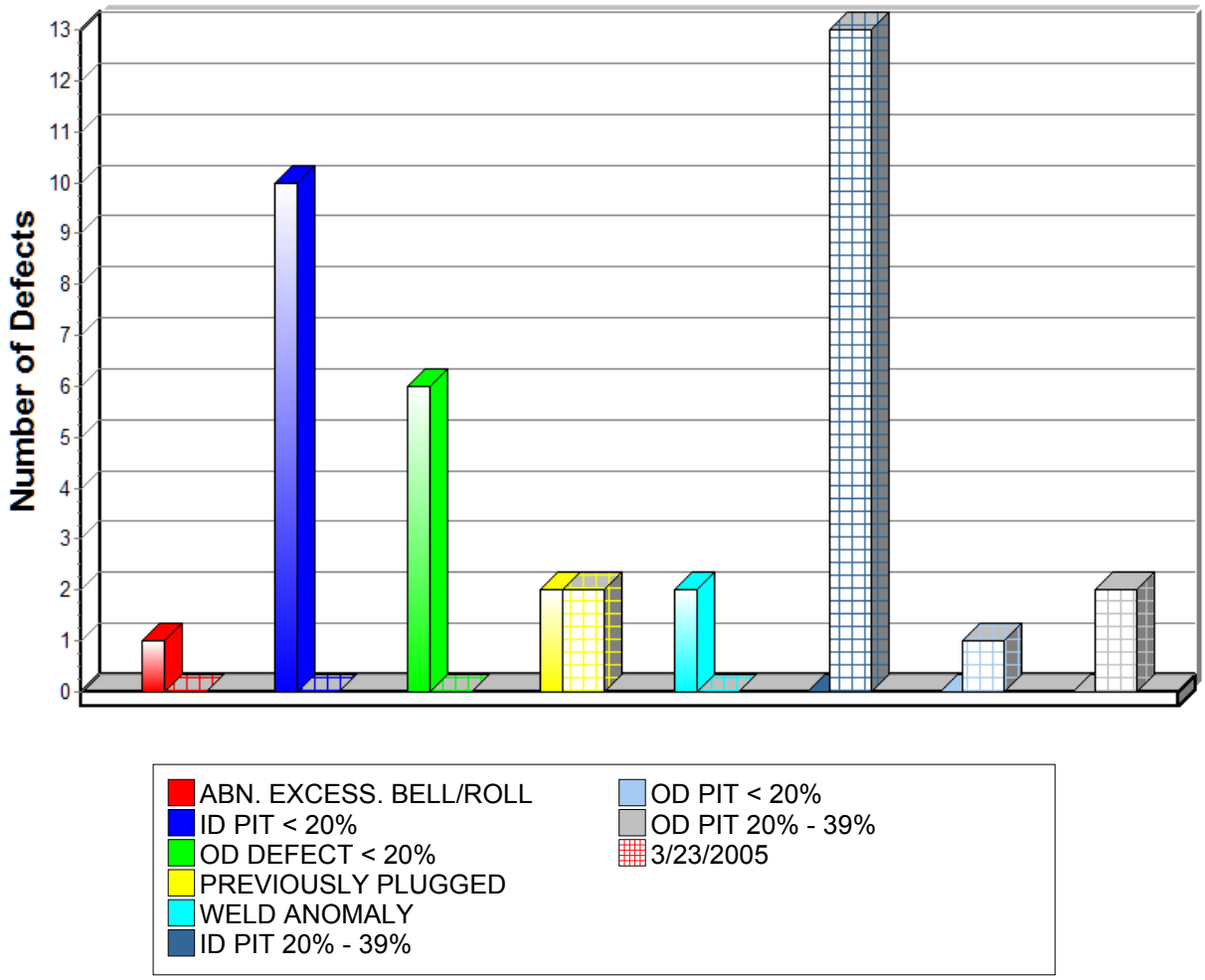
Condenser Defects



Location	Model	Serial Number
DUPONT EXPERIMENTAL STATION	17DA743	01588 #6

Note: The Graph will indicate a Comparison Analysis when the unit has been previously tested by TAI Services.

Sub-Cooler Defects



Location	Model	Serial Number
DUPONT EXPERIMENTAL STATION	17DA743	01588 #6

Note: The Graph will indicate a Comparison Analysis when the unit has been previously tested by TAI Services.

Summary of Inspection

An eddy current tube inspection was performed as part of a preventive maintenance program with the following results.

Condenser: 3990 Tubes		
Tubes Tested: 3990 Tubes		
Significant/Measurable Indications	Number of Tubes Marked	Percent of Bundle
ABN. NOMINAL BELL/ROLL	5	.13
ABN SUPPORT LANDING	1	.03
OD DEFECT < 20%	2	.05
MISSING LAND	4	.10
PREVIOUSLY PLUGGED	36	.90
DIFF WALL THICKNESS	9	.23
Totals	**57**	**1.44**

NOTE: Although not marked, the majority of tubes gave indications of minor generalized ID Corrosion and Pitting. No individual tubes gave indications of significant damage, and therefore none were marked.

NOTE: The tubes in this vessel showed minor indications of tube wall thinning. These indications were attributed to permeability variations and not loss of mass.

Sub-Cooler: 441 Tubes		
Tubes Tested: 441 Tubes		
Significant/Measurable Indications	Number of Tubes Marked	Percent of Bundle
ABN. EXCESS. BELL/ROLL*	1	.23
OD DEFECT < 20%	6	1.36
ID PIT < 20%	10	2.27

Summary of Inspection - Page 2

Sub-Cooler: 441 Tubes		
Tubes Tested: 441 Tubes		
Significant/Measurable Indications	Number of Tubes Marked	Percent of Bundle
PREVIOUSLY PLUGGED	2	.45
DIFF WALL THICKNESS	2	.45
Totals	**21**	**4.76**

* REQUIRES ACTION

NOTE: Although not marked, the majority of tubes gave indications of minor generalized ID Corrosion. No individual tubes gave indications of significant damage, and therefore none were marked.

NOTE: The tubes in this vessel showed minor indications of tube wall thinning. These indications were attributed to permeability variations and not loss of mass.

Recommendations

An eddy current inspection was performed on the tubes in this machine. This test was performed using accepted eddy current test methods for the inspection of in-service tubing. It should be noted that Eddy Current is not a leak detection method. The possibility does exist that tubes could contain defects and/or leaks which are not detectable. If leaks are suspected, we recommend a pressure test be used to identify the leaking tubes.

The following suggested repair actions are based on accepted industry standards. After removing sample tubes to confirm the inspection results, a determination of corrective action should be made by the repair agency and end user. Only these parties have knowledge of the critical applications and long-term use of the equipment. If plugging is selected over replacement, both efficiency and capacity should be considered.

CONDENSER:

The tubes indicating Abnormal Bell End Indications require no corrective action at this time. The indications are that of thinning at the Bell End. The exact cause and description of the anomaly is unknown. However, it is believed to be a non-progressive manufacturing anomaly and should not affect the performance or longevity of the effected tubes.

The tube indicating Abnormal Support Landing Indications requires no corrective action at this time. This tube showed a distorted transition zone at the indicated support. The exact cause of the indication is unknown, but is believed to be the result of manufacturing.

The OD Defects detected appear minor at this time, and require no immediate corrective action. However, the damage mechanism and growth rates are unknown.

Tubes missing support landings showed no detectable loss and require no corrective action.

Tubes marked as Previously Plugged, had been plugged prior to this inspection.

The tube(s) marked as "Different Wall Thickness" were .750/.045/.028 tubes of the same alloy. These tubes were inspected without re- calibrating the test instrument. No measurable indications of tube damage and were identified.

It was noted during the inspection that the tubes contained a moderate amount of what appeared to be lime calcium scale build-up. Consideration should be given to chemically cleaning these tubes to prevent internal tube wall damage and promote heat transfer.

SUB-COOLER:

We recommend the tube indicating an Abnormal Bell End Indication be isolated from the system at this time. The exact cause of the indication is unknown. However, excessive thinning is indicated.

The OD Defects detected appear minor at this time, and require no immediate corrective action. However, the damage mechanism and growth rates are unknown.

Tubes indicating ID Pits require no corrective action at this time. However, this type damage should be monitored for defect growth, as it can be progressive.

Tubes marked as Previously Plugged, had been plugged prior to this inspection.

The tube(s) marked as "Different Wall Thickness" were .750/.045/.028 tubes of the same alloy. These tubes were inspected without re- calibrating the test instrument. No measurable indications of tube damage and were identified.

It was noted during the inspection that the tubes contained a moderate amount of what appeared to be lime calcium scale build-up. Consideration should be given to chemically cleaning these tubes to prevent internal tube wall damage and promote heat transfer.

RE-INSPECTION RECOMMENDATIONS:

We recommend that a follow-up inspection be performed on these vessels as follows:

Condenser: 13 January 2016

Sub-Cooler: 13 January 2016

A copy of this report should be retained in your files to be used for comparison at that time.

If you should have any questions concerning this report, or if we may be of further assistance, please feel free to call upon us.

Data Sheet

Location	Model	Serial Number	Date
DUPONT EXPERIMENTAL STATION	17DA743	01588 #6	January 13, 2014
RTE. 141 BETWEEN 52 & 202			
WILMINGTON, DE 19735			

Row	Tube	Description	Area	Action Req.
SET UP CALIBRATE & STARTED				
CONDENSER 1/13/2014 08:03 am				
CALIBRATION CHECK 1/13/2014 02:33 pm				
CALIBRATION CHECK 1/14/2014 11:02 am				
CALIBRATION CHECK 1/14/2014 05:42 pm				
CALIBRATION CHECK 1/16/2014 08:43 am				
CALIBRATION CHECK 1/16/2014 02:56 pm				
CALIBRATION CHECK 1/17/2014 08:09 am				
1	9	PREVIOUSLY PLUGGED	TE	
3	29	PREVIOUSLY PLUGGED	TE	
4	26	PREVIOUSLY PLUGGED	TE	
5	2	PREVIOUSLY PLUGGED	TE	
5	31	PREVIOUSLY PLUGGED	TE	
6	33	ABN SUPPORT LANDING	S02	
6	63	ABN. NOMINAL BELL/ROLL	OTE	
7	11	DIFF WALL THICKNESS	TE	
7	63	ABN. NOMINAL BELL/ROLL	OTE	
8	18	PREVIOUSLY PLUGGED	TE	
8	21	PREVIOUSLY PLUGGED	TE	
8	62	ABN. NOMINAL BELL/ROLL	OTE	
9	52	PREVIOUSLY PLUGGED	TE	

Row	Tube	Description	Area	Action Req.
10	43	PREVIOUSLY PLUGGED	TE	
11	7	PREVIOUSLY PLUGGED	TE	
11	37	OD DEFECT < 20%	B01	
11	51	PREVIOUSLY PLUGGED	TE	
11	55	PREVIOUSLY PLUGGED	TE	
12	44	MISSING LAND	S02	
13	9	PREVIOUSLY PLUGGED	TE	
13	71	PREVIOUSLY PLUGGED	TE	
14	12	PREVIOUSLY PLUGGED	TE	
14	15	PREVIOUSLY PLUGGED	TE	
14	22	DIFF WALL THICKNESS	TE	
15	50	ABN. NOMINAL BELL/ROLL	OTE	
18	42	ABN. NOMINAL BELL/ROLL	OTE	
18	60	MISSING LAND	S04	
20	71	DIFF WALL THICKNESS	TE	
21	30	PREVIOUSLY PLUGGED	TE	
21	35	PREVIOUSLY PLUGGED	TE	
23	24	PREVIOUSLY PLUGGED	TE	
24	24	MISSING LAND	S02	
27	7	PREVIOUSLY PLUGGED	TE	
28	73	PREVIOUSLY PLUGGED	TE	
29	6	MISSING LAND	S02	
30	2	PREVIOUSLY PLUGGED	TE	
30	28	PREVIOUSLY PLUGGED	TE	
31	28	DIFF WALL THICKNESS	TE	
31	63	PREVIOUSLY PLUGGED	TE	

Row	Tube	Description	Area	Action Req.
33	8	OD DEFECT < 20%	B04	
33	51	DIFF WALL THICKNESS	TE	
33	77	DIFF WALL THICKNESS	TE	
35	73	DIFF WALL THICKNESS	TE	
36	14	PREVIOUSLY PLUGGED	TE	
36	49	PREVIOUSLY PLUGGED	TE	
36	67	DIFF WALL THICKNESS	TE	
37	70	PREVIOUSLY PLUGGED	TE	
38	15	PREVIOUSLY PLUGGED	TE	
40	10	DIFF WALL THICKNESS	TE	
40	28	PREVIOUSLY PLUGGED	TE	
41	39	PREVIOUSLY PLUGGED	TE	
44	17	PREVIOUSLY PLUGGED	TE	
50	18	PREVIOUSLY PLUGGED	TE	
51	9	PREVIOUSLY PLUGGED	TE	
53	3	PREVIOUSLY PLUGGED	TE	
53	26	PREVIOUSLY PLUGGED	TE	
56	18	PREVIOUSLY PLUGGED	TE	
CALIBRATION CHECK & COMPLETED				
CONDENSER 1/17/2014 11:07 am				
SET UP CALIBRATE & STARTED				
SUB-COOLER 1/17/2014 11:18 am				
1	3	ID PIT < 20%	B10	
1	18	ID PIT < 20%	B04	
2	13	ID PIT < 20%	B10	
3	16	ID PIT < 20%	B09	

