SOUTH CAROLINA ELECTRIC & GAS COMPANY
POST OFFICE BOX 764
COLUMBIA, SOUTH CAROLINA 29218

T.C. NICHOLS, JR.
VICE PRESIDENT AND GROUP EXECUTIVE
(Nuclear Operations)

September 23, 1980

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Subject: Virgil C. Summer Nuclear Station
Docket No. 50/395
Underclad Cracking in Reactor
Vessel Nozzles

Dear Mr. Denton:

South Carolina Electric and Gas Company, acting for itself and agent for South Carolina Public Service Authority, provides information request in Mr. A. Schwencer's letter to Mr. E. H. Crews regarding underclad cracking in reactor vessel nozzles. NRC questions and our responses are provided below:

1. Nozzle base metal material specification type and grade, including material certification data of material used in construction.

   The base material of all nozzles in the Virgil C. Summer Nuclear Station reactor vessel is ASTM A-508 Class 2. The base material certification data is provided as Attachment I.

2. The clad process type, electrode size and number of clad layers, including material certification data of material used in construction.

   This information is presented in Attachment II.

   Certification data for cladding material is not required, and, therefore, not available.

3. Heat input (amps, volts, speed) for each clad layer.

   This information is provided in Attachment II.

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4. Clad pre-and post-heat temperature and interpass temperature for each clad layer.

   This information is provided in Attachment II.

5. Vessel stress relief temperature.

   Final Post-Weld Heat Temperature (PWHT) = 1100° - 1175°F held for one hour per inch of weld thickness.

6. The manufacturer or subcontractor who fabricated the vessel and applied the nozzle cladding.

   Chicago Bridge and Iron Company.

If additional information on this subject is required, please let us know.

Very truly yours,

T. C. Nichols, Jr.

T. C. Nichols, Jr.

RBC:TCN:jw

cc: B. A. Bursey
V. C. Summer
G. H. Fischer
W. A. Williams, Jr.
T. C. Nichols, Jr.
E. H. Crews, Jr.
H. T. Babb
D. A. Nauman
O. S. Bradham
J. B. Knotts, Jr.
R. B. Clary
J. B. Cookinham
J. L. Skold
H. Radin
NPCF/Whitaker
File
O. W. Dixon, Jr.

Attachment 1

Purchaser [illegible] Purchaser's Order No. [illegible]

Distributor [illegible] Distributor's Order No. [illegible]

ITEM NO.	QTY.	PRODUCT	SPEC.	HEAT OR CODE NO.	FORGING NO.	HEAT TREATMENT
1	1	Additional tests for inlet nozzle mark 15-1-1.	SA508-2 & Dwg. T13, Rev. 1.	Q2Q41W	4368 1	Tests were stress relieved as follows: 1150°F±25°F for 50 hours. Rate of heating from & cooling to 600°F 0100°F/hr. max.

CHEMICAL ANALYSES AND MECHANICAL PROPERTIES

FORGING NO.	HEAT NO.	C	MN	P	S	SI	CR	NI	MO	NDT REPORTS ATTACHED U.T.	M.P.	D.P.	Ultrasonic
													0° Locatio Two (2) sp break @-10 Two (2) sp @-20°F.

FORGING NO.	HEAT NO.	TEST TEMP.	TENSILE PSI x 1000	YIELD PSI x 1000	ELONG. % IN 8"	R.A. %	B.H.N.	IMPACT TESTS (Average of 3 shown) ENERGY (ft-lbs)	LATERAL EXP. (mils)	SHEAR %
4368-1	Q2Q41W			12[illegible]	Location -			105-117-102 130-133-128	.082-.070-.066 .065-.083-.076	50-60-50 100-100-

Penetration curve from the 0° location is attached.

CONFLICTED TEST REPORT. REVISED PREVIOUS COPY.

We hereby certify the above results to be correct as contained in the records of the Company.

Attachment I

[illegible] No. [illegible] DATE [illegible]

Purchaser [illegible] Purchaser's Order No. [illegible]

Distributor [illegible] Distributor's Order No. [illegible]

ITEM NO.	QTY.	PRODUCT	SPEC.	HEAT OR CODE NO.	FORGING NO.	HEAT TREATMENT	FCE. CHART ATTACHED YES	FCE. CHART ATTACHED NO
1	1	Additional tests for inlet nozzle mark 15-1-1.	SA508-2 & Dwg. T13, Rev. 1.	Q2Q11W	436B 1	Tests were stress relieved as follows: 1150°F±25°F for 50 hours. Rate of heating from & cooling to 600°F @100°F/hr. max.		

CHEMICAL ANALYSES AND MECHANICAL PROPERTIES

FORGING NO.	HEAT NO.	C	MN	P	S	SI	CR	NI	MO				NDT REPORTS ATTACHED U.T.	M.P.	D.P.	Dropweight Testing REMARKS
																0° Location Two (2) specimens break @-10°F Two (2) specimens @-20°F.

FORGING NO.	HEAT NO.	TEST TEMP.	TENSILE PSI x 1000	YIELD PSI x 1000	ELONG. % IN 2"	R.A. %	B.H.N.	IMPACT TESTS ENERGY (Ft-lbs)	LATERAL EXP. (In.)	% SHEAR
[illegible]3-1	Q2Q11W			180°	Location - Axis (weld Dia.)			105-117-102 130-133-128	.065-.070-.066 .085-.083-.076	50-60-50(TD+70°) 100-100-100([illegible])

[illegible]ition curve from the 0° location is attached.

CORRECTED TEST REPORT. DESTROY PREVIOUS COPY.

[signature]

We hereby certify the above results to be correct as contained in the records of the Company.

Attachment 1

MATERIAL TEST REPORT

S.O. No. [illegible]-2

Purchaser: CHICAGO BRIDGE & IRON CO. - Memphis

Purchaser: [illegible]

DATE: January 19, 19[illegible]

Purchaser's Order No. [illegible]

Distributor's Order No. [illegible]

ITEM NO.	QTY.	PRODUCT	SPEC.	HEAT OR CODE NO.	FORGING NO.	HEAT TREATMENT
1	1	Inlet forging per CB&I drawing [illegible], Rev. 6 (except [illegible]-11/16" dim. is corrected to 35-7/8") Mark: 15-1-1	SA508-2 & CB&I Specs. [illegible]-.11, Rev. 3 & Q[illegible]-101 Rev. 3	Q2Q41W Suppliers Ht. No. 12[illegible]327 VA1	945-L 1	L/F approved procedure [illegible]-12, Rev. [illegible] 1650°F, ±25°F, for 14 hours- Air [illegible] 1550°F, ±25°F, for 14 hours- [illegible] 1290°F, ±25°F, for 14 hours- Air Cool. Tests were stress relieved as follows: 1150°F, ±25°F, for 50 hours. L/F approved procedure SP[illegible]-101, Rev. 0.

