

## Addendum to CA1323 9-8-05

This is to supplement and report our progress on this corrective action.

As previously committed, samples from A-1, C-4 and C-5 were sent to Wisconsin Centrifugal, our parent company, for independent analysis of all reported elements. The results indicated a discrepancy in the level of manganese in the results of the analyses performed by the two labs. Consistently, the Pevely lab measured Mn about 0.4 to 0.5% higher than WC measured. To confirm this information we sent three samples to an outside laboratory for wet chemistry analysis. The results correlated well with the results achieved at Wisconsin Centrifugal. See attached report.

In follow-up, samples from C-1, C-2 and C-3 were also sent for verification, with similar outcome. We then located and tested a sample from a test heat #21424 of CF8MNMNMOD made in January 2004. Testing indicated similar results.

It can be stated that, for at least the period of time comprising the Prototype and the Production to the repair of the Spectrometer, that our analysis of Manganese levels has been higher than the level actually present in the alloy. Typically, this deviation is on the order of 0.4-0.5%.

The spectrometer received the preventive maintenance on August 29, 2005. The report was submitted on September 2, 2005. The repair made to the optical card was determined to have rectified the previously reported issue with P and S reporting. No other mechanical or software problem that would affect Mn was determined at the time of the preventative maintenance.

In follow up to the Manganese discrepancy, the same samples were analyzed on the Pevely spectrometer. The levels reported after PM now correlate with the results from WC and the independent laboratory. Further investigation indicates that the BS180 standard used for type standardization may be sufficiently outside the range of Mn and inducing error. No other root cause has been determined, but the investigation continues.

In consideration of the erroneous Mn and other elemental readings, the following actions are proposed:

Create a type standard that closely matches the Mn in CF8MNMNMOD. (In process)
Request a revision to the chemistry range for Mn. (propose widening of Manganese since it has been proven to be effective at much lower concentrations than previously thought).
Have each heat of CF8MNMNMOD verified independently for balance of program.