Row	Tube	Description	Area	Action Req.
3	17	OD DEFECT < 20%	B08	
3	21	OD DEFECT < 20%	B08	
3	24	ID PIT < 20%	B10	
6	28	OD DEFECT < 20%	B09	
7	6	ID PIT < 20%	B07	
7	27	ID PIT < 20%	B02	
8	1	PREVIOUSLY PLUGGED	TE	
8	8	ID PIT < 20%	B09	
8	18	PREVIOUSLY PLUGGED	TE	
8	23	OD DEFECT < 20%	B10	
8	28	DIFF WALL THICKNESS	TE	
10	5	ID PIT < 20%	B10	
10	19	ABN. EXCESS. BELL/ROLL	TE	✓
12	17	DIFF WALL THICKNESS	TE	
14	16	OD DEFECT < 20%	B09	
15	5	OD DEFECT < 20%	B09	
16	10	ID PIT < 20%	B07	
CALIBRATION CHECK & COMPLETED				
SUB-COOLER 1/17/2014 01:57 pm				

Condenser Section

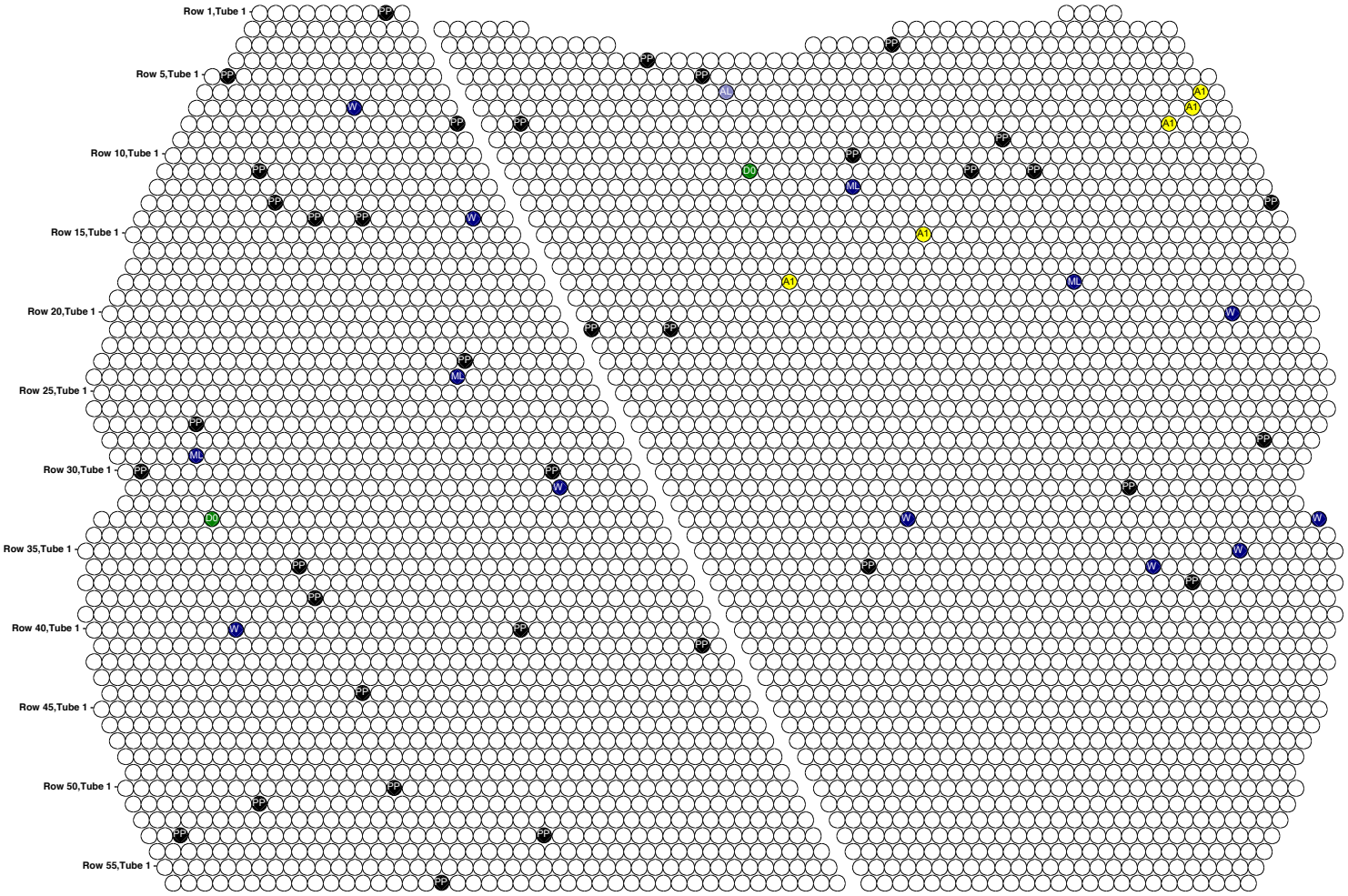
Tubes Numbered
Left to Right

Rows Numbered
Top to Bottom

Top of Vessel

S/N 01588 #6

Opposite Inlet/Outlet



A1 = ABN. NOMINAL BELL/ROLL

