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INTERIM REPORT, PT-105-522-E, EXAMINATION
OF PILE PROCESS TUBE REMOVED FROM 100-B
AND 100-H PILES

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EXAMINATION OF PILE PROCESS TUBE
REMOVED FROM 100-B AND 100-H PILES

Interim Report, PT-105-522-E.

By
D. E. Strege

February 10, 1955

Hanford Atomic Products Operation,
Richland, Washington

UNITED STATES ATOMIC ENERGY COMMISSION
Technical Information Extension, Oak Ridge, Tennessee

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COMPANY INTERIM REPORT, PRODUCTION TEST
EXAMINATION OF PILE PROCESS TUBES REMOVED FROM B PILE AND H PILEINTRODUCTION

This report covers the examination of nine process tubes, five tubes from B Pile and four from H Pile. Four of the tubes from B Pile were removed because they were leaking and the fifth was removed because it contained a stuck ruptured slug. Tube 2681-H was removed for graphite mining, tube 2852-H was removed under PT 313-105-14M "In-Pile Evaluation of 63-S Aluminum Process Tubes", and two tubes were removed from channel 0961-H under PT 105-506-E, "Recirculation of Pile Cooling Water". Visual inspection was made of the inside and outside surfaces of the tubes before and after cleaning with cold 10 per cent nitric acid. Samples varying from one to four inches in length were taken from each section and transferred to the 108-B Metallurgical Laboratory for close examination to determine depth of pitting, 72-S cladding thickness, and wall thickness. These determinations were made at specific points in each section on what appeared to be the area of severest attack. It is indicated on six of the tubes where the sample was taken on the circumference of the tube.

SUMMARY

Two tubes from B Pile were found in average condition except for severely corroded areas on the outside surface. These areas were approximately 15 inches long and adjacent to the rear gun-barrels. This corrosion was the result of aluminum-graphite galvanic corrosion and in several places the tube wall was penetrated.⁽¹⁾ A hole was found in tube 4073-B which from all indications had been caused by mechanical damage. The 72-S cladding was almost or completely removed from the rear sections of the tubes discharged from B Pile. Areas devoid of 72-S cladding contained donut shaped pits or appeared to be ledged. Two or more mils of 2-S aluminum had been removed in several areas where the 72-S cladding was removed.

On one of the 0961-H tubes a localized pitting attack was observed. Some of the pits had penetrated 10 mils into the 2-S aluminum. On the same tube the front Van Stone flange showed excessive pitting for the short time it was in the pile. Tube 2681-H, that operated under normal pile operation, contained pits that penetrated 4 mils into the 2-S aluminum and showed signs of ledging throughout most of the length of the tube.

Pile Coolant Studies Unit
Pile Technology Section
ENGINEERING DEPARTMENT

DE Strege:msj

(1) Richman, R. B., "Aluminum Corrosion Caused by the Graphite-Aluminum Galvanic Couple", HW-31935, 5/3/54

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PROCESS TUBE 1093-BTUBE HISTORY

Date installed in pile - startup
 Date removed from pile - August 25, 1954
 Reason for removal - leaker

Feet from Rear V.S. Flange	Corrosion Product		Film	Slug Junctions		Pit Depth Mile Into 2-S A1	
	Inside	Outside		Before Cleaning	After Cleaning	Inside	Outside
Unknown			Rust	None	None		
Estimated 5-9		Yes	Rust	None	None		16
Unknown	None	None	Rust	Darker rings of film	None visible	9	
Unknown	None	None	Rust	Darker rings of film	Shiny rings		
Unknown	None	None	Rust	Darker rings of film	Shiny rings		
Unknown	None	None	Rust	Darker rings of film	Shiny rings		
Unknown	None	None	Light brown	Darker rings of film	Pitted rings		
Unknown	None	None	Light brown	Not visible	Shiny rings		
Unknown	None	None	Light brown	None	None		
Unknown	Yes	None	Light brown	One ring of heavier film where charge started	A shiny ring where charge started		
Unknown	Yes	None	Bronze	None	None		

PROCESS TUBE 1093-B Cont'dCOOLANT HISTORY

<u>Period</u>	<u>Coagulant</u>	<u>Dichromate, ppm</u>	<u>pH</u>	<u>Outlet Temp., C</u>	<u>Approx. Flow, gpm</u>
Startup to 4/27/52	Ferrifloc	2.0	7.7	Not available	17
4/27/52 to 4/10/53	Ferrifloc	None	7.7	71	17
4/10/53 to discharge	Ferrifloc	2.0	7.7	73	17