C. Ruud

CC: Jim Galaske, Barry Craig, Joe Edwards, E.J. Kubick

Control   Cont												
Colin   Button #T   0.05   0.5   2.5   15.1   13.4   2.4   0.25   0.025   0.010   0.01	Lab	0	Sample	0	S	Mn	ວັ	Z	ω	z	۵	8
Colin   Button #2   Colin   Button #4   Colin   Colin   Button #4   Colin	CAF	C-51-1	Button #1	0.05	0.3	2.6	18.1	13.4	2.4	0.26	0.023	0.011
Net   C-S_1   Button #F   C-S_2   Button #F   C-S_3   Button #F	1 Y C	1	Button #2	1900	0.4	2 8	180	13.4	96	0.26	0.026	
Met CS  1   Button #1   1.03   2.2   18.3   13.4   2.4   0.029   0.012   0.012   0.013   0.013   0.0	Z:5		Duffee #2	8.0		, ,	200	12.5		0.25	0.025	:
1.0.   Sample   C   Si   Min   Cr   Ni   Mio   N   P   Si   Si   C   Si   Min   Cr   Si   Si   Si   Si   Si   Si   Si   S			Difference at		) }	1 0		3	i			Market
Color   Button #1   Color	מור אפו			•		1 0				•		
Color   Sample   Color   Si   Min   Cr   NI   Min   Ni   Ni   Ni   Ni   Ni   Ni   Ni	ş.	<u>ا</u>	Button #1	!	0.3	7.3		13.4		' :	0.029	re-run arrer
Col. 5   Button #1   Col. 6   Si		:!	:		i		,			;	1	
C-5,13   Button #1   0.05   0.4   2.2   17.9   13.2   2.4   0.24   0.033   0.012	Lab	<u>0</u>	Sample	5	تو	٠ ا	ָל ל	Z	gi.	1	۱	· · · · · · · · · · · · · · · · · · ·
C-5,1-3 Button #2 0.05 0.4 1.8 18.2 13.4 2.5 0.23 0.033 0.012 C-5,1-3 Button #1 0.05 0.4 1.8 18.2 13.4 2.5 0.23 0.034 0.018 C-5,1-3 Button #1 0.05 0.3 1.8 18.2 13.4 2.5 0.23 0.034 0.018 C-5,1-5 Button #1 0.05 0.3 2.4 18.1 13.2 2.4 0.25 0.030 0.017 C-5,1-6 Button #1 0.05 0.3 2.4 18.1 13.2 2.4 0.25 0.030 0.017 C-5,1-6 Button #1 0.05 0.3 2.4 18.1 13.2 2.4 0.25 0.030 0.017 C-5,1-6 Button #1 0.05 0.3 2.4 18.1 13.2 2.4 0.25 0.030 0.017 C-5,1-6 Button #1 0.05 0.3 2.4 18.1 13.2 2.4 0.25 0.030 0.017 C-5,1-6 Button #1 0.05 0.3 2.4 18.1 13.2 2.4 0.25 0.030 0.017 C-5,1-6 Button #1 0.05 0.3 2.4 18.1 13.2 2.4 0.25 0.030 0.017 C-5,1-6 Button #1 0.05 0.3 2.4 18.1 13.2 2.4 0.25 0.030 0.017 C-5,1-6 Button #1 0.05 0.3 2.4 18.1 13.2 2.4 0.25 0.030 0.017 C-5,1-6 Button #1 0.05 0.3 2.4 18.1 13.2 2.4 0.25 0.030 0.017 C-5,1-6 Button #1 0.04 0.4 18.1 13.2 2.4 0.25 0.030 0.017 C-5-1-7 Cast on sample 0.04 0.6 1.6 18.1 13.7 2.4 0.25 0.030 0.017 C-4 Cast on sample 0.04 0.6 1.5 17.8 13.5 2.4 0.25 0.030 0.017 C-4 Cast on sample 0.04 0.6 1.5 17.8 13.5 2.4 0.25 0.030 0.017 C-4 Cast on sample 0.04 0.6 1.5 17.8 13.5 2.4 0.25 0.030 0.017 C-4 Cast on sample 0.05 0.7 2.2 18.1 13.1 2.2 0.27 0.018 0.019 C-4 Cast on sample 0.05 0.7 2.2 18.1 13.1 2.2 0.27 0.018 0.019 C-4 Cast on sample 0.0 0.0 0.5 1.8 18.3 13.4 2.0 0.27 0.018 0.010 C-4 Cast on sample 0.0 0.0 0.5 1.8 18.3 13.4 2.0 0.00 0.00 0.010 C-4 Cast on sample 0.0 0.0 0.5 2.8 18.1 13.1 2.2 0.2 0.00 0.010 C-5-1-7 Cast on sample 0.0 0.0 0.5 2.8 18.1 13.1 2.2 0.2 0.00 0.010 C-5-1-7 Cast on sample 0.0 0.0 0.5 2.8 18.0 13.2 2.3 0.20 0.00 0.010 C-5-1-7 Cast on sample 0.0 0.0 0.5 2.8 18.0 13.2 2.2 0.2 0.00 0.010 C-5-1-7 Cast on sample 0.0 0.0 0.5 2.8 18.0 13.2 2.2 0.2 0.00 0.010 C-5-1-7 Cast on sample 0.0 0.0 0.5 1.8 18.3 13.7 2.2 0.2 0.00 0.010 1.0 1.0 1.0 1.0 1.0 1.0 1.0	CAF	5-1-3 C-5-1-3	Button #1	0.05	0.4	2.2	17.9	13.4	2.5	ŀ	0.033	0.012
C-5,   Button #    C-5,   Butt	CAF	C-5/13	Button #2	0.05	0.4	2.2	17.9	13.2	2.4		0.033	0.012
Vet   C5,14   Button #1   .   0,4   1,8   16,3   13,2   2.4   0.034   0.012   to-run after   C5,14   Button #1   .   0,4   1,8   1,8   1,3   2.4   0.25   0.030   0.012     C5,16   Button #2   0.05   0.3   2.4   1,8   1,3   2.4   0.25   0.030   0.012     C5,16   Button #2   0.05   0.3   2.4   1,8   1,3   2.4   0.25   0.030   0.012     C5,16   Button #1   0.05   0.3   2.4   1,8   1,3   2.4   0.25   0.030   0.012     C5,16   Button #1   0.05   0.04   0.3   2.4   1,8   1,3   2.4   0.25   0.030   0.012     C5,16   Button #1   0.05   0.3   2.4   1,8   1,3   2.4   0.25   0.030   0.012     C5,16   Button #1   0.05   0.3   2.4   1,8   1,3   2.4   0.25   0.030   0.012     C5,16   Button #1   0.05   0.3   2.4   1,8   1,3   2.4   0.25   0.030   0.012     C5,16   Button #1   0.05   0.4   2.4   1,8   1,3   2.4   0.25   0.030   0.001     C5,16   Button #1   0.05   0.4   2.4   1,8   1,3   2.4   0.25   0.037   0.009     A-1   Cast on sample   0.06   0.6   1.6   1,8   1,3   2.4   0.25   0.037   0.009     A-1   Cast on sample   0.06   0.5   2.7   1,8   1,3   2.4   0.25   0.037   0.014     C-1   Cast on sample   0.06   0.5   2.7   1,8   1,3   2.4   0.25   0.037   0.014     C-2   Cast on sample   0.06   0.5   2.7   1,8   1,3   1,3   2.4   0.25   0.037   0.014     C-3   Cast on sample   0.07   0.5   1,8   1,3   1,3   2.4   0.25   0.037   0.014     C-3   Cast on sample   0.07   0.5   1,8   1,3   1,3   2.4   0.25   0.037   0.014     C-3   Cast on sample   0.07   0.5   1,8   1,3   1,3   2.4   0.25   0.037   0.014     C-3   Cast on sample   0.07   0.5   1,8   1,3   1,3   2.4   0.25   0.032   0.014     C-3   Cast on sample   0.07   0.4   0.5   1,8   1,3   1,3   2.4   0.25   0.032   0.014     C-3   Cast on sample   0.07   0.4   0.5   1,8   1,3   3.2   2.4   0.25   0.030   0.012     C-3   Cast on sample   0.06   0.5   1,8   1,3   3.3   2.4   0.030   0.012     C-4   Cast on sample   0.06   0.6   1,8   1,3   3.3   2.4   0.000     C-5   Cast on sample   0.06   0.6   1,8   1,3   3.3   2.4   0.000     C-5   Cast on sample   0.06   0.6   1,8		0.513	Button #2	0.05	0.4	.8	18.2	13.4			0.034	0.018
Colored Delta   Colored Delt	CTI Work		Button #1			α				ŀ		
Col.   Sample   Col.   Sin Mn   Cr   Ni No   N   P   S	1 L		D. 44.0	*			10.0	400			1000	of or of
Colored Foreign   Colored Fo				!	5	2	2	5.		!	200	
LD   Sample   C   Si   Mn   Cr   NI   Mo   N   P   S	1	:		!								