AL = ABN SUPPORT LANDING

DO = OD DEFECT < 20%

ML = MISSING LAND

PP = PREVIOUSLY PLUGGED

W = WELD ANOMALY

Sub-Cooler Section

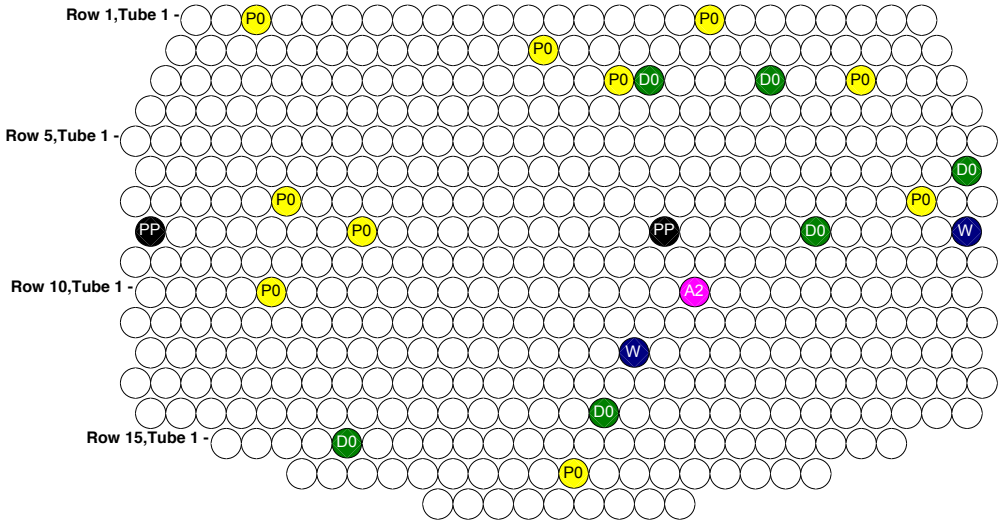
Tubes Numbered
Left to Right

Rows Numbered
Top to Bottom

S/N 01588 #6

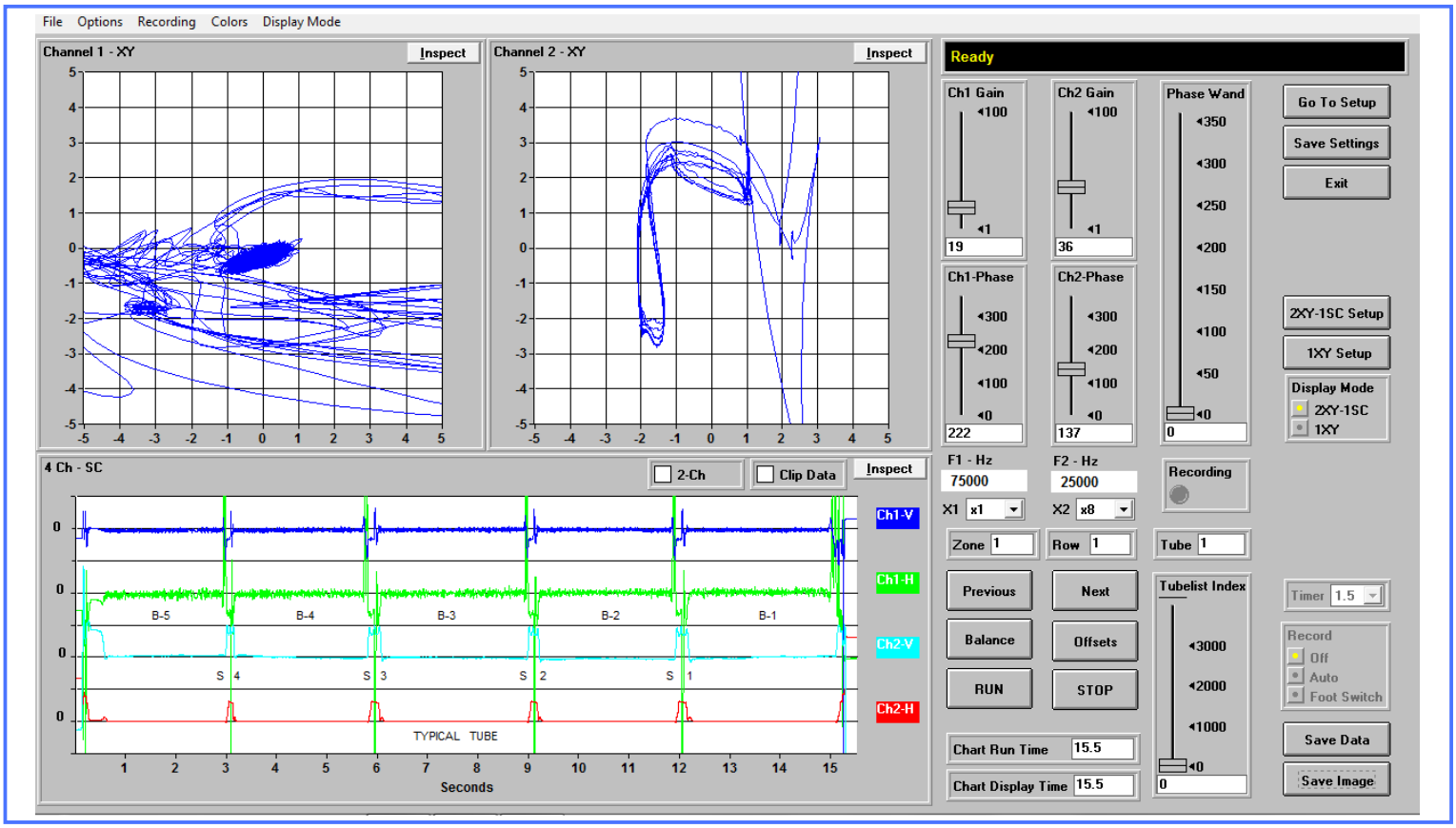
Opposite Inlet/Outlet

Top of Vessel



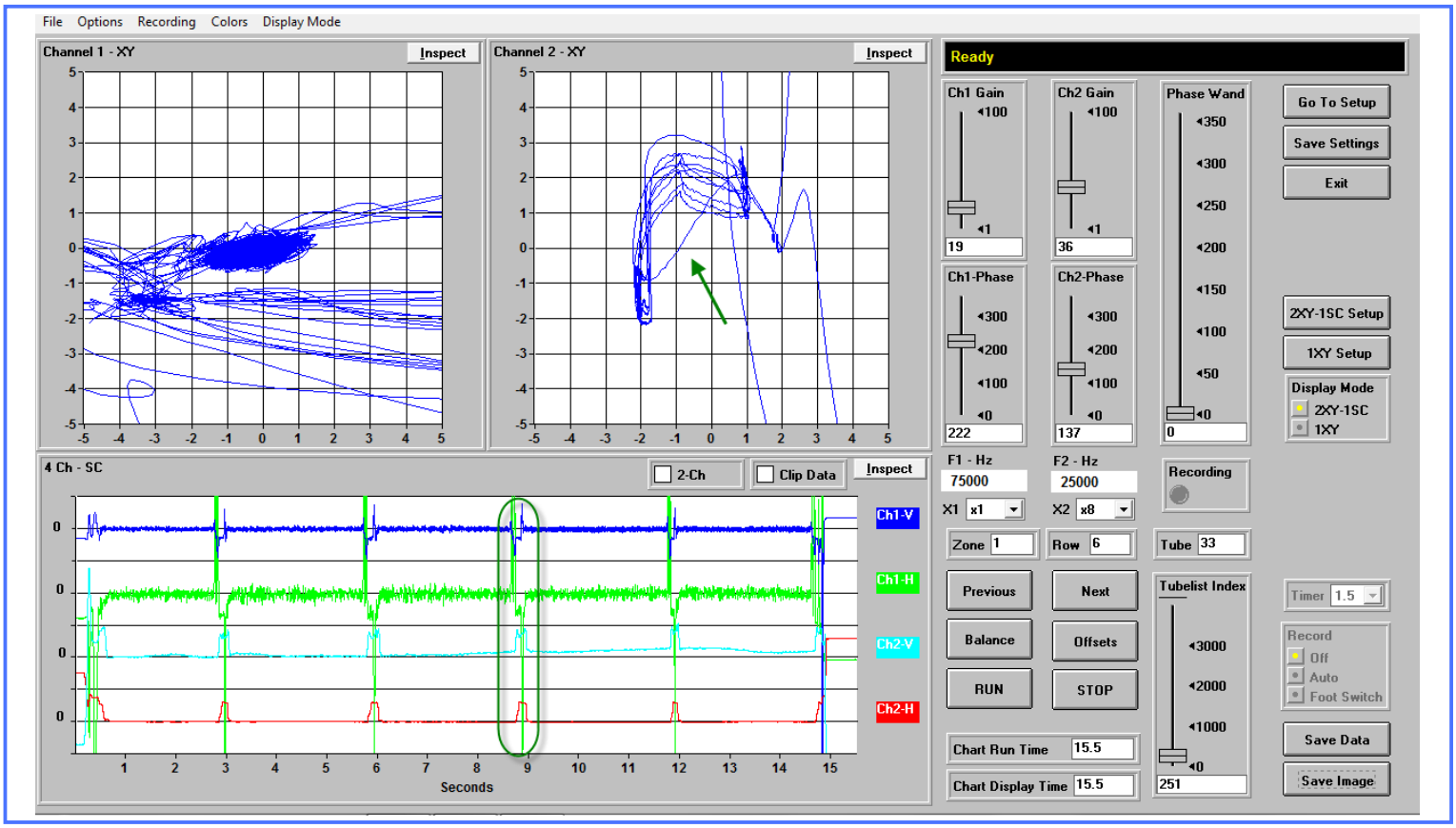
A2	= ABN. EXCESS. BELL/ROLL	REQUIRES ACTION
D0	= OD DEFECT < 20%	
P0	= ID PIT < 20%	
PP	= PREVIOUSLY PLUGGED	
W	= WELD ANOMALY	

Condenser Section



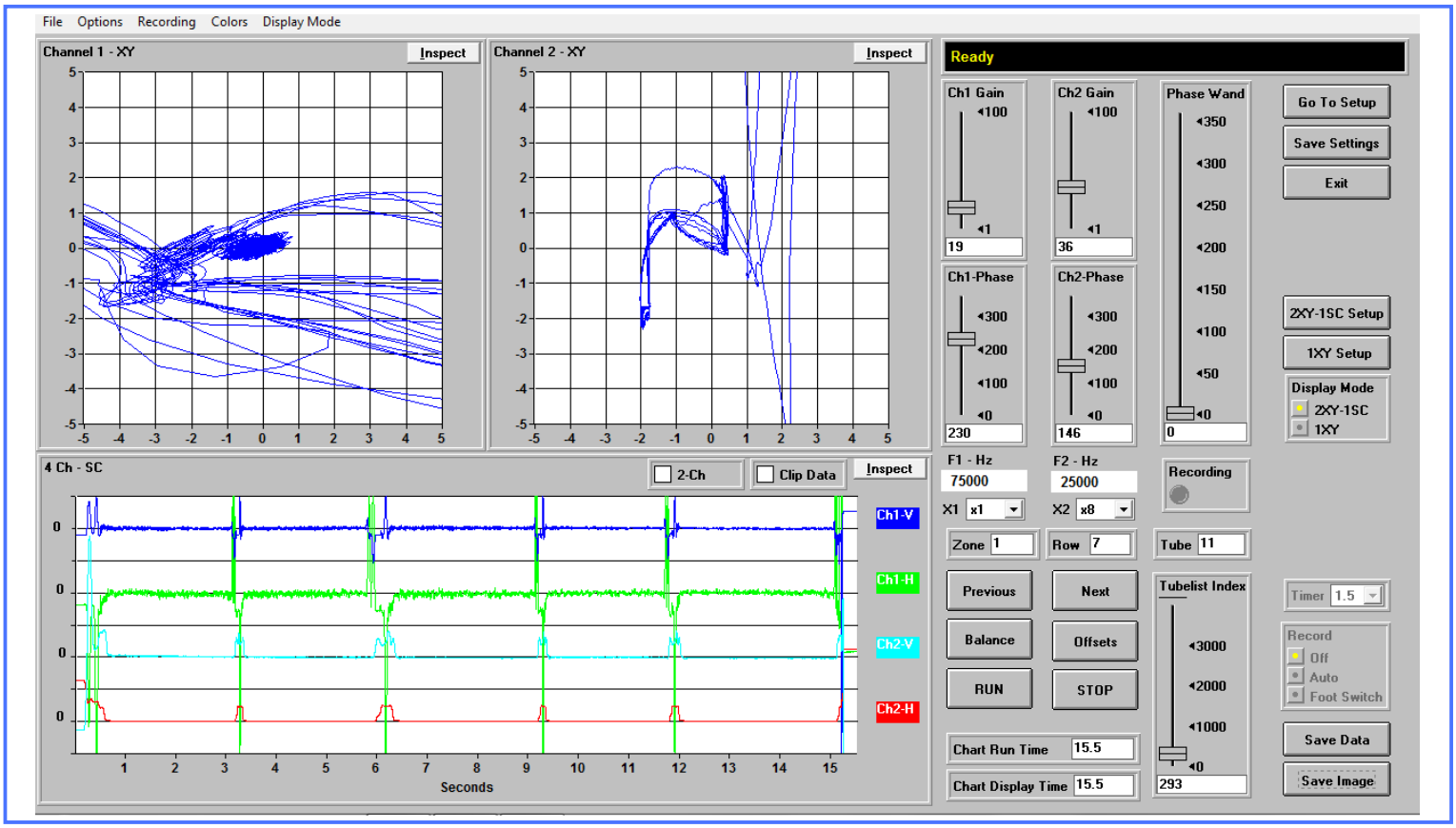
TYPICAL TUBE (Row 1 Tube 1)

Condenser Section



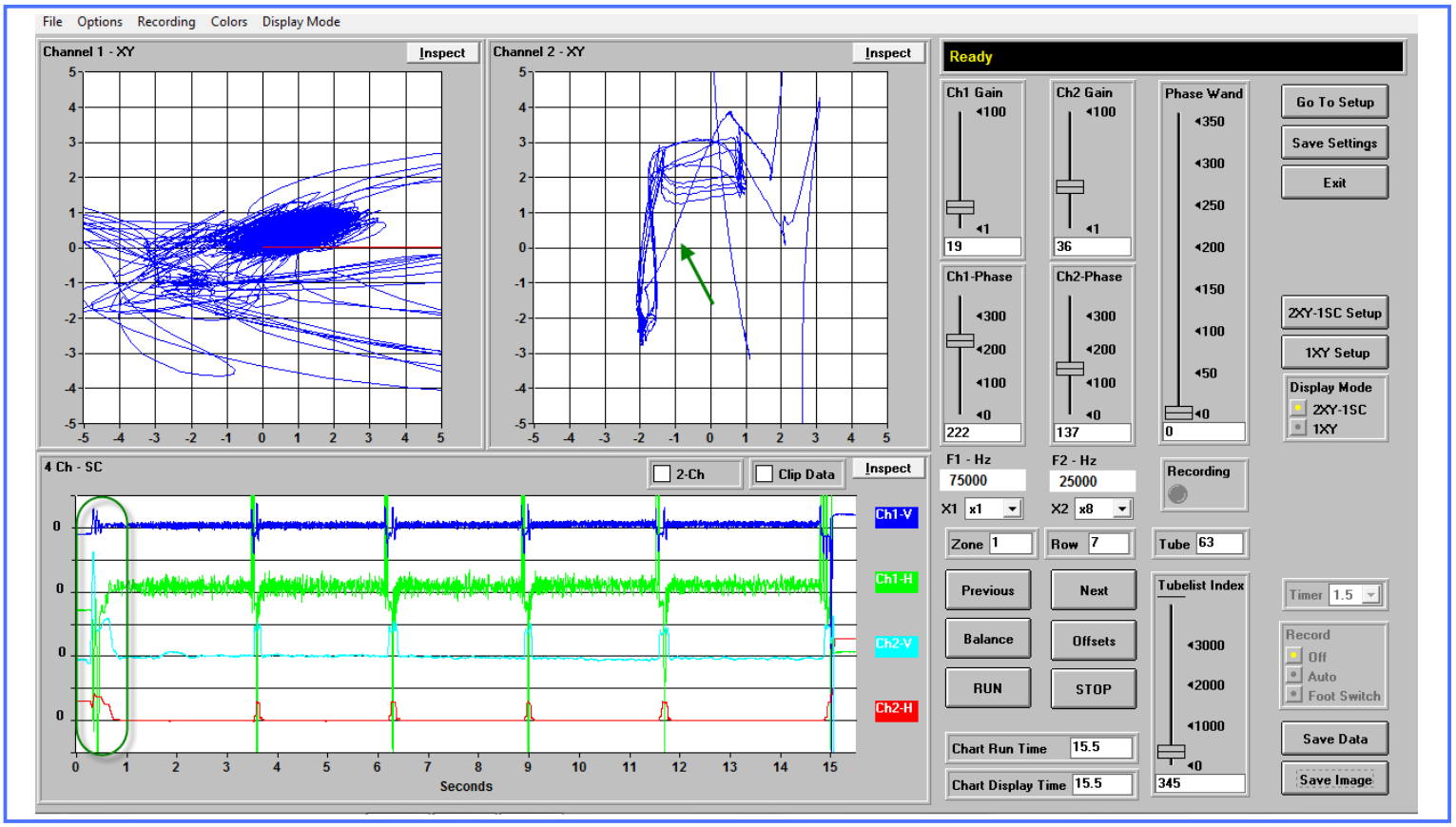
ABN SUPPORT LANDING (Row 6 Tube 33)

Condenser Section



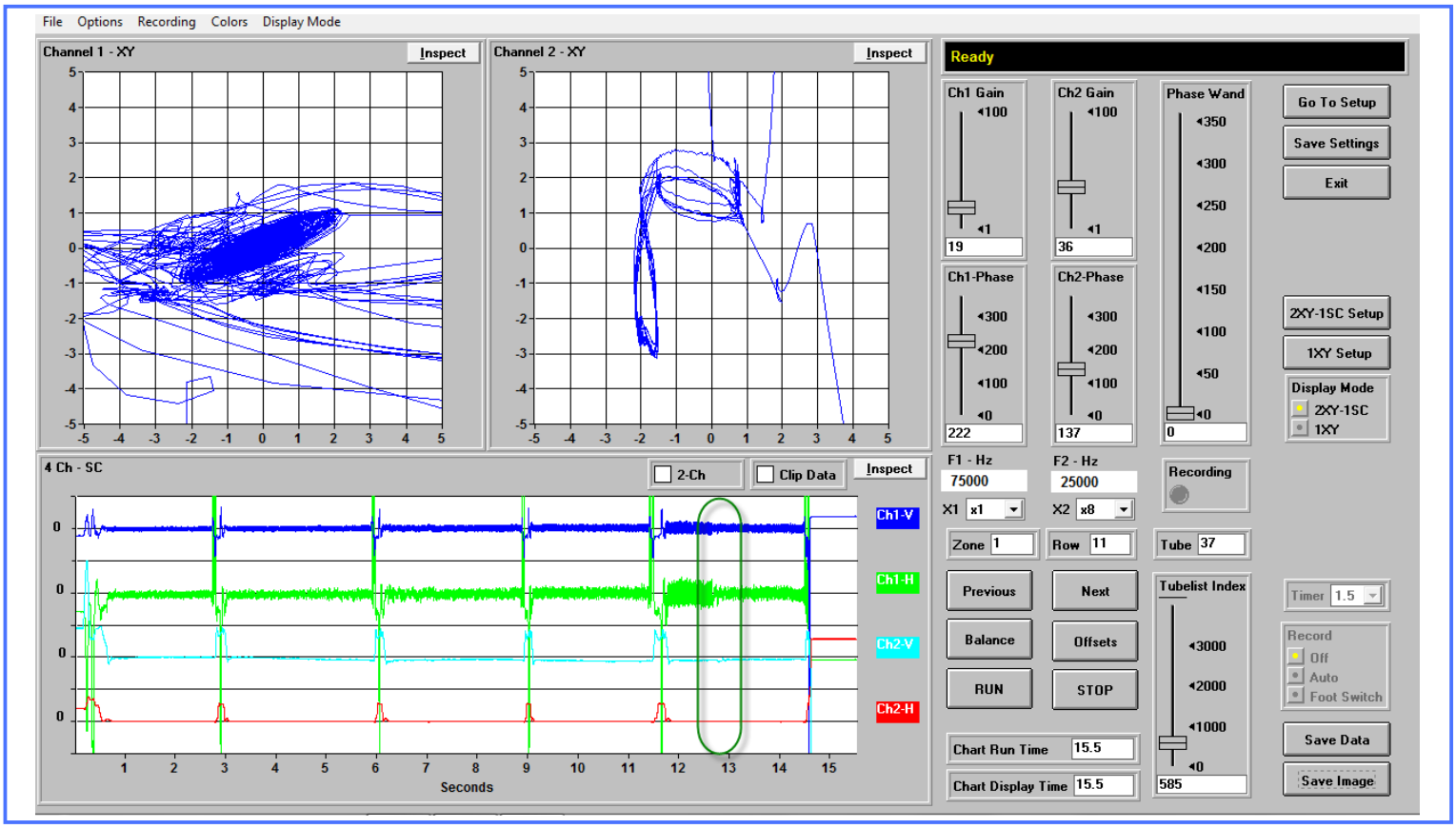
WELD ANOMALY (Row 7 Tube 11)