CHEMICAL ANALYSIS AND MECHANICAL PROPERTIES

FORGING NO.	HEAT NO.	C	MN	P	S	SI	CR	NI	MO	V		Grain Size	NDT REPORTS ATTACHED U/T	M.P.	D.P.	REMARKS
[illegible]-L 1	Q2Q41W	.21 .195	.49 .65	.010 .005	.015 .013	.28 .26	.31 .32	.73 .75	.64 .62	.04 .04	Ladle Check	7	X	X		[illegible] 1 specimen - break [illegible]30°F, 2 specimens break @ -20°F to [illegible] the [illegible] Testing in accordance with L/F approved [illegible]

FORGING NO.	HEAT NO.	RT TEST TEMP.	TENSILE PSI x 1000	YIELD PSI x 1000	ELONG. % in 2"	R.A. %	B.H.N.	IMPACT TESTS (As Shown) ENERGY (ft. lb.)	LATERAL EXP. (in.)	% SHEAR
[illegible]-L 1	Q2Q41W		[illegible] Tests (BACK TRAX)					V-Notch @ [illegible]		
		1	81.675	60.638	30.0	70.0		41 - 37 - 33	.032-.030-.025	20 - 20 - 20
			[illegible] Tests					V-Notch @ [illegible]		
		0	84.125	63.500	27.0	72.2		111 - 116 - 105	.072-.075-.060	80 - [illegible]
		150	85.000	65.625	27.0	71.4		112 - 129 - 125	.076-.080-.076	80 - 80 - 80

[illegible] Forge certifies that all applicable requirements of SA508-2 and CB&I [illegible]-111, Rev. 3 & Q43 101, Rev. 3 have been complied with.

[illegible] [illegible] [illegible]

Attachment I

MATERIAL TEST REPORT

S.O. No. [illegible]-2

Purchaser: CHICAGO BRIDGE & IRON CO. - Memphis

Distributor: ____

DATE: January 19, 19[illegible]

Purchaser's Order No.: [illegible]-1/2531

Distributor's Order No.: "

ITEM NO.	QTY.	PRODUCT	SPEC.	HEAT OR CODE NO.	FORGING NO.	HEAT TREATMENT
1	1	Inlet forging per CB&I drawing [illegible], Rev. 6 (except [illegible]-11/16" dim. is corrected to [illegible]-7/8") Mark: 15-1-1	SA508-2 & CB&I Spec. [illegible]-.11, Rev. 3 & Q[illegible]-101 Rev. 3	[illegible] Suppliers Ht. No. 1253327 VA1	946-L 1	L/F approved procedure [illegible]-12, Rev. [illegible] 1650°F, -25°F, for 1½ hours- [illegible] 1500°F, [illegible], for 1½ hours- [illegible] 1290°F, [illegible], for 1½ hours- [illegible] Tests were stress relieved as follows: 1150°F, -25°F, for 50 hours. L/F [illegible] procedure SP[illegible]-101, Rev. 0.

CHEMICAL AND MECHANICAL PROPERTIES

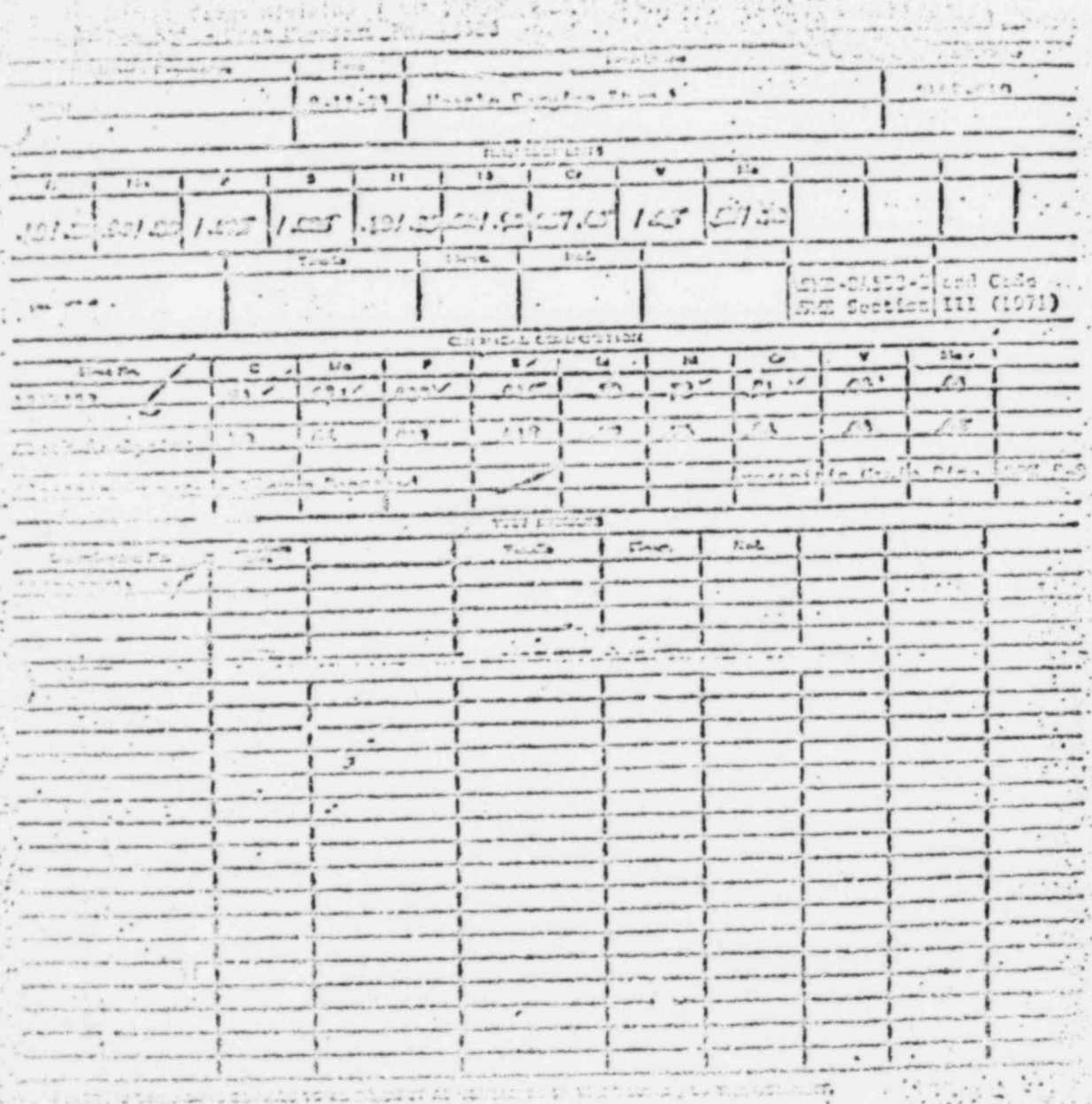
FORGING NO.	HEAT NO.	C	MN	P	S	SI	CR	NI	MO	V		Grain Size	NDT REPORTS ATTACHED U.T.	M.P.	D.P.	REMARKS
946-L 1	[illegible]	.21 .195	.69 .65	.010 .005	.015 .013	.28 .26	.37 .32	.73 .76	.64 .62	.04 .04	Ladle Check	7	X	X		[illegible] 1 specimen - [illegible]

