NRC FORM 195 (2-76)

U.S. NUCLEAR REGULATORY COMMISSION

DOCKET NUMBER: 50-387/388

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TO:	FROM:	DATE OF DOCUMENT
Mr. Olan D. Parr	PP&L Allentown, PA 18101 N. W. Curtis	03/31/78
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ENCLOSURE:

Response to NRC ltr dtd 12/06/77... Furnishing responses to the "Questionaire for Fracture Toughness Properties of Older Reactor Vessels", consiting of:

1. Updated response for Unit 1, including copper content for Q121.2(1), & quantified response to Q121.2(3).
2. Complete response for Unit 2.

19p

PLANT NAME: SEQUEHANNA UNITS 1 & 2

jcm 04/07/78

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1 ENCL

FOR ACTION/INFORMATION

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MAR 31 1978

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Mr. Olan D. Parr, Chief
Light Water Reactors Branch No. 3
Division of Project Management
U.S. Nuclear Regulatory Commission
Washington, DC 20555

SUSQUEHANNA SES
PRESSURE VESSEL FRACTURE TOUGHNESS PROPERTIES
ER 100450 FILE 840-2
PLA-237

DOCKET NOS. 50-387
AND 50-388

Dear Mr. Parr:

Attached are complete responses to the "Questionaire for Fracture Toughness Properties of Older Reactor Vessels" contained in your December 6, 1977 letter. A partial response had been sent to you in our February 16, 1978 letter (PLA-218), since all of the data requested by you was not available at that time. The attached information consists of:

1. An updated response for Unit 1. This response now includes the copper content for Q121.2(1), and a quantified response to Q121.2(3).

2. A complete response for Unit 2. This information is very similar to Unit 1 but is submitted as a separate response.

Very truly yours,

N. W. Curtis
VP-Engr. & Construction

NWC:KMM

Attachment

7809700005

QUESTION:

121.0 - MATERIALS ENGINEERING BRANCH - MATERIALS INTEGRITY SECTION

121.1 Provide the purchase order date for your reactor vessel, identify the firm or firms with whom the purchase order was placed, the vessel fabricator, and applicable edition of the ASME Code requirement pursuant to 10CFR Part 50.55a(c).

RESPONSE:

121.1 The Susquehanna No. 1 reactor pressure vessel was purchased from CBI - Nuclear Company, August 5, 1968. This vessel was fabricated to Section III of the ASME Boiler and Pressure Vessel Code as revised by the following:

Section III Nuclear Vessels - 1968 Edition with Addenda to and including Summer 1970 Addenda and Paragraph NB-3338.2(d)(4) of the Winter 1971 addenda shall supercede Paragraph I-613(d) of the 1968 edition. Paragraph NB-2400 of the 1971 Edition shall apply for all fabrication performed at the Susquehanna Site.

QUESTION:

121.2 Identify each material (plate, and/or forging and weld metal) in the beltline region (as defined by paragraph II. H, Appendix G, 10CFR Part 50) and provide a sketch showing the location of these materials in the reactor vessel. Provide the following information for each material:

(1) Chemical analyses; particularly those elements known to affect irradiation sensitivity and degrade the upper shelf fracture energy (Cu, P, and S).

(2) Unirradiated fracture toughness properties (T_{NDT}, RT_{NDT} and upper shelf fracture energy) as required by Appendix G, 10CFR Part 50, identifying the limiting material in the ractor vessel beltline region.

(3) Estimate the maximum anticipated change in RT_{NDT} and upper shelf fracture energy as a function of the EOL fluence at the inner wall for the materials in the beltline region of the reactor vessel.

RESPONSE:

121.2 Materials in the reactor pressure vessel beltline region are identified as listed below and as shown on the attached sketch:

Vessel Beltline Material Identification

A. Lower Shell Course (CBIN Dwg R-1, Rev. 4, Contract No. 683331)

1. Plates

PC #	ID #	MELT #	SLAB #
21	1	CB5083	1
21	2	C0770	2
21	3	C0814	2

2. Welds

The vertical welds and girth weld for this shell course were completed in the "field". Records were not kept on which of the electrodes, identified by heat and lot numbers, were used in the weld up of the specific field welds of this shell assembly. It is assumed that any of the SMAW electrodes - type 8018 released for field welding could have been used on any or all of the associated seams in the beltline region.