Condenser Section



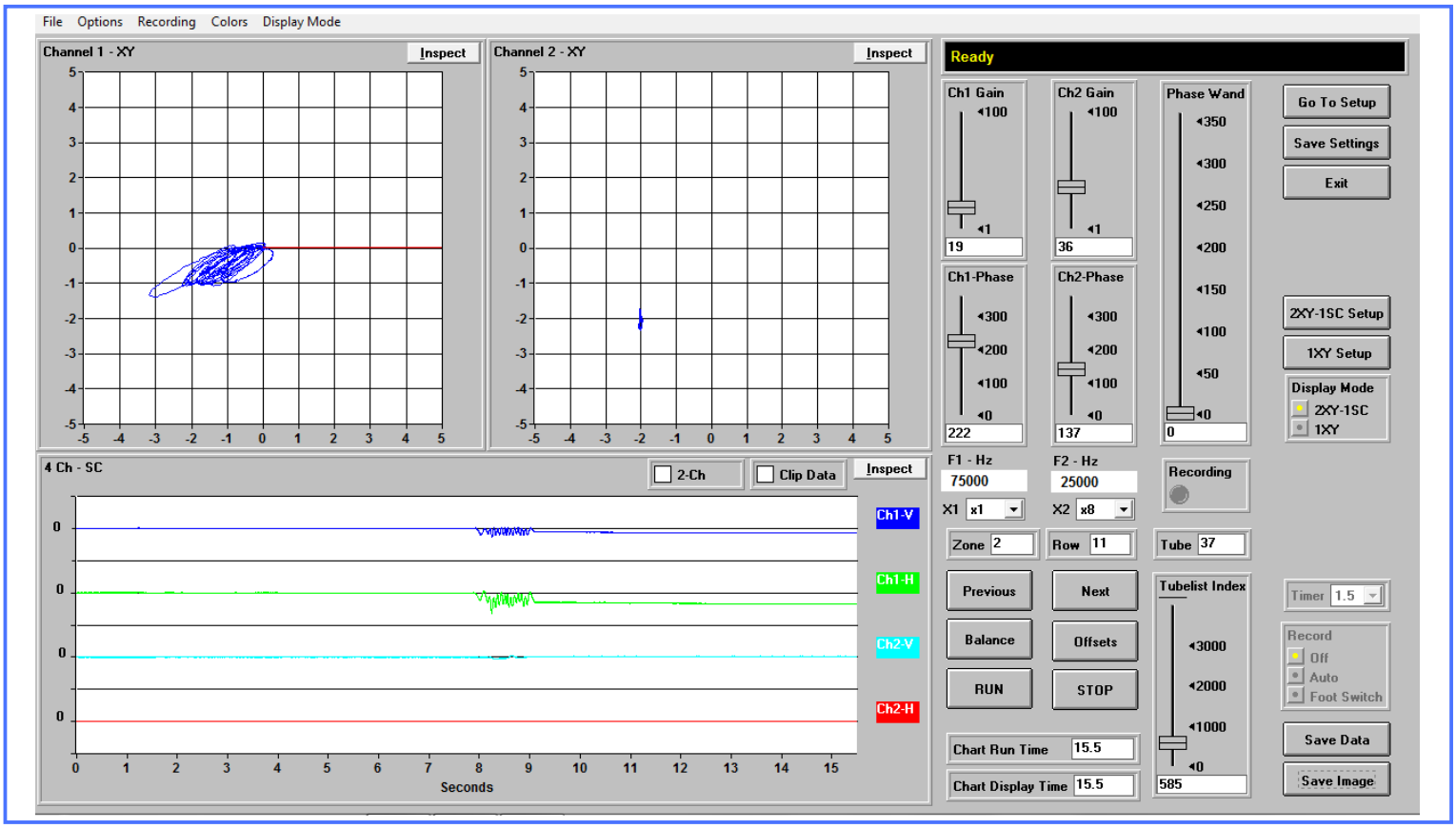
ABN. NOMINAL BELL/ROLL (Row 7 Tube 63)

Condenser Section



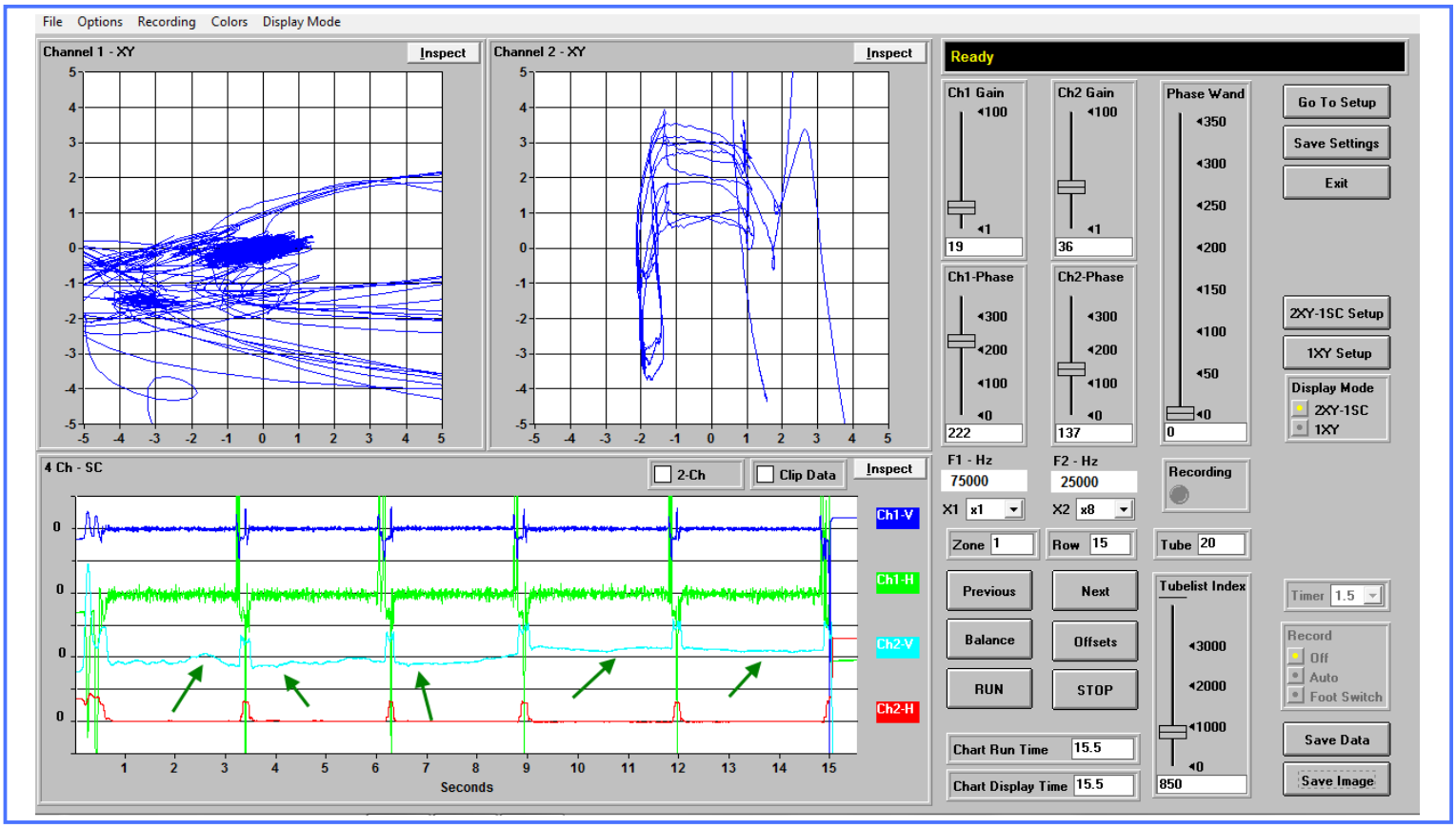
OD DEFECT < 20% (Row 11 Tube 37)

Condenser Section



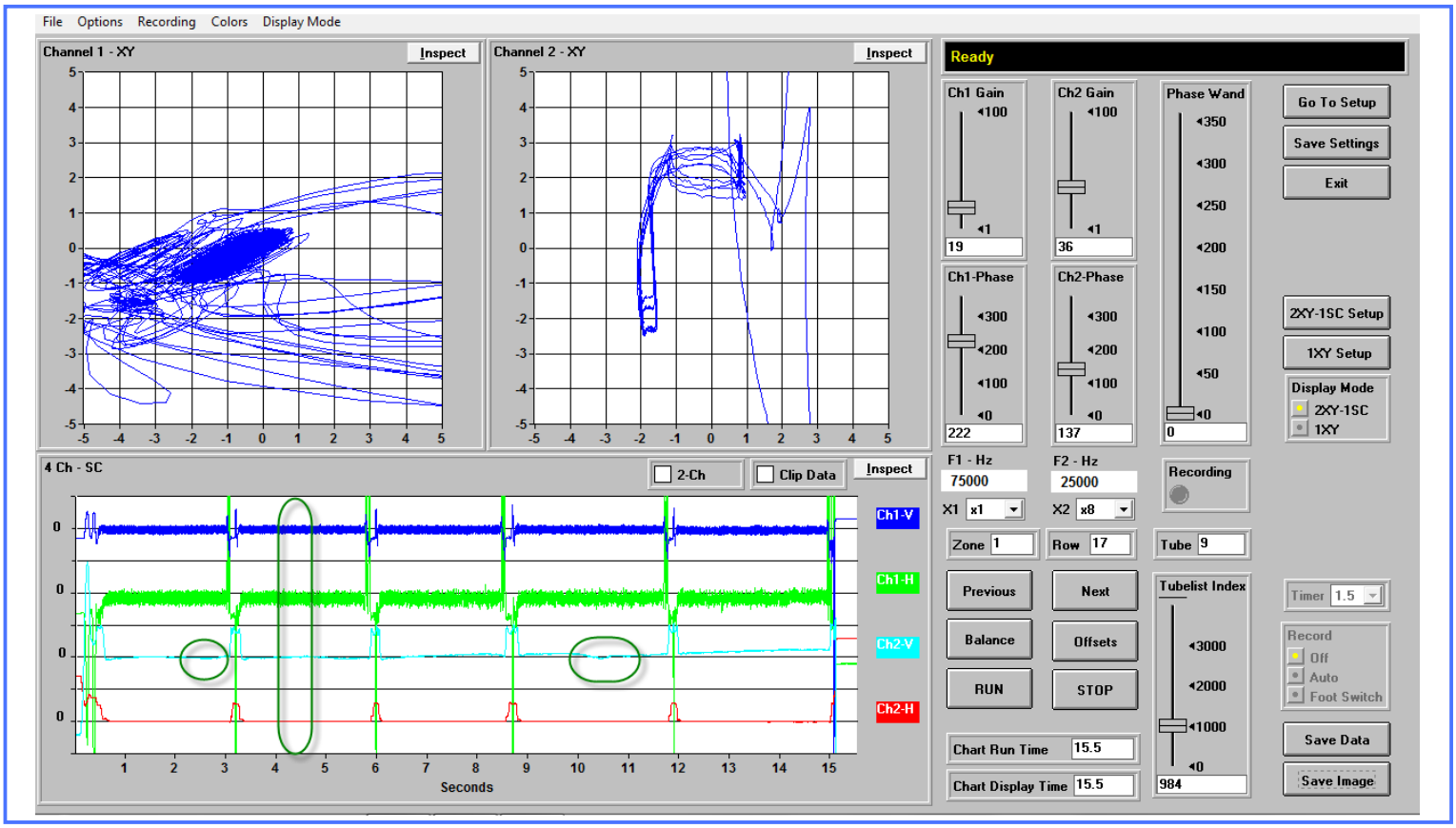
OD DEFECT < 20% (Row 11 Tube 37)

