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Table 4. NCT-ST from Spout Glass (continuation)

Isotope	Content (Ci)	A_2 (Ci/A_2)	MAR (A_2)	DR	ARF	LPF Melter	LPF WVMP	Release (A_2)
	From Table 1		Calculated for heel glass	Glass damage ratios and leak path factors taken from Table 2				Calculated for heel glass
a	b	c	d=b/c	e	f	g	h	i=d*e*f*g*h
Pu-240	2.29E-02	2.70E-02	8.50E-01	0.001	1E-6	0.1	0.1	8.50E-12
Pu-241	1.85E-01	1.60E+00	1.16E-01	0.001	1E-6	0.1	0.1	1.16E-12
Am-241	3.80E-01	2.70E-02	1.41E+01	0.001	1E-6	0.1	0.1	1.41E-10
Am-243	4.55E-03	2.70E-02	1.68E-01	0.001	1E-6	0.1	0.1	1.68E-12
Cm-242	1.05E-11	2.70E-01	3.88E-11	0.001	1E-6	0.1	0.1	3.88E-22
Cm-243	1.85E-03	2.70E-02	6.87E-02	0.001	1E-6	0.1	0.1	6.87E-13
Cm-244	4.07E-02	5.40E-02	7.53E-01	0.001	1E-6	0.1	0.1	7.53E-12
							subtotal	8.3E-10

Table 5. NCT-ST from Heel Glass

Isotope	Content (Ci)	A_2 (Ci/A_2)	MAR (A_2)	DR	ARF	LPF Melter	LPF WVMP	Release (A_2)
	From Table 1		Calculated for heel glass	Glass damage ratios and leak path factors taken from Table 2				Calculated for heel glass
a	b	c	d=b/c	e	f	g	h	i=d*e*f*g*h
C-14	3.47E-03	8.10E+01	4.28E-05	0.001	1E-6	0.1	0.1	4.28E-16
K-40	1.50E-02	2.40E+01	6.25E-04	0.001	1E-6	0.1	0.1	6.25E-15
Mn-54	1.44E-06	2.70E+01	5.33E-08	0.001	1E-6	0.1	0.1	5.33E-19
Co-60	3.16E-03	1.10E+01	2.87E-04	0.001	1E-6	0.1	0.1	2.87E-15
Ni-63	1.52E-01	8.10E+02	1.88E-04	0.001	1E-6	0.1	0.1	1.88E-15
Sr-90	3.12E+01	8.10E+00	3.85E+00	0.001	1E-6	0.1	0.1	3.85E-11
Y-90	3.12E+01	included with Sr-90						
Zr-95	1.30E-20	2.10E+01	6.19E-22	0.001	1E-6	0.1	0.1	6.19E-33
Nb-95	2.86E-20	2.20E+01	1.30E-21	0.001	1E-6	0.1	0.1	1.30E-32
Nb-95m	1.49E-22	included with Zr-95						
Tc-99	2.01E-03	2.40E+01	8.38E-05	0.001	1E-6	0.1	0.1	8.38E-16
Cs-137	5.42E+02	1.60E+01	3.39E+01	0.001	1E-6	0.1	0.1	3.39E-10
Ba-137m	5.12E+02	included with Cs-137						
Eu-154	8.12E-02	1.60E+01	5.08E-03	0.001	1E-6	0.1	0.1	5.08E-14
Hg-206	9.79E-16	5.40E-01	1.81E-15	0.001	1E-6	0.1	0.1	1.81E-26
Tl-206	6.88E-14	included with Bi-210m						
Tl-207	2.56E-09	5.40E-01	4.74E-09	0.001	1E-6	0.1	0.1	4.74E-20
Tl-208	2.72E-03	included with U-232						
Tl-209	8.09E-08	Included with Th-229						

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Table 5. NCT-ST from Heel Glass (continuation)

Isotope	Content (Ci)	A_2 (Ci/A_2)	MAR (A_2)	DR	ARF	LPF Melter	LPF WVMP	Release (A_2)
	From Table 1		Calculated for heel glass	Glass damage ratios and leak path factors taken from Table 2				Calculated for heel glass
a	b	c	d=b/c	e	f	g	h	i=d*e*f*g*h
Tl-210	6.54E-11	5.40E-01	1.21E-10	0.001	1E-6	0.1	0.1	1.21E-21
Pb-209	3.75E-06	included with Th-229						
Pb-210	5.16E-08	1.40E+00	3.69E-08	0.001	1E-6	0.1	0.1	3.69E-19
Pb-211	2.57E-09	5.40E-01	4.76E-09	0.001	1E-6	0.1	0.1	4.76E-20
Pb-212	7.56E-03	included with U-232						
Pb-214	3.11E-07	included with Rn-222						
Bi-209	8.10E-25	included with Pb-210						
Bi-210	5.14E-08	included with Bi-212						
Bi-211	2.57E-09	included with Pb-211						
Bi-212	7.56E-03	included with U-232						
Bi-213	3.75E-06	included with Th-229						
Bi-214	3.11E-07	included with Rn-222						
Bi-215	2.10E-15	5.40E-01	3.89E-15	0.001	1E-6	0.1	0.1	3.89E-26
Po-210	4.71E-08	included with Pb-210						
Po-211	7.01E-12	2.40E-03	2.92E-09	0.001	1E-6	0.1	0.1	2.92E-20
Po-212	4.84E-03	included with U-232						
Po-213	3.67E-06	included with Th-229						
Po-214	3.11E-07	included with U-230						
Po-215	2.57E-09	2.40E-03	1.07E-06	0.001	1E-6	0.1	0.1	1.07E-17
Po-216	7.56E-03	included with U-232						
Po-218	3.11E-07	included with Rn-222						
At-215	1.03E-14	2.40E-03	4.29E-12	0.001	1E-6	0.1	0.1	4.29E-23
At-217	3.75E-06	included with Th-229						
At-218	5.92E-11	2.40E-03	2.47E-08	0.001	1E-6	0.1	0.1	2.47E-19
At-219	2.17E-15	2.40E-03	9.04E-13	0.001	1E-6	0.1	0.1	9.04E-24
Rn-217	4.50E-10	2.40E-03	1.88E-07	0.001	1E-6	0.1	0.1	1.88E-18
Rn-218	5.92E-14	included with U-230						
Rn-219	2.57E-09	2.40E-03	1.07E-06	0.001	1E-6	0.1	0.1	1.07E-17
Rn-220	7.56E-03	included with U-232						
Rn-222	3.11E-07	1.10E-01	2.83E-06	0.001	1E-6	0.1	0.1	2.83E-17
Fr-221	3.75E-06	included with Th-229						
Fr-223	3.61E-11	5.40E-01	6.68E-11	0.001	1E-6	0.1	0.1	6.68E-22
Ra-223	2.57E-09	1.90E-01	1.35E-08	0.001	1E-6	0.1	0.1	1.35E-19
Ra-224	7.56E-03	included with U-232						
Ra-225	3.76E-06	included with Th-229						
Ra-226	3.12E-07	8.10E-02	3.85E-06	0.001	1E-6	0.1	0.1	3.85E-17
Ra-228	5.14E-05	5.40E-01	9.53E-05	0.001	1E-6	0.1	0.1	9.53E-16
Ac-225	3.75E-06	included with Th-229						

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Table 5. NCT-ST from Heel Glass (continuation)

Isotope	Content (Ci)	A_2 (Ci/A_2)	MAR (A_2)	DR	ARF	LPF Melter	LPF WVMP	Release (A_2)
	From Table 1		Calculated for heel glass	Glass damage ratios and leak path factors taken from Table 2				Calculated for heel glass
a	b	c	d=b/c	e	f	g	h	i=d*e*f*g*h
Ac-227	2.61E-09	2.40E-03	1.09E-06	0.001	1E-6	0.1	0.1	1.09E-17
Ac-228	5.14E-05	included with Ra-228						
Th-227	2.55E-09	1.40E-01	1.82E-08	0.001	1E-6	0.1	0.1	1.82E-19
Th-228	7.56E-03	included with U-232						
Th-229	3.78E-06	1.40E-02	2.70E-04	0.001	1E-6	0.1	0.1	2.70E-15
Th-230	6.05E-05	2.70E-02	2.24E-03	0.001	1E-6	0.1	0.1	2.24E-14
Th-231	6.15E-05	included with U-235						
Th-232	6.74E-05	unlimited						
Th-234	3.74E-04	included with U-238						
Pa-231	1.55E-08	1.10E-02	1.41E-06	0.001	1E-6	0.1	0.1	1.41E-17
Pa-233	1.05E-03	included with Np-237						
Pa-234	5.61E-07	5.40E-01	1.04E-06	0.001	1E-6	0.1	0.1	1.04E-17
Pa-234m	3.74E-04	included with U-238						
U-232	7.31E-03	2.70E-02	2.71E-01	0.001	1E-6	0.1	0.1	2.71E-12
U-233	3.35E-03	1.60E-01	2.09E-02	0.001	1E-6	0.1	0.1	2.09E-13
U-234	1.60E-03	1.60E-01	1.00E-02	0.001	1E-6	0.1	0.1	1.00E-13
U-235	6.15E-05	unlimited						
U-235m	2.61E-02							
U-236	1.84E-04	1.60E-01	1.15E-03	0.001	1E-6	0.1	0.1	1.15E-14
U-237	7.37E-06	included with Pu-241						
U-238	3.74E-04	unlimited						
Np-237	1.05E-03	5.40E-02	1.95E-02	0.001	1E-6	0.1	0.1	1.95E-13
Np-239	5.97E-03	included with Am-243						
Pu-238	1.04E-01	2.70E-02	3.85E+00	0.001	1E-6	0.1	0.1	3.85E-11
Pu-239	2.61E-02	2.70E-02	9.66E-01	0.001	1E-6	0.1	0.1	9.66E-12
Pu-240	2.01E-02	2.70E-02	7.43E-01	0.001	1E-6	0.1	0.1	7.43E-12
Pu-241	2.99E-01	1.60E+00	1.87E-01	0.001	1E-6	0.1	0.1	1.87E-12
Am-241	4.95E-01	2.70E-02	1.83E+01	0.001	1E-6	0.1	0.1	1.83E-10
Am-243	5.97E-03	2.70E-02	2.21E-01	0.001	1E-6	0.1	0.1	2.21E-12
Cm-242	3.08E-10	2.70E-01	1.14E-09	0.001	1E-6	0.1	0.1	1.14E-20
Cm-243	2.16E-03	2.70E-02	8.01E-02	0.001	1E-6	0.1	0.1	8.01E-13
Cm-244	4.70E-02	5.40E-02	8.70E-01	0.001	1E-6	0.1	0.1	8.70E-12
							subtotal	6.33E-10

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Table 6. NCT-ST from Refractory Glass

Isotope	Content (Ci)	A_2 (Ci/A_2)	MAR (A_2)	DR	ARF	LPF Melter	LPF WVMP	Release (A_2)
	From Table 1		Calculated for refractory glass	Glass damage ratios and leak path factors taken from Table 2				Calculated for refractory glass
a	b	c	d=b/c	e	f	g	h	i=d*e*f*g*h
Co-60	1.33E-02	1.10E+01	1.21E-03	0.001	1E-6	0.1	0.1	1.21E-14
Sr-90	1.07E+02	8.10E+00	1.32E+01	0.001	1E-6	0.1	0.1	1.32E-10
Y-90	1.07E+02	included with Sr-90						
Tc-99	5.22E-02	2.40E+01	2.18E-03	0.001	1E-6	0.1	0.1	2.18E-14
Cs-137	2.13E+02	1.60E+01	1.33E+01	0.001	1E-6	0.1	0.1	1.33E-10
Ba-137m	2.01E+02	included with Cs-137						
Eu-154	5.53E-01	1.60E+01	3.45E-02	0.001	1E-6	0.1	0.1	3.45E-13
Hg-206	2.54E-16	5.40E-01	4.70E-16	0.001	1E-6	0.1	0.1	4.70E-27
Tl-206	1.78E-14	included with Bi-210m						
Tl-207	2.96E-09	5.40E-01	5.48E-09	0.001	1E-6	0.1	0.1	5.48E-20
Tl-208	1.81E-04	included with U-232						
Tl-209	1.43E-08	5.40E-01	2.66E-08	0.001	1E-6	0.1	0.1	2.66E-19
Tl-210	1.67E-11	5.40E-01	3.10E-11	0.001	1E-6	0.1	0.1	3.10E-22
Pb-209	6.64E-07	included with Th-229						
Pb-210	1.34E-08	1.40E+00	9.54E-09	0.001	1E-6	0.1	0.1	9.54E-20
Pb-211	2.97E-09	5.400E-1	5.50E-09	0.001	1E-6	0.1	0.1	5.50E-20
Pb-212	5.03E-04	included with U-232						
Pb-214	7.96E-08	included with Rn-222						
Bi-209	1.46E-25	included with Pb-210						
Bi-210	1.33E-08	included with Bi-212						
Bi-211	2.97E-09	included with Pb-211						
Bi-212	5.03E-04	included with U-232						
Bi-213	6.64E-07	included with Th-229						
Bi-214	7.96E-08	included with Rn-222						
Bi-215	2.43E-15	2.40E-03	1.01E-12	0.001	1E-6	0.1	0.1	1.01E-23
Po-210	1.22E-08	included with Pb-210						
Po-211	8.10E-12	2.40E-03	3.38E-09	0.001	1E-6	0.1	0.1	3.38E-20
Po-212	3.22E-04	included with U-232						
Po-213	6.50E-07	included with Th-229						
Po-214	7.96E-08	included with U-230						
Po-215	2.97E-09	Included with Ra-223						
Po-216	5.03E-04	included with U-232						
Po-218	7.96E-08	included with Rn-222						
At-215	1.19E-14	2.40E-03	4.95E-12	0.001	1E-6	0.1	0.1	4.95E-23
At-217	6.64E-07	included with Th-229						
At-218	1.51E-11	2.40E-03	6.30E-09	0.001	1E-6	0.1	0.1	6.30E-20
At-219	2.50E-15	2.40E-03	1.04E-12	0.001	1E-6	0.1	0.1	1.04E-23
Rn-217	7.97E-11	2.40E-03	3.32E-08	0.001	1E-6	0.1	0.1	3.32E-19
Rn-218	1.51E-14	included with U-230						
Rn-219	2.97E-09	2.40E-03	1.24E-06	0.001	1E-6	0.1	0.1	1.24E-17
Rn-220	5.03E-04	included with U-232						
Rn-222	7.96E-08	1.10E-01	7.24E-07	0.001	1E-6	0.1	0.1	7.24E-18

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Table 6. NCT-ST from Refractory Glass (continuation)

Isotope	Content (Ci)	A_2 (Ci/A_2)	MAR (A_2)	DR	ARF	LPF Melter	LPF WVMP	Release (A_2)
	From Table 1	From Table 1	Calculated for refractory glass	Glass damage ratios and leak path factors taken from Table 2				Calculated for refractory glass
a	b	c	d=b/c	e	f	g	h	i=d*e*f*g*h
Fr-221	6.64E-07	included with Th-229						
Fr-223	4.17E-11	5.40E-01	7.73E-11	0.001	1E-6	0.1	0.1	7.73E-22
Ra-223	2.97E-09	1.90E-01	1.56E-08	0.001	1E-6	0.1	0.1	1.56E-19
Ra-224	5.03E-04	included with U-232						
Ra-225	6.66E-07	included with Th-229						
Ra-226	7.97E-08	8.10E-02	9.84E-07	0.001	1E-6	0.1	0.1	9.84E-18
Ra-228	3.21E-05	5.40E-01	5.95E-05	0.001	1E-6	0.1	0.1	5.95E-16
Ac-225	6.64E-07	included with Th-229						
Ac-227	3.02E-09	2.40E-03	1.26E-06	0.001	1E-6	0.1	0.1	1.26E-16
Ac-228	3.21E-05	included with Ra-228						
Th-227	2.95E-09	1.40E-01	2.11E-08	0.001	1E-6	0.1	0.1	2.11E-18
Th-228	5.02E-04	included with U-232						
Th-229	6.70E-07	1.40E-02	4.79E-05	0.001	1E-6	0.1	0.1	4.79E-15
Th-230	1.52E-05	2.70E-02	5.63E-04	0.001	1E-6	0.1	0.1	5.63E-14
Th-231	6.92E-05	included with U-235						
Th-232	4.18E-05	unlimited						
Th-234	1.16E-04	included with U-238						
Pa-231	1.78E-08	1.10E-02	1.62E-06	0.001	1E-6	0.1	0.1	1.62E-16
Pa-233	8.49E-04	included with Np-237						
Pa-234	1.74E-07	5.40E-01	3.22E-07	0.001	1E-6	0.1	0.1	3.22E-17
Pa-234m	1.16E-04	included with U-238						
U-232	4.41E-04	2.70E-02	1.63E-02	0.001	1E-6	0.1	0.1	1.63E-12
U-233	5.85E-04	1.60E-01	3.66E-03	0.001	1E-6	0.1	0.1	3.66E-13
U-234	2.84E-04	1.60E-01	1.78E-03	0.001	1E-6	0.1	0.1	1.78E-13
U-235	6.92E-05	unlimited						
U-235m	3.72E-02	unlimited						
U-236	2.08E-04	1.60E-01	1.30E-03	0.001	1E-6	0.1	0.1	1.30E-13
U-237	5.08E-06	Included with Pu-241						
U-238	1.16E-04	unlimited						
Np-237	8.49E-04	5.40E-02	1.57E-02	0.001	1E-6	0.1	0.1	1.57E-13
Np-239	6.72E-03	included with Am-243						
Pu-238	1.41E-01	2.70E-02	5.22E+00	0.001	1E-6	0.1	0.1	5.22E-11
Pu-239	3.72E-02	2.70E-02	1.38E+00	0.001	1E-6	0.1	0.1	1.38E-11
Pu-240	2.85E-02	2.70E-02	1.06E+00	0.001	1E-6	0.1	0.1	1.06E-11
Pu-241	2.06E-01	1.60E+00	1.29E-01	0.001	1E-6	0.1	0.1	1.29E-12
Am-241	8.45E-01	2.70E-02	3.13E+01	0.001	1E-6	0.1	0.1	3.13E-10
Am-243	6.72E-03	2.70E-02	2.49E-01	0.001	1E-6	0.1	0.1	2.49E-12
Cm-242	4.49E-11	2.70E-01	1.66E-10	0.001	1E-6	0.1	0.1	1.66E-21
Cm-243	3.04E-03	2.70E-02	1.13E-01	0.001	1E-6	0.1	0.1	1.13E-12
Cm-244	6.77E-02	5.40E-02	1.25E+00	0.001	1E-6	0.1	0.1	1.25E-11
							subtotal	6.73E-10

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Table 7. NCT-ST from LDCC Internal to Melter

Isotope	Content (Ci)	Leach Ratio	Leached (Ci)	A_2 (Ci/A_2)	MAR (A_2)	DR	ARF	LPF melter	LPF wvmp	Release (A_2)
	From Table 1	Leach Ratio for glass from Table 2	Calculated for LDCC internal to the melter	From Table 1	Calculated for internal LDCC	From Table 2 For internal LDCC				Calculated for internal LDCC
a	b	c	d=b*c	e	f=d/e	g	h	i	j	k=f*g*h*i*j
C-14	3.47E-3	1.6E-3	5.56E-06	8.10E+01	6.87E-08	0.002	1E-5	0.1	0.1	1.37E-16
K-40	1.50E-2	1.6E-3	2.41E-05	2.40E+01	1.00E-06	0.002	1E-5	0.1	0.1	2.00E-15
Mn-54	1.44E-6	1.6E-3	2.31E-09	2.70E+01	8.55E-11	0.002	1E-5	0.1	0.1	1.71E-19
Co-60	3.16E-3	1.6E-3	5.07E-06	1.10E+01	4.61E-07	0.002	1E-5	0.1	0.1	9.21E-16
Ni-63	1.52E-1	1.6E-3	2.44E-04	8.10E+02	3.01E-07	0.002	1E-5	0.1	0.1	6.02E-16
Sr-90	3.12E+1	1.6E-3	5.00E-02	8.10E+00	6.18E-03	0.002	1E-5	0.1	0.1	1.24E-11
Y-90	3.12E+1	included with Sr-90								
Zr-95	1.30E-0	1.6E-3	2.08E-23	2.10E+01	9.48E-25	0.002	1E-5	0.1	0.1	1.90E-33
Nb-95	2.86E-20	1.6E-3	4.59E-23	2.20E+01	1.70E-24	0.002	1E-5	0.1	0.1	3.40E-33
Nb95m	1.49E-22	included with Zr-95								
Tc-99	2.01E-03	1.6E-3	3.22E-06	2.40E+01	1.34E-07	0.002	1E-5	0.1	0.1	2.69E-16
Cs-137	5.42E+2	1.6E-3	8.69E-01	1.60E+01	5.43E-02	0.002	1E-5	0.1	0.1	1.09E-10
Ba-137m	5.12E+2	included with Cs-137								
Eu-154	8.12E-02	1.6E-3	1.30E-04	1.60E+01	8.14E-06	0.002	1E-5	0.1	0.1	1.63E-14
Hg-206	9.79E-16	1.6E-3	1.57E-18	5.40E-01	2.91E-18	0.002	1E-5	0.1	0.1	5.81E-27
Tl-206	6.88E-14	included with Bi-210m								
Tl-207	2.56E-09	1.6E-3	4.11E-12	5.40E-01	7.60E-12	0.002	1E-5	0.1	0.1	1.52E-20
Tl-208	2.72E-03	included with U-238								
Tl-209	8.09E-08	included with Th-229								
Tl-210	6.54E-11	1.6E-3	1.05E-13	5.40E-01	1.94E-13	0.002	1E-5	0.1	0.1	3.88E-22
Pb-210m	3.75E-06	Included with Th-229								
Pb-210	5.16E-08	1.6E-3	8.27E-11	1.40E+00	5.91E-11	0.002	1E-5	0.1	0.1	1.18E-19
Pb-211	2.57E-09	1.6E-3	4.12E-12	5.40E-01	7.63E-12	0.002	1E-5	0.1	0.1	1.53E-20
Pb-212	7.56E-03	included with U-232								
Pb-214	3.11E-07	included with Rn-222								
Bi-209	8.10E-25	included with Pb-210								
Bi-210	5.14E-08	included with Bi-212								
Bi-211	2.57E-09	included with Ra-223								
Bi-212	7.56E-03	included with U-232								
Bi-213	3.75E-06	included with Th-229								
Bi-214	3.11E-07	included with Rn-222								
Bi-215	2.10E-15	1.6E-3	3.37E-18	5.40E-01	6.24E-18	0.002	1E-5	0.1	0.1	1.25E-26
Po-210	4.71E-08	included with Pb-210								
Po-211	7.01E-12	1.6E-3	1.12E-14	2.40E-03	4.68E-12	0.002	1E-5	0.1	0.1	9.37E-21

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Calculation Continuation Sheet

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Table 7. NCT-ST from LDCC Internal to Melter (continuation)

Isotope	Content (Ci)	Leached ratio	Leached (Ci)	A_2 (Ci/A_2)	MAR (A_2)	DR	ARF	LPF melter	LPF wvmp	Release (A2)
	From Table 1	Leach Ratio for glass from Table 2	Calculated for LDCC internal to the melter	From Table 2	Calculated for internal LDCC	From Table 2. LDCC internal to melter				Calculated for internal LDCC
a	b	c	d=b*c	e	f=d/e	g	h	i	j	k=f*g*h*i*j
Po-212	4.84E-3	included Pb-212								
Po-213	3.67E-6	included with Th-229								
Po-214	3.11E-7	included with U-230								
Po-215	2.57E-9	included with Ra-223								
Po-216	7.56E-3	included with U-232								
Po-218	3.11E-7	included with Rn-222								
At-215	1.03E-14	1.6E-3	1.65E-17	2.40E-03	6.88E-15	0.002	1E-5	0.1	0.1	1.38E-23
At-217	3.75E-06	included with Th-229								
At-218	5.92E-11	1.6E-3	9.49E-14	2.40E-03	3.96E-11	0.002	1E-5	0.1	0.1	7.91E-20
At-219	2.17E-15	1.6E-3	3.48E-18	2.40E-03	1.45E-15	0.002	1E-5	0.1	0.1	2.90E-24
Rn-217	4.50E-10	1.6E-3	7.22E-13	2.40E-03	3.01E-10	0.002	1E-5	0.1	0.1	6.01E-19
Rn-218	5.92E-14	included with U-230								
Rn-219	2.57E-09	1.6E-3	4.12E-12	2.40E-03	1.72E-09	0.002	1E-5	0.1	0.1	3.43E-18
Rn-220	7.56E-03	included with U-232								
Rn-222	3.11E-07	1.6E-3	4.99E-10	1.10E-01	4.53E-09	0.002	1E-5	0.1	0.1	9.07E-18
Fr-221	3.75E-06	included with Th-229								
Fr-223	3.61E-11	1.6E-3	5.79E-14	5.40E-01	1.07E-13	0.002	1E-5	0.1	0.1	2.14E-22
Ra-223	2.57E-09	1.6E-3	5.79E-14	1.90E-01	3.05E-13	0.002	1E-5	0.1	0.1	6.09E-22
Ra-224	7.56E-03	included with U-232								
Ra-225	3.76E-06	included with Th-229								
Ra-226	3.12E-07	1.6E-3	5.00E-10	8.10E-02	6.17E-09	0.002	1E-5	0.1	0.1	1.23E-17
Ra-228	5.14E-05	1.6E-3	8.25E-08	5.40E-01	1.53E-07	0.002	1E-5	0.1	0.1	3.06E-16
Ac-225	3.75E-06	included with Th-229								
Ac-227	2.61E-09	1.6E-3	4.19E-12	2.40E-03	1.75E-09	0.002	1E-5	0.1	0.1	3.49E-18
Ac-228	5.14E-05	included with Ra-228								
Th-227	2.55E-09	1.6E-3	4.09E-12	1.40E-01	2.92E-11	0.002	1E-5	0.1	0.1	5.84E-20
Th-228	7.56E-03	included with U-232								
Th-229	3.78E-06	1.6E-3	6.06E-09	1.40E-02	4.33E-07	0.002	1E-5	0.1	0.1	8.65E-16
Th-230	6.05E-05	1.6E-3	9.70E-08	2.70E-02	3.59E-06	0.002	1E-5	0.1	0.1	7.18E-15
Th-231	6.15E-05	included with U-235								
Th-232	6.74E-05	unlimited								
Th-234	3.74E-04	included with U-238								

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Calculation Continuation Sheet

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Table 7. NCT-ST from LDCC Internal to Melter (continuation)

Isotope	Content (Ci)	Leach Ratio	Leached (Ci)	A2 (Ci/A_2)	MAR (A_2)	DR	ARF	LPF melter	LPF WVMP	Release (A_2)
	From Table 1	Leach Ratio for glass from Table 2	Calculated for LDCC internal to the melter	From Table 1	Calculated for LDCC internal to the melter	From Table 2. LDCC internal to melter				Calculated for inhalation from LDCC internal to the melter
a	b	c	d=b*c	e	f=d/e	g	h	i	j	k=f*g*h*i*j
Pa-231	1.55E-08	1.6E-3	2.49E-11	1.10E-02	2.27E-09	0.002	1E-5	0.1	0.1	4.53E-18
Pa-233	1.05E-03	included with Np-237								
Pa-234	5.61E-07	1.6E-3	9.00E-10	5.40E-01	1.67E-09	0.002	1E-5	0.1	0.1	3.33E-18
Pa-234m	3.74E-04	Including U-238								
U-232	7.31E-03	1.6E-3	1.17E-05	2.70E-02	4.34E-04	0.002	1E-5	0.1	0.1	8.68E-13
U-233	3.35E-03	1.6E-3	5.37E-06	1.60E-01	3.36E-05	0.002	1E-5	0.1	0.1	6.71E-14
U-234	1.60E-03	1.6E-3	2.57E-06	1.60E-01	1.61E-05	0.002	1E-5	0.1	0.1	3.22E-14
U-235	6.15E-05	unlimited								
U-235m	2.61E-02	unlimited								
U-236	1.84E-04	1.6E-3	2.95E-07	1.60E-01	1.84E-06	0.002	1E-5	0.1	0.1	3.69E-15
U-237	7.37E-06	included with Pu-241								
U-238	3.74E-04	unlimited								
Np-237	1.05E-03	1.6E-3	1.69E-06	5.40E-02	3.12E-05	0.002	1E-5	0.1	0.1	6.25E-14
Np-239	5.97E-03	included with Am-243								
Pu-238	1.04E-01	1.6E-3	1.67E-04	2.70E-02	6.17E-03	0.002	1E-5	0.1	0.1	1.23E-11
Pu-239	2.61E-02	1.6E-3	4.18E-05	2.70E-02	1.55E-03	0.002	1E-5	0.1	0.1	3.10E-12
Pu-240	2.01E-02	1.6E-3	3.22E-05	2.70E-02	1.19E-03	0.002	1E-5	0.1	0.1	2.38E-12
Pu-241	2.99E-01	1.6E-3	4.79E-04	1.60E+00	3.00E-04	0.002	1E-5	0.1	0.1	5.99E-13
Am-241	4.95E-01	1.6E-3	7.94E-04	2.70E-02	2.94E-02	0.002	1E-5	0.1	0.1	5.88E-11
Am-243	5.97E-03	1.6E-3	9.58E-06	2.70E-02	3.55E-04	0.002	1E-5	0.1	0.1	7.09E-13
Cm-242	3.08E-10	1.6E-3	4.95E-13	2.70E-01	1.83E-12	0.002	1E-5	0.1	0.1	3.66E-21
Cm-243	2.16E-03	1.6E-3	3.47E-06	2.70E-02	1.28E-04	0.002	1E-5	0.1	0.1	2.57E-13
Cm-244	4.70E-02	1.6E-3	7.53E-05	5.40E-02	1.39E-03	0.002	1E-5	0.1	0.1	2.79E-12
									subtotal	1.08E-8

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Table 8. NCT-ST from Increased Pressure (i.e., < 25 Psig) on LDCC Internal to Melter

Isotope	Content (Ci)	Leach Ratio	Leached (Ci)	A_2 (Ci/A_2)	MAR (A_2)	DR	ARF	RF	LPF melter	LPF wvmp	Release (A_2)
	From Table 1	Leach Ratio for glass from Table 2	Calculated for LDCC internal to the melter	From Table 1	Calculated for LDCC internal to the melter	From Table 2. LDCC internal to melter with pressure increase					Calculated for inhalation from LDCC internal to the melter
a	b	c	d=b*c	e	f=d/e	g	h	i	j	k	l=f*g*h*i*j*k
C-14	3.47E-03	1.6E-3	5.56E-06	8.10E+01	6.87E-08	0.002	5E-3	0.4	0.1	0.1	2.75E-15
K-40	1.50E-02	1.6E-3	2.41E-05	2.40E+01	1.00E-06	0.002	5E-3	0.4	0.1	0.1	4.01E-14
Mn-54	1.44E-06	1.6E-3	2.31E-09	2.70E+01	8.55E-11	0.002	5E-3	0.4	0.1	0.1	3.42E-18
Co-60	3.16E-03	1.6E-3	5.07E-06	1.10E+01	4.61E-07	0.002	5E-3	0.4	0.1	0.1	1.84E-14
Ni-63	1.52E-01	1.6E-3	2.44E-04	8.10E+02	3.01E-07	0.002	5E-3	0.4	0.1	0.1	1.20E-14
Sr-90	3.12E+01	1.6E-3	5.00E-02	8.10E+00	6.18E-03	0.002	5E-3	0.4	0.1	0.1	2.47E-10
Y-90	3.12E+01	included with Sr-90									
Zr-95	1.30E-20	1.6E-3	2.08E-23	2.20E+01	9.48E-25	0.002	5E-3	0.4	0.1	0.1	3.79E-32
Nb-95	2.86E-20	1.6E-3	4.59E-23	2.70E+01	1.70E-24	0.002	5E-3	0.4	0.1	0.1	6.79E-32
Nb95m	1.49E-22	included with Zr-95									
Tc-99	2.01E-03	1.6E-3	3.22E-06	2.40E+01	1.34E-07	0.002	5E-3	0.4	0.1	0.1	5.37E-15
Cs-137	5.42E+02	1.6E-3	8.69E-01	1.60E+01	5.43E-02	0.002	5E-3	0.4	0.1	0.1	2.17E-09
Ba-137m	5.12E+2	included with Cs-137									
Eu-154	8.12E-02	1.6E-3	1.30E-04	1.60E+01	8.14E-06	0.002	5E-3	0.4	0.1	0.1	3.26E-13
Hg-206	9.79E-16	1.6E-3	1.57E-18	5.40E-01	2.91E-18	0.002	5E-3	0.4	0.1	0.1	1.16E-25
Tl-206	6.88E-14	included with Bi-210m									
Tl-207	2.56E-09	1.6E-3	4.11E-12	5.40E-01	7.60E-12	0.002	5E-3	0.4	0.1	0.1	3.04E-19
Tl-208	2.72E-03	included with U-238									
Tl-209	8.09E-08	included with Th-229									
Tl-210	6.54E-11	1.6E-3	1.05E-13	5.40E-01	1.94E-13	0.002	5E-3	0.4	0.1	0.1	7.77E-21
Pb-210m	3.75E-06	Included with Th-229									
Pb-210	5.16E-08	1.6E-3	8.27E-11	1.40E+00	5.91E-11	0.002	5E-3	0.4	0.1	0.1	2.36E-18
Pb-211	2.57E-09	1.6E-3	4.12E-12	5.40E-01	7.63E-12	0.002	5E-3	0.4	0.1	0.1	3.05E-19
Pb-212	7.56E-03	included with U-232									
Pb-214	3.11E-07	included with Rn-222									
Bi-209	8.10E-25	included with Pb-210									
Bi-210	5.14E-08	included with Bi-212									
Bi-211	2.57E-09	included with Ra-223									
Bi-212	7.56E-03	included with U-232									
Bi-213	3.75E-06	included with Th-229									
Bi-214	3.11E-07	included with Rn-222									
Bi-215	2.10E-15	1.6E-3	3.37E-18	5.40E-01	6.24E-18	0.002	5E-3	0.4	0.1	0.1	2.49E-25
Po-210	4.71E-08	included with Pb-210									
Po-211	7.01E-12	1.6E-3	1.12E-14	2.40E-03	4.68E-12	0.002	5E-3	0.4	0.1	0.1	1.87E-19

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Table 8. NCT-ST from Increased Pressure (i.e., < 25 Psig) on LDCC Internal to Melter (continuation)

Isotope	Content (Ci)	Leached ratio	Leached (Ci)	A_2 (Ci/A_2)	MAR (A_2)	DR	ARF	RF	LPF melter	LPF wvmp	Release (A_2)
	From Table 1	Leach Ratio for glass from Table 2	Calculated for LDCC internal to the melter	From Table 2	Calculated for internal LDCC	From Table 2. LDCC internal to melter with pressure increase					Calculated for internal LDCC
a	b	c	d=b*c	e	f=d/e	g	h	i	j	k	l=f*g*h*i*j*k
Po-212	4.84E-3	included Pb-212									
Po-213	3.67E-6	included with Th-229									
Po-214	3.11E-7	included with U-230									
Po-215	2.57E-9	included with Ra-223									
Po-216	7.56E-3	included with U-232									
Po-218	3.11E-7	included with Rn-222									
At-215	1.03E-14	1.6E-3	1.65E-17	2.40E-03	6.88E-15	0.002	5E-3	0.4	0.1	0.1	2.75E-22
At-217	3.75E-06	included with Th-229									
At-218	5.92E-11	1.6E-3	9.49E-14	2.40E-03	3.96E-11	0.002	5E-3	0.4	0.1	0.1	1.58E-18
At-219	2.17E-15	1.6E-3	3.48E-18	2.40E-03	1.45E-15	0.002	5E-3	0.4	0.1	0.1	5.80E-23
Rn-217	4.50E-10	1.6E-3	7.22E-13	2.40E-03	3.01E-10	0.002	5E-3	0.4	0.1	0.1	1.20E-17
Rn-218	5.92E-14	included with U-230									
Rn-219	2.57E-09	1.6E-3	4.12E-12	2.40E-03	1.72E-09	0.002	5E-3	0.4	0.1	0.1	6.87E-17
Rn-220	7.56E-03	included with U-232									
Rn-222	3.11E-07	1.6E-3	4.99E-10	1.10E-01	4.53E-09	0.002	5E-3	0.4	0.1	0.1	1.81E-16
Fr-221	3.75E-06	included with Th-229									
Fr-223	3.61E-11	1.6E-3	5.79E-14	5.40E-01	1.07E-13	0.002	5E-3	0.4	0.1	0.1	4.29E-21
Ra-223	3.61E-11	1.6E-3	5.79E-14	1.90E-01	3.05E-13	0.002	5E-3	0.4	0.1	0.1	1.22E-20
Ra-224	7.56E-03	included with U-232									
Ra-225	3.76E-06	included with Th-229									
Ra-226	3.12E-07	1.6E-3	5.00E-10	8.10E-02	6.17E-09	0.002	5E-3	0.4	0.1	0.1	2.47E-16
Ra-228	5.14E-05	1.6E-3	8.25E-08	5.40E-01	1.53E-07	0.002	5E-3	0.4	0.1	0.1	6.11E-15
Ac-225	3.75E-06	included with Th-229									
Ac-227	2.61E-09	1.6E-3	4.19E-12	2.40E-03	1.75E-09	0.002	5E-3	0.4	0.1	0.1	6.99E-17
Ac-228	5.14E-05	included with Ra-228									
Th-227	2.55E-09	1.6E-3	4.09E-12	1.40E-01	2.92E-11	0.002	5E-3	0.4	0.1	0.1	1.17E-18
Th-228	7.56E-03	included with U-232									
Th-229	3.78E-06	1.6E-3	6.06E-09	1.40E-02	4.33E-07	0.002	5E-3	0.4	0.1	0.1	1.73E-14
Th-230	6.05E-05	1.6E-3	9.70E-08	2.70E-02	3.59E-06	0.002	5E-3	0.4	0.1	0.1	1.44E-13
Th-231	6.15E-05	included with U-235									
Th-232	6.74E-05	unlimited									
Th-234	3.74E-04	included with U-238									

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Table 8. NCT-ST from Increased Pressure (i.e., < 25 Psig) on LDCC Internal to Melter (continuation)

Isotope	Content (Ci)	Leach Ratio	Leached (Ci)	A_2 (Ci/A_2)	MAR (A_2)	DR	ARF	RF	LPF melter	LPF WVMP	Release (A_2)
	From Table 1	Leach Ratio for glass from Table 2	Calculated for LDCC internal to the melter	From Table 1	Calculated for LDCC internal to the melter	From Table 2. LDCC internal to melter					Calculated for inhalation from LDCC internal to the melter
a	b	c	d=b*c	e	f=d/e	g	h	i	j	k	l=f*g*h*i*j*k
Pa-231	1.55E-08	1.6E-3	2.49E-11	1.10E-02	2.27E-09	0.002	5E-3	0.4	0.1	0.1	9.06E-17
Pa-233	1.05E-03	included with Np-237									
Pa-234	5.61E-07	1.6E-3	9.00E-10	5.40E-01	1.67E-09	0.002	5E-3	0.4	0.1	0.1	6.66E-17
Pa-234m	3.74E-04	Including U-238									
U-232	7.31E-03	1.6E-3	1.17E-05	2.70E-02	4.34E-04	0.002	5E-3	0.4	0.1	0.1	1.74E-11
U-233	3.35E-03	1.6E-3	5.37E-06	1.60E-01	3.36E-05	0.002	5E-3	0.4	0.1	0.1	1.34E-12
U-234	1.60E-03	1.6E-3	2.57E-06	1.60E-01	1.61E-05	0.002	5E-3	0.4	0.1	0.1	6.43E-13
U-235	6.15E-05	unlimited									
U-235m	2.61E-02	unlimited									
U-236	1.84E-04	1.6E-3	2.95E-07	1.60E-01	1.84E-06	0.002	5E-3	0.4	0.1	0.1	7.38E-14
U-237	7.37E-06	included with Pu-241									
U-238	3.74E-04	unlimited									
Np-237	1.05E-03	1.6E-3	1.69E-06	5.40E-02	3.12E-05	0.002	5E-3	0.4	0.1	0.1	1.25E-12
Np-239	5.97E-03	included with Am-243									
Pu-238	1.04E-01	1.6E-3	1.67E-04	2.70E-02	6.17E-03	0.002	5E-3	0.4	0.1	0.1	2.47E-10
Pu-239	2.61E-02	1.6E-3	4.18E-05	2.70E-02	1.55E-03	0.002	5E-3	0.4	0.1	0.1	6.20E-11
Pu-240	2.01E-02	1.6E-3	3.22E-05	2.70E-02	1.19E-03	0.002	5E-3	0.4	0.1	0.1	4.76E-11
Pu-241	2.99E-01	1.6E-3	4.79E-04	1.60E+00	3.00E-04	0.002	5E-3	0.4	0.1	0.1	1.20E-11
Am-241	4.95E-01	1.6E-3	7.94E-04	2.70E-02	2.94E-02	0.002	5E-3	0.4	0.1	0.1	1.18E-09
Am-243	5.97E-03	1.6E-3	9.58E-06	2.70E-02	3.55E-04	0.002	5E-3	0.4	0.1	0.1	1.42E-11
Cm-242	3.08E-10	1.6E-3	4.95E-13	2.70E-01	1.83E-12	0.002	5E-3	0.4	0.1	0.1	7.33E-20
Cm-243	2.16E-03	1.6E-3	3.47E-06	2.70E-02	1.28E-04	0.002	5E-3	0.4	0.1	0.1	5.14E-12
Cm-244	4.70E-02	1.6E-3	7.53E-05	5.40E-02	1.39E-03	0.002	5E-3	0.4	0.1	0.1	5.58E-11
										subtotal	4.06E-09

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Table 9. NCT-ST from LDCC External to Melter

Isotope	Content (Ci)	Leach Ratio	Leached (Ci)	A_2 (Ci/A_2)	MAR (A_2)	DR	ARF	LPF $_{WVMP}$	Release (A_2)
	Input from Table 1	From Table 2 for Bartlett's PBS	Calculated for LDCC external to melter	Input from Table 1	Calculated for LDCC external to melter	From Table 2. For LDCC external to melter. Note LPF WVMP already credited as part of ARF number			Calculated for inhalation from LDCC external to the melter
a	b	c	d	e	f=d/e	g	h	i	j=f*g*h*i
Cs-137	6.43E+00	1E-2	6.43E-02	1.60E+01	4.02E-03	0.01	1E-5	0.1	4.02E-11
Ba-137m	6.07E+00	1E-2	6.07E-02	included with Cs-137					
Sr-90	2.84E+00	1E-2	2.84E-02	8.10E+00	3.51E-03	0.01	1E-5	0.1	3.51E-11
Y-90	2.84E+00	1E-2	2.84E-02	included with Sr-90					
Pm-147	6.88E-02	1E-2	6.88E-04	5.40E+01	1.27E-05	0.01	1E-5	0.1	1.27E-13
Am-241	3.43E-02	1E-2	3.43E-04	2.70E-02	1.27E-02	0.01	1E-5	0.1	1.27E-10
Eu-154	2.94E-02	1E-2	2.94E-04	1.60E+01	1.84E-05	0.01	1E-5	0.1	1.84E-13
Ni-63	1.55E-02	1E-2	1.55E-04	8.10E+02	1.91E-07	0.01	1E-5	0.1	1.91E-15
Fe-55	1.58E-02	1E-2	1.58E-04	1.10E+03	1.43E-07	0.01	1E-5	0.1	1.43E-15
Pu-238	3.79E-03	1E-2	3.79E-05	2.70E-02	1.40E-03	0.01	1E-5	0.1	1.40E-11
C-14	3.78E-03	1E-2	3.78E-05	8.10E+01	4.67E-07	0.01	1E-5	0.1	4.67E-15
Co-60	1.31E-03	1E-2	1.31E-05	1.10E+01	1.19E-06	0.01	1E-5	0.1	1.19E-14
U-232	1.03E-03	1E-2	1.03E-05	2.70E-02	3.80E-04	0.01	1E-5	0.1	3.80E-12
Pu-239	9.84E-04	1E-2	9.84E-06	2.70E-02	3.64E-04	0.01	1E-5	0.1	3.64E-12
Pu-240	6.82E-04	1E-2	6.82E-06	2.70E-02	2.52E-04	0.01	1E-5	0.1	2.52E-12
Ni-59	5.07E-04	1E-2	5.07E-06	unlimited					
I-129	3.85E-04	1E-2	3.85E-06	unlimited					
U-233	2.35E-05	1E-2	2.35E-07	1.60E-01	1.47E-06	0.01	1E-5	0.1	1.47E-14
Tc-99	1.04E-03	1E-2	1.04E-05	2.40E+01	4.34E-07	0.01	1E-5	0.1	4.34E-15
H-3	1.92E-05	1E-2	1.92E-07	1.10E+03	1.75E-10	0.01	1E-5	0.1	1.75E-18
U-234	8.30E-06	1E-2	8.30E-08	1.60E-01	5.18E-07	0.01	1E-5	0.1	5.18E-15
U-238	6.10E-06	1E-2	6.10E-08	unlimited					
U-236	4.15E-06	1E-2	1.60E-01	1.60E-01	2.60E-07	0.01	1E-5	0.1	2.60E-15
U-235	1.38E-06	1E-2	1.38E-08	unlimited					
Cm-242	1.37E-04	1E-2	2.70E-01	2.70E-01	5.07E-06	0.01	1E-5	0.1	5.07E-14
Am-243	1.34E-04	1E-2	2.70E-02	2.70E-02	4.98E-05	0.01	1E-5	0.1	4.98E-13
Cm-243	8.04E-05	1E-2	2.70E-02	2.70E-02	2.98E-05	0.01	1E-5	0.1	2.98E-13
Th-228	4.56E-05	1E-2	4.56E-07	included with U-232					
Np-237	1.69E-05	1E-2	1.69E-07	5.40E-02	3.13E-06	0.01	1E-5	0.1	3.13E-14
U-232	1.03E-03	1E-2	1.03E-05	2.70E-02	3.80E-04	0.01	1E-5	0.1	3.80E-12
Th-232	8.35E-07	1E-2	8.35E-09	unlimited					
Th-230	3.04E-07	1E-2	3.04E-09	2.70E-02	1.13E-07	0.01	1E-5	0.1	1.13E-15
Pu-241	7.42E-03	1E-2	7.42E-05	1.60E+00	4.64E-05	0.01	1E-5	0.1	4.64E-13
Cm-244	2.15E-03	1E-2	2.15E-05	5.40E-02	3.98E-04	0.01	1E-5	0.1	3.98E-12

subtotal **2.36E-10**

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Table 10. NCT-ST from Increased Pressure (i.e., < 25 Psig) on LDCC External to Melter

Isotope	Content (Ci)	Leach Ratio	Leached (Ci)	A_2 (Ci/A_2)	MAR (A_2)	DR	ARF	RF	LPF WVMP	Release (A_2)
	From Table 1	From Table 2 for Bartlett's PBS	Calculated for LDCC external to melter	From Table 1	Calculated for LDCC external to melter	From Table 2. For LDCC external to melter. Note LPF WVMP already credited as part of ARF number				Calculated for inhalation from LDCC external to the melter
a	b	c	d=b*c	e	f=d*e	g	h	i	j	k=f*g*h*i*j
Cs-137	6.43E+00	1E-2	6.43E-02	1.60E+01	4.02E-03	0.01	5E-3	4E-1	0.1	8.04E-09
Ba-137m	6.07E+00	1E-2	6.07E-02	included with Cs-137						
Sr-90	2.84E+00	1E-2	2.84E-02	8.10E+00	3.51E-03	0.01	5E-3	4E-1	0.1	7.02E-09
Y-90	2.84E+00	1E-2	2.84E-02	included with Sr-90						
Pm-147	6.88E-02	1E-2	6.88E-04	5.40E+01	1.27E-05	0.01	5E-3	4E-1	0.1	2.55E-11
Am-241	3.43E-02	1E-2	3.43E-04	2.70E-02	1.27E-02	0.01	5E-3	4E-1	0.1	2.54E-08
Eu-154	2.94E-02	1E-2	2.94E-04	1.60E+01	1.84E-05	0.01	5E-3	4E-1	0.1	3.67E-11
Ni-63	1.55E-02	1E-2	1.55E-04	8.10E+02	1.91E-07	0.01	5E-3	4E-1	0.1	3.83E-13
Fe-55	1.58E-02	1E-2	1.58E-04	1.10E+03	1.43E-07	0.01	5E-3	4E-1	0.1	2.86E-13
Pu-238	3.79E-03	1E-2	3.79E-05	2.70E-02	1.40E-03	0.01	5E-3	4E-1	0.1	2.81E-09
C-14	3.78E-03	1E-2	3.78E-05	8.10E+01	4.67E-07	0.01	5E-3	4E-1	0.1	9.34E-13
Co-60	1.31E-03	1E-2	1.31E-05	1.10E+01	1.19E-06	0.01	5E-3	4E-1	0.1	2.39E-12
U-232	1.02E-03	1E-2	1.03E-05	2.70E-02	3.80E-04	0.01	5E-3	4E-1	0.1	7.60E-10
Pu-239	9.84E-04	1E-2	9.84E-06	2.70E-02	3.64E-04	0.01	5E-3	4E-1	0.1	7.29E-10
Pu-240	6.82E-04	1E-2	6.82E-06	2.70E-02	2.52E-04	0.01	5E-3	4E-1	0.1	5.05E-10
Ni-59	5.07E-04	1E-2	5.07E-06	unlimited						
I-129	3.85E-04	1E-2	3.85E-06	unlimited						
U-233	2.35E-05	1E-2	2.35E-07	2.70E-02	8.72E-06	0.01	5E-3	4E-1	0.1	1.74E-11
Tc-99	1.04E-03	1E-2	1.04E-05	2.40E+01	4.34E-07	0.01	5E-3	4E-1	0.1	8.68E-13
H-3	1.92E-05	1E-2	1.92E-07	1.10E+03	1.75E-10	0.01	5E-3	4E-1	0.1	3.50E-16
U-234	8.30E-06	1E-2	8.30E-08	1.60E-01	5.18E-07	0.01	5E-3	4E-1	0.1	1.04E-12
U-238	6.10E-06	1E-2	6.10E-08	unlimited						
U-236	4.15E-06	1E-2	4.15E-08	1.60E-01	2.60E-07	0.01	5E-3	4E-1	0.1	5.19E-13
U-235	1.38E-06	1E-2	1.38E-08	unlimited						
Cm-242	1.37E-04	1E-2	1.37E-06	2.70E-01	5.07E-06	0.01	5E-3	4E-1	0.1	1.01E-11
Am-243	1.34E-04	1E-2	1.34E-06	2.70E-02	4.98E-05	0.01	5E-3	4E-1	0.1	9.96E-11
Cm-243	8.04E-05	1E-2	8.04E-07	2.70E-02	2.98E-05	0.01	5E-3	4E-1	0.1	5.95E-11
Th-228	4.56E-05	1E-2	4.56E-07	included with U-232						
Np-237	1.69E-05	1E-2	1.69E-07	5.40E-02	3.13E-06	0.01	5E-3	4E-1	0.1	6.27E-12
U-232	9.94E-06	1E-2	1.03E-05	2.70E-02	3.80E-04	0.01	5E-3	4E-1	0.1	7.60E-10
Th-232	8.35E-07	1E-2	8.35E-09	unlimited						
Th-230	3.04E-07	1E-2	3.04E-09	2.70E-02	1.13E-07	0.01	5E-3	4E-1	0.1	2.25E-13
Pu-241	7.42E-03	1E-2	7.42E-05	1.60E+00	4.64E-05	0.01	5E-3	4E-1	0.1	9.28E-11
Cm-244	2.15E-03	1E-2	2.15E-05	5.40E-02	3.98E-04	0.01	5E-3	4E-1	0.1	7.96E-10

Subtotal **4.72E-8**

Table 11. Total NCT Release in Terms of A_2

from Glass		
	Spout Glass	8.30E-10
	Melter Heel Glass	6.33E-10
	Refractory Glass	6.73E-10
from LDCC		
	LDCC inside the Melter	2.03E-10
	Increased Pressure	4.06E-09
	LDCC outside the Melter	2.36E-10
	Increased Pressure	4.72E-08
	TOTAL	5.38E-08

Based on Table 11, the NCT release is less than 1E-7 A_2.

6.2. Methods and Calculations for Hypothetical Accident Conditions

Using the modified five factors formula shown in Section 2 for ST and using the input and assumptions from Section 5, the corresponding source terms are calculated:

- Table 12 calculates HAC-ST from spout glass
- Table 13 calculates HAC-ST from heel glass
- Table 14 calculates HAC-ST from refractory glass
- Table 15 calculates HAC-ST from LDCC internal to melter
- Table 16 calculates HAC-ST from pressure increase (i.e., > 25 Psig) on LDCC internal to melter
- Table 17 calculates HAC-ST from LDCC external to melter
- Table 18 calculates HAC-ST from pressure increase (i.e., > 25 Psig) on LDCC external to melter
- Table 19 calculates HAC-ST for non-inhalation from LDCC external to melter
- Table 20 calculates the total HAC release in terms of A_2

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Table 12. HAC -ST from Spout Glass

Isotope	Content (Ci)	A_2 (Ci/A_2)	MAR (A_2)	DR	ARF	LPF WVMP	LPF melter	Release (A_2)
	Input from Table 1		Calculated for spout glass	Glass damage ratios and LPFs for melter and WVMP from Table 3				Calculated for spout glass
a	b	c	d=b/c	e	f	g	h	i=d*e*f*g*h
C-14	2.22E-03	8.10E+01	2.74E-05	0.01	3E-4	1	0.1	8.22E-12
K-40	8.60E-03	2.40E+01	3.58E-04	0.01	3E-4	1	0.1	1.08E-10
Mn-54	5.00E-07	2.70E+01	1.85E-08	0.01	3E-4	1	0.1	5.56E-15
Co-60	5.47E-03	1.10E+01	4.97E-04	0.01	3E-4	1	0.1	1.49E-10
Ni-63	9.80E-02	8.10E+02	1.21E-04	0.01	3E-4	1	0.1	3.63E-11
Sr-90	6.33E+01	8.10E+00	7.81E+00	0.01	3E-4	1	0.1	2.34E-06
Y-90	6.33E+01	included with Sr-90						
Zr-95	3.17E-22	2.20E+01	1.44E-23	0.01	3E-4	1	0.1	4.32E-30
Nb-95	6.99E-22	2.70E+01	2.59E-23	0.01	3E-4	1	0.1	7.77E-30
Nb-95m	3.63E-24	included with Zr-95						
Tc-99	1.57E-02	2.40E+01	6.54E-04	0.01	3E-4	1	0.1	1.96E-10
Cs-137	8.57E+02	1.60E+01	5.36E+01	0.01	3E-4	1	0.1	1.61E-05
Ba-137m	8.09E+02	included with Cs-137						
Eu-154	1.04E-01	1.60E+01	6.50E-03	0.01	3E-4	1	0.1	1.95E-09
Hg-206	7.14E-16	5.40E-01	1.32E-15	0.01	3E-4	1	0.1	3.97E-22
Tl-206	5.01E-14	included with Bi-210m						
Tl-207	1.86E-09	5.40E-01	3.44E-09	0.01	3E-4	1	0.1	1.03E-15
Tl-208	1.73E-03	included with U-232						
Tl-209	5.58E-08	5.40E-01	1.03E-07	0.01	3E-4	1	0.1	3.10E-14
Tl-210	4.50E-11	5.40E-01	8.33E-11	0.01	3E-4	1	0.1	2.50E-17
Pb-209	2.58E-06	included with Th-229						
Pb-210	3.76E-08	1.40E+00	2.69E-08	0.01	3E-4	1	0.1	8.06E-15
Pb-211	1.87E-09	5.40E-01	3.46E-09	0.01	3E-4	1	0.1	1.04E-15
Pb-212	4.82E-03	included with U-232						
Pb-214	2.14E-07	included with Rn-222						
Bi-209	5.97E-25	included with Pb-210						
Bi-210	3.75E-08	included with Bi-212						
Bi-211	1.87E-09	included with Pb-211						
Bi-212	4.82E-03	included with U-232						
Bi-213	2.58E-06	included with Th-229						
Bi-214	2.14E-07	included with Rn-222						
Bi-215	1.53E-15	5.40E-01	2.83E-15	0.01	3E-4	1	0.1	8.50E-22
Po-210	3.45E-08	included with Pb-210						

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Table 12. HAC-ST from Spout Glass (continuation)

Isotope	Content (Ci)	A_2 (Ci/A_2)	MAR (A_2)	DR	ARF	LPF WVMP	LPF melter	Release (A_2)
	Input from Table 1		Calculated for spout glass	Glass damage ratios and LPFs for melter and WVMP from Table 3				Calculated for spout glass
a	b	c	d=b/c	e	f	g	h	i=d*e*f*g*h
Po-211	5.10E-12	2.40E-03	2.13E-09	0.01	3E-4	1	0.1	6.38E-16
Po-212	3.09E-03	included with U-232						
Po-213	2.53E-06	included with Th-229						
Po-214	2.14E-07	included with U-230						
Po-215	1.87E-09	2.40E-03	7.79E-07	0.01	3E-4	1	0.1	2.34E-13
Po-216	4.82E-03	included with U-232						
Po-218	2.14E-07	included with Rn-222						
At-215	7.47E-15	2.40E-03	3.11E-12	0.01	3E-4	1	0.1	9.34E-19
At-217	2.58E-06	included with Th-229						
At-218	4.07E-11	2.40E-03	1.70E-08	0.01	3E-4	1	0.1	5.09E-15
At-219	1.57E-15	2.40E-03	6.54E-13	0.01	3E-4	1	0.1	1.96E-19
Rn-217	3.10E-10	2.40E-03	1.29E-07	0.01	3E-4	1	0.1	3.88E-14
Rn-218	4.07E-14	included with U-230						
Rn-219	1.87E-09	2.40E-03	7.79E-07	0.01	3E-4	1	0.1	2.34E-13
Rn-220	4.82E-03	included with U-232						
Rn-222	2.14E-07	1.10E-01	1.95E-06	0.01	3E-4	1	0.1	5.84E-13
Fr-221	2.58E-06	included with Th-229						
Fr-223	2.62E-11	5.40E-01	4.86E-11	0.01	3E-4	1	0.1	1.46E-17
Ra-223	1.87E-09	1.90E-01	9.83E-09	0.01	3E-4	1	0.1	2.95E-15
Ra-224	4.82E-03	included with U-232						
Ra-225	2.59E-06	included with Th-229						
Ra-226	2.14E-07	8.10E-02	2.65E-06	0.01	3E-4	1	0.1	7.94E-13
Ra-228	3.41E-05	5.40E-01	6.31E-05	0.01	3E-4	1	0.1	1.89E-11
Ac-225	2.58E-06	included with Th-229						
Ac-227	1.90E-09	2.40E-03	7.92E-07	0.01	3E-4	1	0.1	2.38E-13
Ac-228	3.41E-05	included with Ra-228						
Th-227	1.85E-09	1.40E-01	1.32E-08	0.01	3E-4	1	0.1	3.97E-15
Th-228	4.82E-03	included with U-232						
Th-229	2.60E-06	1.40E-02	1.86E-04	0.01	3E-4	1	0.1	5.58E-11
Th-230	3.89E-05	2.70E-02	1.44E-03	0.01	3E-4	1	0.1	4.32E-10
Th-231	3.95E-05	included with U-235						
Th-232	4.34E-05	unlimited						
Th-234	2.41E-04	included with U-238						
Pa-231	1.07E-08	1.10E-02	9.69E-07	0.01	3E-4	1	0.1	2.91E-13
Pa-233	7.09E-04	included with Np-237						
Pa-234	3.62E-07	5.40E-01	6.69E-07	0.01	3E-4	1	0.1	2.01E-13
Pa-234m	2.41E-04	included with U-238						

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Table 12. HAC-ST from Spout Glass (continuation)

Isotope	Content (Ci)	A_2 (Ci/A_2)	MAR (A_2)	DR	ARF	LPF WVMP	LPF melter	Release (A_2)
	Input from Table		Calculated for spout glass	Glass damage ratios and LPFs for melter and WVMP from Table 3				Calculated for spout glass
a	b	c	d=b/c	e	f	g	h	i=d*e*f*g*h
U-232	4.66E-03	2.70E-02	1.73E-01	0.01	3E-4	1	0.1	5.18E-08
U-233	2.16E-03	1.60E-01	1.35E-02	0.01	3E-4	1	0.1	4.05E-09
U-234	1.03E-03	1.60E-01	6.46E-03	0.01	3E-4	1	0.1	1.94E-09
U-235	3.95E-05	unlimited						
U-235m	3.01E-02							
U-236	1.19E-04	1.60E-01	7.44E-04	0.01	3E-4	1	0.1	2.23E-10
U-237	4.56E-06	2.40E-03	1.90E-03	0.01	3E-4	1	0.1	5.70E-10
U-238	2.41E-04	unlimited						
Np-237	7.09E-04	5.40E-02	1.31E-02	0.01	3E-4	1	0.1	3.94E-09
Np-239	4.55E-03	included with Am-243						
Pu-238	1.14E-01	2.70E-02	4.22E+00	0.01	3E-4	1	0.1	1.27E-06
Pu-239	3.01E-02	2.70E-02	1.11E+00	0.01	3E-4	1	0.1	3.34E-07
Pu-240	2.29E-02	2.70E-02	8.50E-01	0.01	3E-4	1	0.1	2.55E-07
Pu-241	1.85E-01	1.60E+00	1.16E-01	0.01	3E-4	1	0.1	3.47E-08
Am-241	3.80E-01	2.70E-02	1.41E+01	0.01	3E-4	1	0.1	4.23E-06
Am-243	4.55E-03	2.70E-02	1.68E-01	0.01	3E-4	1	0.1	5.05E-08
Cm-242	1.05E-11	2.70E-01	3.88E-11	0.01	3E-4	1	0.1	1.16E-17
Cm-243	1.85E-03	2.70E-02	6.87E-02	0.01	3E-4	1	0.1	2.06E-08
Cm-244	4.07E-02	5.40E-02	7.53E-01	0.01	3E-4	1	0.1	2.26E-07
							subtotal	2.49E-5

Table 13. HAC-ST from Heel Glass

Isotope	Content (Ci)	A_2 (Ci/A_2)	MAR (A_2)	DR	ARF	LPF WVMP	LPF melter	Release (A_2)
	Input from Table 1		Calculated for heel glass	Glass damage ratios and LPFs for melter and WVMP from Table 3				Calculated for heel glass
a	b	c	d=b/c	e	f	g	h	i=d*e*f*g*h
C-14	3.47E-03	8.10E+01	4.28E-05	0.01	3E-4	1	0.1	1.29E-11
K-40	1.50E-02	2.40E+01	6.25E-04	0.01	3E-4	1	0.1	1.88E-10
Mn-54	1.44E-06	2.70E+01	5.33E-08	0.01	3E-4	1	0.1	1.60E-14
Co-60	3.16E-03	1.10E+01	2.87E-04	0.01	3E-4	1	0.1	8.62E-11
Ni-63	1.52E-01	8.10E+02	1.88E-04	0.01	3E-4	1	0.1	5.63E-11
Sr-90	3.12E+01	8.10E+00	3.85E+00	0.01	3E-4	1	0.1	1.16E-06
Y-90	3.12E+01	included with Sr-90						
Zr-95	1.30E-20	2.10E+01	6.19E-22	0.01	3E-4	1	0.1	1.86E-28
Nb-95	2.86E-20	2.20E+01	1.30E-21	0.01	3E-4	1	0.1	3.90E-28
Nb-95m	1.49E-22	included with Zr-95						
Tc-99	2.01E-03	2.40E+01	8.38E-05	0.01	3E-4	1	0.1	2.51E-11
Cs-137	5.42E+02	1.60E+01	3.39E+01	0.01	3E-4	1	0.1	1.02E-05
Ba-137m	5.12E+02	included with Cs-137						

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Table 13. HAC-ST from Heel Glass (continuation)

Isotope	Content (Ci)	A_2 (Ci/A_2)	MAR (A_2)	DR	ARF	LPF WVMP	LPF melter	Release (A_2)
	Input from Table 1		Calculated for heel glass	Glass damage ratios and LPFs for melter and WVMP from Table 3				Calculated for heel glass
a	b	c	d=b/c	e	f	g	h	i=d*e*f*g*h
Hg-206	9.79E-16	5.40E-01	1.81E-15	0.01	3E-4	1	0.1	5.44E-22
Tl-206	6.88E-14	included with Bi-210m						
Tl-207	2.56E-09	5.40E-01	4.74E-09	0.01	3E-4	1	0.1	1.42E-15
Tl-208	2.72E-03	included with U-232						
Tl-209	8.09E-08	5.40E-01	1.50E-07	0.01	3E-4	1	0.1	4.49E-14
Tl-210	6.54E-11	5.40E-01	1.21E-10	0.01	3E-4	1	0.1	3.63E-17
Pb-209	3.75E-06	included with Th-229						
Pb-210	5.16E-08	1.40E+00	3.69E-08	0.01	3E-4	1	0.1	1.11E-14
Pb-211	2.57E-09	5.40E-01	4.76E-09	0.01	3E-4	1	0.1	1.43E-15
Pb-212	7.56E-03	included with U-232						
Pb-214	3.11E-07	included with Rn-222						
Bi-209	8.10E-25	included with Pb-210						
Bi-210	5.14E-08	included with Bi-212						
Bi-211	2.57E-09	included with Pb-211						
Bi-212	7.56E-03	included with U-232						
Bi-213	3.75E-06	included with Th-229						
Bi-214	3.11E-07	included with Rn-222						
Bi-215	2.10E-15	5.40E-01	3.89E-15	0.01	3E-4	1	0.1	1.17E-21
Po-210	4.71E-08	included with Pb-210						
Po-211	7.01E-12	2.40E-03	2.92E-09	0.01	3E-4	1	0.1	8.76E-16
Po-212	4.84E-03	included with U-232						
Po-213	3.67E-06	included with Th-229						
Po-214	3.11E-07	included with U-230						
Po-215	2.57E-09	2.40E-03	1.07E-06	0.01	3E-4	1	0.1	3.2125E-13
Po-216	7.56E-03	included with U-232						
Po-218	3.11E-07	included with Rn-222						
At-215	1.03E-14	2.40E-03	4.29E-12	0.01	3E-4	1	0.1	1.29E-18
At-217	3.75E-06	included with Th-229						
At-218	5.92E-11	2.40E-03	2.47E-08	0.01	3E-4	1	0.1	7.40E-15
At-219	2.17E-15	2.40E-03	9.04E-13	0.01	3E-4	1	0.1	2.71E-19
Rn-217	4.50E-10	2.40E-03	1.88E-07	0.01	3E-4	1	0.1	5.63E-14
Rn-218	5.92E-14	included with U-230						
Rn-219	2.57E-09	2.40E-03	1.07E-06	0.01	3E-4	1	0.1	3.21E-13
Rn-220	7.56E-03	included with U-232						
Rn-222	3.11E-07	1.10E-01	2.83E-06	0.01	3E-4	1	0.1	8.48E-13
Fr-221	3.75E-06	included with Th-229						
Fr-223	3.61E-11	5.40E-01	6.68E-11	0.01	3E-4	1	0.1	2.00E-17
Ra-223	2.57E-09	1.90E-01	1.35E-08	0.01	3E-4	1	0.1	4.05E-15
Ra-224	7.56E-03	included with U-232						
Ra-225	3.76E-06	included with Th-229						

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Table 13. HAC-ST from Heel Glass (continuation)

Isotope	Content (Ci)	A_2 (Ci/A_2)	MAR (A_2)	DR	ARF	LPF WVMP	LPF melter	Release (A_2)
	Input from Table 1		Calculated for heel glass	Glass damage ratios and LPFs for melter and WVMP from Table 3				Calculated for heel glass
a	b	c	d=b/c	e	f	g	h	i=d*e*f*g*h
Ra-226	3.12E-07	8.10E-02	3.85E-06	0.01	3E-4	1	0.1	1.15E-12
Ra-228	5.14E-05	5.40E-01	9.53E-05	0.01	3E-4	1	0.1	2.86E-11
Ac-225	3.75E-06	included with Th-229						
Ac-227	2.61E-09	2.40E-03	1.09E-06	0.01	3E-4	1	0.1	3.27E-13
Ac-228	5.14E-05	included with Ra-228						
Th-227	2.55E-09	1.40E-01	1.82E-08	0.01	3E-4	1	0.1	5.46E-15
Th-228	7.56E-03	included with U-232						
Th-229	3.78E-06	1.40E-02	2.70E-04	0.01	3E-4	1	0.1	8.10E-11
Th-230	6.05E-05	2.70E-02	2.24E-03	0.01	3E-4	1	0.1	6.72E-10
Th-231	6.15E-05	included with U-235						
Th-232	6.74E-05	unlimited						
Th-234	3.74E-04	included with U-238						
Pa-231	1.55E-08	1.10E-02	1.41E-06	0.01	3E-4	1	0.1	4.24E-13
Pa-233	1.05E-03	included with Np-237						
Pa-234	5.61E-07	5.40E-01	1.04E-06	0.01	3E-4	1	0.1	3.12E-13
Pa-234m	3.74E-04	included with U-238						
U-232	7.31E-03	2.70E-02	2.71E-01	0.01	3E-4	1	0.1	8.12E-08
U-233	3.35E-03	1.60E-01	2.09E-02	0.01	3E-4	1	0.1	6.28E-09
U-234	1.60E-03	1.60E-01	1.00E-02	0.01	3E-4	1	0.1	3.01E-09
U-235	6.15E-05	unlimited						
U-235m	2.61E-02							
U-236	1.84E-04	1.60E-01	1.15E-03	0.01	3E-4	1	0.1	3.45E-10
U-237	7.37E-06	2.40E-03	3.07E-03	0.01	3E-4	1	0.1	9.21E-10
U-238	3.74E-04	unlimited						
Np-237	1.05E-03	5.40E-02	1.95E-02	0.01	3E-4	1	0.1	5.84E-09
Np-239	5.97E-03	included with Am-243						
Pu-238	1.04E-01	2.70E-02	3.85E+00	0.01	3E-4	1	0.1	1.15E-06
Pu-239	2.61E-02	2.70E-02	9.66E-01	0.01	3E-4	1	0.1	2.90E-07
Pu-240	2.01E-02	2.70E-02	7.43E-01	0.01	3E-4	1	0.1	2.23E-07
Pu-241	2.99E-01	1.60E+00	1.87E-01	0.01	3E-4	1	0.1	5.61E-08
Am-241	4.95E-01	2.70E-02	1.83E+01	0.01	3E-4	1	0.1	5.50E-06
Am-243	5.97E-03	2.70E-02	2.21E-01	0.01	3E-4	1	0.1	6.64E-08
Cm-242	3.08E-10	2.70E-01	1.14E-09	0.01	3E-4	1	0.1	3.43E-16
Cm-243	2.16E-03	2.70E-02	8.01E-02	0.01	3E-4	1	0.1	2.40E-08
Cm-244	4.70E-02	5.40E-02	8.70E-01	0.01	3E-4	1	0.1	2.61E-07
							subtotal	1.90E-5

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Table 14. HAC-ST from Refractory Glass

Isotope	Content (Ci)	A_2 (Ci/A_2)	MAR (A_2)	DR	ARF	LPF WVMP	LPF melter	Release (A_2)
	Input from Table 1		Calculated for refractory glass	From Table 3. Same for all HAC glass				Calculated for inhalation from refractory glass
a	b	c	d=b/c	e	f	g	h	i=d*e*f*g*h
Co-60	1.33E-02	1.10E+01	1.21E-03	0.01	3E-4	1	0.1	3.63E-10
Sr-90	1.07E+02	8.10E+00	1.32E+01	0.01	3E-4	1	0.1	3.96E-06
Y-90	1.07E+02	included with Sr-90						
Tc-99	5.22E-02	2.40E+01	2.18E-03	0.01	3E-4	1	0.1	6.53E-10
Cs-137	2.13E+02	1.60E+01	1.33E+01	0.01	3E-4	1	0.1	4.00E-06
Ba-137m	2.01E+02	included with Cs-137						
Eu-154	5.53E-01	1.60E+01	3.45E-02	0.01	3E-4	1	0.1	1.04E-08
Hg-206	2.54E-16	5.40E-01	4.70E-16	0.01	3E-4	1	0.1	1.41E-22
Tl-206	1.78E-14	included with Bi-210m						
Tl-207	2.96E-09	5.40E-01	5.48E-09	0.01	3E-4	1	0.1	1.64E-15
Tl-208	1.81E-04	included with U-232						
Tl-209	1.43E-08	5.40E-01	2.66E-08	0.01	3E-4	1	0.1	7.97E-15
Tl-210	1.67E-11	5.40E-01	3.10E-11	0.01	3E-4	1	0.1	9.29E-18
Pb-209	6.64E-07	included with Th-229						
Pb-210	1.34E-08	1.40E+00	9.54E-09	0.01	3E-4	1	0.1	2.86E-15
Pb-211	2.97E-09	5.400E-01	5.50E-09	0.01	3E-4	1	0.1	1.65E-15
Pb-212	5.03E-04	included with U-232						
Pb-214	7.96E-08	included with Rn-222						
Bi-209	1.46E-25	included with Pb-210						
Bi-210	1.33E-08	included with Bi-212						
Bi-211	2.97E-09	included with Pb-211						
Bi-212	5.03E-04	included with U-232						
Bi-213	6.64E-07	included with Th-229						
Bi-214	7.96E-08	included with Rn-222						
Bi-215	2.43E-15	2.40E-03	1.01E-12	0.01	3E-4	1	0.1	3.04E-19
Po-210	1.22E-08	included with Pb-210						
Po-211	8.10E-12	2.40E-03	3.38E-09	0.01	3E-4	1	0.1	1.01E-15
Po-212	3.22E-04	included with U-232						
Po-213	6.50E-07	included with Th-229						
Po-214	7.96E-08	included with U-230						
Po-215	2.97E-09	2.40E-03	1.24E-06	0.01	3E-4	1	0.1	3.71E-13
Po-216	5.03E-04	included with U-232						
Po-218	7.96E-08	included with Rn-222						
At-215	1.19E-14	2.40E-03	4.95E-12	0.01	3E-4	1	0.1	1.48E-18
At-217	6.64E-07	included with Th-229						
At-218	1.51E-11	2.40E-03	6.30E-09	0.01	3E-4	1	0.1	1.89E-15
Rn-217	7.97E-11	2.40E-03	3.32E-08	0.01	3E-4	1	0.1	9.96E-15
At-219	2.50E-15	2.40E-03	1.04E-12	0.01	3E-4	1	0.1	3.13E-19
Rn-218	1.51E-14	included with U-230						
Rn-219	2.97E-09	2.40E-03	1.24E-06	0.01	3E-4	1	0.1	3.71E-13
Rn-220	5.03E-04	included with U-232						

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Table 14. HAC-ST from Refractory Glass (continuation)

Isotope	Content (Ci)	A_2 (Ci/A_2)	MAR (A_2)	DR	ARF	LPF WVMP	LPF melter	Release (A_2)
	Input from Table 1		Calculated for refractory glass	Glass damage ratios and LPFs for melter and WVMP from Table 3				Calculated for refractory glass
a	b	c	d=b/c	e	f	g	h	i=d*e*f*g*h
Rn-217	7.97E-11	2.40E-03	3.32E-08	0.01	3E-4	1	0.1	9.96E-15
Rn-218	1.51E-14	included with U-230						
Rn-219	2.97E-09	2.40E-03	1.24E-06	0.01	3E-4	1	0.1	3.71E-13
Rn-220	5.03E-04	included with U-232						
Rn-222	7.96E-08	1.10E-01	7.24E-07	0.01	3E-4	1	0.1	2.17E-13
Fr-221	6.64E-07	included with Th-229						
Fr-223	4.17E-11	5.40E-01	7.73E-11	0.01	3E-4	1	0.1	2.32E-17
Ra-223	2.97E-09	1.90E-01	1.56E-08	0.01	3E-4	1	0.1	4.69E-15
Ra-224	5.03E-04	included with U-232						
Ra-225	6.66E-07	included with Th-229						
Ra-226	7.97E-08	8.10E-02	9.84E-07	0.01	3E-4	1	0.1	2.95E-13
Ra-228	3.21E-05	5.40E-01	5.95E-05	0.01	3E-4	1	0.1	1.78E-11
Ac-225	6.64E-07	included with Th-229						
Ac-227	3.02E-09	2.40E-03	1.26E-06	0.01	3E-4	1	0.1	3.78E-13
Ac-228	3.21E-05	included with Ra-228						
Th-227	2.95E-09	1.40E-01	2.11E-08	0.01	3E-4	1	0.1	6.32E-15
Th-228	5.02E-04	included with U-232						
Th-229	6.70E-07	1.40E-02	4.79E-05	0.01	3E-4	1	0.1	1.44E-11
Th-230	1.52E-05	2.70E-02	5.63E-04	0.01	3E-4	1	0.1	1.69E-10
Th-231	6.92E-05	included with U-235						
Th-232	4.18E-05	unlimited						
Th-234	1.16E-04	included with U-238						
Pa-231	1.78E-08	1.10E-02	1.62E-06	0.01	3E-4	1	0.1	4.85E-13
Pa-233	8.49E-04	included with Np-237						
Pa-234	1.74E-07	5.40E-01	3.22E-07	0.01	3E-4	1	0.1	9.67E-14
Pa-234m	1.16E-04	included with U-238						
U-232	4.41E-04	2.70E-02	1.63E-02	0.01	3E-4	1	0.1	4.90E-09
U-233	5.85E-04	1.60E-01	3.66E-03	0.01	3E-4	1	0.1	1.10E-09
U-234	2.84E-04	1.60E-01	1.78E-03	0.01	3E-4	1	0.1	5.33E-10
U-235	6.92E-05	unlimited						
U-235m	3.72E-02	unlimited						
U-236	2.08E-04	1.60E-01	1.30E-03	0.01	3E-4	1	0.1	3.90E-10
U-237	5.08E-06	2.40E-03	2.12E-03	0.01	3E-4	1	0.1	6.35E-10
U-238	1.16E-04	unlimited						
Np-237	8.49E-04	5.40E-02	1.57E-02	0.01	3E-4	1	0.1	4.72E-09
Np-239	6.72E-03	included with Am-243						
Pu-238	1.41E-01	2.70E-02	5.22E+00	0.01	3E-4	1	0.1	1.57E-06
Pu-239	3.72E-02	2.70E-02	1.38E+00	0.01	3E-4	1	0.1	4.13E-07
Pu-240	2.85E-02	2.70E-02	1.06E+00	0.01	3E-4	1	0.1	3.17E-07
Pu-241	2.06E-01	1.60E+00	1.29E-01	0.01	3E-4	1	0.1	3.86E-08

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Table 14. HAC-ST from Refractory Glass (continuation)

Isotope	Content (Ci)	A_2 (Ci/A_2)	MAR (A_2)	DR	ARF	LPF WVMP	LPF melter	Release (A_2)
	Input from Table 1		Calculated for refractory glass	Glass damage ratios and LPFs for melter and WVMP from Table 3				Calculated for refractory glass
a	b	c	d=b/c	e	f	g	h	i=d*e*f*g*h
Am-241	8.45E-01	2.70E-02	3.13E+01	0.01	3E-4	1	0.1	9.39E-06
Am-243	6.72E-03	2.70E-02	2.49E-01	0.01	3E-4	1	0.1	7.47E-08
Cm-242	4.49E-11	2.70E-01	1.66E-10	0.01	3E-4	1	0.1	4.99E-17
Cm-243	3.04E-03	2.70E-02	1.13E-01	0.01	3E-4	1	0.1	3.38E-08
Cm-244	6.77E-02	5.40E-02	1.25E+00	0.01	3E-4	1	0.1	3.76E-07
							subtotal	2.02E-5

Table 15. HAC-ST from LDCC Internal to Melter

Isotope	Content (Ci)	Leach Ratio	Leached (Ci)	A_2 (Ci/A_2)	MAR (A_2)	DR	ARF	LPF WVMP	Release (A_2)
	From Table 1	From Table 3 for glass to LDCC	Calculated for LDCC internal to the melter	From Table 1	Calculated for LDCC internal to the melter	From Table 3 for LDCC internal to the melter			Calculated for inhalation from LDCC internal to the melter
a	b	c	d=b*c	e	f=d/e	g	h	i	j=f*g*h*i
C-14	3.47E-03	1.6E-3	5.56E-06	8.10E+01	6.87E-08	0.1	5E-5	1	3.43E-13
K-40	1.50E-02	1.6E-3	2.41E-05	2.40E+01	1.00E-06	0.1	5E-5	1	5.01E-12
Mn-54	1.44E-06	1.6E-3	2.31E-09	2.70E+01	8.55E-11	0.1	5E-5	1	4.28E-16
Co-60	3.16E-03	1.6E-3	5.07E-06	1.10E+01	4.61E-07	0.1	5E-5	1	2.30E-12
Ni-63	1.52E-01	1.6E-3	2.44E-04	8.10E+02	3.01E-07	0.1	5E-5	1	1.50E-12
Sr-90	3.12E+01	1.6E-3	5.00E-02	8.10E+00	6.18E-03	0.1	5E-5	1	3.09E-08
Y-90	3.12E+01	included with Sr-90							
Zr-95	1.30E-20	1.6E-3	2.08E-23	2.20E+01	9.48E-25	0.1	5E-5	1	4.74E-30
Nb-95	2.86E-20	1.6E-3	4.59E-23	2.70E+01	1.70E-24	0.1	5E-5	1	8.49E-30
Nb-95m	1.49E-22	included with Zr-95							
Tc-99	2.01E-03	1.6E-3	3.22E-06	2.40E+01	1.34E-07	0.1	5E-5	1	6.71E-13
Cs-137	5.42E+02	1.6E-3	8.69E-01	1.60E+01	5.43E-02	0.1	5E-5	1	2.72E-07
Ba-137m	5.12E+02	included with Cs-137							
Eu-154	8.12E-02	1.6E-3	1.30E-04	1.60E+01	8.14E-06	0.1	5E-5	1	4.07E-11
Hg-206	9.79E-16	1.6E-3	1.57E-18	5.40E-01	2.91E-18	0.1	5E-5	1	1.45E-23
Tl-206	6.88E-14	Include with Bi-210m							
Tl-207	2.56E-09	1.6E-3	4.11E-12	5.40E-01	7.60E-12	0.1	5E-5	1	3.80E-17
Tl-208	2.72E-03	included with U-232							
Tl-209	8.09E-08	included with Th-229							
Tl-210	6.54E-11	1.6E-3	1.05E-13	5.40E-01	1.94E-13	0.1	5E-5	1	9.71E-19
Pb-210m	3.75E-06	included with Th-229							
Pb-210	5.16E-08	1.6E-3	8.27E-11	1.40E+00	5.91E-11	0.1	5E-5	1	2.96E-16