C-5 -6   Button ##1   0.005   0.3   2.4   18.1   13.2   2.4   0.25   0.029   0.011	Lab	<u>-</u>	Sample	S	:ō	E E	ర	ž	ş		- 1	S
Vet C-5,1-6 Button #2         0.05         0.3         2.4         18.1         13.2         2.4         0.25         0.029         0.001           C-5,1-6 Button #2         0.04         0.3         2.0         16.4         13.3         2.4         0.25         0.029         0.001           LD.         Sample         C         SI         Mn         Gr         NI         Mo         N         P         S           A-1         Cast on sample         C         SI         Mn         Gr         NI         Mo         N         P         S           A-1         Cast on sample         C         Si         Mn         Gr         NI         Mo         N         P         S           A-1         Cast on sample         C         Si         Mn         Gr         NI         Mo         N         P         S           A-1         Cast on sample         C         Si         Mn         Gr         NI         Mo         N         P         S           C-4         Cast on sample         C         Si         Mn         Gr         NI         Mo         N         N         N         N           C-1         <	CAF	C-5 1-6	Button #1	0.05	0.3	2.4	18.1	13.2	2.4			0.012
Vet C-5,i-6 Button #2         Old of the control	OAF	- 2 - P	Button #2	0.05	03	24	18.1	13.2	2.4		1	0.011
Wet C-5,1-6 Button #1         C Si Ditton #1         No. 2         1.0. 1.0         No. 2	5 5		C# 100000	2	200		007	100		1	1	0.040
Net   C-5 -16   Button #1   .   0.3   2.0   18.4   13.3   2.4   .   0.033   0.012     1.D.   Sample   C   Si   Mn   Cr   Ni   Mo   N   P   S     1.D.   Sample   C   Si   Mn   Cr   Ni   Mo   N   P   S     1.D.   Sample   C   Si   Mn   Cr   Ni   Mo   N   P   S     1.D.   Sample   C   Si   Mn   Cr   Ni   Mo   N   P   S     1.D.   Sample   C   Si   Mn   Cr   Ni   Mo   N   P   S     1.D.   Sample   C   Si   Mn   Cr   Ni   Mo   N   P   S     1.D.   Sample   C   Si   Mn   Cr   Ni   No   N   No   Ni   Ni	١	2	Damoi #7	5	2	7	0.0	5.5	1,1		1	
LD   Sample   C   Si   Mn   Cr   Ni   Mo   N   P   S	STL Wet	C-5,1-6	Button #1			1.9				į	į	
LD   Sample   C   Si   Mn   Cr   Ni   Mo   N   P   S	CAF	0-5,1-6	Button #1	*	0.3	2.0		13.3			0.033	- 1
I.D.   Sample   C   Si   Mn   Gr   Ni   Mo   N   P   Si     A-1   Cast on sample   0.06   0.6   1.6   18.1   13.7   2.4   0.25   0.0027   0.009     A-1   Cast on sample   0.06   0.6   1.6   18.1   13.7   2.4   0.25   0.0027   0.009     A-1   Cast on sample   0.06   0.6   1.6   18.1   13.7   2.4   0.25   0.0027   0.009     C-4   Cast on sample   0.04   0.6   1.6   18.1   13.5   2.3   0.007   0.014     C-4   Cast on sample   0.04   0.6   1.9   17.9   13.5   2.3   0.007   0.014     C-4   Cast on sample   0.06   0.5   1.8   1.3   1.2   2.4   0.25   0.007   0.014     C-4   Cast on sample   0.06   0.5   1.8   1.8   1.3   2.4   0.25   0.007   0.014     C-4   Cast on sample   0.06   0.5   1.8   1.3   1.2   2.4   0.25   0.003   0.014     C-5   Cast on sample   0.06   0.7   1.8   18.3   13.4   2.4   0.25   0.001   0.014     C-7   Cast on sample   0.06   0.7   1.8   18.3   13.2   2.4   0.02   0.014     C-7   Cast on sample   0.07   0.9   1.6   18.2   13.7   2.2   0.024   0.018   0.018     C-7   Cast on sample   0.07   0.9   1.6   18.2   13.7   2.2   0.024   0.018     C-7   Cast on sample   0.07   0.9   1.6   18.2   13.7   2.2   0.024   0.012     C-2   Cast on sample   0.06   0.4   2.5   18.2   13.3   2.3   0.022   0.014     C-2   Cast on sample   0.06   0.4   2.5   18.2   13.5   2.4   0.024   0.012     C-2   Cast on sample   0.06   0.4   2.5   18.2   13.3   2.4   0.024   0.012     C-3   Cast on sample   0.06   0.4   2.5   18.2   13.3   2.4   0.024   0.013     C-3   Cast on sample   0.06   0.6   1.6   18.1   13.5   2.4   0.002   0.014     C-3   Cast on sample   0.06   0.6   1.6   18.1   13.5   2.4   0.002   0.014     C-3   Cast on sample   0.06   0.6   1.6   18.1   13.5   2.4   0.002   0.014     C-3   Cast on sample   0.06   0.6   1.6   18.1   13.5   2.4   0.002   0.010     C-3   Cast on sample   0.06   0.6   1.6   18.1   13.5   2.4   0.002   0.002     C-3   Cast on sample   0.06   0.6   1.6   18.1   13.5   2.4   0.002   0.002     C-4   Cast on sample   0.06   0.6   1.6   18.1   13.5   0.002   0.002     C-4   Cast on sam												
A-1 Reported 0.04 0.4 18.2 13.3 2.4 0.26	4	<u>_</u>	Sample	:	50	M	٥	Z	Mo	Z	_	· · · · · · · · · · · · · · · · · · ·
A-1 Cast on sample	: :	į	Donottod	2		5	18.0	123	2.7	0.06	•	
A-1 Cast on sample 0.06 0.5 2.1 18.0 13.4 2.4 0.2 0.003 0.009 A-1 Cast on sample 0.06 0.6 1.6 18.2 13.5 2.4 0.2 0.022 0.009 A-1 Cast on sample 0.04 0.4 18.2 18.2 18.2 18.2 0.03 0.013 0.009 C-4 Cast on sample 0.04 0.6 1.9 17.9 13.5 2.3 0.037 0.013 0.009 C-4 Cast on sample 0.04 0.6 1.9 17.9 13.5 2.3 0.037 0.013 0.009 C-4 Cast on sample 0.04 0.6 1.9 17.9 13.5 2.3 0.037 0.013 0.009 C-5 Cast on sample 0.06 0.7 1.9 18.1 13.1 2.2 0.2 0.018 0.014 0.014 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.	747	- -	repolled	) :	+ 1	1.4	7.0	3 3	1.7		÷	
A-1 Cast on sample 0.06 0.6 1.6 18.1 13.7 2.4 0.25 0.027 0.009  A-1 Cast on sample 0.04 0.4 2.5 18.2 13.5 2.4 0.25 0.037 0.013  C-4 Reported 0.04 0.4 2.5 18.2 13.5 2.4 0.25 0.037 0.014**  C-4 Cast on sample 0.04 0.4 2.5 18.1 13.1 2.2 0.20 0.037 0.014  C-1 Cast on sample 0.05 0.7 1.8 18.3 13.4 2.4 0.20 0.001 0.009  C-1 Cast on sample 0.07 0.0 0.7 1.8 18.3 13.4 2.4 0.007 0.018**  C-1 Cast on sample 0.07 0.0 0.0 0.0 13.2 2.4 0.002 0.014**  C-1 Cast on sample 0.07 0.0 0.0 0.0 13.2 2.4 0.002 0.014**  C-2 Cast on sample 0.07 0.0 0.0 0.0 0.0 13.2 2.4 0.002 0.014**  C-2 Cast on sample 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.	CAF	Ą-1	Cast on sample		0.5	2.1	18.0	13.4	2.4	- 1	Į.	6000