Condenser Section



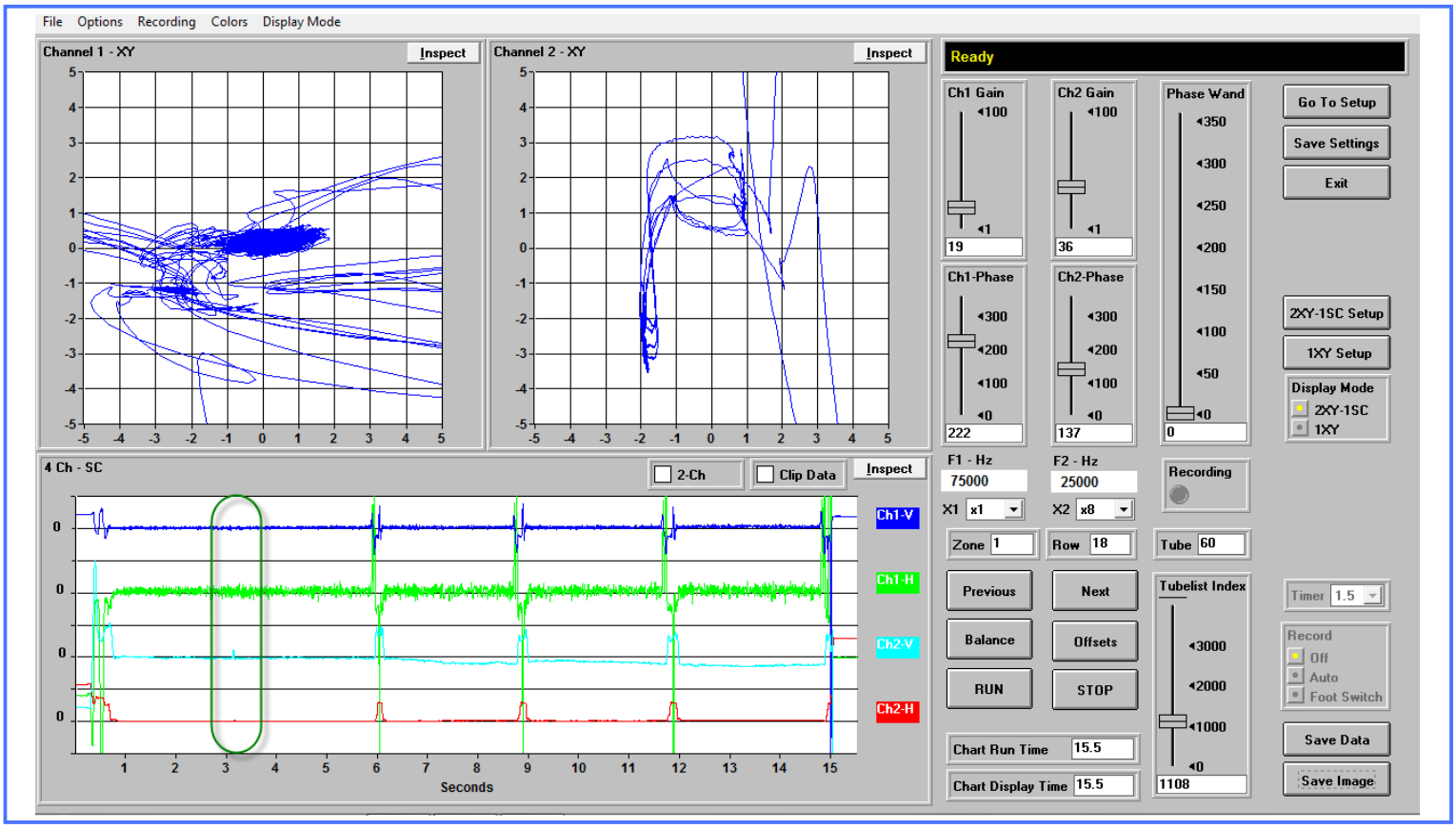
NOTED PERMEABILITY VARIAT (Row 15 Tube 20)

Condenser Section



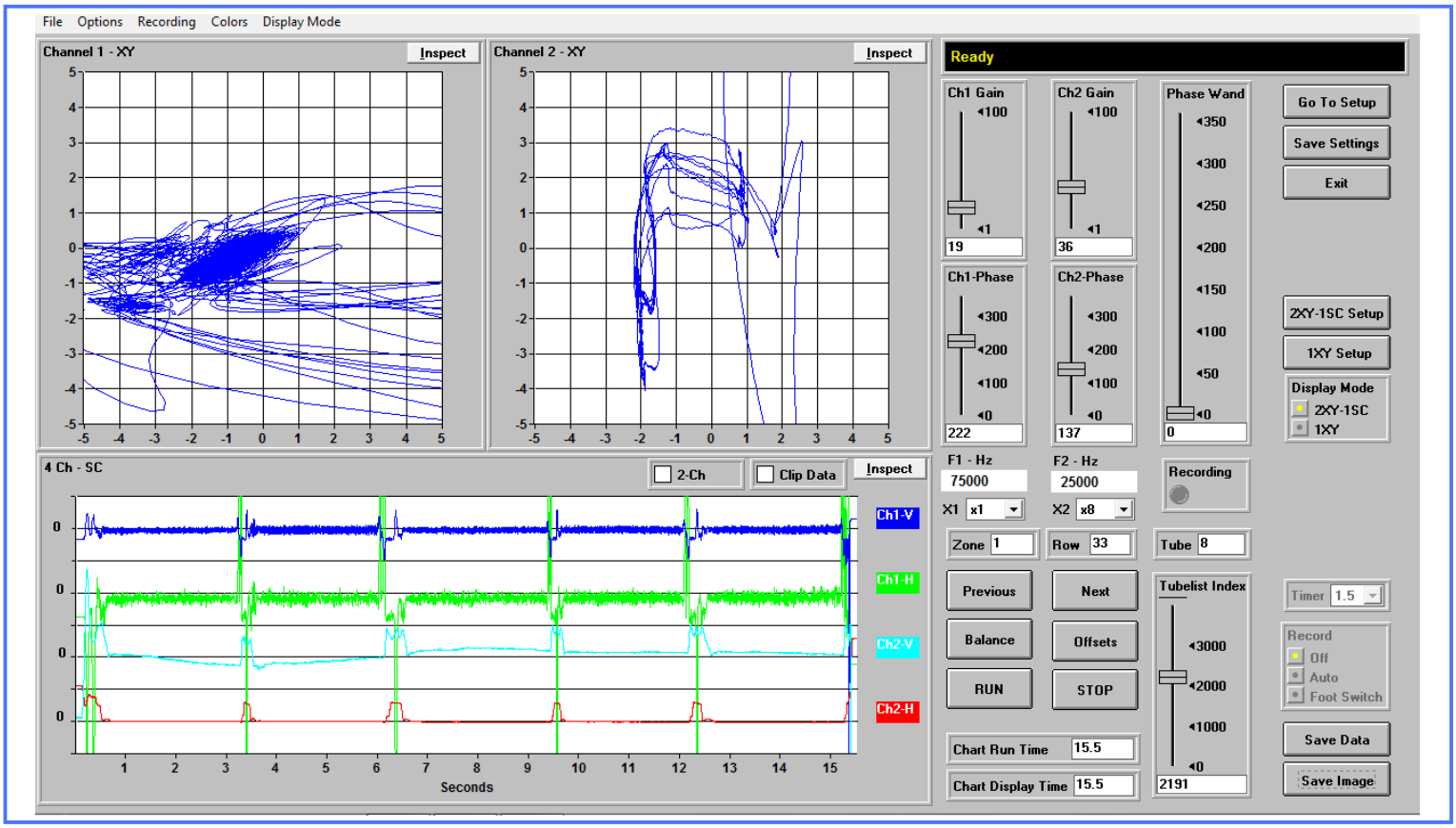
NOTED ID DAMAGE (Row 17 Tube 9)

Condenser Section



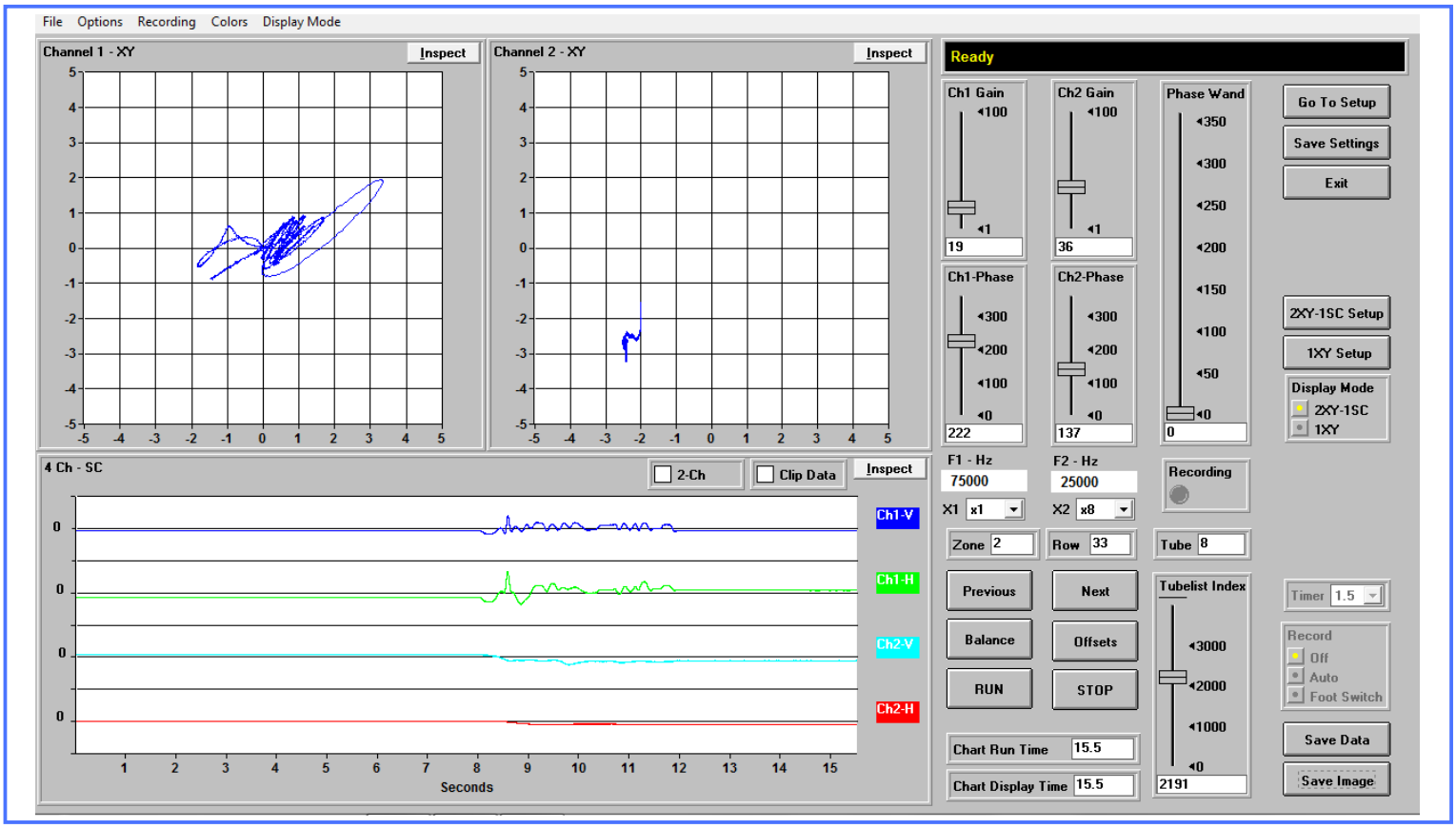
MISSING LAND (Row 18 Tube 60)

Condenser Section



OD DEFECT < 20% (Row 33 Tube 8)

Condenser Section



OD DEFECT < 20% (Row 33 Tube 8)

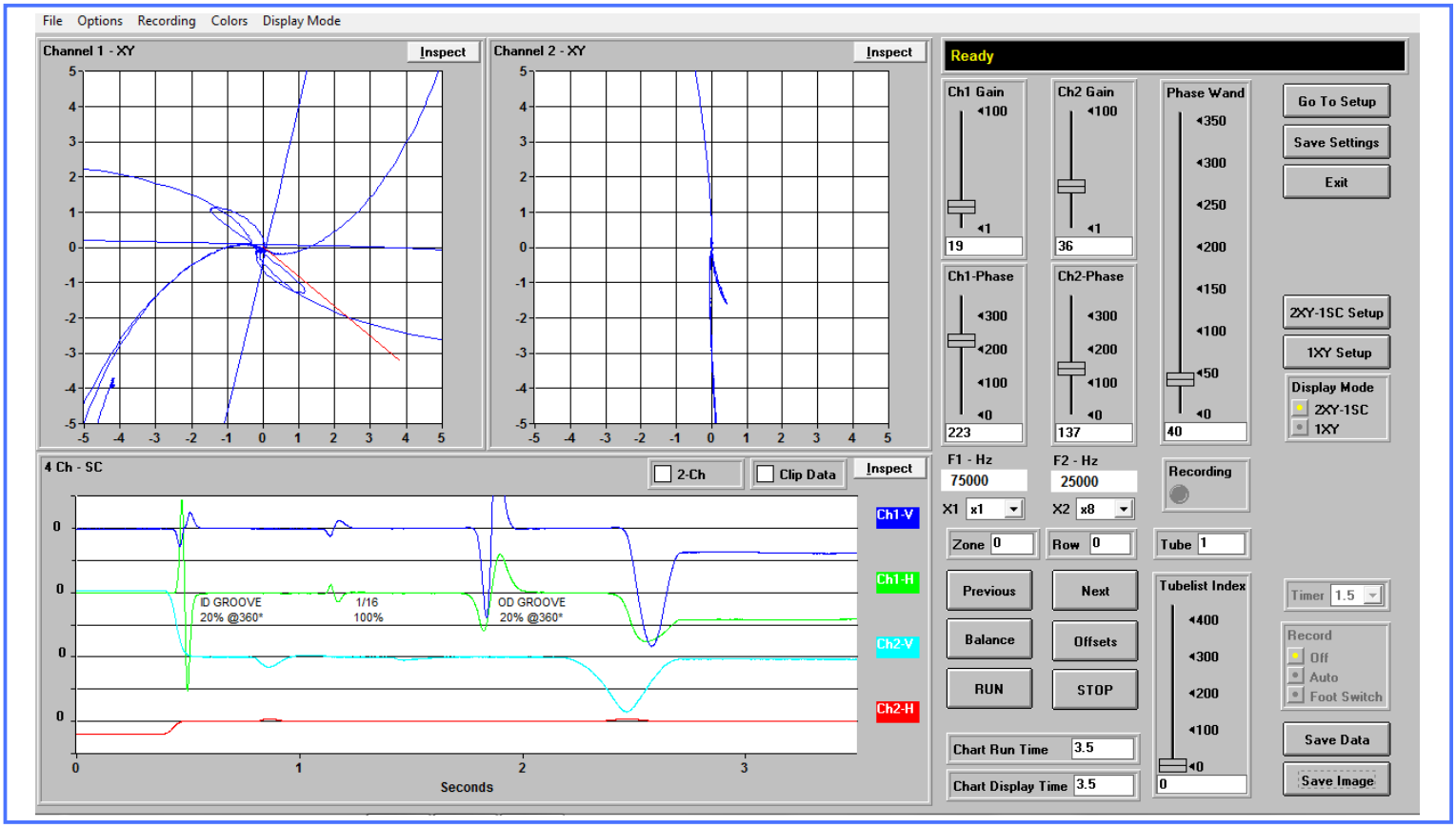
Test Instrument Used
Highline Automation, EC14