JW:csc/7D2

RESPONSE: - (Cont'd)

121.2 Electrodes released for the field welding of these plates are as follows:

Type	Lot No.	Heat No.
SMAW Electrode Type 8018	B504B27AE	401S0371
SMAW Electrode Type 8018	629616	L320A27AG
SMAW Electrode Type 8018	402K9171	K315A27AE
SMAW Electrode Type 8018	411L3071	L311A27AE
SMAW Electrode Type 8018	494K2351	L307A27AD
SMAW Electrode Type 8018	C115A27A	402C4371
SMAW Electrode Type 8018	J417B27A	412P3611

B. Lower Intermediate Shell Course

1. Plates

PC #	ID #	MELT #	SLAB #
22	1	C0803	1
22	2	C0776	1
22	3	C2433	1

2. Welds

The vertical welds and the girth weld for this shell course were completed in the "field". Records were not kept on which of the electrodes, identified by heat and lot numbers, were used in the weld-up of the specific field welds of the shell assembly. It is assumed that any of the SMAW electrodes (type 8018) released for field welding could have been used on any or all of the associated seams in the beltline region.

Electrodes released for the field welding of these plates are as follows:

Type	Lot No.	Heat No.
SMAW Electrode Type 8018	B504B27AE	401S0371
SMAW Electrode Type 8018	629616	L320A27AG
SMAW Electrode Type 8018	402K9171	K315A27AE
SMAW Electrode Type 8018	411L3071	L311A27AF
SMAW Electrode Type 8018	494K2351	L307A27AD
SMAW Electrode Type 8018	C115A27A	402C4371
SMAW Electrode Type 8018	J417B27AF	412P3611

RESPONSE:

121.2(1) Vessel Plate Material

	C	Mn	P	S	Cu	Si	Ni	Mo
	(Values are shown in percent)							
Lower Shell								
PC 21-1, Melt # B5083, Slab #1	.21	1.27	.010	.019	.14	.25	.48	.51
PC 21-2, Melt #C0770, Slab #2	.22	1.23	.008	.016	.14	.19	.50	.49
PC 21-3, Melt #C0814, Slab #2	.20	1.36	.011	.016	.13	.26	.51	.51
Lower Intermediate Shell								
PC 22-1, Melt #C0803, Slab #1	.21	1.30	.009	.019	.09	.24	.53	.52
PC 22-2, Melt #C0776, Slab #1	.22	1.34	.010	.010	.12	.27	.48	.48
PC 22-3, Melt #C2433, Slab #1	.18	1.30	.009	.015	.10	.23	.63	.57

Note: *N/R - Not Reported

	C	Mn	P	S	Cu	Si	Ni	Mo	Cr	V
	(Values are shown in percent)									
Weld Material										
Type SMAW Electrode 8018 Lot # and Heat #										
Lot #B504827AE Ht #401S0371	.05	1.18	.013	.012	.03	.37	1.04	.56	.03	.0
Lot #629616 Ht #L320A 27AG	.05	1.17	.015	.018	.04	.44	.99	.55	.05	.0
Lot #402K9171 Ht #K315A27AE	.06	1.15	.015	.016	.03	.36	.98	.53	.05	.0
Lot #411L3071 Ht #L311A27AF	.05	1.20	.016	.019	.03	.46	.93	.50	.04	.0
Lot #494K2351 Ht #L307A27AD	.05	1.18	.015	.017	.04	.37	1.10	.57	.04	.0
Lot #C115A27A Ht #402C4371	.033	1.22	.009	.014	.02	.49	.92	.57	N/R	N/
Lot #J417B27A F Ht # 412P3611	.07	1.10	.016	.019	.03	.36	.93	.47	.03	.0

JW:csc/7D4

RESPONSE:

121.2(2) Unirradiated fracture toughness properties (T_{NDT}, RT_{NDT} and upper shelf fracture energy) as required by Appendix G, 10CFR Part 50, identifying the limiting material in the reactor vessel beltline region.

The Susquehanna 1 reactor pressure vessel was ordered prior to the issuance of Appendix G, 10CFR Part 50. The ferritic material for the pressure boundary was qualified by drop weight testing for the shell plate material and both drop weight and Charpy V notch testing for the weld material. The test results, along with the specific requirements prevailing at the time of vessel ordering are summarized in the tables which follow.