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Table 15. HAC-ST from LDCC Internal to Melter (continuation)

Isotope	Content (Ci)	Leach Ratio	Leached (Ci)	A_2 (Ci/A_2)	MAR (A_2)	DR	ARF	LPF WVMP	Release (A_2)
	From Table 1	From Table 3 for glass to LDCC	Calculated for LDCC internal to the melter	From Table 1	Calculated for LDCC internal to the melter	From Table 3 for LDCC internal to the melter			Calculated for inhalation from LDCC internal to the melter
a	b	c	d=b*c	e	f=d/e	g	h	i	j=f*g*h*i
Pb-211	2.57E-09	1.6E-3	4.12E-12	5.40E-01	7.63E-12	0.1	5E-5	1	3.82E-17
Pb-212	7.56E-03	included with U-232							
Pb-214	3.11E-07	included with Rn-222							
Bi-209	8.10E-25	included with Pb-210							
Bi-210	5.14E-08	included with Bi-212							
Bi-211	2.57E-09	included with Ra-223							
Bi-212	7.56E-03	included with U-232							
Bi-213	3.75E-06	included with Th-229							
Bi-214	3.11E-07	included with Rn-222							
Bi-215	2.10E-15	1.6E-3	3.37E-18	5.40E-01	6.24E-18	0.1	5E-5	1	3.12E-23
Po-210	4.71E-08	included with Pb-210							
Po-211	7.01E-12	1.6E-3	1.12E-14	2.40E-03	4.68E-12	0.1	5E-5	1	2.34E-17
Po-212	4.84E-03	included with Pb-212							
Po-213	3.67E-06	included with Th-229							
Po-214	3.11E-07	included with U-230							
Po-215	2.57E-09	included with Ra-223							
Po-216	7.56E-03	included with U-232							
Po-218	3.11E-07	included with Rn-222							
At-215	1.03E-14	1.6E-3	1.65E-17	2.40E-03	6.88E-15	0.1	5E-5	1	3.44E-20
At-217	3.75E-06	included with Th-229							
At-218	5.92E-11	1.6E-3	9.49E-14	2.40E-03	3.96E-11	0.1	5E-5	1	1.98E-16
At-219	2.17E-15	1.6E-3	3.48E-18	2.40E-03	1.45E-15	0.1	5E-5	1	7.25E-21
Rn-217	4.50E-10	1.6E-3	7.22E-13	2.40E-03	3.01E-10	0.1	5E-5	1	1.50E-15
Rn-218	5.92E-14	included with U-230							
Rn-219	2.57E-09	1.6E-3	4.12E-12	2.40E-03	1.72E-09	0.1	5E-5	1	8.59E-15
Rn-220	7.56E-03	included with U-232							
Rn-222	3.11E-07	1.6E-3	4.99E-10	1.10E-01	4.53E-09	0.1	5E-5	1	2.27E-14
Fr-221	3.75E-06	included with Th-229							
Fr-223	3.61E-11	1.6E-3	5.79E-14	5.40E-01	1.07E-13	0.1	5E-5	1	5.36E-19
Ra-223	2.57E-09	1.6E-3	4.11E-12	1.90E-01	2.17E-11	0.1	5E-5	1	1.08E-16
Ra-224	7.56E-03	included with U-232							
Ra-225	3.76E-06	included with Th-229							
Ra-226	3.12E-07	1.6E-3	5.00E-10	8.10E-02	6.17E-09	0.1	5E-5	1	3.09E-14
Ra-228	5.14E-05	1.6E-3	8.25E-08	5.40E-01	1.53E-07	0.1	5E-5	1	7.64E-13
Ac-225	3.75E-06	included with Th-229							
Ac-227	2.61E-09	1.6E-3	4.19E-12	2.40E-03	1.75E-09	0.1	5E-5	1	8.73E-15
Ac-228	5.14E-05	included with Ra-228							
Th-227	2.55E-09	1.6E-3	4.09E-12	1.40E-01	2.92E-11	0.1	5E-5	1	1.46E-16
Th-228	7.56E-03	included with U-232							
Th-229	3.78E-06	1.6E-3	6.06E-09	1.40E-02	4.33E-07	0.1	5E-5	1	2.16E-12

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Table 15. HAC-ST from LDCC Internal to Melter (continuation)

Isotope	Content (Ci)	Leach Ratio	Leached (Ci)	A2 (Ci/A_2)	MAR (A_2)	DR	ARF	LPF WVMP	Release (A_2)
	From Table 1	From Table 3 for glass to LDCC	Calculated for LDCC internal to the melter	From Table 1	Calculated for LDCC internal to the melter	From Table 3 for LDCC internal to the melter			Calculated for inhalation from LDCC internal to the melter
a	b	c	d=b*c	e	f=d/e	g	h	i	j=f*g*h*i
Th-230	6.05E-05	1.6E-3	9.70E-08	2.70E-02	3.59E-06	0.1	5E-5	1	1.80E-11
Th-231	6.15E-05	included with U-235							
Th-232	6.74E-05	unlimited							
Th-234	3.74E-04	included with U-238							
Pa-231	1.55E-08	1.6E-3	2.49E-11	1.10E-02	2.27E-09	0.1	5E-5	1	1.13E-14
Pa-233	1.05E-03	included with Np-237							
Pa-234	5.61E-07	1.6E-3	9.00E-10	5.40E-01	1.67E-09	0.1	5E-5	1	8.33E-15
Pa-234m	3.74E-04	included with U-238							
U-232	7.31E-03	1.6E-3	1.17E-05	2.70E-02	4.34E-04	0.1	5E-5	1	2.17E-09
U-233	3.35E-03	1.6E-3	5.37E-06	1.60E-01	3.36E-05	0.1	5E-5	1	1.68E-10
U-234	1.60E-03	1.6E-3	2.57E-06	1.60E-01	1.61E-05	0.1	5E-5	1	8.04E-11
U-235	6.15E-05	unlimited							
U-235m	2.61E-02								
U-236	1.84E-04	1.6E-3	2.95E-07	1.60E-01	1.84E-06	0.1	5E-5	1	9.22E-12
U-237	7.37E-06	included with Pu-241							
U-238	3.74E-04	unlimited							
Np-237	1.05E-03	1.6E-3	1.69E-06	5.40E-02	3.12E-05	0.1	5E-5	1	1.56E-10
Np-239	5.97E-03	included with Am-243							
Pu-238	1.04E-01	1.6E-3	1.67E-04	2.70E-02	6.17E-03	0.1	5E-5	1	3.09E-08
Pu-239	2.61E-02	1.6E-3	4.18E-05	2.70E-02	1.55E-03	0.1	5E-5	1	7.75E-09
Pu-240	2.01E-02	1.6E-3	3.22E-05	2.70E-02	1.19E-03	0.1	5E-5	1	5.95E-09
Pu-241	2.99E-01	1.6E-3	4.79E-04	1.60E+00	3.00E-04	0.1	5E-5	1	1.50E-09
Am-241	4.95E-01	1.6E-3	7.94E-04	2.70E-02	2.94E-02	0.1	5E-5	1	1.47E-07
Am-243	5.97E-03	1.6E-3	9.58E-06	2.70E-02	3.55E-04	0.1	5E-5	1	1.77E-09
Cm-242	3.08E-10	1.6E-3	4.95E-13	2.70E-01	1.83E-12	0.1	5E-5	1	9.16E-18
Cm-243	2.16E-03	1.6E-3	3.47E-06	2.70E-02	1.28E-04	0.1	5E-5	1	6.42E-10
Cm-244	4.70E-02	1.6E-3	7.53E-05	5.40E-02	1.39E-03	0.1	5E-5	1	6.97E-09
							subtotal		5.08E-7

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Table 16. HAC-ST from Increased Pressure (i.e., > 25 Psig) on LDCC Internal to Melter

Isotope	Content (Ci)	Leach Ratio	Leached (Ci)	A_2 (Ci/A_2)	MAR (A_2)	DR	ARF	LPF Melter	Release (A_2)
	From Table 1	From Table 3 for glass to LDCC	Calculated for LDCC internal to the melter	From Table 1	Calculated for LDCC internal to the melter	From Table 3 or LDCC internal to the melter from increase in pressure			Calculated for inhalation from LDCC internal to the melter from increase in pressure
a	b	c	d=b*c	e	f=d/e	g	h	i	j=f*g*h*i
C-14	3.47E-03	1.6E-3	5.56E-06	8.10E+01	6.87E-08	0.1	5E-3	0.1	3.43E-14
K-40	1.50E-02	1.6E-3	2.41E-05	2.40E+01	1.00E-06	0.1	5E-3	0.1	5.01E-13
Mn-54	1.44E-06	1.6E-3	2.31E-09	2.70E+01	8.55E-11	0.1	5E-3	0.1	4.28E-17
Co-60	3.16E-03	1.6E-3	5.07E-06	1.10E+01	4.61E-07	0.1	5E-3	0.1	2.30E-13
Ni-63	1.52E-01	1.6E-3	2.44E-04	8.10E+02	3.01E-07	0.1	5E-3	0.1	1.50E-13
Sr-90	3.12E+01	1.6E-3	5.00E-02	8.10E+00	6.18E-03	0.1	5E-3	0.1	3.09E-09
Y-90	3.12E+01	included with Sr-90							
Zr-95	1.30E-20	1.6E-3	2.08E-23	2.20E+01	9.48E-25	0.1	5E-3	0.1	4.74E-31
Nb-95	2.86E-20	1.6E-3	4.59E-23	2.70E+01	1.70E-24	0.1	5E-3	0.1	8.49E-31
Nb-95m	1.49E-22	included with Zr-95							
Tc-99	2.01E-03	1.6E-3	3.22E-06	2.40E+01	1.34E-07	0.1	5E-3	0.1	6.71E-14
Cs-137	5.42E+02	1.6E-3	8.69E-01	1.60E+01	5.43E-02	0.1	5E-3	0.1	2.72E-08
Ba-137m	5.12E+02	included with Cs-137							
Eu-154	8.12E-02	1.6E-3	1.30E-04	5.40E+01	2.41E-06	0.1	5E-3	0.1	1.21E-12
Hg-206	9.79E-16	1.6E-3	1.57E-18	1.60E+01	9.81E-20	0.1	5E-3	0.1	4.91E-26
Tl-206	6.88E-14	Include with Bi-210m							
Tl-207	2.56E-09	1.6E-3	4.11E-12	5.40E-01	7.60E-12	0.1	5E-3	0.1	3.80E-18
Tl-208	2.72E-03	included with U-232							
Tl-209	8.09E-08	included with Th-229							
Tl-210	6.54E-11	1.6E-3	1.05E-13	5.40E-01	1.94E-13	0.1	5E-3	0.1	9.71E-20
Pb-210m	3.75E-06	included with Th-229							
Pb-210	5.16E-08	1.6E-3	8.27E-11	1.40E+00	5.91E-11	0.1	5E-3	0.1	2.96E-17
Pb-211	2.57E-09	1.6E-3	4.12E-12	5.40E-01	7.63E-12	0.1	5E-3	0.1	3.82E-18
Pb-212	7.56E-03	included with U-232							
Pb-214	3.11E-07	included with Rn-222							
Bi-209	8.10E-25	included with Pb-210							
Bi-210	5.14E-08	included with Bi-212							
Bi-211	2.57E-09	included with Ra-223							
Bi-212	7.56E-03	included with U-232							
Bi-213	3.75E-06	included with Th-229							
Bi-214	3.11E-07	included with Rn-222							
Bi-215	2.10E-15	1.6E-3	3.37E-18	5.40E-01	6.24E-18	0.1	5E-3	0.1	3.12E-24
Po-210	4.71E-08	included with Pb-210							

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Table 16. HAC-ST from Increased Pressure (i.e., > 25 Psig) on LDCC Internal to Melter (continuation)

Isotope	Content (Ci)	Leach Ratio	Leached (Ci)	A_2 (Ci/A_2)	MAR (A_2)	DR	ARF	LPF Melter	Release (A_2)
	From Table 1	From Table 3 for glass to LDCC	Calculated for LDCC internal to the melter	From Table 1	Calculated for LDCC internal to the melter	From Table 3 or LDCC internal to the melter from increase in pressure			Calculated for inhalation from LDCC internal to the melter from increase in pressure
a	b	c	d=b*c	e	f=d/e	g	h	i	j=f*g*h*i
Po-211	7.01E-12	1.6E-3	1.12E-14	2.40E-03	4.68E-12	0.1	5E-3	0.1	2.34E-18
Po-212	4.84E-03	included with Pb-212							
Po-213	3.67E-06	included with Th-229							
Po-214	3.11E-07	included with U-230							
Po-215	2.57E-09	included with Ra-223							
Po-216	7.56E-03	included with U-232							
Po-218	3.11E-07	included with Rn-222							
At-215	1.03E-14	1.6E-3	1.65E-17	2.40E-03	6.88E-15	0.1	5E-3	0.1	3.44E-21
At-217	3.75E-06	included with Th-229							
At-218	5.92E-11	1.6E-3	9.49E-14	2.40E-03	3.96E-11	0.1	5E-3	0.1	1.98E-17
At-219	2.17E-15	1.6E-3	3.48E-18	2.40E-03	1.45E-15	0.1	5E-3	0.1	7.25E-22
Rn-217	4.50E-10	1.6E-3	7.22E-13	2.40E-03	3.01E-10	0.1	5E-3	0.1	1.50E-16
Rn-218	5.92E-14	included with U-230							
Rn-219	2.57E-09	1.6E-3	4.12E-12	2.40E-03	1.72E-09	0.1	5E-3	0.1	8.59E-16
Rn-220	7.56E-03	included with U-232							
Rn-222	3.11E-07	1.6E-3	4.99E-10	1.10E-01	4.53E-09	0.1	5E-3	0.1	2.27E-15
Fr-221	3.75E-06	included with Th-229							
Fr-223	3.61E-11	1.6E-3	5.79E-14	5.40E-01	1.07E-13	0.1	5E-3	0.1	5.36E-20
Ra-223	2.57E-09	1.6E-3	4.11E-12	1.90E-01	2.17E-11	0.1	5E-3	0.1	1.08E-17
Ra-224	7.56E-03	included with U-232							
Ra-225	3.76E-06	included with Th-229							
Ra-226	3.12E-07	1.6E-3	5.00E-10	8.10E-02	6.17E-09	0.1	5E-3	0.1	3.09E-15
Ra-228	5.14E-05	1.6E-3	8.25E-08	5.40E-01	1.53E-07	0.1	5E-3	0.1	7.64E-14
Ac-225	3.75E-06	included with Th-229							
Ac-227	2.61E-09	1.6E-3	4.19E-12	2.40E-03	1.75E-09	0.1	5E-3	0.1	8.73E-16
Ac-228	5.14E-05	included with Ra-228							
Th-227	2.55E-09	1.6E-3	4.09E-12	1.40E-01	2.92E-11	0.1	5E-3	0.1	1.46E-17
Th-228	7.56E-03	included with U-232							
Th-229	3.78E-06	1.6E-3	6.06E-09	1.40E-02	4.33E-07	0.1	5E-3	0.1	2.16E-13
Th-230	6.05E-05	1.6E-3	9.70E-08	2.70E-02	3.59E-06	0.1	5E-3	0.1	1.80E-12
Th-231	6.15E-05	included with U-235							
Th-232	6.74E-05	unlimited							
Th-234	3.74E-04	included with U-238							
Pa-231	1.55E-08	1.6E-3	2.49E-11	1.10E-02	2.27E-09	0.1	5E-3	0.1	1.13E-15
Pa-233	1.05E-03	included with Np-237							

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Table 16. HAC-ST from Increased Pressure (i.e., > 25 Psig) on LDCC Internal to Melter (continuation)

Isotope	Content (Ci)	Leach Ratio	Leached (Ci)	A_2 (Ci/A_2)	MAR (A_2)	DR	ARF	LPF Melter	Release (A_2)
	From Table 1	From Table 3 for glass to LDCC	Calculated for LDCC internal to the melter	From Table 1	Calculated for LDCC internal to the melter	From Table 3 or LDCC internal to the melter from increase in pressure			Calculated for inhalation from LDCC internal to the melter from increase in pressure
a	b	c	d=b*c	e	f=d/e	g	h	i	j=f*g*h*i
Pa-234	5.61E-07	1.6E-3	9.00E-10	5.40E-01	1.67E-09	0.1	5E-3	0.1	8.33E-16
Pa-234m	3.74E-04	included with U-238							
U-232	7.31E-03	1.6E-3	1.17E-05	2.70E-02	4.34E-04	0.1	5E-3	0.1	2.17E-10
U-233	3.35E-03	1.6E-3	5.37E-06	1.60E-01	3.36E-05	0.1	5E-3	0.1	1.68E-11
U-234	1.60E-03	1.6E-3	2.57E-06	1.60E-01	1.61E-05	0.1	5E-3	0.1	8.04E-12
U-235	6.15E-05	unlimited							
U-235m	2.61E-02								
U-236	1.84E-04	1.6E-3	2.95E-07	1.60E-01	1.84E-06	0.1	5E-3	0.1	9.22E-13
U-237	7.37E-06	included with Pu-241							
U-238	3.74E-04	unlimited							
Np-237	1.05E-03	1.6E-3	1.69E-06	5.40E-02	3.12E-05	0.1	5E-3	0.1	1.56E-11
Np-239	5.97E-03	included with Am-243							
Pu-238	1.04E-01	1.6E-3	1.67E-04	2.70E-02	6.17E-03	0.1	5E-3	0.1	3.09E-09
Pu-239	2.61E-02	1.6E-3	4.18E-05	2.70E-02	1.55E-03	0.1	5E-3	0.1	7.75E-10
Pu-240	2.01E-02	1.6E-3	3.22E-05	2.70E-02	1.19E-03	0.1	5E-3	0.1	5.95E-10
Pu-241	2.99E-01	1.6E-3	4.79E-04	1.60E+00	3.00E-04	0.1	5E-3	0.1	1.50E-10
Am-241	4.95E-01	1.6E-3	7.94E-04	2.70E-02	2.94E-02	0.1	5E-3	0.1	1.47E-08
Am-243	5.97E-03	1.6E-3	9.58E-06	2.70E-02	3.55E-04	0.1	5E-3	0.1	1.77E-10
Cm-242	3.08E-10	1.6E-3	4.95E-13	2.70E-01	1.83E-12	0.1	5E-3	0.1	9.16E-19
Cm-243	2.16E-03	1.6E-3	3.47E-06	2.70E-02	1.28E-04	0.1	5E-3	0.1	6.42E-11
Cm-244	4.70E-02	1.6E-3	7.53E-05	5.40E-02	1.39E-03	0.1	5E-3	0.1	6.97E-10
							subtotal		5.08E-6

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Table 17. HAC-ST from Increased Pressure (i.e., > 25 Psig) on LDCC External to Melter

Isotope	Content (Ci)	Leach Ratio	Leached (Ci)	A_2 (Ci/A_2)	MAR (A_2)	DR	ARF	LPF WVMP	Release (A_2)
	From Table 1	From Table 3 for PBS to LDCC	Calculated for LDCC external to melter	From Table 1	Calculated for LDCC external to melter	From Table 3 for LDCC external to the melter from increase in pressure			Calculated for inhalation from LDCC external to the melter from increase in pressure
a	b	c	d=b*c	e	f=d/e	g	h	j	k=f*g*h*i*j
Cs-137	6.43E+00	1E-2	6.43E-02	1.60E+01	4.02E-03	0.35	5E-3	1	7.03E-06
Ba-137m	6.07E+00	1E-2	6.07E-02	included with Cs-137					
Sr-90	2.84E+00	1E-2	2.84E-02	8.10E+00	3.51E-03	0.35	5E-3	1	6.14E-06
Y-90	2.84E+00	1E-2	2.84E-02	included with Sr-90					
Pm-147	6.88E-02	1E-2	6.88E-04	5.40E+01	1.27E-05	0.35	5E-3	1	2.23E-08
Am-241	3.43E-02	1E-2	3.43E-04	1.60E+00	2.14E-04	0.35	5E-3	1	3.75E-07
Eu-154	2.94E-02	1E-2	2.94E-04	1.60E+01	1.84E-05	0.35	5E-3	1	3.21E-08
Ni-63	1.55E-02	1E-2	1.55E-04	8.10E+02	1.91E-07	0.35	5E-3	1	3.35E-10
Fe-55	1.58E-02	1E-2	1.58E-04	1.10E+03	1.43E-07	0.35	5E-3	1	2.51E-10
Pu-238	3.79E-03	1E-2	3.79E-05	2.70E-02	1.40E-03	0.35	5E-3	1	2.45E-06
C-14	3.78E-03	1E-2	3.78E-05	8.10E+01	4.67E-07	0.35	5E-3	1	8.17E-10
Co-60	1.31E-03	1E-2	1.31E-05	1.10E+01	1.19E-06	0.35	5E-3	1	2.09E-09
U-232	1.03E-03	1E-2	1.03E-05	2.70E-02	3.80E-04	0.35	5E-3	1	6.65E-07
Pu-239	9.84E-04	1E-2	9.84E-06	2.70E-02	3.64E-04	0.35	5E-3	1	6.38E-07
Pu-240	6.82E-04	1E-2	6.82E-06	2.70E-02	2.52E-04	0.35	5E-3	1	4.42E-07
Ni-59	5.07E-04	1E-2	5.07E-06	unlimited					
I-129	3.85E-04	1E-2	3.85E-06						
U-233	2.35E-05	1E-2	2.35E-07	1.60E-01	1.47E-06	0.35	5E-3	1	2.57E-09
Tc-99	1.04E-03	1E-2	1.04E-05	2.40E+01	4.34E-07	0.35	5E-3	1	7.60E-10
H-3	1.92E-05	1E-2	1.92E-07	1.10E+03	1.75E-10	0.35	5E-3	1	3.06E-13
U-234	8.30E-06	1E-2	8.30E-08	1.60E-01	5.18E-07	0.35	5E-3	1	9.07E-10
U-238	6.10E-06	1E-2	6.10E-08	unlimited					
U-236	4.15E-06	1E-2	4.15E-08	1.60E-01	2.60E-07	0.35	5E-3	1	4.54E-10
U-235	1.38E-06	1E-2	1.38E-08	unlimited					
Cm-242	1.37E-04	1E-2	1.37E-06	2.70E-01	5.07E-06	0.35	5E-3	1	8.87E-09
Am-243	1.34E-04	1E-2	1.34E-06	2.70E-02	4.98E-05	0.35	5E-3	1	8.72E-08
Cm-243	8.04E-05	1E-2	8.04E-07	2.70E-02	2.98E-05	0.35	5E-3	1	5.21E-08
Th-228	4.56E-05	1E-2	4.56E-07	included with U-232					
Np-237	1.69E-05	1E-2	1.69E-07	5.40E-02	3.13E-06	0.35	5E-3	1	5.48E-09
U-232	1.03E-03	1E-2	1.03E-05	2.70E-02	3.80E-04	0.35	5E-3	1	6.65E-07
Th-232	8.35E-07	1E-2	8.35E-09	unlimited					
Th-230	3.04E-07	1E-2	3.04E-09	2.70E-02	1.13E-07	0.35	5E-3	1	1.97E-10
Pu-241	7.42E-03	1E-2	7.42E-05	1.60E+00	4.64E-05	0.35	5E-3	1	8.12E-08
Cm-244	2.15E-03	1E-2	2.15E-05	5.40E-02	3.98E-04	0.35	5E-3	1	6.97E-07
							subtotal		1.94E-5

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Table 18. HAC-ST from LDCC External to Melter

Isotope	Content (Ci)	Leach Ratio	Leached (Ci)	A_2 (Ci/A_2)	MAR (A_2)	DR	ARF	LPF WV MP	Release (A_2)
	From Table 1	From Table 3 for PBS to LDCC	Calculated for LDCC external to melter	From Table 1	Calculated for LDCC external to melter	From Table 3 for LDCC external to the melter			Calculated for inhalation from LDCC external to the melter
a	b	c	d=b*c	c	f=d*e	g	h	i	j=f*g*h*i
Cs-137	6.43E+00	1E-2	6.43E-02	1.60E+01	4.02E-03	0.35	5E-3	1	7.03E-06
Ba-137m	6.07E+00	1E-2	6.07E-02	included with Cs-137					
Sr-90	2.84E+00	1E-2	2.84E-02	8.10E+00	3.51E-03	0.35	5E-3	1	6.14E-06
Y-90	2.84E+00	1E-2	2.84E-02	included with Sr-90					
Pm-147	6.88E-02	1E-2	6.88E-04	5.40E+01	1.27E-05	0.35	5E-3	1	2.23E-08
Am-241	3.43E-02	1E-2	3.43E-04	1.60E+00	2.14E-04	0.35	5E-3	1	3.75E-07
Eu-154	2.94E-02	1E-2	2.94E-04	1.60E+01	1.84E-05	0.35	5E-3	1	3.21E-08
Ni-63	1.55E-02	1E-2	1.55E-04	8.10E+02	1.91E-07	0.35	5E-3	1	3.35E-10
Fe-55	1.58E-02	1E-2	1.58E-04	1.10E+03	1.43E-07	0.35	5E-3	1	2.51E-10
Pu-238	3.79E-03	1E-2	3.79E-05	2.70E-02	1.40E-03	0.35	5E-3	1	2.45E-06
C-14	3.78E-03	1E-2	3.78E-05	8.10E+01	4.67E-07	0.35	5E-3	1	8.17E-10
Co-60	1.31E-03	1E-2	1.31E-05	1.10E+01	1.19E-06	0.35	5E-3	1	2.09E-09
U-232	1.03E-03	1E-2	1.03E-05	2.70E-02	3.80E-04	0.35	5E-3	1	6.65E-07
Pu-239	9.84E-04	1E-2	9.84E-06	2.70E-02	3.64E-04	0.35	5E-3	1	6.38E-07
Pu-240	6.82E-04	1E-2	6.82E-06	2.70E-02	2.52E-04	0.35	5E-3	1	4.42E-07
Ni-59	5.07E-04	1E-2	5.07E-06	unlimited					
I-129	3.85E-04	1E-2	3.85E-06						
U-233	2.35E-05	1E-2	2.35E-07	1.60E-01	1.47E-06	0.35	5E-3	1	2.57E-09
Tc-99	1.04E-03	1E-2	1.04E-05	2.40E+01	4.34E-07	0.35	5E-3	1	7.60E-10
H-3	1.92E-05	1E-2	1.92E-07	1.10E+03	1.75E-10	0.35	5E-3	1	3.06E-13
U-234	8.30E-06	1E-2	8.30E-08	1.60E-01	5.18E-07	0.35	5E-3	1	9.07E-10
U-238	6.10E-06	1E-2	6.10E-08	unlimited					
U-236	4.15E-06	1E-2	4.15E-08	1.60E-01	2.60E-07	0.35	5E-3	1	4.54E-10
U-235	1.38E-06	1E-2	1.38E-08	unlimited					
Cm-242	1.37E-04	1E-2	1.37E-06	2.70E-01	5.07E-06	0.35	5E-3	1	8.87E-09
Am-243	1.34E-04	1E-2	1.34E-06	2.70E-02	4.98E-05	0.35	5E-3	1	8.72E-08
Cm-243	8.04E-05	1E-2	8.04E-07	2.70E-02	2.98E-05	0.35	5E-3	1	5.21E-08
Th-228	4.56E-05	1E-2	4.56E-07	included with U-232					
Np-237	1.69E-05	1E-2	1.69E-07	5.40E-02	3.13E-06	0.35	5E-3	1	5.48E-09
U-232	1.03E-03	1E-2	1.03E-05	2.70E-02	3.80E-04	0.35	5E-3	1	6.65E-07
Th-232	8.35E-07	1E-2	8.35E-09	unlimited					
Th-230	3.04E-07	1E-2	3.04E-09	2.70E-02	1.13E-07	0.35	5E-3	1	1.97E-10
Pu-241	7.42E-03	1E-2	7.42E-05	1.60E+00	4.64E-05	0.35	5E-3	1	8.12E-08
Cm-244	2.15E-03	1E-2	2.15E-05	5.40E-02	3.98E-04	0.35	5E-3	1	6.97E-07
							subtotal		1.94E-5

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Table 19. HAC-ST from Non-Inhalation LDCC External to Melter

Isotope	Content (Ci)	Leach Fraction	Leached (Ci)	A_2 (Ci/A_2)	MAR (A_2)	DR	LPF WVMP	Release (A_2)
	From Table 1	From Table 3	Calculated for LDCC external to melter	From Table 1	Calculated for LDCC external to melter	From Table 3 for LDCC external to the melter		Calculated for non-inhalation from LDCC external to the melter
a	b	c	d=b*c	e	f=d*/e	g	h	i=f*g*h
Cs-137	6.43E+00	1E-2	6.43E-02	1.60E+01	4.02E-03	0.35	1	1.41E-03
Ba-137m	6.07E+00	1E-2	6.07E-02	included with Cs-137				
Sr-90	2.84E+00	1E-2	2.84E-02	8.10E+00	3.51E-03	0.35	1	1.23E-03
Y-90	2.84E+00	1E-2	2.84E-02	included with Sr-90				
Pm-147	6.88E-02	1E-2	6.88E-04	5.40E+01	1.27E-05	0.35	1	4.46E-06
Am-241	3.43E-02	1E-2	3.43E-04	1.60E+00	2.14E-04	0.35	1	7.50E-05
Eu-154	2.94E-02	1E-2	2.94E-04	1.60E+01	1.84E-05	0.35	1	6.43E-06
Ni-63	1.55E-02	1E-2	1.55E-04	8.10E+02	1.91E-07	0.35	1	6.70E-08
Fe-55	1.58E-02	1E-2	1.58E-04	1.10E+03	1.43E-07	0.35	1	5.01E-08
Pu-238	3.79E-03	1E-2	3.79E-05	2.70E-02	1.40E-03	0.35	1	4.91E-04
C-14	3.78E-03	1E-2	3.78E-05	8.10E+01	4.67E-07	0.35	1	1.63E-07
Co-60	1.31E-03	1E-2	1.31E-05	1.10E+01	1.19E-06	0.35	1	4.17E-07
U-232	1.03E-03	1E-2	1.03E-05	2.70E-02	3.80E-04	0.35	1	1.33E-04
Pu-239	9.84E-04	1E-2	9.84E-06	2.70E-02	3.64E-04	0.35	1	1.28E-04
Pu-240	6.82E-04	1E-2	6.82E-06	2.70E-02	2.52E-04	0.35	1	8.84E-05
Ni-59	5.07E-04	1E-2	5.07E-06	unlimited				
I-129	3.85E-04	1E-2	3.85E-06					
U-233	2.35E-05	1E-2	2.35E-07	1.60E-01	1.47E-06	0.35	1	5.15E-07
Tc-99	1.04E-03	1E-2	1.04E-05	2.40E+01	4.34E-07	0.35	1	1.52E-07
H-3	1.92E-05	1E-2	1.92E-07	1.10E+03	1.75E-10	0.35	1	6.12E-11
U-234	8.30E-06	1E-2	8.30E-08	1.60E-01	5.18E-07	0.35	1	1.81E-07
U-238	6.10E-06	1E-2	6.10E-08	unlimited				
U-236	4.15E-06	1E-2	4.15E-08	1.60E-01	2.60E-07	0.35	1	9.09E-08
U-235	1.38E-06	1E-2	1.38E-08	unlimited				
Cm-242	1.37E-04	1E-2	1.37E-06	2.70E-01	5.07E-06	0.35	1	1.77E-06
Am-243	1.34E-04	1E-2	1.34E-06	2.70E-02	4.98E-05	0.35	1	1.74E-05
Cm-243	8.04E-05	1E-2	8.04E-07	2.70E-02	2.98E-05	0.35	1	1.04E-05
Th-228	4.56E-05	1E-2	4.56E-07	included with U-232				
Np-237	1.69E-05	1E-2	1.69E-07	5.40E-02	3.13E-06	0.35	1	1.10E-06
U-232	1.03E-03	1E-2	1.03E-05	2.70E-02	3.80E-04	0.35	1	1.33E-04
Th-232	8.35E-07	1E-2	8.35E-09	unlimited				
Th-230	3.04E-07	1E-2	3.04E-09	2.70E-02	1.13E-07	0.35	1	3.94E-08
Pu-241	7.42E-03	1E-2	7.42E-05	1.60E+00	4.64E-05	0.35	1	1.62E-05
Cm-244	2.15E-03	1E-2	2.15E-05	5.40E-02	3.98E-04	0.35	1	1.39E-04
						subtotal		3.88E-3

Table 20 summarizes the individual contributions and provides the maximum HAC release in terms of A_2 values.

Table 20. Total HAC Release in Terms of A_2

from Glass	A_2
Spout Glass	2.49E-05
Melter Heel Glass	1.90E-05
Refractory Glass	2.02E-05
from LDCC	
LDCC inside the Melter	5.08E-07
pressure increase	5.08E-06
LDCC external to melter	1.94E-05
pressure increase	1.94E-05
Non-inhalation Release	3.88E-03
Total	3.99E-03

Based on Table 20, the HAC release is conservatively less than 1E-1.

7. RESULTS

The calculated potential A_2 release under NCT is < 1E-7 A_2, while the A_2 release under HAC is < 1E-1.

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8. CONCLUSIONS

The 10 CFR 71.51 requirements for HAC are that the release will be less than one A_2 in one week. Conservatively assuming the limit as an instantaneous release, with the HAC results concluding a release to be < 1E-1 A_2, demonstrates that the limit will not be exceeded.

The 10 CFR 71.51 requirements for NCT are that the release under NCT conditions will be less than 1E-6 A_2 in one hour. Conservatively assuming the limit as an instantaneous release, with the NCT analysis concluding a release to be < 1E-7 A_2, demonstrates that the NCT limit will not be exceeded.

9. ATTACHMENTS

Formula for Table 1

	A	B	C	D	E	F
1 2 3	**Isotope**	**A_2**	**Spout glass content (Ci)**	**Heel Glass content (Ci)**	**Refractory glass content (Ci)**	**Surface contaminatrion (Ci)**
4	**H-3**	1100				0.0000192270792596751
5	**C-14**	81	0.00222	0.00347		0.00378111123902642
6	**Co-60**	11	0.00547	0.00316	0.01332	0.0013118141033357
7	**K-40**	24	0.0086	0.015		
8	**Mn-54**	27	0.0000005	0.00000144		
9	**Fe-55**	1100				0.0157546301626101
10	**Ni-59**	unlimited				0.000506720349719867
11	**Ni-63**	810	0.098	0.152		0.0154974117109756
12	**Sr-90**	8.1	63.3	31.2	106.8	2.84226389056067
13	**Y-90**	included with Sr-90	63.3	31.2	106.8	2.84
14	**Zr-95**	22	3.17E-22	1.3E-20		
15	**Nb-95**	27	6.99E-22	2.86E-20		
16	**Nb95m**	included with Zr-95	3.63E-24	1.49E-22		
17	**Tc-99**	24	0.0157	0.00201	0.0522	0.00104173472911952
18	**I-129**	unlimited				0.000385184631322589
19	**Cs-137**	16	857	542	213.2	6.43046129086125
20	**Ba-137m**	included with Cs-137	809	512	201.2	6.07
21	**Pm-147**	54				0.0688059358122154
22	**Eu-154**	16	0.104	0.0812	0.5527	0.0293872080992359
23	**Hg-206**	0.54	0.000000000000000714	0.000000000000000979	0.0000000000000002537	
24	**Tl-206**	Include with Bi-210m	0.0000000000000501	0.0000000000000688	0.00000000000001782	
25	**Tl-207**	0.54	0.00000000186	0.00000000256	0.00000000296	
26	**Tl-208**	included with U-232	0.00173	0.00272	0.0001806	
27	**Tl-209**	included with Th-229	0.0000000558	0.0000000809	0.00000001434	
28	**Tl-210**	0.54	0.000000000045	0.0000000000654	0.00000000001672	
29	**Pb-210m**	included with Th-229	0.00000258	0.00000375	0.0000006641	
30	**Pb-210**	1.4	0.0000000376	0.0000000516	0.00000001335	
31	**Pb-211**	0.54	0.00000000187	0.00000000257	0.000000002968	
32	**Pb-212**	included with U-232	0.00482	0.00756	0.0005026	
33	**Pb-214**	included with Rn-222	0.000000214	0.000000311	0.0000000796	
34	**Bi-209**	included with Pb-210	5.97E-25	8.1E-25	1.457E-25	
35	**Bi-210**	included with Bi-212	0.0000000375	0.0000000514	0.00000001331	
36	**Bi-211**	included with Ra-223	0.00000000187	0.00000000257	0.000000002968	
37	**Bi-212**	included with U-232	0.00482	0.00756	0.0005026	
38	**Bi-213**	included with Th-229	0.00000258	0.00000375	0.000000664	
39	**Bi-214**	included with Rn-222	0.000000214	0.000000311	0.00000007962	
40	**Bi-215**	0.54	0.0000000000000000153	0.000000000000000021	0.0000000000000002428	
41	**Po-210**	included with Pb-210	0.0000000345	0.0000000471	0.00000001222	

Formulas for Table 1

	A	B	C	D	E	F
42	**Po-211**	0.0024	0.0000000000051	0.00000000000701	0.000000000008103	
43	**Po-212**	included with Pb-212	0.00309	0.00484	0.0003219	
44	**Po-213**	included with Th-229	0.00000253	0.00000367	0.0000006498	
45	**Po-214**	included with U-230	0.000000214	0.000000311	0.0000000796	
46	**Po-215**	inluded with Ra-223	0.00000000187	0.00000000257	0.000000002968	
47	**Po-216**	included with U-232	0.00482	0.00756	0.0005026	
48	**Po-218**	included with Rn-222	0.000000214	0.000000311	0.00000007962	
49	**At-215**	0.0024	0.00000000000000747	0.0000000000000103	0.00000000000001187	
50	**At-217**	included with Th-229	0.00000258	0.00000375	0.0000006641	
51	**At-218**	0.0024	0.0000000000407	0.0000000000592	0.00000000001513	
52	**At-219**	0.0024	0.00000000000000157	0.00000000000000217	0.000000000000002503	
53	**Rn-217**	0.0024	0.00000000031	0.00000000045	0.00000000007969	
54	**Rn-218**	included with U-230	0.0000000000000407	0.0000000000000592	0.00000000000001513	
55	**Rn-219**	0.0024	0.00000000187	0.00000000257	0.000000002968	
56	**Rn-220**	included with U-232	0.00482	0.00756	0.0005026	
57	**Rn-222**	0.11	0.000000214	0.000000311	0.00000007962	
58	**Fr-221**	included with Th-229	0.000002583	0.000003748	0.0000006641	
59	**Fr-223**	0.54	0.00000000002623	0.00000000003608	0.00000000004172	
60	**Ra-223**	0.19	0.000000001868	0.000000002566	0.000000002968	
61	**Ra-224**	included with U-232	0.004823	0.007563	0.0005026	
62	**Ra-225**	included with Th-229	0.000002591	0.00000376	0.0000006663	
63	**Ra-226**	0.081	0.0000002143	0.0000003118	0.00000007972	
64	**Ra-228**	0.54	0.00003409	0.00005144	0.00003211	
65	**Ac-225**	included with Th-229	0.000002583	0.000003748	0.0000006641	
66	**Ac-227**	0.0024	0.000000001901	0.000000002614	0.000000003023	
67	**Ac-228**	included with Ra-228	0.00003409	0.00005144	0.00003211	
68	**Th-227**	0.14	0.000000001854	0.000000002548	0.00000000295	
69	**Th-228**	included with U-232	0.004822	0.007562	0.000502	0.0000455507276345423
70	**Th-229**	0.014	0.000002602	0.000003778	0.00000067	
71	**Th-230**	0.027	0.00003892	0.00006047	0.0000152	
72	**Th-231**	included with U-235	0.0000395	0.0000615	0.0000692	
73	**Th-232**	unlimited	0.0000434	0.0000674	0.0000418	8.34853736085892E-07
74	**Th-234**	included with U-238	0.000241	0.000374	0.000116	3.04278860598743E-07
75	**Pa-231**	0.011	0.00000001066	0.00000001554	0.0000000178	
76	**Pa-233**	included with Np-237	0.0007086	0.001052	0.000849	
77	**Pa-234**	0.54	0.0000003615	0.000000561	0.000000174	
78	**Pa-234m**	included with U-238	0.000241	0.000374	0.000116	
79	**U-232**	0.027	0.00466	0.007309	0.000441	=0.00101601288395608+9.943652688
80	**U-233**	0.16	0.00216	0.00335	0.000585	0.0000235354883245522
81	**U-234**	0.16	0.001034	0.001604	0.000284	8.29529506521102E-06
82	**U-235**	unlimited	0.0000395	0.0000615	0.0000692	6.09607730373647E-06

	A	B	C	D	E	F
83	**U-235m**	unlimited	0.03007	0.02608	0.0372	4.15407799389637E-06
84	**U-236**	0.16	0.000119	0.000184	0.000208	1.38254917753517E-06
85	**U-237**	included with Pu-241	0.000004556	0.000007365	0.00000508	
86	**U-238**	unlimited	0.000241	0.000374	0.000116	
87	**Np-237**	0.054	0.0007086	0.001052	0.000849	0.000016918294211786
88	**Np-239**	included with Am-243	0.004545	0.005973	0.00672	
89	**Pu-238**	0.027	0.1139	0.1039	0.141	0.00378754170031728
90	**Pu-239**	0.027	0.03009	0.02609	0.0372	0.000983860577501772
91	**Pu-240**	0.027	0.02294	0.02005	0.0285	0.000681628896831293
92	**Pu-241**	1.6	0.185	0.299	0.206	0.00742164859034811
93	**Am-241**	0.027	0.3804	0.4952	0.845	0.0342743586802905
94	**Am-243**	0.027	0.004545	0.005973	0.00672	0.000134481633831818
95	**Cm-242**	0.27	0.00000000001047	0.0000000003084	0.0000000000449	0.000136852889825064
96	**Cm-243**	0.027	0.001854	0.002162	0.00304	0.0000803761986794305
97	**Cm-244**	0.054	0.04067	0.04696	0.0677	0.00215006331467477
98			=SUM(C4:C97)	=SUM(D4:D97)	=SUM(E4:E97)	=SUM(F4:F97)

Formulas for Table 2

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
2	Glass into LDCC (g/cm^2 day)		Leach Duration (days)	Glass LDCC Interface (cm^2)		Leaced glass (g)	Leach Ratio glass	Leach Ratio PBS	DR Glass	DR LDCC external	DR LDCC Inter	ARF Glass	Cont ARF LDCC	ARF Pressure	RF Pressure	$LPF_{Melter\ or}$ $LPF_{WVMP\ as\ applicable}$	
3	0.00001		28	267560.755		=A3*D3* C3	=F3/46720	0.01	0.001	0.01	0.002	0.000001	0.00001	0.005	0.4	1	0.1
4	a		b	c		d= a*b*c	e= d/467200	f	g	h	i	j	k	l	m	n	o
5	Based on the maximum leach rate for glass (Ref.8, Summary).		For glass to LDCC. Based on glass requiring 28 days to reach desired strength.	Assumed to be the footprint of the melter of the box multiplied by 2 (Ref. 9 page A-5 =12ft*12ft*2 expressed in cm^2).		Calculated leached fraction of rads from glass to LDCC. Used to calculate A_2 contained within the LDCC inside the melter.	Fraction of glass leached based on using 1/10 of 467.2 kg for total glass (Ref. 15)	Conservatively assumed based on effort required to remove the resultant impermeable covering from Barlett's PBS (Ref. 9&10).	Broken Glass Fraction for glass. Conservative based on using G values from BNWL-1903, which are much higher than actual (see structural analysis) with values taken	External to the melter LDCC Conservative based on structural analysis.	Internal to the melter LDCC impacted from NCT. Conservative based on structural analysis.	For NCT glass based on assuming all Sub 20 Micron glass is dispersed (aka Sub 20 Micron Glass fraction)Values taken from Ref 14, Figure 38 at 20 ft./sec.	Contained LDCC with single LPF already credited (aka Contained Concrete (fly-ash) Airborne Fraction). Ref. 12 (Note: LPF implicit in value based on how testing was performed.	Based on Ref 4, an ARF of 5E-3 can be used when the pressure increases to less than 25 psig.	Also Based on Ref 4, an RF of 0.4 should be applied to l to less than 25 psig.	Assumed for dispersible rads when escaping through 1 WVMP structure (i.e., no additional credit taken).	WVMP is not damaged from NCT therfore LPFs appliediNumber based on recommendation associated with Ref. 11. (LPFs of 0.1 can be applied if sealed relased)

Formula[illegible] Table 3

	A B	C	D E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Leach Rate	LDCC Days to Hard	Surface Area	Glass Leached Mass (g)	Leached Fraction		HAC Fraction Impacted/Broken			HAC Fraction Aerosolized					Leak Path Factors		Non-Inhalation Escape Fraction
2	Glass into LDCC (g/cm^2 day)	Leach Duration (days)	Glass LDCC Interface (cm^2)	Leach Mass (g)	Leach Ratio Glass	Leach Ratio PBS	DR Glass	DR LDCC external	DR LDCC Inter	ARF Glass	Cont ARF LDCC	Uncont ARF LDCC	$ARF_{Pressure}$	$RF_{Pressure}$	LPF_{WVMP}	LPF_{Melter}	$EF_{Non-Aerosol}$
3	0.00001	28	267560.755	=A3*C3*D3	=F3/46720	0.01	0.01	0.35	0.1	=0.03/10	0.00005	0.0075	0.005	1	1	0.1	1
4	Based on the maximum leach rate for glass (Ref.8, Summary) .	For glass to LDCC. Based on glass requiring 28 days to reach desired strength.	Conservatively assumed to be the footprint of the melter of the box multiplied by 2 (Ref.9 page A-5 =12ft*12ft*2 expressed in cm^2).	Calculated leached fraction of rads from glass to LDCC. Used to calculate A2s contained within the LDCC inside the melter.	Fraction of glass leached based on using 1/10 of 467.2 kg for total glass (Ref. 15)	Conservatively assumed based on effort required to remove the resultant impermeable covering from Barlett's PBS (Ref. 9&10).	Broken Glass Fraction for HAC glass. Conservative based on using G values from BNWL-1903, which are much higher than actual (see structural analysis) with values taken from Ref 12, Figure 33 at 60 ft./sec.	External to the melter LDCC impacted from HAC. Based on structural analysis.	Internal to the melter LDCC impacted from HAC. Conservative based on structural analysis.	For HAC glass based on assuming all Sub 20 Micron glass is dispersed (aka Sub 20 Micron Glass fraction)Values taken from Ref 12, Figure 38 at 60 ft./sec.	For contained LDCC with single LPF already applied (aka Contained Concrete (fly-ash) Airborne Fraction). Ref. IAEA/INIS RN:37121627 (Note: LPF implicit in value. For internal to melter LDCC, the final release when calculated will have only 1 (additional) LPF applied to it. If value used for external to the melter LDCC no additional LPF should be applied when calculating release).	For HAC un-contained LDCC (aka Un-Contained Concrete (fly-ash) Airborne Fraction (HAC uncontained LDCC ARF without LPF applied. Ref. 13)	Based on Ref 4, an ARF of 5E-3 can be used when the pressure increases to less than 25 psi.	Also Based on Ref 4, an RF of 1 should be applied.	For dispersible rads when escaping through 1 structure, assumed equal to 1.	For dispersible rads when escaping through external LDCC and out of WVMP. Assumed based on Ref. 12. For HAC only used for melter	For non-inhalation LDCC conservatively assumed to be 1.

Formulas for Table 4

	A	B	C	D	E	F	G	H	I
1	Isotope	Content (Ci)	A_2 (Ci/A_2)	MAR (A_2)	DR	ARF	LPF Melter	LPF WVMP	Release (A_2)
2		From Table 1		Calculated for spout glass	From Table 2, Same or all NCT glass				Calculated for inhalation from spout glass
3	*a*	*b*	*c*	*d=b/c*	*e*	*f*	*g*	*h*	*i=d*e*f*g*h*
4	C-14	='1content'!C5	='1content'!B5	=B4/C4	='2NCTInputs'!I$3	='2NCTInputs'!L$3	='2NCTInputs'!Q$3	='2NCTInputs'!Q$3	=D4*E4*F4*G4*H4
5	K-40	='1content'!C7	='1content'!B7	=B5/C5	='2NCTInputs'!I$3	='2NCTInputs'!L$3	='2NCTInputs'!Q$3	=H$4	=D5*E5*F5*G5*H5
6	Mn-54	='1content'!C8	='1content'!B8	=B6/C6	='2NCTInputs'!I$3	='2NCTInputs'!L$3	='2NCTInputs'!Q$3	=H$4	=D6*E6*F6*G6*H6
7	Co-60	='1content'!C6	='1content'!B6	=B7/C7	='2NCTInputs'!I$3	='2NCTInputs'!L$3	='2NCTInputs'!Q$3	=H$4	=D7*E7*F7*G7*H7
8	Ni-63	='1content'!C11	='1content'!B11	=B8/C8	='2NCTInputs'!I$3	='2NCTInputs'!L$3	='2NCTInputs'!Q$3	=H$4	=D8*E8*F8*G8*H8
9	Sr-90	='1content'!C12	='1content'!B12	=B9/C9	='2NCTInputs'!I$3	='2NCTInputs'!L$3	='2NCTInputs'!Q$3	=H$4	=D9*E9*F9*G9*H9
10	Y-90	='1content'!C13	='1content'!B13						
11	Zr-95	='1content'!C14	='1content'!B14	=B11/C11	='2NCTInputs'!I$3	='2NCTInputs'!L$3	='2NCTInputs'!Q$3	=H$4	=D11*E11*F11*G11*H11
12	Nb-95	='1content'!C15	='1content'!B15	=B12/C12	='2NCTInputs'!I$3	='2NCTInputs'!L$3	='2NCTInputs'!Q$3	=H$4	=D12*E12*F12*G12*H12
13	Nb-95m	='1content'!C16	='1content'!B16						
14	Tc-99	='1content'!C17	='1content'!B17	=B14/C14	='2NCTInputs'!I$3	='2NCTInputs'!L$3	='2NCTInputs'!Q$3	=H$4	=D14*E14*F14*G14*H14
15	Cs-137	='1content'!C19	='1content'!B19	=B15/C15	='2NCTInputs'!I$3	='2NCTInputs'!L$3	='2NCTInputs'!Q$3	=H$4	=D15*E15*F15*G15*H15
16	Ba-137m	='1content'!C20	='1content'!B20						
17	Eu-154	='1content'!C22	='1content'!B22	=B17/C17	='2NCTInputs'!I$3	='2NCTInputs'!L$3	='2NCTInputs'!Q$3	=H$4	=D17*E17*F17*G17*H17
18	Hg-206	='1content'!C23	='1content'!B23	=B18/C18	='2NCTInputs'!I$3	='2NCTInputs'!L$3	='2NCTInputs'!Q$3	=H$4	=D18*E18*F18*G18*H18
19	Tl-206	='1content'!C24	='1content'!B24						
20	Tl-207	='1content'!C25	='1content'!B25	=B20/C20	='2NCTInputs'!I$3	='2NCTInputs'!L$3	='2NCTInputs'!Q$3	=H$4	=D20*E20*F20*G20*H20
21	Tl-208	='1content'!C26	='1content'!B26						
22	Tl-209	='1content'!C27	='1content'!B27						
23	Tl-210	='1content'!C28	='1content'!B28	=B23/C23	='2NCTInputs'!I$3	='2NCTInputs'!L$3	='2NCTInputs'!Q$3	=H$4	=D23*E23*F23*G23*H23
24	Pb-210m	='1content'!C29	='1content'!B29						
25	Pb-210	='1content'!C30	='1content'!B30	=B25/C25	='2NCTInputs'!I$3	='2NCTInputs'!L$3	='2NCTInputs'!Q$3	=H$4	=D25*E25*F25*G25*H25
26	Pb-211	='1content'!C31	='1content'!B31	=B26/C26	='2NCTInputs'!I$3	='2NCTInputs'!L$3	='2NCTInputs'!Q$3	=H$4	=D26*E26*F26*G26*H26
27	Pb-212	='1content'!C32	='1content'!B32						
28	Pb-214	='1content'!C33	='1content'!B33						
29	Bi-209	='1content'!C34	='1content'!B34						
30	Bi-210	='1content'!C35	='1content'!B35						
31	Bi-211	='1content'!C36	='1content'!B36						
32	Bi-212	='1content'!C37	='1content'!B37						
33	Bi-213	='1content'!C38	='1content'!B38						
34	Bi-214	='1content'!C39	='1content'!B39						
35	Bi-215	='1content'!C40	='1content'!B40	=B35/C35	='2NCTInputs'!I$3	='2NCTInputs'!L$3	='2NCTInputs'!Q$3	=H$4	=D35*E35*F35*G35*H35
36	Po-210	='1content'!C41	='1content'!B41						
37	Po-211	='1content'!C42	='1content'!B42	=B37/C37	='2NCTInputs'!I$3	='2NCTInputs'!L$3	='2NCTInputs'!Q$3	=H$4	=D37*E37*F37*G37*H37
38	Po-212	='1content'!C43	='1content'!B43						

Formula Table 4

	A	B	C	D	E	F	G	H	I
39	Po-213	='1content'!C44	='1content'!B44						
40	Po-214	='1content'!C45	='1content'!B45						
41	Po-215	='1content'!C46	='1content'!B46						
42	Po-216	='1content'!C47	='1content'!B47						
43	Po-218	='1content'!C48	='1content'!B48						
44	At-215	='1content'!C49	='1content'!B49	=B44/C44	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!O$3	=H$4	=D44*E44*F44*G44*H44
45	At-217	='1content'!C50	='1content'!B50						
46	At-218	='1content'!C51	='1content'!B51	=B46/C46	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!O$3	=H$4	=D46*E46*F46*G46*H46
47	At-219	='1content'!C52	='1content'!B52	=B47/C47	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!O$3	=H$4	=D47*E47*F47*G47*H47
48	Rn-217	='1content'!C53	='1content'!B53	=B48/C48	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!O$3	=H$4	=D48*E48*F48*G48*H48
49	Rn-218	='1content'!C54	='1content'!B54						
50	Rn-219	='1content'!C55	='1content'!B55	=B50/C50	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!O$3	=H$4	=D50*E50*F50*G50*H50
51	Rn-220	='1content'!C56	='1content'!B56						
52	Rn-222	='1content'!C57	='1content'!B57	=B52/C52	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!O$3	=H$4	=D52*E52*F52*G52*H52
53	Fr-221	='1content'!C58	='1content'!B58						
54	Fr-223	='1content'!C59	='1content'!B59	=B54/C54	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!O$3	=H$4	=D54*E54*F54*G54*H54
55	Ra-223	='1content'!C60	='1content'!B60	=B55/C55	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!O$3	=H$4	=D55*E55*F55*G55*H55
56	Ra-224	='1content'!C61	='1content'!B61						
57	Ra-225	='1content'!C62	='1content'!B62						
58	Ra-226	='1content'!C63	='1content'!B63	=B58/C58	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!O$3	=H$4	=D58*E58*F58*G58*H58
59	Ra-228	='1content'!C64	='1content'!B64	=B59/C59	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!O$3	=H$4	=D59*E59*F59*G59*H59
60	Ac-225	='1content'!C65	='1content'!B65						
61	Ac-227	='1content'!C66	='1content'!B66	=B61/C61	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!O$3	=H$4	=D61*E61*F61*G61*H61
62	Ac-228	='1content'!C67	='1content'!B67						
63	Th-227	='1content'!C68	='1content'!B68	=B63/C63	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!O$3	=H$4	=D63*E63*F63*G63*H63
64	Th-228	='1content'!C69	='1content'!B69						
65	Th-229	='1content'!C70	='1content'!B70	=B65/C65	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!O$3	=H$4	=D65*E65*F65*G65*H65
66	Th-230	='1content'!C71	='1content'!B71	=B66/C66	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!O$3	=H$4	=D66*E66*F66*G66*H66
67	Th-231	='1content'!C72	='1content'!B72						
68	Th-232	='1content'!C73	='1content'!B73						
69	Th-234	='1content'!C74	='1content'!B74						
70	Pa-231	='1content'!C75	='1content'!B75	=B70/C70	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!O$3	=H$4	=D70*E70*F70*G70*H70
71	Pa-233	='1content'!C76	='1content'!B76						
72	Pa-234	='1content'!C77	='1content'!B77	=B72/C72	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!O$3	=H$4	=D72*E72*F72*G72*H72
73	Pa-234m	='1content'!C78	='1content'!B78						
74	U-232	='1content'!C79	='1content'!B79	=B74/C74	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!O$3	=H$4	=D74*E74*F74*G74*H74
75	U-233	='1content'!C80	='1content'!B80	=B75/C75	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!O$3	=H$4	=D75*E75*F75*G75*H75
76	U-234	='1content'!C81	='1content'!B81	=B76/C76	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!O$3	=H$4	=D76*E76*F76*G76*H76
77	U-235	='1content'!C82							
78	U-235m	='1content'!C83	='1content'!B82						
79	U-236	='1content'!C84	='1content'!B84	=B79/C79	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!O$3	=H$4	=D79*E79*F79*G79*H79

Formulas for Table 4

	A	B	C	D	E	F	G	H	I
80	U-237	='1content'!C85	='1content'!B85						
81	U-238	='1content'!C86	='1content'!B86						
82	Np-237	='1content'!C87	='1content'!B87	=B82/C82	='2NCTInputs'!I$3	='2NCTInputs'!L$3	='2NCTInputs'!O$3	=H$4	=D82*E82*F82*G82*H82
83	Np-239	='1content'!C88	='1content'!B88						
84	Pu-238	='1content'!C89	='1content'!B89	=B84/C84	='2NCTInputs'!I$3	='2NCTInputs'!L$3	='2NCTInputs'!O$3	=H$4	=D84*E84*F84*G84*H84
85	Pu-239	='1content'!C90	='1content'!B90	=B85/C85	='2NCTInputs'!I$3	='2NCTInputs'!L$3	='2NCTInputs'!O$3	=H$4	=D85*E85*F85*G85*H85
86	Pu-240	='1content'!C91	='1content'!B91	=B86/C86	='2NCTInputs'!I$3	='2NCTInputs'!L$3	='2NCTInputs'!O$3	=H$4	=D86*E86*F86*G86*H86
87	Pu-241	='1content'!C92	='1content'!B92	=B87/C87	='2NCTInputs'!I$3	='2NCTInputs'!L$3	='2NCTInputs'!O$3	=H$4	=D87*E87*F87*G87*H87
88	Am-241	='1content'!C93	='1content'!B93	=B88/C88	='2NCTInputs'!I$3	='2NCTInputs'!L$3	='2NCTInputs'!O$3	=H$4	=D88*E88*F88*G88*H88
89	Am-243	='1content'!C94	='1content'!B94	=B89/C89	='2NCTInputs'!I$3	='2NCTInputs'!L$3	='2NCTInputs'!O$3	=H$4	=D89*E89*F89*G89*H89
90	Cm-242	='1content'!C95	='1content'!B95	=B90/C90	='2NCTInputs'!I$3	='2NCTInputs'!L$3	='2NCTInputs'!O$3	=H$4	=D90*E90*F90*G90*H90
91	Cm-243	='1content'!C96	='1content'!B96	=B91/C91	='2NCTInputs'!I$3	='2NCTInputs'!L$3	='2NCTInputs'!O$3	=H$4	=D91*E91*F91*G91*H91
92	Cm-244	='1content'!C97	='1content'!B97	=B92/C92	='2NCTInputs'!I$3	='2NCTInputs'!L$3	='2NCTInputs'!O$3	=H$4	=D92*E92*F92*G92*H92
93									=SUM(I4:I92)

Formula [illegible] Table 5

	A	B	C	D	E	F	G	H	I
1	Isotope	Content (Ci)	A_2 (Ci/A_2)	MAR (A_2)	DR	ARF	LPF Melter	LPF WVMP	Release (A_2)
2		From Table 1		Calculated for heel glass	From Table 2. Same or all NCT glass				Calculated for inhalation from heel glass
3	a	b	c	d=b/c	e	f	g	h	i=d*e*f*g*h
4	C-14	='1content'!D5	='1content'!B5	=B4/C4	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D4*E4*F4*G4*H4
5	K-40	='1content'!D7	='1content'!B7	=B5/C5	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D5*E5*F5*G5*H5
6	Mn-54	='1content'!D8	='1content'!B8	=B6/C6	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D6*E6*F6*G6*H6
7	Co-60	='1content'!D6	='1content'!B6	=B7/C7	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D7*E7*F7*G7*H7
8	Ni-63	='1content'!D11	='1content'!B11	=B8/C8	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D8*E8*F8*G8*H8
9	Sr-90	='1content'!D12	='1content'!B12	=B9/C9	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D9*E9*F9*G9*H9
10	Y-90	='1content'!D13	='1content'!B13						
11	Zr-95	='1content'!D14	='1content'!B14	=B11/C11	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D11*E11*F11*G11*H11
12	Nb-95	='1content'!D15	='1content'!B15	=B12/C12	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D12*E12*F12*G12*H12
13	Nb-95m	='1content'!D16	='1content'!B16						
14	Tc-99	='1content'!D17	='1content'!B17	=B14/C14	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D14*E14*F14*G14*H14
15	Cs-137	='1content'!D19	='1content'!B19	=B15/C15	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D15*E15*F15*G15*H15
16	Ba-137m	='1content'!D20	='1content'!B20						
17	Eu-154	='1content'!D22	='1content'!B22	=B17/C17	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D17*E17*F17*G17*H17
18	Hg-206	='1content'!D23	='1content'!B23	=B18/C18	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D18*E18*F18*G18*H18
19	Tl-206	='1content'!D24	='1content'!B24						
20	Tl-207	='1content'!D25	='1content'!B25	=B20/C20	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D20*E20*F20*G20*H20
21	Tl-208	='1content'!D26	='1content'!B26						
22	Tl-209	='1content'!D27	='1content'!B27						
23	Tl-210	='1content'!D28	='1content'!B28	=B23/C23	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D23*E23*F23*G23*H23
24	Pb-210m	='1content'!D29	='1content'!B29						
25	Pb-210	='1content'!D30	='1content'!B30	=B25/C25	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D25*E25*F25*G25*H25
26	Pb-211	='1content'!D31	='1content'!B31	=B26/C26	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D26*E26*F26*G26*H26
27	Pb-212	='1content'!D32	='1content'!B32						
28	Pb-214	='1content'!D33	='1content'!B33						
29	Bi-209	='1content'!D34	='1content'!B34						
30	Bi-210	='1content'!D35	='1content'!B35						
31	Bi-211	='1content'!D36	='1content'!B36						
32	Bi-212	='1content'!D37	='1content'!B37						
33	Bi-213	='1content'!D38	='1content'!B38						
34	Bi-214	='1content'!D39	='1content'!B39						
35	Bi-215	='1content'!D40	='1content'!B40	=B35/C35	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D35*E35*F35*G35*H35
36	Po-210	='1content'!D41	='1content'!B41						
37	Po-211	='1content'!D42	='1content'!B42	=B37/C37	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D37*E37*F37*G37*H37
38	Po-212	='1content'!D43	='1content'!B43						

Formulas for Table 5

	A	B	C	D	E	F	G	H	I
39	Po-213	='1content'!D44	='1content'!B44						
40	Po-214	='1content'!D45	='1content'!B45						
41	Po-215	='1content'!D46	='1content'!B46						
42	Po-216	='1content'!D47	='1content'!B47						
43	Po-218	='1content'!D48	='1content'!B48						
44	At-215	='1content'!D49	='1content'!B49	=B44/C44	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D44*E44*F44*G44*H44
45	At-217	='1content'!D50	='1content'!B50						
46	At-218	='1content'!D51	='1content'!B51	=B46/C46	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D46*E46*F46*G46*H46
47	At-219	='1content'!D52	='1content'!B52	=B47/C47	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D47*E47*F47*G47*H47
48	Rn-217	='1content'!D53	='1content'!B53	=B48/C48	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D48*E48*F48*G48*H48
49	Rn-218	='1content'!D54	='1content'!B54						
50	Rn-219	='1content'!D55	='1content'!B55	=B50/C50	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D50*E50*F50*G50*H50
51	Rn-220	='1content'!D56	='1content'!B56						
52	Rn-222	='1content'!D57	='1content'!B57	=B52/C52	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D52*E52*F52*G52*H52
53	Fr-221	='1content'!D58	='1content'!B58						
54	Fr-223	='1content'!D59	='1content'!B59	=B54/C54	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D54*E54*F54*G54*H54
55	Ra-223	='1content'!D60	='1content'!B60	=B55/C55	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D55*E55*F55*G55*H55
56	Ra-224	='1content'!D61	='1content'!B61						
57	Ra-225	='1content'!D62	='1content'!B62						
58	Ra-226	='1content'!D63	='1content'!B63	=B58/C58	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D58*E58*F58*G58*H58
59	Ra-228	='1content'!D64	='1content'!B64	=B59/C59	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D59*E59*F59*G59*H59
60	Ac-225	='1content'!D65	='1content'!B65						
61	Ac-227	='1content'!D66	='1content'!B66	=B61/C61	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D61*E61*F61*G61*H61
62	Ac-228	='1content'!D67	='1content'!B67						
63	Th-227	='1content'!D68	='1content'!B68	=B63/C63	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D63*E63*F63*G63*H63
64	Th-228	='1content'!D69	='1content'!B69						
65	Th-229	='1content'!D70	='1content'!B70	=B65/C65	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D65*E65*F65*G65*H65
66	Th-230	='1content'!D71	='1content'!B71	=B66/C66	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D66*E66*F66*G66*H66
67	Th-231	='1content'!D72	='1content'!B72						
68	Th-232	='1content'!D73	='1content'!B73						
69	Th-234	='1content'!D74	='1content'!B74						
70	Pa-231	='1content'!D75	='1content'!B75	=B70/C70	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D70*E70*F70*G70*H70
71	Pa-233	='1content'!D76	='1content'!B76						
72	Pa-234	='1content'!D77	='1content'!B77	=B72/C72	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D72*E72*F72*G72*H72
73	Pa-234m	='1content'!D78	='1content'!B78						
74	U-232	='1content'!D79	='1content'!B79	=B74/C74	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D74*E74*F74*G74*H74
75	U-233	='1content'!D80	='1content'!B80	=B75/C75	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D75*E75*F75*G75*H75
76	U-234	='1content'!D81	='1content'!B81	=B76/C76	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D76*E76*F76*G76*H76
77	U-235	='1content'!D82							
78	U-235m	='1content'!D83	='1content'!B82						
79	U-236	='1content'!D84	='1content'!B84	=B79/C79	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D79*E79*F79*G79*H79

Formula Table 5

	A	B	C	D	E	F	G	H	I
80	U-237	='1content'!D85	='1content'!B85						
81	U-238	='1content'!D86	='1content'!B86						
82	Np-237	='1content'!D87	='1content'!B87	=B82/C82	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D82*E82*F82*G82*H82
83	Np-239	='1content'!D88	='1content'!B88						
84	Pu-238	='1content'!D89	='1content'!B89	=B84/C84	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D84*E84*F84*G84*H84
85	Pu-239	='1content'!D90	='1content'!B90	=B85/C85	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D85*E85*F85*G85*H85
86	Pu-240	='1content'!D91	='1content'!B91	=B86/C86	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D86*E86*F86*G86*H86
87	Pu-241	='1content'!D92	='1content'!B92	=B87/C87	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D87*E87*F87*G87*H87
88	Am-241	='1content'!D93	='1content'!B93	=B88/C88	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D88*E88*F88*G88*H88
89	Am-243	='1content'!D94	='1content'!B94	=B89/C89	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D89*E89*F89*G89*H89
90	Cm-242	='1content'!D95	='1content'!B95	=B90/C90	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D90*E90*F90*G90*H90
91	Cm-243	='1content'!D96	='1content'!B96	=B91/C91	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D91*E91*F91*G91*H91
92	Cm-244	='1content'!D97	='1content'!B97	=B92/C92	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='3HACinputs'!K$3	='3HACinputs'!K$3	=D92*E92*F92*G92*H92
93									=SUM(I4:I92)

Formulas for Table 6

	A	B	C	D	E	F	G	H	I
1	Isotope	Content (Ci)	A_2 (Ci/A_2)	MAR (A_2)	DR	ARF	LPF Melter	LPF WVMP	Release (A_2)
2		From Table 1		Calculated for refractory glass	From Table 2. Same or all NCT glass				Calculated for inhalation from refractory glass
3	a	b	c	d=b/c	e	f	g	h	i=d*e*f*g*h
4	Co-60	='1content'!E6	='1content'!B6	=B4/C4	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!Q$3	='2NCTinputs'!Q3	=D4*E4*F4*G4*H4
5	Sr-90	='1content'!E12	='1content'!B12	=B5/C5	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!Q$3	=H$4	=D5*E5*F5*G5*H5
6	Y-90	='1content'!E13	='1content'!B13						
7	Tc-99	='1content'!E17	='1content'!B17	=B7/C7	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!Q$3	=H$4	=D7*E7*F7*G7*H7
8	Cs-137	='1content'!E19	='1content'!B19	=B8/C8	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!Q$3	=H$4	=D8*E8*F8*G8*H8
9	Ba-137m	='1content'!E20	='1content'!B20						
10	Eu-154	='1content'!E22	='1content'!B22	=B10/C10	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!Q$3	=H$4	=D10*E10*F10*G10*H10
11	Hg-206	='1content'!E23	='1content'!B23	=B11/C11	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!Q$3	=H$4	=D11*E11*F11*G11*H11
12	Tl-206	='1content'!E24	='1content'!B24						
13	Tl-207	='1content'!E25	='1content'!B25	=B13/C13	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!Q$3	=H$4	=D13*E13*F13*G13*H13
14	Tl-208	='1content'!E26	='1content'!B26						
15	Tl-209	='1content'!E27	='1content'!B27						
16	Tl-210	='1content'!E28	='1content'!B28	=B16/C16	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!Q$3	=H$4	=D16*E16*F16*G16*H16
17	Pb-210m	='1content'!E29	='1content'!B29						
18	Pb-210	='1content'!E30	='1content'!B30	=B18/C18	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!Q$3	=H$4	=D18*E18*F18*G18*H18
19	Pb-211	='1content'!E31	='1content'!B31	=B19/C19	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!Q$3	=H$4	=D19*E19*F19*G19*H19
20	Pb-212	='1content'!E32	='1content'!B32						
21	Pb-214	='1content'!E33	='1content'!B33						
22	Bi-209	='1content'!E34	='1content'!B34						
23	Bi-210	='1content'!E35	='1content'!B35						
24	Bi-211	='1content'!E36	='1content'!B36						
25	Bi-212	='1content'!E37	='1content'!B37						
26	Bi-213	='1content'!E38	='1content'!B38						
27	Bi-214	='1content'!E39	='1content'!B39						
28	Bi-215	='1content'!E40	='1content'!B40	=B28/C28	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!Q$3	=H$4	=D28*E28*F28*G28*H28
29	Po-210	='1content'!E41	='1content'!B41						
30	Po-211	='1content'!E42	='1content'!B42	=B30/C30	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!Q$3	=H$4	=D30*E30*F30*G30*H30
31	Po-212	='1content'!E43	='1content'!B43						
32	Po-213	='1content'!E44	='1content'!B44						
33	Po-214	='1content'!E45	='1content'!B45						
34	Po-215	='1content'!E46	='1content'!B46						
35	Po-216	='1content'!E47	='1content'!B47						
36	Po-218	='1content'!E48	='1content'!B48						

	A	B	C	D	E	F	G	H	I
37	At-215	='1content'!E49	='1content'!B49	=B37/C37	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!Q$3	=H$4	=D37*E37*F37*G37*H37
38	At-217	='1content'!E50	='1content'!B50						
39	At-218	='1content'!E51	='1content'!B51	=B39/C39	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!Q$3	=H$4	=D39*E39*F39*G39*H39
40	At-219	='1content'!E52	='1content'!B52	=B40/C40	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!Q$3	=H$4	=D40*E40*F40*G40*H40
41	Rn-217	='1content'!E53	='1content'!B53	=B41/C41	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!Q$3	=H$4	=D41*E41*F41*G41*H41
42	Rn-218	='1content'!E54	='1content'!B54						
43	Rn-219	='1content'!E55	='1content'!B55	=B43/C43	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!Q$3	=H$4	=D43*E43*F43*G43*H43
44	Rn-220	='1content'!E56	='1content'!B56						
45	Rn-222	='1content'!E57	='1content'!B57	=B45/C45	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!Q$3	=H$4	=D45*E45*F45*G45*H45
46	Fr-221	='1content'!E58	='1content'!B58						
47	Fr-223	='1content'!E59	='1content'!B59	=B47/C47	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!Q$3	=H$4	=D47*E47*F47*G47*H47
48	Ra-223	='1content'!E60	='1content'!B60	=B48/C48	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!Q$3	=H$4	=D48*E48*F48*G48*H48
49	Ra-224	='1content'!E61	='1content'!B61						
50	Ra-225	='1content'!E62	='1content'!B62						
51	Ra-226	='1content'!E63	='1content'!B63	=B51/C51	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!Q$3	=H$4	=D51*E51*F51*G51*H51
52	Ra-228	='1content'!E64	='1content'!B64	=B52/C52	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!Q$3	=H$4	=D52*E52*F52*G52*H52
53	Ac-225	='1content'!E65	='1content'!B65						
54	Ac-227	='1content'!E66	='1content'!B66	=B54/C54	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!Q$3	=H$4	=D54*E54*F54*G54*H54
55	Ac-228	='1content'!E67	='1content'!B67						
56	Th-227	='1content'!E68	='1content'!B68	=B56/C56	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!Q$3	=H$4	=D56*E56*F56*G56*H56
57	Th-228	='1content'!E69	='1content'!B69						
58	Th-229	='1content'!E70	='1content'!B70	=B58/C58	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!Q$3	=H$4	=D58*E58*F58*G58*H58
59	Th-230	='1content'!E71	='1content'!B71	=B59/C59	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!Q$3	=H$4	=D59*E59*F59*G59*H59
60	Th-231	='1content'!E72	='1content'!B72						
61	Th-232	='1content'!E73	='1content'!B73						
62	Th-234	='1content'!E74	='1content'!B74						
63	Pa-231	='1content'!E75	='1content'!B75	=B63/C63	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!Q$3	=H$4	=D63*E63*F63*G63*H63
64	Pa-233	='1content'!E76	='1content'!B76						
65	Pa-234	='1content'!E77	='1content'!B77	=B65/C65	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!Q$3	=H$4	=D65*E65*F65*G65*H65
66	Pa-234m	='1content'!E78	='1content'!B78						
67	U-232	='1content'!E79	='1content'!B79	=B67/C67	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!Q$3	=H$4	=D67*E67*F67*G67*H67
68	U-233	='1content'!E80	='1content'!B80	=B68/C68	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!Q$3	=H$4	=D68*E68*F68*G68*H68
69	U-234	='1content'!E81	='1content'!B81	=B69/C69	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!Q$3	=H$4	=D69*E69*F69*G69*H69
70	U-235	='1content'!E82	='1content'!B82						
71	U-235m	='1content'!E83	='1content'!B83						
72	U-236	='1content'!E84	='1content'!B84	=B72/C72	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!Q$3	=H$4	=D72*E72*F72*G72*H72
73	U-237	='1content'!E85	='1content'!B85						
74	U-238	='1content'!E86	='1content'!B86						
75	Np-237	='1content'!E87	='1content'!B87	=B75/C75	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!Q$3	=H$4	=D75*E75*F75*G75*H75
76	Np-239	='1content'!E88	='1content'!B88						
77	Pu-238	='1content'!E89	='1content'!B89	=B77/C77	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!Q$3	=H$4	=D77*E77*F77*G77*H77

Formulas for Table 6

	A	B	C	D	E	F	G	H	I
78	Pu-239	='1content'!E90	='1content'!B90	=B78/C78	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!Q$3	=H$4	=D78*E78*F78*G78*H78
79	Pu-240	='1content'!E91	='1content'!B91	=B79/C79	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!Q$3	=H$4	=D79*E79*F79*G79*H79
80	Pu-241	='1content'!E92	='1content'!B92	=B80/C80	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!Q$3	=H$4	=D80*E80*F80*G80*H80
81	Am-241	='1content'!E93	='1content'!B93	=B81/C81	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!Q$3	=H$4	=D81*E81*F81*G81*H81
82	Am-243	='1content'!E94	='1content'!B94	=B82/C82	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!Q$3	=H$4	=D82*E82*F82*G82*H82
83	Cm-242	='1content'!E95	='1content'!B95	=B83/C83	='2NCTinputs'!I$3	='2NCTinputs'!L$3	='2NCTinputs'!Q$3	=H$4	=D83*E83*F83*G83*H83
84	Cm-243	='1content'!E96	='1content'!B96	=B84/C84	='2NCTinputs'!I$3	='2NCTinputs'!L3	='2NCTinputs'!Q$3	=H$4	=D84*E84*F84*G84*H84
85	Cm-244	='1content'!E97	='1content'!B97	=B85/C85	='2NCTinputs'!I$3	='2NCTinputs'!L3	='2NCTinputs'!Q$3	=H$4	=D85*E85*F85*G85*H85
86									=SUM(I4:I85)

Formula Table 7

	A	B	C	D	E	F	G	H	I	J	K
1	Isotope	Content (Ci)	Leach Ratio	Leached (Ci)	A_2 (Ci/A_2)	MAR (A_2)	DR	ARF	LPF Melter	LPF WVMP	Release (A_2)
2		From Table 1	Leach Ratio for glass from Table 2	Calculated for LDCC internal to the melter	From Table 1	Calculated for LDCC internal to the melter	From Table 2. LDCC internal to melter				Calculated for inhalation from LDCC internal to the melter
3	a	b	c	d=b*c	e	f=d/e	g	h	i	j	k=f*g*h*i*j
4	C-14	='1content'!D5	='2NCTinputs'!G$3	=B4*C4	='1content'!B5	=D4/E4	='2NCTinputs'!K$3	='2NCTinputs'!M$3	='2NCTinputs'!Q$3	='2NCTinputs'!Q$3	=F4*H4*G4*I4
5	K-40	='1content'!D7	='2NCTinputs'!G$3	=B5*C5	='1content'!B7	=D5/E5	='2NCTinputs'!K$3	='2NCTinputs'!M$3	='2NCTinputs'!Q$3	='2NCTinputs'!Q$3	=F5*H5*G5*I5
6	Mn-54	='1content'!D8	='2NCTinputs'!G$3	=B6*C6	='1content'!B8	=D6/E6	='2NCTinputs'!K$3	='2NCTinputs'!M$3	='2NCTinputs'!Q$3	='2NCTinputs'!Q$3	=F6*H6*G6*I6
7	Co-60	='1content'!D6	='2NCTinputs'!G$3	=B7*C7	='1content'!B6	=D7/E7	='2NCTinputs'!K$3	='2NCTinputs'!M$3	='2NCTinputs'!Q$3	='2NCTinputs'!Q$3	=F7*H7*G7*I7
8	Ni-63	='1content'!D11	='2NCTinputs'!G$3	=B8*C8	='1content'!B11	=D8/E8	='2NCTinputs'!K$3	='2NCTinputs'!M$3	='2NCTinputs'!Q$3	='2NCTinputs'!Q$3	=F8*H8*G8*I8
9	Sr-90	='1content'!D12	='2NCTinputs'!G$3	=B9*C9	='1content'!B12	=D9/E9	='2NCTinputs'!K$3	='2NCTinputs'!M$3	='2NCTinputs'!Q$3	='2NCTinputs'!Q$3	=F9*H9*G9*I9
10	Y-90	='1content'!D13	='1content'!B13								
11	Zr-95	='1content'!D14	='2NCTinputs'!G$3	=B11*C11	='1content'!B14	=D11/E11	='2NCTinputs'!K$3	='2NCTinputs'!M$3	='2NCTinputs'!Q$3	='2NCTinputs'!Q$3	=F11*H11*G11*I11
12	Nb-95	='1content'!D15	='2NCTinputs'!G$3	=B12*C12	='1content'!B15	=D12/E12	='2NCTinputs'!K$3	='2NCTinputs'!M$3	='2NCTinputs'!Q$3	='2NCTinputs'!Q$3	=F12*H12*G12*I12
13	Nb-95m	='1content'!D16	='1content'!B16								
14	Tc-99	='1content'!D17	='2NCTinputs'!G$3	=B14*C14	='1content'!B17	=D14/E14	='2NCTinputs'!K$3	='2NCTinputs'!M$3	='2NCTinputs'!Q$3	='2NCTinputs'!Q$3	=F14*H14*G14*I14
15	Cs-137	='1content'!D19	='2NCTinputs'!G$3	=B15*C15	='1content'!B19	=D15/E15	='2NCTinputs'!K$3	='2NCTinputs'!M$3	='2NCTinputs'!Q$3	='2NCTinputs'!Q$3	=F15*H15*G15*I15
16	Ba-137m	='1content'!D20	='1content'!B20								
17	Eu-154	='1content'!D22	='2NCTinputs'!G$3	=B17*C17	='1content'!B22	=D17/E17	='2NCTinputs'!K$3	='2NCTinputs'!M$3	='2NCTinputs'!Q$3	='2NCTinputs'!Q$3	=F17*H17*G17*I17
18	Hg-206	='1content'!D23	='2NCTinputs'!G$3	=B18*C18	='1content'!B23	=D18/E18	='2NCTinputs'!K$3	='2NCTinputs'!M$3	='2NCTinputs'!Q$3	='2NCTinputs'!Q$3	=F18*H18*G18*I18
19	Tl-206	='1content'!D24	='1content'!B24								
20	Tl-207	='1content'!D25	='2NCTinputs'!G$3	=B20*C20	='1content'!B25	=D20/E20	='2NCTinputs'!K$3	='2NCTinputs'!M$3	='2NCTinputs'!Q$3	='2NCTinputs'!Q$3	=F20*H20*G20*I20
21	Tl-208	='1content'!D26	='1content'!B26								
22	Tl-209	='1content'!D27	='1content'!B27								
23	Tl-210	='1content'!D28	='2NCTinputs'!G$3	=B23*C23	='1content'!B28	=D23/E23	='2NCTinputs'!K$3	='2NCTinputs'!M$3	='2NCTinputs'!Q$3	='2NCTinputs'!Q$3	=F23*H23*G23*I23
24	Pb-210m	='1content'!D29	='1content'!B29								
25	Pb-210	='1content'!D30	='2NCTinputs'!G$3	=B25*C25	='1content'!B30	=D25/E25	='2NCTinputs'!K$3	='2NCTinputs'!M$3	='2NCTinputs'!Q$3	='2NCTinputs'!Q$3	=F25*H25*G25*I25
26	Pb-211	='1content'!D31	='2NCTinputs'!G$3	=B26*C26	='1content'!B31	=D26/E26	='2NCTinputs'!K$3	='2NCTinputs'!M$3	='2NCTinputs'!Q$3	='2NCTinputs'!Q$3	=F26*H26*G26*I26
27	Pb-212	='1content'!D32	='1content'!B32								
28	Pb-214	='1content'!D33	='1content'!B33								
29	Bi-209	='1content'!D34	='1content'!B34								
30	Bi-210	='1content'!D35	='1content'!B35								
31	Bi-211	='1content'!D36	='1content'!B36								
32	Bi-212	='1content'!D37	='1content'!B37								
33	Bi-213	='1content'!D38	='1content'!B38								
34	Bi-214	='1content'!D39	='1content'!B39								
35	Bi-215	='1content'!D40	='2NCTinputs'!G$3	=B35*C35	='1content'!B40	=D35/E35	='2NCTinputs'!K$3	='2NCTinputs'!M$3	='2NCTinputs'!Q$3	='2NCTinputs'!Q$3	=F35*H35*G35*I35
36	Po-210	='1content'!D41	='1content'!B41								
37	Po-211	='1content'!D42	='2NCTinputs'!G$3	=B37*C37	='1content'!B42	=D37/E37	='2NCTinputs'!K$3	='2NCTinputs'!M$3	='2NCTinputs'!Q$3	='2NCTinputs'!Q$3	=F37*H37*G37*I37
38	Po-212	='1content'!D43	='1content'!B43								
39	Po-213	='1content'!D44	='1content'!B44								
40	Po-214	='1content'!D45	='1content'!B45								