S/N 01588 #6

Calibration Page

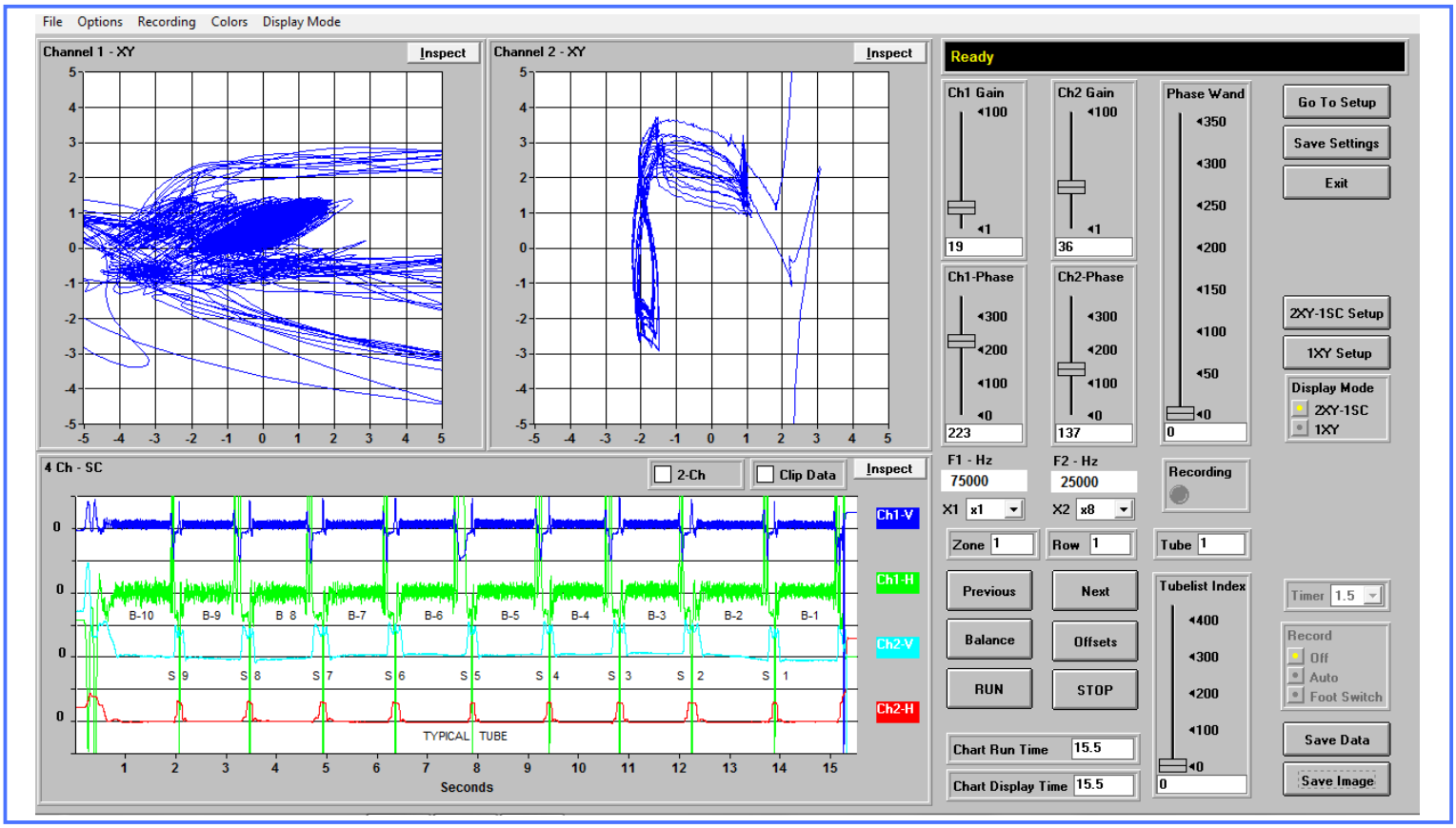
Tube Type	Material	Nom Wall Thick	End Wall Thick	OD	Test Type	Probe Diameter
Skip Fin IE	90/10 CuNi	.035	.049	.750	Cross/Diff	.5625

Condenser	Sub-Cooler



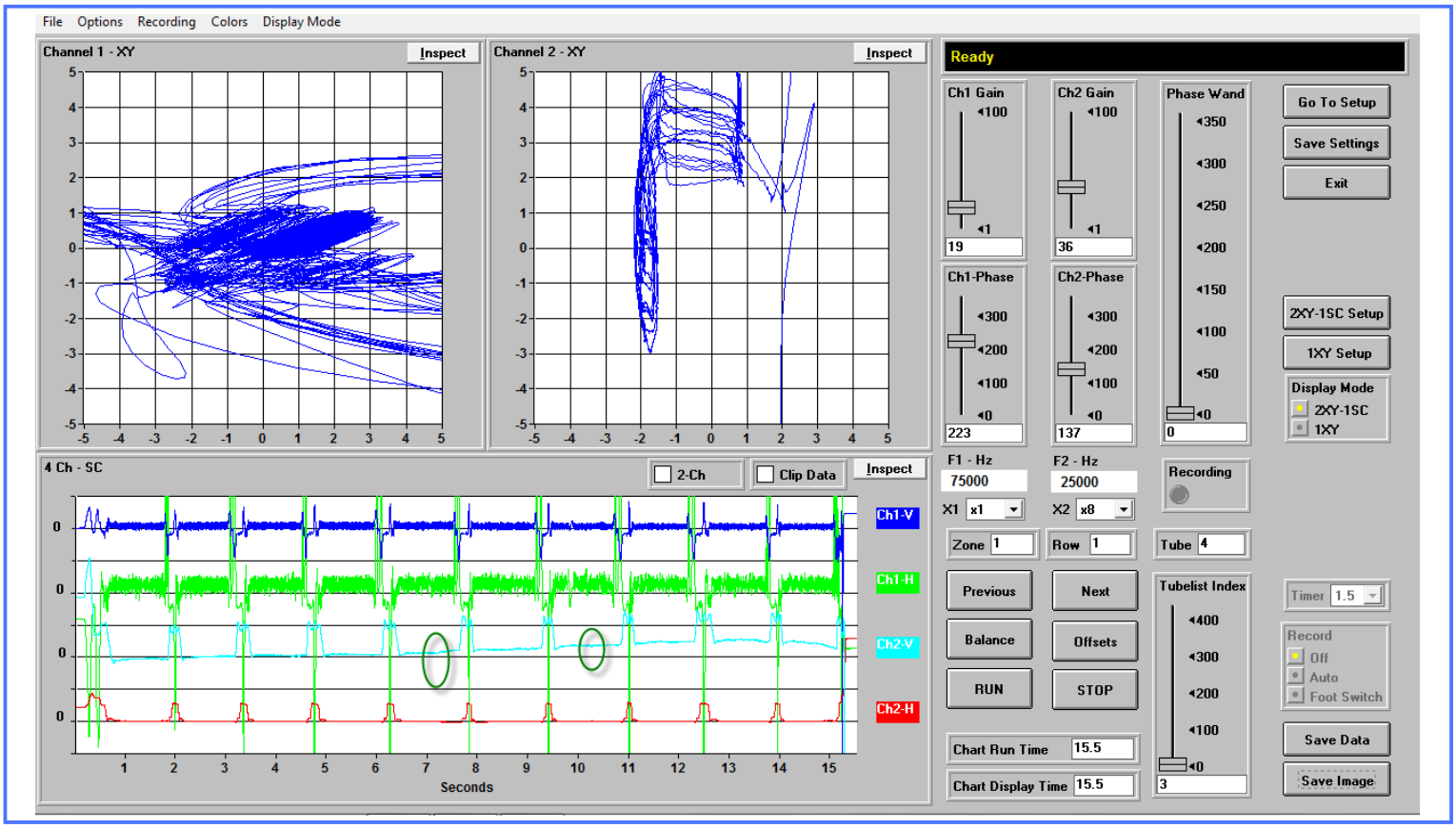
Note: Defects are compared to machined standards.
Actual Defect Geometry may differ.

Sub-Cooler Section



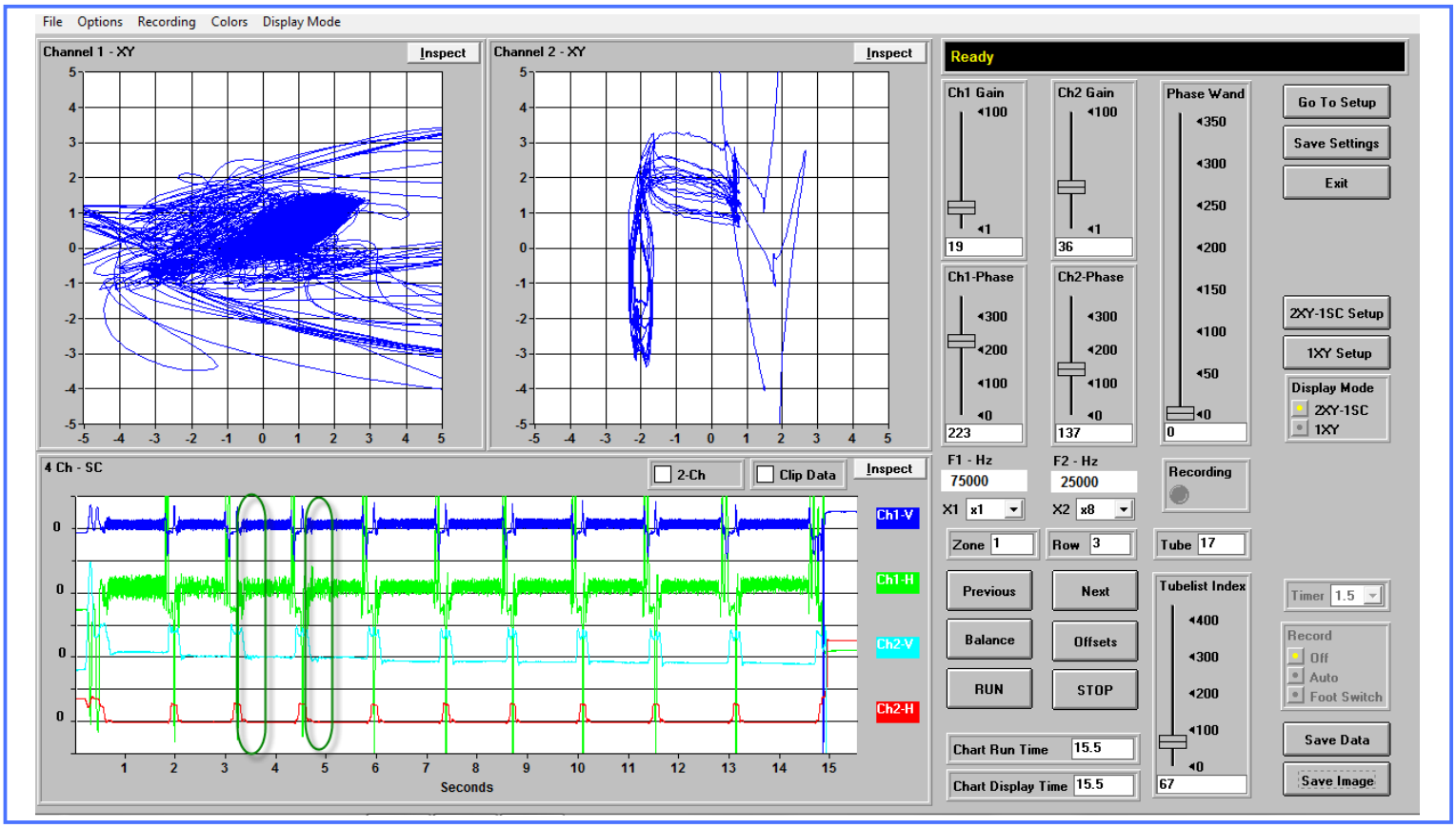
TYPICAL TUBE (Row 1 Tube 1)