Impact Properties of SA533, Grade B, Class 1
Plate Material in Beltline Region

Location	Plates	Drop Wt. NDTT (°F)
Lower shell course	21-1	-10°F
	21-2	-30°F
	21-3	-30°F
Lower intermediate shell course	22-1	-10°F
	22-2	-10°F
	22-3	-50°F

Impact Properties of Weld Materials Employed
In the Beltline Region

Weld Material Identification	Charpy "V" (Ft/lb)	Test Temp. °F	Required	Drop Wt NDTT °F
Lot# B504B27AE, Ht #401S0371	57, 58, 62	-20	30 ft/lbs at 10°F	-80
Lot #629616 Ht #L320A27AG	51, 52	+10	" "	-70
Lot #402K9171 Ht #K315A27AE	58, 58	+10	" "	-70
Lot #411L3071 Ht #L311A27AF	51, 67	+10	" "	-70
Lot #494K2351 Ht #L307A27AD	87, 96	+10	" "	-80
Lot #C115A27A Ht #402C4371	82, 84, 92	+10	" "	No Report
Lot #J417B27AF Ht #412P3611	52, 65, 69	-20	" "	-80

JW:csc/7D5

RESPONSE:

121.2 (3) Estimated maximum changes in RT_{NDT} and upper shelf fracture energy as a function of the end of life (EOL) fluence at the 1/4T depth of the vessel beltline materials are listed below. The predicted peak EOL fluence at the 1/4T depth of the vessel beltline is 1.37×10^{18} n/cm^2 after 40 years of service. Transition temperature changes and changes in upper shelf fracture energy were calculated in accordance with the rules of Regulatory Guide 1.99. Reference temperatures were established in accordance with the instructions in Branch Technical Position MTEB No. 5-2.

Limiting Plate Material (Cu = .14%, P = .010%)	Plate 21-1
Transition Temperature Change (per Regulatory Guide 1.99)	42°F
Reference Temperature (Drop Weight NDTT)	-10°F
Adjusted Reference Temperature at EOL	32°F
Change in Upper Shelf Energy (per Regulatory Guide 1.99)	~-14%
Limiting Weld Material (Cu = .03%, P = .016%)	Lot 411L3071 Heat L311A27AF
Transition Temperature Change (per Regulatory Guide 1.99)	30°F
Reference Temperature (per MTEB No. 5-2)	10°F
Adjusted Reference Temperature at EOL	40°F
Change in Upper Shelf Energy (per Regulatory Guide 1.99)	~-10%

JW:csc/7D11

QUESTION:

121.3 Describe the surveillance program for the reactor vessel(s), list the materials (plate, and/or forging and weld metal) and justify their selection. State any deviation from Appendixes G and H, 10CFR Part 50.

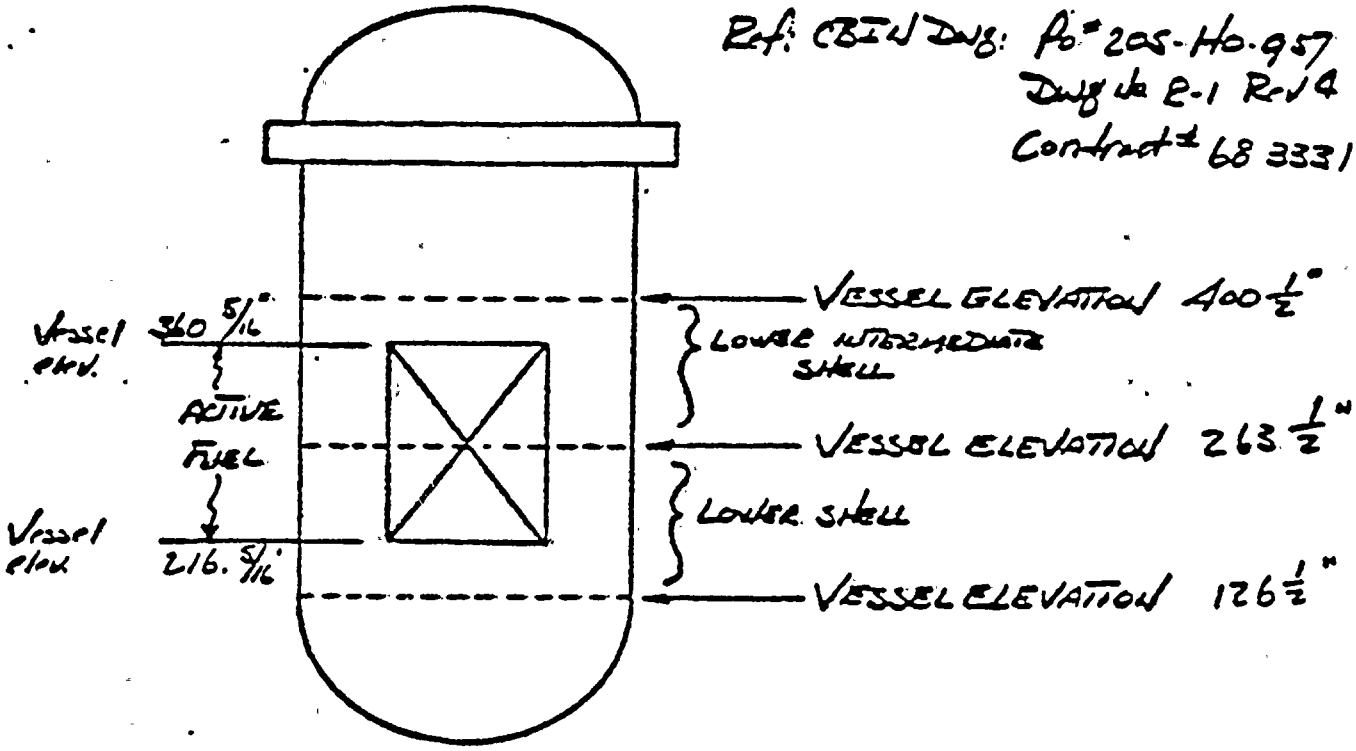
RESPONSE:

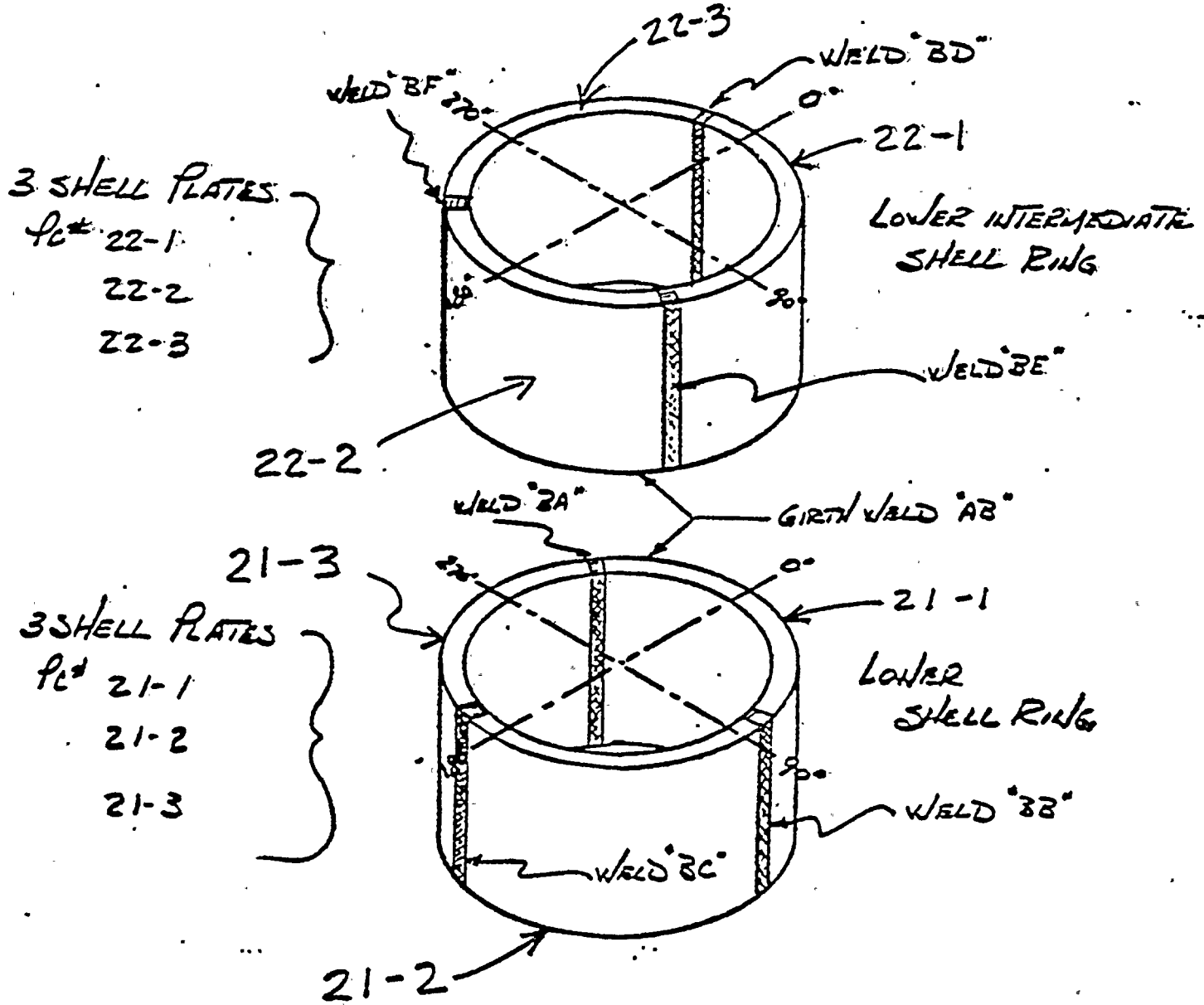
The surveillance program of the reactor pressure vessel materials is described in Section 5.3.1.6 of the FSAR.