FORGING NO.	HEAT NO.	EX TEST TEMP.	TENSILE PSI x 1000	YIELD PSI x 1000	ELONG. % in 2"	R.A. %	B.H.N.	IMPACT TESTS: ENERGY (ft.-lb.)	LATERAL EXP. (in.)	% SHEAR
946-L 1	[illegible]		[illegible] (TAN [illegible])					V-Notch [illegible]		
		1	81.675	60.608	30.0	70.0		41 - 39 - 33	.032-.030-.025	20 - 20 [illegible]
			[illegible]					V-Notch @ +[illegible]		
		0 150	84.125 85.000	63.500 65.025	27.0 27.0	72.2 71.4		111 - 116 - [illegible] 112 - 129 - [illegible]	.072-.073-.0[illegible] .076-.080-.076	80 - [illegible] 80 - 80 - 80

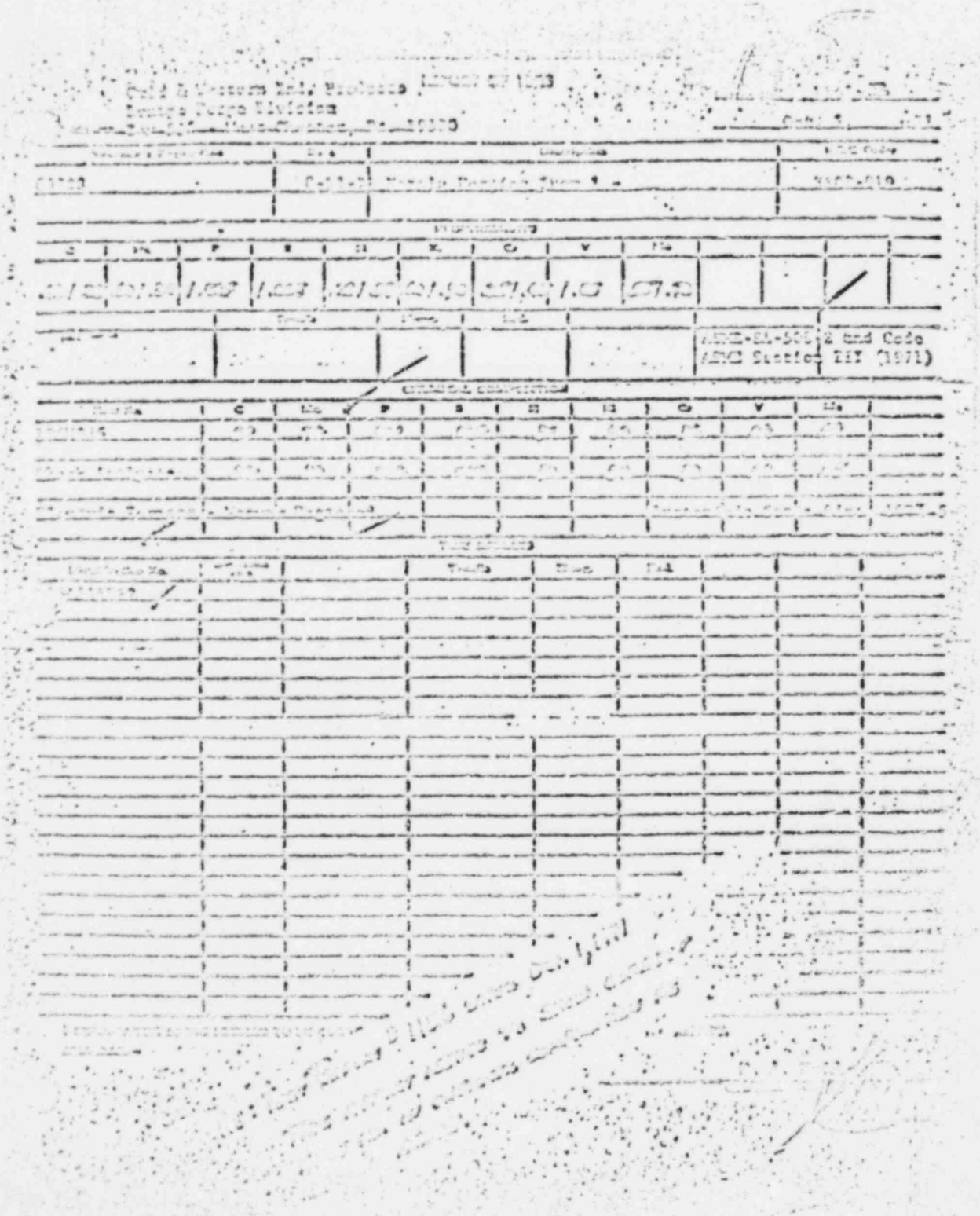
[illegible] Forge certifies that all applicable requirements of SA508-2 and CB&I [illegible]-111, Rev. 3 & Q[illegible] 101, Rev. 3 have been complied with.

[illegible]

Attachment I



Attachment I



Attachment I

Customer's Order No. [illegible]

Distributor's Order No. [illegible]

Item	Qty.	Product	Spec.	Heat or Code No.	Forging No.	Heat Treatment	Attached Yes
2	1	Additional testing for outlet nozzle mark 2[illegible]-2-1	[illegible]-2 & [illegible]. 773, Rev. 1.	[illegible]	[illegible] 1	[illegible] stress relieved as follows: 1150°F[illegible]°F for 50 hours. Rate of heating from & cooling to 600°F [illegible]°F/hr. max.	

Chemical Analysis

Forging No.	Heat No.	C	Mn	P	S	Si	Cr	Ni	Mo				U.T.	M.P.	C.P.	Remarks
																0° location Two (2) specimens no-break [illegible] Two (2) specimens no-break [illegible]

Physical Properties

Forging No.	Heat No.	Test Temp.	Tensile	Yield	Elong. % in 2"	R.A. %		Impact Tests — Energy (ft-lbs)	Lateral Exp.	[illegible]
[illegible]					150° location			107-114-115 176-140-[illegible]	.072-.0[illegible]-.072 .075-.07[illegible]-.067	[illegible] [illegible]

Transition curve from [illegible]° location is attached.