Formulas for Table 7

	A	B	C	D	E	F	G	H	I	J	K
41	Po-215	='1content'!D46	='1content'!B46								
42	Po-216	='1content'!D47	='1content'!B47								
43	Po-218	='1content'!D48	='1content'!B48								
44	At-215	='1content'!D49	='2NCTinputs'!G$3	=B44*C44	='1content'!B49	=D44/E44	='2NCTinputs'!K$3	='2NCTinputs'!M$3	='2NCTinputs'!Q$3	='2NCTinputs'!Q$3	=F44*H44*G44*I44
45	At-217	='1content'!D50	='1content'!B50								
46	At-218	='1content'!D51	='2NCTinputs'!G$3	=B46*C46	='1content'!B51	=D46/E46	='2NCTinputs'!K$3	='2NCTinputs'!M$3	='2NCTinputs'!Q$3	='2NCTinputs'!Q$3	=F46*H46*G46*I46
47	At-219	='1content'!D52	='2NCTinputs'!G$3	=B47*C47	='1content'!B52	=D47/E47	='2NCTinputs'!K$3	='2NCTinputs'!M$3	='2NCTinputs'!Q$3	='2NCTinputs'!Q$3	=F47*H47*G47*I47
48	Rn-217	='1content'!D53	='2NCTinputs'!G$3	=B48*C48	='1content'!B53	=D48/E48	='2NCTinputs'!K$3	='2NCTinputs'!M$3	='2NCTinputs'!Q$3	='2NCTinputs'!Q$3	=F48*H48*G48*I48
49	Rn-218	='1content'!D54	='1content'!B54								
50	Rn-219	='1content'!D55	='2NCTinputs'!G$3	=B50*C50	='1content'!B55	=D50/E50	='2NCTinputs'!K$3	='2NCTinputs'!M$3	='2NCTinputs'!Q$3	='2NCTinputs'!Q$3	=F50*H50*G50*I50
51	Rn-220	='1content'!D56	='1content'!B56								
52	Rn-222	='1content'!D57	='2NCTinputs'!G$3	=B52*C52	='1content'!B57	=D52/E52	='2NCTinputs'!K$3	='2NCTinputs'!M$3	='2NCTinputs'!Q$3	='2NCTinputs'!Q$3	=F52*H52*G52*I52
53	Fr-221	='1content'!D58	='1content'!B58								
54	Fr-223	='1content'!D59	='2NCTinputs'!G$3	=B54*C54	='1content'!B59	=D54/E54	='2NCTinputs'!K$3	='2NCTinputs'!M$3	='2NCTinputs'!Q$3	='2NCTinputs'!Q$3	=F54*H54*G54*I54
55	Ra-223	='1content'!D59	='2NCTinputs'!G$3	=B55*C55	='1content'!B60	=D55/E55	='2NCTinputs'!K$3	='2NCTinputs'!M$3	='2NCTinputs'!Q$3	='2NCTinputs'!Q$3	=F55*H55*G55*I55
56	Ra-224	='1content'!D61	='1content'!B61								
57	Ra-225	='1content'!D62	='1content'!B62								
58	Ra-226	='1content'!D63	='2NCTinputs'!G$3	=B58*C58	='1content'!B63	=D58/E58	='2NCTinputs'!K$3	='2NCTinputs'!M$3	='2NCTinputs'!Q$3	='2NCTinputs'!Q$3	=F58*H58*G58*I58
59	Ra-228	='1content'!D64	='2NCTinputs'!G$3	=B59*C61	='1content'!B64	=D59/E59	='2NCTinputs'!K$3	='2NCTinputs'!M$3	='2NCTinputs'!Q$3	='2NCTinputs'!Q$3	=F59*H59*G59*I59
60	Ac-225	='1content'!D65	='1content'!B65								
61	Ac-227	='1content'!D66	='2NCTinputs'!G$3	=B61*C61	='1content'!B66	=D61/E61	='2NCTinputs'!K$3	='2NCTinputs'!M$3	='2NCTinputs'!Q$3	='2NCTinputs'!Q$3	=F61*H61*G61*I61
62	Ac-228	='1content'!D67	='1content'!B67								
63	Th-227	='1content'!D68	='2NCTinputs'!G$3	=B63*C63	='1content'!B68	=D63/E63	='2NCTinputs'!K$3	='2NCTinputs'!M$3	='2NCTinputs'!Q$3	='2NCTinputs'!Q$3	=F63*H63*G63*I63
64	Th-228	='1content'!D69	='1content'!B69								
65	Th-229	='1content'!D70	='2NCTinputs'!G$3	=B65*C65	='1content'!B70	=D65/E65	='2NCTinputs'!K$3	='2NCTinputs'!M$3	='2NCTinputs'!Q$3	='2NCTinputs'!Q$3	=F65*H65*G65*I65
66	Th-230	='1content'!D71	='2NCTinputs'!G$3	=B66*C66	='1content'!B71	=D66/E66	='2NCTinputs'!K$3	='2NCTinputs'!M$3	='2NCTinputs'!Q$3	='2NCTinputs'!Q$3	=F66*H66*G66*I66
67	Th-231	='1content'!D72	='1content'!B72								
68	Th-232	='1content'!D73	='1content'!B73								
69	Th-234	='1content'!D74	='1content'!B74								
70	Pa-231	='1content'!D75	='2NCTinputs'!G$3	=B70*C70	='1content'!B75	=D70/E70	='2NCTinputs'!K$3	='2NCTinputs'!M$3	='2NCTinputs'!Q$3	='2NCTinputs'!Q$3	=F70*H70*G70*I70
71	Pa-233	='1content'!D76	='1content'!B76								
72	Pa-234	='1content'!D77	='2NCTinputs'!G$3	=B72*C72	='1content'!B77	=D72/E72	='2NCTinputs'!K$3	='2NCTinputs'!M$3	='2NCTinputs'!Q$3	='2NCTinputs'!Q$3	=F72*H72*G72*I72
73	Pa-234m	='1content'!D78	='1content'!B78								
74	U-232	='1content'!D79	='2NCTinputs'!G$3	=B74*C74	='1content'!B79	=D74/E74	='2NCTinputs'!K$3	='2NCTinputs'!M$3	='2NCTinputs'!Q$3	='2NCTinputs'!Q$3	=F74*H74*G74*I74
75	U-233	='1content'!D80	='2NCTinputs'!G$3	=B75*C75	='1content'!B80	=D75/E75	='2NCTinputs'!K$3	='2NCTinputs'!M$3	='2NCTinputs'!Q$3	='2NCTinputs'!Q$3	=F75*H75*G75*I75
76	U-234	='1content'!D81	='2NCTinputs'!G$3	=B76*C76	='1content'!B81	=D76/E76	='2NCTinputs'!K$3	='2NCTinputs'!M$3	='2NCTinputs'!Q$3	='2NCTinputs'!Q$3	=F76*H76*G76*I76
77	U-235	='1content'!D82									
78	U-235m	='1content'!D83	='1content'!B82								
79	U-236	='1content'!D84	='2NCTinputs'!G$3	=B79*C79	='1content'!B84	=D79/E79	='2NCTinputs'!K$3	='2NCTinputs'!M$3	='2NCTinputs'!Q$3	='2NCTinputs'!Q$3	=F79*H79*G79*I79
80	U-237	='1content'!D85	='1content'!B85								
81	U-238	='1content'!D86	='1content'!B86								
82	Np-237	='1content'!D87	='2NCTinputs'!G$3	=B82*C82	='1content'!B87	=D82/E82	='2NCTinputs'!K$3	='2NCTinputs'!M$3	='2NCTinputs'!Q$3	='2NCTinputs'!Q$3	=F82*H82*G82*I82
83	Np-239	='1content'!D88	='1content'!B88								
84	Pu-238	='1content'!D89	='2NCTinputs'!G$3	=B84*C84	='1content'!B89	=D84/E84	='2NCTinputs'!K$3	='2NCTinputs'!M$3	='2NCTinputs'!Q$3	='2NCTinputs'!Q$3	=F84*H84*G84*I84

Formula Table 7

	A	B	C	D	E	F	G	H	I	J	K
85	Pu-239	='1content'!D90	='2NCTInputs'!G$3	=B85*C85	='1content'!B90	=D85/E85	='2NCTInputs'!K$3	='2NCTInputs'!M$3	='2NCTInputs'!O$3	='2NCTInputs'!Q$3	=F85*H85*G85*I85
86	Pu-240	='1content'!D91	='2NCTInputs'!G$3	=B86*C86	='1content'!B91	=D86/E86	='2NCTInputs'!K$3	='2NCTInputs'!M$3	='2NCTInputs'!O$3	='2NCTInputs'!Q$3	=F86*H86*G86*I86
87	Pu-241	='1content'!D92	='2NCTInputs'!G$3	=B87*C87	='1content'!B92	=D87/E87	='2NCTInputs'!K$3	='2NCTInputs'!M$3	='2NCTInputs'!O$3	='2NCTInputs'!Q$3	=F87*H87*G87*I87
88	Am-241	='1content'!D93	='2NCTInputs'!G$3	=B88*C88	='1content'!B93	=D88/E88	='2NCTInputs'!K$3	='2NCTInputs'!M$3	='2NCTInputs'!O$3	='2NCTInputs'!Q$3	=F88*H88*G88*I88
89	Am-243	='1content'!D94	='2NCTInputs'!G$3	=B89*C89	='1content'!B94	=D89/E89	='2NCTInputs'!K$3	='2NCTInputs'!M$3	='2NCTInputs'!O$3	='2NCTInputs'!Q$3	=F89*H89*G89*I89
90	Cm-242	='1content'!D95	='2NCTInputs'!G$3	=B90*C90	='1content'!B95	=D90/E90	='2NCTInputs'!K$3	='2NCTInputs'!M$3	='2NCTInputs'!O$3	='2NCTInputs'!Q$3	=F90*H90*G90*I90
91	Cm-243	='1content'!D96	='2NCTInputs'!G$3	=B91*C91	='1content'!B96	=D91/E91	='2NCTInputs'!K$3	='2NCTInputs'!M$3	='2NCTInputs'!O$3	='2NCTInputs'!Q$3	=F91*H91*G91*I91
92	Cm-244	='1content'!D97	='2NCTInputs'!G$3	=B92*C92	='1content'!B97	=D92/E92	='2NCTInputs'!K$3	='2NCTInputs'!M$3	='2NCTInputs'!O$3	='2NCTInputs'!Q$3	=F92*H92*G92*I92
93											=SUM(K4:K92)

Formulas for Table 8

	A	B	C	D	E	F	G	H	I	J	K	L
1	Isotope	Content (Ci)	Leach Ratio	Leached (Ci)	A_2 (Ci/A_2)	MAR (A_2)	DR	ARF Pressure	RF Pressure	LPF Melter	LPF WVMP	Release (A_2)
2		From Table 1	Leach Ratio from glass from Table 2	Calculated for LDCC internal to the melter	From Table 1	Calculated for LDCC internal to the melter	From Table 2. LDCC internal to melter with pressure increase					Calculated for inhalation from LDCC internal to the melter
3	a	b	c	d=b*c	e	f=d/e	g	h	i	j	k	l=f*g*h*i*j*k
4	C-14	='1content'!D5	='2NCTinputs'!G$3	=B4*C4	='1content'!B5	=D4/E4	='2NCTinputs'!K$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	='2NCTinputs'!Q$3	='2NCTinputs'!Q$3	=F4*G4*H4*I4*J4*K4
5	K-40	='1content'!D7	='2NCTinputs'!G$3	=B5*C5	='1content'!B7	=D5/E5	='2NCTinputs'!K$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	='2NCTinputs'!Q$3	=K$4	=F5*G5*H5*I5*J5*K5
6	Mn-54	='1content'!D8	='2NCTinputs'!G$3	=B6*C6	='1content'!B8	=D6/E6	='2NCTinputs'!K$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	='2NCTinputs'!Q$3	=K$4	=F6*G6*H6*I6*J6*K6
7	Co-60	='1content'!D6	='2NCTinputs'!G$3	=B7*C7	='1content'!B6	=D7/E7	='2NCTinputs'!K$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	='2NCTinputs'!Q$3	=K$4	=F7*G7*H7*I7*J7*K7
8	Ni-63	='1content'!D11	='2NCTinputs'!G$3	=B8*C8	='1content'!B11	=D8/E8	='2NCTinputs'!K$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	='2NCTinputs'!Q$3	=K$4	=F8*G8*H8*I8*J8*K8
9	Sr-90	='1content'!D12	='2NCTinputs'!G$3	=B9*C9	='1content'!B12	=D9/E9	='2NCTinputs'!K$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	='2NCTinputs'!Q$3	=K$4	=F9*G9*H9*I9*J9*K9
10	Y-90	='1content'!D13	='1content'!B13									
11	Zr-95	='1content'!D14	='2NCTinputs'!G$3	=B11*C11	='1content'!B14	=D11/E11	='2NCTinputs'!K$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	='2NCTinputs'!Q$3	=K$4	=F11*G11*H11*I11*J11*K11
12	Nb-95	='1content'!D15	='2NCTinputs'!G$3	=B12*C12	='1content'!B15	=D12/E12	='2NCTinputs'!K$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	='2NCTinputs'!Q$3	=K$4	=F12*G12*H12*I12*J12*K12
13	Nb-95m	='1content'!D16	='1content'!B16									
14	Tc-99	='1content'!D17	='2NCTinputs'!G$3	=B14*C14	='1content'!B17	=D14/E14	='2NCTinputs'!K$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	='2NCTinputs'!Q$3	=K$4	=F14*G14*H14*I14*J14*K14
15	Cs-137	='1content'!D19	='2NCTinputs'!G$3	=B15*C15	='1content'!B19	=D15/E15	='2NCTinputs'!K$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	='2NCTinputs'!Q$3	=K$4	=F15*G15*H15*I15*J15*K15
16	Ba137m	='1content'!D20	='1content'!B20									
17	Eu-154	='1content'!D22	='2NCTinputs'!G$3	=B17*C17	='1content'!B22	=D17/E17	='2NCTinputs'!K$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	='2NCTinputs'!Q$3	=K$4	=F17*G17*H17*I17*J17*K17
18	Hg-206	='1content'!D23	='2NCTinputs'!G$3	=B18*C18	='1content'!B23	=D18/E18	='2NCTinputs'!K$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	='2NCTinputs'!Q$3	=K$4	=F18*G18*H18*I18*J18*K18
19	Tl-206	='1content'!D24	='1content'!B24									
20	Tl-207	='1content'!D25	='2NCTinputs'!G$3	=B20*C20	='1content'!B25	=D20/E20	='2NCTinputs'!K$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	='2NCTinputs'!Q$3	=K$4	=F20*G20*H20*I20*J20*K20
21	Tl-208	='1content'!D26	included with U-232									
22	Tl-209	='1content'!D27	='1content'!B27									
23	Tl-210	='1content'!D28	='2NCTinputs'!G$3	=B23*C23	='1content'!B28	=D23/E23	='2NCTinputs'!K$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	='2NCTinputs'!Q$3	=K$4	=F23*G23*H23*I23*J23*K23
24	Pb210m	='1content'!D29	='1content'!B29									
25	Pb-210	='1content'!D30	='2NCTinputs'!G$3	=B25*C25	='1content'!B30	=D25/E25	='2NCTinputs'!K$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	='2NCTinputs'!Q$3	=K$4	=F25*G25*H25*I25*J25*K25
26	Pb-211	='1content'!D31	='2NCTinputs'!G$3	=B26*C26	='1content'!B31	=D26/E26	='2NCTinputs'!K$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	='2NCTinputs'!Q$3	=K$4	=F26*G26*H26*I26*J26*K26
27	Pb-212	='1content'!D32	='1content'!B32									
28	Pb-214	='1content'!D33	='1content'!B33									
29	Bi-209	='1content'!D34	='1content'!B34									
30	Bi-210	='1content'!D35	='1content'!B35									
31	Bi-211	='1content'!D36	='1content'!B36									
32	Bi-212	='1content'!D37	='1content'!B37									
33	Bi-213	='1content'!D38	='1content'!B38									
34	Bi-214	='1content'!D39	='1content'!B39									
35	Bi-215	='1content'!D40	='2NCTinputs'!G$3	=B35*C35	='1content'!B40	=D35/E35	='2NCTinputs'!K$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	='2NCTinputs'!Q$3	=K$4	=F35*G35*H35*I35*J35*K35
36	Po-210	='1content'!D41	='1content'!B41									
37	Po-211	='1content'!D42	='2NCTinputs'!G$3	=B37*C37	='1content'!B42	=D37/E37	='2NCTinputs'!K$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	='2NCTinputs'!Q$3	=K$4	=F37*G37*H37*I37*J37*K37

	A	B	C	D	E	F	G	H	I	J	K	L
38	Po-212	='1content'!D43	='1content'!B43									
39	Po-213	='1content'!D44	='1content'!B44									
40	Po-214	='1content'!D45	='1content'!B45									
41	Po-215	='1content'!D46	='1content'!B46									
42	Po-216	='1content'!D47	='1content'!B47									
43	Po-218	='1content'!D48	='1content'!B48									
44	At-215	='1content'!D49	='2NCTinputs'!G$3	=B44*C44	='1content'!B49	=D44/E44	='2NCTinputs'!K$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	='2NCTinputs'!Q$3	=K$4	=F44*G44*H44*I44*J44*K44
45	At-217	='1content'!D50	='1content'!B50									
46	At-218	='1content'!D51	='2NCTinputs'!G$3	=B46*C46	='1content'!B51	=D46/E46	='2NCTinputs'!K$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	='2NCTinputs'!Q$3	=K$4	=F46*G46*H46*I46*J46*K46
47	At-219	='1content'!D52	='2NCTinputs'!G$3	=B47*C47	='1content'!B52	=D47/E47	='2NCTinputs'!K$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	='2NCTinputs'!Q$3	=K$4	=F47*G47*H47*I47*J47*K47
48	Rn-217	='1content'!D53	='2NCTinputs'!G$3	=B48*C48	='1content'!B53	=D48/E48	='2NCTinputs'!K$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	='2NCTinputs'!Q$3	=K$4	=F48*G48*H48*I48*J48*K48
49	Rn-218	='1content'!D54	='1content'!B54									
50	Rn-219	='1content'!D55	='2NCTinputs'!G$3	=B50*C50	='1content'!B55	=D50/E50	='2NCTinputs'!K$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	='2NCTinputs'!Q$3	=K$4	=F50*G50*H50*I50*J50*K50
51	Rn-220	='1content'!D56	='1content'!B56									
52	Rn-222	='1content'!D57	='2NCTinputs'!G$3	=B52*C52	='1content'!B57	=D52/E52	='2NCTinputs'!K$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	='2NCTinputs'!Q$3	=K$4	=F52*G52*H52*I52*J52*K52
53	Fr-221	='1content'!D58	='1content'!B58									
54	Fr-223	='1content'!D59	='2NCTinputs'!G$3	=B54*C54	='1content'!B59	=D54/E54	='2NCTinputs'!K$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	='2NCTinputs'!Q$3	=K$4	=F54*G54*H54*I54*J54*K54
55	Ra-223	='1content'!D59	='2NCTinputs'!G$3	=B55*C55	='1content'!B60	=D55/E55	='2NCTinputs'!K$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	='2NCTinputs'!Q$3	=K$4	=F55*G55*H55*I55*J55*K55
56	Ra-224	='1content'!D61	='1content'!B61									
57	Ra-225	='1content'!D62	='1content'!B62									
58	Ra-226	='1content'!D63	='2NCTinputs'!G$3	=B58*C58	='1content'!B63	=D58/E58	='2NCTinputs'!K$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	='2NCTinputs'!Q$3	=K$4	=F58*G58*H58*I58*J58*K58
59	Ra-228	='1content'!D64	='2NCTinputs'!G$3	=B59*C59	='1content'!B64	=D59/E59	='2NCTinputs'!K$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	='2NCTinputs'!Q$3	=K$4	=F59*G59*H59*I59*J59*K59
60	Ac-225	='1content'!D65	='1content'!B65									
61	Ac-227	='1content'!D66	='2NCTinputs'!G$3	=B61*C61	='1content'!B66	=D61/E61	='2NCTinputs'!K$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	='2NCTinputs'!Q$3	=K$4	=F61*G61*H61*I61*J61*K61
62	Ac-228	='1content'!D67	='1content'!B67									
63	Th-227	='1content'!D68	='2NCTinputs'!G$3	=B63*C63	='1content'!B68	=D63/E63	='2NCTinputs'!K$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	='2NCTinputs'!Q$3	=K$4	=F63*G63*H63*I63*J63*K63
64	Th-228	='1content'!D69	='1content'!B69									
65	Th-229	='1content'!D70	='2NCTinputs'!G$3	=B65*C65	='1content'!B70	=D65/E65	='2NCTinputs'!K$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	='2NCTinputs'!Q$3	=K$4	=F65*G65*H65*I65*J65*K65
66	Th-230	='1content'!D71	='2NCTinputs'!G$3	=B66*C66	='1content'!B71	=D66/E66	='2NCTinputs'!K$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	='2NCTinputs'!Q$3	=K$4	=F66*G66*H66*I66*J66*K66
67	Th-231	='1content'!D72	='1content'!B72									
68	Th-232	='1content'!D73	='1content'!B73									
69	Th-234	='1content'!D74	='1content'!B74									
70	Pa-231	='1content'!D75	='2NCTinputs'!G$3	=B70*C70	='1content'!B75	=D70/E70	='2NCTinputs'!K$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	='2NCTinputs'!Q$3	=K$4	=F70*G70*H70*I70*J70*K70
71	Pa-233	='1content'!D76	='1content'!B76									
72	Pa-234	='1content'!D77	='2NCTinputs'!G$3	=B72*C72	='1content'!B77	=D72/E72	='2NCTinputs'!K$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	='2NCTinputs'!Q$3	=K$4	=F72*G72*H72*I72*J72*K72
73	Pa234m	='1content'!D78	='1content'!B78									
74	U-232	='1content'!D79	='2NCTinputs'!G$3	=B74*C74	='1content'!B79	=D74/E74	='2NCTinputs'!K$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	='2NCTinputs'!Q$3	=K$4	=F74*G74*H74*I74*J74*K74
75	U-233	='1content'!D80	='2NCTinputs'!G$3	=B75*C75	='1content'!B80	=D75/E75	='2NCTinputs'!K$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	='2NCTinputs'!Q$3	=K$4	=F75*G75*H75*I75*J75*K75
76	U-234	='1content'!D81	='2NCTinputs'!G$3	=B76*C76	='1content'!B81	=D76/E76	='2NCTinputs'!K$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	='2NCTinputs'!Q$3	=K$4	=F76*G76*H76*I76*J76*K76
77	U-235	='1content'!D82										
78	U-235m	='1content'!D83	='1content'!B82									

Formulas for Table 8

	A	B	C	D	E	F	G	H	I	J	K	L
79	U-236	='1content'!D84	='2NCTInputs'!G$3	=B79*C79	='1content'!B84	=079/E79	='2NCTInputs'!K$3	='2NCTInputs'!N$3	='2NCTInputs'!O$3	='2NCTInputs'!Q$3	=K$4	=F79*G79*H79*I79*J79*K79
80	U-237	='1content'!D85	='1content'!B85									
81	U-238	='1content'!D86	='1content'!B86									
82	Np-237	='1content'!D87	='2NCTInputs'!G$3	=B82*C82	='1content'!B87	=D82/E82	='2NCTInputs'!K$3	='2NCTInputs'!N$3	='2NCTInputs'!O$3	='2NCTInputs'!Q$3	=K$4	=F82*G82*H82*I82*J82*K82
83	Np-239	='1content'!D88	='1content'!B88									
84	Pu-238	='1content'!D89	='2NCTInputs'!G$3	=B84*C84	='1content'!B89	=D84/E84	='2NCTInputs'!K$3	='2NCTInputs'!N$3	='2NCTInputs'!O$3	='2NCTInputs'!Q$3	=K$4	=F84*G84*H84*I84*J84*K84
85	Pu-239	='1content'!D90	='2NCTInputs'!G$3	=B85*C85	='1content'!B90	=D85/E85	='2NCTInputs'!K$3	='2NCTInputs'!N$3	='2NCTInputs'!O$3	='2NCTInputs'!Q$3	=K$4	=F85*G85*H85*I85*J85*K85
86	Pu-240	='1content'!D91	='2NCTInputs'!G$3	=B86*C86	='1content'!B91	=D86/E86	='2NCTInputs'!K$3	='2NCTInputs'!N$3	='2NCTInputs'!O$3	='2NCTInputs'!Q$3	=K$4	=F86*G86*H86*I86*J86*K86
87	Pu-241	='1content'!D92	='2NCTInputs'!G$3	=B87*C87	='1content'!B92	=D87/E87	='2NCTInputs'!K$3	='2NCTInputs'!N$3	='2NCTInputs'!O$3	='2NCTInputs'!Q$3	=K$4	=F87*G87*H87*I87*J87*K87
88	Am-241	='1content'!D93	='2NCTInputs'!G$3	=B88*C88	='1content'!B93	=D88/E88	='2NCTInputs'!K$3	='2NCTInputs'!N$3	='2NCTInputs'!O$3	='2NCTInputs'!Q$3	=K$4	=F88*G88*H88*I88*J88*K88
89	Am-243	='1content'!D94	='2NCTInputs'!G$3	=B89*C89	='1content'!B94	=D89/E89	='2NCTInputs'!K$3	='2NCTInputs'!N$3	='2NCTInputs'!O$3	='2NCTInputs'!Q$3	=K$4	=F89*G89*H89*I89*J89*K89
90	Cm-242	='1content'!D95	='2NCTInputs'!G$3	=B90*C90	='1content'!B95	=D90/E90	='2NCTInputs'!K$3	='2NCTInputs'!N$3	='2NCTInputs'!O$3	='2NCTInputs'!Q$3	=K$4	=F90*G90*H90*I90*J90*K90
91	Cm-243	='1content'!D96	='2NCTInputs'!G$3	=B91*C91	='1content'!B96	=D91/E91	='2NCTInputs'!K$3	='2NCTInputs'!N$3	='2NCTInputs'!O$3	='2NCTInputs'!Q$3	=K$4	=F91*G91*H91*I91*J91*K91
92	Cm-244	='1content'!D97	='2NCTInputs'!G$3	=B92*C92	='1content'!B97	=D92/E92	='2NCTInputs'!K$3	='2NCTInputs'!N$3	='2NCTInputs'!O$3	='2NCTInputs'!Q$3	=K$4	=F92*G92*H92*I92*J92*K92
93												=SUM(L4:L92)

	A	B	C	D	E	F	G	H	I	J
1	Isotope	Content (Ci)	Leach Ratio	Leached (Ci)	A_2 (Ci/A_2)	MAR (A2s)	DR	ARF	LPF WVMP	Release (A_2)
2		From Table 1	From Table 2 for Bartlett's PBS	Calculated for LDCC external to melter	From Table 1	Calculated for LDCC external to melter	From Table 2. For LDCC external to melter . Note LPF WVMP already credited as part of ARF number			Calculated for inhalation from LDCC external to the melter
3	a	b	c	d	e	f=d/e	g	h	i	j=f*g*h*i
4	Cs-137	='1content'!F19	='2NCTinputs'!H$3	=B4*C4	='1content'!B19	=D4/E4	='2NCTinputs'!J$3	='2NCTinputs'!M$3	='2NCTinputs'!Q3	=F4*G4*H4*I4
5	Ba-137m	='1content'!F20	='2NCTinputs'!H$3	=B5*C5	='1content'!B20					
6	Sr-90	='1content'!F12	='2NCTinputs'!H$3	=B6*C6	='1content'!B12	=D6/E6	='2NCTinputs'!J$3	='2NCTinputs'!M$3	=I$4	=F6*G6*H6*I6
7	Y-90	='1content'!F13	='2NCTinputs'!H$3	=B7*C7	='1content'!B13					
8	Pm-147	='1content'!F21	='2NCTinputs'!H$3	=B8*C8	='1content'!B21	=D8/E8	='2NCTinputs'!J$3	='2NCTinputs'!M$3	=I$4	=F8*G8*H8*I8
9	Am-241	='1content'!F93	='2NCTinputs'!H$3	=B9*C9	='1content'!B93	=D9/E9	='2NCTinputs'!J$3	='2NCTinputs'!M$3	=I$4	=F9*G9*H9*I9
10	Eu-154	='1content'!F22	='2NCTinputs'!H$3	=B10*C10	='1content'!B22	=D10/E10	='2NCTinputs'!J$3	='2NCTinputs'!M$3	=I$4	=F10*G10*H10*I10
11	Ni-63	='1content'!F11	='2NCTinputs'!H$3	=B11*C11	='1content'!B11	=D11/E11	='2NCTinputs'!J$3	='2NCTinputs'!M$3	=I$4	=F11*G11*H11*I11
12	Fe-55	='1content'!F9	='2NCTinputs'!H$3	=B12*C12	='1content'!B9	=D12/E12	='2NCTinputs'!J$3	='2NCTinputs'!M$3	=I$4	=F12*G12*H12*I12
13	Pu-238	='1content'!F89	='2NCTinputs'!H$3	=B13*C13	='1content'!B89	=D13/E13	='2NCTinputs'!J$3	='2NCTinputs'!M$3	=I$4	=F13*G13*H13*I13
14	C-14	='1content'!F5	='2NCTinputs'!H$3	=B14*C14	='1content'!B5	=D14/E14	='2NCTinputs'!J$3	='2NCTinputs'!M$3	=I$4	=F14*G14*H14*I14
15	Co-60	='1content'!F6	='2NCTinputs'!H$3	=B15*C15	='1content'!B6	=D15/E15	='2NCTinputs'!J$3	='2NCTinputs'!M$3	=I$4	=F15*G15*H15*I15
16	U-232	='1content'!F79	='2NCTinputs'!H$3	=B16*C16	='1content'!B79	=D16/E16	='2NCTinputs'!J$3	='2NCTinputs'!M$3	=I$4	=F16*G16*H16*I16
17	Pu-239	='1content'!F90	='2NCTinputs'!H$3	=B17*C17	='1content'!B90	=D17/E17	='2NCTinputs'!J$3	='2NCTinputs'!M$3	=I$4	=F17*G17*H17*I17
18	Pu-240	='1content'!F91	='2NCTinputs'!H$3	=B18*C18	='1content'!B91	=D18/E18	='2NCTinputs'!J$3	='2NCTinputs'!M$3	=I$4	=F18*G18*H18*I18
19	Ni-59	='1content'!F10	='2NCTinputs'!H$3	=B19*C19						
20	I-129	='1content'!F18	='2NCTinputs'!H$3	=B20*C20	='1content'!B10					
21	U-233	='1content'!F80	='2NCTinputs'!H$3	=B21*C21	='1content'!B80	=D21/E21	='2NCTinputs'!J$3	='2NCTinputs'!M$3	=I$4	=F21*G21*H21*I21
22	Tc-99	='1content'!F17	='2NCTinputs'!H$3	=B22*C22	='1content'!B17	=D22/E22	='2NCTinputs'!J$3	='2NCTinputs'!M$3	=I$4	=F22*G22*H22*I22
23	H-3	='1content'!F4	='2NCTinputs'!H$3	=B23*C23	='1content'!B4	=D23/E23	='2NCTinputs'!J$3	='2NCTinputs'!M$3	=I$4	=F23*G23*H23*I23
24	U-234	='1content'!F81	='2NCTinputs'!H$3	=B24*C24	='1content'!B81	=D24/E24	='2NCTinputs'!J$3	='2NCTinputs'!M$3	=I$4	=F24*G24*H24*I24
25	U-238	='1content'!F82	='2NCTinputs'!H$3	=B25*C25	='1content'!B86					
26	U-236	='1content'!F83	='2NCTinputs'!H$3	=B26*C26	='1content'!B84	=D26/E26	='2NCTinputs'!J$3	='2NCTinputs'!M$3	=I$4	=F26*G26*H26*I26
27	U-235	='1content'!F84	='2NCTinputs'!H$3	=B27*C27	='1content'!B82					
28	Cm-242	='1content'!F95	='2NCTinputs'!H$3	=B28*C28	='1content'!B95	=D28/E28	='2NCTinputs'!J$3	='2NCTinputs'!M$3	=I$4	=F28*G28*H28*I28
29	Am-243	='1content'!F94	='2NCTinputs'!H$3	=B29*C29	='1content'!B94	=D29/E29	='2NCTinputs'!J$3	='2NCTinputs'!M$3	=I$4	=F29*G29*H29*I29
30	Cm-243	='1content'!F96	='2NCTinputs'!H$3	=B30*C30	='1content'!B96	=D30/E30	='2NCTinputs'!J$3	='2NCTinputs'!M$3	=I$4	=F30*G30*H30*I30
31	Th-228	='1content'!F69	='2NCTinputs'!H$3	=B31*C31	='1content'!B69					
32	Np-237	='1content'!F87	='2NCTinputs'!H$3	=B32*C32	='1content'!B87	=D32/E32	='2NCTinputs'!J$3	='2NCTinputs'!M$3	=I$4	=F32*G32*H32*I32
33	U-232	='1content'!F79	='2NCTinputs'!H$3	=B33*C33	='1content'!B79	=D33/E33	='2NCTinputs'!J$3	='2NCTinputs'!M$3	=I$4	=F33*G33*H33*I33
34	Th-232	='1content'!F73	='2NCTinputs'!H$3	=B34*C34	='1content'!B73					
35	Th-230	='1content'!F74	='2NCTinputs'!H$3	=B35*C35	='1content'!B71	=D35/E35	='2NCTinputs'!J$3	='2NCTinputs'!M$3	=I$4	=F35*G35*H35*I35

Formulas for Table 9

	A	B	C	D	E	F	G	H	I	J
36	Pu-241	='1content'!F92	='2NCTInputs'!H$3	=B36*C36	='1content'!B92	=D36/E36	='2NCTInputs'!J$3	='2NCTInputs'!M$3	=I$4	=F36*G36*H36*I36
37	Cm-244	='1content'!F97	='2NCTInputs'!H$3	=B37*C37	='1content'!B97	=D37/E37	='2NCTInputs'!J$3	='2NCTInputs'!M$3	=I$4	=F37*G37*H37*I37
38										=SUM(J4:J37)

	A	B	C	D	E	F	G	H	I	J	K
1	Isotope	Content (Ci)	Leach Ratio	Leached (Ci)	A_2 (Ci/A_2)	MAR (A_2)	DR	ARF	RF	LPF WVMP	Release (A_2)
2		From Table 1	From Table 2 for Bartlett's PBS	Calculated for LDCC external to melter	From Table 1	Calculated for LDCC external to melter	From Table 2. For LDCC external to melter . Note LPF WVMP already credited as part of ARF number				Calculated for inhalation from LDCC external to the melter
3	a	b	e	c	c	f=d*e	g	h	i	j	k=f*g*h*i*j
4	Cs-137	='1content'!F19	='2NCTinputs'!H$3	=B4*C4	='1content'!B19	=D4/E4	='2NCTinputs'!J$3	='2NCTinputs'!N3	='2NCTinputs'!O$3	='2NCTinputs'!Q3	=F4*G4*H4*I4*J4
5	Ba-137m	='1content'!F20	='2NCTinputs'!H$3	=B5*C5	='1content'!B20						
6	Sr-90	='1content'!F12	='2NCTinputs'!H$3	=B6*C6	='1content'!B12	=D6/E6	='2NCTinputs'!J$3	='2NCTinputs'!N3	='2NCTinputs'!O$3	=J4	=F6*G6*H6*I6*J6
7	Y-90	='1content'!F13	='2NCTinputs'!H$3	=B7*C7	='1content'!B13						
8	Pm-147	='1content'!F21	='2NCTinputs'!H$3	=B8*C8	='1content'!B21	=D8/E8	='2NCTinputs'!J$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	=J4	=F8*G8*H8*I8*J8
9	Am-241	='1content'!F93	='2NCTinputs'!H$3	=B9*C9	='1content'!B93	=D9/E9	='2NCTinputs'!J$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	=J4	=F9*G9*H9*I9*J9
10	Eu-154	='1content'!F22	='2NCTinputs'!H$3	=B10*C10	='1content'!B22	=D10/E10	='2NCTinputs'!J$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	=J4	=F10*G10*H10*I10*J10
11	Ni-63	='1content'!F11	='2NCTinputs'!H$3	=B11*C11	='1content'!B11	=D11/E11	='2NCTinputs'!J$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	=J4	=F11*G11*H11*I11*J11
12	Fe-55	='1content'!F9	='2NCTinputs'!H$3	=B12*C12	='1content'!B9	=D12/E12	='2NCTinputs'!J$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	=J4	=F12*G12*H12*I12*J12
13	Pu-238	='1content'!F89	='2NCTinputs'!H$3	=B13*C13	='1content'!B89	=D13/E13	='2NCTinputs'!J$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	=J4	=F13*G13*H13*I13*J13
14	C-14	='1content'!F5	='2NCTinputs'!H$3	=B14*C14	='1content'!B5	=D14/E14	='2NCTinputs'!J$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	=J4	=F14*G14*H14*I14*J14
15	Co-60	='1content'!F6	='2NCTinputs'!H$3	=B15*C15	='1content'!B6	=D15/E15	='2NCTinputs'!J$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	=J4	=F15*G15*H15*I15*J15
16	U-232	='1content'!F79	='2NCTinputs'!H$3	=B16*C16	='1content'!B79	=D16/E16	='2NCTinputs'!J$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	=J4	=F16*G16*H16*I16*J16
17	Pu-239	='1content'!F90	='2NCTinputs'!H$3	=B17*C17	='1content'!B90	=D17/E17	='2NCTinputs'!J$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	=J4	=F17*G17*H17*I17*J17
18	Pu-240	='1content'!F91	='2NCTinputs'!H$3	=B18*C18	='1content'!B91	=D18/E18	='2NCTinputs'!J$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	=J4	=F18*G18*H18*I18*J18
19	Ni-59	='1content'!F10	='2NCTinputs'!H$3	=B19*C19	='1content'!B10						
20	I-129	='1content'!F18	='2NCTinputs'!H$3	=B20*C20	='1content'!B18						
21	U-233	='1content'!F80	='2NCTinputs'!H$3	=B21*C21	='1content'!B79	=D21/E21	='2NCTinputs'!J$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	=J4	=F21*G21*H21*I21*J21
22	Tc-99	='1content'!F17	='2NCTinputs'!H$3	=B22*C22	='1content'!B17	=D22/E22	='2NCTinputs'!J$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	=J4	=F22*G22*H22*I22*J22
23	H-3	='1content'!F4	='2NCTinputs'!H$3	=B23*C23	='1content'!B4	=D23/E23	='2NCTinputs'!J$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	=J4	=F23*G23*H23*I23*J23
24	U-234	='1content'!F81	='2NCTinputs'!H$3	=B24*C24	='1content'!B81	=D24/E24	='2NCTinputs'!J$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	=J4	=F24*G24*H24*I24*J24
25	U-238	='1content'!F82	='2NCTinputs'!H$3	=B25*C25	='1content'!B86						
26	U-236	='1content'!F83	='2NCTinputs'!H$3	=B26*C26	='1content'!B84	=D26/E26	='2NCTinputs'!J$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	=J4	=F26*G26*H26*I26*J26
27	U-235	='1content'!F84	='2NCTinputs'!H$3	=B27*C27	='1content'!B82						
28	Cm-242	='1content'!F95	='2NCTinputs'!H$3	=B28*C28	='1content'!B95	=D28/E28	='2NCTinputs'!J$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	=J4	=F28*G28*H28*I28*J28
29	Am-243	='1content'!F94	='2NCTinputs'!H$3	=B29*C29	='1content'!B94	=D29/E29	='2NCTinputs'!J$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	=J4	=F29*G29*H29*I29*J29
30	Cm-243	='1content'!F96	='2NCTinputs'!H$3	=B30*C30	='1content'!B96	=D30/E30	='2NCTinputs'!J$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	=J4	=F30*G30*H30*I30*J30
31	Th-228	='1content'!F69	='2NCTinputs'!H$3	=B31*C31	='1content'!B69						
32	Np-237	='1content'!F87	='2NCTinputs'!H$3	=B32*C32	='1content'!B87	=D32/E32	='2NCTinputs'!J$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	=J4	=F32*G32*H32*I32*J32
33	U-232	='1content'!F79	='2NCTinputs'!H$3	=B33*C33	='1content'!B79	=D33/E33	='2NCTinputs'!J$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	=J4	=F33*G33*H33*I33*J33
34	Th-232	='1content'!F73	='2NCTinputs'!H$3	=B34*C34	='1content'!B73						
35	Th-230	='1content'!F74	='2NCTinputs'!H$3	=B35*C35	='1content'!B71	=D35/E35	='2NCTinputs'!J$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	=J4	=F35*G35*H35*I35*J35
36	Pu-241	='1content'!F92	='2NCTinputs'!H$3	=B36*C36	='1content'!B92	=D36/E36	='2NCTinputs'!J$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	=J4	=F36*G36*H36*I36*J36
37	Cm-244	='1content'!F97	='2NCTinputs'!H$3	=B37*C37	='1content'!B97	=D37/E37	='2NCTinputs'!J$3	='2NCTinputs'!N$3	='2NCTinputs'!O$3	=J4	=F37*G37*H37*I37*J37

Formulas for Table 10

	A	B	C	D	E	F	G	H	I	J	K
38											=SUM(K4:K37)

Formulas [illegible] Table 11

	A	B
1	**SOURCE**	**RELEASE**
2	**from Glass**	A_2
3	Spout Glass	='4NCTspoutglass'!I93
4	Melter Heel Glass	='5NCTheelglass'!I93
5	Refractory Glass	='6NCTrefractglass'!I86
6	**from LDCC**	
7	LDCC inside the Melter	='7NCTintLDCC '!K93
8	Increased Pressure	='8NCT<25LDCCint '!L93
9	LDCC external to Melter	='9NCTextLDCC '!J38
10	Increased Pressure	='10NCT<25LDCCext'!K38
11	**Total**	=SUM(B3:B10)

Formulas for Table 12

	A	B	C	D	E	F	G	H	I
1	Isotope	Content (Ci)	A_2 (Ci/A_2)	MAR (A_2)	DR	ARF	LPF WVMP	LPF Melter	Release (A_2)
2		From Table 1		Calculated for spout glass	From Table 3. Same for all HAC glass				Calculated for inhalation from spout glass
3	a	b	c	d=b/c	e	f	g	h	i=d*e*f*g*h
4	C-14	='1content'!C5	='1content'!B5	=B4/C4	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D4*E4*F4*G4*H4
5	K-40	='1content'!C7	='1content'!B7	=B5/C5	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D5*E5*F5*G5*H5
6	Mn-54	='1content'!C8	='1content'!B8	=B6/C6	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D6*E6*F6*G6*H6
7	Co-60	='1content'!C6	='1content'!B6	=B7/C7	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D7*E7*F7*G7*H7
8	Ni-63	='1content'!C11	='1content'!B11	=B8/C8	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D8*E8*F8*G8*H8
9	Sr-90	='1content'!C12	='1content'!B12	=B9/C9	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D9*E9*F9*G9*H9
10	Y-90	='1content'!C13	='1content'!B13						
11	Zr-95	='1content'!C14	='1content'!B14	=B11/C11	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D11*E11*F11*G11*H11
12	Nb-95	='1content'!C15	='1content'!B15	=B12/C12	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D12*E12*F12*G12*H12
13	Nb-95m	='1content'!C16	='1content'!B16						
14	Tc-99	='1content'!C17	='1content'!B17	=B14/C14	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D14*E14*F14*G14*H14
15	Cs-137	='1content'!C19	='1content'!B19	=B15/C15	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D15*E15*F15*G15*H15
16	Ba-137m	='1content'!C20	='1content'!B20						
17	Eu-154	='1content'!C22	='1content'!B22	=B17/C17	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D17*E17*F17*G17*H17
18	Hg-206	='1content'!C23	='1content'!B23	=B18/C18	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D18*E18*F18*G18*H18
19	Tl-206	='1content'!C24	='1content'!B24						
20	Tl-207	='1content'!C25	='1content'!B25	=B20/C20	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D20*E20*F20*G20*H20
21	Tl-208	='1content'!C26	='1content'!B26						
22	Tl-209	='1content'!C27	='1content'!B27						
23	Tl-210	='1content'!C28	='1content'!B28	=B23/C23	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D23*E23*F23*G23*H23
24	Pb-210m	='1content'!C29	='1content'!B29						
25	Pb-210	='1content'!C30	='1content'!B30	=B25/C25	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D25*E25*F25*G25*H25
26	Pb-211	='1content'!C31	='1content'!B31	=B26/C26	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D26*E26*F26*G26*H26
27	Pb-212	='1content'!C32	='1content'!B32						
28	Pb-214	='1content'!C33	='1content'!B33						
29	Bi-209	='1content'!C34	='1content'!B34						
30	Bi-210	='1content'!C35	='1content'!B35						
31	Bi-211	='1content'!C36	='1content'!B36						
32	Bi-212	='1content'!C37	='1content'!B37						
33	Bi-213	='1content'!C38	='1content'!B38						
34	Bi-214	='1content'!C39	='1content'!B39						
35	Bi-215	='1content'!C40	='1content'!B40	=B35/C35	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D35*E35*F35*G35*H35
36	Po-210	='1content'!C41	='1content'!B41						
37	Po-211	='1content'!C42	='1content'!B42	=B37/C37	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D37*E37*F37*G37*H37
38	Po-212	='1content'!C43	='1content'!B43						
39	Po-213	='1content'!C44	='1content'!B44						

	A	B	C	D	E	F	G	H	I
40	Po-214	='1content'!C45	='1content'!B45						
41	Po-215	='1content'!C46	='1content'!B46						
42	Po-216	='1content'!C47	='1content'!B47						
43	Po-218	='1content'!C48	='1content'!B48						
44	At-215	='1content'!C49	='1content'!B49	=B44/C44	='3HACInputs'!I$3	='3HACInputs'!L$3	='3HACInputs'!Q$3	='3HACInputs'!R$3	=D44*E44*F44*G44*H44
45	At-217	='1content'!C50	='1content'!B50						
46	At-218	='1content'!C51	='1content'!B51	=B46/C46	='3HACInputs'!I$3	='3HACInputs'!L$3	='3HACInputs'!Q$3	='3HACInputs'!R$3	=D46*E46*F46*G46*H46
47	At-219	='1content'!C52	='1content'!B52	=B47/C47	='3HACInputs'!I$3	='3HACInputs'!L$3	='3HACInputs'!Q$3	='3HACInputs'!R$3	=D47*E47*F47*G47*H47
48	Rn-217	='1content'!C53	='1content'!B53	=B48/C48	='3HACInputs'!I$3	='3HACInputs'!L$3	='3HACInputs'!Q$3	='3HACInputs'!R$3	=D48*E48*F48*G48*H48
49	Rn-218	='1content'!C54	='1content'!B54						
50	Rn-219	='1content'!C55	='1content'!B55	=B50/C50	='3HACInputs'!I$3	='3HACInputs'!L$3	='3HACInputs'!Q$3	='3HACInputs'!R$3	=D50*E50*F50*G50*H50
51	Rn-220	='1content'!C56	='1content'!B56						
52	Rn-222	='1content'!C57	='1content'!B57	=B52/C52	='3HACInputs'!I$3	='3HACInputs'!L$3	='3HACInputs'!Q$3	='3HACInputs'!R$3	=D52*E52*F52*G52*H52
53	Fr-221	='1content'!C58	='1content'!B58						
54	Fr-223	='1content'!C59	='1content'!B59	=B54/C54	='3HACInputs'!I$3	='3HACInputs'!L$3	='3HACInputs'!Q$3	='3HACInputs'!R$3	=D54*E54*F54*G54*H54
55	Ra-223	='1content'!C60	='1content'!B60	=B55/C55	='3HACInputs'!I$3	='3HACInputs'!L$3	='3HACInputs'!Q$3	='3HACInputs'!R$3	=D55*E55*F55*G55*H55
56	Ra-224	='1content'!C61	='1content'!B61						
57	Ra-225	='1content'!C62	='1content'!B62						
58	Ra-226	='1content'!C63	='1content'!B63	=B58/C58	='3HACInputs'!I$3	='3HACInputs'!L$3	='3HACInputs'!Q$3	='3HACInputs'!R$3	=D58*E58*F58*G58*H58
59	Ra-228	='1content'!C64	='1content'!B64	=B59/C59	='3HACInputs'!I$3	='3HACInputs'!L$3	='3HACInputs'!Q$3	='3HACInputs'!R$3	=D59*E59*F59*G59*H59
60	Ac-225	='1content'!C65	='1content'!B65						
61	Ac-227	='1content'!C66	='1content'!B66	=B61/C61	='3HACInputs'!I$3	='3HACInputs'!L$3	='3HACInputs'!Q$3	='3HACInputs'!R$3	=D61*E61*F61*G61*H61
62	Ac-228	='1content'!C67	='1content'!B67						
63	Th-227	='1content'!C68	='1content'!B68	=B63/C63	='3HACInputs'!I$3	='3HACInputs'!L$3	='3HACInputs'!Q$3	='3HACInputs'!R$3	=D63*E63*F63*G63*H63
64	Th-228	='1content'!C69	='1content'!B69						
65	Th-229	='1content'!C70	='1content'!B70	=B65/C65	='3HACInputs'!I$3	='3HACInputs'!L$3	='3HACInputs'!Q$3	='3HACInputs'!R$3	=D65*E65*F65*G65*H65
66	Th-230	='1content'!C71	='1content'!B71	=B66/C66	='3HACInputs'!I$3	='3HACInputs'!L$3	='3HACInputs'!Q$3	='3HACInputs'!R$3	=D66*E66*F66*G66*H66
67	Th-231	='1content'!C72	='1content'!B72						
68	Th-232	='1content'!C73	='1content'!B73						
69	Th-234	='1content'!C74	='1content'!B74						
70	Pa-231	='1content'!C75	='1content'!B75	=B70/C70	='3HACInputs'!I$3	='3HACInputs'!L$3	='3HACInputs'!Q$3	='3HACInputs'!R$3	=D70*E70*F70*G70*H70
71	Pa-233	='1content'!C76	='1content'!B76						
72	Pa-234	='1content'!C77	='1content'!B77	=B72/C72	='3HACInputs'!I$3	='3HACInputs'!L$3	='3HACInputs'!Q$3	='3HACInputs'!R$3	=D72*E72*F72*G72*H72
73	Pa-234m	='1content'!C78	='1content'!B78						
74	U-232	='1content'!C79	='1content'!B79	=B74/C74	='3HACInputs'!I$3	='3HACInputs'!L$3	='3HACInputs'!Q$3	='3HACInputs'!R$3	=D74*E74*F74*G74*H74
75	U-233	='1content'!C80	='1content'!B80	=B75/C75	='3HACInputs'!I$3	='3HACInputs'!L$3	='3HACInputs'!Q$3	='3HACInputs'!R$3	=D75*E75*F75*G75*H75
76	U-234	='1content'!C81	='1content'!B81	=B76/C76	='3HACInputs'!I$3	='3HACInputs'!L$3	='3HACInputs'!Q$3	='3HACInputs'!R$3	=D76*E76*F76*G76*H76
77	U-235	='1content'!C82							
78	U-235m	='1content'!C83	='1content'!B82						
79	U-236	='1content'!C84	='1content'!B84	=B79/C79	='3HACInputs'!I$3	='3HACInputs'!L$3	='3HACInputs'!Q$3	='3HACInputs'!R$3	=D79*E79*F79*G79*H79
80	U-237	='1content'!C85	='1content'!B85						

Formulas for Table 12

	A	B	C	D	E	F	G	H	I
81	U-238	='1content'!C86	='1content'!B86						
82	Np-237	='1content'!C87	='1content'!B87	=B82/C82	='3HACInputs'!I$3	='3HACInputs'!L$3	='3HACInputs'!Q$3	='3HACInputs'!R$3	=D82*E82*F82*G82*H82
83	Np-239	='1content'!C88	='1content'!B88						
84	Pu-238	='1content'!C89	='1content'!B89	=B84/C84	='3HACInputs'!I$3	='3HACInputs'!L$3	='3HACInputs'!Q$3	='3HACInputs'!R$3	=D84*E84*F84*G84*H84
85	Pu-239	='1content'!C90	='1content'!B90	=B85/C85	='3HACInputs'!I$3	='3HACInputs'!L$3	='3HACInputs'!Q$3	='3HACInputs'!R$3	=D85*E85*F85*G85*H85
86	Pu-240	='1content'!C91	='1content'!B91	=B86/C86	='3HACInputs'!I$3	='3HACInputs'!L$3	='3HACInputs'!Q$3	='3HACInputs'!R$3	=D86*E86*F86*G86*H86
87	Pu-241	='1content'!C92	='1content'!B92	=B87/C87	='3HACInputs'!I$3	='3HACInputs'!L$3	='3HACInputs'!Q$3	='3HACInputs'!R$3	=D87*E87*F87*G87*H87
88	Am-241	='1content'!C93	='1content'!B93	=B88/C88	='3HACInputs'!I$3	='3HACInputs'!L$3	='3HACInputs'!Q$3	='3HACInputs'!R$3	=D88*E88*F88*G88*H88
89	Am-243	='1content'!C94	='1content'!B93	=B89/C89	='3HACInputs'!I$3	='3HACInputs'!L$3	='3HACInputs'!Q$3	='3HACInputs'!R$3	=D89*E89*F89*G89*H89
90	Cm-242	='1content'!C95	='1content'!B95	=B90/C90	='3HACInputs'!I$3	='3HACInputs'!L$3	='3HACInputs'!Q$3	='3HACInputs'!R$3	=D90*E90*F90*G90*H90
91	Cm-243	='1content'!C96	='1content'!B96	=B91/C91	='3HACInputs'!I$3	='3HACInputs'!L$3	='3HACInputs'!Q$3	='3HACInputs'!R$3	=D91*E91*F91*G91*H91
92	Cm-244	='1content'!C97	='1content'!B97	=B92/C92	='3HACInputs'!I$3	='3HACInputs'!L$3	='3HACInputs'!Q$3	='3HACInputs'!R$3	=D92*E92*F92*G92*H92
93									=SUM(I4:I92)

	A	B	C	D	E	F	G	H	I
1	Isotope	Content (Ci)	A_2 (Ci/A_2)	MAR (A_2)	DR	ARF	LPF Melter	LPF WVMP	Release (A_2)
2		From Table 1		Calculated for heel glass	From Table 3. Same for all HAC glass				Calculated for inhalation from heel glass
3	a	b	c	d=b/c	e	f	g	h	i=d*e*f*g*h
4	C-14	='1content'!D5	='1content'!B5	=B4/C4	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D4*E4*F4*G4*H4
5	K-40	='1content'!D7	='1content'!B7	=B5/C5	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D5*E5*F5*G5*H5
6	Mn-54	='1content'!D8	='1content'!B8	=B6/C6	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D6*E6*F6*G6*H6
7	Co-60	='1content'!D6	='1content'!B6	=B7/C7	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D7*E7*F7*G7*H7
8	Ni-63	='1content'!D11	='1content'!B11	=B8/C8	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D8*E8*F8*G8*H8
9	Sr-90	='1content'!D12	='1content'!B12	=B9/C9	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D9*E9*F9*G9*H9
10	Y-90	='1content'!D13	='1content'!B13						
11	Zr-95	='1content'!D14	='1content'!B14	=B11/C11	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D11*E11*F11*G11*H11
12	Nb-95	='1content'!D15	='1content'!B15	=B12/C12	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D12*E12*F12*G12*H12
13	Nb-95m	='1content'!D16	='1content'!B16						
14	Tc-99	='1content'!D17	='1content'!B17	=B14/C14	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D14*E14*F14*G14*H14
15	Cs-137	='1content'!D19	='1content'!B19	=B15/C15	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D15*E15*F15*G15*H15
16	Ba-137m	='1content'!D20	='1content'!B20						
17	Eu-154	='1content'!D22	='1content'!B22	=B17/C17	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D17*E17*F17*G17*H17
18	Hg-206	='1content'!D23	='1content'!B23	=B18/C18	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D18*E18*F18*G18*H18
19	Tl-206	='1content'!D24	='1content'!B24						
20	Tl-207	='1content'!D25	='1content'!B25	=B20/C20	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D20*E20*F20*G20*H20
21	Tl-208	='1content'!D26	='1content'!B24						
22	Tl-209	='1content'!D27	='1content'!B27						
23	Tl-210	='1content'!D28	='1content'!B28	=B23/C23	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D23*E23*F23*G23*H23
24	Pb-210m	='1content'!D29	='1content'!B29						
25	Pb-210	='1content'!D30	='1content'!B30	=B25/C25	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D25*E25*F25*G25*H25
26	Pb-211	='1content'!D31	='1content'!B31	=B26/C26	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D26*E26*F26*G26*H26
27	Pb-212	='1content'!D32	='1content'!B32						
28	Pb-214	='1content'!D33	='1content'!B33						
29	Bi-209	='1content'!D34	='1content'!B34						
30	Bi-210	='1content'!D35	='1content'!B35						
31	Bi-211	='1content'!D36	='1content'!B36						
32	Bi-212	='1content'!D37	='1content'!B37						
33	Bi-213	='1content'!D38	='1content'!B38						
34	Bi-214	='1content'!D39	='1content'!B39						
35	Bi-215	='1content'!D40	='1content'!B40	=B35/C35	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D35*E35*F35*G35*H35
36	Po-210	='1content'!D41	='1content'!B41						
37	Po-211	='1content'!D42	='1content'!B42	=B37/C37	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D37*E37*F37*G37*H37
38	Po-212	='1content'!D43	='1content'!B43						

Formulas for Table 13

	A	B	C	D	E	F	G	H	I
39	Po-213	='1content'!D44	='1content'!B44						
40	Po-214	='1content'!D45	='1content'!B45						
41	Po-215	='1content'!D46	='1content'!B46						
42	Po-216	='1content'!D47	='1content'!B47						
43	Po-218	='1content'!D48	='1content'!B48						
44	At-215	='1content'!D49	='1content'!B49	=B44/C44	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D44*E44*F44*G44*H44
45	At-217	='1content'!D50	='1content'!B50						
46	At-218	='1content'!D51	='1content'!B51	=B46/C46	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D46*E46*F46*G46*H46
47	At-219	='1content'!D52	='1content'!B52	=B47/C47	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D47*E47*F47*G47*H47
48	Rn-217	='1content'!D53	='1content'!B53	=B48/C48	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D48*E48*F48*G48*H48
49	Rn-218	='1content'!D54	='1content'!B54						
50	Rn-219	='1content'!D55	='1content'!B55	=B50/C50	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D50*E50*F50*G50*H50
51	Rn-220	='1content'!D56	='1content'!B56						
52	Rn-222	='1content'!D57	='1content'!B57	=B52/C52	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D52*E52*F52*G52*H52
53	Fr-221	='1content'!D58	='1content'!B58						
54	Fr-223	='1content'!D59	='1content'!B59	=B54/C54	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D54*E54*F54*G54*H54
55	Ra-223	='1content'!D60	='1content'!B60	=B55/C55	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D55*E55*F55*G55*H55
56	Ra-224	='1content'!D61	='1content'!B61						
57	Ra-225	='1content'!D62	='1content'!B62						
58	Ra-226	='1content'!D63	='1content'!B63	=B58/C58	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D58*E58*F58*G58*H58
59	Ra-228	='1content'!D64	='1content'!B64	=B59/C59	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D59*E59*F59*G59*H59
60	Ac-225	='1content'!D65	='1content'!B65						
61	Ac-227	='1content'!D66	='1content'!B66	=B61/C61	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D61*E61*F61*G61*H61
62	Ac-228	='1content'!D67	='1content'!B67						
63	Th-227	='1content'!D68	='1content'!B68	=B63/C63	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D63*E63*F63*G63*H63
64	Th-228	='1content'!D69	='1content'!B69						
65	Th-229	='1content'!D70	='1content'!B70	=B65/C65	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D65*E65*F65*G65*H65
66	Th-230	='1content'!D71	='1content'!B71	=B66/C66	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D66*E66*F66*G66*H66
67	Th-231	='1content'!D72	='1content'!B72						
68	Th-232	='1content'!D73	='1content'!B73						
69	Th-234	='1content'!D74	='1content'!B74						
70	Pa-231	='1content'!D75	='1content'!B75	=B70/C70	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D70*E70*F70*G70*H70
71	Pa-233	='1content'!D76	='1content'!B76						
72	Pa-234	='1content'!D77	='1content'!B77	=B72/C72	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D72*E72*F72*G72*H72
73	Pa-234m	='1content'!D78	='1content'!B78						
74	U-232	='1content'!D79	='1content'!B79	=B74/C74	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D74*E74*F74*G74*H74
75	U-233	='1content'!D80	='1content'!B80	=B75/C75	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D75*E75*F75*G75*H75
76	U-234	='1content'!D81	='1content'!B81	=B76/C76	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D76*E76*F76*G76*H76
77	U-235	='1content'!D82							
78	U-235m	='1content'!D83	='1content'!B82						
79	U-236	='1content'!D84	='1content'!B84	=B79/C79	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D79*E79*F79*G79*H79

Formula Table 13

	A	B	C	D	E	F	G	H	I
80	U-237	='1content'!D85	='1content'!B85						
81	U-238	='1content'!D86	='1content'!B86						
82	Np-237	='1content'!D87	='1content'!B87	=B82/C82	='3HACInputs'!I$3	='3HACInputs'!L$3	='3HACInputs'!Q$3	='3HACInputs'!R$3	=D82*E82*F82*G82*H82
83	Np-239	='1content'!D88	='1content'!B88						
84	Pu-238	='1content'!D89	='1content'!B89	=B84/C84	='3HACInputs'!I$3	='3HACInputs'!L$3	='3HACInputs'!Q$3	='3HACInputs'!R$3	=D84*E84*F84*G84*H84
85	Pu-239	='1content'!D90	='1content'!B90	=B85/C85	='3HACInputs'!I$3	='3HACInputs'!L$3	='3HACInputs'!Q$3	='3HACInputs'!R$3	=D85*E85*F85*G85*H85
86	Pu-240	='1content'!D91	='1content'!B91	=B86/C86	='3HACInputs'!I$3	='3HACInputs'!L$3	='3HACInputs'!Q$3	='3HACInputs'!R$3	=D86*E86*F86*G86*H86
87	Pu-241	='1content'!D92	='1content'!B92	=B87/C87	='3HACInputs'!I$3	='3HACInputs'!L$3	='3HACInputs'!Q$3	='3HACInputs'!R$3	=D87*E87*F87*G87*H87
88	Am-241	='1content'!D93	='1content'!B93	=B88/C88	='3HACInputs'!I$3	='3HACInputs'!L$3	='3HACInputs'!Q$3	='3HACInputs'!R$3	=D88*E88*F88*G88*H88
89	Am-243	='1content'!D94	='1content'!B94	=B89/C89	='3HACInputs'!I$3	='3HACInputs'!L$3	='3HACInputs'!Q$3	='3HACInputs'!R$3	=D89*E89*F89*G89*H89
90	Cm-242	='1content'!D95	='1content'!B95	=B90/C90	='3HACInputs'!I$3	='3HACInputs'!L$3	='3HACInputs'!Q$3	='3HACInputs'!R$3	=D90*E90*F90*G90*H90
91	Cm-243	='1content'!D96	='1content'!B96	=B91/C91	='3HACInputs'!I$3	='3HACInputs'!L$3	='3HACInputs'!Q$3	='3HACInputs'!R$3	=D91*E91*F91*G91*H91
92	Cm-244	='1content'!D97	='1content'!B97	=B92/C92	='3HACInputs'!I$3	='3HACInputs'!L$3	='3HACInputs'!Q$3	='3HACInputs'!R$3	=D92*E92*F92*G92*H92
93									=SUM(I4:I92)

Formulas for Table 14

	B	C	D	E	F	G	H	I
1	Content (Ci)	A_2 (Ci/A_2)	MAR (A_2)	DR	ARF	LPF WVMP	LPF Melter	Release (A_2)
2	From Table 1		Calculated for refractory glass	From Table 3. Same for all HAC glass				Calculated for inhalation from refractory glass
3	b	c	d=b/c	e	f	g	h	i=d*e*f*g*h
4	='1content'!E6	='1content'!B6	=B4/C4	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D4*E4*F4*G4*H4
5	='1content'!E12	='1content'!B12	=B5/C5	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D5*E5*F5*G5*H5
6	='1content'!E13	='1content'!B13						
7	='1content'!E17	='1content'!B17	=B7/C7	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D7*E7*F7*G7*H7
8	='1content'!E19	='1content'!B19	=B8/C8	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D8*E8*F8*G8*H8
9	='1content'!E20	='1content'!B20						
10	='1content'!E22	='1content'!B22	=B10/C10	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D10*E10*F10*G10*H10
11	='1content'!E23	='1content'!B23	=B11/C11	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D11*E11*F11*G11*H11
12	='1content'!E24	='1content'!B24						
13	='1content'!E25	='1content'!B25	=B13/C13	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D13*E13*F13*G13*H13
14	='1content'!E26	='1content'!B26						
15	='1content'!E27	='1content'!B27						
16	='1content'!E28	='1content'!B28	=B16/C16	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D16*E16*F16*G16*H16
17	='1content'!E29	='1content'!B29						
18	='1content'!E30	='1content'!B30	=B18/C18	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D18*E18*F18*G18*H18
19	='1content'!E31	='1content'!B31	=B19/C19	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D19*E19*F19*G19*H19
20	='1content'!E32	='1content'!B32						
21	='1content'!E33	='1content'!B33						
22	='1content'!E34	='1content'!B34						
23	='1content'!E35	='1content'!B35						
24	='1content'!E36	='1content'!B36						
25	='1content'!E37	='1content'!B37						
26	='1content'!E38	='1content'!B38						
27	='1content'!E39	='1content'!B39						
28	='1content'!E40	='1content'!B40	=B28/C28	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D28*E28*F28*G28*H28
29	='1content'!E41	='1content'!B41						
30	='1content'!E42	='1content'!B42	=B30/C30	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D30*E30*F30*G30*H30
31	='1content'!E43	='1content'!B43						
32	='1content'!E44	='1content'!B44						
33	='1content'!E45	='1content'!B45						
34	='1content'!E46	='1content'!B46						
35	='1content'!E47	='1content'!B47						
36	='1content'!E48	='1content'!B48						
37	='1content'!E49	='1content'!B49	=B37/C37	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D37*E37*F37*G37*H37

	B	C	D	E	F	G	H	I
38	='1content'!E50	='1content'!B50						
39	='1content'!E51	='1content'!B51	=B39/C39	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D39*E39*F39*G39*H39
40	='1content'!E52	='1content'!B52	=B40/C40	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D40*E40*F40*G40*H40
41	='1content'!E53	='1content'!B53	=B41/C41	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D41*E41*F41*G41*H41
42	='1content'!E54	='1content'!B54						
43	='1content'!E55	='1content'!B55	=B43/C43	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D43*E43*F43*G43*H43
44	='1content'!E56	='1content'!B56						
45	='1content'!E57	='1content'!B57	=B45/C45	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D45*E45*F45*G45*H45
46	='1content'!E58	='1content'!B58						
47	='1content'!E59	='1content'!B59	=B47/C47	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D47*E47*F47*G47*H47
48	='1content'!E60	='1content'!B60	=B48/C48	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D48*E48*F48*G48*H48
49	='1content'!E61	='1content'!B61						
50	='1content'!E62	='1content'!B62						
51	='1content'!E63	='1content'!B63	=B51/C51	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D51*E51*F51*G51*H51
52	='1content'!E64	='1content'!B64	=B52/C52	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D52*E52*F52*G52*H52
53	='1content'!E65	='1content'!B65						
54	='1content'!E66	='1content'!B66	=B54/C54	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D54*E54*F54*G54*H54
55	='1content'!E67	='1content'!B67						
56	='1content'!E68	='1content'!B68	=B56/C56	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D56*E56*F56*G56*H56
57	='1content'!E69	='1content'!B69						
58	='1content'!E70	='1content'!B70	=B58/C58	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D58*E58*F58*G58*H58
59	='1content'!E71	='1content'!B71	=B59/C59	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D59*E59*F59*G59*H59
60	='1content'!E72	='1content'!B72						
61	='1content'!E73	='1content'!B73						
62	='1content'!E74	='1content'!B74						
63	='1content'!E75	='1content'!B75	=B63/C63	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D63*E63*F63*G63*H63
64	='1content'!E76	='1content'!B76						
65	='1content'!E77	='1content'!B77	=B65/C65	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D65*E65*F65*G65*H65
66	='1content'!E78	='1content'!B78						
67	='1content'!E79	='1content'!B79	=B67/C67	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D67*E67*F67*G67*H67
68	='1content'!E80	='1content'!B80	=B68/C68	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D68*E68*F68*G68*H68
69	='1content'!E81	='1content'!B81	=B69/C69	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D69*E69*F69*G69*H69
70	='1content'!E82	='1content'!B82						
71	='1content'!E83	='1content'!B83						
72	='1content'!E84	='1content'!B84	=B72/C72	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D72*E72*F72*G72*H72
73	='1content'!E85	='1content'!B85						
74	='1content'!E86	='1content'!B86						
75	='1content'!E87	='1content'!B87	=B75/C75	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D75*E75*F75*G75*H75
76	='1content'!E88	='1content'!B88						
77	='1content'!E89	='1content'!B89	=B77/C77	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D77*E77*F77*G77*H77
78	='1content'!E90	='1content'!B90	=B78/C78	='3HACinputs'!I$3	='3HACinputs'!L$3	='3HACinputs'!Q$3	='3HACinputs'!R$3	=D78*E78*F78*G78*H78

Formulas for Table 14

	B	C	D	E	F	G	H	I
79	='1content'!E91	='1content'!B91	=B79/C79	='3HACInputs'!I$3	='3HACInputs'!L$3	='3HACInputs'!Q$3	='3HACInputs'!R$3	=D79*E79*F79*G79*H79
80	='1content'!E92	='1content'!B92	=B80/C80	='3HACInputs'!I$3	='3HACInputs'!L$3	='3HACInputs'!Q$3	='3HACInputs'!R$3	=D80*E80*F80*G80*H80
81	='1content'!E93	='1content'!B93	=B81/C81	='3HACInputs'!I$3	='3HACInputs'!L$3	='3HACInputs'!Q$3	='3HACInputs'!R$3	=D81*E81*F81*G81*H81
82	='1content'!E94	='1content'!B94	=B82/C82	='3HACInputs'!I$3	='3HACInputs'!L$3	='3HACInputs'!Q$3	='3HACInputs'!R$3	=D82*E82*F82*G82*H82
83	='1content'!E95	='1content'!B95	=B83/C83	='3HACInputs'!I$3	='3HACInputs'!L$3	='3HACInputs'!Q$3	='3HACInputs'!R$3	=D83*E83*F83*G83*H83
84	='1content'!E96	='1content'!B96	=B84/C84	='3HACInputs'!I$3	='3HACInputs'!L$3	='3HACInputs'!Q$3	='3HACInputs'!R$3	=D84*E84*F84*G84*H84
85	='1content'!E97	='1content'!B97	=B85/C85	='3HACInputs'!I$3	='3HACInputs'!L$3	='3HACInputs'!Q$3	='3HACInputs'!R$3	=D85*E85*F85*G85*H85
86								=SUM(I4:I85)

Formula Table 15

	A	B	C	D	E	F	G	H	I	J
1	Isotope	Content (Ci)	Leach Ratio	Leached (Ci)	A_2 (Ci/A_2)	MAR (A_2)	DR	ARF	LPF WVMP	Release (A_2)
2		From Table 1	From Table 3 for glass to LDCC	Calculated for LDCC internal to the melter	From Table 1	Calculated for LDCC internal to the melter	From Table 3 for LDCC internal to the melter			Calculated for inhalation from LDCC internal to the melter
3	a	b	c	d=b*c	e	f=d/e	g	h	i	j=f*g*h*i
4	C-14	='1content'!D5	='3HACinputs'!G$3	=B4*C4	='1content'!B5	=D4/E4	='3HACinputs'!K$3	='3HACinputs'!M$3	='3HACinputs'!Q$3	=F4*H4*G4*I4
5	K-40	='1content'!D7	='3HACinputs'!G$3	=B5*C5	='1content'!B7	=D5/E5	='3HACinputs'!K$3	='3HACinputs'!M$3	='3HACinputs'!Q$3	=F5*H5*G5*I5
6	Mn-54	='1content'!D8	='3HACinputs'!G$3	=B6*C6	='1content'!B8	=D6/E6	='3HACinputs'!K$3	='3HACinputs'!M$3	='3HACinputs'!Q$3	=F6*H6*G6*I6
7	Co-60	='1content'!D6	='3HACinputs'!G$3	=B7*C7	='1content'!B6	=D7/E7	='3HACinputs'!K$3	='3HACinputs'!M$3	='3HACinputs'!Q$3	=F7*H7*G7*I7
8	Ni-63	='1content'!D11	='3HACinputs'!G$3	=B8*C8	='1content'!B11	=D8/E8	='3HACinputs'!K$3	='3HACinputs'!M$3	='3HACinputs'!Q$3	=F8*H8*G8*I8
9	Sr-90	='1content'!D12	='3HACinputs'!G$3	=B9*C9	='1content'!B12	=D9/E9	='3HACinputs'!K$3	='3HACinputs'!M$3	='3HACinputs'!Q$3	=F9*H9*G9*I9
10	Y-90	='1content'!D13	='1content'!B13							
11	Zr-95	='1content'!D14	='3HACinputs'!G$3	=B11*C11	='1content'!B14	=D11/E11	='3HACinputs'!K$3	='3HACinputs'!M$3	='3HACinputs'!Q$3	=F11*H11*G11*I11
12	Nb-95	='1content'!D15	='3HACinputs'!G$3	=B12*C12	='1content'!B15	=D12/E12	='3HACinputs'!K$3	='3HACinputs'!M$3	='3HACinputs'!Q$3	=F12*H12*G12*I12
13	Nb-95m	='1content'!D16	='1content'!B16							
14	Tc-99	='1content'!D17	='3HACinputs'!G$3	=B14*C14	='1content'!B17	=D14/E14	='3HACinputs'!K$3	='3HACinputs'!M$3	='3HACinputs'!Q$3	=F14*H14*G14*I14
15	Cs-137	='1content'!D19	='3HACinputs'!G$3	=B15*C15	='1content'!B19	=D15/E15	='3HACinputs'!K$3	='3HACinputs'!M$3	='3HACinputs'!Q$3	=F15*H15*G15*I15
16	Ba-137m	='1content'!D20	='1content'!B20							
17	Eu-154	='1content'!D22	='3HACinputs'!G$3	=B17*C17	='1content'!B22	=D17/E17	='3HACinputs'!K$3	='3HACinputs'!M$3	='3HACinputs'!Q$3	=F17*H17*G17*I17
18	Hg-206	='1content'!D23	='3HACinputs'!G$3	=B18*C18	='1content'!B23	=D18/E18	='3HACinputs'!K$3	='3HACinputs'!M$3	='3HACinputs'!Q$3	=F18*H18*G18*I18
19	Tl-206	='1content'!D24	='1content'!B24							
20	Tl-207	='1content'!D25	='3HACinputs'!G$3	=B20*C20	='1content'!B25	=D20/E20	='3HACinputs'!K$3	='3HACinputs'!M$3	='3HACinputs'!Q$3	=F20*H20*G20*I20
21	Tl-208	='1content'!D26	='1content'!B26							
22	Tl-209	='1content'!D27	='1content'!B27							
23	Tl-210	='1content'!D28	='3HACinputs'!G$3	=B23*C23	='1content'!B28	=D23/E23	='3HACinputs'!K$3	='3HACinputs'!M$3	='3HACinputs'!Q$3	=F23*H23*G23*I23
24	Pb-210m	='1content'!D29	='1content'!B29							
25	Pb-210	='1content'!D30	='3HACinputs'!G$3	=B25*C25	='1content'!B30	=D25/E25	='3HACinputs'!K$3	='3HACinputs'!M$3	='3HACinputs'!Q$3	=F25*H25*G25*I25
26	Pb-211	='1content'!D31	='3HACinputs'!G$3	=B26*C26	='1content'!B31	=D26/E26	='3HACinputs'!K$3	='3HACinputs'!M$3	='3HACinputs'!Q$3	=F26*H26*G26*I26
27	Pb-212	='1content'!D32	='1content'!B32							
28	Pb-214	='1content'!D33	='1content'!B33							
29	Bi-209	='1content'!D34	='1content'!B34							
30	Bi-210	='1content'!D35	='1content'!B35							
31	Bi-211	='1content'!D36	='1content'!B36							
32	Bi-212	='1content'!D37	='1content'!B37							
33	Bi-213	='1content'!D38	='1content'!B38							
34	Bi-214	='1content'!D39	='1content'!B39							

Formulas for Table 15

	A	B	C	D	E	F	G	H	I	J
35	Bi-215	='1content'!D40	='3HACinputs'!G$3	=B35*C35	='1content'!B40	=D35/E35	='3HACinputs'!K$3	='3HACinputs'!M$3	='3HACinputs'!Q$3	=F35*H35*G35*I35
36	Po-210	='1content'!D41	='1content'!B41							
37	Po-211	='1content'!D42	='3HACinputs'!G$3	=B37*C37	='1content'!B42	=D37/E37	='3HACinputs'!K$3	='3HACinputs'!M$3	='3HACinputs'!Q$3	=F37*H37*G37*I37
38	Po-212	='1content'!D43	='1content'!B43							
39	Po-213	='1content'!D44	='1content'!B44							
40	Po-214	='1content'!D45	='1content'!B45							
41	Po-215	='1content'!D46	='1content'!B46							
42	Po-216	='1content'!D47	='1content'!B47							
43	Po-218	='1content'!D48	='1content'!B48							
44	At-215	='1content'!D49	='3HACinputs'!G$3	=B44*C44	='1content'!B49	=D44/E44	='3HACinputs'!K$3	='3HACinputs'!M$3	='3HACinputs'!Q$3	=F44*H44*G44*I44
45	At-217	='1content'!D50	='1content'!B50							
46	At-218	='1content'!D51	='3HACinputs'!G$3	=B46*C46	='1content'!B51	=D46/E46	='3HACinputs'!K$3	='3HACinputs'!M$3	='3HACinputs'!Q$3	=F46*H46*G46*I46
47	At-219	='1content'!D52	='3HACinputs'!G$3	=B47*C47	='1content'!B52	=D47/E47	='3HACinputs'!K$3	='3HACinputs'!M$3	='3HACinputs'!Q$3	=F47*H47*G47*I47
48	Rn-217	='1content'!D53	='3HACinputs'!G$3	=B48*C48	='1content'!B53	=D48/E48	='3HACinputs'!K$3	='3HACinputs'!M$3	='3HACinputs'!Q$3	=F48*H48*G48*I48
49	Rn-218	='1content'!D54	='1content'!B54							
50	Rn-219	='1content'!D55	='3HACinputs'!G$3	=B50*C50	='1content'!B55	=D50/E50	='3HACinputs'!K$3	='3HACinputs'!M$3	='3HACinputs'!Q$3	=F50*H50*G50*I50
51	Rn-220	='1content'!D56	='1content'!B56							
52	Rn-222	='1content'!D57	='3HACinputs'!G$3	=B52*C52	='1content'!B57	=D52/E52	='3HACinputs'!K$3	='3HACinputs'!M$3	='3HACinputs'!Q$3	=F52*H52*G52*I52
53	Fr-221	='1content'!D58	='1content'!B58							
54	Fr-223	='1content'!D59	='3HACinputs'!G$3	=B54*C54	='1content'!B59	=D54/E54	='3HACinputs'!K$3	='3HACinputs'!M$3	='3HACinputs'!Q$3	=F54*H54*G54*I54
55	Ra-223	='1content'!D60	='3HACinputs'!G$3	=B55*C55	='1content'!B60	=D55/E55	='3HACinputs'!K$3	='3HACinputs'!M$3	='3HACinputs'!Q$3	=F55*H55*G55*I55
56	Ra-224	='1content'!D61	='1content'!B61							
57	Ra-225	='1content'!D62	='1content'!B62							
58	Ra-226	='1content'!D63	='3HACinputs'!G$3	=B58*C58	='1content'!B63	=D58/E58	='3HACinputs'!K$3	='3HACinputs'!M$3	='3HACinputs'!Q$3	=F58*H58*G58*I58
59	Ra-228	='1content'!D64	='3HACinputs'!G$3	=B59*C59	='1content'!B64	=D59/E59	='3HACinputs'!K$3	='3HACinputs'!M$3	='3HACinputs'!Q$3	=F59*H59*G59*I59
60	Ac-225	='1content'!D65	='1content'!B65							
61	Ac-227	='1content'!D66	='3HACinputs'!G$3	=B61*C61	='1content'!B66	=D61/E61	='3HACinputs'!K$3	='3HACinputs'!M$3	='3HACinputs'!Q$3	=F61*H61*G61*I61
62	Ac-228	='1content'!D67	='1content'!B67							
63	Th-227	='1content'!D68	='3HACinputs'!G$3	=B63*C63	='1content'!B68	=D63/E63	='3HACinputs'!K$3	='3HACinputs'!M$3	='3HACinputs'!Q$3	=F63*H63*G63*I63
64	Th-228	='1content'!D69	='1content'!B69							
65	Th-229	='1content'!D70	='3HACinputs'!G$3	=B65*C65	='1content'!B70	=D65/E65	='3HACinputs'!K$3	='3HACinputs'!M$3	='3HACinputs'!Q$3	=F65*H65*G65*I65
66	Th-230	='1content'!D71	='3HACinputs'!G$3	=B66*C66	='1content'!B71	=D66/E66	='3HACinputs'!K$3	='3HACinputs'!M$3	='3HACinputs'!Q$3	=F66*H66*G66*I66
67	Th-231	='1content'!D72	='1content'!B72							
68	Th-232	='1content'!D73	='1content'!B73							
69	Th-234	='1content'!D74	='1content'!B74							
70	Pa-231	='1content'!D75	='3HACinputs'!G$3	=B70*C70	='1content'!B75	=D70/E70	='3HACinputs'!K$3	='3HACinputs'!M$3	='3HACinputs'!Q$3	=F70*H70*G70*I70
71	Pa-233	='1content'!D76	='1content'!B76							
72	Pa-234	='1content'!D77	='3HACinputs'!G$3	=B72*C72	='1content'!B77	=D72/E72	='3HACinputs'!K$3	='3HACinputs'!M$3	='3HACinputs'!Q$3	=F72*H72*G72*I72
73	Pa-234m	='1content'!D78	='1content'!B78							
74	U-232	='1content'!D79	='3HACinputs'!G$3	=B74*C74	='1content'!B79	=D74/E74	='3HACinputs'!K$3	='3HACinputs'!M$3	='3HACinputs'!Q$3	=F74*H74*G74*I74
75	U-233	='1content'!D80	='3HACinputs'!G$3	=B75*C75	='1content'!B80	=D75/E75	='3HACinputs'!K$3	='3HACinputs'!M$3	='3HACinputs'!Q$3	=F75*H75*G75*I75