<u>Thickness, Mils</u>				<u>Where Sample was Taken</u>	<u>Remarks</u>
<u>72-S Al</u>	<u>2-S Al</u>	<u>Ave.</u>	<u>Min.</u>		
2	0	54	---	Bottom	Areas of complete 72-S removal and donut pitting overall. Pits penetrated the 2-S aluminum slightly.
0	0	51	47	Top	About 10 to 15 inches of the section was so severely corroded on the outside that the corrosion product had visibly depressed the tube wall, see Figure 1 and 2. On the inside these depressions were rubbed by the metal discharge making a large hole. The 2-S aluminum in the inside was covered with small donut shaped pits.
0	0	54	53	Bottom	Small amount of ledging in the 2-S aluminum. Pits overall section. Pits seemed to be deeper at one area, which possibly could have been a slug junction.
0	0	54	53	Bottom	A severe ledging attack in the entire section.
4	0	60	---	Top	A light ledging attack overall section. Several areas of complete removal of the 72-S cladding, but no attack into the 2-S aluminum.
4	2	55	---	Top	A heavy ledging attack in the remaining 72-S cladding.
6	0	53	---	Bottom	A pitting attack was seen at all slug junctions, pits had penetrated through the 72-S cladding, but did not extend into the 2-S aluminum.
6	6	46	---	Side	A light ledging attack overall.
6	6	47	---	Side	A light ledging attack overall.
6	---	47	---	Side	Countable pile formed barnacles around ribs upstream from start of charge.
6	---	54	---	Bottom	Large countable pile formed barnacles throughout section, barnacles more concentrated along ribs.

PROCESS TUBE 4073-BTUBE HISTORY

Date installed in pile - startup
 Date removed from pile - July 20, 1954
 Reason for removal - Leaker

Feet from Rear V.S. <u>Flange</u>	Corrosion Product		<u>Film</u>	Slug Junctions		Pit Depth Mils Into 2-S Al	
	<u>Inside</u>	<u>Outside</u>		<u>Before Cleaning</u>	<u>After Cleaning</u>	<u>Inside</u>	<u>Outside</u>
0-4	None	None	Brown	None	None		
4-8	None	None	Dark Brown	None	None		
8-10	None	None	Brown	Darker rings of film	Dull gray rings		
10-13	None	None	Brown	Lighter colored film	Shiny rings		
13-15	None	None	Brown	Darker rings of film	Dull gray rings		
15-18	None	None	Light brown	Darker rings of film	Dull gray rings		
18-20	None	None	Dark brown	Lighter colored film	Bright polished rings	5	11
20-23	None	None	Light brown	Lighter colored film	Dull gray rings		
23-26	None	None	Light brown	None visible	Faint gray rings		8
26-30	None	None	Light brown	None	None		
30-33	Yes	None	Bronze	None	None		
33-36	Yes	None	Bronze	None	None		

36-41

Pitting on face and curvature of front Van Stone flange. Rear Van Stone flange not received for inspection.

PROCESS TUBE 4073-B Cont'dCOOLANT HISTORY

<u>Period</u>	<u>Coagulant</u>	<u>Dichromate, ppm</u>	<u>pH</u>	<u>Outlet Temp., C</u>	<u>Approx. Flow, gpm</u>
Startup to 4/27/52	Ferrifloc	2.0	7.7	Not available	---
4/27/52 to 4/10/53	Ferrifloc	None	7.7	69	28
4/10/53 to discharge	Ferrifloc	2.0	7.7	73	28