[illegible]

[signature]

At[illegible]hment I

Item	Product	Spec.	Heat or Code No.	Forging No.	Heat Treatment	Yes
1	Additional Testing for outlet nozzle Mark: [illegible]-1.2	[illegible]-2 & Dwg. [illegible], Rev. 1.	[illegible]	[illegible] 2	Tests were stress relieved as follows: 1150°F±25°F for 50 hours. Rate of heating from & cooling to 600°F [illegible]100°F/hr. max.	

[illegible]	Heat No.	C	Mn	P	S	Si	[illegible]	[illegible]	[illegible]				U.T.	M.P.	D.P.	Remarks
																0° Location [illegible]

[illegible] No.	Heat No.	Test Temp.	Tensile PSI @ 1000	Yield PSI @ 1000	Elong. % in 2"	R.A. %	[illegible]	Energy (ft-lbs)	Lateral Exp. (in)	[illegible]
[illegible]	[illegible]			180° Location				2[illegible]-2[illegible]-2[illegible]9 [illegible]-2[illegible]-257	.072-.0[illegible]-.072 .0[illegible]-.0[illegible]-.0[illegible]	75-[illegible] [illegible]

[illegible] from the 0° location is attached.

[illegible]

[illegible]

Attachment I

	QTY.	[illegible]	[illegible]	[illegible]	[illegible]	HEAT TREATMENT
[illegible]	1	[illegible]	[illegible] & [illegible] Rev. 1.	[illegible]	[illegible] 3	Tests were stress relieved as follows: 1150°F±25°F for [illegible] hours. Rate of heating from & cooling to 600°F [illegible] max.

[illegible]	[illegible]	U.Y.	[illegible]	[illegible]	[illegible]
					[illegible] (1) [illegible] (1) [illegible] (2) [illegible] °F.

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	R.A. %	[illegible]	ENERGY [illegible]	LATERAL [illegible]	[illegible]
[illegible]	[illegible]				[illegible]			[illegible]-119 [illegible]-160-160	.0[illegible]-.0[illegible]-.0[illegible] [illegible]-.0[illegible]	[illegible]

[illegible]

Attachment I

[illegible]

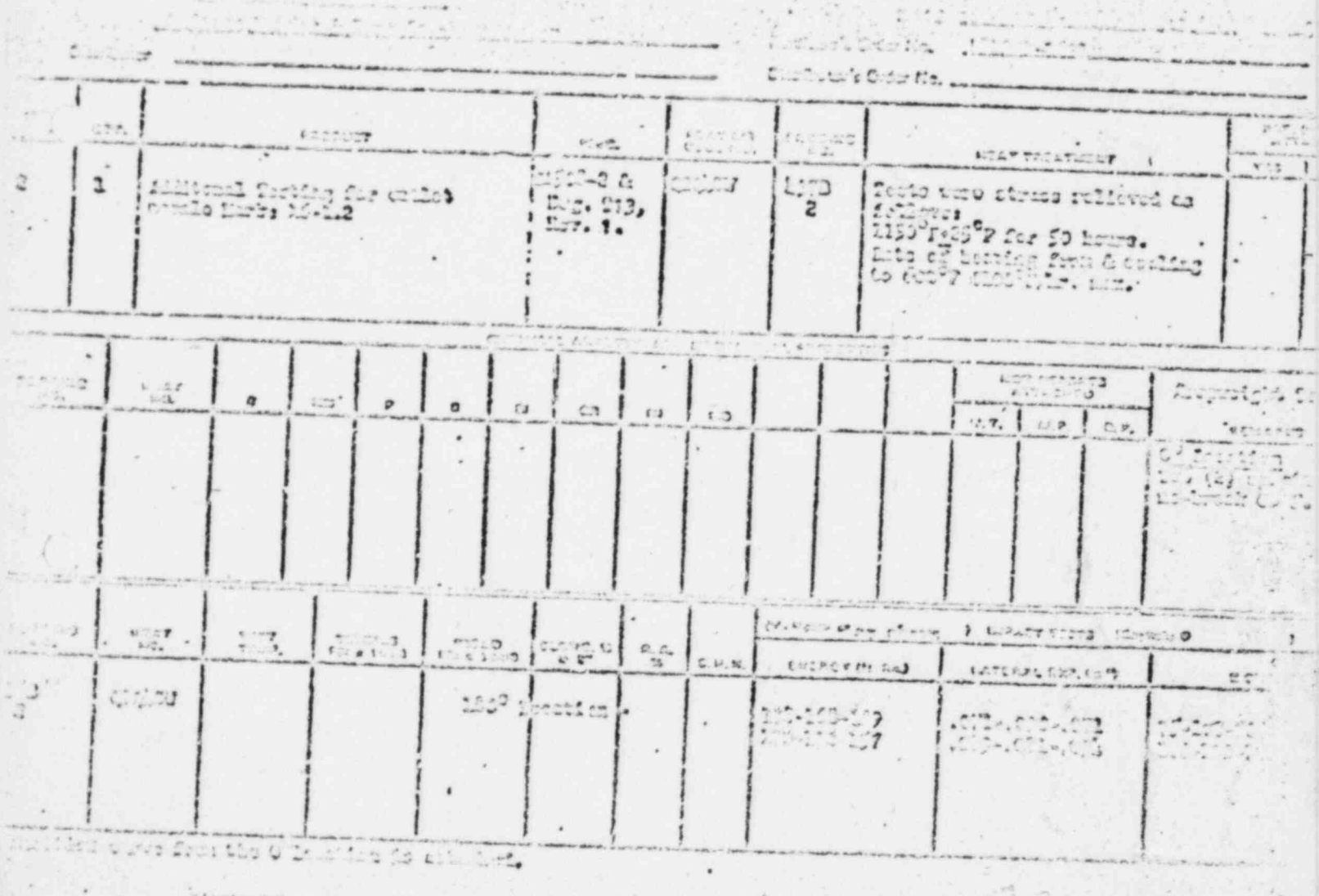
Item	No.	Product	Spec.	[illegible]	[illegible]	Heat Treatment	[illegible]
	1	[illegible] Testing for [illegible] 20-2-3	[illegible] & [illegible] Rev. 1.	[illegible]	[illegible] 3	Tests were stress relieved as follows: 1150°F±25°F for 50 hours. Rate of heating from & cooling to 600°F 100°F/hr. max.	