	A	B	C	D	E	F	G	H	I	J
76	U-234	='1content'!D81	='3HACInputs'!G$3	=B76*C76	='1content'!B81	=D76/E76	='3HACInputs'!K$3	='3HACInputs'!M$3	='3HACInputs'!Q$3	=F76*H76*G76*I76
77	U-235	='1content'!D82								
78	U-235m	='1content'!D83	='1content'!B82							
79	U-236	='1content'!D84	='3HACInputs'!G$3	=B79*C79	='1content'!B84	=D79/E79	='3HACInputs'!K$3	='3HACInputs'!M$3	='3HACInputs'!Q$3	=F79*H79*G79*I79
80	U-237	='1content'!D85	='1content'!B85							
81	U-238	='1content'!D86	='1content'!B86							
82	Np-237	='1content'!D87	='3HACInputs'!G$3	=B82*C82	='1content'!B87	=D82/E82	='3HACInputs'!K$3	='3HACInputs'!M$3	='3HACInputs'!Q$3	=F82*H82*G82*I82
83	Np-239	='1content'!D88	='1content'!B88							
84	Pu-238	='1content'!D89	='3HACInputs'!G$3	=B84*C84	='1content'!B89	=D84/E84	='3HACInputs'!K$3	='3HACInputs'!M$3	='3HACInputs'!Q$3	=F84*H84*G84*I84
85	Pu-239	='1content'!D90	='3HACInputs'!G$3	=B85*C85	='1content'!B90	=D85/E85	='3HACInputs'!K$3	='3HACInputs'!M$3	='3HACInputs'!Q$3	=F85*H85*G85*I85
86	Pu-240	='1content'!D91	='3HACInputs'!G$3	=B86*C86	='1content'!B91	=D86/E86	='3HACInputs'!K$3	='3HACInputs'!M$3	='3HACInputs'!Q$3	=F86*H86*G86*I86
87	Pu-241	='1content'!D92	='3HACInputs'!G$3	=B87*C87	='1content'!B92	=D87/E87	='3HACInputs'!K$3	='3HACInputs'!M$3	='3HACInputs'!Q$3	=F87*H87*G87*I87
88	Am-241	='1content'!D93	='3HACInputs'!G$3	=B88*C88	='1content'!B93	=D88/E88	='3HACInputs'!K$3	='3HACInputs'!M$3	='3HACInputs'!Q$3	=F88*H88*G88*I88
89	Am-243	='1content'!D94	='3HACInputs'!G$3	=B89*C89	='1content'!B94	=D89/E89	='3HACInputs'!K$3	='3HACInputs'!M$3	='3HACInputs'!Q$3	=F89*H89*G89*I89
90	Cm-242	='1content'!D95	='3HACInputs'!G$3	=B90*C90	='1content'!B95	=D90/E90	='3HACInputs'!K$3	='3HACInputs'!M$3	='3HACInputs'!Q$3	=F90*H90*G90*I90
91	Cm-243	='1content'!D96	='3HACInputs'!G$3	=B91*C91	='1content'!B96	=D91/E91	='3HACInputs'!K$3	='3HACInputs'!M$3	='3HACInputs'!Q$3	=F91*H91*G91*I91
92	Cm-244	='1content'!D97	='3HACInputs'!G$3	=B92*C92	='1content'!B97	=D92/E92	='3HACInputs'!K$3	='3HACInputs'!M$3	='3HACInputs'!Q$3	=F92*H92*G92*I92
93										=SUM(J4:J92)

Formulas for Table 16

	B	C	D	E	F	G	H	I	J
1	Content (Ci)	Leach Ratio	Leached (Ci)	A_2 (Ci/A_2)	MAR (A_2)	DR	ARF	LPF Melter	Release (A_2)
2	From Table 1	From Table 3 for glass to LDCC	Calculated for LDCC internal to the melter	From Table 1	Calculated for LDCC internal to the melter	From Table 3 or LDCC internal to the melter from increase in pressure			Calculated for inhalation from LDCC internal to the melter from increase in pressure
3	b	c	d=b*c	e	f=d/e	g	h	i	j=f*g*h*i
4	='1content'!D5	='3HACinputs'!G$3	=B4*C4	='1content'!B5	=D4/E4	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F4*H4*G4*I4
5	='1content'!D7	='3HACinputs'!G$3	=B5*C5	='1content'!B7	=D5/E5	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F5*H5*G5*I5
6	='1content'!D8	='3HACinputs'!G$3	=B6*C6	='1content'!B8	=D6/E6	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F6*H6*G6*I6
7	='1content'!D6	='3HACinputs'!G$3	=B7*C7	='1content'!B6	=D7/E7	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F7*H7*G7*I7
8	='1content'!D11	='3HACinputs'!G$3	=B8*C8	='1content'!B11	=D8/E8	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F8*H8*G8*I8
9	='1content'!D12	='3HACinputs'!G$3	=B9*C9	='1content'!B12	=D9/E9	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F9*H9*G9*I9
10	='1content'!D13	='1content'!B13							
11	='1content'!D14	='3HACinputs'!G$3	=B11*C11	='1content'!B14	=D11/E11	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F11*H11*G11*I11
12	='1content'!D15	='3HACinputs'!G$3	=B12*C12	='1content'!B15	=D12/E12	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F12*H12*G12*I12
13	='1content'!D16	='1content'!B16							
14	='1content'!D17	='3HACinputs'!G$3	=B14*C14	='1content'!B17	=D14/E14	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F14*H14*G14*I14
15	='1content'!D19	='3HACinputs'!G$3	=B15*C15	='1content'!B19	=D15/E15	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F15*H15*G15*I15
16	='1content'!D20	='1content'!B20							
17	='1content'!D22	='3HACinputs'!G$3	=B17*C17	='1content'!B21	=D17/E17	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F17*H17*G17*I17
18	='1content'!D23	='3HACinputs'!G$3	=B18*C18	='1content'!B22	=D18/E18	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F18*H18*G18*I18
19	='1content'!D24	='1content'!B24							
20	='1content'!D25	='3HACinputs'!G$3	=B20*C20	='1content'!B25	=D20/E20	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F20*H20*G20*I20
21	='1content'!D26	='1content'!B26							
22	='1content'!D27	='1content'!B27							
23	='1content'!D28	='3HACinputs'!G$3	=B23*C23	='1content'!B28	=D23/E23	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F23*H23*G23*I23
24	='1content'!D29	='1content'!B29							
25	='1content'!D30	='3HACinputs'!G$3	=B25*C25	='1content'!B30	=D25/E25	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F25*H25*G25*I25
26	='1content'!D31	='3HACinputs'!G$3	=B26*C26	='1content'!B31	=D26/E26	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F26*H26*G26*I26
27	='1content'!D32	='1content'!B32							
28	='1content'!D33	='1content'!B33							
29	='1content'!D34	='1content'!B34							
30	='1content'!D35	='1content'!B35							
31	='1content'!D36	='1content'!B36							
32	='1content'!D37	='1content'!B37							
33	='1content'!D38	='1content'!B38							

	B	C	D	E	F	G	H	I	J
34	='1content'!D39	='1content'!B39							
35	='1content'!D40	='3HACinputs'!G$3	=B35*C35	='1content'!B40	=D35/E35	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F35*H35*G35*I35
36	='1content'!D41	='1content'!B41							
37	='1content'!D42	='3HACinputs'!G$3	=B37*C37	='1content'!B42	=D37/E37	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F37*H37*G37*I37
38	='1content'!D43	='1content'!B43							
39	='1content'!D44	='1content'!B44							
40	='1content'!D45	='1content'!B45							
41	='1content'!D46	='1content'!B46							
42	='1content'!D47	='1content'!B47							
43	='1content'!D48	='1content'!B48							
44	='1content'!D49	='3HACinputs'!G$3	=B44*C44	='1content'!B49	=D44/E44	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F44*H44*G44*I44
45	='1content'!D50	='1content'!B50							
46	='1content'!D51	='3HACinputs'!G$3	=B46*C46	='1content'!B51	=D46/E46	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F46*H46*G46*I46
47	='1content'!D52	='3HACinputs'!G$3	=B47*C47	='1content'!B52	=D47/E47	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F47*H47*G47*I47
48	='1content'!D53	='3HACinputs'!G$3	=B48*C48	='1content'!B53	=D48/E48	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F48*H48*G48*I48
49	='1content'!D54	='1content'!B54							
50	='1content'!D55	='3HACinputs'!G$3	=B50*C50	='1content'!B55	=D50/E50	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F50*H50*G50*I50
51	='1content'!D56	='1content'!B56							
52	='1content'!D57	='3HACinputs'!G$3	=B52*C52	='1content'!B57	=D52/E52	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F52*H52*G52*I52
53	='1content'!D58	='1content'!B58							
54	='1content'!D59	='3HACinputs'!G$3	=B54*C54	='1content'!B59	=D54/E54	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F54*H54*G54*I54
55	='1content'!D60	='3HACinputs'!G$3	=B55*C55	='1content'!B60	=D55/E55	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F55*H55*G55*I55
56	='1content'!D61	='1content'!B61							
57	='1content'!D62	='1content'!B62							
58	='1content'!D63	='3HACinputs'!G$3	=B58*C58	='1content'!B63	=D58/E58	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F58*H58*G58*I58
59	='1content'!D64	='3HACinputs'!G$3	=B59*C59	='1content'!B64	=D59/E59	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F59*H59*G59*I59
60	='1content'!D65	='1content'!B65							
61	='1content'!D66	='3HACinputs'!G$3	=B61*C61	='1content'!B66	=D61/E61	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F61*H61*G61*I61
62	='1content'!D67	='1content'!B67							
63	='1content'!D68	='3HACinputs'!G$3	=B63*C63	='1content'!B68	=D63/E63	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F63*H63*G63*I63
64	='1content'!D69	='1content'!B69							
65	='1content'!D70	='3HACinputs'!G$3	=B65*C65	='1content'!B70	=D65/E65	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F65*H65*G65*I65
66	='1content'!D71	='3HACinputs'!G$3	=B66*C66	='1content'!B71	=D66/E66	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F66*H66*G66*I66
67	='1content'!D72	='1content'!B72							
68	='1content'!D73	='1content'!B73							
69	='1content'!D74	='1content'!B74							
70	='1content'!D75	='3HACinputs'!G$3	=B70*C70	='1content'!B75	=D70/E70	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F70*H70*G70*I70
71	='1content'!D76	='1content'!B76							
72	='1content'!D77	='3HACinputs'!G$3	=B72*C72	='1content'!B77	=D72/E72	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F72*H72*G72*I72
73	='1content'!D78	='1content'!B78							
74	='1content'!D79	='3HACinputs'!G$3	=B74*C74	='1content'!B79	=D74/E74	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F74*H74*G74*I74

Formulas for Table 16

	B	C	D	E	F	G	H	I	J
75	='1content'!D80	='3HACinputs'!G$3	=B75*C75	='1content'!B80	=D75/E75	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F75*H75*G75*I75
76	='1content'!D81	='3HACinputs'!G$3	=B76*C76	='1content'!B81	=D76/E76	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F76*H76*G76*I76
77	='1content'!D82								
78	='1content'!D83	='1content'!B82							
79	='1content'!D84	='3HACinputs'!G$3	=B79*C79	='1content'!B84	=D79/E79	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F79*H79*G79*I79
80	='1content'!D85	='1content'!B85							
81	='1content'!D86	='1content'!B86							
82	='1content'!D87	='3HACinputs'!G$3	=B82*C82	='1content'!B87	=D82/E82	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F82*H82*G82*I82
83	='1content'!D88	='1content'!B88							
84	='1content'!D89	='3HACinputs'!G$3	=B84*C84	='1content'!B89	=D84/E84	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F84*H84*G84*I84
85	='1content'!D90	='3HACinputs'!G$3	=B85*C85	='1content'!B90	=D85/E85	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F85*H85*G85*I85
86	='1content'!D91	='3HACinputs'!G$3	=B86*C86	='1content'!B91	=D86/E86	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F86*H86*G86*I86
87	='1content'!D92	='3HACinputs'!G$3	=B87*C87	='1content'!B92	=D87/E87	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F87*H87*G87*I87
88	='1content'!D93	='3HACinputs'!G$3	=B88*C88	='1content'!B93	=D88/E88	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F88*H88*G88*I88
89	='1content'!D94	='3HACinputs'!G$3	=B89*C89	='1content'!B94	=D89/E89	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F89*H89*G89*I89
90	='1content'!D95	='3HACinputs'!G$3	=B90*C90	='1content'!B95	=D90/E90	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F90*H90*G90*I90
91	='1content'!D96	='3HACinputs'!G$3	=B91*C91	='1content'!B96	=D91/E91	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F91*H91*G91*I91
92	='1content'!D97	='3HACinputs'!G$3	=B92*C92	='1content'!B97	=D92/E92	='3HACinputs'!K$3	='3HACinputs'!O$3	='3HACinputs'!R$3	=F92*H92*G92*I92
93									=SUM(J4:J92)

Formula[illegible] Table 17

	A	B	C	D	E	F	G	H	I	J
1	Isotope	Content (Ci)	Leach Ratio	Leached (Ci)	A_2 (Ci/A_2)	MAR (A_2)	DR	ARF	LPF WVMP	Release (A_2)
2		From Table 1	From Table 3 for PBS to LDCC	Calculated for LDCC external to melter	From Table 1	Calculated for LDCC external to melter	From Table 3 for LDCC external to the melter from increase in pressure			Calculated for inhalation from LDCC external to the melter from increase in pressure
3	a	b	c	d=b*c	e	f=d/e	g	h	j	k=f*g*h*i*j
4	Cs-137	='1content'!F19	='3HACinputs'!H$3	=B4*C4	='1content'!B19	=D4/E4	='3HACinputs'!J$3	='3HACinputs'!O$3	='3HACinputs'!Q$3	=F4*G4*H4*I4
5	Ba-137m	='1content'!F20	='3HACinputs'!H$3	=B5*C5	='1content'!B20					
6	Sr-90	='1content'!F12	='3HACinputs'!H$3	=B6*C6	='1content'!B12	=D6/E6	='3HACinputs'!J$3	='3HACinputs'!O$3	='3HACinputs'!Q$3	=F6*G6*H6*I6
7	Y-90	='1content'!F13	='3HACinputs'!H$3	=B7*C7	='1content'!B13					
8	Pm-147	='1content'!F21	='3HACinputs'!H$3	=B8*C8	='1content'!B21	=D8/E8	='3HACinputs'!J$3	='3HACinputs'!O$3	='3HACinputs'!Q$3	=F8*G8*H8*I8
9	Am-241	='1content'!F93	='3HACinputs'!H$3	=B9*C9	='1content'!B92	=D9/E9	='3HACinputs'!J$3	='3HACinputs'!O$3	='3HACinputs'!Q$3	=F9*G9*H9*I9
10	Eu-154	='1content'!F22	='3HACinputs'!H$3	=B10*C10	='1content'!B22	=D10/E10	='3HACinputs'!J$3	='3HACinputs'!O$3	='3HACinputs'!Q$3	=F10*G10*H10*I10
11	Ni-63	='1content'!F11	='3HACinputs'!H$3	=B11*C11	='1content'!B11	=D11/E11	='3HACinputs'!J$3	='3HACinputs'!O$3	='3HACinputs'!Q$3	=F11*G11*H11*I11
12	Fe-55	='1content'!F9	='3HACinputs'!H$3	=B12*C12	='1content'!B9	=D12/E12	='3HACinputs'!J$3	='3HACinputs'!O$3	='3HACinputs'!Q$3	=F12*G12*H12*I12
13	Pu-238	='1content'!F89	='3HACinputs'!H$3	=B13*C13	='1content'!B89	=D13/E13	='3HACinputs'!J$3	='3HACinputs'!O$3	='3HACinputs'!Q$3	=F13*G13*H13*I13
14	C-14	='1content'!F5	='3HACinputs'!H$3	=B14*C14	='1content'!B5	=D14/E14	='3HACinputs'!J$3	='3HACinputs'!O$3	='3HACinputs'!Q$3	=F14*G14*H14*I14
15	Co-60	='1content'!F6	='3HACinputs'!H$3	=B15*C15	='1content'!B6	=D15/E15	='3HACinputs'!J$3	='3HACinputs'!O$3	='3HACinputs'!Q$3	=F15*G15*H15*I15
16	U-232	='1content'!F79	='3HACinputs'!H$3	=B16*C16	='1content'!B79	=D16/E16	='3HACinputs'!J$3	='3HACinputs'!O$3	='3HACinputs'!Q$3	=F16*G16*H16*I16
17	Pu-239	='1content'!F90	='3HACinputs'!H$3	=B17*C17	='1content'!B90	=D17/E17	='3HACinputs'!J$3	='3HACinputs'!O$3	='3HACinputs'!Q$3	=F17*G17*H17*I17
18	Pu-240	='1content'!F91	='3HACinputs'!H$3	=B18*C18	='1content'!B91	=D18/E18	='3HACinputs'!J$3	='3HACinputs'!O$3	='3HACinputs'!Q$3	=F18*G18*H18*I18
19	Ni-59	='1content'!F10	='3HACinputs'!H$3	=B19*C19						
20	I-129	='1content'!F18	='3HACinputs'!H$3	=B20*C20	='1content'!B10					
21	U-233	='1content'!F80	='3HACinputs'!H$3	=B21*C21	='1content'!B80	=D21/E21	='3HACinputs'!J$3	='3HACinputs'!O$3	='3HACinputs'!Q$3	=F21*G21*H21*I21
22	Tc-99	='1content'!F17	='3HACinputs'!H$3	=B22*C22	='1content'!B17	=D22/E22	='3HACinputs'!J$3	='3HACinputs'!O$3	='3HACinputs'!Q$3	=F22*G22*H22*I22
23	H-3	='1content'!F4	='3HACinputs'!H$3	=B23*C23	='1content'!B4	=D23/E23	='3HACinputs'!J$3	='3HACinputs'!O$3	='3HACinputs'!Q$3	=F23*G23*H23*I23
24	U-234	='1content'!F81	='3HACinputs'!H$3	=B24*C24	='1content'!B81	=D24/E24	='3HACinputs'!J$3	='3HACinputs'!O$3	='3HACinputs'!Q$3	=F24*G24*H24*I24
25	U-238	='1content'!F82	='3HACinputs'!H$3	=B25*C25	='1content'!B86					
26	U-236	='1content'!F83	='3HACinputs'!H$3	=B26*C26	='1content'!B84	=D26/E26	='3HACinputs'!J$3	='3HACinputs'!O$3	='3HACinputs'!Q$3	=F26*G26*H26*I26
27	U-235	='1content'!F84	='3HACinputs'!H$3	=B27*C27	='1content'!B82					
28	Cm-242	='1content'!F95	='3HACinputs'!H$3	=B28*C28	='1content'!B95	=D28/E28	='3HACinputs'!J$3	='3HACinputs'!O$3	='3HACinputs'!Q$3	=F28*G28*H28*I28
29	Am-243	='1content'!F94	='3HACinputs'!H$3	=B29*C29	='1content'!B94	=D29/E29	='3HACinputs'!J$3	='3HACinputs'!O$3	='3HACinputs'!Q$3	=F29*G29*H29*I29
30	Cm-243	='1content'!F96	='3HACinputs'!H$3	=B30*C30	='1content'!B96	=D30/E30	='3HACinputs'!J$3	='3HACinputs'!O$3	='3HACinputs'!Q$3	=F30*G30*H30*I30
31	Th-228	='1content'!F69	='3HACinputs'!H$3	=B31*C31	='1content'!B69					
32	Np-237	='1content'!F87	='3HACinputs'!H$3	=B32*C32	='1content'!B87	=D32/E32	='3HACinputs'!J$3	='3HACinputs'!O$3	='3HACinputs'!Q$3	=F32*G32*H32*I32
33	U-232	='1content'!F79	='3HACinputs'!H$3	=B33*C33	='1content'!B79	=D33/E33	='3HACinputs'!J$3	='3HACinputs'!O$3	='3HACinputs'!Q$3	=F33*G33*H33*I33
34	Th-232	='1content'!F73	='3HACinputs'!H$3	=B34*C34	='1content'!B73					
35	Th-230	='1content'!F74	='3HACinputs'!H$3	=B35*C35	='1content'!B71	=D35/E35	='3HACinputs'!J$3	='3HACinputs'!O$3	='3HACinputs'!Q$3	=F35*G35*H35*I35
36	Pu-241	='1content'!F92	='3HACinputs'!H$3	=B36*C36	='1content'!B92	=D36/E36	='3HACinputs'!J$3	='3HACinputs'!O$3	='3HACinputs'!Q$3	=F36*G36*H36*I36

Formulas for Table 17

	A	B	C	D	E	F	G	H	I	J
37	Cm-244	='1content'!F97	='3HACInputs'!H$3	=B37*C37	='1content'!B97	=D37/E37	='3HACInputs'!J$3	='3HACInputs'!O$3	='3HACInputs'!Q$3	=F37*G37*H37*I37
38										=SUM(J4:J37)

Formula Table 18

	A	B	C	D	E	F	G	H	I	J
1	Isotope	Content (Ci)	Leach Ratio	Leached (Ci)	A_2 (Ci/A_2)	MAR (A_2)	DR	ARF	LPF WVMP	Release (A_2)
2		From Table 1	From Table 3 for PBS to LDCC	Calculated for LDCC external to melter	From Table 1	Calculated for LDCC external to melter	From Table 3 for LDCC exernal to the melter			Calculated for inhalation from LDCC external to the melter
3	a	b	c	d=b*c	c	f=d*e	g	h	i	j=f*g*h*i
4	Cs-137	='1content'!F19	='3HACInputs'!H$3	=B4*C4	='1content'!B19	=D4/E4	='3HACInputs'!J$3	='3HACInputs'!O$3	='3HACInputs'!Q$3	=F4*G4*H4*I4
5	Ba-137m	='1content'!F20	='3HACInputs'!H$3	=B5*C5	='1content'!B20					
6	Sr-90	='1content'!F12	='3HACInputs'!H$3	=B6*C6	='1content'!B12	=D6/E6	='3HACInputs'!J$3	='3HACInputs'!O$3	='3HACInputs'!Q$3	=F6*G6*H6*I6
7	Y-90	='1content'!F13	='3HACInputs'!H$3	=B7*C7	='1content'!B13					
8	Pm-147	='1content'!F21	='3HACInputs'!H$3	=B8*C8	='1content'!B21	=D8/E8	='3HACInputs'!J$3	='3HACInputs'!O$3	='3HACInputs'!Q$3	=F8*G8*H8*I8
9	Am-241	='1content'!F93	='3HACInputs'!H$3	=B9*C9	='1content'!B92	=D9/E9	='3HACInputs'!J$3	='3HACInputs'!O$3	='3HACInputs'!Q$3	=F9*G9*H9*I9
10	Eu-154	='1content'!F22	='3HACInputs'!H$3	=B10*C10	='1content'!B22	=D10/E10	='3HACInputs'!J$3	='3HACInputs'!O$3	='3HACInputs'!Q$3	=F10*G10*H10*I10
11	Ni-63	='1content'!F11	='3HACInputs'!H$3	=B11*C11	='1content'!B11	=D11/E11	='3HACInputs'!J$3	='3HACInputs'!O$3	='3HACInputs'!Q$3	=F11*G11*H11*I11
12	Fe-55	='1content'!F9	='3HACInputs'!H$3	=B12*C12	='1content'!B9	=D12/E12	='3HACInputs'!J$3	='3HACInputs'!O$3	='3HACInputs'!Q$3	=F12*G12*H12*I12
13	Pu-238	='1content'!F89	='3HACInputs'!H$3	=B13*C13	='1content'!B89	=D13/E13	='3HACInputs'!J$3	='3HACInputs'!O$3	='3HACInputs'!Q$3	=F13*G13*H13*I13
14	C-14	='1content'!F5	='3HACInputs'!H$3	=B14*C14	='1content'!B5	=D14/E14	='3HACInputs'!J$3	='3HACInputs'!O$3	='3HACInputs'!Q$3	=F14*G14*H14*I14
15	Co-60	='1content'!F6	='3HACInputs'!H$3	=B15*C15	='1content'!B6	=D15/E15	='3HACInputs'!J$3	='3HACInputs'!O$3	='3HACInputs'!Q$3	=F15*G15*H15*I15
16	U-232	='1content'!F79	='3HACInputs'!H$3	=B16*C16	='1content'!B79	=D16/E16	='3HACInputs'!J$3	='3HACInputs'!O$3	='3HACInputs'!Q$3	=F16*G16*H16*I16
17	Pu-239	='1content'!F90	='3HACInputs'!H$3	=B17*C17	='1content'!B90	=D17/E17	='3HACInputs'!J$3	='3HACInputs'!O$3	='3HACInputs'!Q$3	=F17*G17*H17*I17
18	Pu-240	='1content'!F91	='3HACInputs'!H$3	=B18*C18	='1content'!B91	=D18/E18	='3HACInputs'!J$3	='3HACInputs'!O$3	='3HACInputs'!Q$3	=F18*G18*H18*I18
19	Ni-59	='1content'!F10	='3HACInputs'!H$3	=B19*C19						
20	I-129	='1content'!F18	='3HACInputs'!H$3	=B20*C20	='1content'!B10					
21	U-233	='1content'!F80	='3HACInputs'!H$3	=B21*C21	='1content'!B80	=D21/E21	='3HACInputs'!J$3	='3HACInputs'!O$3	='3HACInputs'!Q$3	=F21*G21*H21*I21
22	Tc-99	='1content'!F17	='3HACInputs'!H$3	=B22*C22	='1content'!B17	=D22/E22	='3HACInputs'!J$3	='3HACInputs'!O$3	='3HACInputs'!Q$3	=F22*G22*H22*I22
23	H-3	='1content'!F4	='3HACInputs'!H$3	=B23*C23	='1content'!B4	=D23/E23	='3HACInputs'!J$3	='3HACInputs'!O$3	='3HACInputs'!Q$3	=F23*G23*H23*I23
24	U-234	='1content'!F81	='3HACInputs'!H$3	=B24*C24	='1content'!B81	=D24/E24	='3HACInputs'!J$3	='3HACInputs'!O$3	='3HACInputs'!Q$3	=F24*G24*H24*I24
25	U-238	='1content'!F82	='3HACInputs'!H$3	=B25*C25	='1content'!B86					
26	U-236	='1content'!F83	='3HACInputs'!H$3	=B26*C26	='1content'!B84	=D26/E26	='3HACInputs'!J$3	='3HACInputs'!O$3	='3HACInputs'!Q$3	=F26*G26*H26*I26
27	U-235	='1content'!F84	='3HACInputs'!H$3	=B27*C27	='1content'!B82					
28	Cm-242	='1content'!F95	='3HACInputs'!H$3	=B28*C28	='1content'!B95	=D28/E28	='3HACInputs'!J$3	='3HACInputs'!O$3	='3HACInputs'!Q$3	=F28*G28*H28*I28
29	Am-243	='1content'!F94	='3HACInputs'!H$3	=B29*C29	='1content'!B94	=D29/E29	='3HACInputs'!J$3	='3HACInputs'!O$3	='3HACInputs'!Q$3	=F29*G29*H29*I29
30	Cm-243	='1content'!F96	='3HACInputs'!H$3	=B30*C30	='1content'!B96	=D30/E30	='3HACInputs'!J$3	='3HACInputs'!O$3	='3HACInputs'!Q$3	=F30*G30*H30*I30
31	Th-228	='1content'!F69	='3HACInputs'!H$3	=B31*C31	='1content'!B69					
32	Np-237	='1content'!F87	='3HACInputs'!H$3	=B32*C32	='1content'!B87	=D32/E32	='3HACInputs'!J$3	='3HACInputs'!O$3	='3HACInputs'!Q$3	=F32*G32*H32*I32
33	U-232	='1content'!F79	='3HACInputs'!H$3	=B33*C33	='1content'!B79	=D33/E33	='3HACInputs'!J$3	='3HACInputs'!O$3	='3HACInputs'!Q$3	=F33*G33*H33*I33
34	Th-232	='1content'!F73	='3HACInputs'!H$3	=B34*C34	='1content'!B73					
35	Th-230	='1content'!F74	='3HACInputs'!H$3	=B35*C35	='1content'!B71	=D35/E35	='3HACInputs'!J$3	='3HACInputs'!O$3	='3HACInputs'!Q$3	=F35*G35*H35*I35
36	Pu-241	='1content'!F92	='3HACInputs'!H$3	=B36*C36	='1content'!B92	=D36/E36	='3HACInputs'!J$3	='3HACInputs'!O$3	='3HACInputs'!Q$3	=F36*G36*H36*I36

Formulas for Table 18

	A	B	C	D	E	F	G	H	I	J
37	Cm-244	='1content'!F97	='3HACInputs'!H$3	=B37*C37	='1content'!B97	=D37/E37	='3HACInputs'!J$3	='3HACInputs'!O$3	='3HACInputs'!Q$3	=F37*G37*H37*I37
38										=SUM(J4:J37)

	A	B	C	D	E	F	G	H	I
1	Isotope	Content (Ci)	Leach Fraction	Leached (Ci)	A_2 (Ci/A_2)	MAR (A_2)	DR	LPF WVMP	Release (A_2)
2		From Table 1	From Table 3	Calculated for LDCC external to melter	From Table 1	Calculated for LDCC external to melter	From Table 3 for LDCC exernal to the melter		Calculated for non-inhalation from LDCC external to the melter
3	a	b	c	d=b*c	e	f=d*/e	g	h	i=f*g*h
4	Cs-137	='1content'!F19	='3HACinputs'!H$3	=B4*C4	='1content'!B19	=D4/E4	='3HACinputs'!J$3	='3HACinputs'!S$3	=F4*G4*H4
5	Ba-137m	='1content'!F20	='3HACinputs'!H$3	=B5*C5	='18HACexLDCC '!E5				
6	Sr-90	='1content'!F12	='3HACinputs'!H$3	=B6*C6	='1content'!B12	=D6/E6	='3HACinputs'!J$3	='3HACinputs'!S$3	=F6*G6*H6
7	Y-90	='1content'!F13	='3HACinputs'!H$3	=B7*C7	='1content'!B13				
8	Pm-147	='1content'!F21	='3HACinputs'!H$3	=B8*C8	='1content'!B21	=D8/E8	='3HACinputs'!J$3	='3HACinputs'!S$3	=F8*G8*H8
9	Am-241	='1content'!F93	='3HACinputs'!H$3	=B9*C9	='1content'!B92	=D9/E9	='3HACinputs'!J$3	='3HACinputs'!S$3	=F9*G9*H9
10	Eu-154	='1content'!F22	='3HACinputs'!H$3	=B10*C10	='1content'!B22	=D10/E10	='3HACinputs'!J$3	='3HACinputs'!S$3	=F10*G10*H10
11	Ni-63	='1content'!F11	='3HACinputs'!H$3	=B11*C11	='1content'!B11	=D11/E11	='3HACinputs'!J$3	='3HACinputs'!S$3	=F11*G11*H11
12	Fe-55	='1content'!F9	='3HACinputs'!H$3	=B12*C12	='1content'!B9	=D12/E12	='3HACinputs'!J$3	='3HACinputs'!S$3	=F12*G12*H12
13	Pu-238	='1content'!F89	='3HACinputs'!H$3	=B13*C13	='1content'!B89	=D13/E13	='3HACinputs'!J$3	='3HACinputs'!S$3	=F13*G13*H13
14	C-14	='1content'!F5	='3HACinputs'!H$3	=B14*C14	='1content'!B5	=D14/E14	='3HACinputs'!J$3	='3HACinputs'!S$3	=F14*G14*H14
15	Co-60	='1content'!F6	='3HACinputs'!H$3	=B15*C15	='1content'!B6	=D15/E15	='3HACinputs'!J$3	='3HACinputs'!S$3	=F15*G15*H15
16	U-232	='1content'!F79	='3HACinputs'!H$3	=B16*C16	='1content'!B79	=D16/E16	='3HACinputs'!J$3	='3HACinputs'!S$3	=F16*G16*H16
17	Pu-239	='1content'!F90	='3HACinputs'!H$3	=B17*C17	='1content'!B90	=D17/E17	='3HACinputs'!J$3	='3HACinputs'!S$3	=F17*G17*H17
18	Pu-240	='1content'!F91	='3HACinputs'!H$3	=B18*C18	='1content'!B91	=D18/E18	='3HACinputs'!J$3	='3HACinputs'!S$3	=F18*G18*H18
19	Ni-59	='1content'!F10	='3HACinputs'!H$3	=B19*C19					
20	I-129	='1content'!F18	='3HACinputs'!H$3	=B20*C20	='1content'!B18				
21	U-233	='1content'!F80	='3HACinputs'!H$3	=B21*C21	='1content'!B80	=D21/E21	='3HACinputs'!J$3	='3HACinputs'!S$3	=F21*G21*H21
22	Tc-99	='1content'!F17	='3HACinputs'!H$3	=B22*C22	='1content'!B17	=D22/E22	='3HACinputs'!J$3	='3HACinputs'!S$3	=F22*G22*H22
23	H-3	='1content'!F4	='3HACinputs'!H$3	=B23*C23	='1content'!B4	=D23/E23	='3HACinputs'!J$3	='3HACinputs'!S$3	=F23*G23*H23
24	U-234	='1content'!F81	='3HACinputs'!H$3	=B24*C24	='1content'!B81	=D24/E24	='3HACinputs'!J$3	='3HACinputs'!S$3	=F24*G24*H24
25	U-238	='1content'!F82	='3HACinputs'!H$3	=B25*C25	='1content'!B86				
26	U-236	='1content'!F83	='3HACinputs'!H$3	=B26*C26	='1content'!B84	=D26/E26	='3HACinputs'!J$3	='3HACinputs'!S$3	=F26*G26*H26
27	U-235	='1content'!F84	='3HACinputs'!H$3	=B27*C27	='1content'!B82				
28	Cm-242	='1content'!F95	='3HACinputs'!H$3	=B28*C28	='1content'!B95	=D28/E28	='3HACinputs'!J$3	='3HACinputs'!S$3	=F28*G28*H28
29	Am-243	='1content'!F94	='3HACinputs'!H$3	=B29*C29	='1content'!B94	=D29/E29	='3HACinputs'!J$3	='3HACinputs'!S$3	=F29*G29*H29
30	Cm-243	='1content'!F96	='3HACinputs'!H$3	=B30*C30	='1content'!B96	=D30/E30	='3HACinputs'!J$3	='3HACinputs'!S$3	=F30*G30*H30
31	Th-228	='1content'!F69	='3HACinputs'!H$3	=B31*C31	='1content'!B69				
32	Np-237	='1content'!F87	='3HACinputs'!H$3	=B32*C32	='1content'!B87	=D32/E32	='3HACinputs'!J$3	='3HACinputs'!S$3	=F32*G32*H32
33	U-232	='1content'!F79	='3HACinputs'!H$3	=B33*C33	='1content'!B79	=D33/E33	='3HACinputs'!J$3	='3HACinputs'!S$3	=F33*G33*H33

Formulas for Table 19

	A	B	C	D	E	F	G	H	I
34	Th-232	='1content'!F73	='3HACinputs'!H$3	=B34*C34	='1content'!B73				
35	Th-230	='1content'!F74	='3HACinputs'!H$3	=B35*C35	='1content'!B71	=D35/E35	='3HACinputs'!J$3	='3HACinputs'!S$3	=F35*G35*H35
36	Pu-241	='1content'!F92	='3HACinputs'!H$3	=B36*C36	='1content'!B92	=D36/E36	='3HACinputs'!J$3	='3HACinputs'!S$3	=F36*G36*H36
37	Cm-244	='1content'!F97	='3HACinputs'!H$3	=B37*C37	='1content'!B97	=D37/E37	='3HACinputs'!J$3	='3HACinputs'!S$3	=F37*G37*H37
38									=SUM(I4:I37)

	A	B
10	**SOURCE**	**RELEASE**
11	**from Glass**	A_2
12	Spout Glass	='12HACspoutglass'!I93
13	Melter Heel Glass	='13HACheelglass'!I93
14	Refractory Glass	='14HACrefrglass '!I86
15		
16	**from LDCC**	
17	LDCC inside the Melter	='15HACintLDCC'!J93
18	pressure increase	='16HAC>25intLDCC '!J93
19	LDCC external to melter	='18HACexLDCC '!J38
20	pressure increase	='17HAC>25exLDCC '!J38
21	Non-Aerosol Release	='19HACnon-areoLDCC '!I38
23		
24	**Total**	=SUM(B12:B21)

WVMP SAR Reference 5-5

West Valley Nuclear Services Company Processing Equipment Characterization Results, WMG Report 4005-RE-024, Revision 4, WMG, Inc., Peekskill, NY, August 2013

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3.0 WASTE CHARACTERIZATION

The Processing Equipment was characterized using dose to curie conversion techniques. Representative isotopic sample data is used in conjunction with gross radioactivity measurements and point kernel shielding models to estimate activity by nuclide. As a practical matter all the measured gamma radiation can be attributed to Cs-137. Geometry models along with measured dose rates can be used to calculate Cs-137 activity. Representative samples are used to determine Cs-137 based scaling factors to calculate the hard to detect nuclides.

The radioactivity in the Processing Equipment is contained in two separate sources. One source is contained in the Processing Equipment cavity and the other is in the plugged discharge port. The sources are treated separately because a thick layer of refractory material separates them. The refractory material that separates the sources consists mainly of Monofrax Z, which is the best shield material in the refractory assembly, and varies in thickness from approximately 18 to 35 inches.

Due to the relatively complex geometries involved in the Processing Equipment cavity source, a detailed dose to curie model was employed to reduce conservatism in the calculations. Typically, complex geometries can be modeled using simple shapes and conservative assumptions to bound the results. Since excessive conservatism limits disposition options, the best available information was used in conjunction with advanced modeling techniques to provide the most accurate results available. Therefore, the QAD-CGGP-A(2) code was used for point kernel modeling. The QAD-CGGP-A code provides for combinatorial geometry input, which allows the user to model complex shapes using unions or intersections of relatively simple shapes. This code is used routinely in the commercial sector to support reactor decommissioning activities. There have been published guidelines regarding integration parameters for point kernel applications(3) and these were adhered to in the analysis. Due to relatively simple geometry involved in the discharge port, a less detailed dose to curie model was employed using the Megashield(4) computer code.

The Processing Equipment cavity model accounted for the inverted pyramidal shape of the residual glass in the cavity as well as a 1/8" internal wall coating up to a fill height of 28". The compounds totaling over 99% of the weight fraction were used to create a custom material type in the QAD-CGGP-A and Megashield models. Table 1 shows the weight fraction by chemical compound and Table 2 shows density by nuclide assuming a density of 2.6 g/cc for the borosilicate glass.

Table 1
Borosilicate Glass Composition

Material	Weight Fraction	Material	Weight Fraction
Li_2O	0.039	SiO_2	0.434
B_2O_3	0.137	K_2O	0.053
Na_2O	0.085	Fe_2O_3	0.127
MgO	0.009	ZrO_2	0.014
Al_2O_3	0.064	ThO	0.038

Table 2
Borosilicate Glass Density by Element

Element	Partial Density	Element	Partial Density
Li (3)	0.047	Si (14)	0.528
B (5)	0.110	K (19)	0.114
O (8)	1.184	Fe (26)	0.232
Na (11)	0.164	Zr (40)*	0.027
Mg (12)*	0.015	Th (90)	0.092
Al (13)	0.087		

*Not used in shielding model due to their low partial densities / attenuation percents

A total of ten (10) source regions were required in the QAD-CGGP-A model to accurately duplicate the remaining glass inside the Processing Equipment cavity. Four (4) sources were used to simulate the inverted pyramid shape while six (6) were used for the wall coating. The wall surface coating contributed about 15% to the measured dose rate. Dose locations reported in the RIR[5] as well as an external dose point recorded on 2/5/04 were used to estimate the Cs-137 activity. A detector was lowered into Nozzles A and BB and recorded dose rates of 749 R/hr and 700 R/hr respectively. A duplicate measurement was taken in Nozzle A of 748 R/hr. A reading of 2.1 R/hr was taken at a 1-foot offset from the lid of the Processing Equipment assembly about midway between nozzles R1 and R2. These points were selected because they provide a profile starting at the center of the cavity and proceed north along the cavity centerline. It is conservatively assumed that the source in the discharge port does not contribute to the dose rates used to characterize the Processing Equipment cavity. See Appendix A for WVNSCO supplied survey data.

WVMP SAR Reference 5-6

Savannah River Nuclear Solutions Criticality Safety Methods Manual, Chapter 5, Standard Material Compositions for Nuclear Criticality Safety Calculations, SRNS-IM-2009-00035, Revision 3, Savannah River Nuclear Solutions, Aiken, South Carolina, January 2014 .

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CRITICALITY SAFETY METHODS MANUAL

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Table 1.Specifications of Materials Commonly Associated with Criticality Analysis (cont.)

Material/Formula	Density, g/cc	Element / Isotope	Weight Percent	Atom Percent	Atom Density, At/ b-cm
Concrete, Magnuson[8]	2.147	H	0.3319	5.97	4.25748E-03
		C	10.532	15.91	1.13374E-02
		O	49.943	56.63	4.03600E-02
		Na	0.1411	0.11	7.93547E-05
		Mg	9.4200	7.03	5.01113E-03
		Al	0.7859	0.53	3.76600E-04
		Si	4.2100	2.72	1.93812E-03
		S	0.2483	0.14	1.00118E-04
		Cl	0.0523	0.03	1.90736E-05
		K	0.9445	0.44	3.12337E-04
		Ca	22.631	10.24	7.30092E-03
		Ti	0.1488	0.06	4.01927E-05
		Mn	0.0512	0.02	1.20497E-05
		Fe	0.5595	0.18	1.29538E-04
Concrete, Oak Ridge[8]	2.2995	H	0.6186	10.67	8.49878E-03
		C	17.519	25.35	2.01981E-02
		O	41.018	44.56	3.55019E-02
		Na	0.02706	0.02	1.62995E-05
		Mg	3.265	2.34	1.86024E-03
		Al	1.083	0.70	5.55831E-04
		Si	3.448	2.13	1.70007E-03
		K	0.1138	0.05	4.03056E-05
		Ca	32.129	13.93	1.11013E-02
		Fe	0.7784	0.24	1.93019E-04
Concrete, Regular[6, 8] (Recommended for use in RBOF/L-Basin analysis.[7])	2.30	H	1.0	16.80	1.37417E-02
		O	53.2	56.32	4.60557E-02
		Na	2.9	2.14	1.74719E-03
		Al	3.4	2.13	1.74537E-03
		Si	33.7	20.32	1.66197E-02
		Ca	4.4	1.86	1.52063E-03
		Fe	1.4	0.42	3.47232E-04
Concrete, Rocky Flats[8]	2.321	H	0.75	13.33	1.04004E-02
		C	5.52	8.23	6.42367E-03
		N	0.02	0.03	1.99580E-05
		O	48.49	54.29	4.23615E-02
		Na	0.63	0.49	3.83027E-04
		Mg	1.25	0.92	7.18849E-04
		Al	2.17	1.44	1.12413E-03
		Si	15.50	9.89	7.71388E-03
		S	0.19	0.11	8.28194E-05
		K	1.37	0.63	4.89763E-04
		Ca	23.00	10.28	8.02130E-03
		Ti	0.10	0.04	2.92003E-05
		Fe	1.01	0.32	2.52790E-04

[8] NUREG/CR-0200, Revision 6, *Standard Composition Library.*

WVMP SAR Reference 6-1

Characterization of DWPF Melter One Glasses, WSRC-TR-2003-00477, Rev 0, A.D. Cozzi and J.M. Pareizs, Westinghouse Savannah River Company, Aiken, South Carolina, October 2003.

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WSRC-TR-2003-00477
October 16, 2003

Characterization of DWPF Melter One Glasses

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Characterization of DWPF Melter One Glasses

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Executive Summary

The Defense Waste Processing Facility's (DWPF) first melter operated continuously for more than eight years. In November 2002 it was decided to replace the melter. As part of the decommissioning and replacement of the first DWPF melter, three samples were collected from the melter, one from the melter surface and two from the core sampler. The melter samples were analyzed for chemical composition and crystal content.

The interface layer glass appeared as a typical pour stream. The surface was dark and reflective with no obvious inclusions. Little information could be obtained from visual observation of the core glasses. The surfaces were coarse from the sample sectioning.

The materials and methods used to sample to melter core influenced the analytical results. The stainless steel sampler contributed measurable amounts of chromium to the samples. The retrieval of the samples after the melter had cooled permitted the core glasses to crystallize extensively. The crystalline species were consistent with long slow cooling.

The consistency of the compositions throughout the melter, from the interface layer to the two melt pool samples to a previously collected pour stream sample, indicate that there is no measurable stratification of actinides or noble metals.

CSEM/EDS analysis of the core samples suggest that the smooth areas are glass, the inclusions are predominantly iron/silicon compounds and that some of the debris on the surface is alumina from the sectioning blade. CRXD analysis identified the inclusions as aegirine (acmite). CSEM analysis of the interface layer did not reveal any appearance other than glass. CXRD analysis confirmed the amorphous state of the interface layer.

Introduction

The Defense Waste Processing Facility's (DWPF) first melter operated continuously for more than eight years, including six years of radioactive operations – more than three times its design life. It produced more than 1,300 waste glass canisters, about 27 percent of the projected total canisters for DWPF. In November 2002 it was decided to replace the melter. Prior to melter shutdown, one sample was taken and a sampler was put in place to retrieve additional samples from the melt pool.

SRTC delivered four samplers to DWPF to collect samples. Two samplers were designed to remove a surface sample from the melt pool while the other two samplers were designed to remove core samples to provide a cross section of the melt pool.

As part of the decommissioning and replacement of the first DWPF melter, three samples were collected from the melter, one from the melter surface and two from the core sampler. The melter samples were analyzed for chemical composition and crystal content.

Objective

The objective of this task is to inspect, characterize and evaluate glass samples from the melter surface and the melt pool. The interface layer was sampled to provide data to aid in the identification and cause of the layer[1]. Two samples of the melt pool were obtained from two depths in the melter. Two depths were chosen to compare relative concentrations of noble metal and actinides to evaluate concerns regarding settling of denser species. It should be recognized as the melt pool samples cooled in the melter, no definite conclusions could be drawn from the amount of crystalline species present.

Discussion

Sample Collection

Interface Layer

A platinum boat sampler was used to sample of the interface layer from the surface of the glass pool that remained after the cold cap was burned off (prior to melter shutdown). The interface layer sample was taken through the north feed tube nozzle, approximately two feet north of melter center. The sampler was lowered into the melter by the crane until it just broke the surface and filled with glass. It was then lifted out and allowed to cool. The interface sample was removed from the boat using the extractor provided by DWPF Engineering. Slightly more than 45 grams of sample were retrieved from the platinum boat. It is believed that a representative sample of the surface layer was obtained during the sampling.

Core Samples

Two samples from the core of the melt pool were obtained from different heights in the melter. The core samples were also obtained through the north feed tube. After glass draw-down via the pour spout was completed, leaving approximately 16 inches of glass in the melter, the stainless steel core sample tube was slowly lowered into the pool till it hit bottom. It was then left in place during melter cooldown. Figure 1 shows the average cooling schedule of the upper and lower thermocouples. It is assumed that the core samples experienced a cooling curve bounded by the two curves in Figure 1. The melter cooled over several days[2], Figure 1. Upon retrieval, the bottom of the sampler broke off and remained in the melter, discontinuing the attempt to sample the very bottom of the glass pool. The remaining sampler was sectioned with a predominantly aluminum oxide saw to retrieve the "upper" and "lower" core samples. DWPF-Engineering estimated that the lower sample was four to six inches above the melter bottom and the upper sample was ten" to fifteen inches above the bottom. An effort was made to retrieve glass from the interior of the core samples. The extractor used for platinum boat samples was used to punch out glass near the center of the core samples. This was done to minimize the influence of the stainless steel sampling tube on the composition and crystallization products of the glass.

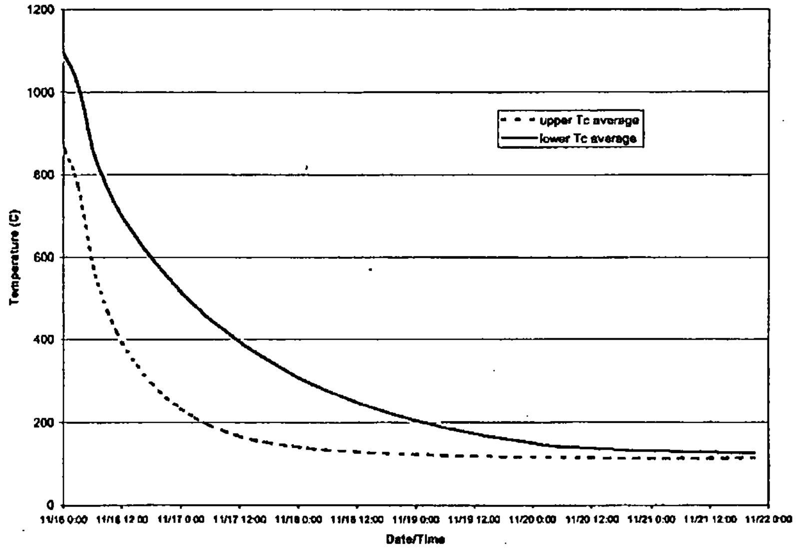

Figure 1. Measured Cooldown Rate of melter one.

Sample Analysis

Visual Observations

The three (one interface layer and two core) samples were placed in the Savannah River Technology Center (SRTC) Shielded Cells, removed from their primary containers, and photographed. Figure 2 is A) the interface layer sample and B) the lower core sample (The upper core sample appeared comparable to the lower core sample). The interface sample was contained in a platinum sampling boat and appeared black and shiny similar to previous pour stream samples[3]. The surfaces of both of the core samples were coarse and low luster from the sectioning procedure. It also appeared that the cutting process smeared the stainless steel sampler across some of the glass surface.

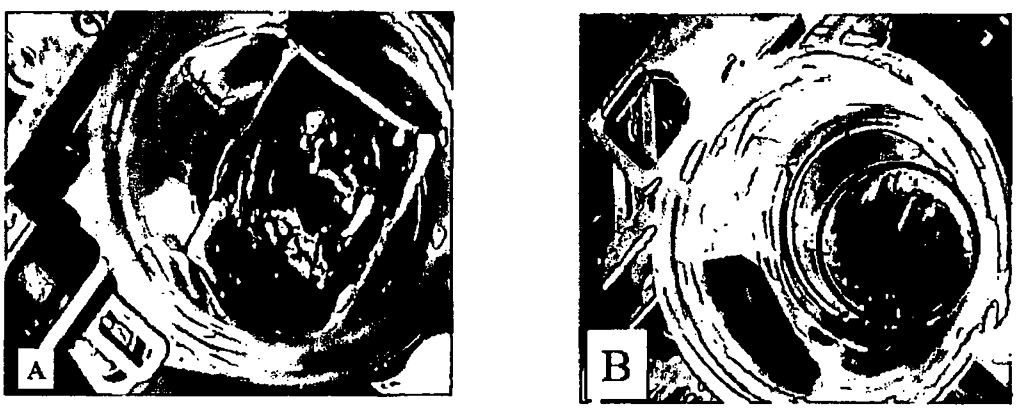

Figure 2. A) Interface layer in platinum sampler, and B) lower core sample in stainless steel sampler (within black circle).

Chemical Compositions

Samples were prepared for dissolution by pulverizing a portion of the sample using agate balls and vial. Four replicates of each of the glass samples were dissolved by two methods* to account for all of the elements of interest. The resulting solutions from the dissolutions were analyzed by Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES) by the SRTC Analytical Development Section (SRTC-ADS). Table 1 is the average composition of four replicates of the three samples. Boron and silicon values are determined from the sodium peroxide/sodium hydroxide dissolution. The use of boron in the acid dissolution method precludes the use of boron values reported in acid dissolution samples. Sodium and zirconium values are determined solely from the acid dissolution method. The use of sodium peroxide and sodium hydroxide to perform the fusion in zirconium crucibles excludes the use of reported sodium and zirconium values obtained by this method. In the upper core sample, two of the acid dissolutions were incomplete (oxides did not total >95%) and were discarded. In the lower core sample, one of the acid dissolutions was incomplete (oxides did not total >95%) and was discarded. The composition of the interface layer is similar to both core samples as well as a pour stream sample taken in FY02[3].

Table 1. Composition of the Interface Layer Glass and the Core Glasses with Previously Reported Composition from a Pour Stream Glass (Wt.%) (NM-Not Measured).

	Interface Layer	Upper Core	Lower Core	Pour Stream*
Al_2O_3	4.13	4.08	4.02	4.22
B_2O_3	7.63	7.54	7.54	7.31
CaO	1.33	1.42	1.35	1.39
Cr_2O_3	0.19	0.37	0.36	0.06
CuO	0.02	0.02	0.02	0.07
Fe_2O_3	13.09	13.38	12.93	12.29
La_2O_3	0.02	0.04	0.04	0.02
Li_2O	3.20	3.11	3.05	3.29
MgO	2.37	2.35	2.27	2.35
MnO	1.54	1.51	1.47	2.14
Na_2O	11.12	10.52	10.07	11.38
NiO	0.73	0.80	0.78	0.54
SO_3	0.94	1.21	1.19	NM
SiO_2	48.96	52.36	52.36	48.73
TiO_2	0.04	0.04	0.04	0.05
U_3O_8	3.21	3.19	3.14	3.57
ZnO	0.07	0.07	0.06	0.09
ZrO_2	0.08	0.07	0.07	0.09
Sum	98.67	102.08	100.76	52.53

* Sampled during filling of canister S01753.

The solutions that resulted from acid dissolution of the three samples also were analyzed to gain more detailed information about the composition of the samples not available by ICP-AES. Noble metals resulting from neutron fission of U-235 and a sampling of other U-235 fission products as well as other select actinides were analyzed by Inductively Coupled Mass Spectroscopy (ICP-MS) and other radioactive species were analyzed by counting. Concentrations in weight percent along with the

* ADS-2502 – Sodium Peroxide/Sodium Hydroxide Dissolutions of Sludge and Glass for Elemental and Ion Analysis.
ADS-2227 – Acid Dissolution of Glass and Sludge for Elemental Analysis.

respective concentrations measured in the pour stream sample are given in Table 2. The isotopes Co-60, Cs-137, Eu-154, Eu-155, and Am-241 were measured by gamma counting. All others were measured by ICP-MS. Results were consistent among the three current (one interface and two core samples) glasses and the previous pour stream glass for the gamma emitters and actinides. Although the core samples were similar in noble metal content, both of the core samples were depleted in noble metals with respect to the interface layer and the pour stream glass. As mentioned in the previous section, incomplete dissolution of the core samples could skew the noble metal concentrations. It is most likely that the undissolved portions of the core glasses consisted primarily of crystals that formed during melter cooldown and that a disproportionate amount of the noble metals would contained in these undissolved crystals and would therefore not be available for measurement via ICP-MS.

Table 2. Isotopic Concentrations (wt.%) of the Three Melter One Glasses and the Pour Stream Glass. (NR – nor reported)

	Isotope	Interface Layer	Upper Core	Lower Core	Pour Stream[3]
	Co-60	1.46E-07	1.37E-07	1.39E-07	1.54E-07
	Tc-99	2.96E-04	1.52E-04	1.34E-04	2.75E-04
Noble Metals	Ru-101	4.03E-03	2.92E-04	2.72E-04	2.97E-03
Noble Metals	Ru-102	3.78E-03	2.60E-04	2.73E-04	2.89E-03
Noble Metals	Rh-103	3.90E-03	3.19E-04	3.33E-04	6.22E-04
Noble Metals	Ru-104	2.38E-03	NR	NR	1.91E-03
Noble Metals	Pd-105	1.92E-04	2.07E-04	1.53E-04	2.07E-04
	Cd-112	1.06E-02	8.95E-03	6.43E-03	1.06E-02
	Cs-137	1.00E-04	9.65E-05	9.76E-05	1.03E-04
	La-139	7.14E-03	3.91E-02	1.07E-02	6.54E-03
	Nd-143	3.77E-03	6.39E-03	3.38E-03	6.10E-03
	Eu-154	9.02E-07	9.08E-07	9.30E-07	8.45E-07
	Eu-155	2.26E-07	2.65E-07	2.56E-07	2.52E-07
	Th-232	5.94E-03	8.14E-03	1.13E-02	NR
	U-235	1.28E-02	1.21E-02	1.27E-02	NR
	U-238	2.93E+00	2.81E+00	2.95E+00	NR
	Pu-239	4.09E-03	4.22E-03	4.97E-03	NR
	Am-241	3.20E-04	3.09E-04	3.05E-04	2.85E-04

Contained Scanning Electron Microscopy

For contained scanning electron microscopy with energy dispersive spectroscopy (CSEM/EDS), the samples ranged from eight to twelve milligrams to minimize the interference of radiation with the detector and personnel exposure. The small size of the sample limits the representative nature of the analysis. That is, there is an assumption that the eight to twelve milligram sample is representative of the larger sample from which it was collected. This is fair in homogeneous samples, however, in partially crystallized or otherwise heterogeneous samples the representative character of the sample could be questioned.

The interface layer is uniform across the sample, Figure 3. The debris on the surface is from sample preparation and, when the image is viewed using the backscatter electron imaging (BSI) mode, Figure 4, the debris is of similar overall composition as the main sample (i.e., the "shaded" or color is similar).

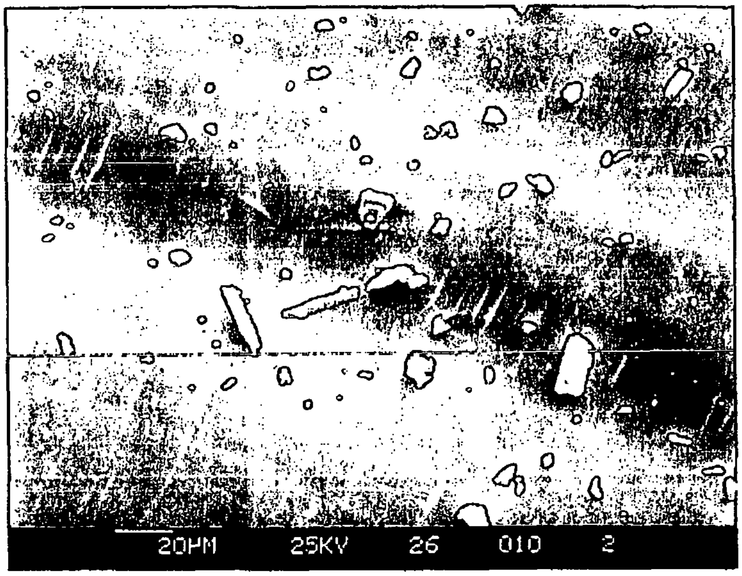

Figure 3. Interface layer glass, 500x.

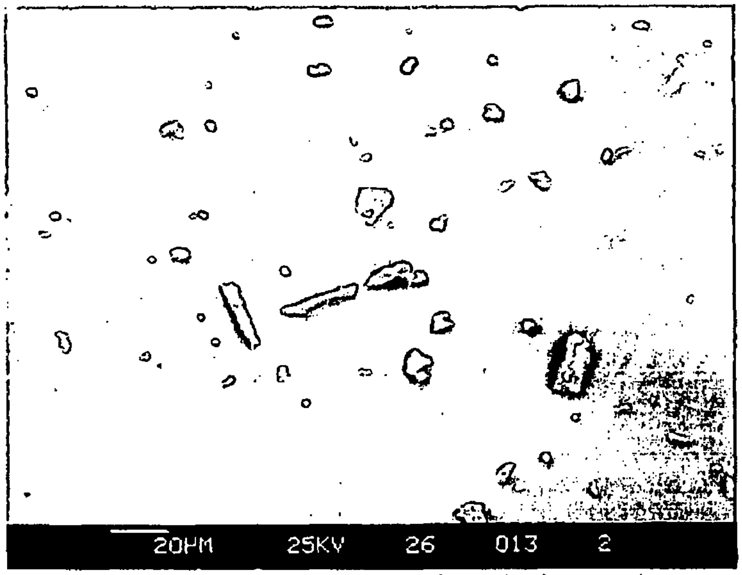

Figure 4. Interface layer glass from Figure 3, viewed using BSI.

The upper and lower core samples exhibited similar features under microscopic examination. Figure 5is the upper core secondary electron image (SEI) of a typical core particle. The texture of the core samples is indicative of a heavily crystallized glass. The mirror and hackle marks in Figure 5 are confined to areas devoid of inclusions. In addition to the debris seen in the image of the interface layer the glass contains a significant quantity of inclusions. The circled features in the figure are typical of the inclusions noted.

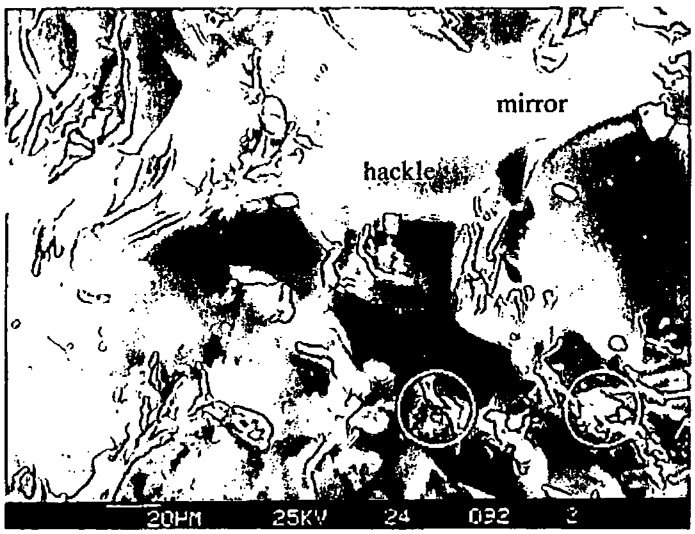

Figure 5. Upper core glass, 500x.

Figure 6 is the BSI image of the sample. Energy dispersive spectroscopy (EDS) evaluations were performed on the spots labeled "A" and "B".

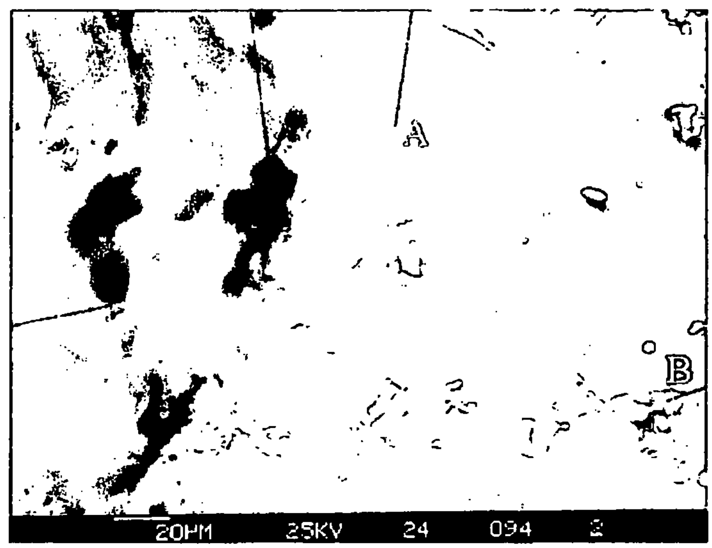

Figure 6. BSI image of upper core glass in Figure 5.

The radioactivity associated with the core glasses limited the ability of the EDS analysis to identify any but the major components of the areas being investigated. The radioactive components can "flood" the EDS detector, limiting the amount of time a spot can be counted. Therefore only sample components with strong signals (from high concentrations) can be easily identified. The interference was such that the EDS analysis was not possible for the interface layer glass. Figure 7 is the associated EDS spectrum of spot "A" in Figure 6 and the corresponding area in Figure 5 and most closely resembles a typical glass sample. Silicon is identified as a major component and iron as a secondary component. The other glass components present in quantities that would be expected to be identified are sodium and boron. In this spectrum, the sodium peak is masked by the leading edge of the silicon peak. Boron is too light an element to be detected with this method. The gold (Au) and palladium (Pd) present in all of the spectra is the conductive coating used to prepare the samples. Figure 8 is spot "B" from Figure 6, which corresponds to the inclusion in Figure 5, identifies iron, in addition to silicon, as a major component of the feature. Aluminum is also identified as part of the area.

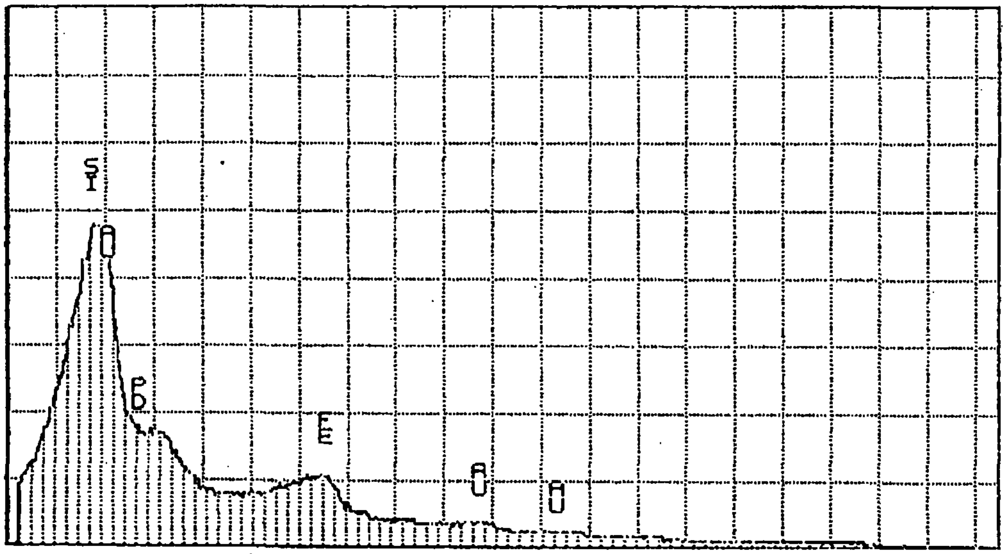

Figure 7. EDS spectrum of Figure 6 spot "A". Au-Pd alloy is used to provide a conductive coating on the sample.

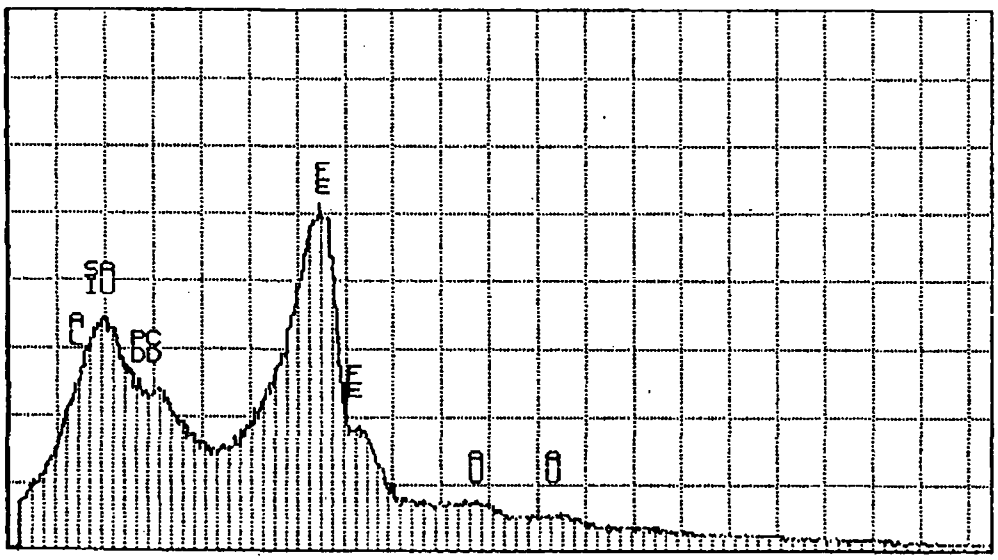

Figure 8. EDS spectrum of Figure 6 spot "B". Au-Pd alloy is used to provide a conductive coating on the sample.

Contained X-ray Diffraction Analysis

For contained x-ray diffraction analysis (CXRD), sample masses were between 15 and 35 milligrams. As with the CSEM samples, the small size of the CXRD samples could limit the representative nature of the samples. Although large samples are preferred for improved signal to noise ratios, the ALARA program encourages the minimization of personnel exposure to radioactive samples. The XRD pattern of the interface layer sample was typical of a borosilicate glass and free of any indicators of crystalline matter, Figure 9. As opposed to the interface layer sample that was collected from the melter prior to shut down of the power (and rapidly cooled to room temperature), the core samples were collected after the melter had cooled significantly as shown in Figure 1. The CXRD analyses of the core samples were similar to each other and indicated the presence of three distinct phases. Along with the amorphous hump associated with a glassy phase, a spinel phase and a clinopyroxene phase were identified. The clinopyroxene phase is the major phase and was identified as aegirine (acmite)[†]. The spinel phase most likely resembles trevorite[‡] as identified in prior DWPF samples[3]. Figure 10 is the CXRD pattern for the lower core sample.

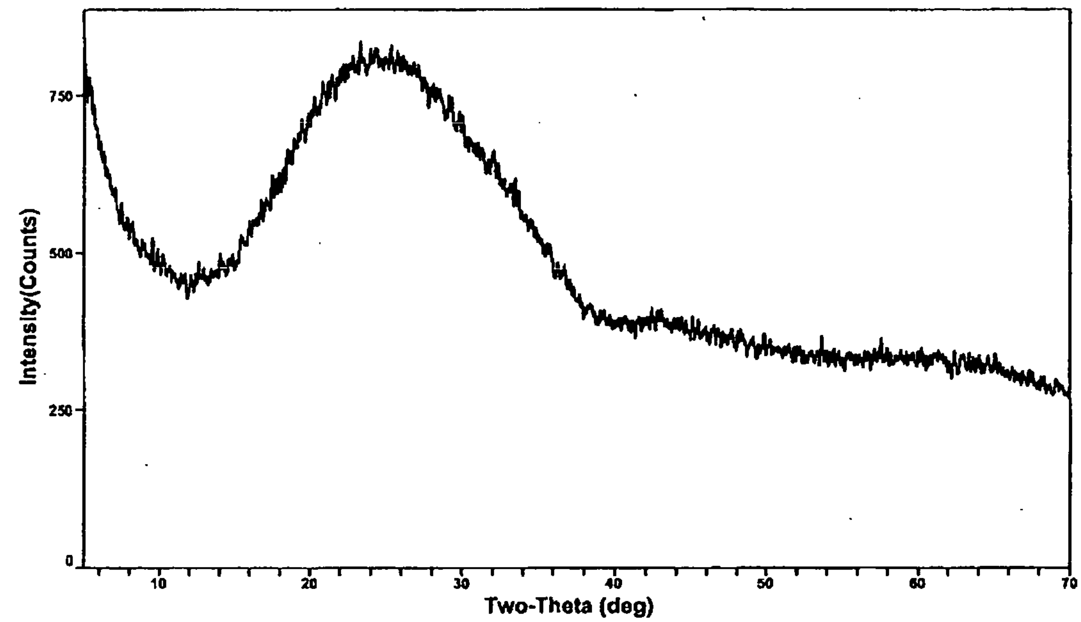

Figure 9. CXRD pattern of the interface layer sample.

[redacted]

[†] Aegirine ICDD card 71-1066 $NaFe(Si_2O_6)$
[‡] Trevorite ICDD card 10-0325 $NiFe_2O_4$

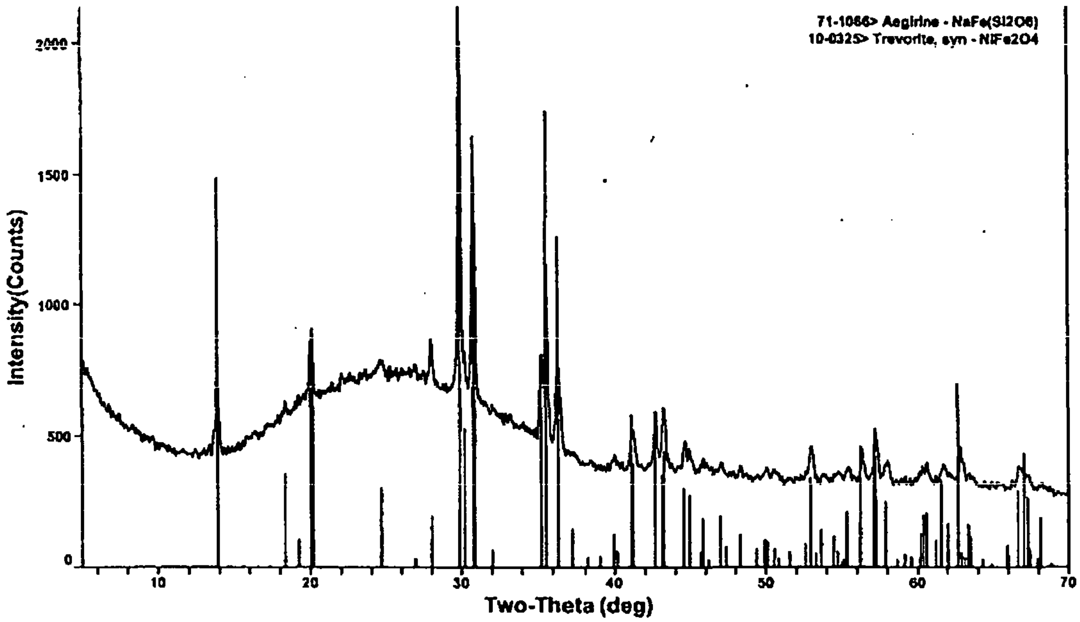

Figure 10. CXRD patter of the lower core sample.

Conclusions

Visual Observations

The interface layer glass appeared as a typical pour stream sample as described in Reference 3. It is therefore possible that a sample of the actual interface layer was not obtained. The surface was dark and reflective with no obvious inclusions. Little information could be obtained from visual observation of the core glasses. The surfaces were coarse from the sample sectioning.

Chemical Compositions

All three of the melter samples, the interface layer, the upper core and the lower core samples, were similar in composition to each other and the pour stream glass sampled in Reference 3 for the elements measured using ICP-AES. Both of the core samples were enriched in chromium. This can be attributed to chromium contribution from the stainless steel sampler. It is evident that the attempt to reduce the influence of the materials of construction of the sampler (stainless steel) on the chemical analysis was not completely successful.

For the elements analyzed by gamma counting (Co-60, Cs-137, Eu-154, Eu-155, and Am-241), the results were consistent among the three melter samples as well as the pour stream sample analyzed previously.

Elements associated with the fission of U-235 were consistent among the three melter samples as well as the pour stream sample analyzed previously with the exception of noble metals in the two core samples. Both the upper and lower core samples were depleted in the noble metals analyzed (Ru-101, Ru-102, Rh-103, and Pd-105). This can be attributed to the sole use of the mixed acid dissolutions for ICP-MS analyses. The core samples both contained significant quantities of crystallized material.

The mixed acid dissolution is not as aggressive as the fusion dissolution and, based on ICP-AES results, did not fully dissolve the core samples. It is probable that the apparent noble metal depletion in the core samples results from the noble metals participating in the formation of the crystalline phases.

The consistency of the compositions throughout the melter, from the interface layer to the two melt pool samples to a previously collected pour stream sample, indicate that there is no measurable stratification of the more massive actinides or noble metals. These are of interest because increased levels of these elements could contribute to either a criticality concern (actinide segregation) or a reduction in melter life (settling of noble metals).

Contained Scanning Electron Microscopy

The interface layer glass was uniform in appearance. EDS analysis of the sample was not possible due to the radiation emitted flooding the detector. The core samples were similar to each other in appearance. Both samples had a heavily textured surface with inclusions. EDS analysis suggests that the smooth areas are glass, the inclusions are rich in iron and silicon and that some of the debris on the surface is alumina from the sectioning blade.

Contained X-ray Diffraction

X-ray diffraction analysis of the interface layer glass indicated that the sample was amorphous. Analysis of the core samples identified aegirine (acmite) and trevorite (spinel) as the two crystalline phases. These results are consistent with results reported during waste glass compositional region development work[4-5]. An amorphous hump in the spectra suggests that significant quantities of amorphous material remain in the sample.

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Characterization of DWPF Metler One Glass				
Primary Author/Contact: A. D. Cozzi	Location: 999-W	Phone No.: 819-8414	Position	User ID
Organization Code: L3100A	Organization (No Abbreviations): Savannah River Technology Center/Immobilization Technology Section			
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November 17, 2003

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Author's Name: A. D. Cozzi
Location: 999-W Phone 819-8414
Department: SRTC/Immobilization Technology Section
Document Title: Characterization of DWPF Melter One Glasses

Presentation/Publication:
Meeting/Journal:

Location:
Meeting Date: NA

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II. DOE-SR ACTION

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K. DESCRIPTION/ABSTRACT

The Defense Waste Processing Facility's first melter operated continuously for more thaneight years. In November 2002 it was decided to replace the melter. As part of the decommissioning and replacement of the first DWPF melter, three samples were collected from the melter, one from the melter surface and two from the core sampler. The melter samples were analyzed for chemical composition and crystal content.

US DEPARTMENT OF ENERGY

ANNOUNCEMENT OF U. S. DEPARTMENT OF ENERGY (DOE) SCIENTIFIC AND TECHNICAL INFORMATION (STI)

DOE F 241.1 (p. 2 of 2)

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WVMP SAR Reference 7-5

Remove Melter from Vitrification Facility, WVNSCO work instruction package VFS-112008-WIP, West Valley Nuclear Services Company, West Valley, December 2004.

Pages 3-5

5.0 PROCEDURE DETAILS

5.1 Special Tools and Equipment

The following special tools and equipment, provided by WVNSCO, need to be staged for installation of the container cover plates:

- Rigging and lifting attachments (i.e., slings, hoist rings, shackles, etc.), inspected, tagged, and ready for use
- Torque wrench and adapters for installation of 5/16" SHCS's (i.e., 0 to 50 ft-lb range)
- Torque wrench, adapters, and torque multiplier capable of applying 500 ft-lb, inspected and ready for use
- Two (2) 2-3/8" sockets (i.e., for the 1-1/2" bolts and nuts)
- Two (2) 2-3/8" open wrenches
- Two (2) 1-5/8" sockets (i.e., for the 1" bolts and nuts)
- Two (2) 1-5/8" open wrenches
- Two (2) 1/4" hex bit sockets (i.e., for the 5/16" SHCS's)
- Four (4) spud wrenches
- Anti-galling lubricant (nickel antiseize, or equivalent)
- Silicone rubber sealant (Dow 732 - clear, or equivalent)
- Caulk guns
- WVNSCO approved gasket adhesive

5.2 Installation of the Melter Container Cover Plate

5.2.1 Perform an ALARA pre-job.

5.2.2 Stage the Melter container cover plate horizontally on wood cribbing under the Load Out crane, **in a low dose area**, and as close as possible to the loaded container, in preparation for installation.

5.2.3 Clean the container cover plate gasket seating area, if necessary, with isopropyl alcohol, or equivalent approved cleaning solution.

5.2.4 Align the cover plate to the container by aligning the cover lift tabs to the slots in the container top skirt to guide it into position. Use pry bars and the pry bar slots, if necessary, to complete the final cover alignment of the cover to the container.

5.2.5 WVDP RP shall verify dose rates and revise the radiation protection controls, as necessary, prior to continuing work.