C-4   Cast on sample   C   St   Mn   Cr   Ni   Mo   N   P   S	VC.	Ą-1	Cast on sample		9.0	9.1	18.1	13.7	2.4			0.009
LD   Sample   C   St   Mn   Cr   Ni   Mo   N   P   S	AF	A-1	Cast on sample		9.0	1.6	18.2	13.5	2.4			12-e1
LD   Sample   C   Si   Mn   Cr   Ni   Mo   N   P   S					,							
C-4         Reported         0.04         0.4         2.5         18.2         13.2         2.2         0.26         0.037         0.013           C-4         Cast on sample         *         0.6         1.9         17.9         13.5         2.3         *         0.037         0.013           C-4         Cast on sample         0.06         0.6         1.4         18.2         13.6         2.4         *         0.031         0.001           C-4         Cast on sample         *         0.6         1.4         18.2         13.6         2.4         *         0.031         0.001           C-1         Cast on sample         *         0.7         1.8         18.1         13.1         2.2         *         0.021         0.01           C-1         Cast on sample         *         0.7         1.9         18.3         13.2         2.4         *         0.021         0.01           C-1         Cast on sample         *         0.6         0.7         1.9         18.3         13.2         2.4         *         0.021         0.01           C-1         Cast on sample         *         0.8         2.2         18.1         13.4         2.4	ab	.o.	Sample	ပ	š	Ψ	ၓ	Z	ΜO	ı	<b>~</b>	S
C4         Cast on sample         •         0.6         1.9         17.9         13.5         2.3         •         0.037         0.013           C4         Cast on sample         •         0.6         1.5         17.8         13.6         2.4         •         0.020         0.012           C4         Cast on sample         •         0.6         1.4         18.2         13.6         2.4         •         0.031         0.001           C-1         Reported         0.06         0.5         2.7         18.1         13.1         2.2         0.27         0.014***           C-1         Cast on sample         •         0.7         2.2         18.1         13.1         2.2         0.27         0.014***           C-1         Cast on sample         •         0.7         1.9         18.3         13.2         2.4         •         0.024         0.014***           C-2         Cast on sample         •         0.7         1.9         18.2         13.7         2.4         •         0.024         0.014***           C-2         Cast on sample         •         0.8         1.6         18.2         13.7         2.2         0.23         0.024	CAF	4	Reported	0.04	0.4	2.5	18.2	13.2	2.5			.014**
C-4         Cast on sample         0.04         0.6         1.5         17.8         13.6         2.4         0.25         0.030         0.017           C-4         Cast on sample         *** 0.6         1.4         18.2         13.6         2.4         *** 0.031         0.009           LD.         Sample         *** 0.7         2.2         18.1         13.1         2.2         *** 0.024         0.014***           C-1         Cast on sample         *** 0.7         2.2         18.1         13.1         2.2         *** 0.021         0.014***           C-1         Cast on sample         *** 0.7         1.9         18.3         13.2         2.4         *** 0.024         0.014***           C-2         Cast on sample         *** 0.8         2.2         18.1         13.2         2.4         *** 0.024         0.018***           C-2         Cast on sample         *** 0.8         2.2         18.1         13.4         2.2         *** 0.024         0.014**           C-2         Cast on sample         *** 0.8         1.6         18.2         13.7         2.2         0.23*** 0.024**         0.014**           C-3         Cast on sample         *** 0.8         1.6         18.0	CAF	24	Cast on sample	*	9.0	1.9	17.9	13.5	2.3	*		0.013
C-4         Cast on sample         •         0.6         1.4         18.2         13.6         2.4         •         0.031         0.009           LID.         Sample         C-1         Reported         0.06         0.5         2.7         18.1         13.1         2.2         0.27         0.018*** 0.014***           C-1         Cast on sample         0.07         1.9         18.3         13.4         2.4         0.24         0.021         0.014***           C-1         Cast on sample         0.07         1.9         18.3         13.2         2.4         *         0.024         0.014**           C-2         Cast on sample         0.06         0.5         2.8         18.0         13.2         2.3         0.26         0.037**         0.018**           C-2         Cast on sample         0.07         0.9         1.6         18.2         13.7         2.2         *         0.024         0.018**           C-2         Cast on sample         0.07         0.9         1.6         18.2         13.5         2.3         *         0.024         0.014**           C-3         Cast on sample         0.06         0.6         1.6         18.2         13.3	ပ္	4.0	Cast on sample	0	0.6	5.	17.8	13.6	2.4		ļ	0.012
LD.   Sample   C   Si   Mn   Cr   Ni   Mo   N   P   S	1		Pact or cample		90	7	18.2	12.6	2.4	1	- -	1
LD.         Sample         C         Simple         <	ζ	5	Cast Oil solition		2		4.0	2	-	-	_	