[illegible]	[illegible]	C	Mn	P	S	Si	Cr	Ni	Mo				[illegible]			[illegible]
													[illegible]	[illegible]	[illegible]	[illegible]
																0° [illegible] [illegible]

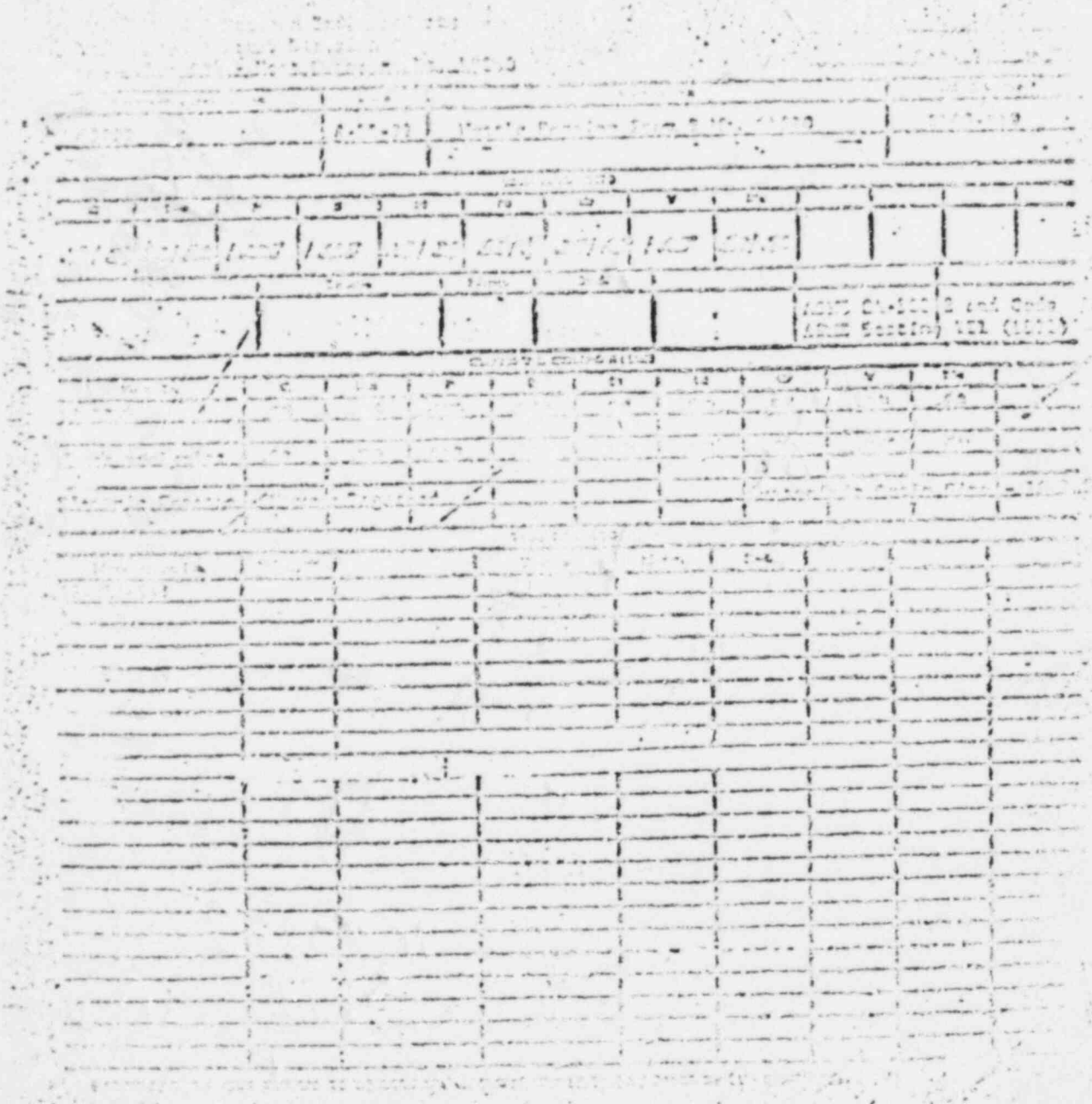
[illegible] No.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]-3	[illegible]				[illegible] [illegible]			230-130-119 [illegible]	[illegible] [illegible]	[illegible]

[illegible]

Attachment I



Attachment I



Attachment I

MATERIAL TEST [illegible]

[illegible] FORGE AND [illegible] CO. – [illegible] [illegible] 10 [illegible]

Purchaser's Order No. [illegible] 150375-3/2671

Customer [illegible]

Distributor's Order No. [illegible]

ITEM	QTY.	PRODUCT	SPEC	HEAT OR CODE NO.	FORGING NO.	HEAT TREATMENT	PHYS. CHARTS ATTACHED YES	PHYS. CHARTS ATTACHED NO
	—	Outlet Nozzle Forging per CB&I Dwg. 81, Rev. 6 Marks 16-1-2	S1505-2 & CB&I Specs. NB-112, Rev. 3 & QAS-101 Rev. 3	[illegible] Supplier Ht. No. 124327[illegible]	5471-1	L/F approved procedure HT-12, Rev. 4 1650°F±25°F for 10½ hrs. Air Cooled 1560°F±25°F for 10½ hrs. Water Quenched 1250°F±25°F for 10½ hrs. Air Cooled Tests were stress relieved as follows: 1150°F±25°F for 50 hrs. L/F approved procedure SRHT-101, Rev. 0		X

CHEMICAL ANALYSIS AND MECHANICAL PROPERTIES

ITEM NO.	HEAT NO.	C	MN	P	S	SI	CR	NI	MO	V		Grain Size	NDT REPORTS ATTACHED U.T.	M.P.	D.P.	REMARKS
[illegible]	[illegible]	.22 .204	.68 .69	.012 .007	.011 .003	.24 .25	.35 .37	.82 .81	.62 .61	.04 .04	Ladle Check	7	X	X		Drop weight [illegible] 1 specimen break @ -30°F, -20°F, & -10[illegible] 2 specimens no-break [illegible] 0°F to establish [illegible] NDT @ -10°F. Testing in accordance with [illegible] approved test plan QAST-023, Rev. 2

ITEM NO.	HEAT NO.	R.T. TEST TEMP.	TENSILE PSI x 1000	YIELD [illegible]	ELONG. % in 2"	R.A. %	[illegible]	IMPACT TESTS ENERGY (Ft-Lbs)	LATERAL EXP. (In.)	% SHEAR
[illegible]	[illegible]		[illegible] x t ([illegible])					V-Notch @ +10°F		
		1	91.026	70.774	25.0	69.8		33-74-87	.033-.051-.060	20-60-70
			T x 2T Tests					V-Notch @ [illegible]		
		0° 180°	99.072 85.503	81.733 67.253	23.5 27.0	70.0 73.5		95-61-85 113-98-125	.051-.045-.062 .078-.073-.073	50-40-50 70-60-70

[illegible] certifies that all applicable requirements of [illegible]-2 and [illegible] Specs. NB-112, Rev. 3 & QAS-101, Rev. 3 have been complied with.

[illegible] were removed from the 1/4T location adjacent to the [illegible] [illegible] specimens used for the transition curve [illegible]

[illegible]

Attachment I

MATERIAL TEST REPORT DATE [illegible] Sept. 9, 19[illegible] 19 [illegible]

Purchaser: CHICAGO BRIDGE & IRON COMPANY - Memphis — Purchaser's Order No. [illegible]

Distributor: — Distributor's Order No.