<u>Thickness, Mils</u>				<u>Bursting Pressure, psi</u>	<u>Remarks</u>
<u>72-S Al Ave.</u>	<u>Min.</u>	<u>2-S Al Ave.</u>	<u>Min.</u>		
0	0	53	51	---	Perf shadows overall section, appearing as darker brown film areas. The 2-S aluminum was covered with small donut shaped pits.
0	0	61	56	2000	Small donut shaped pits in the 2-S aluminum. A small amount of ledging occurred in an area between the ribs.
0	0	54	53	---	A small amount of ledging occurred at several of the slug junctions.
0	0	54	52	---	A general ledging attack occurred in the entire section, ledging being more pronounced at the slug junctions.
5	0	---	---	---	A general ledging attack throughout section, causing small areas of complete 72-S cladding removal.
2	0	58	---	---	A very pronounced ledging overall leaving areas with complete 72-S removal.
6	0	---	---	1700	Large pits scattered on top wall of section, see Figures 3 and 4.
6	5	59	---	---	Slight ledging occurred in the entire section.
6	6	---	---	---	The metal in the tube had a rippled appearance.
7	---	55	---	---	A hole was found on the top wall of section. It appeared the hole was caused by mechanical damage at one time, and during discharge of the tube some metal was forced back into the hole.
7	---	57	---	---	Pile formed barnacles overall section. Areas of complete 72-S cladding removal where barnacles occurred.
7	---	---	---	---	Numerous pile formed barnacles overall entire section.

Not received for inspection.

PROCESS TUBE 4474-BTUBE HISTORY

Date installed in pile - startup

Date removed from pile - August 25, 1954

Reason for removal - rear Van Stone flange

Feet from Rear V.S. Flange	Corrosion Product		Film	Slug Junctions		Pit Depth Mils Into 2-S Al	
	Inside	Outside		Before Cleaning	After Cleaning	Inside	Outside
0-4	None	None	Brown	None	None	---	---
4-7	None	None	Brown	None	None	---	---
7-9	None	None	Brown	Darker rings of film	Dull gray rings	---	---
9-11							
11-13	None	None	Brown	Darker rings of film	None visible	---	---
13-15	None	None	Brown over tan	Darker rings of film	Shiny rings	---	---
15-18							
18-22	None	None	Light brown	Darker rings of film	Shiny rings	---	---
22-25	None	None	Brown	None visible	Faint dull gray rings	---	---
25-29	None	None	Brown over tan	Faint shadows of junctions in the film	Faint shiny rings	---	12
29-33	Yes	None	Brown over bronze	One ring of brown film where charge started	3" shiny band where charge started	---	---
33-37	Yes	None	Bronze	None	None	---	---
37-41							

PROCESS TUBE 4474-B Cont'dCOOLANT HISTORY

<u>Period</u>	<u>Coagulant</u>	<u>Dichromate, ppm</u>	<u>pH</u>	<u>Outlet Temp., C</u>	<u>Approx. Flow, gpm</u>
Startup to 4/27/52	Ferrifloc	2.0	7.7	Not available	
4/27/52 to 4/10/53	Ferrifloc	None	7.7	69	19
4/10/53 to discharge	Ferrifloc	2.0	7.7	69	19

<u>Thickness, Mils</u>				<u>Where Sample was Taken</u>	<u>Remarks</u>
<u>72-S Al Ave.</u>	<u>Min.</u>	<u>2-S Al Ave.</u>	<u>Min.</u>		
2	0	54	---	Bottom	Few areas of complete removal of 72-S cladding with small donut shaped pits in the remaining 72-S cladding. The outside surface was covered with a rust film.
4	2	58	---	Side	Numerous small pits in the 72-S cladding. The outside surface was covered with a rust film.
3	3	51	---	Bottom	The remaining 72-S cladding was thin, but quite uniform.
					Not received for inspection.
0	0	50	48	Bottom	A general ledging attack in the entire section causing complete removal of the 72-S cladding and penetration into the 2-S aluminum, see Figure 5.
0	0	62	60	Top	Ledging attack occurred in the entire section being more severe at the slug junctions.
					Not received for inspection.
4	2	62	---	Top	General ledging in section. Surface had flaky appearance.
5	4	48	---	Bottom	Small areas of ledging throughout section.
6	3	50	---	Side	Shallow pitting at slug junctions. Several areas of ledging.
5	2	50	---	Side	Pile formed barnacles in upstream portion from where charge started.
8	0	46	---	Top	Pile formed barnacles throughout section, more concentrated near the ribs.
					Not received for inspection.