Lib.   Sample   C   Si   Mn   Cr   Ni   Mo   N   Si   C   C   C   C   C   Si   Mn   Cr   Ni   Mo   N   C   C   C   C   C   C   C   C   C					ě		į	1		2		
C-1 Cast on sample 0.06 0.5 2.7 18.1 13.1 2.2 0.27 0.018***0.014***  C-1 Cast on sample 0.06 0.7 1.9 18.3 13.4 2.4 0.24 0.021 0.010  C-1 Cast on sample 0.06 0.5 2.8 18.0 13.2 2.4 * 0.024 0.013 re-run affer C-2 Cast on sample 0.07 0.9 1.6 18.2 13.7 2.2 0.23 0.023 0.014  C-2 Cast on sample 0.07 0.9 1.6 18.2 13.7 2.2 0.23 0.023 0.014  C-2 Cast on sample 0.07 0.9 1.6 18.2 13.7 2.2 0.23 0.024 0.012 re-run affer C-2 Cast on sample 0.07 0.9 1.6 18.2 13.7 2.2 0.23 0.024 0.012 re-run affer C-3 Cast on sample 0.04 0.4 2.5 18.2 13.5 2.3 * 0.024 0.013**  C-3 Cast on sample 0.06 0.6 1.6 18.2 13.5 2.3 * 0.024 0.012 re-run affer C-3 Cast on sample 0.06 0.6 1.6 18.2 13.5 2.4 * 0.029 0.009  C-3 Cast on sample 0.06 0.6 1.6 18.1 13.5 2.4 * 0.029 0.009  C-3 Cast on sample 0.06 0.6 1.6 18.1 13.5 2.4 * 0.029 0.009  C-3 Cast on sample 0.06 0.6 1.6 18.1 13.5 2.4 * 0.029 0.010  C-3 Cast on sample 0.06 0.6 1.6 18.1 12.9 2.2 0.27 0.020 0.010	ap	<u>:</u>	Sample	د	7	E .	5	Z	9	-1	-	0
C-1         Cast on sample         *         0.7         2.2         18.1         13.1         2.2         *         0.021         0.010           C-1         Cast on sample         0.06         0.7         1.8         18.3         13.4         2.4         *         0.024         0.014           C-1         Cast on sample         *         0.7         1.9         18.3         13.2         2.4         *         0.024         0.014           C-2         Reported         0.06         0.5         2.8         18.0         13.7         2.2         *         0.03         0.012**           C-2         Cast on sample         *         0.8         2.2         18.1         13.4         2.2         *         0.03         0.012**           C-2         Cast on sample         *         0.8         1.6         18.2         13.7         2.2         0.23         0.024         0.014*           C-2         Cast on sample         *         0.8         1.6         18.2         13.7         2.2         0.23         0.014*           C-2         Cast on sample         *         0.6         1.6         18.2         13.3         2.3         *         <	SAF	?	Reported		0.5	2.7	18.1	3.1	2.2	- 1	018	0.014**
C-1         Cast on sample         0.06         0.7         1.8         18.3         13.4         2.4         0.24         0.07         0.014           C-1         Cast on sample         0.7         1.9         18.3         13.2         2.4         *         0.024         0.014         0.013 re-run after           C-2         Reported         0.06         0.5         2.8         1.8.0         13.2         2.3         0.026         0.03**         0.012           C-2         Cast on sample         *         0.8         2.2         18.1         13.4         2.2         *         0.030         0.012           C-2         Cast on sample         *         0.8         1.6         18.2         13.7         2.2         0.23         0.014           C-2         Cast on sample         *         0.8         1.6         18.2         13.5         2.3         *         0.024         0.014           C-2         Cast on sample         *         0.8         1.6         18.2         13.5         2.3         *         0.024         0.014           C-3         Cast on sample         *         0.6         1.6         18.3         13.3         2.4 <t< td=""><td>AF.</td><td>?</td><td>Cast on sample</td><td></td><td>0.7</td><td>2.5</td><td>18.1</td><td>13.</td><td>2:5</td><td></td><td>-</td><td>0.010</td></t<>	AF.	?	Cast on sample		0.7	2.5	18.1	13.	2:5		-	0.010
C-1 Cast on sample C Si Mn Cr Ni Mo N P S Cast on Sample C Si Mn Cr Ni Mo N P S Cast on Sample C Si Mn Cr Ni Mo N P S Cast on Sample C Si Mn Cr Ni Mo N P S Cast on Sample C Si Mn Cr Ni Mo N P S Cast on Sample C Si Mn Cr Ni Mo N P S Cast on Sample C Si Mn Cr Ni Mo N P S Cast on Sample C Si Mn Cr Ni Mo N P S Cast on Sample C Si Mn Cr Ni Mo N P S Cast on Sample C Si Mn Cr Ni Mo N P S Cast on Sample C Si Mn Cr Ni Mo N P S Cast on Sample C Si Mn Cr Ni Mo N P S Cast on Sample C Si Mn Cr Ni Mo N P S Cast on Sample C Si Mn Cr Ni Mo N P S Cast on Sample C Si Mn Cr Ni Mo N P S Cast on Sample C Si Mn Cr Ni Mo N P S Cast on Sample C Si Mn Cr Ni Mo N P S Cast on Sample C Si Mn Cr Ni Mo N P S Cast on Sample C Si Mn Cr Ni Mo N P S Cast on Sample C Si Mn C Cr Ni Mo N P S Cast on Sample C Si Mn C Cr Ni Mo N P S Cast on Sample C Si Mn C Cr Ni Mo N P S Cast on Sample C Si Mn C Cr Ni Mo N P S Cast on Sample C Si Mn C Cr Ni Mo N P S Cast on Sample C Si Mn C Cr Ni Mo N P S C Cast on Sample C Si Mn C Cr Ni Mo N P S C C C C C C C C C C C C C C C C C C	V	į	Cast on sample		0.7	18	183	13.4	2.4	24	١.	0.014
LD   Sample   C   Si   Mn   Cr   NI   Mo   N   P   S	1	  -  -		į		2 0	000		1			
1.D.   Sample   C   Si   Min   Cr   Ni   Mo   N   P   S	¥.	: ز	Cast on sample	i	0	25	20.3	13.2	4.4		4-	- 1
1.D. Sample									-			
C-2         Reported         0.06         0.5         2.8         18.0         13.2         2.3         0.26         0.023**         0.018**           C-2         Cast on sample         *         0.8         2.2         18.1         13.4         2.2         *         0.030         0.012           C-2         Cast on sample         *         0.8         1.6         18.2         13.7         2.2         0.23         0.023         0.014           C-2         Cast on sample         *         0.8         1.6         18.2         13.5         2.3         *         0.024         0.012         re-run after           I.D. Sample         C.3         III         II	ab	.D.	Sample	ပ	S	툳	ა ნ	z	율		<u> </u>	<b>S</b>