Item	Product	Spec.	Heat or Code No.	Forging No.	Heat Treatment (L/F approved procedure HT-12, Rev. 4)	Full Drafts Attached Yes	No
1	Outlet Nozzle Forging per CB&I Dwg. 11, Rev. 6 Mark: 16-1-2	SA508-2 & CB&I Specs. NS-111, Rev 3 & QAS-101 Rev. 3	Q2Q4GJ Suppliers Ht. No. 124274	947L-2	1650°F±25°F for 10½ hrs. Air Cooled 1550°F±25°F for 10½ hrs. Water Quenched 1290°F±25°F for 10½ hrs. Air Cooled Tests were stress relieved as follows: 1150°F±25°F for 50 hrs. - L/F approved procedure SPWHT-101, Rev. 0		X

CHEMICAL ANALYSIS AND MECHANICAL PROPERTIES

Forging No.	Heat No.	C	MN	P	S	SI	CR	NI	MO	V		Grain Size	NDT Reports Attached U.T.	M.P.	D.P.	Remarks
7L-2	Q2Q4GJ	.22 .207	.66 .71	.012 .005	.011 .012	.24 .33	.38 .40	.82 .80	.62 .62	.04 .03	Ladle Check	— 7	X	X	—	DROPWEIGHT TESTING [illegible] 1 specimen break @ [illegible] -20°F, & -10°F. 2 [illegible] mens no-break @ 0°[illegible] establish NDT @ -[illegible] Testing in accordance with L/F approved [illegible] plan Q2T-02, Rev. [illegible]

Forging No.	Heat No.	R.T. Test Temp.	Tensile PSI x 1000	Yield PSI x 1000	Elong. % in 2"	R.A. %	B.H.N.	Impact Tests (V-Notch or As Shown) Energy (Ft-Lbs)	Lateral Exp. (In")	% Shear
7L-2	Q2Q4GJ		kt x t (DATA-TRAK)					V-NOTCH @ +10°F		
			91.000	71.750	25.0	70.5		71-72-56	.059-.051-.050	50-50-30
			T = 2T					T-NOTCH @ +10°F		
		0°	91.620	73.605	25.0	72.5		121-118-108	.070-.073-.079	80-50-70
		180°	93.277	71.049	25.5	73.2		128-111-158	.079-.075-.084	70-70-80

[illegible] certifies that all applicable requirements of SA 508-2 and CB&I Specs NS-111, Rev. 3 and QAS-101, Rev. 3 have been complied with.

[illegible] specimens were removed from the 180° location adjacent to Charpy impact specimens used for the transition curve.

COMBINED TEST REPORT. [illegible] COPY.

[signature]

We hereby certify the above figures to be correct as contained in the records of the Company.

Attachment I

MATERIAL TEST REPORT

Spec. No. [illegible]-2

DATE February 24, 1972

Customer: CHICAGO BRIDGE & IRON CO. - Memphis

Purchaser's Order No. [illegible]

Distributor's Order No.

Item	Product	Spec.	Heat or Code No.	Forging No.	Heat Treatment (L/P approved procedure HT-12, Rev. 4)	Pol. Charts Attached: Yes	No
1	Outlet Nozzle Forging per CBI Dwg. 12, Rev. 6 Mark: 16-1-3	SA508-2 & CBI Spec. HS-111, Rev. 3 & QAS-101 Rev. 3	C2[illegible] Supplier Ht. No. 12[illegible]	947L-3	1650°F±25°F for 10½ hrs. Air Cooled 1550°F±25°F for 10½ hrs. Water Quenched 1250°F±25°F for 10½ hrs. Air Cooled Tests were stress relieved as follows: 1150°F±25°F for 50 hrs. L/P approved procedure SR[illegible]-101, Rev. 0		X

CHEMICAL ANALYSIS AND MECHANICAL PROPERTIES

Item	Heat No.	C	Mn	P	S	Si	Cr	Ni	Mo	V		Grain Size	Not Reports Attached: U.T.	M.P.	D.P.	Remarks
-3	C2[illegible]	.21 .192	.67 .65	.009 .006	.012 .010	.24 .25	.38 .37	.78 .78	.65 .62	.04 .03	Ladle Check	8	X	X		[illegible] 1 specimen - break @ -30°F & -20°F. Two specimens - No break -10°F to establish the NDT @ -20°F. Testing in accordance with L/P approved test plan QCP7-2, Rev. 4

Item	Heat No.	Test Temp.	Tensile PSI x 1000	Yield PSI x 1000	Elong. % in 2"	R.A. %	B.H.N.	Impact Tests (Energy Ft.-Lbs.)	Lateral Exp. Unit	% Shear
3	C2[illegible]		[illegible] Tests (DATA-TRAK)						V-Notch @ +100°F	
			90.215	83.402	25.5	69.9		75-37-75	.055-.026-.054	40-20-50
			T x 2T [illegible]						V-Notch @ +100°F	
		0°	87.500	67.500	25.5	72.0		116-111-115	.076-.073-.074	70-70-70
		180°	86.375	67.500	25.5	72.4		127-121-120	.079-.078-.073	80-80-70

000125

[illegible] Forge certifies that all applicable requirements of [illegible]-2 & CBI Spec. HS-111, Rev. 3 & QAS-101, Rev. 3 have been complied with.

[illegible] specimens were removed from the 180° location adjacent [illegible] charpy V-notch specimens used for the transition curve.

We hereby certify the above results to be correct as contained in the records of the Company.

Attachment I

S.O. No. C137-2

MATERIAL TEST REPORT

Purchaser CHICAGO BRIDGE & IRON CO. - Memphis

DATE January 19, 19

Purchaser's Order No. CB3306-1/2551

Distributor

Distributor's Order No.

ITEM	QTY.	PRODUCT	SPEC.	HEAT OR CAST NO.	FORGING NO.	H/T approved procedure SS-12, Rev. HEAT TREATMENT
1	1	Inlet forging per CB&I drawing F2, Rev. 6 (except 35-11/16" dim. is corrected to 35-7/8") Marks 15-1-1	SA508-2 & CB&I Specs. M3-.11, Rev. 3 & Q1C-101 Rev. 3	Q2C116 Supplier's Ht. No. 123327 VA1	945-L 1	1650°F, -25°F, for 14 hours- Air 1500°F, -25°F, for 14 hours- Air 1200°F, -25°F, for 14 hours- Air Tests were stress relieved as follows: 1150°F, -25°F, for 50 hours. H/T per procedure SR-101, Rev. 0.