NRC QUESTION 121.1 & 121.2

SUSQUEHANNA-1

Ref: CBI NJ Dwg: P.O.# 205-Ho-957
Dwg No E-1 Rev 4
Contract # 68 3331





QUESTION:

121.0 MATERIALS ENGINEERING BRANCH - MATERIALS INTEGRITY SECTION

121.1 Provide the purchase order date for your reactor vessel, identify the firm or firms with whom the purchase order was placed, the vessel fabricator, and applicable edition of the ASME Code requirement pursuant to 10CFR Part 50.55a(c).

RESPONSE:

121.1 The Susquehanna No. 2 reactor pressure vessel was purchased from CBI - Nuclear Company, August 5, 1968. This vessel was fabricated to Section III of the ASME Boiler and Pressure Vessel Code as revised by the following:

Section III Nuclear Vessels - 1968 Edition with Addenda to and including Summer 1970 Addenda and Paragraph NB-3338.2(d)(4) of the Winter 1971 addenda shall supercede Paragraph I-613(d) of the 1968 edition. Paragraph NB-2400 of the 1971 Edition shall apply for all fabrication performed at the Susquehanna Site.

JW:csc/7D1

QUESTION:

121.2 Identify each material (plate, and/or forging and weld metal) in the beltline region (as defined by paragraph II.11, Appendix G, 10CFR Part 50) and provide a sketch showing the location of these materials in the reactor vessel. Provide the following information for each material:

(1) Chemical analyses; particularly those elements known to affect irradiation sensitivity and degrade the upper shelf fracture energy (Cu, P, and S).

(2) Unirradiated fracture toughness properties (T_{NDT}, RT_{NDT} and upper shelf fracture energy) as required by Appendix G, 10CFR Part 50, identifying the limiting material in the ractor vessel beltline region.

(3) Estimate the maximum anticipated change in RT_{NDT} and upper shelf fracture energy as a function of the EOL fluence at the inner wall for the materials in the beltline region of the reactor vessel.

RESPONSE:

121.2 Materials in the reactor pressure vessel beltline region are identified as listed below and as shown on the attached sketch:

Vessel Beltline Material Identification

A. Lower Shell Course

1. Plates

PC ID#	MELT #	SLAB #
21-1	6C956	1-1
21-2	6C980	1-1
21-3	6C1053	1-1

2. Welds

The vertical welds and girth weld for this shell course were completed in the "field". Records were not kept on which of the electrodes, identified by heat and lot numbers, were used in the weld up of the specific field welds of this shell assembly. It is assumed that any of the SMAW electrodes - type 8018 released for field welding could have been used on any or all of the associated seams in the beltline region.

JW:csc/7D2

RESPONSE: - (Cont'd)

121.2. - Electrodes released for the field welding of these plates are as follows:

Type	Lot No.	Heat No.
SMAW Electrode Type 8018	B504B27AE	401S0371
SMAW Electrode Type 8018	629616	L320A27AG
SMAW Electrode Type 8018	402K9171	K315A27AE
SMAW Electrode Type 8018	411L3071	L311A27AF
SMAW Electrode Type 8018	494K2351	L307A27AD
SMAW Electrode Type 8018	C115A27A	402C4371
SMAW Electrode Type 8018	J417B27A	412P3611
SMAW Electrode Type 8018	C109A27A	09M057
SMAW Electrode Type 8018	E204A27A	624263
SMAW Electrode Type 8018	F414B27AF	659N315

B. Lower Intermediate Shell Course

1. Plates

PC ID#	MELT #	SLAB #
22-1	C2421	3
22-2	C2929	1
22-3	C2433	2

2. Welds

The vertical welds and the girth weld for this shell course were completed in the "field". Records were not kept on which of the electrodes, identified by heat and lot numbers, were used in the weld-up of the specific field welds of the shell assembly. It is assumed that any of the SMAW electrodes (type 8018) released for field welding could have been used on any or all of the associated seams in the beltline region.