C-2         Cast on sample         *         0.8         2.2         18.1         13.4         2.2         *         0.030         0.012           C-2         Cast on sample         *         0.8         1.6         18.2         13.7         2.2         0.23         0.023         0.014           C-2         Cast on sample         *         0.8         1.6         18.2         13.5         2.3         *         0.024         0.014           LD.         Sample         C         SI         Mn         Cr         NI         Mo         N         P         S           C-3         Cast on sample         0.04         0.4         2.5         18.2         13.3         2.3         0.25         0.023**         0.010           C-3         Cast on sample         0.06         1.6         18.3         13.7         2.4         *         0.027         0.010           C-3         Cast on sample         0.6         1.6         18.1         13.5         2.4         *         0.028         0.011         re-run after           C-3         Cast on sample         0.6         1.6         18.1         13.5         2.4         *         0.028 <td< td=""><td>CAF</td><td>C-2</td><td>Reported</td><td>90.0</td><td>0.5</td><td>2.8</td><td>18.0</td><td>13.2</td><td>2.3</td><td></td><td>.023**[[</td><td>0.018**;</td></td<>	CAF	C-2	Reported	90.0	0.5	2.8	18.0	13.2	2.3		.023**[[	0.018**;
C-2 Cast on sample 0.07 0.9 1.6 18.2 13.7 2.2 0.23 0.023 0.014  C-2 Cast on sample C Si Mn Cr Ni Mo N P S  C-3 Cast on sample C O.04 0.4 2.5 18.2 13.3 2.3 0.027 0.013**  C-3 Cast on sample C O.06 1.9 18.0 13.3 2.4 0.25 0.023** 0.017**  C-3 Cast on sample C O.06 1.6 18.1 13.5 2.4 0.24 0.029 0.009  C-3 Cast on sample C O.06 1.6 18.1 13.5 2.4 0.24 0.029 0.001  C-3 Cast on sample C Si Mn Cr Ni Mo N P S  Z4424 Button C Si Mn Cr Ni Mo N P S	ZAF.	C-2	Cast on sample		0.8	2.2	18.1	13.4	2.2	i	0.030	0.012
C-2 Cast on sample C Si Mn Cr Ni Mo N P S  C-3 Reported C.006 0.6 1.6 18.3 13.7 2.4 0.025 0.017 re-run after  C-3 Cast on sample 0.06 0.6 1.6 18.3 13.7 2.4 0.029 0.009  C-3 Cast on sample 0.06 1.6 18.1 13.5 2.4 0.029 0.011 re-run after  C-3 Cast on sample 0.06 0.6 1.6 18.1 13.5 2.4 0.029 0.010  C-3 Cast on sample 0.06 0.6 1.6 18.1 13.5 2.4 0.029 0.011  C-3 Cast on sample 0.06 0.6 1.6 18.1 13.5 2.4 0.028 0.011 re-run after  C-3 Cast on sample 0.06 0.6 1.6 18.1 13.5 2.4 0.028 0.011 re-run after  C-3 Cast on sample 0.06 0.6 1.6 18.1 13.5 2.4 0.028 0.011 re-run after  LD. Sample C Si Min Cr Ni Mo N P S  24424 Button 0.05 0.4 2.8 18.1 12.9 2.2 0.27 0.020 0.010	. 0/4		Cacton cample		00	4	18.2	137	22	23	-	0.014
1.D.   Sample   C   SI   Mn   Gr   Ni   Mo   N   P   S     1.D.   Sample   C   SI   Mn   Gr   Ni   Mo   N   P   S     1.D.   Sample   C   SI   Mn   Gr   Ni   Mo   N   P   S     1.D.   Sample   C   SI   Mn   Gr   Ni   Mo   N   P   S     1.D.   Sample   C   Si   Mn   Gr   Ni   Mo   N   P   S     1.D.   Sample   C   Si   Mn   Gr   Ni   Mo   N   P   S     1.D.   Sample   C   Si   Mn   Gr   Si   Si   Si   Si   Si   Si   Si   S	215	100	Cast on sample	2	200	2	100	5			- 1	200
1.D.   Sample   C   Si   Mn   Cr   Ni   Mo   N   P   S     C-3   Reported   0.04   0.4   2.5   18.2   13.3   2.3   0.25   0.023* 0.013**   C-3   Cast on sample   0.06   1.6   18.3   13.7   2.4   0.24   0.029   0.009     C-3   Cast on sample   0.06   1.6   18.1   13.5   2.4   * 0.028   0.011   re-run after     Heat poured 1/14/04   C   Si   Mn   Cr   Ni   Mo   N   P   S     24424 Button   0.05   0.4   2.8   18.1   12.9   2.2   0.27   0.020   0.010	4	֡֝֝֝֝֝֝֝֝֝֝֝֝֡֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֡֓֓֓֓֓֡֓֡֓֡֓֡֓֡֓֡֓֡֓֡	Cast on sample		0.0	0.	7.0	0.0	<b>6.5</b>	[	+	re-run alter
D. Sample   C   Si   Mn   Cr   Ni   Mo   N   P   S		!!							!			
C-3 Reported 0.04 0.4 2.5 18.2 13.3 2.3 0.25 0.023** 0.013** C-3 Cast on sample 0.06 0.6 1.9 18.0 13.7 2.4 0.24 0.029 0.009 C-3 Cast on sample 0.06 1.6 18.1 13.5 2.4 * 0.029 0.009 C-3 Cast on sample 0.06 1.6 18.1 13.5 2.4 * 0.028 0.011 re-run after theat poured 1/14/04 L.D. Sample C SI Mn Cr NI Mo N P S 24424 Button 0.05 0.4 2.8 18.1 12.9 2.2 0.27 0.020 0.010	g	<u>.</u>	Sample	ပ	ळ	Ę	5	Z	ì	.	ما	S.
C-3 Cast on sample	CAF	င္ပ	Reported	0.04	0.4	2.5	18.2	13.3	-		.023** C	0.013**
C-3 Cast on sample 0.06 0.6 1.6 18.3 13.7 2.4 0.24 0.029 0.009 C-3 Cast on sample 0.6 1.6 18.1 13.5 2.4 * 0.028 0.011 re-run affer Heat poured 1/14/04 LD. Sample C SI Min Cr NI Mo N P S 24424 Button 0.05 0.4 2.8 18.1 12.9 2.2 0.27 0.020 0.010	CAF	6-3	Cast on sample		9.0	1.9		13.3				0.010
C-3 Cast on sample • 0.6 1.6 18.1 13.5 2.4 • 0.028 0.011 re-run after Heat poured 1/14/04 LD. Sample C SI Min Cr NI Mo N P S 24424 Button 0.05 0.4 2.8 18.1 12.9 2.2 0.27 0.020 0.010	NC.	53	Cast on sample		9.0	9		13.7	2.4	24	!	0.009
Heat poured 1/14/04 LD. Sample C Si Mn Cr Ni Mo N P S 24424 Button 0.05 0.4 2.8 18.1 12.9 2.2 0.27 0.020 0.010	ΨV	, c	Cast on sample	1	0.6	4	1	13.5	2.4			re-nin affer
Heat poured 1/14/04 I.D. Sample C Si Mn Cr Ni Mo N P 24424 Button 0.05 0.4 2.8 18.1 12.9 2.2 0.27 0.020	:	· •									i	
LD. Sample C SI Mn Cr NI Mo N P 24424 Button 0.05 0.4 2.8 18.1 12.9 2.2 0.27 0.020	Pest Heat	poured 1/1	4/04	1				:				
24424 Button 0.05 0.4 2.8 18.1 12.9 2.2 0.27 0.020	ab.	I.D.	Sample	: :	, or	M		Z	:	z	: . a	8
24424 DUNUI 0.03 0.4 2.0 10.1 12.3 2.2 0.21 0.020	200		Carrier	200			5 6	200	:			0040
	A.	7447	+ Button	cn.n	0.0	0.0	.0.5	8.7	-			
0.4 2.2 18.2 13.2 2.2 0.018	CAF	24424	Keel bar	•	4.0	2.2	7 % 7					
							1	!	-		-	