CHEMICAL ANALYSIS AND MECHANICAL PROPERTIES

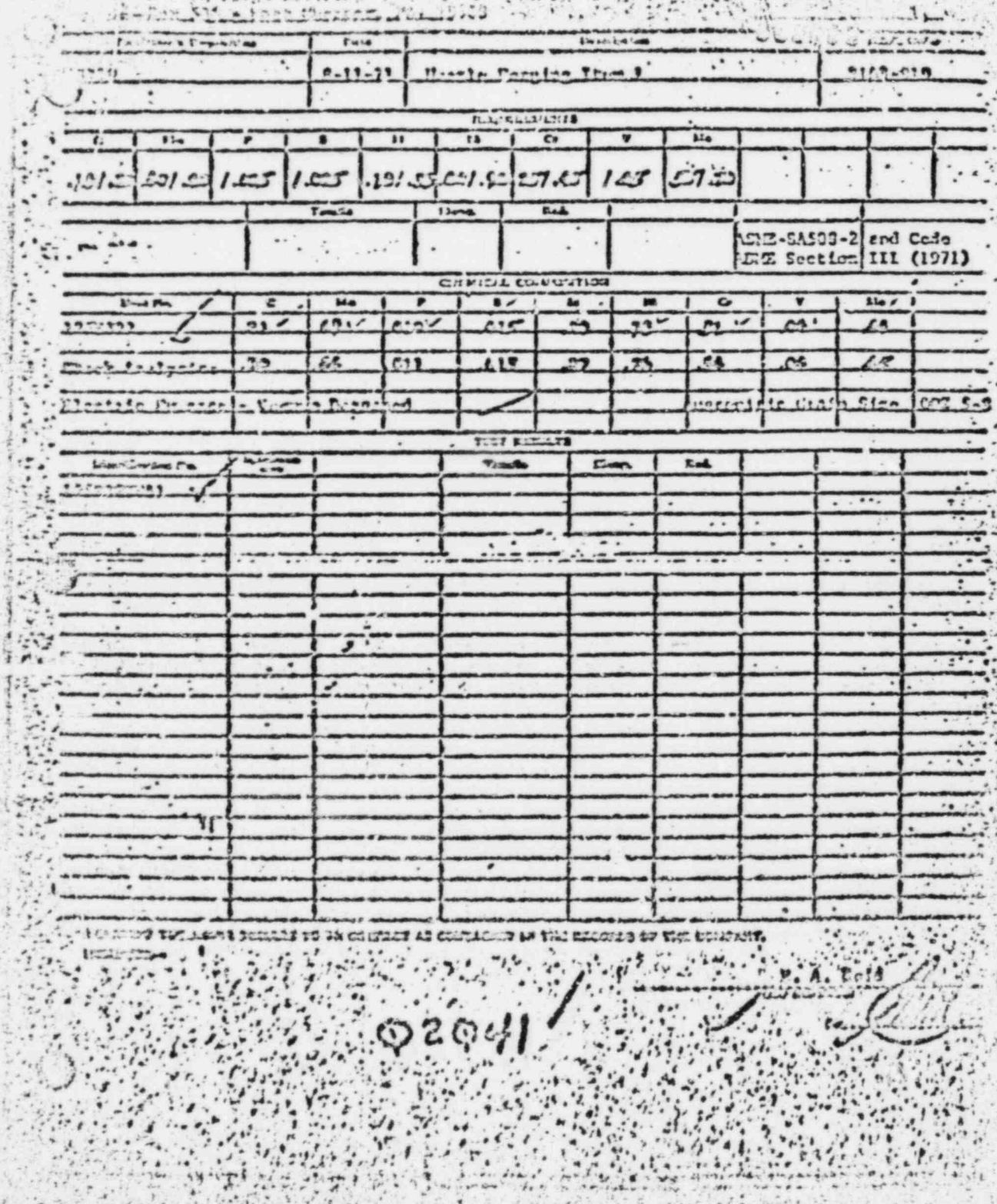
FORGING NO.	HEAT NO.	C	Mn	P	S	Si	Cr	Ni	Mo	V		Grain Size	NDT REPORTS ATTACHED U.T.	M.P.	D.P.	REMARKS
945-L 1	Q2C116	.21 .195	.69 .65	.010 .005	.015 .013	.28 .26	.31 .32	.78 .76	.61 .62	.01 .01	Cert Check	7	X			

FORGING NO.	HEAT NO.	TEST TEMP.	TENSILE PSI x 1000	YIELD PSI x 1000	ELONG. % in 2"	R.A. %	B.H.N.	IV. Notch at As Shown IMPACT TESTS (Keyway @ ENERGY (ft-lbs)	LATERAL EXP. (mils)	% SHEAR
945-L 1	Q2C116		Heat Treat Coupon (DAC/TRAX)							
		1	81.375	60.625	30.0	70.0		41 - 32 - 33	.032-.030-.026	20 - 20 -
			T x 2T Coupon					Tangential Notch		
		0	84.125	63.500	27.0	72.2		111 - 116 - 105	.072-.073-.06	80 - 80 -
		180	85.000	65.625	27.0	71.4		112 - 123 - 125	.076-.080-.076	80 - 80 -

Manufacturer certifies that all applicable requirements of SA508-2 and CB&I Sp. M3-111, Rev. 3 & Q1C 101, Rev. 3 have been complied with.

* The specimen was removed from the 1000 location adjacent

Attachment I



SA508-2 and Code Section III (1971)

Q2041

Attachment I

[illegible] CO. - [illegible]

[illegible]'s Order No. [illegible]

[illegible]'s Order No.

QTY.	PRODUCT	SPEC.	HEAT OR CODE NO.	FORGING NO.	HEAT TREATMENT	[illegible] ATTACHED
					L/P approved procedure [illegible]-12, Rev. 4.	
1.	Inlet forging per CBAI drawing [illegible], Rev. 6 (Except the 35-11/16" dim. corrected to 35-7/8"). Mark: 15-1-3	SA 508-2 & CBAI specs. [illegible]-111, Rev. 3 & C[illegible]-101, Rev. 3.	C[illegible] Supplier Ht. No. 12[illegible] V12	015-L 3	1650°F, ±25°F, for 14 hours- Air Cool 1560°F, ±25°F, for 14 hours- Water Quench 1250°F, ±25°F, for 14 hours- Air Cool Tests were stress relieved as follows: 1150°F, ±25°F, for 50 hours. L/P approved procedure SpHT-101, Rev. 0.	