Electrodes released for the field welding of these plates are as follows:

Type	Lot No.	Heat No.
SMAW Electrode Type 8018	B504B27AE	401S0371
SMAW Electrode Type 8018	629616	L320A27AG
SMAW Electrode Type 8018	402K9171	K315A27AE
SMAW Electrode Type 8018	411L3071	L311A27AF
SMAW Electrode Type 8018	494K2351	L307A27AD
SMAW Electrode Type 8018	C115A27A	402C4371

Type	Lot No.	Heat No.
SMAW Electrode Type 8018	J417B27AF	412P3611
SMAW Electrode Type 8018	C109A27A	09M057
SMAW Electrode Type 8018	E204A27A	624263
SMAW Electrode Type 8018	F414B27AF	659N315

JW:csc/7D4

RESPONSE:

121.2(1) Vessel Plate Material

	C	Mn	P	S	Cu	Si	Ni	Mo
	(Values are shown in percent)							
Lower Shell								
PC 21-1, Melt #6C956 Slab #1-1	.18	1.43	.012	.006	.11	.22	.55	.52
PC 21-2, Melt #6C980 Slab #1-1	.19	1.35	.011	.006	.10	.22	.56	.51
PC 21-3, Melt #6C1053 Slab #1-1	.18	1.37	.012	.010	.10	.30	.58	.50
Lower Intermediate Shell								
PC 22-1, Melt #C2421, Slab #3	.19	1.22	.007	.011	.13	.25	.68	.55
PC 22-2, Melt #C2929, Slab #1	.20	1.27	.006	.015	.13	.22	.64	.56
PC 22-3, Melt #C2433, Slab #2	.18	1.30	.009	.015	.10	.23	.63	.57

Note: *N/R - Not Reported

	C	Mn	P	S	Cu	Si	Ni	Mo	Cr	Vr
	(Values are shown in percent)									
Weld Material										
Type SMAW Electrode 8018 Lot # and Heat #										
Lot #B504B27AE Ht #401S0371	.05	1.18	.013	.012	.03	.37	1.04	.56	.03	.02
Lot #629616 Ht #L320A27AG	.05	1.17	.015	.018	.04	.44	.99	.55	.05	.02
Lot #402K9171 Ht #K315A27AE	.06	1.15	.015	.016	.03	.36	.98	.53	.05	.02
Lot #411L3071 Ht #L311A27AF	.05	1.20	.016	.019	.03	.46	.93	.50	.04	.02
Lot #494K2351 Ht #L307A27AD	.05	1.18	.015	.017	.04	.37	1.10	.57	.04	.02
Lot #C115A27A Ht #402C4371	.033	1.22	.009	.014	.02	.49	.92	.57	N/R	N/R

JW:csc/7D5

	C	Mn	P	S	Cu	Si	Ni	Mo	Cr	Vr
	(Values are shown in percent)									
Lot #J417B27A F Ht #412P3611	.07	1.10	.016	.019	.03	.36	.93	.47	.03	.02
Lot #C109A27A Ht #09M057	.063	1.18	.009	.021	.03	.47	.89	.53	N/R	N/R
Lot #E204A427A Ht # 624263	.051	1.08	.010	.023	.06	.38	.89	.50	N/R	N/R
Lot #F414B27AF Ht #659N315	.05	1.14	.015	.013	.04	.35	1.00	.49	.05	N/R

Note: N/R - Not Reported

JW:csc/7D6

RESPONSE:

121.2(2) Unirradiated fracture toughness properties (T_{NDT}, RT_{NDT} and upper shelf fracture energy) as required by Appendix G, 10CFR Part 50, identifying the limiting material in the reactor vessel beltline region.

The Susquehanna 1 reactor pressure vessel was ordered prior to the issuance of Appendix G, 10CFR Part 50. The ferritic material for the pressure boundary was qualified by drop weight testing for the shell plate material and both drop weight and Charpy V notch testing for the weld material. The test results, along with the specific requirements prevailing at the time of vessel ordering are summarized in the tables which follow.