not analyzed by wet chemistry.

\*\* analyzed by wet chemistry.

For C-5 C and N were analyzed at CAF and at WC by Leco Analyzer, P+S analyzed on spectrometer.



## Carondelet Division

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August 16, 2005

Report on Alloy Specification Development of Contaminants Limits

MetalTek International was requested to comment on the limits set for the contaminants, specifically Sulfur and Phosphorus, in its specification recommendation to PPPL for the NCSX program. This is the result of that investigation.

In review of the data and efforts in the 2.1.2 Task (Alloy Selection) under the prototype contract, several items were of note relative to the alloy chemistry development:

- In the onset, Alloy#1, a less alloyed variant of 316ss, was considered; however, the concern within PPPL and MetalTek was the effects of water quenching on the alloy during solution anneal (e.g. dimensional control and residual stresses).
- 2.) The limits for P and S in the Alloy #1 were set to comply with standard CF8M (cast "316ss") limits of 0.04% maximum for both.
- 3.) In order to eliminate water quench, a second alloy was funded under the scope of the 2.1.2 Task. This alloy was successful and has been referred to as "Stellaloy."
- 4.) The limits for P and S in the Alloy #2 were set to comply with standard limits for CF8M, again 0.04% maximum.
- 5.) Heats were made for each alloy, with both P and S well below the 0.04% maximum limits; however, one heat showed P above the 0.015% ultimately recommended.
- 6.) Based on review of the testing, MetalTek International Research recommended a chemical composition range for the ultimate 2.1.2 task. This range incorporated restrictions on the P and S at 0.015% maximum limits. Insufficient review of this recommendation against historic chemical analyses and those reported in the task was performed, resulting in the recommendation to PPPL to use the lower limits.