Sub-Cooler Section



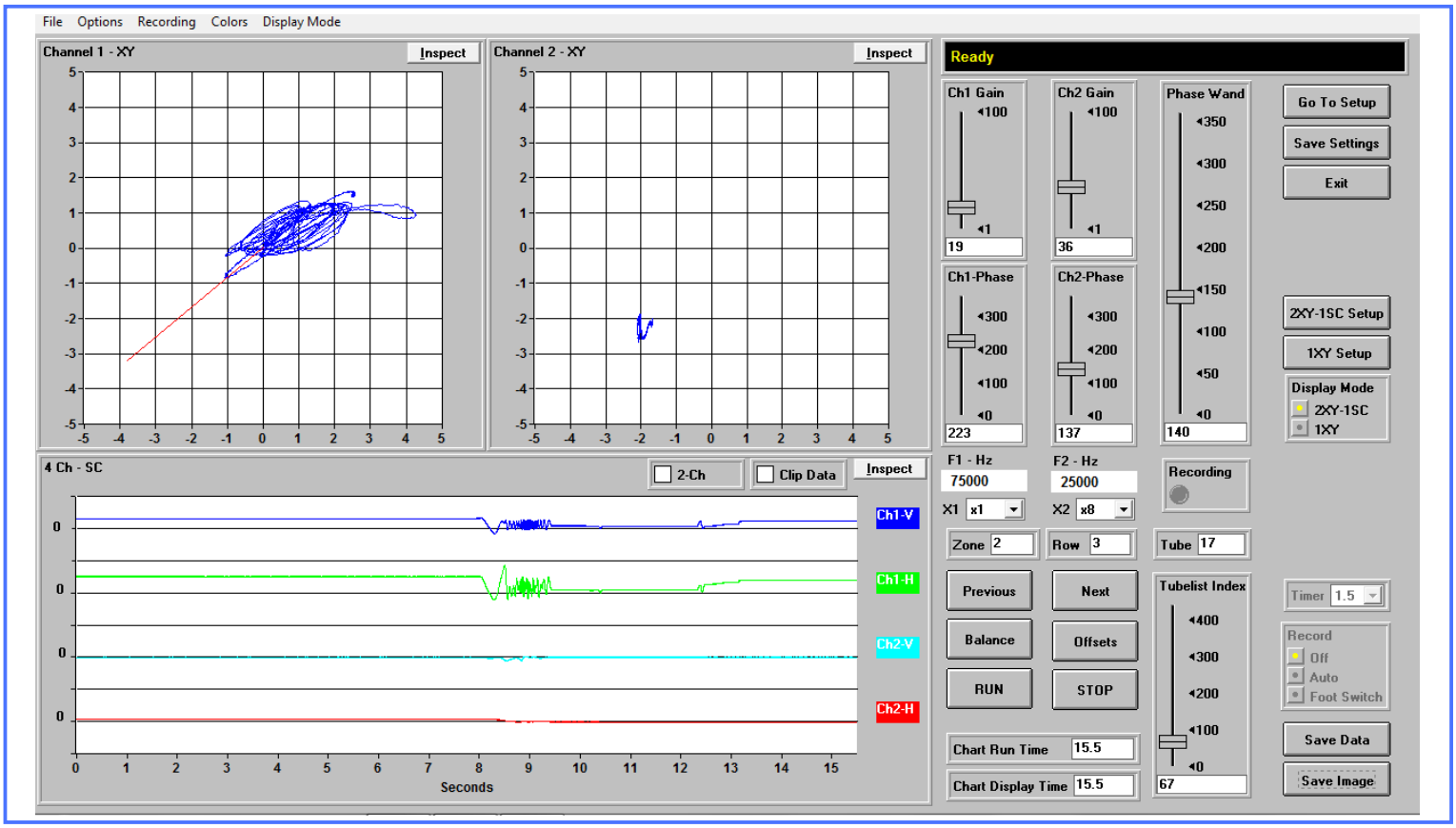
NOTED ID CORROSION (Row 1 Tube 4)

Sub-Cooler Section



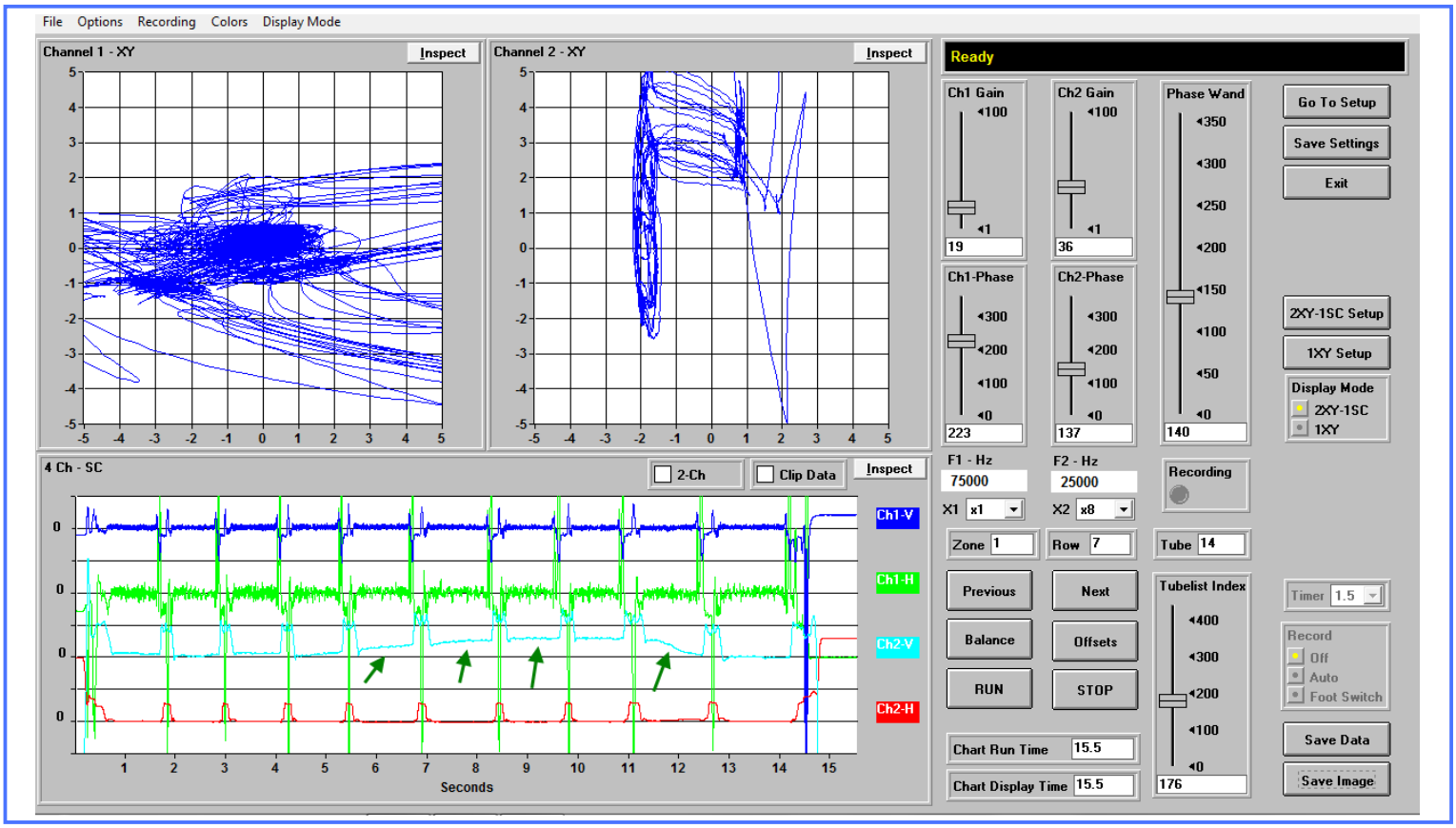
OD DEFECT < 20% (Row 3 Tube 17)

Sub-Cooler Section



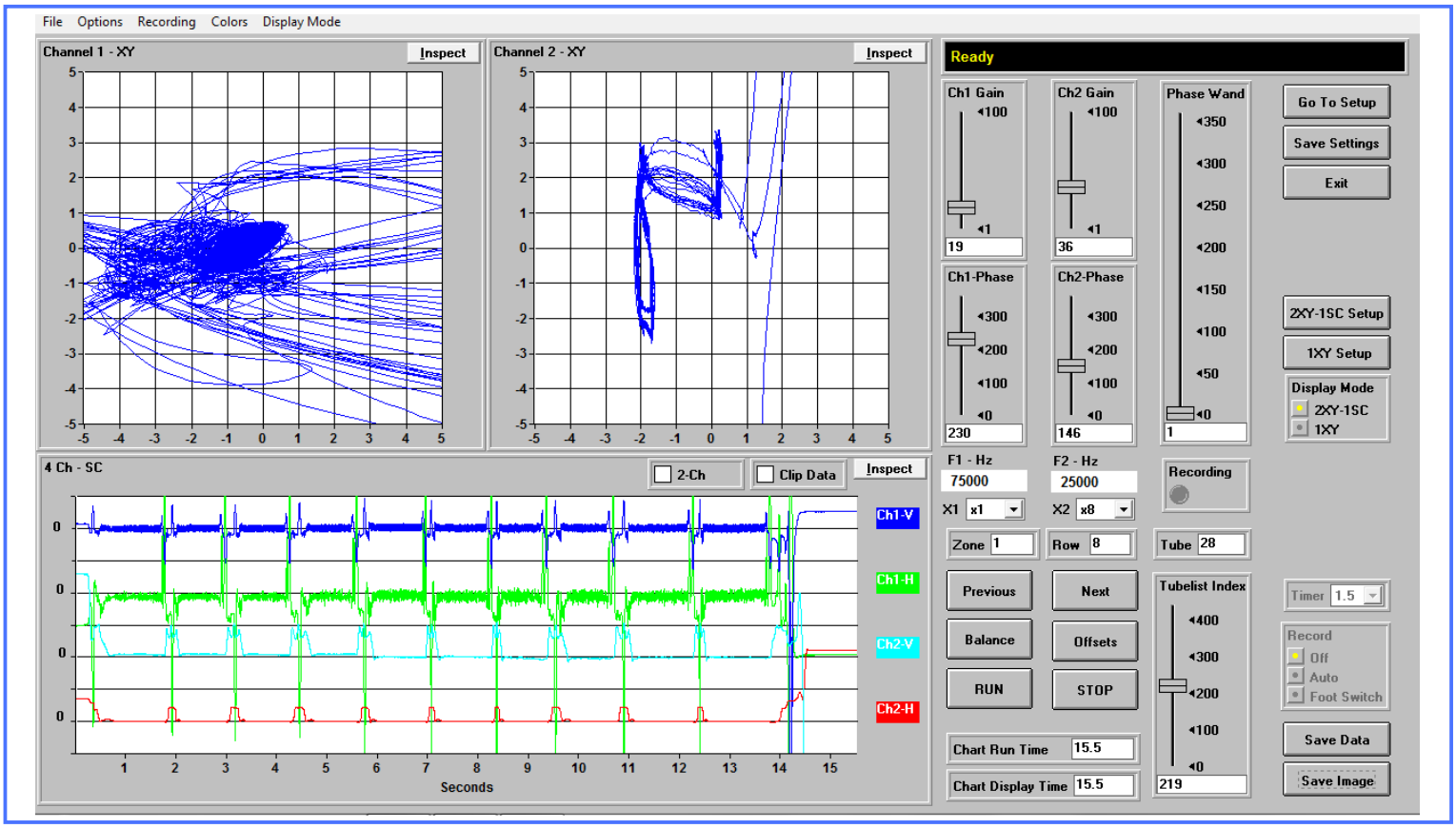
OD DEFECT < 20% (Row 3 Tube 17)