Impact Properties of SA533, Grade B, Class 1
Plate Material in Beltline Region

Location	Plates	Drop Wt. NDTT (°F)
Lower Shell Ring	21-1	-20°F
	21-2	-20°F
	21-3	+10°F
Lower Intermediate Shell Ring	22-1	-10°F
	22-2	-20°F
	22-3	-30°F

Impact Properties of Weld Materials Employed
In the Beltline Region

Weld Material Identification	Charpy "V" (Ft/lb)	Test Temp. °F	Required	Drop Wt NDTT °F
Lot# B504B27AE, Ht #401S0371	57, 58, 62	-20	30 ft/lbs at 10°F	-80
Lot #629616	51, 52	+10	" "	-70
Ht #L320A27AG Lot #402K9171	58, 58	+10	" "	-70
Ht #K315A27AE Lot #411L3071	51, 67	+10	" "	-70
Ht #L311A27AF Lot #494K2351	87, 96	+10	" "	-80
Ht #L307A27AD Lot #C115A27A	82, 84, 92	+10	" "	N/R
Ht #402C4371 Lot #J417B27AF Ht #412P3611	52, 65, 69	-20	" "	-80

JW:csc/7D7

Impact Properties of Weld Materials Employed
In the Beltline Region

Weld Material Identification	Charpy "V" (Ft/lb)	Test Temp. °F	Required	Drop Wt NDTT °F
Lot #C109A27A Ht #09M057	43, 43, 44	+10	" "	N/R
Lot #E204A27A Ht 624263	26, 38, 42, 50, 76	-20	" "	-70
Lot #F414B27AF Ht 659N315	74, 76, 77	-10	" "	-80

JW:csc/7D8

RESPONSE:

121.2 (3) Estimated maximum changes in RT_{NDT} and upper shelf fracture energy as a function of the end of life (EOL) fluence at the 1/4T depth of the vessel beltline materials are listed below. The predicted peak EOL fluence at the 1/4T depth of the vessel beltline is 1.37×10^{18} n/cm^2 after 40 years of service. Transition temperature changes and changes in upper shelf fracture energy were calculated in accordance with the rules of Regulatory Guide 1.99. Reference temperatures were established in accordance with the instructions in Branch Technical Position MTEB No. 5-2.

Limiting Plate Material (Cu = .13%, P = .007%)	Plate 22-1
Transition Temperature Change (per Regulatory Guide 1.99)	34°F
Reference Temperature (Drop Weight NDTT)	-10°F
Adjusted Reference Temperature at EOL	24°F
Change in Upper Shelf Energy (per Regulatory Guide 1.99)	~-14%
Limiting Weld Material (Cu = .03%, P = .016%)	Lot 411L3071 Heat L311A27AF
Transition Temperature Change (per Regulatory Guide 1.99)	30°F
Reference Temperature (per MTEB No. 5-2)	10°F
Adjusted Reference Temperature at EOL	40°F
Change in Upper Shelf Energy (per Regulatory Guide 1.99)	~-10%