CHEMICAL ANALYSIS AND MECHANICAL PROPERTIES

[illegible]	HEAT NO.	C	MN	P	S	SI	CR	NI	MO	V		Grain Size	NDT REPORTS ATTACHED U.T.	M.P.	O.P.	REMARKS
[illegible] 3	C[illegible]	.20 .209	.74 .71	.011 .009	.016 .012	.31 .27	.35 .35	.62 .61	.64 .64	.04 .04	Ladle Check	7	X	X		[illegible] TEST 1 specimen-break @ -20°F. 2 specimens no-break @ -10°F [illegible] establish the NDT [illegible]. Testing in acc. with L/P approved [illegible]

[illegible]	HEAT NO.	TEST TEMP.	TENSILE PSI x 1000	YIELD PSI x 1000	ELONG. % in 2"	R.A. %	B.H.N.	ENERGY (FT-LBS)	LATERAL EXP. (IN)	% [illegible]
								(V-Notch at As Shown) IMPACT TESTS (Charpy @		
[illegible] 3	C[illegible]		40 x t	Tests (DATA ONLY)				V-Notch @ 10°F		
			67.615	69.593	25.5	69.6		25 - 40 - 45	.020-.031-.035	10 - 30 - [illegible]
			T x 2T	Tests				V-Notch @ 40°F		
		0	69.170	67.703	25.5	70.3		115-105-83	.075-.069-.054	80 - 80 - 60
		100	67.500	65.875	26.5	71.2		113-111-120	.069-.074-.075	80 - 80 - 80

[illegible] certifies that all applicable requirements of SA 508-2 and [illegible]-111, Rev. 3 & C[illegible] 101, Rev. 3 have been complied with.

[illegible] were removed from the 180° location [illegible]

[signature]

[illegible]

Attachment I

MATERIAL TEST REPORT

C.O. No. [illegible] DATE [illegible], 19 [illegible]

Purchaser Chicago Bridge & Iron Company-[illegible] Purchaser's Order No. [illegible]

Distributor Distributor's Order No.

ITEM NO.		PRODUCT	SPEC.	HEAT OR CODE NO.	FORGING NO.	HEAT TREATMENT	FCE. CHARTS ATTACHED YES	NO
1	1	Additional Testing for inlet nozzle Mark: 15-1-3	S[illegible] & [illegible], Rev. 1.	C2Q37W	435B 3	[illegible] were stress relieved as follows: 1150°F±25°F for 50 hours. Rate of heating from & cooling to 600°F <100°F/hr. max.		

CHEMICAL ANALYSIS AND MECHANICAL PROPERTIES

FORGING NO.	HEAT NO.	C	MN	P	S	SI	CR	NI	MO				NDT REPORTS ATTACHED U.T.	M.P.	D.P.	Dropweight Testing REMARKS
																0° Location Two (2) specimens no-break @-10°F

FORGING NO.	HEAT NO.	TEST TEMP.	TENSILE PSI x 1000	YIELD PSI x 1000	ELONG. % in 2"	R.A. %	B.H.N.	(V-Notch as above) IMPACT TESTS (Keyhole) ENERGY (Ft-lbs.)	LATERAL EXP. (in")	% SHEAR
[illegible]53-3						180° location		112-101-96 140-142-153	.074-.064-.060 .089-.066-.073	50-40-40([illegible]°F) 100-100-100([illegible])

[Tr]ansition curve from the 0° location is attached.

CORRECTED TEST REPORT. DESTROY PREVIOUS COPY.

[signature]

We hereby certify the above [illegible] to be correct as contained in the records of the Company.

Attachment II

OUTLET NOZZLES

Nozzle	1st Layer Process Type	1st Layer Elect. Tng/Size	1st Layer Amps	1st Layer Volts	1st Layer Speed	1st Layer Preheat	1st Layer Post-Heat	1st Layer Interpass Temp.	2nd Layer Process Type	2nd Layer Elect Tng/Size	2nd Layer Amps	2nd Layer Volts	2nd Layer Speed	2nd Layer Preheat	2nd Layer Post-Heat	2nd Layer Interpass Temp.
25°																
Bore & First	SMA	309 / 1/8"	90-150	21-25	≃8 IPM	200°F MIN	Directly to 2nd Layer	400°F MAX.	Sub-Arc &	308L / 5/32"	230-275	34-40	3½-4½ IPM	200°F MIN	1100-1175°F	400°F MAX.
Two Layers		5/32"	120-190	22-26	"	"	"	"	GMA	308L / 1/16"	275-375	28-34	5-8 IPM	"	"	"
& Space		3/16"	150-225	22-26	"	"	"	"								
Remaining Layers & Space	SMA	308L / 1/8"	80-150	21-25	≃8 IPM	NONE	NONE	400°F MAX								
		5/32"	100-190	22-26	"											
		3/16"	150-225	22-26	"											
		1/4"	205-290	23-27	"											
195°																
Bore First	SMA &	309 / 1/8"	90-150	21-25	≃8 IPM	200°F MIN	Directly to 2nd Layer	400°F MAX	GMA &	308L / 1/16"	275-375	28-34	5-8 IPM	200°F MIN	1100°-1175°F	400°F MAX
Two Layers		5/32"	120-190	22-26	"	"	"	"	Sub-Arc	308L / 3/32"	375-425	31-33	6.0-6.5 IPM	"	"	"
& Space		3/16"	150-225	22-26	"	"	"	"								
	S-6 Arc	309L / 3/32"	400-450	34-36	6.0-6.5 IPM	"	"	"								
Remaining Layers & Space	Same As	25° Nozzle														
265°																
Bore First	SMA	309 / 1/8"	90-150	21-25	≃8 IPM	200°F MIN	Directly to 2nd Layer	400°F MAX	GMA &	308L / 1/16"	275-375	28-34	5-8 IPM	200°F MIN	1100-1175°F	400°F MAX
Two Layers		5/32"	120-190	22-26	"	"	"	"	SMA	308L / 1/8"	80-150	21-25	≃8 IPM	"	"	"
& Space		3/16"	150-225	22-26	"	"	"	"		5/32"	100-190	22-26	"	"	"	"
										3/16"	150-225	22-26	"	"	"	"
										1/4"	205-290	23-27	"	"	"	"
Remaining Layers & Space	Same As	25° Nozzle														

INLET NOZZLES

Nozzle	1st Layer Process Type	1st Layer Electrode Type/Size	1st Layer Amps	1st Layer Volts	1st Layer Speed	1st Layer Preheat	1st Layer Post-Heat	1st Layer Interpass Temp	2nd Layer Process Type	2nd Layer Electrode Tng/Size	2nd Layer Amps	2nd Layer Volts	2nd Layer Speed	2nd Layer Preheat	2nd Layer Post-Heat	2nd Layer Interpass Temp
All Inlet Nozzles	SMA	309 / 1/8"	80-150	21-25	≃8 IPM	200°F MIN	Directly to 2nd Layer	400°F MAX	SMA &	308L / 1/8"	80-150	21-25	≃8 IPM	200°F MIN	1100-1175°F	400°F MAX
95°		5/32"	120-190	22-26	"	"				5/32"	100-190	22-26	"	"	"	"
215°		3/16"	150-225	22-26	"	"				3/16"	150-225	22-26	"	"	"	"
335°										1/4"	205-290	23-27	"	"	"	"
									GMA	308L / 1/16"	275-375	28-34	5-8 IPM	"	"	"
215° 3rd Layer	Same As	2nd Layer Above														

(3)