INSP HOLD Witness the installation of "anti-galling lubricant" and the torquing of the cover plate attachment bolts to 500 ft-lbs (450 ft-lbs to 550 ft-lbs).

Actual torque applied: 500 ft-lb

Tool No. 35245 Cal Due Date: 9/13/05

INSP: Joyce Abbott (Signature) 11/14/04 (Date)

NOTE: A minimum of 30 bolts and washers are required to be installed for installation of grout or installation of securement devices, prior to movement of Melter package at the West Valley site. All 32 bolts and washers are required to be installed prior to transport of the package from the West Valley site. Step 5.2.6b can be performed at any time after receipt of the remaining two (2) bolts, but must be performed prior to transport of the package from West Valley.

5.2.6a Apply "anti-galling lubricant" to the threads of each of the 1-1/2" diameter bolts, then tighten thirty (30) of the bolts and washers to "snug tight" attach the cover plate to the Melter container (Note that a minimum of four (4) bolts are required to hold the cover plate to the container). Torque the bolts to 500 ft-lbs (450 ft-lbs to 550 ft-lbs) using a calibrated torque wrench. Use a crisscross tightening sequence that alternately tightens the bolts located 180 degrees apart. Perform the crisscross torquing sequence for three (3) torque increments starting at 200 ft-lbs, then 400 ft-lbs, and finally 500 ft-lbs. The tightening to the final torque value of 500 ft-lbs shall be performed by tightening the bolts sequentially clockwise.

WMG inc.

INSP HOLD Witness the installation of "anti-galling lubricant" and the torquing of the cover plate attachment bolts to 500 ft-lbs (450 ft-lbs to 550 ft-lbs).

Bolt 18 cannot be made to fit flush to lid all others are acceptable Joyce Abbott 11/14/04

11-15-04 - Bolt fixed & torqued to 500 ft lb. Joyce Abbott 11-15-04

Actual torque applied: 500 ft-lb

Tool No. 35745 Cal Due Date: 9/13/05

INSP: Joyce Abbott (Signature) 11/14/04 (Date)

5.2.6b Apply "anti-galling lubricant" to the threads of each of the remaining two (2) 1-1/2" diameter bolts, then tighten the bolts and washers to 500 ft-lbs (450 ft-lbs to 550 ft-lbs) using a calibrated torque wrench.

5.2.7 Disconnect the rigging from the hoist rings, then remove the hoist rings from the cover plate tabs.

5.2.8 WVDP RP shall perform the "loaded package" survey and again revise the radiation protection controls, as necessary, prior to continuing work. Surveys shall be provided to the WMG representative.

5.3 Installation of the Melter Securement Devices

NOTE: The Melter securement devices shall be installed if the low density cellular concrete is not placed in the Melter container prior to movement of the packaged Melter on site.

5.3.1 Install Melter securement devices in accordance with Reference 3.1.5 (drawing 4005-DW-007, (current revision) "West Valley Melter Securement Device.")

5.4 Installation of the Melter Container Grout Port Plugs

This section is included to provide the user with instructions for installation of the grout port plugs following the placement of low density cellular concrete (not covered by this procedure) into the Melter container. It assumes that the threaded holes in the container, into which the 5/16" socket head cap screws (SHCS's) will be attached, and the associated gasket seating surfaces, have been cleaned (or verified clean) prior to beginning this work.

112008 FC#5

WVMP SAR Reference 7-6

Weigh and Prepare Melter Container TC 474 for Grouting at the Rail Packaging and Staging Area, CHBWV work instruction package W1303663, CH2M Hill-B&W West Valley, LLC, West Valley, New York, completed October 2013.

Pages 8 - 11

5.6.7 Use hand tools in the glove bag to pry the device and slightly separate it from the container allowing the container to vent into the glove bag.

5.6.8 Allow the container to vent into the glove bag and the PVU to take up vented air.

5.6.9 After the container is vented THEN unscrew and remove the four bolts.

5.6.10 Carefully pull the securement device completely out of the melter container and into the glove bag.

5.6.11 Remove scrape and clean any gasket material (neoprene) and or RTV from the recessed area of port.

5.6.12 If required wipe down the inside of the glove bag and recessed area of port using Wypalls and Windex.

5.6.13 Twist the glove bag at the port and tape.

5.6.14 Allow the ventilation to suck air out of the bag and allow the bag to collapse.

5.6.15 Peel bag away from container and j-seal the bag.

5.6.16 RC perform survey around port area.

A. **IF** removable contamination levels are >20 dpm/100cm² alpha and >200dpm/100cm² beta/gamma.

THEN DDWO decontaminate surfaces to <20 dpm/100cm² alpha and <200dpm/100cm² beta/gamma.

B. Waste created during decontamination shall be disposed with profile VGAS.001. Windex cans shall be emptied and punctured.

5.6.17 Bag glove bag containing the securement device as rad waste using waste profile VGAS.001 and remove 4"duct from bag.

5.7 Install Container Plug into port left by removal of securement Device. *(See Photo on Attachment A Page 2 and "Melter Container Plug Details" SKJHS052913)*

5.7.1 RTV new gasket onto new 6" Deep plug.

5.7.2 Lubricate 5/16" x 3 ¾" long Cap Screws with a small amount of never seez (or equal)

5.7.3 Position plug into recessed area of container port.

5.7.4 Install Cap Screws and tighten (hand tight).

FC1> A. Torque each to 35 ft lbs. (+or- 4 ft lbs) QA to witness torqueing.

[+] QA Print/Sign/Date Paul Kaiser Paul Kaiser 9-10-13

[+] Calibrated Torque Wrench ID# 41-TW-18

[+] Calibration Due Date ~~12-31-13~~ 12-31-13

B. Apply RTV in the gap around the top of the port cover.

C. RC perform survey around port area.

1. **IF** removable contamination levels are >20 dpm/100cm² alpha and >200dpm/100cm² beta/gamma.

   THEN DDWO decontaminate surfaces to <20 dpm/100cm² alpha and <200dpm/100cm² beta/gamma.

2. Waste created during decontamination shall be disposed with profile VGAS.001. Windex cans shall be emptied and punctured.

OR

5.7.5 If Cap screws cannot be made, remove screws and plug, secure penetration with temp cover, position shield blanket, and notify WGS and cog engineer

A. RC perform survey around port area.

1. **IF** removable contamination levels are >20 dpm/100cm² alpha and >200dpm/100cm² beta/gamma.

   THEN DDWO decontaminate surfaces to <20 dpm/100cm² alpha and <200dpm/100cm² beta/gamma.

2. Waste created during decontamination shall be disposed with profile VGAS.001. Windex cans shall be emptied and punctured.

5.8 Remove port cover. (Top of container on West Side). *(See Photo on Attachment A Page 2, and SK-NJA-071613 Sheet 10 of 18 (Step 10 for reference)*

5.8.1 DDWO field install herculite or equivalent around port.

5.8.2 Run a 4" duct from the PVU for ventilation. Alternately, an environmentally sampled HEPA vacuum may be used.

5.8.3 Loosen and remove the three 5/16" SHCS cap screws securing the port cover.

5.8.4 Use ½" lift eye or T-handle, and lift the port cover and separate it from the container.

A. Remove the port cover and bag as waste using waste profile VGAS.001 .

5.8.5 RC perform survey around port area.

A. **IF** removable contamination levels are >20 dpm/100cm² alpha and >200dpm/100cm² beta/gamma.

1. **THEN** DDWO decontaminate surfaces to <20 dpm/100cm² alpha and <200dpm/100cm² beta/gamma.

2. Waste created during decontamination shall be disposed with profile VGAS.001. Windex cans shall be emptied and punctured.

5.8.6 Remove scrape and clean any gasket material (neoprene) and or RTV from the recessed area of port recessed area drop into waste container.

5.8.7 Remove herculite or equivalent from the port area.

5.8.8 RC perform survey around port area.

A. **IF** removable contamination levels are >20 dpm/100cm² alpha and >200dpm/100cm² beta/gamma.

1. **THEN** DDWO decontaminate surfaces to <20 dpm/100cm² alpha and <200dpm/100cm² beta/gamma.

2. Waste created during decontamination shall be disposed with profile VGAS.001. Windex cans shall be emptied and punctured.

5.9 Install Grouting Support Assembly. *(See Sketch SKJHSO52813 Melter Vessel Grouting Support Assembly and SK-NJA-071613 Sheet 10 of 18 (Step 10 for reference))*

[+] 5.9.1 Ensure to CLOSE all valves on the Grouting Support Assembly and install all caps.

WGS or Designee Print/Sign/Date Andrew Rupp / Andrew Rupp 9-10-2013

5.9.2 Place the Grouting Support Assembly (with gasket) inside of the port.

5.9.3 Install three 5/16" x 2 ¼" Hex Head Bolts with washers through the hole pattern securing the assembly to the container.

5.9.4 Tighten all bolts wrench tight.

5.9.5 If bolts cannot be made, remove screws and Grouting Support Assembly, secure penetration with temp cover, position shield blanket, and notify WGS and cog engineer

5.9.6 RC perform survey around port area.

A. **IF** removable contamination levels are >20 dpm/100cm² alpha and >200dpm/100cm² beta/gamma.

1. **THEN** DDWO decontaminate surfaces to <20 dpm/100cm² alpha and <200dpm/100cm² beta/gamma.

2. Waste created during decontamination shall be disposed with profile VGAS.001. Windex cans shall be emptied and punctured.

5.10 Remove Vertical securement Device #1. (top of container North Side) *(See Photo on Attachment A Page 3, WMG Sketch "Securement Device 4OO5-DWOO7" and SK-NJA-071613 Sheet 11 of 18 (Step 11 for reference)*

NOTE: *Either of 5.10.1 or 5.10.2 may be performed to remove the vertical securement device form the North Port. (if device will not fit out the port using 5.10.1 then 5.10.2 may be used instead to cut the rod)*

5.10.1 **Pull the whole device from the container**

A. Place herculite or equal around Jack Screw Port cover prior to removing port cover. North

AR 9-11-13 ~~B. Remove the threaded pipe cap from the securement device half coupling~~

C. ~~Install~~ Drill and tap the securement device cap (SKJHS062513), for installation of 3/8"~16 UNC thread.

D. Remove the four screws holding flange in place. AR 9-11-13 DK 9-11-13

E. Place sleeving approximately 6 feet long around the diameter of the securement device and seal to container.

F. Secure the sleeving to the flange.

[+] G. Complete WV-2180, if needed AR 9-11-13 DK 9-11-13

H. If a rigging sketch is needed then obtain one from Engineering.

I. Rig to the securement device, if needed AR 9-11-13 DK 9-11-13

J. Lift the device up and out of the container.

K. Tape sleeving and perform and umbilical cut.

L. Remove sleeving from port area.

M. RC perform survey around port area.

1. **IF** removable contamination levels are >20 dpm/100cm² alpha and >200dpm/100cm² beta/gamma.

a. **THEN** DDWO decontaminate surfaces to <20 dpm/100cm² alpha and <200dpm/100cm² beta/gamma.

b. Waste created during decontamination shall be disposed with profile VGAS.001. Windex cans shall be emptied and punctured.

OR

5.10.2 **Cut the threaded rod**

A. Place herculite or equal around Jack Screw Port cover prior to removing port cover.

AR 9-11-13 DK 9-11-13 ~~B. Remove the threaded pipe cap from the securement device half coupling.~~

C. ~~Install~~ Drill and tap the securement device cap (SKJHS062513), for installation 3/8"-16 UNC thread

D. Remove the four screws holding flange in place. AR 9-11-13 DK 9-11-13

E. Place sleeving approximately 12 feet long around the diameter of the securement device and seal to container.

F. Secure the sleeving to the flange.

[+] G. Complete WV-2180, if needed.

H. Rig to the top of the Securement Device, if needed.

I. Lift the Securement Device flange section up approximately 1ft above the container and hold.

J. Install cribbing under flange to safely prop it up at approximately 1 ft high.

K. Disconnect rigging from fork lift.

L. Tape sleeving tight to threaded rod for contamination control during cutting.

M. Drape a sheet of herculite over the securement device and tape on three sides to create a small tent.

N. Run a 4" duct from the PVU for ventilation. Alternately, an environmentally sampled HEPA vacuum may be used.

O. Use a reciprocating saw or equivalent to cut the threaded rod. (Allow the lower section of rod to fall into the waste container)

P. Tape to and secure open edges (on threaded rod)

Q. Remove sleeving from port area.

R. RC perform survey around port area.

1. IF removable contamination levels are >20 dpm/100cm² alpha and >200dpm/100cm² beta/gamma.

a. **THEN** DDWO decontaminate surfaces to <20 dpm/100cm² alpha and <200dpm/100cm² beta/gamma.

b. Waste created during decontamination shall be disposed with profile VGAS.001. Windex cans shall be emptied and punctured.

S. Remove herculite tent.

5.10.3 Bag the securement device and herculite.

5.10.4 Remove the securement device from the top of container.

5.10.5 Package and remove waste using waste profile VGAS.001.

5.11 Plug port on North Side *(See Photo on Attachment A Page 2)*

NOTE: *The Plug (4") and Cap Screws (5/16 x 2 ¾" SHCS) required by this section are different sizes than those items required by Section 5.7.*

5.11.1 RTV new gasket onto new 4" Deep plug.

5.11.2 Lubricate *(5/16 x 2 ¾" SHCS)* long Cap Screws with a small amount of never seez (or equal)

5.11.3 Position plug into recessed area of container port.

5.11.4 Install Cap Screws and tighten (hand tight).

FC1> A. Torque each to 35 ft lbs. (+or- 4 ft lbs) QA to witness torqueing.

[+] QA Print/Sign/Date Christopher Barton / Christopher Barton 9/16/13

[+] Calibrated Torque Wrench ID# 41-TW-18

[+] Calibration Due Date 12/31/13

B. Apply RTV in the gap around the top of the port cover.

C. RC perform survey around port area.

1. IF removable contamination levels are >20 dpm/100cm² alpha and >200dpm/100cm² beta/gamma.

WVMP SAR Reference 7-7

Melter Waste Package Grouting Implementation/QA Plan, Revision 2, CH2M Hill-B&W West Valley, LLC, West Valley, New York, October 23, 2013.

MELTER WASTE PACKAGE GROUTING IMPLEMENTATION/QA PLAN
(SUBJECT TO CHANGE BASED ON ENCOUNTERED CONDITIONS)
(Rev 2, October 23, 2013)

1.0 BACKGROUND

The current Certificate of Conformance for the melter waste package, as designed and provided by WMG, Inc., indicates:

> *"Packaging requirements, prior to shipment, include the addition of Low Density Cellular Concrete (LDCC) at a density that yields a minimum compressive strength of 1,000 PSI. The maximum gross weight of the completed package shall not exceed 390,000 pounds."*

GeoScience Group was awarded a contract to develop a LDCC recipe that meets these criteria and provide such material to the WVDP for placement into the melter waste package.

1.1 1,000 Pounds Per Square Inch (PSI) Specification

As indicated in Section 2.2 of the Statement of Work (SOW) (Mix Design), GeoScience is required to:

> *"... submit a mix design for the proposed grout, to meet the above specification requirements. The mix design shall be proven by laboratory testing (e.g., compressive strength tests) with the results submitted to CHBWV for approval prior to grout placement. If the schedule does not permit sufficient time to perform a 28 day compressive strength test, then the compressive strength test results for 3, 5, 7, etc. day tests shall meet or exceed the expected strength results plotted on the strength cure for the designated mix design."*

As of October 23, 2013, the 70 pounds per cubic foot (PCF) wet-density LDCC recipe mocked up at Wayne Concrete by GeoScience on September 30, 2013 has resulted in four (4) day cylinder breaks ranging from 520 to 900 PSI with the latest 22 day breaks at >1,000 PSI for all the 3"x6" cylinders (Attachment D). It is anticipated that the PSI results will continue to graph upward as the curing cycle continues through the ASTM spec-required 28th day break on October 28, 2014. It appears worst case is that the PSI results do not continue to graph upward but remain at the 22 day PSI results (i.e., results would not trend downward).

1.1.1 Lifts

As also required in Section 2.2 of the SOW (Mix Design), to be conservative and for risk management purposes, GeoScience's has determined that the grout should be added to the melter waste package in two lifts (i.e., ~three (3) to six (6) cement trucks per day for two (2) days). The two (2) lift approach:

- Further insures the integrity of the cellular structure of the grout is maintained
- Reduces time-limit stresses associated with emptying six (6) cement trucks into the package in one day versus all 12 in one (1) day, and
- If deployment issues require abandonment of first day grouting activities (e.g., unexpected rad concerns), then only six (6) truckloads of grout would be wasted versus 12.

1.2 390,000 Pound Maximum Gross Weight Capacity

The melter waste package has an approximate height, length, and width of 13 feet and currently weighs 160 tons. The annular void space that is required to be filled is approximately 910 cubic feet. However, passive migration of the LDCC in spent equipment cavities may occur which would increase the volume to 1025 cubic feet. [See Attachment A how void space volume was calculated]. [The maximum void space calculation was validated by WMG in June 2013 (see Attachment B)]. Upon completion of grouting, the package must weigh less than 390,000 pounds as measured by CHBWV.

The 2004 SOP 300-07 Appendix D for the melter waste package (TC-474) states that the pre-grout weight of the melter waste package, that was determined using a crane, was 318,200 lbs (with lift lugs). The only crane on site at the time that was capable of performing the lift was the 500 ton gantry; the gantry would have been lifting eight 55 ton shackles and other assorted rigging.

In September 2013, the melter waste package was re-weighed using WIP# 1303663 with 310,672.1 pounds or 155.34 tons being recorded. The 2013 weighing method used (as explained in the WIP) would result in a more accurate weight than the 2004 500 ton gantry method by its very nature and allow cost effective weighing of the container while grouting. The more accurate weight is reflected in a new SOP 300-07 Appendix D data sheet for the waste package (TC-474) (supporting documentation is also in container file) [See Attachment C]

The annular void space in the melter waste package needs to be grouted to meet the package's Certificate of Conformance. If only the annular void space was grouted, the final gross weight of the grouted package would be far less than its currently stated 390,000 capacity. However, there are open penetrations in the melter inside the package which may allow grout to enter the melter cavity, which is not required. Using a grout with a PCF of 70 (see above) and assuming as a worst case the entire melter cavity if passively filled with grout, the entire package may weigh between 377,710 to 387,477 pounds (as compared to the current package maximum gross weight capacity of 390,000 pounds) [The conclusion that the grouted package, assuming all voids were filled with grout, would weigh below the package's gross weight capacity was validated by WMG in June 2013 (see Attachment B)]. (Although the Certificate of Conformance does not state that the annular void space needs to be "filled" nor a requirement as to how such is qualified, the above reflects a scenario where the final level of grout comes to approximately six to twelve inches from the inside top of the melter package to insure that grout is not allowed to come out of the penetrations on top of the waste package and the melter is encased in grout.)

2.0 RISK MANAGEMENT

2.1 1,000 PSI Specification

28-day PSI data will be generated, by its nature, after the grout is placed into the melter waste package. (Note: although the ASTM C495 spec for LDCC recognizes the 28-day cure period for LDCC, if required, but not anticipated, the use of 56-day break data to confirm achievement of the 1,000 PSI requirements is an option.) As such, a high degree of confidence is needed to insure such results will be obtained. In other words, once the melter package is filled with grout and if subsequent associated grout cylinder breaks do not meet 1,000 PSI (or the package weights more than 390,000 lbs, as discussed below), since we will not be able to remove the grout easily, the entire grouted waste package we will have to repackaged which will cost millions of dollars and may not even be feasible (size and weight restrictions will not allow rail/road transport of such a package).

Recipe mockups at 70 PCF indicate 22 day breaks exceeding the 1,000 PSI specification. As an additional risk management option, in discussions with WMG, it appears the 1,000 PSI may be very conservative and that models could be re-run at a lower PSI (e.g., 750 PSI) to determine if a less stringent PSI grout could be used and still meet regulatory requirements for the package (for an ~$45,000). If the less conservative PSI meets regulatory requirements, WMG would modify the Certificate of Conformance appropriately to reflect the new PSI requirement. Given the 22-day cylinder data [>1,000 PSI for all 3"x6" cubes, worst case potential that the PSI through 28 days (October 28, 2013) would stay at 22-day levels and not decrease (would expect it to increase)], the re-modeling by WMG and their Russian subcontractor will not be performed unless needed after the waste package is grouted and 28-day cylinder break data is received.

2.2 390,000 Pound Maximum Gross Weight Capacity Specification

Assuming a 70 PCF grout is realized and the entire package void space and the entire melter cavity becomes filled with grout due to open penetrations on one (1) side (a unplugged discharge chute/pour spout approximately half way down the side of the melter) and on top of the melter [R1, R2 (~5" open plenum / glass thermowell ports)], it is anticipated that there will be an approximately 2,500 to 12,300 pound cushion before the package's rated weight capacity of 390,000 pounds is reached.

Risk management actions to be taken in the field include, as discussed more below, include re-weighing the waste package as it is being filled and using optics to determine height of grout as the package is being filled.

As an additional risk management option, in discussions with WMG, it appears, like the package PSI spec, the weight capacity spec may also be very conservative and that models could be re-run to determine a higher weight capacity that would still meet regulatory requirements (for ~$45,000).

If the worst case scenario is realized (entire melter cavity if passively filled with grout in addition to the required annular void space), a calculated cushion of between 2,500 and 12,300 pounds is expected before the maximum gross weight capacity of the package is reached. Field activities, as discussed in more detail below will be utilized to insure the package weight does not exceed 390,000 pounds. As such, the re-modeling by WMG and their Russian subcontractor will not be performed unless needed.

3.0 IMPLEMENTATION/QUALITY ASSURANCE WORK PLAN

3.1 Meeting PSI Spec

As indicated in Section 2.5 of the SOW (Testing and Laboratory Services) GeoScience's is required to:

"*2.5.1 The subcontractor shall provide testing and laboratory services from a third party independent testing laboratory. The independent testing laboratory shall have a qualified quality control field representative present each day of grout placement, including the batch plant testing operation.*

2.5.1.2 The quality control field representative shall test each load of grout for wet density, to assure that it falls within the specified range, in accordance with ASTM C-138.

2.5.1.3 The quality control field representative shall cast a minimum of 8 test cylinders per day, for each container placement, to be taken at a point in the discharge line that has been subjected to a maximum head pressures developed in the discharge line. Test specimens shall be prepared, handled, cured and tested for compressive strength in accordance with the requirements of ASTM C495."

3.1.1 Wet Density Range (corresponding to SOW Section 2.5.1.2)

One sample from each concrete truck load (after the addition of the foam additive) will be taken. The PCF will be required to be between 68 and 72 PCF (with a goal of 70 to 72) for each truck (or an average of all the day's trucks) to reflect a nominal PCF of between 70 and 72 PCF inside the melter waste package. The 70 to 72 PCF range inside the melter was calculated as indicated in Table A.

3.1.2 PSI Test Cylinders (corresponding to SOW Section 2.5.1.3)

For additional risk management purposes, for each cement truck load that passes wet density testing, test cylinders will be cast (not just one truck per day as indicated in SOW Section 2.5.1.3). Grout volume to fill the cylinders will be taken at a sample station located post-grout at a location that has been subjected to the maximum head pressures developed in the discharge line. Cylinders may be stored in cure box. For one of the trucks on each day of grouting, a full sequence of test cylinders will be generated and tested, at a minimum, as follows:

- 2 cylinders for 8-day breaks
- 4 cylinders for 28 day breaks
- 4 cylinders for 56-day breaks (if needed)
- Contingency: 2 cylinders

For the remainder of the trucks to be used in a particular day, the following sequence of test cylinders may also be generated, at a minimum. For each day of grouting, these remaining truck cylinders will be broken only if the full sequence of cylinders for that day fails to display 1,000 PSI at 28 days. If these cylinders are broken, the 28 day (or 56 day) results from all broken cylinders will be averaged together, with the data generated from the other days of grouting, to document the final PSI of the grout inside the waste package.

- 4 cylinders for potential 28-day breaks
- 4 cylinders for potential 56-day breaks (if needed)

3.2 Meeting Gross Weight Capacity Spec

The largest unknown factor relative to staying below the melter waste package's stated gross weight capacity of 390,000 pounds is to what degree grout is going to enter the melter's cavity via open penetrations R1 and R2 located on top of the melter (approximately 20" from underside of top of waste container) and the one non-plugged discharge chute located approximately half way down the melter's side. As such, the tentative plan to monitor the weight of the package is being filled is as follows. Although subject to change, while pouring the lifts, the melter is anticipated to be weighed before the level of the open penetrations in the side and top of the melter are approached. As the grout level approaches the penetrations and after the penetrations are immersed in grout, more frequent weighing may occur. Visual and dose rate readings will be collected to determine the approximate height of the grout within the package. Once the waste package weighs approximately 387,000 pounds, no further grout will most likely be added to maintain a 3,000 pound cushion.

WVMP SAR Reference 7-8

Grout Melter Container TC-474 at the Rail Packaging and Staging Area, CHBWV work instruction package W1303694, CH2M Hill-B&W West Valley, LLC, West Valley, New York, completed November 2013.

Pages 9 - 10

b. Waste created during decontamination shall be disposed with profile VGAS.001. Windex cans shall be emptied and punctured.

5.10.4 Inspect port for grout clean and remove grout from port if needed.

5.10.5 Perform Section 5.11 to install container plug.

5.11 Install Container Plug into port left by removal of Grout Support Assembly. *(See "Melter Container Plug Details" SKJHS052913)* AR 11/5/13 DK 11/5/13 AR 11/5/13 DK 11-5-13

5.11.1 RTV ~~new~~ gasket onto ~~new~~ 4" Deep plug.

5.11.2 Lubricate (5/16 x 2 ¾" SHCS) long Cap Screws with a small amount of never seez (or equal)

5.11.3 Position plug into recessed area of container port.

5.11.4 Install Cap Screws and tighten (hand tight).

A. Torque each to 35 ft lbs. (+or- 4 lbs) QA to witness torqueing.

[+] QA Print/Sign/Date Paul Kaiser / Paul Kaiser 11-5-13

[+] Calibrated Torque Wrench ID# 41-TW-18

[+] Calibration Due Date 12-31-13

B. Apply RTV in the gap around the top of the port cover.

C. RC perform survey around port area.

AR 10-17-13
DK 10-17-13

1. **IF** removable contamination levels are >20 dpm/100cm² alpha and /or >200dpm/100cm² beta/gamma THEN.

a. DDWO decontaminate surfaces to <20 dpm/100cm² alpha and <200dpm/100cm² beta/gamma.

b. Waste created during decontamination shall be disposed with profile VGAS.001. Windex cans shall be emptied and punctured.

OR

5.11.5 If Cap screws cannot be made, remove screws and plug, secure penetration with temp cover, position shield blanket, and notify WGS and cog engineer

A. RC perform survey around port area.

AR 10-17-13
DK 10-17-13

1. **IF** removable contamination levels are >20 dpm/100cm² alpha and /or >200dpm/100cm² beta/gamma **THEN**.

a. DDWO decontaminate surfaces to <20 dpm/100cm² alpha and <200dpm/100cm² beta/gamma.

b. Waste created during decontamination shall be disposed with profile VGAS.001. Windex cans shall be emptied and punctured.

5.12 Remove vent ducting, box filter and knock out pot.

NOTE: *Keep PVU running during vent line breakdown. The PVU will remain running until directed to be secured by the Cognizant Engineer.*

5.12.1 Close the 4" Ball Valve on the Grouting Support Assembly on the (vent side) of the container. (vent assembly)

5.12.2 Disconnect the 4" vent duct from the vent assembly and bag open ends.

5.12.3 Disconnect vent duct from the Knock Out Pot and bag open ends on each.

5.12.4 Disconnect duct (bag open ends) from the filter box. Bag filter box as waste using waste profile VGAS.001.

5.12.5 Dispose of the ventilation duct as waste using waste profile VGAS.001.

5.12.6 Check knock-out drum for liquids.

A. If ≥ 2 gallons of liquid is collected THEN Sample for interceptor acceptance Per Attachment A "Liquid Sampling Instructions".

B. IF < 2 gallons of liquid is collected THEN obtain field pH of the liquid and check for visible oil sheen and provide results to WPD. If pH is ≤2 or ≥12.5, See Attachment A, Step 1.1.4.

5.12.7 Set-up contamination area with herculite on container around the port.

5.12.8 Disconnect grout inlet valve assembly.

WARNING:

EXCESS GROUT MAY OVERFLOW FROM PORT WHEN DISCONNECTING VALVE ASSEMBLY. GROUT IS POTENTIALLY CONTAMINATED.

5.12.9 Tape & cut sleeving between valve assembly & port to maintain seal on container.

5.12.10 Remove sleeving and Inspect port for grout.

5.12.11 RC survey prior to cleaning port.

A. RC perform survey around port area.

AR 10-17-13
DC 10-17-13

1. IF removable contamination levels are >20 dpm/100cm² alpha and/or >200dpm/100cm² beta/gamma.

2. THEN DDWO decontaminate surfaces to <20 dpm/100cm² alpha and <200dpm/100cm² beta/gamma.

3. Waste created during decontamination shall be disposed with profile VGAS.001. Windex cans shall be emptied and punctured

5.12.12 Inspect port for grout clean and remove grout from port if needed.

5.12.13 Perform Section 5.13 to install container plug.

5.13 Install Container Plug into port left by removal of Grout Support Assembly. *(See "Melter Container Plug Details" SKJHS052913)* AR 11/5/13 DC 11-5-13 AR 11/5/13 DC 11-5-13

5.13.1 RTV ~~new~~ gasket onto ~~new~~ 4" Deep plug.

5.13.2 Lubricate *(5/16 x 2 ¾" SHCS)* long Cap Screws with a small amount of never seez (or equal)

5.13.3 Position plug into recessed area of container port.

5.13.4 Install Cap Screws and tighten (hand tight).

A. Torque each to 35 ft lbs. (+or- 4 lbs) QA to witness torqueing.

[+] QA Print/Sign/Date Paul Kaiser / Paul Kaiser 11-5-13

[+] Calibrated Torque Wrench ID# 41-TW-18

[+] Calibration Due Date 12-31-13

B. Apply RTV in the gap around the top of the port cover.

C. RC perform survey around port area.

1. IF removable contamination levels are >20 dpm/100cm² alpha and >200dpm/100cm² beta/gamma THEN.

WVMP SAR Reference 7-9

Administration of Work Instruction Packages, EP-5-002, Revision 37, CH2M Hill-B&W West Valley, LLC, West Valley, New York, March 19, 2014.

CH2MHILL • B&W West Valley, LLC

ENGINEERING PROCEDURES

TITLE: ADMINISTRATION OF WORK INSTRUCTION PACKAGES

1.0 PURPOSE

This engineering procedure provides instructions for the administration of Work Instruction Packages (WIPs) including development, revision, cancellation, closeout, and periodic review/recall of issued WIPs.

The administration of WIPs is a Worker Safety and Health Administrative Control program as identified in Addendum 1, "WVDP Worker Safety and Health Plan" (WVDP/WSHP) to WVDP-310, "WVDP Integrated Safety Management System (ISMS) Description." The WVDP/WSHP includes a program statement associated with each Worker Safety and Health Administrative Control program. In accordance with 10 CFR 851.11(c)(1), any proposed change (i.e., modification, addition, or deletion) to EP-5-002 that would invalidate the program statement in the WVDP/WSHP requires prior DOE approval.

2.0 GENERAL

2.1 Terms used in this procedure are defined in Attachment A, "Definitions."

2.2 Attachment B, "Writing Guidelines and Document Structure," assists originators with WIP formatting and writing guidelines.

2.3 Attachment C, "Reviewer/Planning Team Selection Checklist," is provided to assist in identifying the required reviewer/planning team members for WIP development.

2.4 When necessary, approval signatures may be obtained via telecon or the use of emails. Attachment D, "Telecon/Email Approvals," provides the method for obtaining approvals via telecon or email.

3.0 WIP DEVELOPMENT PROCESS

This section may be performed in the order that best suits the efficiency of time and effort to develop and issue WIPs.

3.1 Originator: Defines the scope of the WIP, identifies the hazards associated with the work, and develops the work instructions. To accomplish this task:

3.1.1 Perform a scoping assessment of the assigned task with the work group(s) that will use the final instruction as well as applicable support groups, including hazard control specialists (HCS), as deemed appropriate. The scoping assessment should include a walkdown of the proposed tasks to assess actual field conditions.

3.1.2 Refer to historical files (e.g., completed work instructions, related operating procedures, lessons learned documents) for guidance and experience that can be incorporated into the work instructions.

3.1.3 Refer to available resources (CHBWV Intranet Lessons Learned, WVDP Operating Experience Program Coordinator, Occurrence Reports [ORPS], and/or DOE lessons learned system) for lessons learned information on activities similar to those being proposed. Incorporate applicable lessons learned information into the work process and/or identify the information for inclusion into training or briefing material, if applicable.

3.1.4 Identify hazards using form WV-3909, "Activity Hazards Analysis" (AHA).

NOTE *The originator may obtain a Work Control Number (WIP number) from Work Control at any time.*

3.1.5 Develop WIP using form WV-2571, "WVDP Work Instruction Package (WIP Form)" and guidelines in Attachment B, "Writing Guidelines and Document Structure."

3.1.6 Include hazard controls in the WIP in accordance with WV-921, *Hazards Identification and Analysis*. Ensure that hazard controls not specifically discussed in the WIP are captured in other permits (e.g., RWP, IWP) or are identified on the Pre-Job Briefing form (WV-3745) as required by WV-921.

NOTE *When the risks to the planning team outweigh the potential benefits of the walkdown, a tabletop review using photographs and drawings with group discussion may be performed in-lieu of the walkdown, as approved by the Work Review Group Coordinator (WRGC).*

3.2 Work Group Supervisor and/or Originator lead Planning Team Walkdowns in accordance with SOP 00-46, *Work Instruction Walkdowns, Pre-Job and Daily Briefings and Post-Job Feedback/Lessons Learned,* as needed during the development and review of the work package.

3.3 The originator sends an electronic copy of the WIP draft and supporting documents to the planning team participants and any other required reviewers identified on Attachment C for review and approval.

3.3.1 Discuss and ensure applicable HCSs concur with hazard mitigations addressed in the WIP.

3.3.2 Regulatory Strategy shall evaluate and approve all WIPs to determine whether or not each WIP is a RCRA Operating Record and determine whether all applicable environmental and regulatory requirements are addressed in the WIP.

3.4 Work Review Group Coordinator (WRGC) performs a Work Control Management review of the WIP and ensures the following:

3.4.1 The WIP was developed following the processes in this procedure.

3.4.2 Hazards and controls identified by the hazard analysis process are incorporated into the WIP and supporting documents (e.g., RWP, IWP, GDP).

3.5 A USQD Evaluator determines the applicability of WV-914, *Unreviewed Safety Question Process (USQP)*, to the proposed activity and indicates if Form WV-3306 is required.

3.6 The Responsible Manager (RM) and Operations Manager approves the WIP and ensures the following:

A. Referenced permits do not provide conflicting directions, PPE, or other mitigations and controls.

B. Post maintenance tests are specific, have acceptance criteria, and are approved by the appropriate Cognizant Systems Engineer and Operations authorization.

3.7 Additional Management Review Processes

3.7.1 Final Interactive Meeting for High Hazard or Complex Work (see def.)

A. Held when deemed necessary by the Responsible Manager.

B. The Final Interactive WIP review meeting is a face-to-face review of the draft work order with planning team members, which allows the reviewers to improve the final product based on the shared discussions.

C. During the interactive WIP review meeting, the following contingency planning techniques will be discussed and documented in the meeting minutes:

1. What is the critical work scope
2. What can go wrong when performing the work scope
3. What Error likely situations/Error precursors are applicable to performing the work scope
4. What are the Defenses in depth barriers to improve safety when performing the work scope

3.7.2 Hazard Review Board (HRB)

A. Convened at senior management discretion for particularly complex/high hazard tasks (e.g., work in High Radiation Area; work with high electrical hazards or fire hazards, work requiring fall protection, work involving cranes, work affecting facility design).

B. The HRB focuses on the implementation of Integrated Safety Management principles, best practices, lessons learned and key elements of the Voluntary Protection Program. (Refer to EMD-002).

C. Upon satisfactory completion of the HRB, the Hazard Review Board Chairman will document with signature on WV-2571 indicating approval to perform work.

3.8 The originator forwards WIP to Work Control for issuance when WIP is approved.

3.9 Work Control reviews the WIP for completeness, makes data entry, and issues the WIP with all supporting documents (e.g., RWP, IWP, GDP).

3.10 If Work Control is not available, (e.g., off-shift, weekends, and holidays) originator performs the following:

3.10.1 Obtains the Work Control Number, if not already assigned, from the Daily Log Book located in the PSO Supervisor's office and enters the number on WV-2571.

3.10.2 Writes "Issued" and the date and time on the cover page.

3.10.3 Ensures a copy of the cover page is placed under the cover of the logbook.

3.10.4 Ensures that Work Control is notified the next working day.

4.0 WORK INSTRUCTION PACKAGE REVISION PROCESS

4.1 Type of Change Determination

The originator and WGS determine the type of change to be used by utilizing the following guidelines as approved by the RM or Work Review Group Coordinator (WRGC):

4.1.1 A direct document change (DDC) may be used when:

A. Change does NOT exceed the boundaries of the original scope.

B. Hazards originally reviewed are NOT increased, no new additional hazards are identified, and no hazard mitigations are added or modified.

C. Change does NOT modify the process that generated a previously identified hazard.

D. Change does NOT affect technical identification (e.g., valve designation).

E. Hazard is identified and mitigated in the work instructions but unintentionally left unchecked in the AHA or requires additional clarification.

F. Limiting conditions or acceptance criteria are NOT changed.

G. The change DOES NOT affect QA activities, requirements, or functions.

H. The change DOES NOT affect Regulatory Strategy activities or requirements.

I. The change DOES NOT affect a critical step, hold or verification point step.

J. Hazardous energy boundaries are NOT changed or added.

4.1.2 Examples of changes that may be performed as a DDC are:

A. Corrections of typographical errors, misspellings, worker designations, correcting a cross-reference to another step, updating the reference number to a permit or JSA or other administrative corrections.

B. Addition or deletion of steps, if the above requirements are met.

C. Sequence of steps is changed that DOES NOT affect the intent or any critical steps.

4.1.3 A Field Change (FC) shall be used when:

A. Change is outside the boundaries of the original scope.

B. Hazards originally reviewed are increased, additional hazards are identified, or hazard mitigations are added or modified.

C. Limiting conditions or acceptance criteria are changed.

D. The change affects QA activities, requirements, or functions.

E. The change affects Regulatory Strategy activities or requirements.

F. The change affects a critical step, hold or verification point step.

G. Hazardous energy boundaries are changed or added.

H. A partially worked WIP is cancelled (see Section 5.3).

4.2 Direct Document Changes (DDC)

NOTE *When the originator of the WIP is not available (e.g., off-shift) and the work needs to be performed, another person having the qualifications of an originator may act as the originator to write the DDC.*

4.2.1 The originator reviews the Activity Hazards Analysis (WV-3909) to confirm that the modifications do not increase or add to the hazards originally reviewed.

4.2.2 If a hazard is identified and mitigated in the work instructions but unintentionally left unchecked in the AHA checklist, then update AHA checklist and annotate or provide additional clarification in the hazard control/mitigation section.

4.2.3 The originator performs a DDC as follows:

A. Annotates the changed step(s) or information in the work instruction and lines out/deletes step(s) or information no longer applicable

B. The originator and WGS reviews and approves each DDC by initialing and dating.

C. The originator provides a copy of DDC to Work Control.

4.3 Field Changes (FC)

NOTE1 *When the originator of the WIP is not available (e.g., off-shift) and the work needs to be performed, another person having the equal qualifications of an originator (see Attachment A for qualifications) may act as the originator to perform the FC.*

NOTE2 *For field changes that are required immediately in the field, it is acceptable to obtain Form WV-1085 and hand write the change, then obtain signatures per telecon.*

4.3.1 If performing an electronic field change, the originator checks for and incorporates all previous DDCs in the electronic FC.

4.3.2 The originator determines the FC number by reviewing the entire document for previous FCs. The next sequential number following the last FC is used.

4.3.3 The originator completes form WV-1085, "Work Instruction Package (WIP) Field Change Form."

4.3.4 Include change lines for each revision change - indicate changes, additions, and deletions in the DRAFT review copies using the Track Changes feature.

4.3.5 The originator annotates the changes with the symbol FC# (where # represents the number of the FC, e.g.,FC1, FC2, FC3) in the left margin of the items changed.

4.3.6 The originator reviews the original Activity Hazards Analysis (WV-3909), if not done already, to determine if the FC imposes additional hazards, hazardous situations or increases hazards/consequences which have not been evaluated and updates WV-3909 in accordance with WV-921, as needed.

NOTE *HCSs should work with the WGS to determine applicable permit requirements and hazard mitigations prior to and/or during the walkdown.*

4.3.7 The WGS or designee performs a walkdown in accordance with SOP 00-46, *Work Instruction Walkdowns, Pre-Job and Daily Briefings and Post-Job Feedback/Lessons Learned.* This includes coordination with applicable support groups (e.g., RS, Safety) and work groups (e.g., Maintenance) if applicable.

4.3.8 The originator provides the description of the FC including additional hazards and controls required and pages affected that are required to be replaced.

4.3.9 The originator provides the reason(s) the FC was necessary.

4.3.10 The originator obtains signatures from all other departments and work groups affected by the change. See Attachment D for assistance in determining affected groups.

4.3.11 If Regulatory Strategy requires change to the status of the document as an RCRA Operating Record, change the designation on the original cover page and initial and date.

4.3.12 USQD Evaluator determines the applicability of WV-914, *Unreviewed Safety Question Process (USQP)*, to the proposed activity and indicates if Form WV-3306 is required.

4.3.13 The Responsible Manager (or designee) and the Operations Manager approves the FC.

NOTE *FC pages supersede existing pages of the WIP. All sign-offs are made on the latest FC page unless the steps were already performed.*

4.3.14 Work Control reviews WV-1085 for completeness and issues the FC.

4.3.15 If Work Control is not available (e.g., off-shift, weekends, holidays), the WGS or originator performs the following:

A. Writes "Issued" and the date and time on the Field Change form.

B. Ensures a copy of the Field Change is placed under the cover of the Daily Log Book located in the PSO Shift Supervisor's office.

C. Ensures that Work Control is notified the next working day.

5.0 WORK INSTRUCTION PACKAGE CANCELLATION PROCESS

5.1 Voiding Work Instruction Packages

NOTE *Only WIPs given a number, but NOT issued, may be voided.*

Voided WIP's shall be recorded as such in the CMMS database

5.2 Canceling Work Instruction Packages (Work NOT started)

5.2.1 The originator and WGS complete WV-2571.

5.2.2 The originator forwards WV-2571 to Work Control.

NOTE *A partially worked WIP may be canceled if a task is no longer required to be completed or is replaced by another work instruction.*

5.3 Canceling Partially Worked Work Instruction Packages

5.3.1 The originator forwards the entire WIP (including permits [e.g., ALARA PRE/Post Job briefings, IWP, GDP] that were used) to Work Control.

5.3.2 Work Control will determine if DDC, Field Change or Cancellation per 5.2 is required.

6.0 WORK INSTRUCTION PACKAGE COMPLETION, REVIEW, AND DOCUMENTATION

6.1 The WGS conducts a post-job review in accordance with SOP 00-46. Where lessons learned/problems encountered or input from the workers indicate that there is a benefit for the review, the WGS documents feedback on form WV-2573, "Work Package Status Log and Post-Job Feedback/ Lessons Learned." The WGS also indicates if lessons learned apply on WV-2571.

6.2 When required, the WGS conducts a post-job of ALARA jobs in accordance with WV-984, *ALARA Program*. The WGS attaches a copy of Form WV-3118, "West Valley Demonstration Project, ALARA Post-Job Review," to the WIP.

6.3 The WGS verifies documents (e.g., IWP, HWP, Pre-Job Briefing) associated with the WIP are in the WIP folder.

6.4 The originator and WGS verify completion of the work and sign on WV-2571.

6.5 For WIPs used to perform maintenance on site equipment, the originator shall provide a brief description of the work performed and the cause of the problem if known on form WV-2573 and Work Control will enter this information into the CMMS database.

6.6 Originator forwards the WIP to Work Control.

6.7 Work Control reviews the completed WIP to ensure package is properly prepared for storage and transfers the closed out WIP to Records in accordance with WVDP-262, *WVDP Records Management Program Plan.*

7.0 PERIODIC REVIEW AND RECALL OF WORK INSTRUCTION PACKAGES

7.1 Work Control performs a periodic review and 90 day recall on all work instructions for:

7.1.1 Any WIP in which work has not commenced and notifies the applicable WGS.

7.1.2 Any WIP that has been authorized and work performed but not worked in 90 days.

7.1.3 Any WIP that has significant multiple revisions (more than 5 or content is no longer clearly defined)

7.2 The WGS and originator determine if the work still needs to be performed and if the WIP is in compliance with current requirements.

7.3 If it is determined that the work instruction is no longer needed, the WGS or originator closes out the WIP by canceling it per step 5.0.

7.4 If it is determined that the work needs to be performed but the work instruction does not meet current requirements, the originator should field change the WIP or cancel the WIP and issue a new one.

8.0 RECORDS

The following forms, data sheets, logs, reports, or any other form of documentation are considered records and when created are to be prepared, maintained, and transferred to Records in accordance with WVDP-262 and WVDP-529. Refer to the CHBWV Master File Plan for further information.

8.1 Work Instruction Package (WV-2571, attachments, and associated documents).

8.2 Work Instruction Package (WIP) Field Change (WV-1085and associated documents0

9.0 REFERENCES

NOTE *Refer to E-docs for the latest version of WVDP Controlled Documents. Refer to the S:/WPFORMS folder for the latest revision of WVDP forms used in this procedure.*

EP-3-007	*Engineering Change Notice*
SHIP-108	*Job Safety Analysis* (and form WV-3043)
SHIP-201	*Industrial Work Permits* (and form WV-1107)
SOP 00-04	*Lock, Tag, and Confirm Procedure*
SOP 00-11	*Troubleshooting and Maintenance of Electrical Equipment*
SOP 00-30	*System and Component Labeling*
SOP 00-38	*Administration of Hoisting and Rigging Activities*
SOP 00-46	*Work Instruction Walkdowns, Pre-Job and Daily Briefings and Post-Job Feedback/Lessons Learned* (and forms WV-2573 and WV-3745)
SOP 00-49	*Control of Temporary Modifications* (and form WV-3811)
SOP 00-52	*Conduct of Operations*
SOP 00-54	*Minor Work Request*
SOP 300-07	*Waste Generation, Packaging, and On-Site Transportation*
WV-370	*Underground Utility Review Policy* (and forms WV-3521 and WV-3522)
WV-914	*Unreviewed Safety Question Process (USQP)* (and form WV-3306)
WV-921	*Hazards Identification and Analysis* (and form WV-3909)
WV-984	*ALARA Program* (and forms WV-2404, WV-4281 and WV-3118)
WVDP-010	*WVDP Radiological Controls Manual*
WVDP-106	*WVDP Conduct of Operations Applicability Matrix*
WVDP-111	*CH2M HILL • B&W West Valley, LLC Quality Assurance Program*
WVDP-200	*West Valley Demonstration Project (WVDP) Waste Acceptance Manual*
WVDP-227	*WVDP Facility Identification and Categorization Matrix*
WVDP-204	*WVDP Quality List Q-List*
WVDP-262	*WVDP Records Management Plan*
WVDP-274	*Maintenance Implementation Plan (MIP)*
WVDP-352	*WVDP Site Welding Manual* (and form WV-1888)
WVDP-357	*WVDP Issues Reporting Program*
WVDP-485	*Work Control*
WVDP-529	*WVDP Records Disposition Plan*

10.0 ATTACHMENTS

Attachment A, "Definitions"
Attachment B, "Writing Guidelines and Document Structure"
Attachment C, "Reviewer/Planning Team Selection Checklist"
Attachment D, "Telecon/Email Approvals"

ATTACHMENT A
DEFINITIONS
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1. Activity Hazard Analysis (AHA) – an activity hazard analysis that documents: 1) Hazards Controls Specialists (HCSs) included in the work planning process; 2) identification of specific task activities where hazards are present; 3) identification of hazards applicable to the specific tasks; and 4) incorporation of the mitigation of the hazards into the work document/associated documents using a hierarchy of controls whenever elimination is not possible.

2. Bench Top – a small scale mockup used when the size of the modeling is restrictive.

3. Cognizant Manager – the manager, or designee, with the technical cognizance over the work to be performed.

4. Cognizant System Engineer (SE) – the individual with design cognizance over the system or the work to be performed, who is officially recognized as responsible for a specific system. See the Cognizant Responsibility List for an up-to-date listing of all SEs.

5. Criticality Safety Engineer (CSE) – an individual that is responsible for providing support to the Nuclear Criticality Safety Program, including the preparation of Nuclear Criticality Safety Evaluations (NCSEs) and for providing recommendations to the Engineering Manager with respect to Criticality Control Zones (CCZs). See the Technical Specialist List for an up-to-date listing of CSEs.

6. Critical Work Steps – steps which have significant importance to safety, the safety basis, or are regulatory in nature and require the continuous presence of supervision during completion.

7. Facility Manager – an individual, or designee, that authorizes work in their assigned facility. The Cognizant Responsibility List maintains the list of currently identified Facility Managers.

8. High Hazard or Complex Work – Work that meets any of the following criteria:

   - Performed at or above ALARA trigger levels;
   - First-of-a-type complex work evolution;
   - Critical lifts;
   - Certain types of elevated work (per ESH&Q direction);
   - Facility demolitions;
   - Electrical work with the potential of encountering live conductors;
   - Confined Space entry (per ESH&Q direction);
   - Non-routine hazardous, radiological, or mixed waste packaging or transportation;
   - Certain types of Hot work activities;
   - Non-routine electrical troubleshooting or repair work;
   - Any other activity as prescribed by senior management.

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9. Independent Verification – verification performed INDEPENDENTLY of the initial application to verify the isolation point has been correctly identified:

- NOT performed by the person who performed the original activity;
- NOT done at the same time as the original activity. There must be enough time and distance between the original activity and verification to ensure that they are independent of each other.

10. Mockup – performance of a proposed work activity or portion of a work activity in a low risk, low hazard environment using actual, exact, or nearly exact replica models of the equipment, system, or area. The purpose of the mockup is to evaluate and/or develop the hazard controls, sequencing, tooling and/or ability to perform the actual work activity.

11. Operating Experience Program Coordinator – an individual that interfaces with functional organizations to assist in accessing information systems for identification of potential lessons learned for incorporation into work documents.

12. Operations Manager – for purposes of this procedure, the Operations Manager or designee responsibilities are:

- Provide prerequisites and facility initial conditions requirements to Originators/Planners during the development of Work Control document (WCD).
- Authorize, release and coordinate work activities;
- Ensure facility conditions are established, (including LOTO), to support performance of scheduled maintenance activities;
- Ensure that the appropriate Unreviewed Safety Questions (USQ) actions are completed per WV-914, Unreviewed Safety Question Process (USQP) prior to the modification of a Hazard Category 1, 2, or 3 facilities;
- Ensure post maintenance testing or functional testing is incorporated into the WCD;
- Ensure prescribed post maintenance testing is performed and properly documented;

13. Originator– an individual assigned to prepare a WIP/WCD that has completed Q071 Work Planning TRVC TR1486Q and is responsible for the following:

- Leads the Planning Team in work site walkdowns, work scope definition, job hazard identification, analysis and control selection, and WCD development;
- Reviews Lessons Learned database and feedback for entries with applicability to the work to be performed;
- Develops the WCD incorporating input from the Planning Team, the RM, and appropriate task related requirements;
- Coordinates WCD comment resolution and submits the package for concurrence by Work Group Supervisor and relevant Subject Matter Experts (SME/HCSs) and approval by the RM;
- Confirms the WCD is ready to issue and forwards to Work Control for issuance.

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14. Permits – written documents specifying hazard controls for identified hazards, such as an Industrial Work Permit (IWP), Radiation Work Permit (RWP), Ground Disturbance Permit (GDP), Confined Space Entry Permit, Hot Work Permit (HWP).

15. Planning Team - the Planning Team consists of personnel/departments identified as applicable in Attachment C, "Reviewer/Planning Team Selection Checklist," (e.g., Hazard Control Specialists (HCSs)/SMEs identified on the AHA, Work Review Group Coordinator, applicable system engineers and other support groups). The Planning Team provides an integrated approach to the review and issuance of work documents by participating in the walkdown, development, review and approval process.

16. Planning Team Walkdown –HCSs/SMEs identified on the AHA and other support groups from the Planning Team as deemed necessary by the Originator or Work Group Supervisor perform Planning Team walkdowns in accordance with SOP 00-46. Planning Team walkdowns may be performed at various times during the work package generation process and may consist of multiple walkdowns, meetings, and individual or smaller group settings based upon resource availability and need.

17. Planner – an individual that has completed Q071 Work Planning TRVC TR1486Q and is responsible for the following:

    - May act as the Originator to prepare and issue a WIP/WCD.
    -
    - Ensures work is ready to commence as scheduled (e.g., obtains required tooling and parts, coordinates the integration of controls and preparation of the required permits (e.g., industrial work permits (IWP), radiological work permits (RWP), hot work permits, confined space permits)).

18. Responsible Manager – for purposes of this procedure, the Responsible Manager (RM) or designee, is the individual responsible for organizing, scheduling, and approving expenditures for individual, specific projects in progress at the WVDP

    - Reviews and approves all WCDs;
    - Reviews and approves changes to WCDs;

19. Routine Work – work performed that is well understood, repeated regularly, and is within recognized skill-of-the-craft attributes.

20. Source Requirements - requirements that are directly implemented by a controlled document. The following are some examples of source requirements: DOE, Federal, State, or Local laws or regulatory requirements; Process Safety Requirements (PSRs); Waste Qualification Reports (WQRs); Documented Safety Analysis (DSA); Industry Codes and Standards; and other requirements and contractual commitments.

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21. Subject Matter Expert (SME/HCSs) – are drawn from various site functions (e.g., Radiological Controls, Safety, Industrial Hygiene, Engineering, etc. – See Technical Specialists List in Web Publishing):
    - Participates in the work site job/task walkdowns, job hazard analysis and control selection, and WCD development as part of the Planning Team when assigned;
    - Ensures Planning Team decisions are consistent with programmatic requirements;
    - Reviews WCDs to ensure that the hazard controls have been incorporated consistent with programmatic requirements;
    - Participates in development of WCD instructions ensuring that the steps with safety basis or other regulatory permit requirements are properly incorporated;
    - Specifies inspections and acceptance criteria, identifies hold and witness points;
    - Reviews subcontractor prepared documents for suitability;
    - Reviews completed WCDs to ensure that required data is properly recorded in accordance with programmatic requirements;
    - Concurs with the WCD as part of the approval process.

22. Use Classification – determines the manner in which a work instruction must be used in the field. The Use Classification for WIPs is as follows:
    - Critical Use – WIPs are classified as Critical Use and require the worker(s) to have the work instruction present and open with each step performed exactly as written. Initials and/or signoffs shall be made, where required, at the time the step is performed or as directed in the WIP.
    - Reference Use – Sections and steps considered as Reference Use may be performed out of sequence and/or in parallel. Sections and steps must be specified as such.

23. WIP – Work Instruction Package that is used for more complex and infrequently performed work, with moderate to high consequences of improper performance:
    - Contain detailed step-by-step instructions with a suggested or required sequence of performance;
    - Require the highest level of review and approval;
    - Require activity level work instructions in the body which include work steps, special requirements, hazards, and controls.

24. Work Group Supervisor – for purposes of this procedure, the Work Group Supervisor (WGS) is the individual responsible for the supervision of workers safely performing work activities, assuring work is performed continuously within scope, and in compliance with written instructions. In addition:
    - Participates as a Planning Team member in the WCD walkdown
    - Concurs with the WCD, confirming workability, as part of the approval process;
    - Ensures the WCD is approved and work is released;
    - Conducts Pre-Job Briefings to review scope of work, hazards and controls with assigned workers;
    - Ensures that the prerequisites for work have been performed;
    - Ensures hazard controls are implemented;
    - Ensures that personnel executing the work have attended the Pre-Job Briefing or are briefed separately;

ATTACHMENT A
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- Ensures a pre-issuance and workability walkdown is conducted
- Ensures referenced documents are current prior to start of work;
- Ensures workers are aware of their responsibility to stop work and notify supervision whenever changing conditions or unidentified hazards are encountered or work practices compromise quality or safety;
- Reviews training requirements and ensures workers are qualified to perform their duties;
- Supervises work activities to meet WCD requirements;
- Ensures the safety and health of workers during the conduct of work activities including proper wearing of PPE;
- Ensures a proper turnover of work status when transferring WGS responsibilities and documents in Work Package Status log (WV-2573);
- Ensures that good housekeeping practices are followed during performance of work, and that work areas are cleaned and restored after completion of work.
- Conducts a post-job review and documents feedback / lessons learned on (WV-2573).

25. Work Package Status Log and Post-Job Feedback / Lessons Learned (WV-2573) – a log that **SHALL** be added to a WIP that provides the WGS or designee a place to record information pertinent to the performance of the WIP. This includes information such as the status of field work, changes in conditions, issues and events which have influenced or may influence work performance or schedule, notifications made or concurrences obtained on operational decisions, or any other information relevant to the job task, personnel, equipment, or planning. A section of this log is for documentation of post-job feedback / lessons learned.

26. Work Review Group – for the purpose of this instruction, the Work Review Group (WRG) is part of the iterative Planning Team process that participates in the work site job/task walkdowns, activity hazard analysis (AHA) and hazard control/mitigation selection, WCD development, and review and approval. This process is also applicable to procedures developed in accordance with DCIP-100, "Controlled Document Preparation".

27. Work Review Group Coordinator – for the purpose of this instruction, the WRGC is the Work Control Management responsible for:

- Screens requests for work ensuring work scope and associated boundaries are clearly defined;
- Ensures Planning Team is comprised of the appropriate personnel (e.g., planner/originator, workers, operations, safety and health Subject Matter Experts (SME), other SMEs/HCSs, etc.);
- Working with the Planning Team, determines the type of work document to be used for each work task based upon the criteria established for work types which takes into account the degree of hazards, and complexity of the work activity;
- Ensures the WIP was developed following the processes in this procedure;
- Ensures hazards and controls identified by the HIM process are incorporated into the WIP;
- Conducts periodic assessments of the work control process in accordance with Contractor Assurance System guidance.

ATTACHMENT B
WRITING GUIDELINES AND DOCUMENT STRUCTURE
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NOTE *This attachment is a guideline for proper writing style. There may be exceptions wherein the authors and work groups may use a different style or method.*

The following is a list of sections that are used when writing a Work Instruction Package. Included is a description of each section. ALL section headings are required. If there is no information or need for a section, the originator shall enter "NONE," or equivalent, under the section heading (the reason for requiring all section headings is to maintain numbering consistency for all sections, e.g., Section 5.0 PERFORMANCE will always be Section 5.0).

Microsoft WORD shall be used for preparing all WIPs.

1.0 Scope

1.1 This section provides supplemental information the originator believes will help users understand the purpose of and reason for the task to be completed including:

1.1.1 A clear definition of the work scope, major tasks, and associated boundaries required.

1.1.2 Critical steps (see def.).

1.2 DO NOT include action statements, warnings, cautions, or other statements that are critical to the completion of the task.

2.0 Precautions and Limitations

NOTE *Any precaution or limitation that applies to an individual action step should be written as a warning or caution and placed just before the affected section or step.*

2.1 This section delineates precautions and limits that must be considered for multiple steps, sections, or throughout the procedure.

2.2 Precautions alert users to actions and conditions that represent actual and potential hazards to personnel or possible damage to equipment or establish abnormal conditions.

2.3 General hazards and controls may be listed in this section.

2.4 Limitations define the boundaries that must not be exceeded to ensure the work is performed safely.

2.5 In general, do no put actions steps in this section. If action is required in response to the precaution or limitation, provide action steps at the appropriate location in the procedure. There may be exceptions where a required response best fits with the precaution.

3.0 Material/Special Tools and Equipment

3.1 This section lists all material, special tools, measuring and test equipment, parts and supplies necessary to perform the procedure that must be staged prior to commencing the procedure. Do not specify ordinary craft tools such as standard pliers and wrenches or materials/tools and equipment normally found in the area.

ATTACHMENT B
WRITING GUIDELINES AND DOCUMENT STRUCTURE

NOTE *If using foam containing isocyanates (e.g., Handi-Foam), see Attachment B, step 5.1.24.*

3.2 If using a chemical, list the chemical name and product number and include an MSDS with the product number used.

4.0 Prerequisites

This section identifies actions that must be completed and the requirements and conditions that must be met before the user commences the Performance Section. The following information may also be included in 5.0 Performance Section:

4.1 Field Preparations – provide instructions for any field activities that must be completed before continuing with the procedure. This includes:

4.1.1 Initial Conditions – specify the physical parameters associated with an area, facility, system, component operation, or job, which are the conditions required prior to the initiation of work.

NOTE *See SOP 00-04, "Lock, Tag, and Confirm Procedure," for LOTO requirements.*

4.1.2 Lockout/Tagout of Equipment

A. Specify all equipment and components which require LOTO for the safe performance of the work. DO NOT specify any LOTO requirements in the performance section that can be performed prior to the commencement of the work.

B. Specify the type of LOTO required (e.g., Operations, Single Point, Multi-Point)

C. If the work instruction includes lockout/tagout instructions where an operations lock is not required per SOP 00-04, identify all LOTO points and include required independent verifications in the work instruction.

D. If the work instruction includes the use of a Multi-Point LOTO, include a step to obtain/verify the NOS Manager's approval to use a Multi-Point LOTO as required by SOP 00-04.

4.1.3 Performance of Valve Lineups – specify the valve(s) position and description with independent verification required.

4.2 Required Permits - include those not listed on WV-2571 or WV-1085.

4.3 Completion of Mockup - If a mockup or bench top is used, a prerequisite should be included requiring verification of the completion of the mockup or bench top and satisfactory incorporation of all changes resulting from the mockup or bench top.

4.4 Training Requirements– include required Health and Safety Training and any other additional training required.

4.5 Approvals and Notifications – provide instructions to ensure that all necessary notifications are made and approvals are obtained before initiating the procedure.

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WRITING GUIDELINES AND DOCUMENT STRUCTURE
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5.0 Performance

5.1 General Guidelines

5.1.1 Organize activities in the logical order they will be performed.

5.1.2 Specify sections and steps that are Reference Use. This may be written as a note stating something similar to the following: "The steps in the following section may be performed out of sequence and/or in parallel with concurrence from the WGS."

5.1.3 DO NOT write steps that state "Perform activities to verbal instructions,' or "at the direction of....," etc. Originators, or other personnel authorized by the originator, may make decisions and provide field instructions for clarification of work steps that are within the scope of the work and hazard controls. Steps that allow decision making within specific parts of the procedure are permitted.

5.1.4 Do not write action steps containing multiple actions unless necessary to ensure proper performance of the work.

5.1.5 Avoid action steps that require workers to convert numbers from one unit of measure to another. If conversions are required, provide an aid. Specify numbers at the same precision and the same units of measure as those marked on, or indicated by the instrument. Specify appropriate limits and tolerances for parameters. Be consistent with the readable accuracy of the instrument.

5.1.6 If someone other than the primary user of the procedure is responsible for performing an action step, identify the department or group to perform the task.

5.1.7 Steps within WIPs may direct actions to be performed in other supporting documents (e.g., IWP's, RWP's, Confined space permits, Hot Work permits, SOPs).

5.1.8 At the originator's discretion, if only a few steps of an SOP are to be performed in the work instruction, or a deviation from an SOP is needed, the originator should add excerpted steps to the WIP and not mention the SOP. If specific section(s) of an SOP is specified to be performed as part of the work instruction, specify the SOP number, revision to be used, applicable section(s) number, and section(s) description. If the SOP is referenced in its entirety, the revision and FC number are not needed.

5.1.9 Use of Conditional action steps. Steps to direct the performer to NOT perform or bypass the applicable step. Conditional action steps are used when a decision is based upon the occurrence of a condition or a combination of conditions.

Conditional action steps use the following terms:

- IF or WHEN to present the condition
- THEN to present the action
- OR, AND, OTHERWISE, or OR ELSE to present more complex conditions

5.1.10 If a task or step cannot be performed and provisions have not been made to allow the step to NOT be performed or bypassed, then a revision to the WIP is required.

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WRITING GUIDELINES AND DOCUMENT STRUCTURE
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5.1.11 All references to equipment or components must match label plate identifiers. Where a drawing and label plate is not consistent, an ECN or an Issue Documentation Form (IR) is to be initiated and issued. Temporary tags may be used as an interim measure in accordance with SOP 00-30, *System and Component Labeling*.

5.1.12 Write work instructions to the level of detail consistent with the qualifications and training of the expected users as well as commensurate to the level of detail necessary to perform the work.

5.1.13 The chosen method of implementing the hazard control from the hazard analysis into the work documents is appropriate. The stated hazard control in the hazard analysis may have several ways to implement the control, but the intent of the control is maintained.

5.1.14 Control selection is based upon the following hierarchy: (1) hazard elimination or reduction; (2) engineered controls; (3) administrative controls; (4) personal protective equipment.

5.1.15 The level of control established for a hazard is maintained throughout the activity or until the hazard has been eliminated or reduced (controls can be graded to level of hazard reduction).

5.1.16 Provisions are also included to assure evaluation of the possibility of creating additional hazards due to selected controls (e.g., excessive PPE causing heat exhaustion) and also evaluate the possibility of negative synergistic effects of selected controls.

5.1.17 If the WIP performs sampling for data collection, the sampling shall comply with the applicable planning procedure (e.g., Sampling and Analysis Plan [SAP] or Data Quality Objectives [DQOs].

5.1.18 If the WIP installs/removes a Temporary Modification (TM), include instructions to complete WV-3811, "Temporary Modification Control," in the WIP. See SOP 00-49, *Control of Temporary Modifications*, for instructions concerning TMs.

5.1.19 If the WIP involves underground or utilities work, or penetrating the surface of a floor, wall or ceiling; at a minimum perform the following:

A. Complete a Ground Disturbance Permit (GDP).

B. Conduct a thorough review of drawings (including as-built) to determine the presence of electrical conduit, mechanical piping (e.g., air, water, steam, chemical), and structural steel in the ground, floor, wall, or ceiling.

C. Conduct interviews with Cognizant System Engineer and/or facility personnel that are familiar with the area where the work will be performed.

D. Conduct non-destructive techniques, when practical, to verify the presence or absence or electrical conduit or mechanical piping.

E. Consider the potential for cooling water from cutting/drilling/core boring to create radiological or electrical issues (conduit or piping may become a flow path to energized circuits or adjacent areas).

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WRITING GUIDELINES AND DOCUMENT STRUCTURE
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5.1.20 If the WIP involves physical isolation of piping or electrical conduit by cutting or mechanical means:

A. Include step(s) in the WIP requiring independent verification of isolation points prior to cutting. Independent verification shall be performed as defined in Attachment A.

NOTE *Once physical isolation is complete and piping/conduit being removed is properly labeled per SOP 00-30, remaining cut points are no longer required to be marked in the field.*

B. Indicate that isolation points shall be clearly marked in the field.

C. Reference SOP 00-30, Section 5.6, for labeling instructions and requirements applicable to D&D work.

D. Attach a photo, drawing, or sketch that indicates all isolation points.

5.1.21 Identify steps in the procedure which implement specific source requirements (refer to Attachment D of DCIP-100) per one of the following:

A. Reference the source document in the left margin adjacent to the step:

Example:

PSR-3 [3] Make sure Blower 15K-20 is operating.

B. Place the text and source requirement in a box format prior to the step that it applies:

Example:

Radiological control records SHALL be maintained as necessary to document compliance with the requirements of 10 CFR 835. 10 CFR 835.704(c)

C. List the source requirement after the text in bold or as a reference statement.

Example:

Radiological control records SHALL be maintained as necessary to document compliance with the requirements of 10 CFR 835.
10 CFR 835.704(c).

OR

Radiological control records SHALL be maintained as necessary to document compliance with the requirements of 10 CFR 835. (Refer to 10 CFR 835.704(c).)

ATTACHMENT B
WRITING GUIDELINES AND DOCUMENT STRUCTURE
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5.1.22 If the WIP has embedded within it a mechanism allowing additional work without requiring a field change, the following must be met:

A. The change or addition does NOT alter the original scope of the work and is still within the risks, hazards and location(s) that were originally analyzed and documented on WV-3909 and USQP.

B. The change mechanism is authorized by the WRGC.

C. Examples of acceptable use of this approach are:

1. Taking additional samples at different locations within the same project area.
2. Adding tasks to a work instruction package for Maintenance to perform shop work.
3. Packaging and handling multiple waste components within the same project area when component-specific instructions are required.
4. Introducing the use of different remotely operated tools within the same project area to perform the same task (e.g., mechanical size reduction, using different types of saws or shears).
5. Providing additional guidance in performance of existing task activities where limiting conditions or acceptance criteria are NOT changed, or does NOT affect a critical step, hold or verification point step.
6. Using work travelers for repetitious tasks such as logging the contents of waste containers.

D. Signatures are obtained from departments that are directly affected by the added work instructions.

1. If the addition will involve any changes to facilities as described in the documented safety analysis, involve tests or experiments, or differ from assumptions or limitations in the USQD for the WIP, a USQD Evaluator must review and determine if USQP Form WV-3306 is required.
2. Include QA for the following:
    a. The work is Quality Level 'C' or 'B' as defined by WVDP-204 (Q-List) or WVDP-111, section 1.4.2 (QA Program).
    b. The work will involve QA acceptance testing or verification
    c. The work involves a Critical Lift activity.
    d. The work will involve RCRA or Regulatory Closure Plans.
    e. The work involves the use of any Measuring and Test Equipment (calibration).
    f. The work involves Load Testing of H&R equipment.
    g. The work will involve Welding, or Nondestructive Examination.
    h. The work will involve pressure testing to ensure process line/system integrity (e.g. Hydro, or Pneumatic) or any In-Service Leak testing.
    i. The work will involve the utilization of LOKRING's.
    j. The work will utilize concrete expansion anchors or adhesive anchors (excluding core boring machine anchors).

5.1.23 If the WIP involves application of fixatives for radiological purposes, specify the approved fixatives and method of application. Radiological Controls (RC) must approve and/or specify the type of fixatives used and the methods of application.

ATTACHMENT B
WRITING GUIDELINES AND DOCUMENT STRUCTURE

5.1.24 If the WIP involves the use of foam containing isocyanates (e.g., Handi-Foam), include instructions to track the amount used and the location used.

5.1.25 If the WIP includes the use of a LOTO in the Performance Section,

A. Specify the type of LOTO required (e.g., Operations, Single Point, Multi-Point)

B. If a non-operations LOTO is specified, identify all LOTO points and include required independent verifications in the work instruction.

C. If the use of a Multi-Point LOTO is specified, include a step to obtain/verify the NOS Manager's approval to use a Multi-Point LOTO as required by SOP 00-04.

5.2 Critical Steps, Verifications, Notifications, Data Recording, and Hold Points

5.2.1 **Critical Steps** are steps with significant importance to safety, safety basis, or are regulatory in nature and require the continuous presence of supervision during completion.

5.2.2 **Verifications** confirm that an action, including filling out paperwork, was performed accurately.

5.2.3 **Hold Points** are where an action or condition is required to be satisfied and signed off before proceeding with the activity.

5.2.4 **Notifications** inform another person or department of the starting or stopping of an activity.

5.2.5 For steps requiring signoff or data recording:

A. Place a "[+]" in the left margin.

B. Indicate who is to sign and where the individual is to sign.

C. Indicate where data recording is to be made if it is not immediately at the action step to be performed.

D. Specify the expected method of verification to be used (e.g., personal observation, direct report of a worker, review of official records).

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WRITING GUIDELINES AND DOCUMENT STRUCTURE
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5.3 Warnings, Cautions, and Notes

Warnings, Cautions, and Notes are information that is NOT action steps. They are essential to the safe and effective completion of work step(s) which follow. Use **Warnings** to alert workers of actual or potential hazards that may harm personnel.

Example

WARNING

ELECTRICAL HAZARD: Unmarked electrical systems or systems that penetrate walls, ceilings, and floors shall be identified / verified or considered as energized. No electrical activities shall be performed without positive confirmation / zero energy verification to protect personnel from arc, shock, blast, electrocution hazards.

5.3.1 Use **Cautions** to alert workers of actual or potential hazards that may damage equipment or facilities, or harm the environment.

Example

CAUTION

To prevent a potential release to the environment or spread of contamination: Anticipate the probability of abandoned tanks, vessels and piping containing residual liquids.

5.3.2 Use **Notes** to assist in making decisions or to improve performance of action steps.

Example

NOTE *The following steps 5.0.1 through 5.0.7 may be performed out of sequence and throughout the work instruction to support work activities.*

5.3.3 Place Warnings, Cautions, and Notes immediately before and on the same page as the step to which they apply.

5.3.4 Warnings and Cautions shall include the hazard(s), consequence of the hazard(s), and any critical time constraints, when applicable.

5.3.5 Do NOT include actions in Warnings, Cautions, or Notes.

ATTACHMENT B
WRITING GUIDELINES AND DOCUMENT STRUCTURE
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6.0 Post Maintenance Testing

When operability of equipment has been affected while performing a procedure and operability has to be verified before returning the equipment to service, include action steps that specify these tests.

6.1 Unless otherwise specified in the work instruction, the Post Maintenance Testing Section is considered "Critical Use."

6.2 Include testing acceptance criteria and tolerances.

6.3 Specify testing requirements, including documenting data sheet and verification that the results meet acceptance criteria.

7.0 Post Completion Configuration

Ensure steps are written in the Performance and/or Post Maintenance Testing Sections to perform the necessary actions to achieve the conditions stated in this section. Performance steps (except WGS verification) are not to be placed in this section.

7.1 List intended final conditions of the area, equipment, systems, etc. that were affected by the performance of the WIP and have been verified by the WGS.

7.2 Include a step for signoff by the WGS to document verification of the following (examples):

7.2.1 All personnel locks/tags are removed.

7.2.2 The work area has been cleaned up (e.g., disposal of waste generated, all temporary utilities used for the job such as extension cords and hoses have been removed).

7.2.3 System(s) and/or equipment are/is ready for turnover to the applicable operations group.

8.0 References

8.1 List the documents used to create the work instructions and those used for the performance of work associated with the work instruction.

8.2 List applicable drawings, P&IDs, and electrical one-line drawings.

8.3 Include a list of required design, process, and instrument drawings with the work instruction, if applicable. Include the revision number, sheet number(s), and Engineering Change Notice (ECN) numbers, if pending.

8.4 List SOPs where WIP users must perform actions contained within the referenced SOP (e.g., "Perform hoisting and rigging activities in accordance with SOP 00-38.")

9.0 Source Requirements

9.1 List source requirements documents and the specific sections of those documents which are implemented by the procedure.

ATTACHMENT B
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10.0 Attachments

10.1 When the work instruction includes opening, modifying, or removing part of a system containing radioactive or hazardous materials or energy sources such that personnel or the environment are potentially exposed to the hazard, the system boundaries shall be identified on a marked up P&ID or isometric drawing, sketch, diagram, or a photograph accompanying the work instruction indicating the isolations/engineering barriers surrounding the work area. The system status (e.g., active, abandoned, pressurized, vacuum) is to be verified and considered in the hazard analysis and controls.

10.2 Include information in an attachment/appendix when it is more convenient to locate the information outside the main body of the procedure.

10.3 Attachments should be numbered independently.

10.4 Reference all attachments in the WIP.

ATTACHMENT C
REVIEWER/PLANNING TEAM SELECTION CHECKLIST
(Page 1 of 1)

Situation	**Required Reviewers**
All work packages	Work Group Supervisor Facility Manager Work Review Group Coordinator
Hazard present in area of expertise (i.e., hazard identified as "Yes" on WV-3909)	HCS specified on WV-3909
Work steps performed by personnel other than the work group.	Department performing work step
Work activities performed by subcontractors under the direction of a Subcontractor Technical Representative (STR)	STR
Any work activity performed by Maintenance **NOTE:** *NA if the Work Group Supervisor is the Maintenance Supervisor.*	Maintenance
Work activities performed on equipment, or in an area, under PSO's cognizance.	PSO
Work activities performed on equipment, or in an area, under an Operations Supervisor's cognizance other than PSO.	Applicable Operations Supervisor
Work activities affect a system or involve work on a system.	Applicable System Engineers
Work activities under the cognizance of an engineer other than the System Engineer or the Originator.	Cognizant Engineer
Work activities involve QA review, inspection, verification, or oversight activities: ➢ The work is Quality Level 'C' or 'B' as defined by WVDP-204 (Q-List) or WVDP-111, section 1.4.2 (QA Program) ➢ The work will involve QA acceptance testing or verification ➢ The work involves a Critical Lift activity ➢ The work will involve RCRA or Regulatory Closure Plans ➢ The work involves the use of any Calibrated Measuring and Test Equipment ➢ The work involves Load Testing of H&R equipment ➢ The work will involve Welding, or Nondestructive Examination ➢ Will the work involve any pressure testing to ensure process line/system integrity (e.g. Hydro, or Pneumatic) or any In-Service Leak testing ➢ The work will involve the utilization of LOKRING's ➢ The work will utilize concrete expansion anchors or adhesive anchors (excluding core boring machine anchors)	QA
Work identified as High Level Waste (See WVDP-200).	HLW Process and WQR Compliance Engineer
Any other department affected by the work activities.	Applicable departments

ATTACHMENT D
TELECON/EMAIL APPROVALS
(Page 1 of 1)

The following may be used to obtain and document telecon or email approvals when the person required to sign (signatory) is not physically present.

To obtain the signatory's approval, the originator or his designee should perform the following:

A. Contact the signatory via telephone, email, or other means of communication.

B. Provide the signatory with a description of the purpose and scope of the work instruction and read verbatim the part of the work instruction explaining what the signatory is being asked to approve.

C. Provide the signatory with any additional information needed to fully explain what is to be approved.

D. Answer any questions the signatory may have.

NOTE *The signatory shall NOT grant approval until satisfied and fully understands what is to be approved.*

E. Once the signatory has approved, the originator or designee documents approvals as follows:

1. Telecon approval - as shown in the following example:

Jim Jones for Bob Brown per telecon 12/17/99

2. E-mail approval - as shown in the following example:

See attached e-mail approval 12/17/99

a. Print the e-mail message and attachments (if applicable) and retain with the record copy of the work control document (Ref.: WVDP-262).

WVDP RECORD OF REVISION CONTINUATION FORM

Rev. No.	Description of Changes	Revision On Page(s)	Dated
31	General Revision - Administrative changes and Revised Attachment A, "Definitions" with additional responsibilities for WGRC, RM, WGS, Planner and SMEs/HCSs Revised Attachment B, "Writing Guidelines and Document Structure" This change affects WIP originators, HCS, SME's, and Responsible Managers	ALL	12/01/11
32	General Revision - Administrative changes. Revised QA section 3.4.6 to include QA review required for Regulatory Strategy RCRA Plans, and Critical lifts only. This change affects WIP originators and QA.	ALL	08/16/12
33	Minor Revision – Administrative changes. 3.23 & 9.0 Updated title of SOP 00-46. Steps 3.4.3, 4.3.8 A and Attachment B revised USQD Originator and Safety Analyst to USQD Evaluator. Attachment A-Changed ESH&Q to Engineering Manager. Added WVDP-227 to the references. Engineering, Records, Work Control and Planners are impacted by this change.	 2, 9 3, 7 9, 22 11	10/31/12
34	General Revision - Administrative changes. Steps affected are 3.2, 3.4, 4.1 thru 4.4, 5.1, 6.5, 9.0 and Attachments A and B. Revision changes documentation of hazard analysis on AHA or JSA. Revised QA review applicability, Revised Field Change process to include hand-written WV-1085. Clarified Attachment guidance. This change affects WIP originators and QA.	ALL	12/ 17/12
35	Minor Revision – Administrative changes: Deleted form WV-3743 in reference section, form is cancelled. Clarified documentation for obtaining telecon/e-mail approvals in Attachment C. This change affects WIP originators	 9 26	01/08/13

WVDP RECORD OF REVISION CONTINUATION FORM

Rev. No.	Description of Changes	Revision On Page(s)	Dated
36	General Revision Added requirement for Originator to ensure that hazard mitigations not specifically addressed in the WIP are captured elsewhere in the work package (e.g., RWP, IWP, Pre-Job Brief). Added new attachment D for determining required reviewers. Text in the procedure related to determining reviewers was deleted as the requirements are captured in this attachment. Deleted reference to the TRT as TRT actions are outside the scope of this procedure. Deleted part of note allowing USQ signatures to be obtained per telecon. Deleted detail on planning team walkdown and referred to SOP 00-46 for performance Deleted Training from the Material/Special Tools and Equipment Section as training requirements are contained in the Prerequisite Section Added steps in the performance section of Attachment B on specific requirements pertaining to the use of LOTOs. Modified requirements for using a DDC for clarity and consistency with SOP 00-54. Deleted definitions in Attachment A that are no longer refered to in this procedure. Added requirement to track foam use when using foam containing isocyanates in Attachment B. Clarified definitions for Originator and Planner. Attachments reordered to follow the procedure flow. Additional editorial changes made throughout. This change affects WIP Originators/Planners.	All	09/05/13
37	Administrative Changes. Added a new step 4.3.4, requiring all current field changes be identified by a change line generated by utilizing the Microsoft Word "Track Changes" function. Revised step 4.3.5 to simplify the symbol used to identify field changes. Revised Attachment "A", Definitions, deleting requirement that Cognizant System Engineer (SE) be a trained work instruction originator, and incorporated language from WV-921, "Hazards Identification and Analysis" into the definition of Hazard Control Specialists. Paginated Attachment "D". These changes affects WIP Originators/Planners, System Engineers, and Hazard Control Specialists.	All	03/19/14

WVMP SAR Reference 8-1

Receipt Inspection, Quality Assurance Procedure QP 10-2, Revision 15, CH2M Hill-B&W West Valley, LLC, West Valley, New York, October 22, 2013

CHBWV West Valley Decommissioning Team

CH2MHILL • B&W West Valley, LLC

QUALITY PROCEDURES

TITLE: Receiving Inspection

GENERAL REVISION

1.0 PURPOSE

This procedure establishes the method to be followed for planning and performance of material receipt inspection by Quality Assurance personnel.