JW:csc/7D9

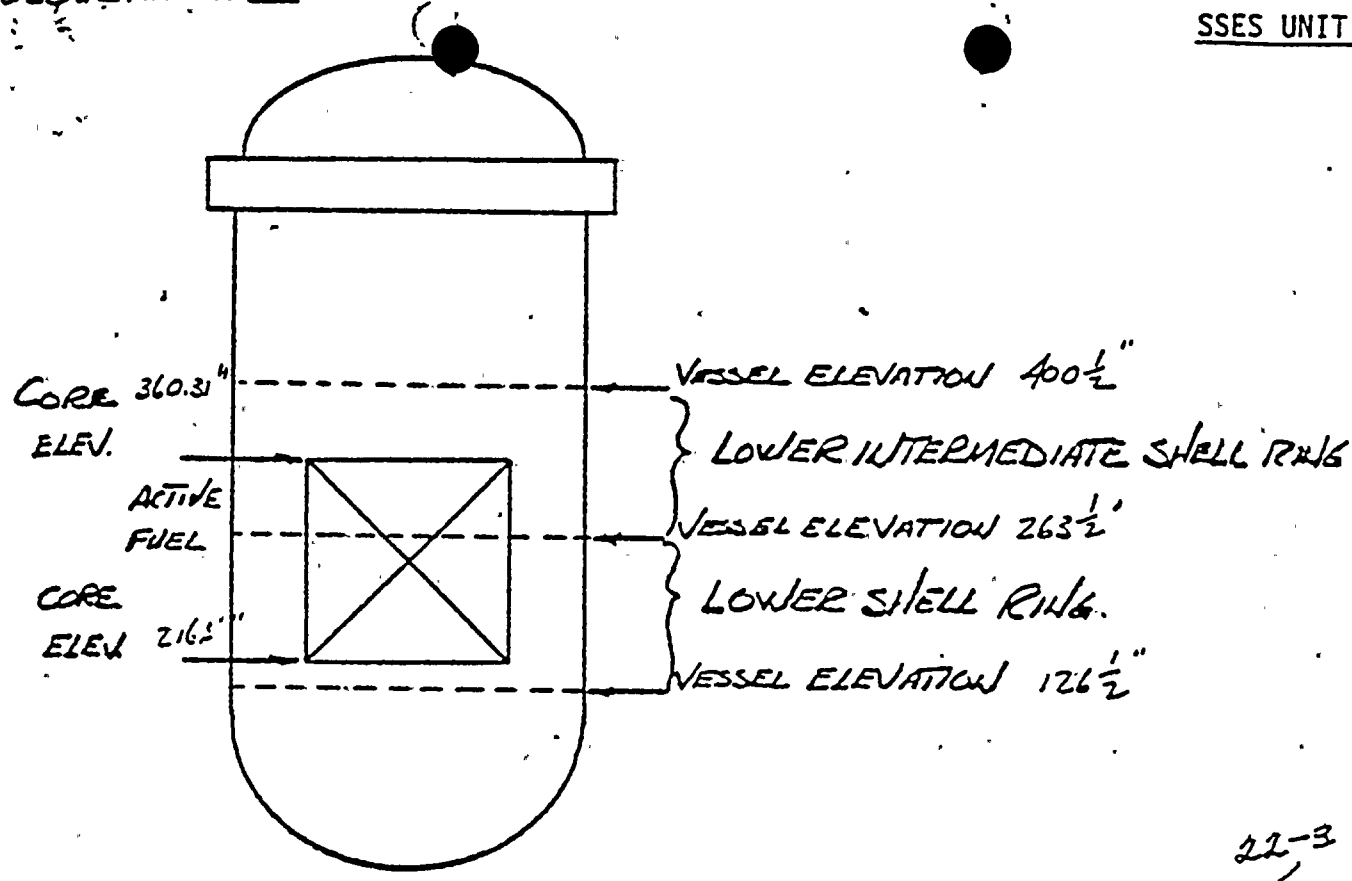
QUESTION:

121.3 Describe the surveillance program for the reactor vessel(s), list the materials (plate, and/or forging and weld metal) and justify their selection. State any deviation from Appendixes G and H, 10CFR Part 50.

RESPONSE:

The surveliance program of the reactor pressure vessel materials is described in Section 5.3.1.6 of the FSAR.

JW:csc/7D10

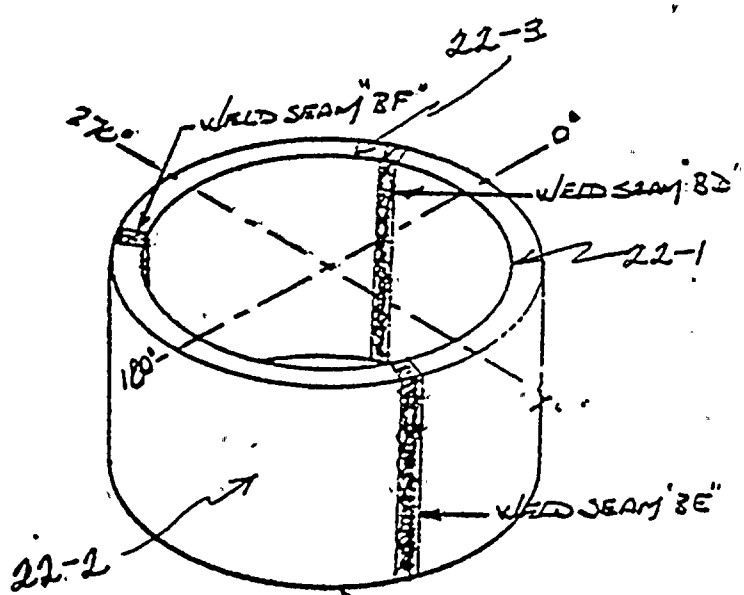


LOWER INTERMEDIATE SHELL
(3 PLATES)

Pc# 22-A SHELL ASS'Y

PLATES

Pc# 22-1 Heat # C2421, SLAB# 3
Pc# 22-2 " C2929, " 1
Pc# 22-3 " C2453 " 2



LOWER SHELL
(3 PLATES)

Pc# 21-A - SHELL ASS'Y

PLATES

Pc# 21-1, Heat # 6C956, SLAB# 1-1
Pc# 21-2, " 6C980, " 1-1
Pc# 21-3, " 6C1053, " 1-1