PROCESS TUBE 1457-BTUBE HISTORY

Date installed in pile - startup
 Date removed from pile - August 25, 1954
 Reason for removal - leaker

Feet from Rear V.S. Flange	Corrosion Product		Film	Slug Junctions		Pit Depth Mils Into 2-S Al	
	Inside	Outside		Before Cleaning	After Cleaning	Inside	Outside
0-3	None	None	Rust	None	None		
3-6	None	None	Rust	None	None	No data	
6-9	None	Yes	Rust	One darker ring of film	One shiny ring	9	4
Unknown	None	None	Rust	Darker rings of film	Shiny		14
Unknown	None	None	Orange	None visible	Faint traces of bands of shiny metal	No data	

PROCESS TUBE 1457-B Cont'dCOOLANT HISTORY

<u>Period</u>	<u>Coagulant</u>	<u>Dichromate, ppm</u>	<u>pH</u>	<u>Outlet Temp., C</u>	<u>Approx. Flow, gpm</u>
Startup to 4/27/52	Ferrifloc	2.0	7.7	Not available	
4/27/52 to 4/10/53	Ferrifloc	None	7.7	70	23
4/10/53 to discharge	Ferrifloc	2.0	7.7	72	23

<u>Thickness, Mils</u>				<u>Where Sample</u>	<u>Remarks</u>
<u>72-S A1</u>	<u>2-S A1</u>	<u>Ave.</u>	<u>Min.</u>	<u>was Taken</u>	
0	0	53	52	Bottom	The outside surface was heavily covered with a layer of rust film. Perf shadows appeared as darker film areas. Slight ledging throughout section.
No data					The outside surface was heavily covered with a rust film. Perf shadows appeared as darker film areas. Conut shaped pits in the entire section.
0	0	59	52	Top	About 10 to 15 inches was heavily corroded on the outside surface. It appeared similar to Figure 1, except for the large hole. A one inch sample was taken of this corroded area, and no holes found, but undoubtedly there were pin holes somewhere in the corroded area.
6	5	56		Side	Light ledging attack at all the slug junctions.
No data					Section had an etched appearance.

PROCESS TUBE 4286-BTUBE HISTORY

Date installed in pile - startup
 Date removed from pile - July 18, 1954
 Reason for removal - rupture

Feet from Rear V.S. <u>Flange</u>	Corrosion Product		<u>Film</u>	Slug Junctions		Pit Depth Mils Into 2-S Al	
	<u>Inside</u>	<u>Outside</u>		<u>Before Cleaning</u>	<u>After Cleaning</u>	<u>Inside</u>	<u>Outside</u>
Unknown	None	None	Light brown	None	None		
Unknown	None	None	Brown	Darker rings of film	Some were dull gray and several were shiny rings		
Unknown	None	None	Brown	Heavier deposits of film	Dull gray rings	6	15
Unknown	None	None	Dark brown	None	None		
Unknown	None	None	Brown	Lighter rings of film	Shiny rings		23
Unknown	Yes	None	Brown	One shiny ring where charge started	Ring was not visible		10

PROCESS TUBE 4286--B Cont'dCOOLANT HISTORY

<u>Period</u>	<u>Coagulant</u>	<u>Dichromate, ppm</u>	<u>pH</u>	<u>Outlet Temp., C</u>	<u>Approx. Flow, gpm</u>
Startup to 4/27/52	Ferrifloc	2.0	7.7	Not available	
4/27/52 to 4/10/53	Ferrifloc	None	7.7	69	21
4/10/53 to discharge	Ferrifloc	2.0	7.7	74	21

<u>Thickness, Mils</u>				<u>Where Sample was Taken</u>	<u>Remarks</u>
<u>72-S Al</u>	<u>2-S Al</u>	<u>Ave.</u>	<u>Min.</u>		
<u>Ave.</u>	<u>Min.</u>	<u>Ave.</u>	<u>Min.</u>		
1	1	54	---	Side	The tube looked good except for the mechanical damage.
---	---	55	53	Top	Before cleaning, an area approximately 2 inches long and one inch wide contained very dark and scaly film and directly in the center of this area was a spot void of film. After cleaning the metal was very bright and had a rippled appearance. All indications this area was caused by a coked slug.
2	0	49	---	Bottom	Ledging in the entire section; more severe at slug junctions.
3	0	52	---	Side	Pitting overall section, small areas of complete 72S cladding removal.
6	5	53	31	Bottom	Shallow pitting at slug junction, deep pits on the outside.
8	---	64	---	Bottom	Pile formed barnacles overall section. Pits penetrating through the 72-S cladding where barnacles occurred.