This procedure details the method to conduct inspection of items when receiving inspection is required for Quality Levels A, B, C, and selected N items.

2.0 REQUIREMENTS, REFERENCES, AND FORMS

Refer to E-DOCS for the latest version of WVDP Controlled Documents. Refer to the S:\WPFORMS directory and/or site standards word processing templates for the latest revision of WVDP forms used in this procedure.

2.1 Requirements

2.1.1 WVDP-111 "CH2M HILL • B&W West Valley, LLC Quality Assurance Program"

2.2 References

2.2.1 QP 4-1, "Procurement Document Review"

2.2.2 QP 10-1, "Inspection"

2.2.3 QP 15-2, "QA Hold Tag Procedure"

2.2.4 WVDP-204, "WVDP Quality List Q-List"

2.2.5 WVDP-310, "WVDP Safety Management System (SMS) Description"

2.2.6 WVDP-357, "WVDP Issues Reporting Program Manual"

2.2.7 WV-620, "Purchase Requisitions and Supplements"

2.2.8 WV-695, "Procurement Card Purchases"

2.2.9 PROP- 11, "Warehouse Receiving, Storage, Inventory, and Withdrawal "

2.3 Forms

2.3.1 WV-3245 - Material Receiving Inspection and Release (MRIR)

2.3.2 WV-0172 - CHBWV Procurement Card Requisition Checklist, for QA signature and inspection criteria.

3.0 GENERAL INFORMATION

3.1 Quality Assurance Receiving Inspector - performs inspections and tests per the acceptance criteria provided on the Material Receiving Inspection and Release (MRIR) and approved procurement document.

3.2 Quality Assurance Representative (QAR)

3.2.1 Reviews procurement documents such as: Purchase Requisitions (PR), Procurement Technical Specifications or attachments to Purchase Requisitions, Purchase Requisition Change Orders, and Credit Card Orders (CCO) per QP 4-1.

3.2.2 Plans inspections, concurs with inspection acceptance criteria and ensures a MRIR is prepared with the requisitioner based on information contained in the purchase requisition, or credit card order.

3.2.3 The inspection criteria should include consideration for verifying completeness, markings, calibrations, adjustments, protection from damage or other characteristics as required to verify the quality and conformance of the item(s) to specified requirements. Quality records are required to be examined for adequacy and completeness.

3.2.4 Items may be added to procurement documents as desirable quality attributes, such as painted surfaces being smooth and free of visible imperfections in waste boxes, even though these attributes do not affect the integrity or DOT rating of the box. Quality will inspect for such attributes if they are listed in the applicable procurement documentation.

3.2.5 Provisions shall be made for prohibiting delivery or acceptance of suspect/counterfeit items.

3.3 Receipt Inspection is required for items identified as Quality Level A, B or C per WVDP-111and WVDP-204, including credit card orders, unless other inspection provisions have been approved by QA.

3.4 Personnel shall always be cognizant of Integrated Safety Management System (ISMS) policies/objectives when planning and performing inspections.

4.0 PROCEDURE

4.1 Inspection Criteria

4.1.1 The QAR reviews the procurement document per QP 4-1 and concurs with the receipt inspection acceptance criteria established by the requisitioner per WV-620 and/or WV-695.

4.1.2 The QAR establishes a MRIR in the W:\MRIR drive if required. If the W:\MRIR file does not contain a procurement specific MRIR a standard receipt inspection MRIR can be used (W:\MRIR\STNDMRIR) as denoted on the copy of the procurement document. The QAR shall designate the applicable standard MRIR which is to be used.

4.1.3 The QAR shall ensure that the procurement document and MRIR acceptance criteria is adequate for the procurement and that a Material Receiving Inspection and Release (MRIR) is prepared for Receiving Inspection that includes the inspection acceptance criteria. As a minimum, basic acceptance criteria shall include:

Item(s) ordered is the item(s) received;
There is no shipping damage;
Item(s) is not suspect/counterfeit (ref: form WV-0141);
MSDS is received or is on file, and is item specific if a chemical containing material is ordered.

4.2 Inspection Performance

4.2.1 The QAR enters the procurement information into the QA reports database and creates an informational file.

4.2.2 Inspector is notified that items requiring receipt inspection have arrived. Inspector obtains approved procurement document and MRIR.

NOTE *Typically, items are delivered to the warehouse, tagged "Hold for QA Inspection" by warehouse personnel and placed in the QA hold cage. Some items that are too large for the cage or are delivered to another location (e.g., hard stand, Vit Test Facility) are staged for receipt inspection at their drop location.*

4.2.3 Inspect the item(s) per the MRIR and the approved procurement document as reference.

4.2.4 If item(s) is/are acceptable:

Obtain an MRIR number from QA reports.

Complete and issue MRIR. Original certificates must also be retained with the MRIR. For credit card receipts, attach a copy of the CHBWV Procurement Card Requisition (WV-0172) as part of the MRIR. The requisitioner receives copies of the MRIR, certifications and the original packing slip.
Apply Accept Tag or QA release stamp to the item(s), as appropriate.
Release the item from QA Receiving Inspection area.

NOTE *Some items are received as multiples within a single or several containers. For example, small bolts packaged within a single plastic bag. If determined to be acceptable by receipt inspection, the package may be released for use if stored within a controlled, secure area that tracks usage. The MRIR for such items will be specific in detail to describe the multiple items.*

4.2.5 If Item(s) is/are unacceptable, discuss the discrepancy with the requisitioner and proceed as follows:

A. Documentation Inadequacy

If documentation is insufficient (e.g. missing, incorrect documents, or insufficient data) and requisitioner agrees to obtain corrected documentation, keep item(s) in QA hold cage area or ensure the "Hold for QA Inspection" tag is on the item.

When acceptable documentation is received, follow 4 .2.4.

If acceptable documentation is not received in 30 days, implement WVDP-357.

B. Substitutions, minor changes and damage

If unacceptability was caused by substitution of material, wrong quantity, minor change etc. and the discrepancy is considered acceptable by requisitioner, complete the MRIR with documented written requisitioner approval on the MRIR, or attach email authorization.

If unacceptability is caused by substitution of material or shipping damage, which makes the material unacceptable, the material or item(s) may be returned. Issue a MRIR marking the Requirements Met column with an X in the NO column opposite the criteria not met and note that the item is to be returned to the vendor in the Comments section.

NOTE *Coordination of the decision to return must be with the concurrence of the requisitioner and the Purchasing agent.*

Inform warehouse personnel that the material must be returned to the vendor and request that they prepare the L Order to allow the material to be shipped off site. A QAR will verify that the material has been shipped off site by signing the L-Order for QA.

C. Quality Requirements Not Met
If quality requirements are not met and the item(s) or material requires disposition or further justification for acceptance, implement WVDP-357 and process per 5.2.6.

4.2.6 Processing Nonconforming Item(s)

Place Hold Tag(s) on the item(s) per QP 15-2.

Maintain the item(s) in QA Hold Area or segregate.

Note the Issue Report (IR) number on the MRIR, retain the MRIR and a copy of the IR with the PO file until disposition has been received.
Follow the requirement of the dispositioned Issue Action Documentation Form, document the disposition and IR closure date in the comment section of the MRIR:

1) If disposition is "Use-as-is," complete the Material Release section of the MRIR, remove the Hold Tag per QP 15-2, place Accept Tag, and release the item(s) from the QA Hold Area.
2) If disposition is "Rework" remove the Hold Tag per QP 15-2 when item(s) is/are acceptable and complete MRIR. Use of a Conditional Release tag may be required.
3) If disposition is "Repair" use acceptance criteria as defined in the Issue Action Documentation Form, if applicable. Upon completion of the repairs(s) and a successful re-inspection, remove the Hold Tag per QP 15-2 and complete MRIR. Use of a conditional release tag may be required.
4) If disposition is "Scrap," ensure that the material is scrapped by destroying the item or by placing the item in an on-site scrap receptacle for the proper type of material.
5) If the disposition is "Return to Vendor" secure a copy of the completed L Order. This will show the item shipped off site.

NOTE *Conditional Release Tags may be attached to material to allow further testing, repair, rework, or mock-up work. See Attachment B.*

5.0 <u>RECORDS</u>

5.1 The following forms, data sheets, logs, reports, or any other form of documentation are considered records and when created are to be prepared, maintained, and transferred to Records in accordance with WVDP-262 and WVDP-529. Refer to the CHBWV Master File Plan for further information

NOTE *Original MRIR reports for Purchase Orders and QA documentation (eg. certifications, test reports) are sent to purchasing. For Credit Card orders, the original MRIR reports and QA documentation (e.g. certifications, test reports) are sent to the Purchase Card Holder.*

5.1.1 WV-3245, Material Receiving Inspection and Release (MRIR)

5.1.2 WV-0172, WVES Procurement Card Requisition and Certifications received with Credit Card Orders.

6.0 ATTACHMENTS

Attachment A Accept Tag & "Q.A. RELEASE" Stamp
Attachment B Conditional Release Tag

ATTACHMENT A
ACCEPT TAG

ACCEPT TAG
(Green)

ACCEPT TAG	
P.O.__________	MRIR _______
Insp. By_______	Date_______
Piece__________	Of__________

Accept Tag will contain the following information:

1. Purchase Order number
2. Material Inspection and Release (MRIR) number
3. Initials of the Inspector who determined that the item(s) were acceptable
4. Date material was accepted.
5. If multiple pieces or parts are received at one time, multiple tags will be issued for the same MRIR number. This avoids loss of control. Tags might read "Piece 1 of 6," "Piece 2 of 6"; this increased piece count is continued until all pieces/parts have been tagged or a "QA Released" stamp may be utilized when quantities are high. The "QA Released" stamp may be used on boxes within which the procured items are not suitable for stamping or tagging. For example, PPE filters contained within boxes may have just the boxes stamped since it is impractical and unsafe to tag or stamp each individual filter.

Example of Q.A. Release Stamp

QA RELEASED

ATTACHMENT B
CONDITIONAL RELEASE TAG

CONDITIONAL RELEASE TAG

(Yellow)

CONDITIONAL RELEASE
Limiting Condition ________________
____
____
____
PO/WIP/etc.__________ IR_________
Inspector:
Print Name__________________________
Sign__________________ DATE ________
DO NOT REMOVE THIS TAG

This tag may be used to allow further testing, repair, rework, fit-up or mock-up prior to full release. The item shall not be allowed to be used for its intended use until the condition is met. After the testing, repair, rework or mock-up is complete, the item may be released or a red Hold Tag may be required to continue control of the item.

WVDP RECORD OF REVISION

Rev. No.	Description of Changes	Revision On Page(s)	Dated
6	Added 7.2.5.1 to clarify how items that are unacceptable are handled.	3	04/14/03
	Procedure also updated to the requirements of DCIP-100 (e.g., modified section 8, "Records Maintenance," added titles and pagination to attachments, changed font throughout)	All	
	This change affects QA.		
7	This change is made to add a reference to location of receipt inspection MRIR, add a note concerning items delivered to the warehouse, change QA receiving area references to QA hold cage, update step to place a red hold tag on the item received, delete step 6.2.5.1, and update procedure per DCIP-100. This change affects QA.	1-3	04/13/04
8	Adds explanation for Drawing/Specification block on MRIR and change numbers accordingly on example form	10-11	01/24/05
	Changed days to implement WVDP-357 from 90 to 30 days.	3	
	This change affects QA		
9	Added a note for clarification		
	Revised wording; added P-Card statement	3	12/27/05
	Added to item 5 to address other items	6	
	Updated "Conditional Release Tag" as shown.	7	
	This change affects QA		
10	General Revision	All	10/10/06
	Clarified and added information to general instructions. Deleted form WV-3245 from procedure. This change affects QA		
11	General Revision	1, 5	04/15/09
	Update to WVES template Update sections to reflect current department activities This change affects QA		
12	Periodic Review - Revision		12/03/09
	Clarified inspection criteria.	2	
	Update Records responsibilities.	5	
	Minor editorial changes throughout. These changes affect QA.		

WVDP RECORD OF REVISION CONTINUATION FORM

Rev. No.	Description of Changes	Revision On Page(s)	Dated
13	Combined Responsibilities with General Information. Added Section 4.2.3 Delineated Section 5.1 Inspection Criteria Section 5.2.5 separated paragraphs into sections A. B. C. Replace PO and PR with procurement document and/or approved procurement document. Minor editorial comments. These changes affect QA.	2 2 2 3 All All	09/16/10
14	General Revision- minor document revision to address CHBWV Transition Team Blue Sheet & Terminology Replacement Matrix Comments. Updated company logo & name, department names, etc., throughout. Other editorial format changes made as needed. These changes are administrative in nature and have no direct affect on any department.	All	04/23/12
15	General Revision- New bullet added in General Information moved 3.2.4 to 3.2.5 and added new bullet 3.2.4 to address mechanism by which quality attributes are added to receipt inspections that are not requirements but are desired by the requisitioner. These changes are administrative in nature and have no direct affect on any department.	All	10/22/13

WVMP SAR Reference 8-3

Material Receiving Inspection and Release (MRIR) report #04-1152, West Valley Nuclear Services Company, West Valley, New York, October 15, 2004.

Material Receiving Inspection and Release

MRIR #	04-1152
Page 1 of 1	

Purchase Order/Credit Card 19-104320	Material Description: West Valley Melter Container
Supplier WMG, inc.	
Drawing Spec No : 4005-DW-001, shts 1-8. Rev No : rev 4.	
Requisitioner: T.J. Jones	QAR: Robert Czyzewski

Inspection Requirements	Requirements Met Yes	No
1. Material does not show any shipping damage.	X	
2. Material received is as specified on purchase order. Including gaskets (Items 8 and 9 on Bill of Materials)	X	
3. No suspect/counterfeit parts are used. (A193-B7 w/washers specified as Item #6 on Bill of Materials)	X	
4. Documentation Package Received.	X	
5. Certificate of Conformance Received and acceptable.	X	
6. Package marked with the following: - USA - TYPE-IP2	X	

IP No. N/A	Inspected By/Date: Paula Ciszak 10/15/04 [signature]

Comments N/A

Distribution: **Requisitioner** **QA Purchase Order File** **Warehouse (Purchasing, General Accounting)** **QA DCC (Original)**

ORIGINAL

WVMP SAR Reference 8-5

Nondestructive Test Reports MT-110-04, VT-35-04, X-R-I Testing Division of X-Ray Industries, Inc., Troy, Michigan, October 13, 2004.

XRI TESTING Division of X-Ray Industries, Inc.

The American Tank & Fabricting Co.
12314 Elmwood Avenue
Cleveland, OH 44111

Report Number: MT-110-04

Date: 10/13/2004

Shop Order # 40945-0000

P. O.# 19-104320-C-LH

Magnetic Particle Inspection

Inspec. Operation # NA

PART #: 4005-DW-001-Rev.3 | QUANTITY 1 Assembly

INSPECTION PERFORMED IN ACCORDANCE WITH:

STANDARD AWSD1.1 2004

PROCEDURE AWSD1.1 2004

PROD METHOD

TWO DIRECTIONS N/A
CONTINUOUS N/A
HWDC N/A DC N/A
COLOR CONTRAST POWDER N/A
SPACING N/A
AMPERAGE N/A

YOKE METHOD

TWO- DIRECTIONS YES
CONTINUOUS YES
AC YES
COLOR CONTRAST POWDER See Note
SPACING < 6"
NOTE:
ETHER 8A RED OR #1 GRAY POWDER USED AT THE DISCRETION OF THE INSPECTOR

QUANTITY	DESCRIPTION		RESULTS	
1 Assembly	MT Backgrooves	JT 1	Accept	9/1/2004
		JT 2	Accept	9/1/2004
		JT 3	Accept	9/2/2004
		JT 5	Accept	9/7/2004
	Item	7A	Accept	9/1/2004
		7B	Accept	9/2/2004
		7C	Accept	9/3/2004
		7D	Accept	9/9/2004
		7E	Accept	9/8/2004
		7F	Accept	9/1/2004
		7G	Accept	9/3/2004
		7H	Accept	9/3/2004
		JT 26	Accept	9/1/2004
		JT 27	Accept	9/2/2004
		JT 28	Accept	9/2/2004
		JT 29	Accept	9/1/2004
	Backgroove of 4 lifting lugs	JT 34	Accept	9/24/2004

Inspected by: John J Kubit

T.A. Ward

Ryan Pratt

Certification: SNT-TC-1A

Level: II

XRI TESTING Division of X-Ray Industries, Inc.

The American Tank & Fabricting Co.
12314 Elmwood Avenue
Cleveland, OH 44111

Report Number: VT-35-04

Date: 10/13/2004

Shop Order # 40945-0000 P. O.# 19-104320-C-LH

Visual Inspection
Magnetic Particle Inspection Inspec. Operation # NA

PART #: 4005-DW-001-Rev. 3 | QUANTITY 1 Assembly

INSPECTION PERFORMED IN ACCORDANCE WITH:

STANDARD AWSD1.1 2004
PROCEDURE AWSD1.1 2004

PROD METHOD		YOKE METHOD	
TWO DIRECTIONS	N/A	TWO- DIRECTIONS	YES
CONTINUOUS	N/A	CONTINUOUS	YES
HWDC N/A DC	N/A	AC	YES
COLOR CONTRAST POWDER	N/A	COLOR CONTRAST POWDER	See Note
SPACING	N/A	SPACING	< 6"
AMPERAGE	N/A	NOTE: ETHER 8A RED OR #1 GRAY POWDER USED AT THE DISCRETION OF THE INSPECTOR	

QUANTITY	DESCRIPTION		RESULTS		
1 Assembly	VT, MT Final Welds	JT 1	Accept	9/7/2004	9/19/2004
		JT 2	Accept	9/2/2004	
		JT 3	Accept	9/7/2004	9/17/2004
		JT 4	Accept	9/11/2004	9/17/2004
		JT'S 5,6,7	Accept	9/15/2004	9/22/2004
		JT 8	Accept	9/11/2004	9/17/2004
		JT 9	Accept	9/15/2004	9/21/2004
		JT 10	Accept	9/14/2004	9/22/2004
		JT 11	Accept	9/24/2004	
		JT'S 12,13,14,15	Accept	9/11/2004	
		JT'S 16,17	Accept	9/7/2004	9/24/2004
		JT 18	Accept	9/7/2004	9/17/2004
		JT 19	Accept	9/7/2004	9/21/2004
		JT'S 20,21	Accept	9/11/2004	9/17/2004
		JT'S 22,23	Accept	9/15/2004	9/19/2004
		JT'S 24,25	Accept	9/21/2004	9/22/2004
		JT,S 26,27,28,29	Accept	9/23/2004	
		JT'S 30,31	Accept	9/24/2004	
	ITEM'S	7A,7B,7F,7H	Accept	9/24/2004	
	ITEM'S	7D,7C	Accept	9/22/2004	
	ITEM'S	7E,7G	Accept	9/23/2004	
	4Lift Lugs	JT'S 32,36,34	Accept	9/27/2004	9/28/2004
	4Lift Lugs	JT'S 32,36,34 AFTER LOAD	Accept	10/5/2004	
	4Lift Lugs	JT'S 33,35	Accept	10/7/2004	

Inspected by: John J Kubit
T.A. Ward

Certification: SNT-TC-1A
Level: II

WVMP SAR Reference 8-7

WVDP Site Welding Manual, WVDP-352, Revision 5, CH2M Hill-B&W West Valley, LLC, West Valley, New York, July 11, 2012.

West Valley Demonstration Project

Doc. ID Number WVDP-352

Revision Number 5

Revision Date 07/11/12

WVDP SITE WELDING MANUAL

Cognizant Author: P. J. Mussel

Cognizant Manager: A. Upshaw

CHBWV
West Valley Decommissioning Team

CH2MHILL • B&W West Valley, LLC
10282 Rock Springs Road
West Valley, New York USA 14171-9799

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WVDP SITE WELDING MANUAL

SECTION 1 - WELDING MANUAL GENERAL REQUIREMENTS

1.0 PURPOSE

1.1 This manual presents CHM2HILL B&W West Valley, LLC Company (CHBWV) policy and requirements for welding and brazing at West Valley Demonstration Project (WVDP). Policies set forth in this manual apply to all welding performed on site.

The manual provides direction for welding activities performed by CHBWV personnel, the administrative direction for development and issuance of new or revised welding procedures, CHBWV welder performance certification, weld filler control, and responsibility for control of this manual.

When welding is to be accomplished on site or off site by a subcontractor/vendor, welding shall be in accordance with the provisions of Section 1.7, "Welding by Subcontractor/Supplier/Others."

1.2 Responsibilities

1.2.1 The Site Engineering Manager shall be responsible for implementation and revision as necessary of this manual; development and revision of Weld Procedure Specifications (WPS) and their Procedure Qualification Records (PQR); and support for welder performance qualification testing. The Site Engineering Manager may delegate this responsibility to a designated welding Subject Matter Expert (SME) in the Technical Specialist List.

1.2.2 The Quality Assurance Manager (QAM) is responsible for assuring compliance to this manual.

1.2.3 The Nuclear Operations and Storage Facility Manager or designee shall be responsible for personnel training, welder qualifications, filler metal control, assigning qualified personnel to specific tasks, and implementing written procedures.

1.2.4 CHBWV Welders, Welding Operators, and Brazers (Welders) are responsible for knowing the extent of their certifications and performing assigned tasks in accordance with this manual and written procedures.

1.2.5 Where responsibilities are assigned by position title, it shall be understood that the person holding that position may delegate the responsibilities to other(s) who are qualified to perform the task with that person's manager's concurrence.

1.2.6 Cognizant Engineers who generate CHBWV work instructions requiring welding per EP-5-002 shall complete form WV-1888.

1.2.7 Performance of Nondestructive Examination (NDE) as described in this manual shall be performed by current ASNT-TC-1A certified NDE Level II or III personnel.

1.3 Definitions

1.3.1 Welders/Welding Operators Performance Qualification Record (WPQ): A document with basic criteria established for welder/welding operator qualification used to determine the welders ability to produce welds meeting prescribed standards.

1.3.2 Welding Procedure Specification (WPS): A written qualified welding procedure prepared to provide direction for making production welds.

1.3.3 Procedure Qualification Record (PQR): A record of the welding data used to weld a test coupon to qualify the WPS. The PQR is a record of variables recorded during the welding of the test coupons and contains the test results of the tested specimens. Recorded variables normally fall within a small range of the actual variables that will be used in production welding.

NOTE *Other terms and definitions shall be in accordance with AWS A3.0 - Terms and Definitions.*

1.4 Welding Symbols

1.4.1 All drawings and sketches that require welding shall use welding symbols as shown in AWS A2.4 (latest revision). Symbols for Welding and Nondestructive Examination.

1.5 Filler Metal, Issuance and Control

1.5.1 Filler metal and electrodes shall be procured, controlled, stored, and issued in accordance with approved CHBWV procedures.

1.5.2 Low hydrogen covered electrodes shall be stored at a minimum temperature of 250°F. Recording charts will be used to verify temperatures. Temperature monitoring devices for weld rod ovens shall be calibrated in accordance with approved CHBWV procedures.

1.5.3 Traceability of filler material shall be to the point of issuance (CHBWV Warehouse) unless otherwise specified by the SME on form WV-1888 within the work document.

1.5.4 A Senior Specialist DDWO/Craft (Mechanic) or Maintenance Supervisor will authorize warehouse requisition/withdrawal for obtaining filler material containers. Only undamaged containers will be transferred.

1.5.5 Once filler material is requisitioned/withdrawn from Warehouse stock, all electrodes shall then be placed in locked storage locker(s) within its original container indicating the type, size, heat and/or lot number.

1.5.6 Upon opening each low hydrogen electrode container, the Senior Specialist DDWO/Craft (Mechanic) will store the entire contents in a locked weld rod holding oven. A tag containing type, size, and heat and/or lot number will be affixed to the container.

1.5.7 A Senior Specialist DDWO/Craft (Mechanic) or Maintenance Supervisor will issue weld filler material to qualified welders by entering the following information into the Weld Filler Issuance Log:

A. Employee badge number
B. Process as applicable: e.g. SMAW or GTAW
C. Filler material description: e.g. E7018, 1/8"; ER70S-2, 1/8"
D. Date of issuance
E. Time of issuance
F. Quantity issued in pounds
G. Applicable work document or task number

1.5.8 Low hydrogen covered electrodes shall either be issued in quantities that can be used within four (4) hours, or shall be contained in heated portable rod caddies. Portable rod caddies do not require calibration.

1.5.9 Welders are responsible for discarding used stubs, damaged electrodes as well as low hydrogen electrodes which have been exposed to air (removed from the holding oven) for a period greater than four (4) hours.

1.5.10 Upon completion of work, each welder shall place their unique ID on form WV-1888 of the work document (if applicable) and when required, enter the heat/lot number(s).

1.5.11 A Senior Specialist DDWO/Craft (Mechanic) or Maintenance Supervisor shall monitor and initial/date the rod oven chart recorder daily (for days worked). As part of this monitoring, the temperatures since the last verification shall also be reviewed for potential temperature deficiency.

1.5.12 The Senior Specialist DDWO/Craft (Mechanic) or Maintenance Supervisor shall immediately report any temperature discrepancy which is outside the prescribed limits to the supervisor, and QA..

1.6 Other Joining Processes

1.6.1 Welding processes other than fusion welding and torch brazing of metallic components are not controlled by this manual.

1.6.2 Processes such as resistance spot welding, soldering, non code-related torch brazing or bonding/fusion of non-metallic components are a DDWO/Craft specific skill which may be employed by CHBWV without qualified procedures or specific qualification tests.

1.6.3 Situations may arise where special training and/or qualification on processes or techniques are warranted. The responsible cognizant engineer may then coordinate with the SME to develop joining processes per manufacturer's installation instructions and/or applicable codes.

1.6.4 Stud welding procedures for special projects may be developed by the cognizant engineer and the SME and documented on the work document.

1.7 Welding by Subcontractor/Supplier/Others

1.7.1 When welding is to be accomplished on site by a subcontractor/supplier/other (e.g. fixed price purchase order), welding program(s) and welding activities shall be in accordance with the contract documents. The welding program shall be approved by CHBWV per contract requirements prior to commencement of welding activities.

1.7.2 Equipment solely owned by a supplier under current CHBWV rental/lease agreement (e.g. Liquid Nitrogen tank manifold), may be installed/serviced on site by the supplier or authorized representative. WPS, PQR and welder qualification are the responsibility of the supplier. Control of filler material shall be at the discretion of the SME and Cog Eng.

1.7.3 Equipment (e.g. excavator, dozer) solely owned by suppliers, or CHBWV protegee for D&D activities may be serviced on site by the owner or authorized representative. WPS, PQR and welder qualification are the responsibility of the equipment owner. Control of filler material shall be at the discretion of the SME and Cog. Eng. Any modification or repair and any related testing/inspection shall be the owners responsibility.

1.8 Records

1.8.1 The following forms, data sheets, logs, reports, or any other form of documentation are considered records and when generated are to be prepared, maintained, and transferred to Records in accordance with WVDP-262 and WVDP-529. Refer to the CHBWV Master File Plan for further information.

A. Weld Rod Oven Temperature Data
B. Welding Procedure Specification
C. Procedure Qualification Record
D. Welder Performance Qualification
E. Brazing Procedure Specification
F. Brazer Performance Qualification
G. CHBWV Weld Data Sheet

1.9 Forms / Templates

Template - "Welding Procedure Specification"
WV-2524, "Procedure Qualification Record"
WV-2525, "Welder Performance Qualification"
Template - "Brazing Procedure Specification"
WV-2527, "Procedure Qualification Record (Brazing)"
WV-2528, "Brazer Performance Qualification"
WV-2529, "CHBWV Weld Data Sheet"
WV-1888, "Procedures, Inspections and Controls Checklist"

1.10 References

AWS Codes "American Welding Society"
ASME Codes "American Society of Mechanical Engineers"
EP-5-002, "Administration of Work Instruction Packages"
WVDP-111, "Quality Assurance Program"
WVDP-204, "WVDP Quality List Q-List"
WVDP-262, "WVDP Records Management Plan"
WVDP-485, "Work Control"
WVDP-529, "WVDP Records Disposition Plan"
ANSI Z49.1, "Safety in Welding, Cutting and Allied Processes"
ASNT-TC-1A, "Recommended Practice for Nondestructive Testing Personnel Qualification and Certification"
CHBWV Technical Specialist List

SECTION 2 - QUALIFICATION OF CHBWV WELDERS, WELDING OPERATORS AND BRAZERS (WELDERS)

2.1 General

2.1.1 Performance qualification tests shall be conducted by SME using qualified procedures in accordance with ASME Section IX or applicable AWS code. Successful completion of performance qualification shall be documented on form WV-2525 or WV-2528 as applicable.

2.1.2 Quality Assurance shall be notified prior to performance qualification testing. The Quality Assurance representative reserves the right to witness all performance qualification tests.

2.2 General Performance Qualification Testing

2.2.1 A welder may take performance qualification tests with individual processes on separate test coupons or a combination of welding processes in a single test coupon at the direction of the appropriate SME.

2.2.2 Welders and Welding Operators shall typically demonstrate ability on full penetration groove welds, unless the procedure to be used during production is limited to fillet welds.

2.2.3 Base metals used for welder qualification may be substituted for the base metal specified in the WPS in accordance with the applicable code.

2.2.4 Production welds shall not be used to qualify welders.

2.3 Specific Performance Qualification Testing

2.3.1 The SME shall coordinate the performance test to ensure all essential variables for each process of the selected WPS/BPS are satisfied.

2.3.2 The SME shall document acceptable performance testing information by completing form WV-2525 or WV-2528.

2.3.3 Quality Assurance shall perform in-process surveillance(s) during Welder performance testing. If performed, the surveillance shall assure the following:

- Materials appropriate to the WPS/BPS are used.
- Filler metal used is as specified on the WPS/BPS.
- Test position is as specified by the SME, coupon orientation is marked.
- Fit up and internal alignment are as specified by the SME.
- Tack welds are tapered as required.
- Root pass is visually acceptable in accordance with paragraph 2.3.4 below.
- Random examination of intermediate pass cleaning and condition.

2.3.4 After making a qualification test weld and prior to preparing the test specimens, the test coupon shall be visually inspected and accepted by Quality Assurance in accordance with the applicable code.

2.3.5 Appropriate tests shall be used to determine the degree of soundness and ductility of weld joints as determined by the SME.

2.3.6 Final signature of welder's or welding operator's test form shall be the responsibility of the SME. The test may be terminated at any time if, in the opinion of the SME, the welder fails to exhibit the required skill needed to satisfactorily complete the test.

2.3.7 At the discretion of the SME, test specimens may be discarded after evaluation.

2.3.8 Upon successful qualification, the welder shall be issued an identification symbol that shall be recorded on the Form WV-2525/WV-2528. The welder shall record this symbol or name when required on the appropriate work documents.

2.3.9 In the event a welder fails to meet the test acceptance criteria, a retest may be allowed at the discretion of the SME in accordance with applicable code.

2.4 Maintenance of Qualification - Period of Effectiveness

2.4.1 Certification for Welders qualified in any one process shall remain in effect for 180 days from the date the Welder last successfully used that process.

A. Successful use of a process is accomplished by a fabrication or repair weld made by a certified welder and documented through a work document or task.

B. The Period of Effectiveness (welder qualification maintenance) for each welder is maintained through MM262Q-SMAW and MM265Q-GTAW.

2.4.2 When there is a specific reason to question the ability of a welder by a qualified weld inspector, the welder may be retested with concurrence of the SME. If the first retest fails, the qualifications shall be revoked.

2.5 The SME shall maintain a list of all certified CHBWV welders under his/her cognizance that indicates the WPSs each person is qualified to use.

SECTION 3 - CHBWV WELDING AND BRAZING PROCEDURE QUALIFICATION

3.1 Requirements for WPS/BPS Development

3.1.1 Welding and Brazing Procedure Specifications and, if required, their associated Procedure Qualification Record(s) (PQR) shall be developed in accordance with ASME Section IX or applicable AWS code.

3.1.2 When a new or revised WPS/BPS is required, the SME or designee will develop it.

3.1.3 The SME may elect to adopt a WPS/BPS qualified by other corporate divisions in lieu of performing additional PQR testing. The SME may also utilize a procedure qualification from another division, in accordance with the ASME or AWS Code. The WPS/BPS shall be identified in accordance with requirements of this manual.

3.1.4 If qualification is required, the SME shall prepare an informational preliminary procedure specification for use during procedure qualification. The preliminary procedure specification shall contain the necessary information (essential and non-essential variables) required for the particular process to be used. This information may include but is not limited to:

3.1.5

- Coupon size (thickness/diameter)
- Filler metals/electrodes to be used
- Welding process(es) and techniques to be used
- Base metal specification(s)
- Shielding/Backing gas and flow rates
- Electrical characteristics (Amps, Volts, Polarity, etc.)
- Joint configuration
- Method of cleaning and back gouging
- Pre- or Post-weld heat treating

3.1.6 The SME shall coordinate test coupon preparation and notify Quality Assurance prior to the test initiation.

3.1.7 The actual values of all essential variables and supplementary essential variables (when required) shall be recorded during welding of the test coupon.

3.1.8 The preliminary WPS may be altered by the SME as needed to produce a satisfactory weldment. Changes shall be appropriately documented.

3.1.9 The SME shall direct the preparation and testing of the test specimens from the test coupon. If required, services for mechanical tests or non-destructive examinations shall be procured from qualified agencies in accordance with approved CHBWV procedures.

3.1.10 Test results shall be discussed with the welder, the applicable supervisor, and the QA representative by the SME.

3.1.11 Tests that meet the requirements of the applicable code will result in the preparation and issuance of a new or revised WPS/BPS and PQR by the SME.

A. The WPS/BPS and the PQR shall be recorded on the appropriate CHBWV forms.

3.2 Identification System

3.2.1 Each WPS/BPS and PQR shall be uniquely identified using the alpha numeric system described in this section.

3.2.2 The first character shall identify the process or combination of processes. Table 1 lists the applicable processes and their identifying characters.

TABLE 1

IDENTIFYING CHARACTER	PROCESS
S	SMAW (Shielded Metal Arc Welding)
T	GTAW (Gas Tungsten Arc Welding)
M	GMAW (Gas Metal Arc Welding)
F	FCAW (Flux Cored Arc Welding)
B	BRAZING

3.2.3 The second and third characters shall be separated by a hyphen, which identifies the base materials to be joined (e.g., ASME Section IX P number 8 for stainless steel). The fourth character, when present, shall be a two digit number assigned sequentially for a given process/base metal as needed.

3.2.4 The revision level of the WPS shall be numerically assigned at the time of preparation by the SME.

3.2.5 As an example of this system, T 43-8 01, Revision 1, would be interpreted as follows:

1st Char	2nd Char	3rd Char	4th Char	Rev.
T	43	8	01	Rev. 1
GTAW	P-43 (NICKEL)	P-8 (STAINLESS)	2ND P-43/P8 GTAW PROCEDURE ISSUED	first revision

3.2.6 An existing WPS/BPS may contain a 'W' prefix which coincide with the applicable PQR(s).

SECTION 4 - TECHNIQUE AND WORKMANSHIP

4.1 Technique

4.1.1 All CHBWV welding shall be performed in accordance with site safety requirements. Appropriate protective equipment shall be worn during welding and burning operations. Refer to ANSI Z49.1and Safety for selection criteria and options.

4.1.2 All welding requires an Industrial Work Permit (IWP) and a Hot Work Permit (HWP) prior to start of work. A task specific Job Safety Analysis (JSA) may also be utilized as necessary. Hazard analysis and screening will be performed by the Cognizant Engineer and/or Maintenance Supervisor prior to start of work.

4.1.3 All welding equipment shall be maintained in good operating condition.

4.1.4 The size and length of welds shall be designated through design requirements, detail drawings, or work instructions.

4.1.5 Welding shall not be done when the base metal temperature is lower than 50 degrees F, when surfaces are wet or exposed to rain, snow, or high wind velocities. Preheating shall be performed to bring the weld joint area above 50°F or the minimum preheat temperature specified on the WPS.

4.1.6 The following minimum preheat temperatures shall be utilized for preheating carbon steel materials. When joining materials of varying thicknesses, the preheat temperature shall correspond to the thicker material being joined. Preheats shall be maintained during welding.

Thickness:	Minimum Preheat Temperature
>1-1/2" thru 2-1/2" incl.	150 degrees F
> 2-1/2"	225 degrees F

4.1.7 Generally, post-weld heat treatments do not apply to WVDP work. If needed for specific application, a welding procedure that specifies the stress relief heat treatment to be used will be developed by the SME.

4.1.8 Interpass temperature for nonferrous materials shall not exceed 350 degrees F when measured 3" from either side of the weld.

4.1.9 Weld deposited overlay or buttering shall use an appropriate WPS for the selected process and base material.

4.1.10 Backing rings or consumable inserts may be used when required through work documents and approved by the SME and Cognizant System Engineer prior to work. Specific systems may restrict their use due to contamination control purposes.

4.1.11 For full penetration joints welded from both sides, the root shall be back gouged or ground to sound metal prior to welding the second side.

4.1.12 Intermediate weld passes shall be sufficiently cleaned prior to welding subsequent passes.

4.1.13 If required, the SME or cognizant engineer will prepare additional welding information in conjunction with the welding procedure and denoted on the work document. The direction of progression, sequencing, size considerations, heating, distortion control, etc. may be addressed to enable the welder to satisfactorily complete the required weld.

4.1.14 Welding may be performed by CHBWV certified welders at the direction of the Maintenance Supervisor in accordance with WVDP-485, "Work Control" provided it is Low Risk Routine Work and all the following criteria are met:

- Scope of work is non-process,
- Scope of work is non-code,
- Work is non-safety related,
- Work is non-environmentally impacting, and
- Work is Quality Level N per WVDP-111 and Q-List (WVDP-204)

4.2 Workmanship

4.2.1 Weld-o-lets, thread-o-lets, and soc-o-lets shall be prepared with a root opening of 3/32" minimum and tack welded to maintain alignment and gap. The root pass shall consist of a full penetration groove weld and finished with a cover fillet weld.

4.2.2 Fit-up and alignment of socket welds shall be accomplished as follows: fit the pipe entirely into fitting; lightly scribe a line on the pipe 1 inch above the fitting shoulder; withdraw the pipe 1/16" to 1/8" using the scribed line as a reference point; tack weld a minimum of three (3) places. The welder shall check for pullback prior to welding.

4.2.3 Butt weld end preparation shall be specified on the design drawings, or sketches.

A. For pipe, when the joint is fit up concentrically, a uniform mismatch of 1/16" is allowable.

B. For circumferential butt welds the maximum root gap shall be maximum of 5/32".

C. Should tolerances on diameter, wall thickness, out-of-roundness, or other mismatch result in inside diameter variations that do not meet these limits, the inside diameter can be counterbored or taper-ground to produce a bore within these limits.

D. Counterboring/taper-grinding shall not infringe on the minimum wall thickness of the pipe.

E. The counterbore length shall be a minimum of twice the wall thickness of the thinner member. In parts of unequal thickness, the thicker wall shall be tapered to at least a 3:1 transition or as required on the design drawing.

F. For joining pipe and components with unequal wall thickness, the joint fit-up and permitted off-set (OD) shall be per the applicable code.

4.2.4 Cold spring shall not be used to align joints. Care shall be taken at tie-ins to equipment, to preclude any undue stresses at these joints.

4.2.5 Purging and Shielding Gases

A. Backing, shielding and trailing gases if used, shall be specified on the applicable WPS.

B. Welding grade gases shall be used.

C. Where purging is required, the purge envelope shall not exceed 2% oxygen content.

D. This percentage can be verified with a oxygen meter, or by purging at least 6 volume changes of the volume needed to be purged. Caution shall be used if high flow rate is used for purging as gasses may mix or entrain air instead of creating an inert envelope.

E. Purge envelopes shall be as small as reasonably possible.

NOTE *Soluble paper purge dams can only be used if the line is subsequently flushed with water.*

F. Where purging requires the use of purge dams, such as water soluble paper, they shall be approved by the cognizant system engineer and SME prior to use.

G. Purge dams shall be located outside the heat affected area to prevent damage to the purge device and contamination of the components being welded.

H. Purge gas shall be maintained until 3/16" of weld metal thickness is deposited.

I. Internal purge is not required for fillet welds, joints with internal backing rings, double welded joints, or socket welds.

4.2.6 Appropriate cleaning shall be accomplished prior to proceeding with welding.

A. Surfaces and edges to be welded shall be smooth, uniform, and free from fins, tears, cracks, foreign material including scale and other discontinuities.

B. An area extending at least one inch on each side of the weld joint shall be free from foreign material (i.e. - paint, oil, galvanizing) that might prevent proper welding or produce objectionable fumes. When used, cleaning solvents shall be allowed to completely evaporate prior to welding.

CAUTION
Solvents are flammable and require careful planning for proper ventilation. Refer to IWP and/or JSA.

C. Slag and spatter shall be removed from existing weld deposits and brushed clean before successive weld beads are applied.

D. Slag shall be removed from all completed welds. The weld and adjacent base metal shall be cleaned by appropriate methods. Tightly adherent spatter remaining after the cleaning operation is acceptable unless its removal is required for non-destructive testing. Welded joints shall not be painted until after acceptance of inspections/testing.

E. Non-ferrous parts to be joined or repaired by welding shall be degreased by cleaning the weld area with an approved solvent or by mechanical methods.

F. Surfaces that have been thermally cut or gouged shall be ground or machined to sound metal prior to welding.

4.2.7 Pre-heat and interpass temperature shall be monitored by the welder by use of temperature indicating crayons (e.g. Tempilstik) or by contact pyrometers or thermometers. Preheat temperature shall be in accordance with the WPS.

4.2.8 Caulking or slugging of welds is not permitted.

4.2.9 Peening is not allowed unless specifically directed by the SME and the work document.

A. When directed, peening shall be witnessed by the SME or designee per the following criteria.

- The first and last layer of weld shall not be peened.
- Prior to peening, the weld pass shall be carefully cleaned and visually examined. If defects are present, they shall be removed.
- Reference marks may be employed to prevent peening from causing more distortion than caused by welding.
- The peening tool shall have a round nose no less than 1/8" diameter.

4.2.10 Arc strikes are not allowed on process piping or equipment. Inadvertent arc strikes shall be removed per weld repair section 4.4.1.F.

4.2.11 Weld reinforcement shall have a gradual transition to the plane of the base metal. Surfaces of butt welds which are to be ground or machined flush shall be finished so as not to reduce the thickness of the base material more than 1/32".

4.2.12 Undercut shall not exceed 1/32" and shall not encroach on minimum wall thickness. When undercut exceeds these limits, the area shall be reworked.

4.2.13 Final weld contour shall be sufficiently free from coarse ripples, grooves, overlaps, abrupt edges, and valleys to allow clear interpretation of applicable Non-Destructive Examination (NDE) methods.

4.3 Tool Control

4.3.1 To prevent free-iron contamination of non-ferrous base materials, mechanical metal removal shall be performed using new non-ferrous tools or tools previously used only on non-ferrous materials. A tool identification scheme using: blue paint/segregation and/or stainless steel marking/segregation will be utilized.

A. Stainless steel wire brushes shall be used on non ferrous alloys.

B. Jaws of vises used for stainless steel and nickel based alloy work shall be "isolated" to prevent carbon steel contamination.

C. In the material storage area and fabrication area, stainless steel and nickel alloys shall be separated from carbon steel.

4.4 Weld Repairs

4.4.1 When a repair is required for a welded joint that has been rejected because of radiography or ultrasonic testing, the documentation for that repair shall indicate an R-1 for the first repair and R-2 for the second. More than two repairs requires the SME's approval.

A. The types, extent and method of repair examination shall be the same as for the original weld.

B. Weld end prep repairs required because of physical damage due to handling, etc. may require a combination of welding and mechanical methods to be restored.

C. Welded repairs may be made using the same WPS as the original weld or compatible WPS and process.

D. Areas to be repaired shall be excavated to eliminate the defect and prepared as necessary to provide for proper electrode manipulation.

E. The excavated area shall be examined with an appropriate NDE method (PT, MT, or VT) to assure complete defect removal prior to proceeding with repair.

F. Arc strikes on pressure retaining components shall be removed by grinding or blending to the bottom of the depression. The blended area shall be visually free of crater cracks. If the remaining thickness is less than minimum wall, the area shall be repaired by welding.

4.4.2 If a repair (or alteration) is required on an ASME-Stamped vessel, work will be performed in accordance with the National Board Inspection Code, by an authorized repair organization. No work on ASME stamped vessels shall be initiated without the Engineering Manager and SME approval on the work document.

4.4.3 To ensure internal components are not damaged, planning for welding of items such as valves or pumps may provide for disassembly and reassembly of the components to manufacturer's instructions or methods of reducing the amount of heat input to the item.

4.4.4 Temporary Attachments to Pressure Boundaries

A. Attachments which are welded onto the component during the process of manufacturing or installation are permitted, provided the following requirements are met.

- Attachment material is compatible with base material
- The immediate area around the attachment is marked in a suitable manner to identify the area for examination after attachment removal.
- Attachments are not to be removed by hammer blows.
- The area is examined and documented after attachment removal by an appropriate NDE method (PT or MT).

4.5 Acceptance Criteria

4.5.1 Structural steel, pipe supports, hangers, and miscellaneous metals shall be visually examined to meet the acceptance criteria in AWS D1.1 (static), unless otherwise specified.

4.5.2 Piping welding and all attachments welded to the pipe shall be visually examined to the criteria required in ASME B31.3 (normal service) unless otherwise specified.

4.5.3 Lifting devices designated as 'Below the Hook Lift Devices' per DOE-STD-1090, 'Hoisting and Rigging Manual' shall be inspected per AWS D14.1 unless otherwise noted.

4.5.4 Stainless steel structural welding shall be inspected to AWS D1.6 unless otherwise noted.

4.6 In-Process Documentation

The CHBWV Weld Data Sheet (WV-2529) will be used for documenting welding information when such information is required by the governing work document. Weld maps and weld data sheets are generated by the Cognizant Engineer and Quality Assurance. Completed weld maps and form WV-2529 shall be retained within the work document.

4.6.1 After welding on a particular weld joint, the welder will be responsible for applying his/her symbol and the electrode heat number in the blocks provided next to the applicable weld number.

4.6.2 The Quality Assurance Inspector will document their inspections/examinations by initialing and dating the applicable block(s).

ATTACHMENT A
CHBWV WELDING PROCEDURE SPECIFICATIONS
(w/ MAX. BASE METAL GROOVE THICKNESSES)

1.	W TS 1-1	- C.S. GTAW/SMAW, 1 3/4" MAX.
2.	W S 1-1	- C.S. SMAW, 1 ½" Max. (E6010 & E7018)
3.	S1-1-01	- C.S. SMAW 2½" Max.
4.	W TS 8-1	- S.S./C.S. GTAW/SMAW, 1 ½" MAX.
5.	W TS 8-8	- S.S. GTAW/SMAW, 1 ½" MAX.
6.	W T 10H-8	- S.S. GTAW, 3/4" MAX.
7.	W T 23-23	- Aluminum GTAW, ½" MAX.
8.	W T 43-8	- Inconel/S.S. GTAW, 1" MAX.
9.	W T 43-43	- Inconel GTAW, 1" MAX.
10.	W T 51-51	- Titanium GTAW, .560" MAX.
11.	F 1-1	- C.S. FCAW, Unlimited
12.	W F 8-1	- S.S./C.S. FCAW, ½" MAX.
13.	W F 8-8	- S.S. FCAW, ½" MAX.
14.	W M 8-1	- S.S./C.S. GMAW, .275" MAX.
15.	W M 8-8	- S.S. GMAW, .275" MAX.
16.	W B 107-107	- Brazing, .100" MAX.
17.	TS 43-8	- Inconel/S.S. GTAW/SMAW, 1" MAX.
18.	TS 43-43	- Inconel GTAW/SMAW, 1" MAX.

WELDING PROCEDURE SPECIFICATION (WPS)

Company Name: CHM2HILL B&W West Valley, LLC

Welding Procedure Specification No.: W TS1-1 | Date: 7-10-96 | Supporting PQR No(s) WT1-1, & WS1-1

Revision No.: 3 | Date: 03/15/12

Welding Process(es): GTAW / SMAW

Types: MANUAL

JOINTS (QW-402): Details

Joint Design: GROOVES OR FILLETS

Backing (Yes) ★ (No) X

Backing material ★ - WHEN USED, BACKING MATERIAL SHALL BE AS SPECIFIED IN WORK DOCUMENT

(Refer to both backing & retainers)

☐ Metal ☐ Nonfusing Metal

☐ Nonmetallic ☐ Other

BASE METALS (QW-403)

P-No. 1 Group No. 1 OR 2 to P-No. 1 Group No. 1 OR 2

Specification type and grade

to Specification type and grade

Chem. Analysis and Mech. Prop.:

to Chem. Analysis and Mech. Prop.:

Thickness Range:

Base Metal: Groove: 1/16" - 1 3/4" Fillet: ALL

Pipe Dia. Range: Groove: ALL Fillet: ALL

FILLER METALS (QW-404)	GTAW	SMAW
SFA Specification:	SFA 5.18	SFA 5.1
AWS Classification:	ER70S-X	E7018
F-No.:	6	4
A-No.:	1	1
Size of Filler Metal:	1/16", 3/32", 1/8"	3/32", 1/8", 5/32"
Deposited Weld Metal:		
Thickness Range:		
Groove:	3/4" MAX.	1" MAX.
Fillet:	ALL	ALL
Electrode-Flux (Class): N/A		
Flux Trade Name: N/A		
Consumable Insert:	ONLY IF SPECIFIED IN WORK DOCUMENT	

(BACK) WPS No. W TS1-1 Rev. 3

POSITION (QW-405)	POSTWELD HEAT TREATMENT (QW-407)		
Position of Groove: ALL	Temperature Range: N/A		
Weld Progression UPHILL	Time Range: N/A		
Position of Fillet: ALL	Gas (QW-408): (FOR GTAW PORTION ONLY)		
Other: N/A	Gas(es)	(Mixture)	Flow Rate
PREHEAT (QW-406)	ARGON	99.9%	10 - 25 CFH
Preheat Temp. Min.: 50° F.			
Interpass Temp. Min.: 50° F. Max: 600° F.	Trailing: N/A		
Preheat Maintenance: AS REQUIRED	Backing: N/A ★		

ELECTRICAL CHARACTERISTICS (QW-409)	
Current (AC or DC): DIRECT CURRENT	Polarity: SEE BELOW
Amps (Range): SEE BELOW	Volts (Range): SEE BELOW
Tungsten Electrode Size and Type: 1/16", 3/32", 1/8" (SFA 5.12, EWTh-2 or EWLa)	
Mode of Metal Transfer for GMAW: N/A	
Electrode Wire Feed Speed Range: N/A	

TECHNIQUE (QW-410)
String or Weave Bead: BOTH
Office or Gas Cup Size: #4 - #10
Initial and Interpass Cleaning: BURRING, GRINDING, WIRE BRUSH, OR CHEMICALS AS REQUIRED
Method of Back Gouging: BURRING, GRINDING, OR ARC-GOUGING FOLLOWED BY GRINDING
Oscillation: N/A
Contact Tube to Work Distance: N/A
Multiple or Single Pass (Per Side): EITHER
Multiple or Single Electrodes: SINGLE
Travel Speed (Range): 1 - 8 IPM
Peening: N/A
Other NO PASS SHALL BE GREATER THAN 3/8" IN THICKNESS

Weld Layer(s)	Process	Filler Metal		Current		Volt Range	Travel Speed Range	Remarks/ Comments
		Class	Diameter	Type Polar.	Amp. Range			
ROOT & SUBSEQUENT PASSES	GTAW	ER70S-X	1/16"	STRAIGHT	50 - 90	8 - 17	1 - 8 IPM	NO PULSING
	"	"	3/32"	"	70 - 140	"	"	
	"	"	1/8"	"	90 - 180	"	"	
	SMAW	E7018	3/32"	REVERSE	60 - 110	19 - 28	1 - 12 IPM	
	"	"	1/8"	"	90 - 160	"	"	
	"	"	5/32"	"	140 - 210	"	"	

WELDING PROCEDURE SPECIFICATION (WPS)

Company Name: CHM2HILL B&W West Valley, LLC

Welding Procedure Specification No.:	Date:	Supporting PQR No(s)
W S1-1	6-18-96	WS1-1

Revision No.: 3 Date: 03-15-12

Welding Process(es): SMAW

Types: MANUAL

JOINTS (QW-402): Details

Joint Design GROOVES OR FILLETS

Backing (Yes) ★ (No) X

Backing material (type) ★ -WHEN USED, BACKING MATERIAL SHALL BE AS SPECIFIED IN WORK DOCUMENT (Refer to both backing & retainers)

☐ Metal ☐ Nonfusing Metal

☐ Nonmetallic ☐ Other

BASE METALS (QW-403)			
P-No. 1	Group No. 1 OR 2	to P-No. 1	Group No. 1 OR 2
Specification type and grade			
to Specification type and grade			
Chem. Analysis and Mech. Prop.			
to Chem. Analysis and Mech. Prop.			
Thickness Range:			
Base Metal:	Groove: 3/16" - 1 ½"	Fillet: ALL	
Pipe Dia. Range:	Groove: ALL	Fillet: ALL	

FILLER METALS (QW-404)		
SFA Specification:	SFA 5.1	SFA 5.1
AWS Classification:	E6010	E7018
F-No.:	3	4
A-No.:	1	1
Size of Filler Metal:	3/32", 1/8"	3/32", 1/8", 5/32"
Deposited Weld Metal Thickness Range:		
Groove:	½" MAX.	1" MAX.
Fillet:	ALL	ALL
Electrode-Flux (Class): N/A		
Flux Trade Name: N/A		
Consumable Insert: N/A		

(BACK) WPS No. W S1-1 Rev. 3

POSITION (QW-405)	POSTWELD HEAT TREATMENT (QW-407)
Position of Groove: ALL	Temperature Range: N/A
Weld Progression UPHILL	Time Range: N/A
Position of Fillet: ALL	Gas (QW-408):
Other: N/A	Percent Composition
PREHEAT (QW-406)	Gas(es) (Mixture) Flow Rate
Preheat Temp. Min.: 50° F.	Shielding: N/A
Interpass Temp. Min.: 50° F. Max: 600° F.	Trailing: N/A
Preheat Maintenance: AS REQUIRED	Backing: N/A

ELECTRICAL CHARACTERISTICS (QW-409)
Current (AC or DC): DC Polarity: REVERSE
Amps (Range): SEE BELOW Volts (Range): SEE BELOW
Tungsten Electrode Size and Shape: N/A
Mode of Metal Transfer for GMAW: N/A (Pure Tungsten, 2% Thoriated, etc...)
Electrode Wire Feed Speed Range: N/A (Spray arc, short circuiting arc, etc..)
TECHNIQUE (QW-410)
String or Weave Bead: BOTH
Office or Gas Cup Size: N/A
Initial and Interpass Cleaning: BURRING, GRINDING, WIRE BRUSH, OR CHEMICALS AS REQUIRED
Method of Back Gouging: GRINDING, OR ARC-GOUGING FOLLOWED BY GRINDING
Oscillation: MAX. WEAVE BEAD WIDTH SHOULD NOT EXCEED 5X CORE DIAMETER
Contact Tube to Work Distance: N/A
Multiple or Single Pass (Per Side): EITHER
Multiple or Single Electrodes: SINGLE
Travel Speed (Range): 1 - 12 IPM
Peening: N/A
Other NO PASS SHALL BE GREATER THAN 3/8" IN THICKNESS

Weld Layer(s)	Process	Filler Metal		Current		Volt Range	Travel Speed Range	Remarks/ Comments
		Class	Diameter	Type Polar.	Amp. Range			
1st (ROOT)	SMAW	E6010	3/32	REVERSE	60 - 90	19 - 22	1 - 12 IPM	
	"	"	1/8	"	75 - 125	21 - 25	"	
SUBSEQUENT LAYERS	SMAW	E7018	3/32	REVERSE	60 - 110	20 - 28	"	
	"	"	1/8	"	90 - 160	"	"	
	"	"	5/32	"	140 - 210	"	"	

WELD PROCEDURE SPECIFICATION (WPS)

Company Name:
CHM2HILL B&W West Valley, LLC

Welding Procedure Specification No.: S1-1-01 | Date: 9-17-01 | Supporting PQR No(s) AWS D1.1 prequalified | N/A

Revision No.: 1 | Date: 3-15-12

Welding Process(es): SMAW

Types (Manual, Automatic, Machine, Semi-Auto): Manual

JOINTS (QW-402): | Details

Joint Design Groove - Partial Penetration and Fillets

Backing (Yes) Yes (No)

Backing material (type)

(Refer to both backing & retainers)

AWS D1.1 Prequalified Joint BTC-P5

X Metal (base metal) ☐ Nonfusing Metal

☐ Nonmetallic ☐ Other

Sketches, Production Drawings, Weld Symbols or Written Description should show the general arrangement of the parts to be welded. Where applicable, the root spacing and the details of the weld groove may be specified.

(At the option of the Mfr., sketches may be attached to illustrate joint design, weld layers and bead sequence, e.g. for notch toughness procedures, for multiple process procedures, etc....)

*BASE METALS (QW-403)			
P-No. 1	Group No. 1 or 2	to P-No. 1	Group No. 1 or 2
OR			
Specification type and grade ASTM A-36 Plate			
to Specification type and grade ASTM A-36 Plate			
OR			
Chem. Analysis and Mech. Prop.: n/a			
to Chem Analysis and Mech. Prop: n/a			
Thickness Range:			
Base Metal:	Groove: 5/16" to 2-1/2"	Fillet: All	
Pipe Dia. Range:	Groove: n/a	Fillet: n/a	
Other: n/a			

*FILLER METALS (QW-404)		
SFA Specification:	5.1	
AWS Classification:	E7018	
F-No.:	4	
A-No.:	1	
Size of Filler Metal:	1/8", 5/32", 3/16"	
Deposited Weld Metal Range		
Groove:	1/4" to 2-1/4"	
Fillet:	ALL	
Electrode-Flux (Class):	n/a	
Flux Trade Name:	n/a	
Consumable Insert:	n/a	
Other:	n/a	

*Each base metal-filler combination should be recorded individually

(BACK) WPS No. S1-1-01 Rev. 1

POSITION (QW-405	POSTWELD HEAT TREATMENT (QW-407)
Position of Groove: All	Temperature Range: n/a
Weld Progression (Uphill, Downhill): Uphill	Time Range: n/a
Position of Fillet: All	Gas (QW-408): n/a
Other: n/a	Percent Composition
PREHEAT (QW-406)	Gas(es) (Mixture) Flow Rate
Preheat Temp. Min.: 50 ° F (5/16" to 1-1/2") / 150°F (>1-1/2" to 2-1/2")"	Shielding: n/a
Interpass Temp. Min.: See Preheat above Max: 500°F	Trailing: n/a
Preheat Maintenance: Continuous	Backing: n/a
	Other: n/a

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC or DC): DC Polarity: Reverse

Amps (Range): See below Volts (Range): See below

(Amps & volts should be recorded for each electrode size, position, and thickness, etc.... This information may be listed in a tabular form similar to that shown below.)

Tungsten Electrode Size and Type: n/a

~~(Pure Tungsten, 2% Thoriated, etc...)~~

Mode of Metal Transfer for GMAW and FCAW: n/a

~~(Spray arc, short circuiting arc, etc..)~~

Electrode Wire Feed Speed Range: n/a

TECHNIQUE (QW-410)

String or Weave Bead: Both

Orifice or Gas Cup Size: n/a

Initial and Interpass Cleaning (Brushing, Grinding, etc...): Brushing, Grinding

Method of Back Gouging: Grinding

Oscillation: n/a

Contact Tube to Work Distance: n/a

Multiple or Single Pass (Per Side): Multiple

Multiple or Single Electrodes: Single

Travel Speed (Range): See below

Peening: Not allowed on root pass or surface layer passes

Other: No pass shall be greater than 3/8" in thickness

Weld Layer(s)	Process	Filler Metal		Current		Volt Range	Travel Speed Range	Other (e.g. Remarks, Comments, Hot Wire Addition, Technique, Torch Angle, Etc.)
		Class	Diameter	Type Polar.	Amp. Range			
Root, 2nd pass	SMAW	E7018	1/8"	REVERSE (Typ.)	90-160	19-28	1-12 IPM	NONE (Typ.)
Subsequent layers	SMAW	E7018	5/32"		140-210	19-28	1-12 IPM	
	SMAW	E7018	3/16"		200-290	23-32	1-15 IPM	

WELDING PROCEDURE SPECIFICATION (WPS)

Company Name: CHM2HILL B&W West Valley, LLC

Welding Procedure Specification No.: W TS8-1 Date: 7-9-96 Supporting PQR No(s) WT8-1, & WS8-1

Revision No.: 3 Date: 03/15/12

Welding Process(es): GTAW / SMAW

Types: MANUAL

JOINTS (QW-402): Details

Joint Design GROOVES OR FILLETS

Backing (Yes) ★ (No) X

Backing material (type) ★ -WHEN USED, BACKING MATERIAL SHALL BE AS SPECIFIED IN WORK DOCUMENT (Refer to both backing & retainers)

☐ Metal ☐ Nonfusing Metal

☐ Nonmetallic ☐ Other

BASE METALS (QW-403)			
P-No. 8	Group No. 1 & 2	to P-No. 1	Group No. 1 & 2
Specification type and grade			
to Specification type and grade			
Chem. Analysis and Mech. Prop.:			
to Chem. Analysis and Mech. Prop.:			
Thickness Range:			
Base Metal:	Groove: 1/16" - 1 ½"		Fillet: ALL
Pipe Dia. Range:	Groove: ALL	Fillet: ALL	

FILLER METALS (QW-404)	GTAW	SMAW
SFA Specification:	SFA 5.9	SFA 5.4
AWS Classification:	ER 309-X	E309-X
F-No.:	6	5
A-No.:	8	8
Size of Filler Metal:	1/16", 3/32", 1/8"	3/32", 1/8"
Deposited Weld Metal:		
Thickness Range:		
Groove:	3/4" MAX.	3/4" MAX.
Fillet:	ALL	ALL
Electrode-Flux (Class): N/A		
Flux Trade Name: N/A		
Consumable Insert:	ONLY IF SPECIFIED IN WORK DOCUMENT	

(BACK) WPS No. W TS8-1 Rev. 3

POSITION (QW-405)	POSTWELD HEAT TREATMENT (QW-407)
Position of Groove: ALL	Temperature Range: N/A
Weld Progression: UPHILL	Time Range: N/A
Position of Fillet: ALL	Gas (QW-408): (FOR GTAW PORTION ONLY)
Other: N/A	Percent Composition
PREHEAT (QW-406)	Gas(es) (Mixture) Flow Rate
Preheat Temp. Min.: 50° F.	Shielding: ARGON 99.9% 10 - 25 CFH
Interpass Temp. Min.: 50° F. Max: 350°F.	Trailing: N/A
Preheat Maintenance: AS REQUIRED	Backing: ARGON 99.9% 5 - 15 CFH
	Other: GAS BACKING NOT REQUIRED WITH BACKING RINGS, OR FILLETS

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC or DC): DIRECT CURRENT Polarity: STRAIGHT / REVERSE

Amps (Range): SEE BELOW Volts (Range): SEE BELOW

Tungsten Electrode Size and Type: 1/16", 3/32", 1/8" (SFA 5.12, EWTh-2 or EWLa)

Mode of Metal Transfer for GMAW: N/A

Electrode Wire Feed Speed Range: N/A

TECHNIQUE (QW-410)

String or Weave Bead: BOTH

Office or Gas Cup Size: #4 - #10

Initial and Interpass Cleaning: BURRING, GRINDING, WIRE BRUSH, OR CHEMICALS AS REQUIRED

Method of Back Gouging: BURRING, GRINDING, OR ARC-GOUGING FOLLOWED BY GRINDING

Oscillation: N/A

Contact Tube to Work Distance: N/A

Multiple or Single Pass (Per Side): EITHER

Multiple or Single Electrodes: SINGLE

Travel Speed (Range): 1 - 8 IPM

Peening: N/A

Other NO PASS SHALL BE GREATER THAN 1/4" IN THICKNESS

Weld Layer(s)	Process	Filler Metal		Current		Volt Range	Travel Speed Range	Remarks/ Comments
		Class	Diameter	Type Polar.	Amp. Range			
ROOT & SUBSEQUENT LAYERS	GTAW " "	ER309-X " "	1/16" 3/32" 1/8"	STRAIGHT " "	40 - 70 50 - 100 70 - 140	10 - 20 " "	1 - 8 IPM " "	NO PULSING
	SMAW "	E309-X "	3/32" 1/8"	REVERSE "	50 - 100 70 - 140	10 - 20 "	1 - 12 IPM "	

WELDING PROCEDURE SPECIFICATION (WPS)

Company Name: CHM2HILL B&W West Valley, LLC

Welding Procedure Specification No.: W TS8-8 Date: 7-10-96 Supporting PQR No(s) WT8-8, & WS8-8

Revision No.: 3 Date: 03/15/12

Welding Process(es): GTAW / SMAW

Types: MANUAL

JOINTS (QW-402): Details

Joint Design GROOVES OR FILLETS

Backing (Yes) ★ (No) X

Backing material (type) ★ -WHEN USED, BACKING MATERIAL SHALL BE AS SPECIFIED IN WORK DOCUMENT
(Refer to both backing & retainers)

☐ Metal ☐ Nonfusing Metal

☐ Nonmetallic ☐ Other

BASE METALS (QW-403)

P-No. 8 Group No. 1 & 2 to P-No. 8 Group No. 1 & 2

Specification type and grade

to Specification type and grade

Chem. Analysis and Mech. Prop.:

to Chem. Analysis and Mech. Prop

Thickness Range:

Base Metal: Groove: 1/16" - 1 ½" Fillet: ALL

Pipe Dia. Range: Groove: ALL Fillet: ALL

FILLER METALS (QW-404)	GTAW	SMAW
SFA Specification:	SFA 5.9	SFA 5.4
AWS Classification:	ER 308L	ER 308L
F-No.:	6	5
A-No.:	8	8
Size of Filler Metal:	1/16", 3/32", 1/8"	3/32", 1/8"
Deposited Weld Metal:		
Thickness Range:		
Groove:	3/4" MAX.	3/4" MAX.
Fillet:	ALL	ALL
Electrode-Flux (Class): N/A		
Flux Trade Name: N/A		
Consumable Insert:	ONLY IF SPECIFIED IN WORK DOCUMENT	

(BACK) WPS No. W TS8-8 Rev. 3

POSITION (QW-405)	POSTWELD HEAT TREATMENT (QW-407)
Position of Groove: ALL	Temperature Range: N/A
Weld Progression: UPHILL	Time Range: N/A
Position of Fillet: ALL	Gas (QW-408): (FOR GTAW PORTION ONLY)
Other: N/A	Percent Composition
PREHEAT (QW-406)	Gas(es) (Mixture) Flow Rate
Preheat Temp. Min.: 50° F.	Shielding: ARGON 99.9% 10 - 25 CFH
Interpass Temp. Min.: 50° F. Max: 350°F.	Trailing: N/A
Preheat Maintenance: AS REQUIRED	Backing: ARGON 99.9% 5 - 15 CFH
	Other: GAS BACKING NOT REQUIRED WITH BACKING RINGS, OR FILLETS

ELECTRICAL CHARACTERISTICS (QW-409)	
Current (AC or DC): DIRECT CURRENT	Polarity: STRAIGHT / REVERSE
Amps (Range): SEE BELOW	Volts (Range): SEE BELOW
Tungsten Electrode Size and Type: 1/16", 3/32", 1/8" (SFA 5.12, EWTh-2 or EWLa)	
Mode of Metal Transfer for GMAW: N/A	
Electrode Wire Feed Speed Range: N/A	
TECHNIQUE (QW-410)	
String or Weave Bead: BOTH	
Office or Gas Cup Size: #4 - #10	
Initial and Interpass Cleaning: BURRING, GRINDING, WIRE BRUSH, OR CHEMICALS AS REQUIRED	
Method of Back Gouging: BURRING, GRINDING, OR ARC-GOUGING FOLLOWED BY GRINDING	
Oscillation: N/A	
Contact Tube to Work Distance: N/A	
Multiple or Single Pass (Per Side): EITHER	
Multiple or Single Electrodes: SINGLE	
Travel Speed (Range): 1 - 8 IPM	
Peening: N/A	
Other NO PASS SHALL BE GREATER THAN 1/4" IN THICKNESS	

Weld Layer(s)	Process	Filler Metal		Current		Volt Range	Travel Speed Range	Remarks/ Comments
		Class	Diameter	Type Polar.	Amp. Range			
ROOT & SUBSEQUENT	GTAW	ER3XX-X	1/16"	STRAIGHT	40 - 80	10 - 20	1 - 8 IPM	NO PULSING
	"	"	3/32"	"	50 - 100	"	"	
	"	"	1/8"	"	70 - 140	"	"	
	SMAW	E3XX-X	3/32"	REVERSE	50 - 100	10 - 20	1 - 8 IPM	
	"	"	1/8"	"	70 - 140	"	"	

WELDING PROCEDURE SPECIFICATION (WPS)

Company Name:
CHM2HILL B&W West Valley, LLC

Welding Procedure Specification No.: W T10H-8 Date: 9-16-98 Supporting PQR No: WT10H-8

Revision No.: 2 Date: 03-15-12

Welding Process: GTAW

Types: MANUAL

JOINTS (QW-402): Details

Joint Design GROOVES OR FILLETS

Backing (Yes) ★ (No) X

Backing material (type)★ WHEN USED, BACKING MATERIAL SHALL BE AS SPECIFIED IN WORK DOCUMENT
(Refer to both backing & retainers)

☐ Metal ☐ Nonfusing Metal

☐ Nonmetallic ☐ Other

BASE METALS (QW-403)							
P-No.	10H	Group No.	N/A	to P-No.	8	Group No.	N/A
Specification type and grade							
to Specification type and grade							
Chem. Analysis and Mech. Prop.							
to Chem. Analysis and Mech. Prop.							
Thickness Range:							
Base Metal:	Groove:	1/16" - 3/4"	Fillet:	ALL			
Pipe Dia. Range:	Groove:	ALL	Fillet:	ALL			

FILLER METALS (QW-404)		
SFA Specification:	SFA 5.9	
AWS Classification:	ER308L	
F-No.:	6	
A-No.:	8	
Size of Filler Metal:	1/16", 3/32", 1/8"	
Deposited Weld Metal:		
Thickness Range:		
Groove:	3/4" MAX.	
Fillet:	ALL	
Electrode-Flux (Class):N/A		
Flux Trade Name:N/A		
Consumable Insert:	ONLY IF SPECIFIED IN WORK DOCUMENT	

(BACK) WPS No. W T10H-8 Rev. 2

POSITION (QW-405)	POSTWELD HEAT TREATMENT (QW-407)
Position of Groove: ALL	Temperature Range: N/A
Weld Progression (Uphill, Downhill): UPHILL	Time Range: N/A
Position of Fillet: ALL	Gas (QW-408):
Other: N/A	Percent Composition
PREHEAT (QW-406)	Gas(es) (Mixture) Flow Rate
Preheat Temp. Min.: 100°F.	Shielding: ARGON 99.9% 10-25 CFH
Interpass Temp. Min.: 100°F. Max: 350°F.	Trailing:
Preheat Maintenance: AS REQUIRED	Backing: ARGON 99.9% 5-15 CFH

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC or DC): DIRECT CURRENT Polarity: STRAIGHT

Amps (Range): SEE BELOW Volts (Range): SEE BELOW

Tungsten Electrode Size and Type: 1/16", 3/32", 1/8" (SFA 5.12, EWLa OR EWTh-2)

Mode of Metal Transfer for GMAW: N/A

Electrode Wire Feed Speed Range: N/A

TECHNIQUE (QW-410)

String or Weave Bead: STRING

Office or Gas Cup Size: #4 - #10

Initial and Interpass Cleaning: BURRING, GRINDING, S.S. WIRE BRUSH, OR CHEMICALS

AS REQUIRED

Method of Back Gouging: BURRING, GRINDING, OR ARC GOUGING FOLLOWED BY GRINDING

Oscillation: N/A

Contact Tube to Work Distance: N/A

Multiple or Single Pass (Per Side): EITHER

Multiple or Single Electrodes: SINGLE

Travel Speed (Range): 1 - 10 IPM

Peening: N/A

Weld Layer(s)	Process	Filler Metal		Current		Volt Range	Travel Speed Range	Remarks/ Comments
		Class	Diameter	Type Polar.	Amp. Range			
ALL	GTAW	ER308L	1/16" 3/32" 1/8"	STRAIGHT	40-80 50-100 70-140	10-20 " "	1-10 IPM "	NO PULSING

WELDING PROCEDURE SPECIFICATION (WPS)

Company Name: CHM2HILL B&W West Valley, LLC

Welding Procedure Specification No.: W T23-23 | Date: 7-8-96 | Supporting PQR No: WT23-23 (3812)

Revision No.: 2 | Date: 03-15-12

Welding Process: GTAW

Types: MANUAL

JOINTS (QW-402): Details

Joint Design GROOVES OR FILLETS

Backing (Yes) ★ (No) X

Backing material (type) ★ -WHEN USED, BACKING MATERIAL SHALL BE AS SPECIFIED IN WORK DOCUMENT

(Refer to both backing & retainers)

☐ Metal ☐ Nonfusing Metal

☐ Nonmetallic ☐ Other

BASE METALS (QW-403)

P-No. 23 Group No. N/A to P-No. 23 Group No. N/A

Specification type and grade

to Specification type and grade

Chem. Analysis and Mech. Prop.:

to Chem. Analysis and Mech. Prop:

Thickness Range:

Base Metal: Groove: 1/16" - ½" Fillet: ALL

Pipe Dia. Range: Groove: ALL Fillet: ALL

FILLER METALS (QW-404)		
SFA Specification:	SFA 5.10	
AWS Classification:	ER 4043	
F-No.:	23	
A-No.:	N/A	
Size of Filler Metal:	1/16", 3/32", 1/8"	
Deposited Weld Metal:		
Thickness Range:		
Groove:	½" MAX.	
Fillet:	ALL	
Electrode-Flux (Class): N/A		
Flux Trade Name: N/A		
Consumable Insert:	ONLY IF SPECIFIED IN WORK DOCUMENT	

(BACK) WPS No.W T23-23 Rev. 2

POSITION (QW-405)	POSTWELD HEAT TREATMENT (QW-407)
Position of Groove: ALL	Temperature Range: N/A
Weld Progression (Uphill, Downhill): UPHILL	Time Range: N/A
Position of Fillet: ALL	Gas (QW-408):
Other: N/A	Percent Composition
PREHEAT (QW-406)	Gas(es) (Mixture) Flow Rate
Preheat Temp. Min.: 50° F.	Shielding: ARGON 99.9% 10 - 25 CFH
Interpass Temp. Min.: 50° F.Max: 350°F.	Trailing: N/A
Preheat Maintenance: AS REQUIRED	Backing: N/A ★
	Other: ★ - ONLY WHEN SPECIFIED IN WORK DOCUMENT

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC or DC): ALTERNATING CURRENT Polarity: N/A

Amps (Range): SEE BELOW Volts (Range): SEE BELOW

Tungsten Electrode Size and Type: 1/16", 3/32", 1/8" (SFA 5.12, EWP, or EWZr) w/ A ROUNDED POINT

Mode of Metal Transfer for GMAW: N/A

Electrode Wire Feed Speed Range: N/A

TECHNIQUE (QW-410)

String or Weave Bead: BOTH

Office or Gas Cup Size: #4 - #10

Initial and Interpass Cleaning: BURRING, S.S. WIRE BRUSH, OR CHEMICALS AS REQUIRED

Method of Back Gouging: BURRING, OR GRINDING FOLLOWED BY S.S. WIRE BRUSHING

Oscillation: N/A

Contact Tube to Work Distance: N/A

Multiple or Single Pass (Per Side): EITHER

Multiple or Single Electrodes: SINGLE

Travel Speed (Range): 1 - 10 IPM

Peening: N/A

Other NO PASS SHALL BE GREATER THAN 1/4" IN THICKNESS, RECOMMENDED EQUIPMENT: HIGH-FREQUENCY, REMOTE CONTROL. PROCEDURE DERIVED FROM WESTINGHOUSE NCD PENSACOLA.

Weld Layer(s)	Process	Filler Metal		Current		Volt Range	Travel Speed Range	Remarks/ Comments
		Class	Diameter	Type Polar.	Amp. Range			
ALL	GTAW	ER4043	1/16" 3/32" 1/8"	AC " "	40 - 90 50 - 120 30 - 160	N/A	1 - 10 IPM " "	NO PULSING

WELDING PROCEDURE SPECIFICATION (WPS)

Company Name: CHM2HILL B&W West Valley, LLC

Welding Procedure Specification No.: W T43-8 | Date: 6-25-96 | Supporting PQR No(s): WT43-8, WT43-8 01

Revision No.: 3 | Date: 03/15/12

Welding Process: GTAW

Types: MANUAL

JOINTS (QW-402): Details

Joint Design GROOVES OR FILLETS

Backing (Yes) ★ (No) X

Backing material (type) ★ -WHEN USED, BACKING MATERIAL SHALL BE AS SPECIFIED IN WORK DOCUMENT (Refer to both backing & retainers)

☐ Metal ☐ Nonfusing Metal
☐ Nonmetallic ☐ Other

BASE METALS (QW-403)

P-No. 43 Group No. N/A to P-No. 8 Group No. 1 & 2

Specification type and grade

to Specification type and grade

Chem. Analysis and Mech. Prop.:

to Chem. Analysis and Mech. Prop:

Thickness Range:

Base Metal: Groove: 1/16" - 1" Fillet: ALL

Pipe Dia. Range: Groove: ALL Fillet: ALL

FILLER METALS (QW-404)		
SFA Specification:	SFA 5.14	
AWS Classification: †	UNS #N06052	
F-No.:	43	
A-No.:	N/A PER QW-404.5	
Size of Filler Metal:	1/16", 3/32", 1/8"	
Deposited Weld Metal:		
Thickness Range:		
Groove:	1" MAX.	
Fillet:	ALL	
Electrode-Flux (Class): N/A		
Flux Trade Name: N/A		
Consumable Insert:	ONLY IF SPECIFIED IN WORK DOCUMENT	
† -A DIFFERENT CLASSIFICATION WITHIN "F-43" MAY BE USED IF SPECIFIED IN WORK DOCUMENT.		