Sub-Cooler Section



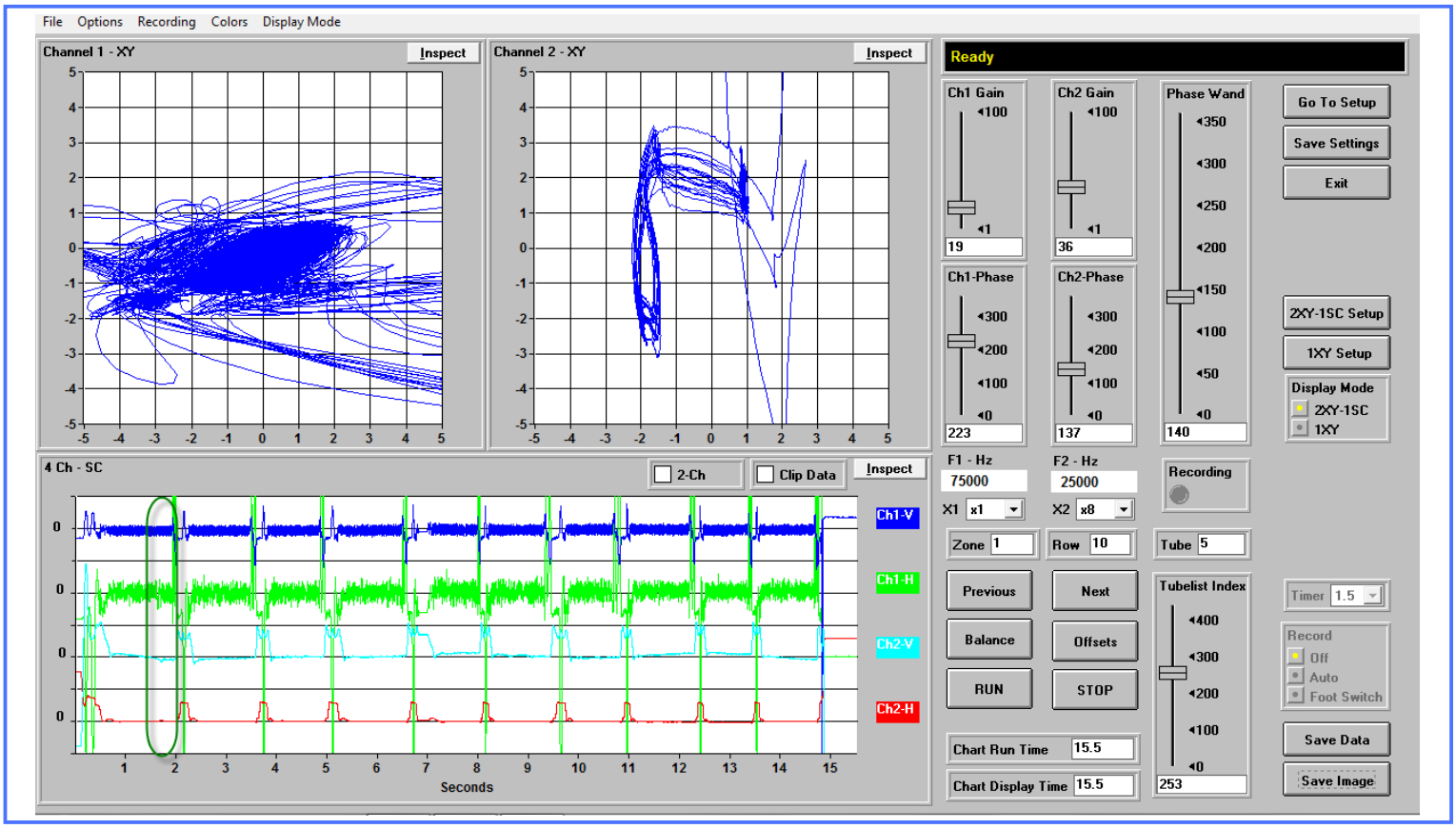
NOTED PERMEABILITY VARIAT (Row 7 Tube 14)

Sub-Cooler Section



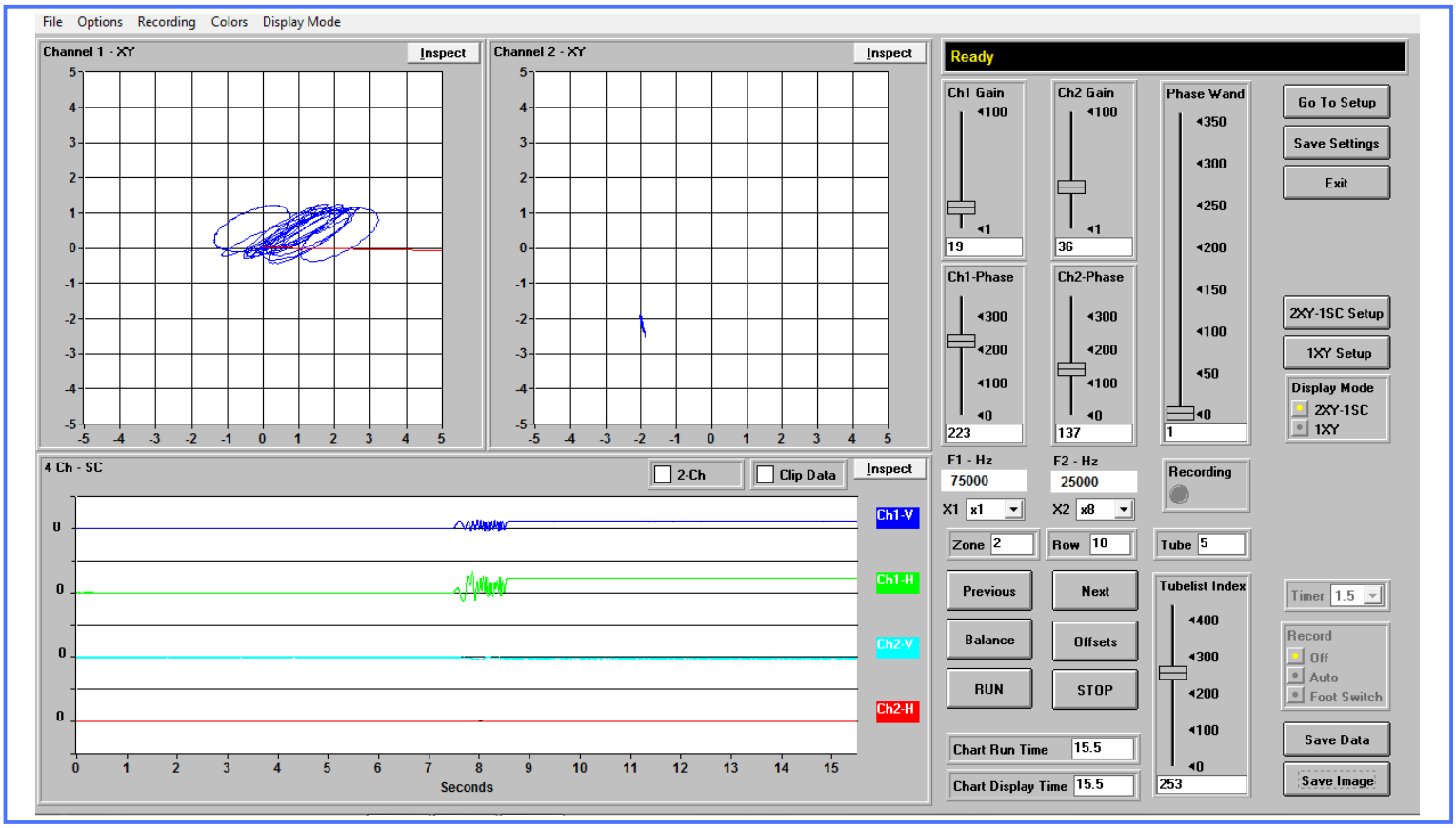
WELD ANOMALY (Row 8 Tube 28)

Sub-Cooler Section



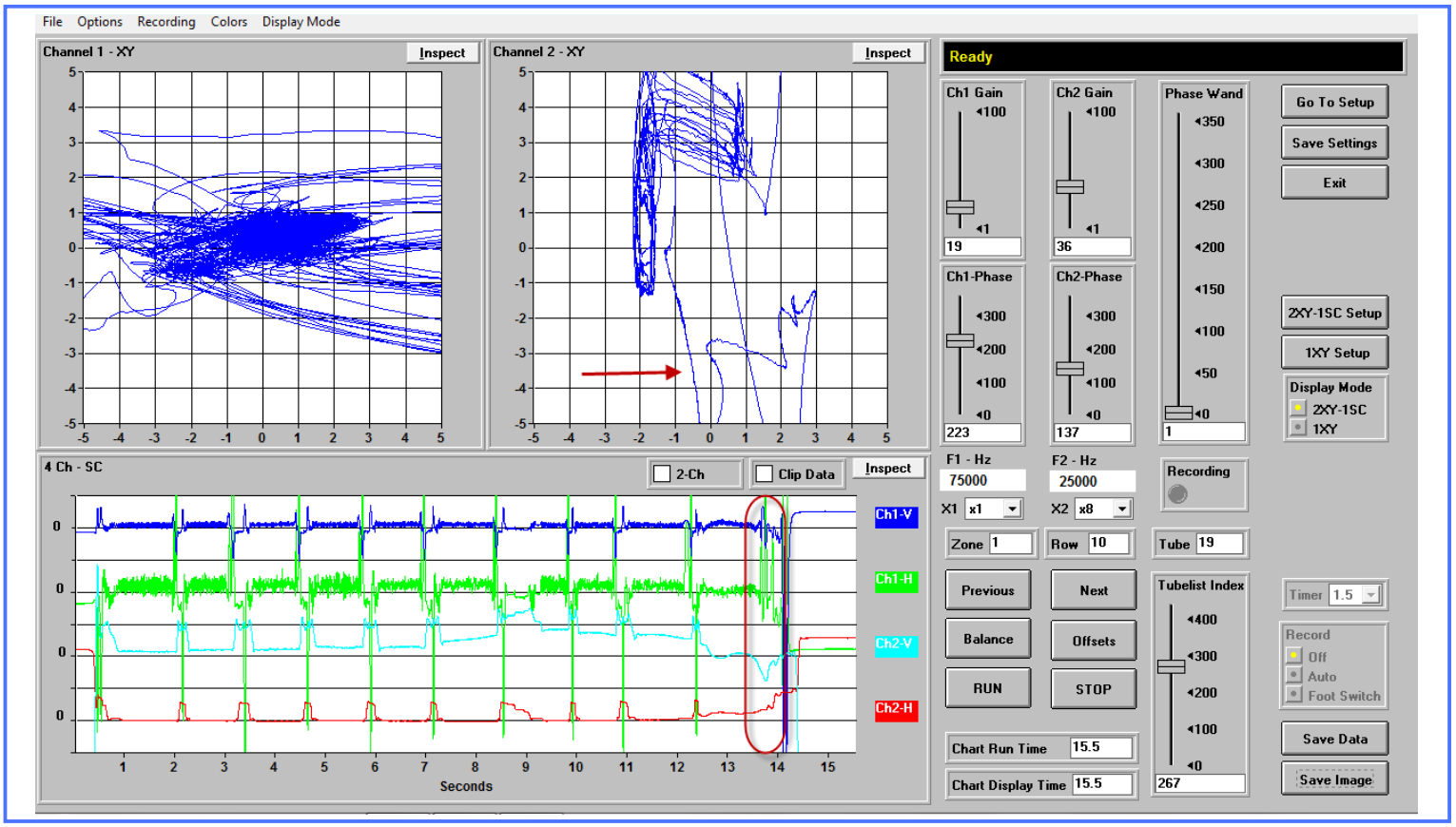
ID PIT < 20% (Row 10 Tube 5)

Sub-Cooler Section



ID PIT < 20% (Row 10 Tube 5)

Sub-Cooler Section



ABN. EXCESS. BELL/ROLL (Row 10 Tube 19)

Calibration Procedure

A calibration procedure is performed prior to an inspection, and is repeated every 2 hours, or whenever improper operation of the test instrument is suspected. Test frequencies are selected prior to an inspection through experimentation to achieve optimum phase separation, and amplitude response for the tube type and alloy being inspected. An appropriate inspection probe is selected based on tube type, wall thickness, and alloy. The inspection probe will have a minimum fill factor of 80% through the smallest areas of the tubes being inspected. Instrument sensitivity is set high enough to determine background noise inherent in the tube and to produce a .05 Volt deflection for a .031 through wall hole at .25 V/Div.

Calibration Reference Standard

A Calibration Reference Standard representing a typical production run tube of the same alloy, tube type and nominal wall thickness is used to adjust test system response. The calibration reference standard used for the inspection of finned and internally enhanced tubing, has been milled in accordance with the American Society for Testing and Materials (ASTM). Standard Recommended Practices, E-243-80, E-426-76, and E571-76. The depth of the grooves and notches used for establishing instrument response are calculated to compensate for the influence of the fins and/or internal enhancements used on finned tubes. Where applicable, calibration reference standards are milled in accordance with the American Society of Mechanical Engineers (ASME), Section V, Article 8, Appendix I.

A strip chart recording of each calibration reference standard used for the inspection has been included in this report. Each artificial discontinuity has been identified on the strip chart recording.

Explanation of Abbreviations

Abbreviation	Explanation
ABN IND	Abnormal Indication
B	Bay
FB	Freeze Bulge
FBH	Flat Bottom Hole
FM	Foreign Material
ID	Internal Diameter
ID CORROSION	Internal Diameter, Corrosion
ID DEPOSIT	Internal Diameter, Deposit
ID PIT	Internal Diameter, Pit
IDML	Internal Diameter, Metal Loss
IE	Internally Enhanced
OD	Outside Diameter
ODML	Outside Diameter, Metal Loss
ODML@S	Outside Diameter Metal Loss at Support
OD DEPOSIT	Outside Diameter, Deposit
PLF	Possible Longitudinal Flaw
PRF	Possible Radial Flaw
PSC	Possible Stress Corrosion
S	Support
WAS	Wear at Support
>	Greater Than
<	Less Than
OTE	Opposite Test End
TE	Test End