PROCESS TUBE 0961-HTUBE HISTORY

Date installed in pile - March 16, 1954

Date removed from pile - August 4, 1954

Reason for removal - PT-105-506-E, "Recirculation of Pile Cooling Water"

Feet from Rear V.S. Flange	Corrosion Product		Film	Slug Junctions		Pit Depth Mills Into 2-S A1	
	Inside	Outside		Before Cleaning	After Cleaning	Inside	Outside
0-3	None	None	Orange	None	None	10	
3-5	None	None	Orange	None	None		
5-7	None	None	Rust	None	None		
7-9	None	None	Orange	None visible	Shiny silver rings		
9-12	None	None	Orange	None visible	Shiny silver rings		
12-15	None	None	Orange	None visible	Shiny silver rings		
15-18	None	None	Orange	None visible	Faint shiny rings		
18-21	None	None	Orange	None	None		
21-24	None	None	Orange	None	None		
24-28	None	None	Pink	None	None		
28-32	None	None	Brown	None	None		
32-34	None	None	Void	None	None		
34-37							
37-41	None	None	Void	None	None		

Front Van Stone flange had pits in the curvature of the flange. Areas of complete 72-S removal on the face of the flange, see Figure 8. Rear Van Stone was not received for inspection.

PROCESS TUBE 0961-H Cont'dCOOLANT HISTORY

	<u>Coagulant</u>	<u>Dichromate, ppm</u>	<u>pH</u>	<u>Outlet Temp., C</u>	<u>Approx. Flow, gpm</u>
Operated 140 days on	Deionized Water	None	6.3	132	19
Operated 140 days on	Alum	2.0	7.7	71	---

<u>Thickness, Mils</u>				<u>Bursting Pressure, psi</u>	<u>Remarks</u>
<u>72-S Al Ave.</u>	<u>63-S Al Min.</u>	<u>72-S Al Ave.</u>	<u>63-S Al Min.</u>		
8	0	55	---	2000	A localized pitting attack on one side of section. There were about five large pits surrounded by numerous shallow pits, see Figure 7. The outside surface was covered with a rust film coming from the gun barrel.
4	4	49	---	---	One small area contained a slight amount of ledging. Few shallow pits on wall near rib. Solid rust film on outside of section.
6	4	52	---	1700	About 3 inches on one end of section, showed signs of ledging attack.
4	4	49	---	---	Small pits scattered on the outside surface. The inside surface looked good.
6	6	58	---	---	A small amount of ledging occurred at the slug junction.
10	9	50	---	---	Inside of the section looked good. Several small pits on the outside.
8	7	46	---	---	Section looked good.
8	7	43	---	---	A few shallow pits in the inside of section near a rib.
7	6	47	---	---	Section had a new appearance.
9	8	54	---	---	Inside looked good, a few shallow pits on the outside.
8	8	42	---	---	Section looked good.
8	8	45	---	2000	Section looked good.
					Not received for inspection.
7	6	47	---	---	Section looked good.

PROCESS TUBE 2681-HTUBE HISTORY

Date installed in pile - startup, October 20, 1949

Date removed from pile - July 13, 1954

Reason for removal - graphite mining

Feet from Rear V.S. Flange	Corrosion Product		Film	Slug Junctions		Pit Depth Mils Into 63-S Al	
	Inside	Outside		Before Cleaning	After Cleaning	Inside	Outside
0-4	None	None	Rust	None	None	---	---
4-8	None	None	Rust	None	None	---	---
8-10	None	None	Rust	Faint traces of shiny gray rings	Dark gray rings	4	---
10-12	None	None	Rust	Gray rings	Dull gray rings	---	11
12-14	None	None	Rust	Darker rings of film	Shiny gray rings	---	8
14-16	None	None	Rust	Darker rings of film	Shiny rings	---	---
16-19	None	None	Rust	Darker rings of film	Dull gray rings	---	---
19-22	None	None	Rust	Darker rings of film	Faint shiny rings	---	---
22-26	None	None	Orange	Rings void of film	Shiny rings	---	---
26-30	None	None	Orange	Rings void of film	Faint shiny rings	---	---
30-35	None	None	Orange	One ring where charge had started	A shiny band where charge started	---	12
35-39	Yes	None	Bronze	None	None	---	---

Shallow pits on curvature of front Van Stone flange. Rear Van Stone flange not received for inspection