(BACK) WPS No.W T43-8 Rev. 3

POSITION (QW-405)	POSTWELD HEAT TREATMENT (QW-407)
Position of Groove: ALL	Temperature Range: N/A
Weld Progression UPHILL	Time Range: N/A
Position of Fillet: ALL	Gas (QW-408):
Other: N/A	Percent Composition
PREHEAT (QW-406)	Gas(es) (Mixture) Flow Rate
Preheat Temp. Min.: 50° F.	Shielding: ARGON 99.9% 10 - 25 CFH
Interpass Temp. Min.: 50° FMax: 350°F.	Trailing: N/A
Preheat Maintenance: AS REQUIRED	Backing: ARGON 99.9% 5 - 15 CFH
	Other: GAS BACKING NOT REQUIRED WITH BACKING RINGS, OR FILLETS

ELECTRICAL CHARACTERISTICS (QW-409)	
Current (AC or DC): DIRECT CURRENT	Polarity: STRAIGHT
Amps (Range): SEE BELOW	Volts (Range): SEE BELOW
Tungsten Electrode Size and Type: 1/16", 3/32", 1/8" (SFA 5.12, EWTh-2 or EWLa)	
Mode of Metal Transfer for GMAW: N/A	
Electrode Wire Feed Speed Range: N/A	
TECHNIQUE (QW-410)	
String or Weave Bead: BOTH	
Office or Gas Cup Size: #4 - #10	
Initial and Interpass Cleaning: BURRING, GRINDING, WIRE BRUSH, OR CHEMICALS AS REQUIRED. GRINDING WHEELS SHALL BE OF THE ALUMINUM OXIDE TYPE.	
Method of Back Gouging: BURRING, GRINDING, OR ARC-GOUGING FOLLOWED BY GRINDING (SEE CLEANING NOTE ABOVE)	
Oscillation: N/A	
Contact Tube to Work Distance: N/A	
Multiple or Single Pass (Per Side): EITHER	
Multiple or Single Electrodes: SINGLE	
Travel Speed (Range): 1 - 8 IPM	
Peening: N/A	
Other NO PASS SHALL BE GREATER THAN 1/4" IN THICKNESS	

Weld Layer(s)	Process	Filler Metal		Current		Volt Range	Travel Speed Range	Remarks/ Comments
		Class	Diameter	Type Polar.	Amp. Range			
ALL	GTAW	★ " "	1/16" 3/32" 1/8"	STRAIGHT " "	40 - 70 50 - 100 70 - 140	10 - 20 " "	1 - 8 IPM " "	NO PULSING ★ -UNS #N06052

WELDING PROCEDURE SPECIFICATION (WPS)

Company Name: CHM2HILL B&W West Valley, LLC

Welding Procedure Specification No.: W T43-43 | Date: 6-24-96 | Supporting PQR No(s) WT43-43

Revision No.: 3 | Date: 03-15-12

Welding Process: GTAW

Types: MANUAL

JOINTS (QW-402): Details

Joint Design: GROOVES OR FILLETS

Backing (Yes) ★ (No) X

Backing material (type) ★ -WHEN USED, BACKING MATERIAL SHALL BE AS SPECIFIED IN WORK DOCUMENT (Refer to both backing & retainers)

☐ Metal ☐ Nonfusing Metal

☐ Nonmetallic ☐ Other

BASE METALS (QW-403)			
P-No. 43 Group No. N/A		to P-No. 43	Group No. N/A
Specification type and grade			
to Specification type and grade			
Chem. Analysis and Mech. Prop.:			
to Chem. Analysis and Mech. Prop:			
Thickness Range:			
Base Metal:	Groove: 1/16" - 1"		Fillet: ALL
Pipe Dia. Range:	Groove: ALL		Fillet: ALL

FILLER METALS (QW-404)		
SFA Specification:	SFA 5.14	
AWS Classification:	UNS #N06052	
F-No.:	43	
A-No.:	N/A PER QW-404.5	
Size of Filler Metal:	1/16", 3/32", 1/8"	
Deposited Weld Metal:		
Thickness Range:		
Groove:	1" MAX.	
Fillet:	ALL	
Electrode-Flux (Class): N/A		
Flux Trade Name: N/A		
Consumable Insert:	ONLY IF SPECIFIED IN WORK DOCUMENT	

(BACK) WPS No.W T43-43 Rev. 3

POSITION (QW-405)	POSTWELD HEAT TREATMENT (QW-407)
Position of Groove: ALL	Temperature Range: N/A
Weld Progression UPHILL	Time Range: N/A
Position of Fillet: ALL	Gas (QW-408):
Other: N/A	Percent Composition
PREHEAT (QW-406)	Gas(es) (Mixture) Flow Rate
Preheat Temp. Min.: 50° F.	Shielding: ARGON 99.9% 10 - 25 CFH
Interpass Temp. Min.: 50° F. Max: 350°F.	Trailing: N/A
Preheat Maintenance: AS REQUIRED	Backing: ARGON 99.9% 5 - 15 CFH
	Other: GAS BACKING NOT REQUIRED WITH BACKING RINGS, OR FILLETS

ELECTRICAL CHARACTERISTICS (QW-409)
Current (AC or DC): DIRECT CURRENT Polarity: STRAIGHT
Amps (Range): SEE BELOW Volts (Range): SEE BELOW
Tungsten Electrode Size and Type: 1/16", 3/32", 1/8" (SFA 5.12, EWTh-2 or EWLa)
Mode of Metal Transfer for GMAW: N/A
Electrode Wire Feed Speed Range: N/A
TECHNIQUE (QW-410)
String or Weave Bead: BOTH
Office or Gas Cup Size: #4 - #10
Initial and Interpass Cleaning: BURRING, GRINDING, WIRE BRUSH, OR CHEMICALS AS REQUIRED. GRINDING WHEELS SHALL BE OF THE ALUMINUM OXIDE TYPE.
Method of Back Gouging: BURRING, GRINDING, OR ARC-GOUGING FOLLOWED BY GRINDING (SEE CLEANING NOTE ABOVE)
Oscillation: N/A
Contact Tube to Work Distance: N/A
Multiple or Single Pass (Per Side): EITHER
Multiple or Single Electrodes: SINGLE
Travel Speed (Range): 1 - 8 IPM
Peening: N/A
Other NO PASS SHALL BE GREATER THAN 1/4" IN THICKNESS

Weld Layer(s)	Process	Filler Metal		Current		Volt Range	Travel Speed Range	Remarks/ Comments
		Class	Diameter	Type Polar.	Amp. Range			
ALL	GTAW	INCO 52 " "	1/16" 3/32" 1/8"	STRAIGHT " "	40 - 70 50 - 100 70 - 140	10 - 20 " "	1 - 8 IPM " "	NO PULSING ★ -UNS #N06052

WELDING PROCEDURE SPECIFICATION (WPS)

Company Name: CHM2HILL B&W West Valley, LLC

Welding Procedure Specification No.: W T51-51 | Date: 6-27-96 | Supporting PQR No: WT51-51 (410)

Revision No.: 3 | Date: 03/15/12

Welding Process: GTAW

Types: MANUAL

JOINTS (QW-402): Details

Joint Design: GROOVES OR FILLETS

Backing (Yes) ★ (No) X

Backing material (type) ★ -WHEN USED, BACKING MATERIAL SHALL BE AS SPECIFIED IN WORK DOCUMENT

(Refer to both backing & retainers)

☐ Metal ☐ Nonfusing Metal

☐ Nonmetallic ☐ Other

BASE METALS (QW-403)

P-No. 51 Group No. N/A to P-No. 51 Group No. N/A

Specification type and grade

to Specification type and grade

Chem. Analysis and Mech. Prop.:

to Chem. Analysis and Mech. Prop:

Thickness Range:

Base Metal: Groove: 1/16" - .560" Fillet: ALL

Pipe Dia. Range: Groove: ALL Fillet: ALL

FILLER METALS (QW-404)		
SFA Specification:	SFA 5.16	
AWS Classification:	ERTi-1	
F-No.:	51	
A-No.:	N/A PER QW-404.5	
Size of Filler Metal:	1/16", 3/32"	
Deposited Weld Metal:		
Thickness Range:		
Groove:	.560" MAX.	
Fillet:	ALL	
Electrode-Flux (Class): N/A		
Flux Trade Name: N/A		
Consumable Insert: N/A		
Other: CLEAN GLOVES SHOULD BE WORN WHEN HANDLING MATERIAL.		

(BACK) WPS No. W T51-51 Rev. 3

Position of Groove: ALL	Temperature Range: N/A
Weld Progression: UPHILL	Time Range: N/A
Position of Fillet: ALL	Gas (QW-408):
Other: N/A	Percent Composition
PREHEAT (QW-406)	Gas(es) (Mixture) Flow Rate
Preheat Temp. Min.: 70° F.	Shielding: ARGON 99.9% 10 - 25 CFH
Interpass Temp. Min.: 70° F. Max: 350°F.	Trailing: ARGON 99.9% 20 - 35 CFH
Preheat Maintenance: AS REQUIRED	Backing: ARGON 99.9% 10 - 25 CFH
	Other: GAS BACKING NOT REQUIRED WITH BACKING RINGS, OR FILLETS

ELECTRICAL CHARACTERISTICS (QW-409)	
Current (AC or DC): DIRECT CURRENT	Polarity: STRAIGHT
Amps (Range): SEE BELOW	Volts (Range): SEE BELOW
Tungsten Electrode Size and Type: 1/16", 3/32", 1/8" (SFA 5.12, EWTh-2 or EWLa)	
Mode of Metal Transfer for GMAW: N/A	
Electrode Wire Feed Speed Range: N/A	
TECHNIQUE (QW-410)	
String or Weave Bead: STRING	
Office or Gas Cup Size: #8 - #12 (GAS LENS TYPE)	
Initial and Interpass Cleaning: CLEANLINESS IS IMPERATIVE. BURRING, GRINDING, S.S. WIRE BRUSH, OR CHEMICALS (NON-CHLORINATED) AS REQUIRED. GRINDING WHEELS SHALL BE OF THE ALUMINUM OXIDE TYPE.	
Method of Back Gouging: BURRING, GRINDING (SEE CLEANING NOTE ABOVE)	
Oscillation: N/A	
Contact Tube to Work Distance: N/A	
Multiple or Single Pass (Per Side): EITHER	
Multiple or Single Electrodes: SINGLE	
Travel Speed (Range): 1 - 10 IPM	
Peening: N/A	
Other: EQUIPMENT SHOULD INCLUDE HIGH-FREQUENCY REMOTE; WELD AND H.A.Z. TO REMAIN IN INERT ATMOSPHERE UNTIL <600° F.; WHEN "DIPPING" THE FILLER, KEEP THE WIRE'S TIP IN THE SHIELDING GAS; IF WELD BEAD HAS OTHER THAN A SILVERY METALLIC APPEARANCE, EVALUATION WILL BE REQUIRED. PROCEDURE DERIVED FROM WESTINGHOUSE ENERGY DIVISION/PCI SERVICES.	

Weld Layer(s)	Process	Filler Metal Class	Filler Metal Diameter	Current Type Polar.	Current Amp. Range	Volt Range	Travel Speed Range	Remarks/ Comments
ALL	GTAW	ERTi-1	1/16"	STRAIGHT	70 - 100	10 - 20	1 - 10 IPM	NO PULSING
		"	3/32"	"	80 - 150	"	"	
		"	1/8"	"	110 - 170	"	"	

WELDING PROCEDURE SPECIFICATION (WPS)

Company Name:
CHM2HILL B&W West Valley, LLC.

Welding Procedure Specification No.:	Date:	Supporting PQR No(s)
F 1-1	03/25/98	AWS Pre-qualified

Revision No.: 2 — Date: 3-15-12

Welding Process(es):
FCAW

Types (Manual, Automatic, Machine, Semi-Auto):
Semi-Automatic

JOINTS (QW-402): Details

Joint Design All pre-qualified joints per AWS D1.1-96

Backing (Yes) X (No) X

Backing material (type) When used, compatible w/ base material

(Refer to both backing & retainers)

☐ Metal ☐ Nonfusing Metal

☐ Nonmetallic ☐ Other

Sketches, Production Drawings, Weld Symbols or Written Description should show the general arrangement of the parts to be welded. Where applicable, the root spacing and the details of the weld groove may be specified.

(At the option of the Mfr., sketches may be attached to illustrate joint design, weld layers and bead sequence, e.g. for notch toughness procedures, for multiple process procedures, etc....)

*BASE METALS (QW-403)			
P-No.	Group No.	to P-No.	Group No.
OR			
Specification type and grade (Pre-qualified base metals from Table 3.1, Groups I or II of AWS D1.1-96)			
to Specification type and grade (Pre-qualified base metals from Table 3.1, Groups I or II of AWS D1.1-96)			
OR			
Chem. Analysis and Mech. Prop.:			
to Chem. Analysis and Mech. Prop:			
Thickness Range:			
Base Metal:	Groove: 1/8" - Unlimited	Fillet: ALL	
Pipe Dia. Range:	Groove: N/A	Fillet: N/A	
Other:			

*FILLER METALS (QW-404)		
SFA Specification:	A5.20	
AWS Classification:	E71T-8	
F-No..	6	
A-No.:	1	
Size of Filler Metal:	.035" - 5/64"	
Deposited Weld Metal Range		
Groove:	1/8" - Unlimited	
Fillet:	Unlimited	
Electrode-Flux (Class):	N/A	
Flux Trade Name:	N/A	
Consumable Insert:	N/A	
Other:	NOT TO BE USED ON PROCESS PIPING	

*Each base metal-filler combination should be recorded individually.

(BACK) WPS No. F 1-1 Rev. 2

POSITION (QW-405)	POSTWELD HEAT TREATMENT (QW-407)
Position of Groove: ALL	Temperature Range: N/A
Weld Progression (Uphill, Downhill): UP	Time Range: N/A
Position of Fillet: ALL	Gas (QW-408): N/A
Other:	Percent Composition
PREHEAT (QW-406)	Gas(es) (Mixture) Flow Rate
Preheat Temp. Min.: 50 DEGREES	Shielding: N/A
Interpass Temp. Min.: 50 DEGREES Max: 600 DEGREES	Trailing: N/A
Preheat Maintenance: DURING WELDING	Backing: N/A
	Other: N/A

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC or DC): DC Polarity: STRAIGHT

Amps (Range): SEE BELOW Volts (Range): SEE BELOW

(Amps & volts should be recorded for each electrode size, position, and thickness, etc.. This information may be listed in a tabular form similar to that shown below.)

Tungsten Electrode Size and Type: N/A

~~(Pure Tungsten, 2% Thoriated, etc...)~~

Mode of Metal Transfer for GMAW and FCAW: SPRAY

~~(Spray arc, short circuiting arc, etc..)~~

Electrode Wire Feed Speed Range: SEE BELOW

TECHNIQUE (QW-410)

String or Weave Bead: STRINGER

Orifice or Gas Cup Size:

Initial and Interpass Cleaning (Brushing, Grinding, etc...): WIRE BRUSHING OR GRINDING, AS REQUIRED

Method of Back Gouging: GRINDING

Oscillation: MINIMAL

Contact Tube to Work Distance: 3/8" - 1", DEPENDING ON WIRE DIAMETER

Multiple or Single Pass (Per Side): EITHER

Multiple or Single Electrodes: SINGLE

Travel Speed (Range): SEE BELOW

Peening: N/A

Other

Weld Layer(s)	Process	Filler Metal		Current		Volt Range	Travel Speed Range	Other (e.g. Remarks, Comments, Hot Wire Addition, Technique, Torch Angle, Etc.)
		Class	Diameter	Type Polar.	Amp. Range			
ALL	FCAW	E71T-8	.035"	DCEN	60 - 140	14 - 19	5 - 12 IPM	NO PULSING
	"	"	.068"	"	110 - 280	16 - 22	7 - 16 IPM	
	"	"	5/64"	"	180 - 320	18 - 24	8 - 18 IPM	

WELDING PROCEDURE SPECIFICATION (WPS)

Company Name: CHM2HILL B&W West Valley, LLC

Welding Procedure Specification No.: W F8-1 Date: 5-12-99 Supporting PQR No: WF 8-1

Revision No.: 2 Date: 3-15-12

Welding Process: FCAW

Types: SEMI - AUTOMATIC

JOINTS (QW-402): Details

Joint Design GROOVES OR FILLETS

Backing (Yes) ★ (No) X

Backing material (type)★ WHEN USED, BACKING MATERIAL SHALL BE AS SPECIFIED IN WORK DOCUMENT
(Refer to both backing & retainers)

☐ Metal ☐ Nonfusing Metal

☐ Nonmetallic ☐ Other

BASE METALS (QW-403)

P-No. 8 Group No. N/A to P-No. 1 Group No. N/A

Specification type and grade

to Specification type and grade

Chem. Analysis and Mech. Prop:

to Chem. Analysis and Mech. Prop:

Thickness Range:

Base Metal: Groove: 1/16" - ½" Fillet: ALL

Pipe Dia. Range: Groove: ALL Fillet: ALL

FILLER METALS (QW-404)		
SFA Specification:	SFA 5.22	
AWS Classification:	E309LT	
F-No.:	6	
A-No.:	N/A	
Size of Filler Metal:	.035"	
Deposited Weld Metal:		
Thickness Range:		
Groove:	½" MAX.	
Fillet:	ALL	
Electrode-Flux (Class):N/A		
Flux Trade Name:N/A		
Consumable Insert:N/A		

(BACK) WPS No. W F 8-1 Rev. 2

POSITION (QW-405)	POSTWELD HEAT TREATMENT (QW-407)
Position of Groove: ALL	Temperature Range: N/A
Weld Progression: UPHILL	Time Range: N/A
Position of Fillet: ALL	Gas (QW-408):
Other: N/A	Percent Composition
PREHEAT (QW-406)	Gas(es) (Mixture) Flow Rate
Preheat Temp. Min.: 50°F.	Shielding: ARGON / CO2 75 / 25 30-50 CFH
Interpass Temp. Min.: 50°F. Max: 350°F.	Trailing:
Preheat Maintenance: AS REQUIRED	Backing:

ELECTRICAL CHARACTERISTICS (QW-409)	
Current (AC or DC): DIRECT CURRENT	Polarity: REVERSE
Amps (Range): SEE BELOW	Volts (Range): SEE BELOW
Tungsten Electrode Size and Type: N/A	
Mode of Metal Transfer for GMAW and FCAW: SPRAY	
Electrode Wire Feed Speed Range: 350 - 550 IPM	
TECHNIQUE (QW-410)	
String or Weave Bead: STRING	
Office or Gas Cup Size: ½" - 3/4"	
Initial and Interpass Cleaning: BURRING, GRINDING, S.S. WIRE BRUSH, OR CHEMICALS	
AS REQUIRED	
Method of Back Gouging: BURRING, GRINDING, OR ARC GOUGING FOLLOWED BY GRINDING	
Oscillation: N/A	
Contact Tube to Work Distance: ½"	
Multiple or Single Pass (Per Side): EITHER	
Multiple or Single Electrodes: SINGLE	
Travel Speed (Range): 6 - 14 IPM	
Peening: N/A	
Other CONSULT MFR's. RECOMMENDATIONS FOR CORRELATION BETWEEN DIFFERENT WIRE FEED, AMPERAGE AND VOLTAGE	
SETTINGS	

Weld Layer(s)	Process	Filler Metal		Current		Volt Range	Travel Speed Range	Remarks/ Comments
		Class	Diameter	Type Polar.	Amp. Range			
ALL	FCAW	E309LT	.035"	REVERSE	80-150	23-31	6-14 IPM	NO PULSING

WELDING PROCEDURE SPECIFICATION (WPS)

Company Name: CHM2HILL B&W West Valley, LLC

Welding Procedure Specification No.: W F8-8 Date: 5-12-99 Supporting PQR No: WF 8-8

Revision No.: 2 Date: 3-15-12

Welding Process: FCAW

Types: SEMI - AUTOMATIC

JOINTS (QW-402): Details

Joint Design GROOVES OR FILLETS

Backing (Yes) ★ (No) X

Backing material (type)★ WHEN USED, BACKING MATERIAL SHALL BE AS SPECIFIED IN WORK DOCUMENT
(Refer to both backing & retainers)

☐ Metal ☐ Nonfusing Metal

☐ Nonmetallic ☐ Other

BASE METALS (QW-403)

P-No. 8 Group No. N/A to P-No. 8 Group No. N/A

Specification type and grade

to Specification type and grade

Chem. Analysis and Mech. Prop.:

to Chem. Analysis and Mech. Prop:

Thickness Range:

Base Metal: Groove: 1/16" - ½" Fillet: ALL

Pipe Dia. Range: Groove: ALL Fillet: ALL

FILLER METALS (QW-404)		
SFA Specification:	SFA 5.22	
AWS Classification:	E308LT	
F-No.:	6	
A-No.:	N/A	
Size of Filler Metal:	.035"	
Deposited Weld Metal:		
Thickness Range:		
Groove:	½" MAX.	
Fillet:	ALL	
Electrode-Flux (Class):N/A		
Flux Trade Name:N/A		
Consumable Insert:N/A		

(BACK) WPS No. W F 8-8 Rev. 2

POSITION (QW 405)	POSTWELD HEAT TREATMENT (QW-407)
Position of Groove: ALL	Temperature Range: N/A
Weld Progression: UPHILL	Time Range: N/A
Position of Fillet: ALL	Gas (QW-408):
Other: N/A	Percent Composition
PREHEAT (QW-406)	Gas(es) (Mixture) Flow Rate
Preheat Temp. Min.: 50°F.	Shielding: ARGON / CO2 75 / 25 35-50 CFH
Interpass Temp. Min.: 50°F. Max: 350°F.	Trailing:
Preheat Maintenance: AS REQUIRED	Backing:

ELECTRICAL CHARACTERISTICS (QW-409)	
Current (AC or DC): DIRECT CURRENT	Polarity: REVERSE
Amps (Range): SEE BELOW	Volts (Range): SEE BELOW
Tungsten Electrode Size and Type: N/A	
Mode of Metal Transfer for GMAW and FCAW: SPRAY	
Electrode Wire Feed Speed Range: 180 - 550 IPM	

TECHNIQUE (QW-410)
String or Weave Bead: STRING
Office or Gas Cup Size: ½" - 3/4"
Initial and Interpass Cleaning BURRING, GRINDING, S.S. WIRE BRUSH, OR CHEMICALS
AS REQUIRED
Method of Back Gouging: BURRING, GRINDING, OR ARC GOUGING FOLLOWED BY GRINDING
Oscillation: N/A
Contact Tube to Work Distance: ½"
Multiple or Single Pass (Per Side): EITHER
Multiple or Single Electrodes: SINGLE
Travel Speed (Range): 6 - 14 IPM
Peening: N/A

Weld Layer(s)	Process	Filler Metal		Current		Volt Range	Travel Speed Range	Remarks/ Comments
		Class	Diameter	Type Polar.	Amp. Range			
ALL	FCAW	E308LT	.035"	REVERSE	80-150	23 31	6-14 IPM	NO PULSING

WELDING PROCEDURE SPECIFICATION (WPS)

Company Name: CHM2HILL B&W West Valley, LLC

Welding Procedure Specification No.: W M8-1 Date: Supporting PQR No: WM 8-1

Revision No.: 2 Date: 3-15-12

Welding Process: GMAW

Types: SEMI - AUTOMATIC

JOINTS (QW-402): Details

Joint Design GROOVES OR FILLETS

Backing (Yes) ★ (No) X

Backing material (type)★ WHEN USED, BACKING MATERIAL SHALL BE AS SPECIFIED IN WORK DOCUMENT
(Refer to both backing & retainers)

☐ Metal ☐ Nonfusing Metal

☐ Nonmetallic ☐ Other

BASE METALS (QW-403)

P-No. 8 Group No. N/A to P-No. 1 Group No. N/A

Specification type and grade

to Specification type and grade

Chem. Analysis and Mech. Prop.:

to Chem. Analysis and Mech. Prop.:

Thickness Range:

Base Metal: Groove: 1/16" - .275" Fillet: ALL

Pipe Dia. Range: Groove: Not to be used Fillet: Not to be used

FILLER METALS (QW-404)		
SFA Specification:	SFA 5.9	
AWS Classification:	ER309LSi	
F-No.:	6	
A-No.:	N/A	
Size of Filler Metal:	.030"	
Deposited Weld Metal:		
Thickness Range:		
Groove:	.275" MAX.	
Fillet:	ALL	
Electrode-Flux (Class):N/A		
Flux Trade Name:N/A		
Consumable Insert:N/A		

(BACK) WPS No. W M 8-1 Rev. 2

POSITION (QW-405)	POSTWELD HEAT TREATMENT (QW-407)
Position of Groove: ALL	Temperature Range: N/A
Weld Progression: UPHILL	Time Range: N/A
Position of Fillet: ALL	Gas (QW-408):
Other: N/A	Percent Composition
PREHEAT (QW-406)	Gas(es) (Mixture) Flow Rate
Preheat Temp. Min.: 50°F.	Shielding: He/Ar/CO2 90/7.5/2.5 25-45 CFH
Interpass Temp. Min.: 50°F. Max: 350°F.	Trailing: N/A
Preheat Maintenance: AS REQUIRED	Backing: N/A

ELECTRICAL CHARACTERISTICS (QW-409)
Current (AC or DC): DIRECT CURRENT Polarity: REVERSE
Amps (Range): SEE BELOW Volts (Range): SEE BELOW
Tungsten Electrode Size and Type: N/A
Mode of Metal Transfer for GMAW: SHORT-CIRCUIT
Electrode Wire Feed Speed Range: 156 - 312 IPM
TECHNIQUE (QW-410)
String or Weave Bead: STRING
Office or Gas Cup Size: ½" - 3/4"
Initial and Interpass Cleaning BURRING, GRINDING, S.S. WIRE BRUSH, OR CHEMICALS
AS REQUIRED
Method of Back Gouging: BURRING, GRINDING, OR ARC GOUGING FOLLOWED BY GRINDING
Oscillation: N/A
Contact Tube to Work Distance: 3/8"
Multiple or Single Pass (Per Side): EITHER
Multiple or Single Electrodes: SINGLE
Travel Speed (Range): 6 - 14 IPM
Peening: N/A

Weld Layer(s)	Process	Filler Metal		Current		Volt Range	Travel Speed Range	Remarks/ Comments
		Class	Diameter	Type Polar.	Amp. Range			
ALL	GMAW	ER309LSi	.030"	REVERSE	40-120	15-21	6-14 IPM	NO PULSING

WELDING PROCEDURE SPECIFICATION (WPS)

Company Name:
CHM2HILL B&W West Valley, LLC

Welding Procedure Specification No.: W M8-8 | Date: 06-04-99 | Supporting PQR No: WM 8-8

Revision No.: 2 | Date: 3-15-12

Welding Process: GMAW

Types: SEMI - AUTOMATIC

JOINTS (QW-402): | Details

Joint Design GROOVES OR FILLETS

Backing (Yes) ★ (No) X

Backing material (type)★ WHEN USED, BACKING MATERIAL SHALL BE AS SPECIFIED IN WORK DOCUMENT
(Refer to both backing & retainers)

☐ Metal ☐ Nonfusing Metal
☐ Nonmetallic ☐ Other

BASE METALS (QW-403)			
P-No. 8	Group No. N/A	to P-No. 8	Group No. N/A
Specification type and grade			
to Specification type and grade			
Chem. Analysis and Mech. Prop.			
to Chem. Analysis and Mech. Prop.			
Thickness Range:			
Base Metal:	Groove: 1/16" - .275"	Fillet: ALL	
Pipe Dia. Range:	Groove: Not to be used	Fillet: Not to be used	

FILLER METALS (QW-404)		
SFA Specification:	SFA 5.9	
AWS Classification:	ER308LSi	
F-No.:	6	
A-No.:	N/A	
Size of Filler Metal:	.030"	
Deposited Weld Metal:		
Thickness Range:		
Groove:	.275" MAX.	
Fillet:	ALL	
Electrode-Flux (Class):N/A		
Flux Trade Name:N/A		
Consumable Insert:N/A		

(BACK) WPS No.W M 8-8 Rev. 2

POSITION (QW-405)	POSTWELD HEAT TREATMENT (QW-407)
Position of Groove: ALL	Temperature Range: N/A
Weld Progression: UPHILL	Time Range: N/A
Position of Fillet: ALL	Gas (QW-408):
Other: N/A	Percent Composition
PREHEAT (QW-406)	Gas(es) (Mixture) Flow Rate
Preheat Temp. Min.: 50°F.	Shielding: He/Ar/CO2 90/7.5/2.5 25-45 CFH
Interpass Temp. Min.: 50°F. Max: 350°F.	Trailing: N/A
Preheat Maintenance: AS REQUIRED	Backing: N/A

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC or DC): DIRECT CURRENT — Polarity: REVERSE

Amps (Range): SEE BELOW — Volts (Range): SEE BELOW

Tungsten Electrode Size and Type: N/A

Mode of Metal Transfer for GMAW: SHORT-CIRCUIT

Electrode Wire Feed Speed Range: 156 - 312 IPM

TECHNIQUE (QW-410)

String or Weave Bead: STRING

Office or Gas Cup Size: ½" - 3/4"

Initial and Interpass Cleaning: BURRING, GRINDING, S.S. WIRE BRUSH, OR CHEMICALS

AS REQUIRED

Method of Back Gouging: BURRING, GRINDING, OR ARC GOUGING FOLLOWED BY GRINDING

Oscillation: N/A

Contact Tube to Work Distance: ½"

Multiple or Single Pass (Per Side): EITHER

Multiple or Single Electrodes: SINGLE

Travel Speed (Range): 6 - 14 IPM

Peening: N/A

Weld Layer(s)	Process	Filler Metal		Current		Volt Range	Travel Speed Range	Remarks/ Comments
		Class	Diameter	Type Polar.	Amp. Range			
ALL	GMAW	ER308LSi	.030"	REVERSE	40-120	15-21	6-14 IPM	NO PULSING

BRAZING PROCEDURE SPECIFICATIONS (BPS)

Company Name CHM2HILL B&W West Valley, LLC

BPS No. W B107-107 Date 06/27/96 Supporting PQR No. WB107-107

Revisions 1 5-16-11

2 3-15-12

Brazing Process(es) Torch Type(s) Manual
(Manual, mechanical torch, etc.)

JOINTS (QB-408) **Details**

Type of Joint(s) Lap/Socket

Joint Clearance Range .002" - .005"

Lap Length Range .250" - 1.170"

BASE METALS (QB-402)

P-No. 107 to P-No. 107
Spec. type and grade
to spec. type and grade
OR
Chem. analysis and mech. prop.
to chem. analysis and mech. prop.
Thickness Range .025" - .100"
Tube/Pipe Diam. Range All
Other

BRAZING FLUX OR ATMOSPHERE (QB-406)

Flux Trade Name or Composition N/A
Atmosphere for Furnace Brazing N/A
[name or trade designation of the fuel used or the name or trade designation of the gas compressing the atmosphere (hydrogen, Ammo-Gas, etc.) and a statement regarding the designed character of the furnace atmosphere, e.g., whether it is reducing, decarburizing, inert, etc.]

FILLER METALS (QB-403)

F-No. 103 Other
ASME Spec. No. A5.8 Other
AWS Class No. BCUP-5 Other
Size or Shape of Filler Metal 1/16", 3/32", 1/8"
Other

FLOW POSITION (QB-407)

Flow Position(s) Horizontal & Vertical Down
Method of Applying Filler Metal Face Feed
(face feeding, preplaced rings, shims, spray deposit, cladding, etc.)
Other

BRAZING TEMPERATURE (QB-404)

Temperature Range* N/A
Other

*Not applicable for torch brazing

POSTBRAZE HEAT TREATMENT (QB-409)

Type and temperature of aging or stabilizing thermal treatment after brazing N/A

TECHNIQUE (QB-410)

Method of Precleaning Emery Cloth

Method of Postbrazing Cleaning Emery Cloth, Wire Brush

Type of Flame Neutral

Torch Tip Size #1 - #10

Other

WELDING PROCEDURE SPECIFICATION (WPS)

Company Name: CHM2HILL B&W West Valley, LLC

Welding Procedure Specification No. TS 43-8 Date 9/10/99 Supporting PQR No(s) TS43/8-M

Revision No.: 1 Date: 3/15/12

Welding Process(es) GTAW/SMAW

Types (Manual, Automatic, Machine, Semi-Auto): MANUAL

JOINTS (QW-402): Details

Joint Design GROOVES OR FILLETS

Backing (Yes) (No) X

Backing material (type) N/A

(Refer to both backing & retainers)

☐ Metal ☐ Nonfusing Metal

☐ Nonmetallic ☐ Other

Sketches, Production Drawings, Weld Symbols or Written Description should show the general arrangement of the parts to be welded. Where applicable, the root spacing and the details of the weld groove may be specified.

(At the option of the Mfr., sketches may be attached to illustrate joint design, weld layers and bead sequence, e.g. for notch toughness procedures, for multiple process procedures, etc....)

*BASE METALS (QW-403)			
P-No. P43	Group No. N/A	to P-No. P8	Group No. 1 & 2
OR			
Specification type and grade N/A			
to Specification type and grade N/A			
OR			
Chem. Analysis and Mech Prop.: N/A			
to Chem. Analysis and Mech. Prop: N/A			
Thickness Range. N/A			
Base Metal:	Groove: 3/16" TO 1"	Fillet: ALL	
Pipe Dia. Range.	Groove: ALL	Fillet: ALL	
Other: N/A			

*FILLER METALS (QW-404)	GTAW	SMAW
SFA Specification:	SFA 5.14	SFA 5.11
AWS Classification:	ERNiCrXX-X	ENiCrXX-X
F-No.:	43	43
A-No.:	9	9
Size of Filler Metal	1/16", 3/32"	3/32", 1/8", 5/32"
Deposited Weld Metal Range		
Groove	3/8" MAX.	5/8" MAX
Fillet:	ALL	ALL
Electrode-Flux (Class):	N/A	N/A
Flux Trade Name:	N/A	N/A
Consumable Insert.	N/A	N/A
Other:	N/A	N/A

*Each base metal filler combination should be recorded individually

(BACK) WPS No. TS 43-8 Rev. 1

POSITION (QW-405)	POSTWELD HEAT TREATMENT (QW-407)
Position of Groove: ALL	Temperature Range: N/A
Weld Progression (Uphill, Downhill): UPHILL	Time Range: N/A
Position of Fillet: ALL	Gas (QW-408): (FOR GTAW ONLY)
Other: N/A	Percent Composition
PREHEAT (QW-406)	Gas(es) (Mixture) Flow Rate
Preheat Temp. Min.: 50° F	Shielding: ARGON 99.9% 15-30 CFH
Interpass Temp. Min.: 50° F Max: 350° F	Trailing: N/A
Preheat Maintenance: AS REQUIRED	Backing: ARGON 99.9% 5-15 CFH
	Other: GAS BACKING IS N/A FOR BACKING RINGS AND FILLETS

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC or DC): DC Polarity: GTAW: STRAIGHT SMAW: REVERSE

Amps (Range): SEE BELOW Volts (Range): SEE BELOW

(Amps & volts should be recorded for each electrode size, position, and thickness, etc.... This information may be listed in a tabular form similar to that shown below.)

Tungsten Electrode Size and Type: 3/32" (SFA 5.12, EWTh-2, EWLa)

Mode of Metal Transfer for GMAW and FCAW: N/A (Pure Tungsten, 2% Thoriated, etc...)

Electrode Wire Feed Speed Range: (Spray arc, short circuiting arc, etc..)

TECHNIQUE (QW-410)

String or Weave Bead: BOTH

Orifice or Gas Cup Size: #4 - #10

Initial and Interpass Cleaning: BRUSHING, GRINDING, BURRING OR CHEMICAL AS REQUIRED

Method of Back Gouging: BURRING, GRINDING OR AIR-ARC FOLLOWED BY GRINDING

Oscillation: N/A

Contact Tube to Work Distance: N/A

Multiple or Single Pass (Per Side):

Multiple or Single Electrodes: SINGLE

Travel Speed (Range): SEE BELOW

Peening: NONE

Other NO PASS SHALL BE GREATER THAN 3/16 IN. THICKNESS

Weld Layer(s)	Process	Filler Metal		Current		Volt Range	Travel Speed Range	Other (e.g. Remarks, Comments, Hot Wire Addition, Technique, Torch Angle, Etc.)
		Class	Diameter	Type Polar.	Amp. Range			
ROOT AND SUBSEQUENT LAYERS	GTAW	ERNiCrXX-X	1/16" 3/32"	(-) (-)	70 - 120 70 - 150	10 - 20 10 - 20	1-8 IPM 1-8 IPM	NO PULSING (TYP.)
	SMAW	ENiCrXX-X	3/32" 1/8" 5/32"	(+) (+) (+)	70 - 130 80 - 130 90 - 140	20 - 28 20 - 28 20 - 28	3-10 IPM 3-10 IPM 3-10 IPM	

WELDING PROCEDURE SPECIFICATION (WPS)

Company Name: CHM2HILL B&W West Valley, LLC

Welding Procedure Specification No.: TS 43-43 Date: 9/10/99 Supporting PQR No(s) TS43/43-M

Revision No.: 1 Date: 3-15-12

Welding Process(es): GTAW/SMAW

Types (Manual, Automatic, Machine, Semi-Auto): MANUAL

JOINTS (QW-402): Details

Joint Design GROOVES OR FILLETS

Backing (Yes) (No) X

Backing material (type) N/A

(Refer to both backing & retainers)

☐ Metal ☐ Nonfusing Metal

☐ Nonmetallic ☐ Other

Sketches, Production Drawings, Weld Symbols or Written Description should show the general arrangement of the parts to be welded. Where applicable, the root spacing and the details of the weld groove may be specified.

(At the option of the Mfr., sketches may be attached to illustrate joint design, weld layers and bead sequence, e.g. for notch toughness procedures, for multiple process procedures, etc....)

*BASE METALS (QW-403)			
P-No. P43	Group No. N/A	to P-No. P43	Group No. N/A
OR			
Specification type and grade N/A			
to Specification type and grade N/A			
OR			
Chem. Analysis and Mech. Prop.: N/A			
to Chem. Analysis and Mech. Prop: N/A			
Thickness Range: N/A			
Base Metal:	Groove: 3/16" TO 1"	Fillet: ALL	
Pipe Dia Range:	Groove: ALL	Fillet: ALL	
Other: N/A			

*FILLER METALS (QW-404)	GTAW	SMAW
SFA Specification:	SFA 5.14	SFA 5.11
AWS Classification:	ERNiCrXX-X	ENiCrXX-X
F-No.:	43	43
A-No.:	9	9
Size of Filler Metal:	1/16", 3/32"	3/32", 1/8", 5/32"
Deposited Weld Metal Range		
Groove.	3/8" MAX	5/8" MAX
Fillet:	ALL	ALL
Electrode-Flux (Class):	N/A	N/A
Flux Trade Name:	N/A	N/A
Consumable Insert.	N/A	N/A
Other:	N/A	N/A

*Each base metal-filler combination should be recorded individually

(BACK) WPS No. TS 43-43 Rev. 1

POSITION (QW-405)	POSTWELD HEAT TREATMENT (QW-407)
Position of Groove: ALL	Temperature Range: N/A
Weld Progression (Uphill, Downhill): UPHILL	Time Range: N/A
Position of Fillet: ALL	Gas (QW-408): (FOR GTAW ONLY)
Other: N/A	Percent Composition
PREHEAT (QW-406)	(Gases) (Mixture) Flow Rate
Preheat Temp. Min.: 50° F	Shielding: ARGON 99.9% 15-30 CFH
Interpass Temp. Min.: 50° F Max: 350° F	Trailing: N/A
Preheat Maintenance: AS REQUIRED	Backing: ARGON 99.9% 5-15 CFH
	Other: GAS BACKING IS N/A FOR BACKING RINGS AND FILLETS

ELECTRICAL CHARACTERISTICS (QW-409)

Current (AC or DC): DC — Polarity: GTAW: STRAIGHT SMAW: REVERSE

Amps (Range): SEE BELOW — Volts (Range): SEE BELOW

(Amps & volts should be recorded for each electrode size, position, and thickness, etc. .. This information may be listed in a tabular form similar to that shown below.)

Tungsten Electrode Size and Type: 3/32" (SFA 5.12, EWTh-2, EWLa)

Mode of Metal Transfer for GMAW: N/A — (Pure Tungsten, 2% Thoriated, etc...)

Electrode Wire Feed Speed Range: N/A — *(Spray arc, short circuiting arc, etc..)*

TECHNIQUE (QW-410)

String or Weave Bead: BOTH

Orifice or Gas Cup Size: #4 - #10

Initial and Interpass Cleaning: BRUSHING, GRINDING, BURRING OR CHEMICAL AS REQUIRED

Method of Back Gouging: BURRING, GRINDING OR AIR-ARC FOLLOWED BY GRINDING

Oscillation: N/A

Contact Tube to Work Distance: N/A

Multiple or Single Pass (Per Side):

Multiple or Single Electrodes: SINGLE

Travel Speed (Range): SEE BELOW

Peening: NONE

Other NO PASS SHALL BE GREATER THAN 3/16 IN. THICKNESS

Weld Layer(s)	Process	Filler Metal		Current		Volt Range	Travel Speed Range	Other (e.g. Remarks, Comments, Hot Wire Addition, Technique, Torch Angle, Etc.)
		Class	Diameter	Type Polar.	Amp. Range			
ROOT AND SUBSEQUENT LAYERS	GTAW	ERNiCrXX-X	1/16" 3/32"	(-) (-)	70 - 120 70 - 150	10 - 20 10 - 20	1-8 IPM 1-8 IPM	NO PULSING (TYP.)
	SMAW	ENiCrXX-X	3/32" 1/8" 5/32"	(+) (+) (+)	70 - 130 80 - 130 90 - 140	20 - 28 20 - 28 20 - 28	3-10 IPM 3-10 IPM 3-10 IPM	

WVDP RECORD OF REVISION

Rev. No.	Description of Changes	Revision On Page(s)	Dated
0	Original Issue	All	08/23/99
FC1	Section A - added TS43-8 and TS43-43 to Form WV-1888;	32	11/17/99
	Attachment A - added TS43-8 and TS43-43;	34	
	Added WPS TS43-8 (front)(Form WV-4161);	69	
	Added WPS TS43-8 (back) " " ;	70	
	Added WPS TS43-43 (front) " " ;	71	
	Added WPS TS43-43 (back) " " .	72	
FC2	Note deleted after 4.1.1;	11	01/21/00
	4.2.11 - changed reference section to 4.4.1[F];	15	
	4.6 - added wording from deleted Note (p. 11);	17	
	Updated Form WV-1888	32	
FC3	1.2.7, 1.2.8, 1.9 - Deleted reference to WV-119.	3, 5	08/09/00
FC4	Added Weld Filler Material Control Sections from SOP 00-32 No departments are affected by this change	3-7,27,28,29 31,33,38,39	10/19/01
FC5	Update Form WV-1888 to new revision number 4	31	11/06/01
1	**NEW-TYPE REVISION** **INCORPORATION OF FIELD CHANGES**	**ALL**	**11/19/01**
2	General Revision. This change was made to update the procedure per a periodic review. Changes include removing forms, updating personnel and department titles, removing unnecessary information, updating forms WV-1888, WV-4161 and WV-2526 and reformatting the procedure per DCIP-100. Qualified welders and engineering are affected by this change.	ALL	10/06/03
3	Updated cognizant manager	Cover	02/06/07
	Corrected typo in 1.5.5	4	
	Added reference to ANSI Z49.1 in 1.9, 4.1.1	6, 9	
	Changed WO/WR to Work document on WV-1888	15	
	Safety and certified welders are affected by this change		

WVDP RECORD OF REVISION CONTINUATION FORM

Rev. No.	Description of Changes	Revision On Page(s)	Dated
4	Major revision. Changed WVNSCO to WVES. Added W as prefix to WPS's to match existing PQR's. Clarified WPS weld progression to Uphill. Deleted CSWE. Added warehouse 'stock' requirements for filler material. Removed form WV-1888 from manual. Deleted WPS T17/4-8 and T17/4-17/4. Added JSA and hazard analysis requirements. Engineering, Infrastructure, QA and Safety are affected by this change.	All	06/29/11
5	General Revision - document revision to address CHBWV Transition Team Blue Sheet & Terminology Replacement Matrix comments. Updated company logo & name, department names, etc., throughout. All Weld Procedures were revised (3-15-12) due to company name change. Changed WE to SME throughout and added DDWO/Craft (mechanic) to filler material control. Updated forms and templates utilized to meet current ASME IX.(2011a). Forms WV-2526 and WV-4161 changed to templates. Added sect 1.7. Engineering, QA, and Infrastructure are affected by this change.	All	07/11/12

WVMP SAR Reference 8-9

Certified Test Reports, 2004:

Receiving Inspection and Material Validation – Steel Plate
Steel Warehouse, Certificate of Analysis and Tests
United States Steel Corporation, Metallurgical Test Reports
Bethlehem Steel Test Certificates; Report of Tests and Analysis
Fastenal Certificate of Compliance
Cardinal Fastener Test Certification
Wrought Washer Mfg. Certificate of Compliance
Steel Dynamics Chemical/Physical Certification
Nova Machine Products Corporation Material Test Report
Dyson Corp. Certified Test Report
Technical Stamping Material Certification
Sabre Steel Inc. Certificate of Conformance

RECEIVING INSPECTION & MATERIAL VALIDATION—STEEL PLATE

1.Receiving Information :

Purchased by : ATF   Supplier 15G   P.O.No. 53634

Line Item No. 3   AT&F Job NO. 40945   AT&F Heat Code NA

Receiver No. 7583   Date Rec'd. 6/18/04   Quantity Rec'd. 1

2.Dimensional Inspection :

Thickness : 6   6   6   6

(4 corners)

Width : 153   Length : 155

3. Material Marking or Stamping

Record the following information from Plate Stamping : (example)

15G	Plate Manufacturer	(BLP)
SA-516-70 MT	Material Spec and Type or Grade (G, MT, LTV if applicable)	(SA516-70 G MT LTV)
U2395	Plate Heat Number	(402T6511)
2	Plate Slab Number	(1)
	UT Number (if applicable)	(UT SA435)

4. Remarks : (e.g. shipping damage, other stamping or noted nonconformance)

Plate conforms to the attached P.O. requirements and the attached Material Test Reports match the Plate Markings.

Inspected by : [signature] Date 6/24/04 X Accept __ Reject

Validated by : [signature] Date 7-9-04 X Accept __ Reject

Code No.____ QDR S/N ______

Material Identification & Verification

(performed at time of fit-up)

1. Item Information :

Mfg. Serial #__________ AT&F Job No.__________ DWG./Item #__________ Rev.No.___

2. Permanent Stamping Information : (Center of Plate edge 6" from weld or as req'd.)

__________ Plate Manufacturer

__________ Material Spec and Type or Grade (G, MT, LTV if applicable)

__________ Plate Heat No.

__________ Plate Slab No.

__________ UT Number (if applicable)

Mfg. Ser. No. __________ Manufacturers Serial Number

Plate verified to be same as receipt inspected, plate edges visually inspected for laminations and permanent stamping inspected per attached AT&F validated Material Test Report (s)

Verified by : __________ Date ______ Q/C Review : __________ Date ______

AI-Review : __________ Date ______

SP110-2F1 Rev. 1 4/11/02

ISG PLATE INC.   TEST CERTIFICATE

SHIP TO:
AMERICAN TANK & FABR. CO.
12314 ELMWOOD AVE.
DOOR #11
CLEVELAND OH 44111

PAGE NO: 01 OF 02
FILE NO: 0325-01-05
MILL ORDER NO: 10291-002
MELT NO: U2395 ✓
SLAB NO: 2
DATE: 06/16/04

SOLD TO:
AMERICAN TANK & FAB. CO.
12314 ELMWOOD AVE.
CLEVELAND OH 44111

SEND TO:
TEST REPORT WITH SHIPMENT

FOR BOL # 44024

PLATE DIMENSIONS / DESCRIPTION

TOTAL QTY	GAUGE	WIDTH	LENGTH	DESCRIPTION	PIECE WEIGHT
	6"	153"	155"	RECTANGLE	40853#

CUSTOMER INFORMATION

CUSTOMER PO: 53634

SPECIFICATION(S)

THIS MATERIAL HAS BEEN MANUFACTURED AND TESTED IN ACCORDANCE WITH PURCHASE ORDER REQUIREMENTS AND SPECIFICATION(S).

ASTM A516 YR 90 GR 70
ASME SA516 2001 EDITION GRADE 70
MATERIAL PRODUCED UNDER A CERTIFIED QUALITY MGMT SYSTEM COMPLYING WITH
ISO 9001 ABS-QE CERT. NO. 30130

CHEMICAL COMPOSITION

	C	MN	P	S	CU	SI	NI	CR	MO
MELT:U2395	.24	.93	.008	.009	.25	.19	.12	.07	.05

	V	TI	AL	CB
MELT:U2395	.002	.002	.022	.001

MANUFACTURE

MCQUAID-EHN GRAIN SIZE PER E112 - 7-8

MEETS THE REQUIREMENTS
ASME SA 516-70 2001 Edition
J R 7-9-04 pg 1 of 2

HEAT TREAT CONDITION

MATL OR TEST	HEAT TREAT DESCRIPTION	NOM TEMP	HOLD MINS	COOL MTHD
PL/TEST	NORMALIZE	1650F	181	AIR COOL

PO# 53634

TENSILE PROPERTIES

40945-00a

SLAB NO.	LOC	DIR	STRENGTH PSI X 100	STRENGTH PSI X 100	GAGE LGTH	%
2	BOT.	TRANS.	423	766	2.00"	24.0

WE HEREBY CERTIFY THAT THE ABOVE INFORMATION IS CORRECT:

QUALITY ASSURANCE LABORATORY
COATESVILLE, PA 19320

SUPERVISOR - TEST REPORTING
ELINORE ZAPLITNY

MEETS THE REQUIREMENTS
ASME SA516-70 2001 edition
7-9-04 pg 2 of 2

40945-0000

ISG PLATE INC. T E S T C E R T I F I C A T E

FILE NO: 0325-01-05
MILL ORDER NO: 10291-002
MELT NO: U2395
SLAB NO: 2
DATE: 06/16/04

G E N E R A L I N F O R M A T I O N

ALL STEEL HAS BEEN MELTED AND MANUFACTURED IN THE U.S.A.
MERCURY OR MERCURY COMPOUNDS ARE NOT USED
IN THE MANUFACTURE OF ISG PRODUCTS.

40945-0000

RECEIVING INSPECTION & MATERIAL VALIDATION—STEEL PLATE

1.Receiving Information :

Purchased by : ATF Supplier ISG P.O.No. 53634

Line Item No. 3 AT&F Job NO. 40945 AT&F Heat Code NA

Receiver No. 7615 Date Rec'd. 6/23/04 Quantity Rec'd. 1

2.Dimensional Inspection :

Thickness : 6 6 6 6
(4 corners)

Width : 153 Length : 155

3. Material Marking or Stamping

Record the following information from Plate Stamping : (example)

ISG	Plate Manufacturer	(BLP)
SA516-70 MT	Material Spec and Type or Grade (G, MT, LTV if applicable)	(SA516-70 G MT LTV)
42395	Plate Heat Number	(402T6511)
3	Plate Slab Number	(1)
	UT Number (if applicable)	(UT SA435)

4. Remarks : (e.g. shipping damage, other stamping or noted nonconformance)

Plate conforms to the attached P.O. requirements and the attached Material Test Reports match the Plate Markings.

Inspected by : [signature] Date 6/24/04 X Accept __ Reject

Validated by : [signature] Date 7-9-04 X Accept __ Reject

Code No.____ QDR S/N______

Material Identification & Verification
(performed at time of fit-up)

1. Item Information :

Mfg. Serial #__________ AT&F Job No.________ DWG./ Item #________ Rev.No.____

2. Permanent Stamping Information : (Center of Plate edge 6" from weld or as req'd.)

____________ Plate Manufacturer

____________ Material Spec and Type or Grade (G, MT, LTV if applicable)

____________ Plate Heat No.

____________ Plate Slab No.

____________ UT Number (if applicable)

Mfg. Ser. No. ________ Manufacturers Serial Number

Plate verified to be same as receipt inspected, plate edges visually inspected for laminations and permanent stamping inspected per attached AT&F validated Material Test Report (s)

Verified by :__________ Date ______ Q/C Review :__________ Date ______

AI-Review : ______________ Date ______

SP110-2F1 Rev. 1 4/11/02

ISG PLATE INC. TEST CERTIFICATE

SHIP TO:
AMERICAN TANK & FABR. CO.
12314 ELMWOOD AVE.
DOOR #11
CLEVELAND OH 44111

PAGE NO: 01 OF 02
FILE NO: 0325-01-05
MILL ORDER NO: 10291-002
MELT NO: U2395
SLAB NO: 3
DATE: 06/16/04

SOLD TO:
AMERICAN TANK & FAB. CO.
12314 ELMWOOD AVE.
CLEVELAND OH 44111

SEND TO:
TEST REPORT WITH SHIPMENT

FOR BOL # 44027

PLATE DIMENSIONS / DESCRIPTION

TOTAL QTY	GAUGE	WIDTH	LENGTH	DESCRIPTION	PIECE WEIGHT
	6"	153"	155"	RECTANGLE	40353#

CUSTOMER INFORMATION

CUSTOMER PO: 53634

SPECIFICATION(S)

THIS MATERIAL HAS BEEN MANUFACTURED AND TESTED IN ACCORDANCE WITH PURCHASE ORDER REQUIREMENTS AND SPECIFICATION(S).

ASTM A516 YR 90 GR 70
ASME SA516 2001 EDITION GRADE 70
MATERIAL PRODUCED UNDER A CERTIFIED QUALITY MGMT SYSTEM COMPLYING WITH ISO 9001 ABS-QE CERT. NO. 30130

CHEMICAL COMPOSITION

	C	MN	P	S	CU	SI	NI	CR	MO
MELT:U2395	.24	.93	.008	.009	.25	.19	.12	.07	.05

	V	TI	AL	CB
MELT:U2395	.002	.002	.022	.001

MEETS THE REQUIREMENTS ✓
ASME SA516-70 2001 Edition
[signature] 7-9-04 pg 1 of 2

MANUFACTURE

MCQUAID-EHN GRAIN SIZE PER E112 - 7-8

HEAT TREAT CONDITION

P.O. 53634

MATL OR TEST	HEAT TREAT DESCRIPTION	NOM TEMP	HOLD MINS	COOL MTHD
PL/TEST	NORMALIZE	1650F	241	AIR COOL

40945-0000

TENSILE PROPERTIES

SLAB NO.	LOC	DIR	STRENGTH PSI X 100	STRENGTH PSI X 100	GAGE LGTH	%
3	BOT.	TRANS.	423	763	2.00"	25.0

WE HEREBY CERTIFY THAT THE ABOVE
INFORMATION IS CORRECT:

QUALITY ASSURANCE LABORATORY
COATESVILLE, PA 19320

SUPERVISOR - TEST REPORTING
ELINORE ZAPLITNY

40945-0000

MEETS THE REQUIREMENTS ✓

~~Meets +~~ ASME SA516-70 2001 ed.

J R 9-9-04. pg 2 of 2

ISG PLATE INC. T E S T   C E R T I F I C A T E

PAGE NO: 02 OF 02
FILE NO: 0325-01-05
MILL ORDER NO: 10291-002
MELT NO: U2395
SLAB NO: 3
DATE: 06/16/04

G E N E R A L   I N F O R M A T I O N

ALL STEEL HAS BEEN MELTED AND MANUFACTURED IN THE U.S.A.
MERCURY OR MERCURY COMPOUNDS ARE NOT USED
IN THE MANUFACTURE OF ISG PRODUCTS.

40945-0000

RECEIVING INSPECTION & MATERIAL VALIDATION—STEEL PLATE

1.Receiving Information :
Purchased by : ATF Supplier ISG P.O.No. 53634
Line Item No. 2 AT&F Job NO. 40945 AT&F Heat Code UA
Receiver No. 7582 Date Rec'd. 6/18/04 Quantity Rec'd. 1

2.Dimensional Inspection :
Thickness : 6 6 6 6
(4 corners)
Width : 154 Length : 153

3. Material Marking or Stamping
Record the following information from Plate Stamping : (example)

ISG	Plate Manufacturer	(BLP)
SA516-70 MT	Material Spec and Type or Grade (G, MT, LTV if applicable)	(SA516-70-G MT LTV)
U2465	Plate Heat Number	(402T6511)
2	Plate Slab Number	(1)
	UT Number (if applicable)	(UT SA435)

4 Remarks : (e.g. shipping damage, other stamping or noted nonconformance)

Plate conforms to the attached P.O. requirements and the attached Material Test Reports match the Plate Markings.
Inspected by : [signature] Date 6/24/04 X Accept __ Reject

Validated by [signature] Date 7-9-04 X Accept __ Reject
Code No.____ QDR S/N______

Material Identification & Verification
(performed at time of fit-up)

1. Item Information :
Mfg. Serial #__________ AT&F Job No.__________ DWG./ Item #__________ Rev.No.___

2. Permanent Stamping Information : (Center of Plate edge 6" from weld or as req'd.)

______________ Plate Manufacturer

______________ Material Spec and Type or Grade (G, MT, LTV if applicable)

______________ Plate Heat No.

______________ Plate Slab No.

______________ UT Number (if applicable)

Mfg. Ser. No. __________ Manufacturers Serial Number

Plate verified to be same as receipt inspected, plate edges visually inspected for laminations and permanent stamping inspected per attached AT&F validated Material Test Report (s)

Verified by :__________ Date ______ Q/C Review :__________ Date ______

AI-Review : ______________ Date ______

SP110-2F1 Rev. 1 4/11/02

ISG PLATE INC. T E S T   C E R T I F I C A T E

FILE NO: 0325-01-05
MILL ORDER NO: 10291-001
MELT NO: U2465 ✓
SLAB NO: 2
DATE: 06/16/04

SHIP TO:
AMERICAN TANK & FABR. CO.
12314 ELMWOOD AVE.
DOOR #11
CLEVELAND OH 44111

SOLD TO:
AMERICAN TANK & FAB. CO.
12314 ELMWOOD AVE.
CLEVELAND OH 44111

SEND TO:
TEST REPORT WITH SHIPMENT

FOR BOL # 44025

P L A T E   D I M E N S I O N S   /   D E S C R I P T I O N

TOTAL QTY	GAUGE	WIDTH	LENGTH	DESCRIPTION	PIECE WEIGHT
	6" ✓	154"	153"	RECTANGLE	40093#

C U S T O M E R   I N F O R M A T I O N

CUSTOMER PO: 53634

S P E C I F I C A T I O N (S)

THIS MATERIAL HAS BEEN MANUFACTURED AND TESTED IN ACCORDANCE WITH PURCHASE ORDER REQUIREMENTS AND SPECIFICATION(S).

ASTM A516 YR 90 GR 70
ASME SA516 2001 EDITION GRADE 70
MATERIAL PRODUCED UNDER A CERTIFIED QUALITY MGMT SYSTEM COMPLYING WITH ISO 9001 ABS-QE CERT. NO. 30130

C H E M I C A L   C O M P O S I T I O N

	C	MN	P	S	CU	SI	NI	CR	MO
MELT:U2465	.23	.95	.010	.011	.26	.19	.11	.10	.03

	V	TI	AL	CB
MELT:U2465	.002	.001	.029	.001

M A N U F A C T U R E

MCQUAID-EHN GRAIN SIZE PER E112 - 7-8

MEETS THE REQUIREMENTS ✓
ASME SA516-70 ✓ 2001 edition
J R 7-8-04 pg 1 of 2
40945-000

H E A T   T R E A T   C O N D I T I O N

MATL OR TEST	HEAT TREAT DESCRIPTION	NOM TEMP	HOLD MINS	COOL MTHD
PL/TEST	NORMALIZE	1650F	180	AIR COOL

PO# 53634

T E N S I L E   P R O P E R T I E S

SLAB NO.	LOC	DIR	YIELD STRENGTH PSI X 100	TENSILE STRENGTH PSI X 100	ELONGATION GAGE LGTH	%
2	BOT.	TRANS.	423	781	2.00"	23.0

WE HEREBY CERTIFY THAT THE ABOVE
INFORMATION IS CORRECT:

QUALITY ASSURANCE LABORATORY
COATESVILLE, PA 19320

SUPERVISOR - TEST REPORTING
ELINORE ZAPLITNY

40945-0000

MEETS THE REQUIREMENTS
ASME SA 516-70 - 2001 Sub/ad 02
7-9-04 pg 2 of 2

ISG PLATE

T E S T   C E R T I F I C A T E

FILE NO: 0925-01-05
MILL ORDER NO: 10291-001
MELT NO: U2465
SLAB NO: 2
DATE: 06/16/04

G E N E R A L   I N F O R M A T I O N

ALL STEEL HAS BEEN MELTED AND MANUFACTURED IN THE U.S.A.
MERCURY OR MERCURY COMPOUNDS ARE NOT USED
IN THE MANUFACTURE OF ISG PRODUCTS.

40945-0000

ISG PLATE 1

T E S T   C E R T I F I C A T E

PAGE NO: 02 OF 02
FILE NO: 0325-01-05
MILL ORDER NO: 10291-001
MELT NO: U2465
SLAB NO: 2
DATE: 06/16/04

NERAL INFORMATION

ALL STEEL HAS BEEN MELTED AND MANUFACTURED IN THE U.S.A.
MERCURY OR MERCURY COMPOUNDS ARE NOT USED
IN THE MANUFACTURE OF ISG PRODUCTS.

40945-0000

SLAB NO.	LOC	DIR	YIELD STRENGTH PSI X 100	TENSILE STRENGTH PSI X 100	ELONGATION GAGE LGTH	%
2 ✓	BOT.	TRANS.	423	781	2.00"	23.0

WE HEREBY CERTIFY THAT THE ABOVE
INFORMATION IS CORRECT:

QUALITY ASSURANCE LABORATORY
COATESVILLE, PA 19320

SUPERVISOR - TEST REPORTING
ELINORE ZAPLITNY

40945-0000

MEETS THE REQUIREMENTS ✓

ASME SA 516-70 - 2001 Ed/..

7-9-04 pg 2 of 2

ISG PLATE ₁ T E S T C E R T I F I C A T E

FILE NO: 0325-01-05
MILL ORDER NO: 10291-001
MELT NO: U2465
SLAB NO: 2
DATE: 06/16/04

G E N E R A L I N F O R M A T I O N

ALL STEEL HAS BEEN MELTED AND MANUFACTURED IN THE U.S.A.
MERCURY OR MERCURY COMPOUNDS ARE NOT USED
IN THE MANUFACTURE OF ISG PRODUCTS.

40945-0000

RECEIVING INSPECTION & MATERIAL VALIDATION—STEEL PLATE

1.Receiving Information :
Purchased by : ATF   Supplier ISG   P.O.No. 53634
Line Item No. 2   AT&F Job NO. 40945   AT&F Heat Code NA
Receiver No. 7616   Date Rec'd. 6/23/04   Quantity Rec'd. 1

2.Dimensional Inspection :
Thickness : 6 6 6 6
(4 corners)
Width : 154   Length : 153

3. Material Marking or Stamping
Record the following information from Plate Stamping :   (example)

ISG	Plate Manufacturer	(BLP)
SA516-70 MT	Material Spec and Type or Grade (G, MT, LTV if applicable)	(SA516-70 G MT LTV)
U2465	Plate Heat Number	(402T6511)
1	Plate Slab Number	(1)
	UT Number (if applicable)	(UT SA435)

4. Remarks : (e.g. shipping damage, other stamping or noted nonconformance) Plate has twist out of flat

Plate conforms to the attached P.O. requirements and the attached Material Test Reports match the Plate Markings.
Inspected by : [signature] Date 6/24/04 ~~X~~ Accept ✓ Reject Plate with A-20
Validated by : [signature] Date 7-9-04 X Accept __ Reject Flatness tolerance.
Code No.____ QDR S/N______ [initials] 7-9-04

Material Identification & Verification
(performed at time of fit-up)

1. Item Information :
Mfg. Serial #__________ AT&F Job No.__________ DWG./ Item #__________ Rev.No.___

2. Permanent Stamping Information : (Center of Plate edge 6" from weld or as req'd.)

______________________ Plate Manufacturer

______________________ Material Spec and Type or Grade
(G, MT, LTV if applicable)

______________________ Plate Heat No.

______________________ Plate Slab No.

______________________ UT Number (if applicable)

Mfg. Ser. No. ___________ Manufacturers Serial Number

Plate verified to be same as receipt inspected, plate edges visually inspected for laminations and permanent stamping inspected per attached AT&F validated Material Test Report (s)

Verified by :__________ Date ______ Q/C Review :____________ Date ______

AI Review : ____________________ Date ________

SP110-2F1 Rev. 1 4/11/02

ISG PLATE INC. T E S T   C E R T I F I C A T E

SHIP TO:
AMERICAN TANK & FABR. CO.
12314 ELMWOOD AVE.
DOOR #11
CLEVELAND OH 44111

PAGE NO: 01 OF 02
FILE NO: 0325-01-05
MILL ORDER NO: 10291-001
MELT NO: U2465
SLAB NO: 1
DATE: 06/21/04

SOLD TO:
AMERICAN TANK & FAB. CO.
12314 ELMWOOD AVE.
CLEVELAND OH 44111

SEND TO:
TEST REPORT WITH SHIPMENT

FOR BOL # 44482

P L A T E   D I M E N S I O N S   /   D E S C R I P T I O N

TOTAL QTY	GAUGE	WIDTH	LENGTH	DESCRIPTION	PIECE WEIGHT
	6"	154"	153"	RECTANGLE	40093#

C U S T O M E R   I N F O R M A T I O N

CUSTOMER PO: 53634

S P E C I F I C A T I O N (S)

THIS MATERIAL HAS BEEN MANUFACTURED AND TESTED IN ACCORDANCE WITH PURCHASE ORDER REQUIREMENTS AND SPECIFICATION(S).

ASTM A516 YR 90 GR 70
ASME SA516 2001 EDITION GRADE 70
MATERIAL PRODUCED UNDER A CERTIFIED QUALITY MGMT SYSTEM COMPLYING WITH ISO 9001 ABS-QE CERT. NO. 30130

C H E M I C A L   C O M P O S I T I O N

	C	MN	P	S	CU	SI	NI	CR	MO
MELT:U2465	.23	.95	.010	.011	.26	.19	.11	.10	.03

	V	TI	AL	CB
MELT:U2465	.002	.001	.029	.001

M A N U F A C T U R E

MCQUAID-EHN GRAIN SIZE PER E112 - 7-8

40945-0000

MEETS THE REQUIREMENTS ✓
ASME SA516-70 2001 edition
7-9-04 PS 1of2

H E A T   T R E A T   C O N D I T I O N

MATL OR TEST	HEAT TREAT DESCRIPTION	NOM TEMP	HOLD MINS	COOL MTHD
PL/TEST	NORMALIZE	1650F	180	AIR COOL

PO# 53634

T E N S I L E   P R O P E R T I E S

SLAB NO.	LOC	DIR	YIELD STRENGTH PSI X 100	TENSILE STRENGTH PSI X 100	ELONGATION GAGE LGTH	%
1	BOT.	TRANS.	385	758	2.00"	27.0

WE HEREBY CERTIFY THAT THE ABOVE
INFORMATION IS CORRECT:

QUALITY ASSURANCE LABORATORY
COATESVILLE, PA 19320

SUPERVISOR - TEST REPORTING
ELINORE ZAPLITNY

MEETS THE REQUIREMENTS ✓
ASME SA516-70 2001 Edition
7-9-04 pg 2 of 2

40945-0000

ISG PLATE INC. T E S T   C E R T I F I C A T E

PAGE NO: 02 OF 02
FILE NO: 0325-01-05
MILL ORDER NO: 10291-001
MELT NO: U2465
SLAB NO: 1
DATE: 06/21/04

GENERAL INFORMATION

ALL STEEL HAS BEEN MELTED AND MANUFACTURED IN THE U.S.A.
MERCURY OR MERCURY COMPOUNDS ARE NOT USED
IN THE MANUFACTURE OF ISG PRODUCTS.

40945-0000

ISG PLATE INC. T E S T C E R T I F I C A T E

SHIP TO:
AMERICAN TANK & FABR. CO.
12314 ELMWOOD AVE.
DOOR #11
CLEVELAND OH 44111

PAGE NO: 01 OF 02
FILE NO: 0325-01-
MILL ORDER NO: 10291-0(
MELT NO: U2395
SLAB NO: 1A
DATE: 07/16/

SOLD TO:
AMERICAN TANK & FAB. CO.
12314 ELMWOOD AVE.
CLEVELAND OH 44111

SEND TO:
AMERICAN TANK & FABR. CO.
12314 ELMWOOD AVENUE
ATTN: WAREHOUSE DEPT.
CLEVELAND, OH 44111

03

P L A T E D I M E N S I O N S / D E S C R I P T I O N

TOTAL QTY	GAUGE	WIDTH	LENGTH	DESCRIPTION	PIECE WEIGHT
1	4"	151"	162"	RECTANGLE	27750#

C U S T O M E R I N F O R M A T I O N

CUSTOMER PO: 53634

S P E C I F I C A T I O N (S)

THIS MATERIAL HAS BEEN MANUFACTURED AND TESTED IN ACCORDANCE WITH PURCHA
ORDER REQUIREMENTS AND SPECIFICATION(S).

ASTM A516 YR 90 GR 70
ASME SA516 2001 EDITION GRADE 70
MATERIAL PRODUCED UNDER A CERTIFIED QUALITY MGMT SYSTEM COMPLYING WITH
ISO 9001 ABS-QE CERT. NO. 30130

C H E M I C A L C O M P O S I T I O N

	C	MN	P	S	CU	SI	NI	CR	M
MELT:U2395	.24	.93	.008	.009	.25	.19	.12	.07	.0

	V	TI	AL	CB
MELT:U2395	.002	.002	.022	.001

M A N U F A C T U R E

MCQUAID-EHN GRAIN SIZE PER E112 - 7-8

H E A T T R E A T C O N D I T I O N

MATL OR TEST	HEAT TREAT DESCRIPTION	NOM TEMP	HOLD MINS	COOL MTHD
PL/TEST	NORMALIZE	1650F	134	AIR COOL

T E N S I L E P R O P E R T I E S

SLAB NO.	LOC	DIR	YIELD STRENGTH PSI X 100	TENSILE STRENGTH PSI X 100	ELONGATION GAGE LGTH	%
1A	BOT.	TRANS.	443	790	2.00"	26.0

WE HEREBY CERTIFY THE ABOVE
INFORMATION IS CORRECT:

QUALITY ASSURANCE LABORATORY
COATESVILLE, PA 19320

SUPERVISOR - TEST REPORTING
ELINORE ZAPLITNY

ISG PLATE INC. T E S T C E R T I F I C A T E

FILE NO: 0325-01-(
MILL ORDER NO: 10291-00
MELT NO: U2395
SLAB NO: 1A
DATE: 07/16/04

G E N E R A L I N F O R M A T I O N

ALL STEEL HAS BEEN MELTED AND MANUFACTURED IN THE U.S.A.
MERCURY OR MERCURY COMPOUNDS ARE NOT USED
IN THE MANUFACTURE OF ISG PRODUCTS.

B/L #46938 CUSTOMER'S TRUCK

WE HEREBY CERTIFY THE ABOVE
INFORMATION IS CORRECT:

QUALITY ASSURANCE LABORATORY
COATESVILLE, PA 19320

SUPERVISOR - TEST REPORTING
ELINORE ZAPLITNY

ISG PLATE INC. T E S T C E R T I F I C A T E

SHIP TO:
AMERICAN TANK & FABR. CO.
12314 ELMWOOD AVE.
DOOR #11
CLEVELAND OH 44111

PAGE NO: 01 OF 02
FILE NO: 0325-01-05
MILL ORDER NO: 10291-003
MELT NO: U2395
SLAB NO: 1B
DATE: 07/21/04

SOLD TO:
AMERICAN TANK & FAB. CO.
12314 ELMWOOD AVE.
CLEVELAND OH 44111

SEND TO:
AMERICAN TANK & FABR. CO.
12314 ELMWOOD AVENUE
ATTN: WAREHOUSE DEPT.
CLEVELAND, OH 44111

03-C

P L A T E D I M E N S I O N S / D E S C R I P T I O N

TOTAL QTY	GAUGE	WIDTH	LENGTH	DESCRIPTION	PIECE WEIGHT
1	4" ✓	151"	162"	RECTANGLE	27750#

C U S T O M E R I N F O R M A T I O N

CUSTOMER PO: 53634

S P E C I F I C A T I O N (S)

THIS MATERIAL HAS BEEN MANUFACTURED AND TESTED IN ACCORDANCE WITH PURCHASE ORDER REQUIREMENTS AND SPECIFICATION(S).

ASTM A516 YR 90 GR 70
ASME SA516 2001 EDITION GRADE 70
MATERIAL PRODUCED UNDER A CERTIFIED QUALITY MGMT SYSTEM COMPLYING WITH ISO 9001 ABS-QE CERT. NO. 30130

C H E M I C A L C O M P O S I T I O N

	C	MN	P	S	CU	SI	NI	CR	MO
MELT:U2395	.24	.93	.008	.009	.25	.19	.12	.07	.05

	V	TI	AL	CB
MELT:U2395	.002	.002	.022	.001

M A N U F A C T U R E

MCQUAID-EHN GRAIN SIZE PER E112 - 7-8

H E A T T R E A T C O N D I T I O N

MATL OR TEST	HEAT TREAT DESCRIPTION	NOM TEMP	HOLD MINS	COOL MTHD
PL/TEST	NORMALIZE	1650F	133	AIR COOL

T E N S I L E P R O P E R T I E S

SLAB NO.	LOC	DIR	YIELD STRENGTH PSI X 100	TENSILE STRENGTH PSI X 100	ELONGATION GAGE LGTH	%
1B	BOT.	TRANS.	426	787	2.00"	27.0

WE HEREBY CERTIFY THE ABOVE INFORMATION IS CORRECT:

QUALITY ASSURANCE LABORATORY
COATESVILLE, PA 19320

SUPERVISOR - TEST REPORTING
ELINORE ZAPLITNY

ISG PLATE INC. T E S T C E R T I F I C A T E

FILE NO: 0325-01-05
MILL ORDER NO: 10291-003
MELT NO: U2395
SLAB NO: 1B
DATE: 07/21/04

G E N E R A L I N F O R M A T I O N

ALL STEEL HAS BEEN MELTED AND MANUFACTURED IN THE U.S.A.
MERCURY OR MERCURY COMPOUNDS ARE NOT USED
IN THE MANUFACTURE OF ISG PRODUCTS.

B/L #47375 CUSTOMER'S TRUCK

WE HEREBY CERTIFY THE ABOVE
INFORMATION IS CORRECT:

QUALITY ASSURANCE LABORATORY
COATESVILLE, PA 19320

SUPERVISOR - TEST REPORTING
ELINORE ZAPLITNY

PAGE 1

CERT. #: 00422400

steel warehouse

2722 West Tucker Drive
South Bend, In 46624-1377

P.O. Box 1377
(574) 236-5100

CERTIFICATE OF ANALYSIS AND TESTS

FOR: AM. TANK & FAB CO.
12314 ELMWOOD AVE.
CLEVELAND OH 44111
DOOR 6

DATE: 09/15/04
YOUR P/O NUMBER 54275 ✓
SHIPPER NUMBER 00652848
OUR INVOICE NUMBER
OUR SALES ORDER 00646710

DESCRIPTION OF MATERIAL AND SPECIFICATIONS

1. HRTPHS 0001 11 0.1120 55.0000 X 372.0000 ✓ TCGXL

HEAT # 60515 NAFTA Y BUNDLE # 004035352B

CHEMICAL ANALYSIS

HEAT #	C ✓	MN ✓	P ✓	S ✓	SI ✓	AL	CB	V ✓
1. 60515 ✓	.050	0.800	.012	.002	.020	.020	.001	.056
	CR ✓	CU ✓	MO ✓	NI ✓	NIT	TI	B	
	0.040	0.070	.010	0.030	.0140	.001	.0000	

MECHANICAL PROPERTIES

BUNDLE # NAF	YIELD ✓	TENSILE ✓	ELONGATION % IN 2 IN. ✓	D		MISC
1. 004035352B Y	67500 psi	76150 psi	30	L		
				T		

S/N TCGXL
P.O. 54275

Meets The Requirements Of
ASTM A 572-50 Type 3 04A
BK 9/20/04
Bought to stock

THIS MATERIAL IS IN ACCORDANCE WITH AND CONFORMS TO
A572 -00 GR50 ✓

We hereby certify that the foregoing data is a true copy of the data furnished us by our supplier or resulting from tests performed in a recognized laboratory or our laboratory.

By ______________
Authorized Agent

FORM # SW-17 REV 1-99

United States Steel Corporation
Gary Works
Gary, IN 46402

Metallurgical Test Report

ORDER: UE51304-01
LOAD: T02438
PO NBR: 051170-00

PART:
INVOICE: 154-198163 SHIP DATE: 01/30/02
00 OH

SOLD TO:

THE AMERICAN TANK&FABRICATING CO
12314 ELMWOOD AVE
CLEVELAND OH 44111-5991

SHIP TO:

THE AMERICAN TANK&FABRICATING CO
12314 ELMWOOD AVE NW
DOOR #5
CLEVELAND OH 44111-5991

SERIAL (HEAT: M27525 I/C: 53W2) STEEL TYPE = CAST REDUCTION RATIO = 11.9 TO 1
84071B00 1.0" X 75.0" X 257.0" 5466LBS 1PC

SPEC: PLATE HIGH STRENGTH LOW ALLOY USS SIXTY-N ASTM A633 REV A 01-JAN-2000 GR E APPROVED STRUCTURAL QUALITY NORMALIZED PLATE

INSP: 01 MILL INSPECTION PRELIMINARY T/R TO ACCOMPANY SHIPPING PAPERS ALSO T/R TO INDICATE NO MERCURY CONTENT UPON SHIPMENT FAX T/R TO ATTN: GREG MAZUR AT 216-252-4871 RA/SN ALSO RA/LT CERTIFY THAT ALL MELTING AND MANUFACTURING TOOK PLACE IN THE USA.

HEAT M27525 MELTED AND MANUFACTURED IN THE USA. FINE GRAIN
C=.20 MN=1.37 P=.016 S=.008 SI=.21 CU=.30 NI=.15 CR=.13 MO=.05 AL=.027 N=.01 V=.09 CB=.001

TRANSVERSE	YIELD:	63.0	KSI	TENSILE:	84.0	KSI	2" % ELONGATION: 50.0
		63000	PSI		84000	PSI	8" % ELONGATION: 25.0

PRODUCT AND TEST SPECIMENS WERE NORMALIZED AT 1660 DEG F. FOR 00 HR 56 MIN. COOLING COMPLETED IN STILL AIR.

** END OF TEST RESULT DATA **

TEST RESULTS WERE CONDUCTED AND RECORDED IN ACCORDANCE WITH TEST METHODS ACCREDITED BY A2LA.
THIS REPORT SHALL NOT BE REPRODUCED OR ALTERED WITHOUT THE PRIOR WRITTEN APPROVAL OF UNITED STATES STEEL.
THIS PRODUCT WAS MANUFACTURED IN ACCORDANCE WITH THE QUALITY MANAGEMENT SYSTEM WHICH COMPLIES WITH ISO 9002:1994.

THIS IS TO CERTIFY THAT THE PRODUCT DESCRIBED HEREIN WAS MANUFACTURED, TESTED AND/OR INSPECTED IN ACCORDANCE WITH THE SPECIFICATION AND FULFILLS REQUIREMENTS IN SUCH RESPECT.
PREP. BY THE OFFICE OF D.M. BORMET, MANAGER, Q.A. BY: Ruben Fontaine DATE: 2-1-02

*0900 C F 3 0 0 0277450007A BKM 3 1 0

** LOAD TALLY **

PLATES

PICKUP(S)
32694,

Purchase Order Date	Purchase Order No.
11/19/01	051170-00

Invoice No.	U.S. Steel Order No.	Page
198163	UE51304	01

Subject to Section 7 of conditions of Bill of Lading in N.M.F.C. and U.F.C. No recourse clause is exercised.
USS Corp. - Consignor

Shipper's No. 154T02438-01

FROM
U. S. STEEL CORP.
GARY WORKS
GARY, INDIANA 46402

CHARGE 0277450 SHIP TO 007

SOLD TO
THE AMERICAN TANK&FABRICATING CO
12314 ELMWOOD AVE
CLEVELAND OH 44111-5991

SHIP TO
THE AMERICAN TANK&FABRICATING CO
12314 ELMWOOD AVE NW
DOOR #5
CLEVELAND OH 44111-5991

Date Shipped	From	Route / Carrier	
01/30/02	GARY, INDIANA	CAR CAP. 000 CAR TYPE CUSTOMER TRUCK FOR HIRE	9999998
Ship Mode	**Minimum Weight**		**PPD / COL.**
CTH	404	00 OH	COL

IF YOU USE A SHIPPER REFERENCE NBR FOR PYMT, USE 154T02438-01

ORDER ITEM HEAT ING CUT PC PLATE# GAUGE WIDTH LENGTH WEIGHT
ORDERED SIZE 1.0000 75.0000 257.0000

SPEC: USS SIXTY-N ASTM A633 REV A 01-JAN-2000 GR E APPROVED STRUCTURAL
CUST: PT#A633E-1.0000-W--
PT#: A633E-1.0000-W-
MARK: STAMP USS HT# SLAB# MT IN 1 PLACE
STEN CUST ORD# & USS EA PLT
STENCIL SIXTY-N STEEL A633 GR E
PACK: OR 1 PC - KEEP SIZES SEP
LOAD: FLATBED TRK - SHEET LIFTER UNLDG - BLOCK - COVER W/TARP
20000 LB ABSOLUTE MAX
B/L COVER WITH TARP

		BDHBD		METRIC	25.40MM	1905.00MM	6527.80MM	2479KG
UE51304	01	M27525 53 W2	1	084071A00	1.000	75.00	257.00	5466#
		BDHCY		METRIC	25.40MM	1905.00MM	6527.80MM	2479KG
UE51304	01	M27525 53 W2	1	084071B00	1.000	75.00	257.00	5466#

Per Controller - Gary Works USS Corp. - Shipper ________ Agent

Permanent Post Office Address of Shipper:
600 Grant Street, Pittsburgh, PA 15219-4776

Per ________

(MORE)

Bethlehem
Bethlehem Lukens Plate

TEST CERTIFICATE

CUSTOMER P.O.: J.C.R. 2765
DESCRIPTION :
1 - RECTANGLE 4 -X- 120 -X- 240
03-C

FILE N° 462-01-01
DATE: 07/23/99
MILL ORDER NO: 46292-005

SOLD TO:	SEND TO:	SHIP TO:
WARREN FABRICATING CORPORATION P.O. BOX 1032 WARREN OH 44482	WARREN FABRICATING CORPORATION P.O. BOX 1032 WARREN OH 44482	WARREN FABRICATING HUBBARD SIDE (OLD GATX) WEST END HUBBARD OH 44452

THIS MATERIAL HAS BEEN MANUFACTURED AND TESTED IN ACCORDANCE WITH PURCHASE ORDER REQUIREMENTS AND SPECIFICATION(S):

ASTM A36 YR 96 ASME SA36 YR 98

MATERIAL PRODUCED UNDER A CERTIFIED QUALITY MGMT SYSTEM COMPLYING WITH ISO 9002 ABS-QE CERT. NO. 30130

MELT/SLAB	CHEMICAL ANALYSIS															PRACTICES
	C	MN	P	S	CU	SI	NI	CR	MO	V	TI	B	AL	CB			
R2476	✓ .16	✓ .89	✓ .014	✓ .012	✓ .29	✓ .20	✓ .20	✓ .16	✓ .06	✓ .001			.032	✓ .001			

TENSILES					CHARPY V IMPACTS					OTHER TESTS PERFORMED
TYPE	YLD (PSI	TENS X 100)	% ELONG 2"	% R.A.	TYPE	TEMP		MILS LATERAL EXPANSION	% SHEAR	
SX	453 ✓	703 ✓	27.0 ✓							BBWJQ

INFORMATION

WEIGHT PER PIECE = 32671 LBS. 14850 KG.
ALL STEEL HAS BEEN MELTED AND MANUFACTURED IN THE U.S.A.
CUSTOMER ITEM NO. 006
B/L #61146 NUKL 2904

The American Tank & Fabricating Co.
MEETS THE REQUIREMENTS OF
ASTM A36-97a
REVIEWED BY: PJC DATE 3/14/00

HEAT TREAT CYCLES - MATL. OR TESTS - DEG							
MATL.	TEST	NOM TEMP	MIN TEMP	MAX TEMP	HOLD MINS.	COOL METHOD	E. TE

HEAT TREAT CYCLES - TESTS ONLY - DEG						
START END TEMP	NOM TEMP	MIN TEMP	MAX TEMP	HOLD MINS.	HEAT RATE MAX	CO RA M.

WE HEREBY CERTIFY THE ABOVE INFORMATION IS CORRECT: Quality Assurance Laboratory

Elinore Zaplitny

EV. F1-99)

BETHLEHEM STEEL CORPORATION
QUALITY and PRACTICE DEVELOPMENT
REPORT OF TESTS AND ANALYSES

ETHLEHEM LUKENS PLATE DIVISION

IPMENT NO.	DATE SHIPPED	CAR OR VEHICLE NO.		
803-06934	3-23-00	NS	BN 614279	PAGE 1

SOLD

SERIAL NUMBER	PAT. NO.	HEAT NUMBER	NO. PCS.	THICKNESS INCHES	WIDTH OR DIA. INCHES	LENGTH INCHES	WEIGHT POUNDS	YIELD POINT PSI	TENSILE STRENGTH PSI	ELONG. IN	ELONG. %	RED. %
PRODUCED UNDER A CERTIFIED QMS COMPLYING WITH ISO 9002 ABS-QE CERT. #30477												
QUALITY STEEL MELTED & MANUFACTURED IN THE U. S. A.												
PLATES - ASTM A516-90 GR 70 PVQ, ASME SA516 GR 70 PVQ 1998 EDITION												
MFST - LIFT MAX 15 TON-SIZES & GAUGES SEP UNLOG OH-MAGNET-CHAIN-SLING												
CO# J.C.R. 2887 GH 365-0653												
YIELD STRENGTH @ .5% E.U.L.												
S 62195		823L71250	1	1.5	120	240	12252	44200	79500	2	23	
S 62196		823L71250	1	1.5	120	240	12252	46300	79500	2	29	
PLATES - ASTM A 36-96, ASME SA36 1998 EDITION												
MFST - LIFT MAX 15 TON-SIZES & GAUGES SEP UNLOG OH-MAGNET-CHAIN-SLING												
CO# J.C.R. 2886 GH 365-0654												
		813L70150	1	1	120	480	16335	40400	64200	8	30	
		823L70120	2	1	120	480	32670	40000 41900	66400 67400	8 8	28 26	
		823L70130	1	1	120	480	16335	41400	67600	8	27	

Q—QUENCH TEMPERATURE T—TEMPER TEMPERATURE N—NORMALIZE TEMPERATURE

BDAYZ

SERIAL NUMBER	PAT. NO.	HEAT NUMBER	HARD	BEND	THICKNESS INCHES	TYPE	SIZE	DIR.	TEST TEMP. F	CHARPY IMPACT ENERGY FT. LBS. 1	2	3	SHEAR (%) 1	2	3	LAT. EXP. MILS 1	2	3

The American Tank & Fabricating Co.
MEETS THE REQUIREMENTS OF
ASTM A516-70 99A
REVIEWED BY: J Dean [signature] DATE 3-28-01

HEAT NUMBER	C	Mn	P	S	Si	Cu	Ni	Cr	Mo	V	Ti	Al	B	Cb	N	McQUAID GRAIN SIZE
823L71250	.24	1.10	.012	.007	.253	.019	.01	.03	.005	.002		.036		.002		
813L70150	.14	1.06	.017	.006	.208	.009	.01	.03	.005	.003				.002		
823L70120	.16	1.08	.015	.012	.232	.014	.01	.04	.005	.002				.002		
823L70130	.16	1.09	.015	.012	.224	.010	.01	.04	.005	.004				.002		

I CERTIFY THAT THE ABOVE RESULTS ARE A TRUE AND CORRECT COPY OF ACTUAL RESULTS CONTAINED IN RECORDS MAINTAINED BY BETHLEHEM AND ARE IN FULL COMPLIANCE WITH THE REQUIREMENTS OF THE SPECIFICATION CITED ABOVE. THIS TEST REPORT CANNOT BE ALTERED AND MUST BE TRANSMITTED INTACT WITH ANY SUBSEQUENT THIRD PARTY TEST REPORTS, IF REQUIRED.

SUPV. QUALITY and PRACTICE DEVELOPMENT D. W. ELWOOD PER WNK

United States Steel Corporation
Gary Works
Gary, IN 46402

PRELIMINARY TEST REPORT
CONFIRMING TEST REPORT WILL BE MAILED

ORDER: UE55784-06 PART:
LOAD: T13642 INVOICE: 154 241121 SHIP DATE: 12/05/02
J NBR: 52060 VEH ID: 130A OH 38097

SOLD TO:
THE AMERICAN TANK&FABRICATING CO
12314 ELMWOOD AVE
CLEVELAND OH 44111-5991

SHIP TO:
THE AMERICAN TANK&FABRICATING CO
12314 ELMWOOD AVE
DOOR #11
CLEVELAND OH 44111-5991

SERIAL HEAT: Y49461 I/C: 54W2 STEEL TYPE = CAST REDUCTION RATIO = 4.0 TO 1
X9108A00 3.0" X 93.0" X 330.0" 1 PC 26111.00 LBS

SPEC: PLATE HIGH STRENGTH LOW ALLOY USS SIXTY-N ASTM A633 01-JAN-2001 GR E APPROVED STRUCTURAL QUALITY NORMALIZED PLATE LCVN IMPACT TEST HEAT LOT FREQ. H LCVN 20 FT-LBS AVG @ +0 F LCVN 15 FT-LBS MIN @ +0 F

INSP: 01 MILL INSPECTION TEST REPORT TO INDICATE NO MERCURY CONTENT AND REPORT CB RA/SN ALSO RA/LT CERTIFY THAT ALL MELTING AND MANUFACTURING TOOK PLACE IN THE USA. ,

HEAT Y49461 MELTED AND MANUFACTURED IN THE USA. FINE GRAIN
C=.18 MN=1.33 P=.015 S=.007 SI=.22 CU=.28 NI=.13 CR=.12 MO=.05 AL=.027 N=.010 V=.11 CB=.001

TRANSVERSE	YIELD:	61.0	KSI	TENSILE:	85.0	KSI	2" % ELONGATION:	23.0
		61000	PSI		85000	PSI		
TRANSVERSE	YIELD:	63.0	KSI	TENSILE:	87.0	KSI	2" % ELONGATION:	32.0
		63000	PSI		87000	PSI		

LONGITUDINAL FL SIZE CHARPY IMPACT V-NOTCH +000 DEG F FT LBS/ 067-074-074
-18 DEG C AVG IMPACT STRENGTH +72 FT LBS
LONGITUDINAL FL SIZE CHARPY IMPACT V-NOTCH +000 DEG F FT LBS/ 098-074-088
-18 DEG C AVG IMPACT STRENGTH +87 FT LBS

PRODUCT AND TEST SPECIMENS WERE NORMALIZED AT 1660 DEG F. FOR 02 HR 48 MIN. COOLING COMPLETED IN STILL AIR.

MERCURY OR MERCURY BEARING COMPOUNDS ARE NOT USED IN THE MANUFACTURE OF THIS MATERIAL.
** END OF TEST RESULT DATA **

TEST RESULTS WERE CONDUCTED AND RECORDED IN ACCORDANCE WITH TEST METHODS ACCREDITED BY A2LA.
THIS REPORT SHALL NOT BE REPRODUCED OR ALTERED WITHOUT THE PRIOR WRITTEN APPROVAL OF UNITED STATES STEEL.
THIS PRODUCT WAS MANUFACTURED IN ACCORDANCE WITH THE QUALITY MANAGEMENT SYSTEM WHICH COMPLIES WITH ISO 9002:1994.

RDSUB

The American Tank & Fabricating Co.
MEETS THE REQUIREMENTS OF
ASTM A633 Grade E 00 400 & ASTM 673-01
REVIEWED BY: [signature] DATE 12-12-02

THIS IS TO CERTIFY THAT THE PRODUCT DESCRIBED HEREIN WAS MANUFACTURED, TESTED AND/OR INSPECTED IN ACCORDANCE WITH THE SPECIFICATION AND FULFILLS REQUIREMENTS IN SUCH RESPECT.
PREP. BY THE OFFICE OF D.M. BORMET, MGR, PLATE TECH BY: DATE:

*1515 PCNF NNN 0 0 0 0277450002A BKW 0 1 0

U.S. Steel Corporation Metallurgical Test Report

Gary Works
Gary, IN 46402

Heat Treat Number M47470

Grade A516-70

Size 3.0

ORDER: UE55761-01 PART:
LOAD: H04202 INVOICE: 154-239192 SHIP DATE: 11/20/02
PO NBR: JCR-3497 VEH ID: EJE 006257 H4202
SOLD TO: SHIP TO:

SERIAL HEAT: M47470 I/C: 55W1 STEEL TYPE = CAST REDUCTION RATIO = 4.0 TO 1
C9170A00 3.0" X 96.0" X 360.0" 1 PC 29404.00 LBS

SPEC: PLATE CARBON ASME SA 516 01-JUL-2001 2001 EDITION 2002 ADDENDA GR 70 APPROVED ASTM A516 01-JAN-2001 GR 70 APPROVED PVQ NORMALIZED PLATE KILLED FINE GRAIN MILL EDGE

INSP: 01 MILL INSPECTION RA/SW ALSO RA/LT CERTIFY THAT ALL MELTING AND MANUFACTURING TOOK PLACE IN THE USA.

HEAT M47470 MELTED AND MANUFACTURED IN THE USA. FINE GRAIN
C=.26 MN=0.99 P=.017 S=.010 SI=.22 CU=.02 NI=.02 CR=.04 MO=.01 AL=.025 V=.001 TI=.001 CB=.001

TRANSVERSE *YIELD: 44.0 KSI TENSILE: 77.0 KSI 2" % ELONGATION: 29.0
44000 PSI 77000 PSI
TENSILE TEST WAS TAKEN ON INGOT/CUT: 55W 1

PRODUCT AND TEST SPECIMENS WERE NORMALIZED AT 1660 DEG F. FOR 02 HR 48 MIN. COOLING COMPLETED IN STILL AIR.

* - YIELD STRENGTH @ 0.5% E.U.L.
** END OF TEST RESULT DATA **

TEST RESULTS WERE CONDUCTED AND RECORDED IN ACCORDANCE WITH TEST METHODS ACCREDITED BY A2LA.
THIS REPORT SHALL NOT BE REPRODUCED OR ALTERED WITHOUT THE PRIOR WRITTEN APPROVAL OF UNITED STATES STEEL.
THIS PRODUCT WAS MANUFACTURED IN ACCORDANCE WITH THE QUALITY MANAGEMENT SYSTEM WHICH COMPLIES WITH ISO 9002:1994.

BDWUX

The American Tank & Fabricating Co.
MEETS THE REQUIREMENTS OF
ASTM A516-70, 03a
REVIEWED BY: B Kennedy DATE 7/17/03

THIS IS TO CERTIFY THAT THE PRODUCT DESCRIBED HEREIN WAS MANUFACTURED, TESTED AND/OR INSPECTED IN ACCORDANCE WITH THE SPECIFICATION AND FULFILLS REQUIREMENTS IN SUCH RESPECT.
PREP. BY THE OFFICE OF D.M. BORMET, MGR, PLATE TECH BY: DATE: 11/22/02

[redacted] **ipsco steel inc.**

1770 Bill Sharp Boulevard, Muscatine, IA 52761-9412

T[redacted]ertificate

Form TC.1: Revision 1: Date 31 [redacted] 00

Customer P.O. No.: 106761	Mill Order No.: 41-046195-13	Shipping Manifest: 205387	
Product Description: ASTM A36(01)/A709(01A)36/ASME SA36(01ED) AASHTO M270(01)36		Ship Date: 31 Oct 03 Cert Date: 31 Oct 03	Cert No: 224975
Size: 2.000 X 96.00 X 240.0 (IN)			

Tested Pieces			Tensiles						Charpy Impact Tests												
Heat Id	Piece Id	Piece Dimensions	YS (PSI)	UTS (PSI)	Elong % of 2in	Elong % of 8in	Bend Test	Average Hardness	Absorbed Energy 1	2	3	Avg	% Shear 1	2	3	Avg	Test Temp	Test Dir	Test Size	BDWTT
B3J624	B34	1.995 X 96.96	42000	75000	25															
B3J624	B35	1.995 X 96.96	44000	76000	27															
A3J225	E09	1.995 X 96.87	42000	76000	33															

Chemical Analysis

Heat Id	C	Mn	P	S	Si	Tot Al	Cu	Ni	Cr	Mo	Cb	V	Ti	B	N
B3J624	.19	1.03	.015	.008	.26	.035	.24	.11	.11	.02	.003	.002	.029	.0003	.0063
A3J225	.19	1.02	.015	.002	.29	.033	.29	.12	.15	.03	.004	.003	.027	.0003	.0068

100 % MELTED AND MANUFACTURED IN THE USA. MTR.DIN50049/EN10204 PAR 3.1B
MERCURY HAS NOT BEEN USED IN THE DIRECT MANUFACTURING OF THIS MATERIAL
B3J624 B36 PIECES: 2, WEIGHT: 26968 A3J225 E09 PIECES: 1, WEIGHT: 13442

The American Tank & Fabricating Co.
MEETS THE REQUIREMENTS OF
ASTM A-36/03a
REVIEWED BY: BK DATE 12/22/03

Cust Part # :

WE HEREBY CERTIFY THAT THIS MATERIAL WAS TESTED IN ACCORDANCE WITH THE APPROPRIATE SPECIFICATION

P. A. CROZIER
Q.A. METALLURGIST

FASTENAL®
INDUSTRIAL & CONSTRUCTION SUPPLIES

Attn: Greg Moyer
6 pages

Certificate of Compliance

Sold To: Purchase Order: 54338

AMERICAN TANK AND FABRICATING CO

Job:

Invoice Date: 9/20/04

THIS IS TO CERTIFY THAT WE HAVE SUPPLIED YOU WITH THE FOLLOWING PARTS.
THESE PARTS WERE PURCHASED TO THE FOLLOWING SPECIFICATIONS.

10 PCS 2"-4.5x6.25 SHCS A193 B7 SUPPLIED UNDER OUR TRACE NUMBER mdoh2184 AND UNDER PART NUMBER 10971-01550

38 PCS 1"-8X2 ASTM A193 B7 HEAVY HEX BOLT, DOMESTIC SUPPLIED UNDER OUR TRACE NUMBER ic021254 AND UNDER PART NUMBER 0155550

38 PCS 1" A325 Plain F436 Dom Structural Flat Washer SUPPLIED UNDER OUR TRACE NUMBER sy031642 AND UNDER PART NUMBER 0133548

This is to certify that the above document is true and accurate to the best of my knowledge.

Fastenal Account Representative

This document was printed on 9/20/04 and was current at that time.
Please check current revision date of 12-15-03 to avoid using obsolete copies.

Cardinal Fastener Test Certification

Reported:9/22/2004

Certification No.:	20428	Shop Order#:	225206
Order No.:	105890 1	Heat No.:	HT# 11610780
Customer PO:	MDOH2184	Grade:	B7 SHCS
		Thread Class:	2A
Customer No.:	000000032106	Shipped Qty:	10
Customer:	FASTENAL MIDDLEBURG HTS, OH	Heat Treat Spec:	
Address:	17851 ENGLE ROAD	Supplier:	
	MIDDLEBURG HTS, OH 44130	Finish Spec.:	
		Supplier:	
Manufacturer:	Cardinal Fastener & Specialty Co.,	Item description:	2 - 4.5 x 8-1/4 B7 SHCS
Address:	5185 Richmond Road	Headmark:	Socket Head Capscrew
	Bedford Heights, Ohio 44146		
Laboratory:	Cardinal Fastener & Specialty Co.,		
Address:	5185 Richmond Road		
	Bedford Heights, Ohio 44146		

Notes:

Test No.:	28745	Order No.:	221728 0	Test Date:	5/25/2004	Test Disposition:	PASS
Specification:	MET_A574[5/8"TO3">=3D] -98 SPECIMEN MACHINED					Test Facility:	CFS
Tech. Name:	DFD	Tech. Title:	LT			LotSize(pcs/lbs):	244
Notes:	Tensile Test Per ASTM F606					Sample Size:	1
	Hardness Per ASTM E18						
	Accept Per. ASTM A574 Para.8.1& 12.3.2 Carb/Decarb						

Inspection (min. - max.) units	Disposition	Sample Values:
HARDNESS (37, 45) Rc	PASS	40
TENSILE (170000, 999999) PSI	PASS	182000
YIELD (153000, 999999) PSI	PASS	170000
ELONGATION% (8, 999) %	PASS	14
REDUCTION OF AREA (0, 999) %	PASS	49

Test No.:	27554	Order No.:	11610780 0	Test Date:	2/5/2004	Test Disposition:	PASS
Specification:	CHEM_GRADE 4140					Test Facility:	CHAPARREL
Tech. Name:	T HARRINGTON	Tech. Title:	QA			LotSize(pcs/lbs):	16737
Notes:	MACRO ETCH RESULTS: S1 R1 C1					Sample Size:	1

Inspection (min. - max.) units	Disposition	Sample Values:
CARBON (0, 999) %	PASS	0.4
MANGANESE (0, 999) %	PASS	0.83
PHOSPHORUS (0, 999) %	PASS	0.011
SULFUR (0, 999) %	PASS	0.014

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SILICON (0, 999) %	PASS	0.26
COPPER (0, 999) %	PASS	0.28
NICKEL (0, 999) %	PASS	0.08
CHROMIUM (0, 999) %	PASS	0.08
MOLYBDENUM (0, 999) %	PASS	0.197
ALUMINUM (0, 999) %	PASS	0.033
VANADIUM (0, 999) %	PASS	0.03

Cert No: 20428

ALL MANUFACTURING AND MATERIAL PROCESSES IN THIS PRODUCT HAVE OCCURED WITHIN THE U.S.A. IN COMPLIANCE WITH THE BUY AMERICA PROVISIONS OF THE SURFACE TRANSPORTATION ACT OF 1982

All data represented on this report relates only to the item(s) tested, which have been sampled in order to represent the processed lot identified in the description.

Information and data in the report is correct and reliable to the best of our knowledge; however, results are not guaranteed and no responsibility is assumed.

All items furnished on the above referenced Purchase Order are in full conformance with all Purchase Order and Specification Requirements. Test values, either provided by our supplier or generated in Cardinal's Laboratory, represent actual attributes of the items furnished and the test results are in full compliance with all applicable specification and order requirements. All manufacturing, testing, sampling and inspections have been performed in accordance with Cardinal's Quality Assurance Program. All applicable tests are in accordance with the Quality Control Manual dated 4/24/98. The product was manufactured and supplied free from mercury contamination. This document may only be reproduced unaltered and only for the purpose of certifying the same or lesser quality of the product specified herein. Reproduction or alteration of this document for any other purpose is prohibited.

(Approval)

Q.A.
(Title)

9/22/2004
(Date Approved)

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CARDINAL FASTENER & SPECIALTY CO., INC. / 5185 RICHMOND RD. BEDFORD HEIGHTS, OHIO 44146 / 216-831-3661

SB031642
-013356

STAMPING THE FUTURE

WROUGHT WASHER MFG., INC.

®

September 8, 2003

Certification of Compliance

118553
JESSUP WAREHOUSE
1225 MID-VALLEY DRIVE
JESSUP, PA 18434

Wrought Washer
Ordr/Lot Number
432774

Heat Number	Chemical Analysis C	Mn	P	S	Si
40313120	.340	.770	.009	.002	.200

Purchase Order Number	Part Description	Date Shipped	Quantity Shipped
JESSUP STOCK	1" S MARK HT	09/05/2003	12,000

We hereby certify that the subject parts conform to the requirements of the applicable specification indicated for the subject parts and are in complete conformance to F436-93. We hereby certify that the subject parts were hardened to RC 38-45.

We hereby certify that all statutory requirements as to American Production and Labor Standards and all conditions of purchase applicable to the transaction have been complied with and that the subject parts were melted and manufactured in the U.S.A.

Truly yours,
Wrought Washer Mfg., Inc.

David Zupancic
Q.C. Manager

Sworn and subscribed before me on September 8, 2003
My commission expires June 5, 2005

(030) SMARK, HT, F436
WW INTERNAL USE : 43352508/108/017318/62404

Steel Dynamics, Inc.
4500 County Road 59
Butler, IN 46721 USA
Telephone (260) 868-8000
Fax (260) 868-8935

CHEMICAL/PHYSICAL CERTIFICATION

SDI Steel Dynamics, Inc.

SHIP TO
HS Processing-Butler
4460 CR 59
Butler, IN 46721
United States

Butler RECEIVING
868-0880
868-9977

SOLD TO
Heidtman Steel - Erie
640 Lavoy Road
Erie, MI 48133
United States

Greg Good
CR,CRG & HRG Purchas
1-734-848-2915
868-0893

Customer #	Part #	Po #	Order #	Line Item #	Coil #	Heat #	Coil Weight (lbs)
11	16118	AP 18665	87714	1	B578573	40313120	48,520

Width (In)	Gauge (In)	Length(ft)	Material Specification	Product Description
48.50	0.125	2,027	SAE 1025	Prime Hot Rolled Band

Ladle Chemical Analysis %

C	Mn	P	S	Si	Al	Cu	Ni	Cr	Mo	Sn	N	V	Nb	Ti	B	Ca
0.34	0.77	0.009	0.002	0.20	0.03	0.08	0.04	0.04	0.01	0.005	0.009	0.00	0.00	0.00	0.000	0.002

Mechanical Properties

Yield Strength (PSI)	Tensile Strength (PSI)	Percent Elongation	Rockwell Result	
66,110	97,139	23.0	94	Tail Sample

62404

"Made & Mfg in the USA"

Melted, thin-slab cast, and rolled by proud Americans in Butler, Indiana, USA.
Shipped from Butler, IN, United States.
All tests were performed according to applicable standards and are correct as contained in the records of the company.
Quality Assurance

NOVA MACHINE PRODUCTS CORPORATION

18001 Sheldon Road
Middleburg Heights, OH
44130

216 267 3200
Fax 216 433 1640

MATERIAL TEST REPORT #0000029383 Page: 1

Date: 11/02/02

PO #: IC021254
Rel :
SO #: 0000080927
Line #: 38
Qty: 80 EA
Lot #: 0040011844
Heat #: US Y06420
Drwg: (80/BOX)

FASTENAL COMPANY
5851 GUION ROAD

INDIANAPOLIS, IN 46254

CL./STOCK: 0155550

DESC: 1"-8 UNC 2A x 2" HEAVY HEX SCREW

MATERIAL SPECIFICATIONS: ASTM A-193('01) Gr.B7

HEAT SPECIFICATIONS:
Quenched & tempered per the material specification, minimum tempering temperature: 1100 F

APPLICABLE SPECIFICATIONS:
ANSI/ASME B1.1 ANSI/ASME B18.2.1

QUALITY SPECIFICATIONS:
Domestic manufactured; This is a commercial grade item;

CHEMICAL TEST:
C .40 MN .92 P .012 S .005 SI .21 CU .02 NI .03 CR 1.01
MO .225 AL .034

MECHANICAL TEST:
TENSIL 134000PSI YIELD 115400PSI ELONG 21.4 REDUCT 61.7
HARD RC 29.2
MACRO ETCH: ACCEPTABLE

PROGRAM STATEMENT:
Nova Machine Products Corporation certifies that the material, parts, components or services supplied on this purchase order have been processed in accordance with, and therefore meet or exceed the quality requirements established by the references or specifications in this order. Maintained mercury free by Nova.

I certify that these results are a true and correct copy of records prepared and maintained by Nova Machine Products Corporation in compliance with the requirements of the purchase order and specifications cited.

Processed per ISO-9001('94)/ISO-9002, Certificate QQC 211. Fastener products received from Nova are FQA compliant.

Your salesperson is Beau Laslo
Please call day or night if you have any questions or comments.

Sheila Galaday, Quality Control

CERTIFIED TEST REPORT

DYSON CORP.
DN DOMESTIC NUT

53 Freedom Road
Painesville, OH 44077

440-946-3500
440-352-2700 fax

DYSON ORDER#	CUSTOMER ORDER#	ITEM NUMBER	QUANTITY SHIPPED	DATE SHIPPED
C 70701	MDOH2160	4 of 4	32 pc	8/26/04

CUSTOMER
Fastenal Company
17851 Englowood Drive
Middleburg Heights, OH 44130
USA

PRODUCT DESCRIPTION
1.50" (bolt diameter) flat washer, Plain

SPECIFICATIONS
ASTM-F436 Type 1

DRAWING

STARTING MATERIAL	DIA	GRADE	QTY	LOT CODE	HEAT NO.	ORIGINAL MILL
Flat Washer	1.500	F436	32	JEI	22469001	Sabre Steel

The product listed above was manufactured, tested, sampled, and inspected in accordance with the specification, purchase order, and any supplementary requirements and was found to meet those requirements unless otherwise noted.

1. The steel was melted and manufactured in the USA and the product was manufactured and tested in the USA.

MEETS REQ'TS OF: ✓
ASTM F436, TYPE
PC 9/24/04

PO# 054265
ITEM #1
P. 1 of 4

Attachments:
Mill/Supplier Test Reports

Deborah A. Smith
Q.A. Admin. Assistant
8/26/04

TSI TECHNICAL STAMPING EST. 1991

TECHNICAL STAMPING, INC.

50600 E. RUSSELL SCHMIDT BLVD.
CHESTERFIELD TWP., MI 48051
PH(586)948-3285 / FX(586)948-3286

CERTS OK
MAY 2 7 2003

MATERIAL CERTIFICATION

CODE JEI

CUSTOMER	CUSTOMER ORDER NUMBER	DATE
ZIEGLER'S BOLT & NUT HOUSE	146288	5/23/03

PART NUMBER	LOT NUMBER	QUANTITY
1-1/2" F436	0301-717	15,000

STEEL GRADE	HEAT	C	MN	P	S	SI	AL	[illegible]
	22469001 ✓	.29	1.34	✓ .011	✓ .001	.034	.027	REL.

SPECIFICATION		ACTUAL	GAUGE
O.D	2.969 - 3.031	2.997 - 3.000	CALIPER
I.D	1.625 - 1.656	1.639 - 1.641	CALIPER, PIN GAUGE
THICKNESS	.136 - .177	.138 - .140	MICROMETER
FLATNESS	MAX .010	.002	CALIPER
STEEL		SEE CERT	
HEAT TREAT		SEE CERT	
PLATING			
OTHER			

WE HEARBY CERTIFY THAT THE SUBJECT PARTS CONFORM TO THE REQUIREMENTS OF THE APPLICABLE SPECIFICATIONS INDICATED FOR THE SUBJECT PARTS AND ARE IN COMPLETE CONFORMANCE TO ASTM F436,HARDENED TO RC 38-45. THE MATERIAL WAS MELTED DOMESTICALLY. THE SUBJECT PARTS WERE MANUFACTURED DOMESTICALLY IN CHESTERFIELD TWP., MI U.S.A.

MEETS REQ'TS OF: CHEMISTRY OF ASTM F-436-04, TYPE I
PC 9/24/04

Robin Vaughn
AUTHORIZED SIGNATURE

JUNE M. SAXTON
Notary Public, Macomb County, MI
My Commission Expires Mar. 11, 2008

June M Saxton
5-23-03

PO# 054265
ITEM #1
P. 2 of 4

NOTARY PUBLIC

Qlty.3008 Rev. 1 11-28-01

Q.A. REVIEWED
DS
DATE 12/23/03
DYSON

2833

Alpha Steel Treating Inc.
32969 GLENDALE AVENUE
LIVONIA, MICHIGAN 48150-1613
PHONE (734) 523-1030
FAX (734) 523-1039

WORK ORDER–CERTIFICATION

QS 9000 REGISTERED
ISO 9002 REGISTERED
ACCREDITED MECHANICAL 0220-01
0220-01

CODE JEI

1/14/03

CUSTOMER SHIPPER	DATE RECEIVED	Q NUMBER	WORK ORDER
1449	1/14/03		00897553/001

SOLD TO	SHIP TO
TECHNICAL STAMPING 50600 E. RUSSELL SCHMIDT CHESTERFIELD TWP MI	TECHNICAL STAMPING 50600 E. RUSSELL SCHMIDT CHESTERFIELD TWP MI

PART NUMBER	DESCRIPTION
FO112	2.99ID x 1.64IDx.140Th FLAT WASHER

LOT NUMBER	HEAT NUMBER	ORDER WEIGHT	ORDER QUANTITY
0301-717		9059 7545	6

QUALITY CONTROL	QUALITY CONTROL CODES
Hold for Q.C.	PMF10/16/2002 JDP

PROCESS DESCRIPTION	REV. # & DATE	MATERIAL	GRADE/CLASS
Harden Temper ASTM F434		1035	

HEAT TREAT SPECIFICATIONS

HARDNER TEMP	BELT SPEED	CARBON PROBE	QUENCH MEDIUM	LOADER SETTING	MMI RECIPE	RUN TIME	PROD. RATE	TIME/BI
1575	18.0	.50	130-140	OI 4000 #/HR	1861	1.68	269	27.1

CORE SPEC	MEAN	SURFACE SPEC	WASHER SPEC	CASE SPEC
HRC 39.00-43.00 Hold 38.00-45.00	41.00	15N 79.5-83.0		

CONTAINER INFORMATION

Desc - 6 BIN
Cnts - 083 535 701 413 555 847

Q.A. REVIEWED
DATE 1/23/03
DYSON

SPECIAL INSTRUCTIONS

Run Samples RC RB 43-42 Temp 750 FCE 3
MMI S/36 INSP 220

CHECK HARDNESS ON FLAT AFTER BUFF

OPERATORS MUST SIGN ROUTING TAGS!!!!!!!!

QUENCH TEMP NOT TO EXCEED 160xF MAINTAIN 130-160xF

PO#05426
ITEM #1
P. 3 of 4

NO MINIMUM TEMPERING TEMP.
OPERATOR SIGN OFF
HARDNER OPE __________ DRAW OPE 249

CERTIFIED COPY

MEETS REQ'TS OF:
MECHANICAL PROPERTIES OF ASTM F436-04, TYPE 1
PC 9/24/04

STAGING/LOADING INSPECTION: FURNACE OPERATOR #1	110	FURNACE OPERATOR #2	220
BINS FREE OF GREEN PARTS: FURNACE OPERATOR	220	OPERATOR INSPECTOR	249
SOLUBLE OIL	DRY	TEMPERING TEMPERATURE	760

THIS TWO SIDED DOCUMENT MUST BE REPRODUCED IN WHOLE

2833

CERTIFICATE OF CONFORMANCE

SABRE STEEL INC.
23680 RESEARCH DRIVE
FARMINGTON HILL, MI 48335
248-615-0500

DATE: 1/03/03

CODE JET

SOLD TO: TECHNICAL STAMPING
50600 E. RUSSELL SCHMIDT BLVD.
CHESTERFIELD TWP., MI 48051

SHIP TO: TECHNICAL STAMPING
50600 RUSSELL SCHMIDT BLVD.
CHESTERFIELD TWP., MI 48051

Cust P/O# 7003 Part# F0112 Sales Ord 007389
Work Ord 016100

SIZE: .136 MIN X 3.20 X COIL

GRADE:

DATE SHPPD: 1/03/03 B/L# 060787

Wt.Shipped 16585

CHEMICAL ANALYSIS

Heat Number 22469001

C : .29 ✓ Mn: 1.34 P : .011 S : .001 ✓
Si: .034 Al: .027

PHYSICAL PROPERTIES

Chemistry: C1027

Q.A. REVIEWED
DATE 12/23/03
DYSON

MADE AND MELTED IN THE USA

MEETS REQ'TS OF:
CHEMISTRY OF ASTM F436-04, TYPE 1
PC 9/24/04

PO# 054265
ITEM #1
P. 4 OF 4

WE HEREBY CERTIFY THE ABOVE FIGURES ARE ACCURATELY STATED, MEET YOUR MATERIAL REQUIREMENTS AND ARE TRACEABLE IN OUR RECORDS BACK TO THE PRODUCER AND/OR AN ACCREDITED TEST LABORATORY.

QUALITY ASSURANCE MANAGER

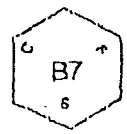
Attn: GREG MAZUR

Cardinal Fastener Test Certification

(216) - 252 - 4871
(440) 243-6072

Reported:9/27/2004

Certification No.:	20489	Shop Order#:	00224750
Order No.:	106603 1	Heat No.:	300187
Customer PO:	MDOH2157	Grade:	B7 Heavy hex bolt
Customer No.:	000000032106	Thread Class:	2A
Customer:	FASTENAL MIDDLEBURG HTS, OH	Shipped Qty:	32
Address:	17651 ENGLE ROAD MIDDLEBURG HTS, OH 44130	Heat Treat Spec:	
		Supplier:	
		Finish Spec.:	
		Supplier:	
Manufacturer:	Cardinal Fastener & Specialty Co.,	Item description:	1 1/2 - 6 x 8: B7 ✓
Address:	5185 Richmond Road Bedford Heights, Ohio 44146	Headmark:	Heavy Hex Bolt
Laboratory:	Cardinal Fastener & Specialty Co.,		
Address:	5185 Richmond Road Bedford Heights, Ohio 44146		
Notes:			



Test No.:	28982	Order No.:	221531 0	Test Date:	6/10/2004	Test Disposition:	PASS
Specification:	MET_A193(1/2"TO1 3/4">=3D) -99				Test Facility:	CFS	
Tech. Name:	DFD	Tech. Title:	LT			LotSize(pcs/lbs):	557
Notes:	Wedge Test Per ASTM A370 Hardness Per ASTM E18 1100 Deg. Min Temper Wedge Angle 10 Degrees					Sample Size:	1

Inspection (min. - max.) units	Disposition	Sample Values:
HARDNESS (0, 35) Rc	PASS	33 ✓
TENSILE (125000, 999999) PSI	PASS	153566

Test No.:	28983	Order No.:	221531 0	Test Date:	6/18/2004	Test Disposition:	PASS
Specification:	MET_A193(1/2"TO2">=3D) -99 Specimen				Test Facility:	CFS	
Tech. Name:	DFD	Tech. Title:	LT			LotSize(pcs/lbs):	557
Notes:	Tensile Test Per ASTM A370 1100 Deg. Min Temper ✓					Sample Size:	1

Inspection (min. - max.) units	Disposition	Sample Values:
TENSILE (125000, 999999) PSI	PASS	152000 ✓
YIELD (105000, 999999) PSI	PASS	140200 ✓
ELONGATION% (16, 999) %	PASS	16 ✓
REDUCTION IN AREA (50, 999) %	PASS	52 ✓

MEETS REQ'TS OF:
ASTM A193-01b, GRADE B7 ✓
PC 9/28/04

PO #054625
ITEM #2
P. 1 OF 2

This report shall not be reproduced except in full, without the written approval of Cardinal Fastener & Specialty Co., Inc.

CARDINAL FASTENER & SPECIALTY CO., INC. / 5185 RICHMOND RD. BEDFORD HEIGHTS, OHIO 44146 / 216-831-3661

Test No.: 27569	Order No.:	300187 0	Test Date: 2/6/2004	Test Disposition:	PASS
Specification: CHEM_GRADE 4140 HR			Test Facility:	ALTON STEEL INC	
Tech. Name: R CAULEY		Tech. Title: QA		LotSize(pcs/lbs):	35186
Notes: MACRO ETCH RESULTS: S2 R3 C2				Sample Size:	1

Inspection (min. - max.) units	Disposition	Sample Values:
CARBON (0, 999) %	PASS	0.41 ✓
MANGANESE (0, 999) %	PASS	0.79 ✓
PHOSPHORUS (0, 999) %	PASS	0.015 ✓
SULFUR (0, 999) %	PASS	0.025 ✓
SILICON (0, 999) %	PASS	0.027 ✓
COPPER (0, 999) %	PASS	0.22
NICKEL (0, 999) %	PASS	0.074
CHROMIUM (0, 999) %	PASS	0.939 ✓
MOLYBDENUM (0, 999) %	PASS	0.18 ✓
ALUMINUM (0, 999) %	PASS	0.004
VANADIUM (0, 999) %	PASS	0.036

Cert No: 20488

ALL MANUFACTURING AND MATERIAL PROCESSES IN THIS PRODUCT HAVE OCCURED WITHIN THE U.S.A. IN COMPLIANCE WITH THE BUY AMERICA PROVISIONS OF THE SURFACE TRANSPORTATION ACT OF 1982

All data represented on this report relates only to the item(s) tested, which have been sampled in order to represent the processed lot identified in the description.

Information and data in the report is correct and reliable to the best of our knowledge; however, results are not guaranteed and no responsibility is assumed.

All items furnished on the above referenced Purchase Order are in full conformance with all Purchase Order and Specification Requirements. Test values, either provided by our supplier or generated in Cardinal's Laboratory, represent actual attributes of the items furnished and the test results are in full compliance with all applicable specification and order requirements. All manufacturing, testing, sampling and inspections have been performed in accordance with Cardinal's Quality Assurance Program. All applicable tests are in accordance with the Quality Control Manual dated 4/24/98. The product was manufactured and supplied free from mercury contamination. This document may only be reproduced unaltered and only for the purpose of certifying the same or lesser quality of the product specified herein. Reproduction or alteration of this document for any other purpose is prohibited.

Denise L Merba
(Approval)

Q.A.
(Title)

9/27/2004
(Date Approved)

MEETS REQ'TS OF: ✓
ASTM A193-01b, GRADE B7
PC 9/28/04

PO #054625
ITEM #2
P. 2 OF 2

This report shall not be reproduced except in full, without the written approval of Cardinal Fastener & Specialty Co., Inc.

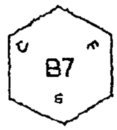
CARDINAL FASTENER & SPECIALTY CO., INC. / 5185 RICHMOND RD. BEDFORD HEIGHTS, OHIO 44146 / 216-831-3651

Attn: Wally Danko

Cardinal Fastener Test Certification

Reported: 10/20/2004

Certification No.:	20634	Shop Order#:	00226086
Order No.:	107459 1	Heat No.:	300187
Customer PO:	MDOH2236	Grade:	A193 b7
Customer No.:	00000032108	Thread Class:	2a
Customer:	FASTENAL MIDDLEBURG HTS, OH	Shipped Qty:	7
Address:	17851 ENGLE ROAD MIDDLEBURG HTS, OH 44130	Heat Treat Spec:	
		Supplier:	
		Finish Spec.:	
		Supplier:	
Manufacturer:	Cardinal Fastener & Specialty Co.,	Item description:	1 1/2 - 6 x 8: B7
Address:	5185 Richmond Road Bedford Heights, Ohio 44146	Headmark:	Heavy Hex Bolt
Laboratory:	Cardinal Fastener & Specialty Co.,		
Address:	5185 Richmond Road Bedford Heights, Ohio 44146		
Notes:			



Test No.:	28982	Order No.:	221531 0	Test Date:	6/18/2004	Test Disposition:	PASS
Specification:	MET_A193[1/2"TO1 3/4">=3D] -99					Test Facility:	CFS
Tech. Name:	DFD	Tech. Title:	LT			LotSize(pcs/lbs):	557
Notes:	Wedge Test Per ASTM A370 Hardness Per ASTM E18 1100 Deg. Min Temper Wedge Angle 10 Degrees					Sample Size:	1

Inspection (min. - max.) units	Disposition	Sample Values:
HARDNESS (0, 35) Rc	PASS	33
TENSILE (125000, 999999) PSI	PASS	183566

Test No.:	28983	Order No.:	221531 0	Test Date:	6/18/2004	Test Disposition:	PASS
Specification:	MET_A193(1/2"TO2">=3D) -99 Specimen					Test Facility:	CFS
Tech. Name:	DFD	Tech. Title:	LT			LotSize(pcs/lbs):	557
Notes:	Tensile Test Per ASTM A370 1100 Deg. Min Temper					Sample Size:	1

Inspection (min. - max.) units	Disposition	Sample Values:
TENSILE (125000, 999999) PSI	PASS	152000
YIELD (105000, 999999) PSI	PASS	140200
ELONGATION% (16, 999) %	PASS	16
REDUCTION IN AREA (50, 999) %	PASS	52

This report shall not be reproduced except in full, without the written approval of Cardinal Fastener & Specialty Co., Inc.

Test No.:	27669	Order No.:	300187 0	Test Date:	2/6/2004	Test Disposition:	PASS
Specification:	CHEM_GRADE 4140 HR				Test Facility:	ALTON STEEL INC	
Tech. Name:	R DAULEY		Tech. Title:	QA		LotSize(pcs/lbs):	35186
Notes:	MACRO ETCH RESULTS: S2 R3 C2					Sample Size:	1

Inspection (min. - max.) units	Disposition	Sample Values:
CARBON (0, 999) %	PASS	0.41
MANGANESE (0, 999) %	PASS	0.79
PHOSPHORUS (0, 999) %	PASS	0.015
SULFUR (0, 999) %	PASS	0.025
SILICON (0, 999) %	PASS	0.027
COPPER (0, 999) %	PASS	0.22
NICKEL (0, 999) %	PASS	0.074
CHROMIUM (0, 999) %	PASS	0.939
MOLYBDENUM (0, 999) %	PASS	0.18
ALUMINUM (0, 999) %	PASS	0.004
VANADIUM (0, 999) %	PASS	0.038

Cert No: 20634

ALL MANUFACTURING AND MATERIAL PROCESSES IN THIS PRODUCT HAVE OCCURED WITHIN THE U.S.A. IN COMPLIANCE WITH THE BUY AMERICA PROVISIONS OF THE SURFACE TRANSPORTATION ACT OF 1982

All data represented on this report relates only to the item(s) tested, which have been sampled in order to represent the processed lot identified in the description.

Information and data in the report is correct and reliable to the best of our knowledge; however, results are not guaranteed and no responsibility is assumed.

All items furnished on the above referenced Purchase Order are in full conformance with all Purchase Order and Specification Requirements. Test values, either provided by our supplier or generated in Cardinal's Laboratory, represent actual attributes of the items furnished and the test results are in full compliance with all applicable specification and order requirements. All manufacturing, testing, sampling and inspections have been performed in accordance with Cardinal's Quality Assurance Program. All applicable tests are in accordance with the Quality Control Manual dated 4/24/98. The product was manufactured and supplied free from mercury contamination. This document may only be reproduced unaltered and only for the purpose of certifying the same or lesser quality of the product specified herein. Reproduction or alteration of this document for any other purpose is prohibited.

Denise L Marka
(Approval)

Q.A.
(Title)

10/20/2004
(Date Approved)

This report shall not be reproduced except in full, without the written approval of Cardinal Fastener & Specialty Co., Inc.

CARDINAL FASTENER & SPECIALTY CO., INC. / 5185 RICHMOND RD. BEDFORD HEIGHTS, OHIO 44146 / 216-831-3851

Received Time Oct. 20. 4:29PM

NOVA MACHINE PRODUCTS CORPORATION

18001 Sheldon Road
Middleburg Heights, OH
44130

216 267 3200
Fax 216 433 1640

MATERIAL TEST REPORT #0000029387 Page: 1

Date: 10/20/04

FASTENAL COMPANY
5851 GUION ROAD

INDIANAPOLIS, IN 46254

CL./STOCK:0155558

PO #: IC021254
Rel :
SO #: 0000080927
Line #: 42
Qty: 150 EA
Lot #: 0040012015
Heat #: US Y06420
Drwg:(50/BOX)

DESC: 1"-8 UNC 2A x 4" HEAVY HEX SCREW

MATERIAL SPECIFICATIONS: ASTM A-193('01) Gr.B7
HEAT SPECIFICATIONS:
Quenched & tempered per the material specification, minimum tempering temperature: 1100 F

APPLICABLE SPECIFICATIONS:
ANSI/ASME B1.1 ANSI/ASME B18.2.1

QUALITY SPECIFICATIONS:
Domestic manufactured; This is a commercial grade item;

CHEMICAL TEST:
C .40 MN .92 P .012 S .005 SI .21 CU .02 NI .03 CR 1.01
MO .225 AL .034

MECHANICAL TEST:
TENSIL 135800PSI YIELD 116600PSI ELONG 21.4 REDUCT 59.1
HARD RC 30.5
MACRO ETCH: ACCEPTABLE

PROGRAM STATEMENT:
Nova Machine Products Corporation certifies that the material, parts, components or services supplied on this purchase order have been processed in accordance with, and therefore meet or exceed the quality requirements established by the references or specifications in this order. Maintained mercury free by Nova.

I certify that these results are a true and correct copy of records prepared and maintained by Nova Machine Products Corporation in compliance with the requirements of the purchase order and specifications cited.

Processed per ISO-9001('94)/ISO-9002, Certificate GQC 211. Fastener products received from Nova are FQA compliant.

Your salesperson is Beau Laslo
Please call day or night if you have any questions or comments.

SM Galaday QC
Sheila Galaday G, Quality Control

AR 23A

NOVA MACHINE PRODUCTS CORPORATION

18001 Sheldon Road
Middleburg Heights, OH
44130

216 267 3200
Fax 216 433 1640

CERT. OF COMPLIANCE/CONFORMANCE #0000029387 Page: 1

Date: 10/20/04

PO #: IC021254
Rel :

FASTENAL COMPANY
5851 GUION ROAD

INDIANAPOLIS, IN 46254

SO #: 0000080927
Line #: 42
Qty: 150 EA
Lot #: 0040012015
Heat #: US Y06420
Drwg: (50/BOX)

CL./STOCK:0155558

DESC: 1"-8 UNC 2A x 4" HEAVY HEX SCREW

MATERIAL SPECIFICATIONS: ASTM A-193('01) Gr.B7
HEAT SPECIFICATIONS:
Quenched & tempered per the material specification, minimum tempering temperature: 1100 F

APPLICABLE SPECIFICATIONS:
ANSI/ASME B1.1 ANSI/ASME B18.2.1

QUALITY SPECIFICATIONS:
Domestic manufactured; This is a commercial grade item;

PROGRAM STATEMENT:
Nova Machine Products Corporation certifies that the material, parts, components or services supplied on this purchase order have been processed in accordance with, and therefore meet or exceed the quality requirements established by the references or specifications in this order. Maintained mercury free by Nova.

I certify that these results are a true and correct copy of records prepared and maintained by Nova Machine Products Corporation in compliance with the requirements of the purchase order and specifications cited.

Processed per ISO-9001('94)/ISO-9002, Certificate GQC 211. Fastener products received from Nova are FQA compliant.

Your salesperson is Beau Laslo
Please call day or night if you have any questions or comments.

SM Galaday QC

Sheila Galaday G, Quality Control

Bethlehem
Bethlehem Lukens Plate

TEST CERTIFICATE

CUSTOMER P.O.: J.C.R.2663
DESCRIPTION :
1 - RECTANGLE 2.5 -X- 96 -X- 480

FILE NO. 8462-01-01
DATE: 02/04/99
MILL ORDER NO: 33510-006

SOLD TO:
WAR
COR
P.O

WAR

SEND TO:

03-C SHIP TO:

44452

MATERIAL HAS BEEN MANUFACTURED AND TESTED IN ACCORDANCE WITH PURCHASE ORDER REQUIREMENTS AND SPECIFICATION(S)

ASTM A516 GR 70 YR 90 ASME SA516 GR 70 YR 96A

MATERIAL PRODUCED UNDER A CERTIFIED QUALITY MGMT SYSTEM COMPLYING WITH ISO 9002 ABS-QE CERT. NO. 30130

MELT/SLAB	C	MN	P	S	CU	SI	NI	CR	MO	V	TI	B	CB				PRACTICES
028 /5																	GS 7-8
R1028	.23	.97	.011	.009	.22	.21	.14	.14	.07	.002			.001				

TENSILES / CHARPY V IMPACTS

YLD (PSI	TENS X 100)	% ELONG 2"	% R.A.	TYPE	TEMP		MILS LATERAL EXPANSION	% SHEAR
490	746	30.0						

OTHER TESTS PERFORMED

INFORMATION

WEIGHT PER PIECE = 32671 LBS. 14850 KG.
#41132 BWRY 5402

HEAT TREAT CYCLES - MATL. OR TESTS - DEG FAHR.

MATL.	TEST	NOM TEMP	MIN TEMP	MAX TEMP	HOLD. MINS.	COOL METHOD	END TEMP
X	X	1650			0082	AC	

HEAT TREAT CYCLES - TESTS ONLY - DEG FAHR.

START END TEMP	NOM TEMP	MIN TEMP	MAX TEMP	HOLD MINS:	HEAT RATE MAX	COOL RATE MAX

The American Tank & Fabricating Co.
FASRF
MEETS THE REQUIREMENTS OF
ASME SA 516 Gr. 70 (1998 ed., 1999 add.)
REVIEWED BY: PJC DATE 5/8/00

HEREBY CERTIFY THE ABOVE INFORMATION IS CORRECT:
NO. 2221T

Quality Assurance Laboratory
Coatesville, PA 19320

Elinore Zaplitny
SUPERVISOR - TEST REPORTING

. S. STEEL GROUP
A division of USX Corporation
0100000772 (REV. 8/H)

Metallurgical Test Report

USS, USX, USX are trademarks of USX Corp. USX

REQ. JOB. CONTRACT NO.	P.O. DATE	PURCHASE ORDER NO.
	11/21/97	01-74317

SHIPPERS NO.	MILL ORDER NO.	INVOICE NO.
T04917 04 28 98	UH55692	151-186488
VEHICLE NUMBER 28 IL		37967

VENDOR:
GARY WORKS
GARY, INDIANA 46402

** MELTED AND MANUFACTURED IN THE USA **

SOLD TO:
A M CASTLE & CO
3400 NORTH WOLF ROAD
FRANKLIN PARK IL 60131-1319

SHIP TO:
A M CASTLE & CO
3400 NORTH WOLF ROAD
BAY #4
FRANKLIN PARK IL

THIS IS TO CERTIFY THAT THE PRODUCT DESCRIBED HEREIN WAS MFGD., SAMPLED, TESTED AND/OR INSPECTED IN ACCORDANCE WITH THE SPECIFICATION AND FULFILLS REQUIREMENTS IN SUCH RESPECT. [signature]
PREPARED BY THE OFFICE OF:
S.C.PARK GEN.MGR. Q.A.

PART NO: PT#I.A.C.26136-- ** NAFTA CERTIFIED AS NORTH AMERICAN DOMESTIC ** 5-1-98

SPEC. & INSP.: PLATE CARBON ASTM A516-*90 GRADE 70 ASME SA516-*1995 EDITION, 96 ADDENDA, DECEMBER 31, 1996 GRADE 70 A M CASTLE AND CO SPEC K02700-67 REV 5 DATED 8/2/96 PRESSURE VESSEL QUALITY NORMALIZE REST FLATNESS TOL 1/2 STD
INSP:01 MILL RA/SM ALSO RA/LT CERTIFIED T/R WITH LOAD ANALYSIS MERCURY FREE STATEMENT REQUIRED

ITEM NO.	THICKNESS OR SECTION	WIDTH, DIA. OR FL. WT.	LENGTH	QUANTITY	WEIGHT	HEAT NO.	TEST OR PIECE IDENTITY	YIELD PT. KSI	TENSILE STR. KSI	ELONGATION % IN 8"	ELONGATION % IN 2"	% RED. OF AREA	BEND
03	5.0000	96.0000	240"	01	39205	Y55720	34W 1						
	STEEL-TYPE = INGOT												
							34W 1 *	47.0	78.0		26.0		

PRODUCT & TEST SPECIMENS WERE NORMALIZED AT 1660 DEG.F. FOR 0192 MINUTES.COOLING COMPLETED IN STILL AIR.
END OF DATA

CASTLE METALS-FP
DATE REC'D 5/98
REC'D FROM
APPROVED BY [initials]

*YIELD STRENGTH @ 0.5% E.U.L.

THIS REPORT SHALL NOT BE REPRODUCED WITHOUT THE PRIOR WRITTEN APPROVAL OF THE USX CORPORATION.

HEAT NO.	TYPE	C	MN	P	S	SI	CU	NI	CR	MO	SN	AL	N	V	B	TI	CB	CO
Y55720	HEAT	25	095	011	009	22	02	02	05	01		029		001			001	

END OF DATA

FINE GRAIN

ALL TEST RESULTS WERE CONDUCTED AND RECORDED IN ACCORDANCE WITH TEST METHODS ACCREDITED BY A2LA
MATRIX DECIMAL POSITIONS FOR ELEMENTS ARE INDICATED BY THE LEFT MARGIN, VERTICAL DOTTED LINE OR DECIMAL POINT.

USX Corporation

Metallurgical Test Report

P.O. DATE	PURCHASE ORDER NO.		
11/21/97	01-74317		
SHIPPERS NO.		MILL ORDER NO.	INVOICE NO.
704917	04 28 98	UM85692	154-486488
28	IL		37967

THIS IS TO CERTIFY THAT THE PRODUCT DESCRIBED HEREIN WAS MFGD., SAMPLED, TESTED AND/OR INSPECTED IN ACCORDANCE WITH THE SPECIFICATION AND FULFILLS REQUIREMENTS IN SUCH RESPECT. MEO

PREPARED BY THE OFFICE OF:
S.C.PAPE GEN.MGR. Q.A.

VENDOR: GARY WORKS
GARY, INDIANA 46402

** MELTED AND MANUFACTURED IN THE USA **

SOLD TO:
A M CASTLE & CO
3400 NORTH WOLF ROAD
FRANKLIN PARK IL 60131-1319

SHIP TO:
A M CASTLE & CO
3400 NORTH WOLF ROAD
BAY #4
FRANKLIN PARK IL

PART NO: PT#L.A.C.26136-- ** NAFTA CERTIFIED AS NORTH AMERICAN DOMESTIC ** 5-1-98

SPEC & INSP.: PLATE CARBON ASTM A516-*90 GRADE 70 ASME SA516-*1995 EDITION, 96 ADDENDA, DECEMBER 31,1996 GRADE 70 A M CASTLE AND CO SPEC K02700-67 REV 5 DATED 6/2/96 PRESSURE VESSEL QUALITY NORMALIZE BEST FLATNESS TOL 1/2 STD
INSP:01 MILL RA/SM ALSO RA/LT CERTIFIED T/R WITH LOAD ANALYSIS MERCURY FREE STATEMENT REQUIRED

ITEM NO.	MATERIAL DESCRIPTION THICKNESS OR DIAMETER	WIDTH OR LB. PER FT	LENGTH	QUANTITY	WEIGHT	HEAT NO.	TEST OR PIECE IDENTITY	YIELD PT.	TENSILE STR.	ELONGATION % IN 8"	IN 2"	% RED. OF AREA	BEND
	MERCURY OR MERCURY BEARING COMPOUNDS ARE NOT USED IN THE MANUFACTURE OF THIS MATERIAL.												
	END OF DATA												

THIS REPORT SHALL NOT BE REPRODUCED WITHOUT THE PRIOR WRITTEN APPROVAL OF THE USX CORPORATION.

HEAT NO.	TYPE	C	MN	P	S	SI	CU	NI	CR	MO	SN	AL	N	V	B	TI	CB	CO
END OF DATA																		

ALL TEST RESULTS WERE CONDUCTED AND RECORDED IN ACCORDANCE WITH TEST METHODS ACCREDITED BY A2LA
MATRIX DECIMAL POSITIONS FOR ELEMENTS ARE INDICATED BY THE LEFT MARGIN, VERTICAL DOTTED LINE OR DECIMAL POINT.

No. 4062 P.

09/15/2004 From: AMERICAN ALLOY STEEL To: AMERICAN TANK & FABRICATING
P.O.# :054337-00 S.O.# :37811-NY AA PL#:8024766
Item :1 (1 PC) 3" X 96" X 60"
:ISG HEAT# U0624 ALREADY APPROVED

ISG PLATE INC. TEST CERTIFICATE

SHIP TO:
AMERICAN ALLOY STEEL INC
C/O B & R MARINE SVS
PORT OF GREATER BATON ROUGE
TRACK #791
PORT ALLEN LA 70767

PAGE NO: 01 OF 02
FILE NO: 0284-01-20
MILL ORDER NO: 85476-001
MELT NO: U0624
SLAB NO: 4
DATE: 04/09/04

SOLD TO:
AMERICAN ALLOY STEEL, INC
P. O. BOX 40469
HOUSTON TX 77240-0469

SEND TO:
AMERICAN ALLOY STEEL, INC
P. O. BOX 40469
ATTN: HOMER GARZA
HOUSTON, TX 77240-0469

02-C

PLATE DIMENSIONS / DESCRIPTION

TOTAL QTY	GAUGE	WIDTH	LENGTH	DESCRIPTION	PIECE WEIGHT
1	3"	96"	480"	RECTANGLE	39205#

CUSTOMER INFORMATION

CUSTOMER PO: 57082-LA

SPECIFICATION(S)

THIS MATERIAL HAS BEEN MANUFACTURED AND TESTED IN ACCORDANCE WITH PURCHASE ORDER REQUIREMENTS AND SPECIFICATION(S).

API 2H-8TH-EDITION YR 99 GR 50 S1 S3 S4
SUPPL. PARA. S5 & SUPPL. PARA. S12
SPEC MOD FOR PHYSICALS
SPEC MOD FOR CARBON
ASME SA537 99 CLASS 1 MODIFIED TO .04 MAX CB,
ABS PART 2-SECT-1 00 GRS EH36/DH36, ASTM A633
95 GR C AND MIL-S-22698C GR DH36
MATERIAL PRODUCED UNDER A CERTIFIED QUALITY MGMT SYSTEM COMPLYING WITH ISO 9001 ABS-QE CERT. NO. 30130

Certified a true copy of the original, retained in our file.
AMERICAN ALLOY STEEL, INC.
06/3/04

CHEMICAL COMPOSITION

	C	MN	P	S	CU	SI	NI	CR	MO
MELT:U0624	.14	1.53	.008	.002	.14	.37	.09	.10	.03

	V	TI	B	AL	CB	CA	N	CEF
MELT:U0624	.001	.004	.0004	.041	.031	.002	.0077	.44

CARBON EQUIVALENT FORMULA (CEF)
CEF = C + (MN * .1667) + ((CR + MO + V) * .2000) + ((CU + NI) * .0667)

MANUFACTURE

FINELINE - VACUUM DEGASSED - FINE GRAIN PRACTICE

AMERICAN BUREAU OF SHIPPING ABS PHILADELPHIA

HEAT TREAT CONDITION

MATL OR TEST	HEAT TREAT DESCRIPTION	NOM TEMP	HOLD MINS	COOL MTHD
PL/TEST	NORMALIZE	1650F	106	AIR COOL

AMERICAN ALLOY PLATE # 8024766

36809

PA514374

WE HEREBY CERTIFY THE ABOVE INFORMATION IS CORRECT:

QUALITY ASSURANCE LABORATORY
COATESVILLE, PA 19320

Elinore Zaplitny
SUPERVISOR - TEST REPORTING
ELINORE ZAPLITNY

MEETS THE REQUIREMENTS
ASTM A 633 Grade E pg 1 of 2
9-22-04

PO# 54337-
SO# 40945-00

... ...: AMERICAN ALLOY STEEL To: AMERICAN TANK & FABRICATING
P.O.# :054337-00 S.O.# :37811-NY AA PL#:8024766
Item :1 (1 PC) 3" X 96" X 60" :
:ISG HEAT# U0624 ALREADY APPROVED

ISG PLATE INC. **T E S T C E R T I F I C A T E**

PAGE NO: 02 OF 02
FILE NO: 0284-01-20
MILL ORDER NO: 85476-001
MELT NO: U0624
SLAB NO: 4
DATE: 04/09/04

T E N S I L E P R O P E R T I E S

SLAB NO.	LOC	DIR	YIELD STRENGTH PSI X 100	TENSILE STRENGTH PSI X 100	ELONGATION GAGE LGTH	ELONGATION %	%R.A.
4	BOT.	THRU GA.	—	—	—		71.0
4	TOP	THRU GA.					69.0
4	BOT.	TRANS.	559	807	2.00"	30.0	

CHARPY V-NOTCH IMPACT RESULTS

SLAB	LOC	DIR	TEMP	SIZE	FT. LBS.
4	BOT.	TRANS.	-40F	FULL	90 133 135

D R O P W E I G H T T E S T I N G

LOC	DIR	SIZE	DEPTH	TEMP	RSLT	TEMP	RSLT
BOT.	LONG.	P3	SURF	-30F	NB	-30F	NB

G E N E R A L I N F O R M A T I O N

ALL STEEL HAS BEEN MELTED AND MANUFACTURED IN THE U.S.A.
A.B.S. Q.A. CERTIFICATE 00-QA1415-X.
MATERIAL HAS BEEN VACUUM DEGASSED AND CALCIUM TREATED
FOR SULFIDE SHAPE CONTROL.
FINELINE MOD FOR SULPHUR
TEST CERTS. ARE PREPARED IN ACCORD. WITH PROCEDURES
OUTLINED IN DIN 50049 3.1.B/EN 10204 3.1.B.

B/L# 36809 UP 262082
PCM = .25

Certified a true copy of the original, retained in our file.
AMERICAN ALLOY STEEL, INC.

MEETS THE REQUIREMENTS
ASTM A 633 Grade E pg 2 of 2 PO# 54337
SO# 40945-00
9.22.04

WE HEREBY CERTIFY THE ABOVE
INFORMATION IS CORRECT:

QUALITY ASSURANCE LABORATORY
COATESVILLE, PA 19320

SUPERVISOR - TEST REPORTING
ELINORE ZAPLITNY

WVMP SAR Reference 8-10

Supplier Surveillance Reports SR-13-078 (10/31/2013)
and SR-13-085 (11/06/2013).

SUPPLIER SURVEILLANCE REPORT

No: SR- 13 - 078

PAGE 1 OF 1

PO No (Suppl.): Ch-001821	COG. ENGR. Neil Armknecht	SPEC. No. (Rev.): N/A

SURV. DATE: 10/31/2013	SUPPLIER SURVEYED: GeoScience Group, Inc. 86 Gunville Rd. Lancaster, NY 14086

ORIGINAL

PERSON(S) CONTACTED:

Mick Honeck, Geo-Science Group, Inc. Project Executive
Linda Michalczak, CHBWV Project Manager
Kenneth Koleff, QISI Field Test Specialist
Ernie Kihl, QISI Field Test Specialist
Neil Armknecht, Cognizant Engineer
Dan Sullivan, DOE-WVDP

SURVEILLANCE OBJECTIVES: (Reference & Describe applicable compliance/performance criteria)

Witness grout/foam mixing to ensure the following:

1. Verify wet density of grout in accordance with ASTM C-138. (Req'd 68-72 PCF)
2. Observe casting of test cylinders per PO Scope of Work and ASTM C495/C495M
3. Verify calibration of equipment used for density measurement.
4. Verify that qualified field test personnel are present (Ernie Kihl) as approved on 9/17/13.

COPY

SUMMARY (RESULTS/COMMENTS): [X] Satisfactory [ ] Unsatisfactory [ ] Indeterminate

1. Liquid Concentrate (foaming agent) was added to the cement drum for timed intervals (i.e. 50 sec.) to determine the best grout mix design based on the wet density measurement. Four trucks were brought onsite to grout the melter. Density measurements were witnessed for the first three, results are listed below:

   a. Truck #1 reached a wet density of 71.6 PCF, additional tests verified stability of grout mix.

   b. Truck #2 reached a wet density of 71.2 PCF which also stayed consistent.

   c. Truck #3 reached a wet density of 70.4 PCF

   SATISFACTORY

2. Test cylinders (20 - 3" X 6" and 2 - 6" X 12") were cast from the grout in truck #1, and 8 from the remaining three trucks. Cylinders were stored in a cure box awaiting delivery to the QISI-ApplusRTD, test facility.

   SATISFACTORY

3. Calibration of the equipment used for wet density measurement and calculation (i.e. bucket #QC0032 and scale #3771) was verified and found to be up-to-date (the test bucket was recalibrated on 10/25/2013).

   SATISFACTORY

4. The field testing was performed by Ernie Kihl of QISI, ApplusRTD with assistance from Ken Koleff, also of QISI. Documentation of his qualification(s) were submitted and approved by CHBWV. **SATISFACTORY**

The weight of the melter at this point was calculated at 357,000 lbs.

Hold Point Release No: N/A SNR No. N/A Issue Report No. N/A

Linda M. Lund / *Linda M. Lund* 10/31/2013
Quality Assurance Representative Date

cc: QADCC QAM Procurement & Contracts
Cognizant Engineer Neil Armknecht MS- PL-6 QA PO File

SUPPLIER SURVEILLANCE REPORT

No: SR - 13 - 085

PO No (Suppl.): Ch-001821	COG. ENGR. Neil Armknecht	SPEC. No. (Rev.): N/A

SURV. DATE: 11/04/2013	SUPPLIER SURVEYED: GeoScience Group, Inc. 86 Gunville Rd. Lancaster, NY 14086

PERSON(S) CONTACTED:
Mick Honeck, Geo-Science Group, Inc. Project Executive
Linda Michalczak, CHBWV Project Manager
Dan Sullivan, DOE-WVDP
Mason Smith, QISI Field Test Specialist
Neil Armknecht, Cognizant Engineer

SURVEILLANCE OBJECTIVES: (Reference & Describe applicable compliance/performance criteria)

Witness grout/foam mixing to ensure the following:
1. Verify wet density of grout in accordance with ASTM C-138. (Req'd 68-72 PCF)
2. Observe casting of test cylinders per PO Scope of Work and ASTM C495/C495M
3. Verify calibration of equipment used for density measurement.
4. Verify that qualified field test personnel are present.

COPY

SUMMARY (RESULTS/COMMENTS): [X] Satisfactory [ ] Unsatisfactory [ ] Indeterminate

1 Liquid Concentrate (foaming agent) was added to the cement drum for timed intervals (i.e. 50 sec.). Foamed cement was tested from each truck to verify the ASTM C-138 required wet density measurement (68-72 PCF). Four trucks were brought onsite to complete the project of grouting the melter. Density measurements were witnessed for all four, results are listed below:

a. Truck #1 reached a wet density of 70.80 PCF, additional test of the concrete/foam mix taken from the sample spout after pumping into the melter for 5 minutes showed 84.15 PCF. The operation was ceased and the truck sent away.
b. Truck #2 reached a wet density of 68.75 PCF. ***At this time, the unofficial weight was recorded at 370,025 #***
c. Truck #3 reached a wet density of 69.3 PCF.
d. Truck #4 reached a wet density of 70.12 PCF.

SATISFACTORY

2 Test cylinders (20 – 3" X 6" and 2 – 6" X 12") were cast from the grout in truck #1, and 8 from the remaining three trucks. Cylinders were stored in a cure box awaiting delivery to the QISI-ApplusRTD, test facility. See photos #2 & #3-Attachment A. **SATISFACTORY**

3. Calibration of the equipment used for wet density measurement and calculation (i.e. bucket #Q416 and scale #3153) was verified and found to be up-to-date (test bucket was calibrated on 10/16/2013, scale calibrated 1/22/2013).
SATISFACTORY

4 The field testing was performed by Mason Smith of QISI, ApplusRTD (Certification –Attachment B).
SATISFACTORY

The weight of the melter at this point was calculated at 381,539 lbs. (see Attachment C)
Safety observation: Spoils containers for runoff and rinsate were available and hazard marking was visible. (See photo #1)

Hold Point Release No: N/A SNR No. N/A Issue Report No. N/A

Linda M. Lund / *Linda M. Lund* 11/06/2013
Quality Assurance Representative Date

cc: QADCC QAM Procurement & Contracts
Cognizant Engineer Neil Armknecht MS- PL-6 QA PO File

Photo 1 – excess foamed cement and water runoff was collected in labeled catch basins

Photo 2 – casting cylinders

Photo 3 – due to inclement weather, cylinders were placed in cure boxes

SR-13-085
Attachment B
Pg 3 of 4

AMERICAN CONCRETE INSTITUTE

This is to certify that

MASON P SMITH

has demonstrated knowledge and ability by successfully completing the ACI Certification requirements and is hereby recognized as an

ACI Concrete Field Testing Technician - Grade I

Certified Date: 08/10/2013 Expires: 08/10/2018

Examiner of Record: Donald E Borkowski

ACI Managing Director of Certification

The Authenticity of this certification can be verified at www.ACICertification.org/verify

Melter Container TC-474 Weight

Melter package was weighed using four Enerpac RSC-1002 hydraulic cylinders.

Each cylinder has an effective area of 19.63 square inches.

Individual cylinder pressures (per calibrated gauges) as follow:

Cylinder 1 = 5000 psi

Cylinder 2 = 4850 psi

Cylinder 3 = 4800 psi

Cylinder 4 = 4950 psi

Total = 19600 psi

Mult. by effective area of cylinder = 19.63 in sq

Therefore = 384.748 lbs current weight

Calculated weight of lift lug = 790.98 lbs., mult four lugs = 3163.92 lbs

Weight of 1" – 8UNC x 4" Bolt with washer = 1.25 lbs mult 36 bolts = 45 lbs

Therefore = 384,748 lbs

- 3,163.92 lbs
- 45 lbs

Total for package = 381.539 lbs

WVMP SAR Reference 8-11

Grout Compressive Strength Test Reports, ASTM C-1019, Ticket Numbers 522, 523, 524, 526, 544, 546, and 547, Quality Inspection Services, Inc., Buffalo, New York, December 9, 2013.

Applus® RTD

Quality Inspection Services, Inc.

GROUT COMPRESSIVE STRENGTH TEST REPORT (ASTM C-1019)

Project: West Valley Cellular Grout

Client: Geo Science

Contractor: N/A

Project No.: 1101-13-CIV-0073 Set No.: WVWP-8

Supplier: N/A

Cylinder Compression Machine Q #: 3964 Cal. due date: 01/21/14

Mix Data: Grout Ticket No.: 522

Date Molded: 10/31/13 Date Received: 11/04/13

Condition Received: Good # of Cylinders in Set: 22

Cubic Yards Placed: 6 Truck No: M24

Placement Location: First lift in Melter Box

Specimens Cast By: E. Kihl Unit Wt. (ASTM C138): 71.6

Batch Time: 9:31 AM Cylinder Cast Time: 10:45 AM

Concrete Temperature (C-1064): 65°F Air Temperature: 56°F

Slump (C-143): N/A Air Content (C-173 / C-231): N/A

Strength Specific. @ 28 Days: 1000 PSI Water Added On Site: N/A

Remarks: Stable Air Foam added prior to pumping

COMPRESSIVE STRENGTH DATA

Laboratory #	Date Tested	Age (Days)	Cross Sectional Area (in^2)	Maximum Load (lbs)	Compressive Strength (PSI)
193	11-07-13	7	7.16	7850	1100
194	11-07-13	7	7.21	12400	1720
195	11-07-13	7	7.16	11750	1640
196	11-07-13	7	7.21	9400	1300
197	11-14-13	14	7.16	9120	1270
198	11-14-13	14	7.16	8890	1240
199	11-14-13	14	7.16	9630	1340
200	11-14-13	14	7.12	8990	1260
201	11-21-13	21	7.07	7740	1090
202	11-21-13	21	7.07	7940	1120
203	11-21-13	21	7.07	9350	1320
204	11-21-13	21	7.12	8960	1260
205	11-28-13	28	7.12	9970	1400
206	11-28-13	28	7.07	9860	1390
207	11-28-13	28	7.07	9910	1400
208	11-28-13	28	7.12	10030	1410

Applus® RTD

Quality Inspection Services, Inc.

GROUT COMPRESSIVE STRENGTH TEST REPORT (ASTM C-1019)

Laboratory #	Date Tested	Age (Days)	Cross Sectional Area (in^2)	Maximum Load (lbs)	Compressive Strength (PSI)
209	1-23-14	56			
210	1-23-14	56			
211	1-23-14	56			
212	1-23-14	56			
213	UW	28			63.8
214	UW	28			64.5

12/9/13

Respectively Submitted, *Date*
Quality Inspection Services, Inc.

For Job Satisfaction - Think Quality

Form TP 1.8-2
Rev. 1

Applus® RTD

Quality Inspection Services, Inc.

GROUT COMPRESSIVE STRENGTH TEST REPORT (ASTM C-1019)

Project: West Valley Cellular Grout

Client: Geo Science

Contractor: N/A

Project No.: 1101-13-CIV-0073   Set No.: WVWP-9

Supplier: Wayne Concrete

Cylinder Compression Machine Q #: 3964   Cal. due date: 01/21/14

Mix Data: Grout   Ticket No.: 523

Date Molded: 10/31/13   Date Received: 11/04/13

Condition Received: Good   # of Cylinders in Set: 8

Cubic Yards Placed: 6   Truck No: M56

Placement Location: First lift in Melter Box

Specimens Cast By: E. Kihl   Unit Wt. (ASTM C138): 71.2

Batch Time: 10:58 AM   Cylinder Cast Time: 12:10 PM

Concrete Temperature (C-1064): 67°F   Air Temperature: 56°F

Slump (C-143): N/A   Air Content (C-173 / C-231): N/A

Strength Specific. @ 28 Days: 1000 PSI   Water Added On Site: N/A

Remarks: Stable Air Foam added prior to pumping

COMPRESSIVE STRENGTH DATA

Laboratory #	Date Tested	Age (Days)	Cross Sectional Area (in^2)	Maximum Load (lbs)	Compressive Strength (PSI)
215	11-14-13	14	7.16	6870	960
216	11-14-13	14	7.12	6710	940
217	11-14-13	14	7.12	6690	940
218	11-14-13	14	7.16	6760	940
219	11-28-13	28	7.12	7180	1010
220	11-28-13	28	7.12	7230	1020
221	11-28-13	28	7.07	7610	1080
222	11-28-13	28	7.12	8060	1130

12/9/13

Respectively Submitted,
Quality Inspection Services, Inc.   *Date*

For Job Satisfaction - Think Quality

Form TP 1.8-2

Applus® RTD

Quality Inspection Services, Inc.

GROUT COMPRESSIVE STRENGTH TEST REPORT (ASTM C-1019)

Project: West Valley Cellular Grout

Client: Geo Science

Contractor: N/A

Project No.: 1101-13-CIV-0073 Set No.: WVWP-10

Supplier: Wayne Concrete

Cylinder Compression Machine Q #: 3964 Cal. due date: 01/21/14

Mix Data: Grout Ticket No.: 524

Date Molded: 10/31/13 Date Received: 11/04/13

Condition Received: Good # of Cylinders in Set: 8

Cubic Yards Placed: 6 Truck No: M44

Placement Location: First lift in Melter Box

Specimens Cast By: E. Kihl Unit Wt. (ASTM C138): 70.4

Batch Time: 11:51 AM Cylinder Cast Time: 1:00 PM

Concrete Temperature (C-1064): 64°F Air Temperature: 56°F

Slump (C-143): N/A Air Content (C-173 / C-231): N/A

Strength Specific. @ 28 Days: 1000 PSI Water Added On Site: N/A

Remarks: Stable Air Foam added prior to pumping

COMPRESSIVE STRENGTH DATA

Laboratory #	Date Tested	Age (Days)	Cross Sectional Area (in^2)	Maximum Load (lbs)	Compressive Strength (PSI)
223	11-14-13	14	7.16	19010	2660
224	11-14-13	14	7.12	16900	2370
225	11-14-13	14	7.21	24370	3380
226	11-14-13	14	7.16	20960	2930
227	11-28-13	28	7.12	26420	3710
228	11-28-13	28	7.12	23800	3340
229	11-28-13	28	7.07	24120	3410
230	11-28-13	28	7.06	30380	4240

[signature] 12/9/13

Respectively Submitted, Quality Inspection Services, Inc. *Date*

For Job Satisfaction - Think Quality

Form TP 1.8-2

Applus⊕ RTD

Quality Inspection Services, Inc.

GROUT COMPRESSIVE STRENGTH TEST REPORT (ASTM C-1019)

Project: West Valley Cellular Grout

Client: Geo Science

Contractor: N/A

Project No.: 1101-13-CIV-0073 Set No.: WVWP-11

Supplier: Wayne Concrete

Cylinder Compression Machine Q #: 3964 Cal. due date: 01/21/14

Mix Data: Grout Ticket No.: 526

Date Molded: 10/31/13 Date Received: 11/04/13

Condition Received: Good # of Cylinders in Set: 8

Cubic Yards Placed: 6 Truck No: M24

Placement Location: First lift in Melter Box

Specimens Cast By: E. Kihl Unit Wt. (ASTM C138): 68.0

Batch Time: 12:55 PM Cylinder Cast Time: 1:50 PM

Concrete Temperature (C-1064): 67°F Air Temperature: 56°F

Slump (C-143): N/A Air Content (C-173 / C-231): N/A

Strength Specific. @ 28 Days: 1000 PSI Water Added On Site: N/A

Remarks: Stable Air Foam added prior to pumping

COMPRESSIVE STRENGTH DATA

Laboratory #	Date Tested	Age (Days)	Cross Sectional Area (in^2)	Maximum Load (lbs)	Compressive Strength (PSI)
231	11-14-13	14	7.12	18240	2560
232	11-14-13	14	7.12	26570	3730
233	11-14-13	14	7.16	31980	4470
234	11-14-13	14	7.16	29980	4190
235	11-28-13	28	7.12	29680	4170
236	11-28-13	28	7.07	29780	4210
237	11-28-13	28	7.02	24750	3530
238	11-28-13	28	7.07	29580	4180

[signature] 12/9/13

Respectively Submitted, *Date*

Quality Inspection Services, Inc.

For Job Satisfaction - Think Quality

Form TP 1.8-2

Applus® RTD

Quality Inspection Services, Inc.

GROUT COMPRESSIVE STRENGTH TEST REPORT (ASTM C-1019)

Project: West Valley Cellular Grout

Client: Geo Science

Contractor: N/A

Project No.: 1101-13-CIV-0073 Set No.: WVWP-12

Supplier: Wayne Concrete

Cylinder Compression Machine Q #: 3964 Cal. due date: 01/21/14

Mix Data: Grout Ticket No.: 544

Date Molded: 11/04/13 Date Received: 11/07/13

Condition Received: Good # of Cylinders in Set: 22

Cubic Yards Placed: 6 Truck No: M53

Placement Location: Second lift in Melter Box

Specimens Cast By: M. Smith Unit Wt. (ASTM C138): 68.8

Batch Time: 12:49 PM Cylinder Cast Time: 1:15 PM

Concrete Temperature (C-1064): 64°F Air Temperature: 31°F

Slump (C-143): N/A Air Content (C-173 / C-231): N/A

Strength Specific. @ 28 Days: 1000 PSI Water Added On Site: N/A

Remarks: Stable Air Foam added prior to pumping

COMPRESSIVE STRENGTH DATA

Laboratory #	Date Tested	Age (Days)	Cross Sectional Area (in^2)	Maximum Load (lbs)	Compressive Strength (PSI)
239	11-11-13	7	7.16	8000	1120
240	11-11-13	7	7.12	7100	1000
241	11-11-13	7	7.12	7850	1100
242	11-11-13	7	7.16	7400	1030
243	11-18-13	14	7.07	8650	1220
244	11-18-13	14	7.12	7680	1080
245	11-18-13	14	7.12	9300	1310
246	11-18-13	14	7.12	7700	1080
247	11-25-13	21	7.07	7990	1130
248	11-25-13	21	7.07	8800	1240
249	11-25-13	21	7.12	9100	1280
250	11-25-13	21	7.12	9350	1310
251	12-02-13	28	7.16	10790	1510
252	12-02-13	28	7.21	10250	1420
253	12-02-13	28	7.21	12370	1720
254	12-02-13	28	7.21	11240	1560

Applus® RTD

Quality Inspection Services, Inc.

GROUT COMPRESSIVE STRENGTH TEST REPORT
(ASTM C-1019)

Laboratory #	Date Tested	Age (Days)	Cross Sectional Area (in^2)	Maximum Load (lbs)	Compressive Strength (PSI)
255	12-30-13	56			
256	12-30-13	56			
257	12-30-13	56			
258	12-30-13	56			
259	UW	28			62.6
260	UW	28			64.1

12/4/13

Respectively Submitted, *Date*
Quality Inspection Services, Inc.

For Job Satisfaction - Think Quality

Form TP 1.8-2
Rev. 1

Applus® RTD

Quality Inspection Services, Inc.

GROUT COMPRESSIVE STRENGTH TEST REPORT (ASTM C-1019)

Project: West Valley Cellular Grout

Client: Geo Science

Contractor: N/A

Project No.: 1101-13-CIV-0073 Set No.: WVWP-13

Supplier: Wayne Concrete

Cylinder Compression Machine Q #: 3964 Cal. due date: 01/21/14

Mix Data: Grout Ticket No.: 546

Date Molded: 11/04/13 Date Received: 11/07/13

Condition Received: Good # of Cylinders in Set: 8

Cubic Yards Placed: 6 Truck No: M24

Placement Location: Second lift in Melter Box

Specimens Cast By: M. Smith Unit Wt. (ASTM C138): 69.3

Batch Time: 1:25 PM Cylinder Cast Time: 2:00 PM

Concrete Temperature (C-1064): 65°F Air Temperature: 31°F

Slump (C-143): N/A Air Content (C-173 / C-231): N/A

Strength Specific. @ 28 Days: 1000 PSI Water Added On Site: N/A

Remarks: Stable Air Foam added prior to pumping

COMPRESSIVE STRENGTH DATA

Laboratory #	Date Tested	Age (Days)	Cross Sectional Area (in^2)	Maximum Load (lbs)	Compressive Strength (PSI)
261	11-18-13	14	7.12	16350	2300
262	11-18-13	14	7.12	10550	1480
263	11-18-13	14	7.12	13400	1880
264	11-18-13	14	7.12	12850	1800
265	12-02-13	28	7.16	13290	1860
266	12-02-13	28	7.12	14160	1990
267	12-02-13	28	7.16	11090	1550
268	12-02-13	28	7.21	17110	2370

12/9/13

Respectively Submitted, *Date*

Quality Inspection Services, Inc.

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Form TP 1.8-2

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Quality Inspection Services, Inc.

GROUT COMPRESSIVE STRENGTH TEST REPORT (ASTM C-1019)

Project: West Valley Cellular Grout
Client: Geo Science
Contractor: N/A
Project No.: 1101-13-CIV-0073 Set No.: WVWP-14
Supplier: Wayne Concrete

Cylinder Compression Machine Q #: 3964 Cal. due date: 01/21/14
Mix Data: Grout Ticket No.: 547
Date Molded: 11/04/13 Date Received: 11/07/13
Condition Received: Good # of Cylinders in Set: 8
Cubic Yards Placed: 6 Truck No: M44
Placement Location: Second lift in Melter Box
Specimens Cast By: M. Smith Unit Wt. (ASTM C138): 70.1
Batch Time: 3:14 PM Cylinder Cast Time: 3:40 PM
Concrete Temperature (C-1064): 63°F Air Temperature: 31°F
Slump (C-143): N/A Air Content (C-173 / C-231): N/A
Strength Specific. @ 28 Days: 1000 PSI Water Added On Site: N/A
Remarks: Stable Air Foam added prior to pumping

COMPRESSIVE STRENGTH DATA

Laboratory #	Date Tested	Age (Days)	Cross Sectional Area (in^2)	Maximum Load (lbs)	Compressive Strength (PSI)
269	11-18-13	14	7.16	9850	1380
270	11-18-13	14	7.12	9750	1370
271	11-18-13	14	7.16	10150	1420
272	11-18-13	14	7.07	13900	1970
273	12-02-13	28	7.12	11210	1570
274	12-02-13	28	7.16	10030	1400
275	12-02-13	28	7.16	12690	1770
276	12-02-13	28	7.21	13360	1850

12/4/13

Respectively Submitted,
Quality Inspection Services, Inc. *Date*

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