PROCESS TUBE 2681-H Cont'dCOOLANT HISTORY

<u>Period</u>	<u>Coagulant</u>	<u>Dichromate, ppm</u>	<u>pH</u>	<u>Outlet Temp., C</u>	<u>Approx. Flow, gpm</u>
10/20/49 to 4/18/52	Ferrifloc	2.0	7.7	Not available	26
4/18/52 to 4/10/53	Ferrifloc	None	7.7	66	26
4/10/53 to 6/9/53	Ferrifloc	2.0	7.7	77	29
6/9/53 to 7/13/54	Alum	2.0	7.7	84	29

<u>Thickness, Mils</u>				<u>Bursting Pressure, psi</u>	<u>Remarks</u>
<u>72-S Al</u>	<u>2-S Al</u>	<u>Ave.</u>	<u>Min.</u>		
<u>Ave.</u>	<u>Min.</u>	<u>Ave.</u>	<u>Min.</u>		
4	0	49	---	1700	Perf shadows appeared as darker colored film. Donut type pits overall section. Few small areas of complete removal of 72-S cladding. The outside was covered with a rust film.
4	0	53	---	---	The outside was covered with a rust film. Ledging occurred around perf shadows, rest of section had an etched appearance.
2	0	50	---	---	Large round shallow pits into the 2-S aluminum. Some areas the 72-S cladding was completely removed, see Figures 9 and 10.
0	0	46	---	---	Ledging occurred in the entire section. More severe on bottom half.
0	0	49	38	---	Ledging occurred in the entire section; more severe in the areas surrounding the slug junctions. A few small islands of 72-S cladding remained where the severest ledging occurred.
3	0	50	---	1900	In half of the section the ribs were severely damaged. Ledging occurred near the slug junctions.
7	6	46	---	---	The entire section was severely damaged.
6	3	48	---	---	Light ledging occurred on top wall in the section.
6	4	50	---	---	Light ledging occurred in several small areas. Ribs were severely damaged.
6	5	49	---	---	Section looked good except the ribs were severely damaged.
8	7	44	---	---	Pitting on outside of tube; inside looked good.
8	---	44	---	---	Medium pile barnacles in section. Pits penetrating the 72-S cladding where barnacles occurred.

PROCESS TUBE 0961-HTUBE HISTORY

Date installed in pile - August 6, 1954

Date removed from pile - September 29, 1954

Reason for removal - PT-105-506-E, "Recirculation of Pile Cooling Water"

Feet from Rear V.S. Flange	Corrosion Product		Film	Slug Junctions		Pit Depth Mils Into 2-S Al.	
	Inside	Outside		Before Cleaning	After Cleaning	Inside	Outside
0-4	None	None	Tan	None	None		
4-8	None	None	Orange	None	None		
8-12	None	None	Orange	None	None		
12-14	None	None	Orange	Two light orange rings, 4" apart	None visible		
14-17	None	None	Orange	None	None		
17-20	None	None	Orange	None visible	Two shiny rings 4" apart		
20-23	None	None	Light gray	Dark gray rings	Light gray rings		
23-26	None	None	White	Light gray rings	Shiny rings		5
26-30	None	None	White	Faint gray rings	None visible		
30-34	None	None	White	One orange ring possibly start of charge	None visible		
34-38	None	None	White	None	None		
38-41	None	None	White	None	None		

PROCESS TUBE 0961-H Cont'dCOOLANT HISTORY

<u>Period</u>	<u>Coagulant</u>	<u>Dichromate, ppm</u>	<u>pH</u>	<u>Outlet Temp., C</u>	<u>Approx. Flow, gpm</u>
Operated 55 days	Demineralized Water	---	6.0	152	12

<u>Thickness, Mils</u>				<u>Where Sample was Taken</u>	<u>Remarks</u>
<u>72-S Al</u>	<u>63-S Al</u>	<u>Ave.</u>	<u>Min.</u>		
5	4	58	---	Top	Approximately half the section on the outside was covered with a rust film. Perf shadows appeared in the inside as spots of brown film. Small areas that appeared as black stains overall section. After the section was cleaned these areas appeared as slightly shinier than the surrounding metal.
4	3	50	---	Bottom	This section has the same black stains as the above section, see Figure 11.
2	2	57	---	Side	Several areas in the section looked as though the metal was polished.
5	5	64	---	Top	One dark area in the section, possibly was caused by a cocked slug, see Figure 12.
4	3	64	---	Top	Sample from section had a light ledging attack and the 72-S cladding appeared wavy.
4	3	49	---	Bottom	Section looked good.
No data received				---	Section looked good.
5	4	49	---	Side	Slug junctions had an etched appearance.
No data received				---	Section looked good.
5	5	59	---	Top	Section looked like new.
No data received				---	Section looked like new.
6	5	60	---	Top	Section looked good.

PROCESS TUBE 2852-HTUBE HISTORY

Date installed in pile -- June 9, 1953

Date removed from pile -- September 30, 1954

Reason for removal -- PT-313-105-14M, "In-Pile Evaluation of 63S Aluminum Process Tubes"

Feet from Rear V.S. Flange	Corrosion Product		Film	Slug Junctions		Pit Depth Mils Into 2-S Al	
	Inside	Outside		Before Cleaning	After Cleaning	Inside	Outside
0-4	None	None	Tan	None	None		
4-8	None	None	Tan	None	None		
8-10	None	None	Gray	Faint traces of two lighter colored film rings	Shiny rings		
10-12	None	None	Light orange	Lighter rings of film	Shiny rings		
12-14	None	None	Orange	Lighter rings of film	Shiny rings		
14-17	None	None	Orange	Darker rings of film	Faint shiny rings		
17-20							
20-23	None	None	Light orange	Lighter rings of film	Shiny rings		
23-26	None	None	Light orange	Lighter rings of film	Shiny rings		
26-29	None	None	Light orange	Lighter rings of film	Shiny rings		
29-32	None	None	Light orange	Darker rings of film	Faint shiny rings		
32-36	None	None	Light orange	None	None		
36-40	None	None	Light orange	None	None		

PROCESS TUBE 2852-H Cont'dCOOLANT HISTORY

<u>Period</u>	<u>Coagulant</u>	<u>Dichromate, ppm</u>	<u>pH</u>	<u>Outlet Temp., C</u>	<u>Approx. Flow, gpm</u>
6/19/53 to 10/9/53	Ferrifloc	2.0	7.7	77	17
10/9/53 to 9/30/54	Alum	2.0	7.7	19	18

<u>Thickness, Mils</u>				<u>Where Sample was Taken</u>	<u>Remarks</u>
<u>72-S Al</u>	<u>63-S Al</u>	<u>Ave.</u>	<u>Min.</u>		
---	---	64	59	Side	The outside surface was covered with a rust film. Perf shadows appeared as darker colored film. A rust film on the outside surface.
---	---	65	60	Side	A small amount of rust film on the outside surface. Inside looked good.
---	---	63	60	Side	
---	---	59	58	Bottom	
---	---	68	65	Top	
---	---	59	58	Bottom	
Not received for inspection.					
---	---	64	60	Side	
---	---	59	59	Bottom	
---	---				
---	---	66	62	Top	
---	---				
---	---	60	59	Bottom

FIGURE 1

Corroded outside surface of process tube 1093-B where corrosion product has caused a depression in the metal.

FIGURE 2

Inside view of the dample shown in Figure 1, where the slugs made contact with the tube.

Photographs Unclassified

FIGURE 3

Sample of pitting that occurred approximately 19 feet from the rear Van Stone flange in process tube 4073-B.

FIGURE 4

Cross-section view of some of the pitting shown in Figure 3.
Photographs Unclassified

FIGURE 5

Cross-section of a sample taken between 11 and 13 feet from the rear Van Stone flange in tube 4474-B, showing the affect the ledging had on the metal. Note: the complete removal of the 72-S cladding and slight penetration into the 2-S aluminum.

FIGURE 6

Surface view of the pitting caused by pile formed barnacles in process tube 4474-B.

Photographs Unclassified

FIGURE 7

A surface view of the localized pitting that occurred about 2 feet from the rear Van Stone flange in tube 0961-H.

FIGURE 8

Surface view of the pitting that occurred on the front Van Stone flange of tube 0961-H.

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FIGURE 9

Pitting attack that occurred between 8 and 10 feet from the rear Van Stone flange in process tube 2681-H.

FIGURE 10

Cross-section of Figure 9.

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FIGURE 11

The black stained areas seen in process tube 0961-H. These areas occurred from 0 to 8 feet from the rear Van Stone flange.

FIGURE 12

Surface view of the dark area, possibly caused by a cocked slug. This occurred between 12 and 14 feet from the rear Van Stone flange in process tube 0961-H.

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DATE

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4/18/94

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