In essence, insufficient review of available data outside the recommendation of the MetalTek International Research group resulted in the proposal of a specification beyond the limits of the planned production processes.

Joe Edwards/Chuck Ruud

(All



## Addendum to CA1323 9-30-05

This is to supplement and report our progress on this corrective action.

We have discussed the variation in reading the Mn levels with the service technician and the spectrometer manufacturer. No new information has been obtained to explain the differences in reading Mn levels.

The chemistry for the shims poured from heat 29198 has been analyzed and is added to the spreadsheet attached. It shows similar readings for Mn.

The chemistry for the C-6 coil is also added to the spreadsheet. We aimed for higher Mn at the furnace to assure the higher Mn levels. The results indicate the effort was successful.

Update as to action steps:

Create a type standard that closely matches the Mn in CF8MNMNMOD.

Completed at WC and has been sent to another laboratory.

Request a revision to the chemistry range for Mn. (propose widening of Manganese since it has been proven to be effective at much lower concentrations than previously thought).

Pending.

Have each heat of CF8MNMNMOD verified independently for balance of program.

Complete for all coils to date.

C. Ruud

CC: Jim Galaske, Barry Craig, Joe Edwards, E.J. Kubick

l l	,,	with WISCO	Revised	9-30-05	<u> </u>	Informa	tion in bl	ue adde	d 9-30-0	5		
3	l.D.	Sample	C	Si	Mn	Cr	Ni	Mo	N	P	S	
at #2919	98 for 5 C a	nd 8 Å shims								<u> </u>	<del> </del>	
F		Reported 9/24/05	0.07	0.7	2 97	18 1	13.12	2.45	0.255	0.013	0.01**	
F	29198	Separale Test bar	*	0.8	2.7	18.2	13.2	2.4	,	0.028	0.011	re-run after PKI
	-	0										
<del>5</del>	I.D. C-6,1-1	Sample Button #1	0.04	<b>Si</b> 0.3	Mn 2.5	Cr 18.2	Ni 45.5	Mo 2.4	N	β 0.000	S 040	run after Pil
F	C-6,I-1	Button #2	0.0 <del>.1</del>	0.3	24	18.1	13.5 13.6	2.4	0.25	0.028	0 010	run after PN
-	C-6,I-1	Button #2	0.03	0.2	24	17.9	13.7	2.4	0.26	0.03	0.010	iun allei Fivi
	0.5,,	Edition 72	9.55	Ψ.Δ		17.5	[0.1		0.20	0.520	9.010	
	I.D.	Sample	С	Si	Min	Cr	Ni	Mo	N	P	S	-
F	C-5,1-3	Eutton #1	0.04	0.4	2.4	18.2	13.4	2.3	0.25	0.034		run after PM
,F	C-6.1-3	Eutton #2	7	0.4	2.4	18.2	13.7	23	-	0.033	0.012	run after Pf.1
5	C-6,I-3	Button #2	0.03	0.4	22	17.9	13.6	2.4	0.25	0.023	0.013	
b	I.D.	6		Si								
F	C-6,1-6	Sample Button #1	C 0.04	0.4	Min 2.6	Cr 18.3	Ni 13.4	<b>Mo</b> 2.4	N 0.26	P 0.031	S	run after Fi.1
<u></u>	C-6,1-6	Button #2	0.04	0.4	2.5	18.3	13.7	24	0.20	0.031		run aiter PM
-:	C-6.1-6	Button #2	0.04	0.4	2.4	18.2	13 7	$\frac{27}{24}$	0.26	0 03 )	0.013	ion alter mix
-	3 9.1 3		- V.O.	J :-		10.2	5 + 2 /		0.20	1-0-03/	0 0 14	
	I.D.	Sample	С	Si	Mn	Cr	Ni	Мо	N	P	\$	
¥F	C-5.Z-3	Cast on sample	•	0.6	1.7	18 1	13.6	24	7	0.031	0.012	run after PM
3	0-6,2-3	Cast on sample	0.04	0.6	1.7	17.8	13.8	2.4	0.26	0.023	0.011	
.b ∤F	I.D.	Sample	C	Si	Mn	Cr	Ni	Мо	N	P	S	
	C-5,I-1 C-5,I-1	Button #1	0.05	0.3	2.6	18.1	13.4	2.4	0.26	0.023	0.011	
	C-5,I-1	Button #2 Button #2	0.05 0.02	0.4	2.6 2.2	18.0 18.2	13.4 13.5	2.6 2.4	0.26	0.023	0.013	
	C-5,I-1	Button #1	0.02	0.5	2.2	10.2	13.5	2.4	0.25	0.025	0.010	
₹F	C-5,I-1	Button #1	•	0.3	2.3	18.3	13.4	2.4	+	0.023	0.012	re-run after PM
	I.D.	Sample	С	Si	Mn	Cr	Ni	Мо	N	Р	S	
₹F	C-5,1-3	Button #1	0.05	0.4	2.2	17.9	13.4	2.5	0.24	0.033	0.012	
C C	C-5,I-3	Button #2	0.05	0.4	2.2	17.9	13.2	2.4	0.24	0.033	0.012	
	C-5,I-3 C-5,I-3	Button #2 Button #1	0.05	0.4	1.8 1.8	18.2	13.4	2.5	0.23	0.034	0.018	
₹F	C-5,1-3	Button #1	•	0.4	1.8	18.3	13.3	2.5		0.034	0.012	re-run after PM
.,	0,10	Dation 1		. 0,7	1.0	10.3	13.5	2.5	<del> </del>	0.054	0.012	re-run alter Five
	I.D.	Sample	С	Si	Mn	Cr	Ni	Мо	N	Р	\$	
	C-5,I-6	Button #1	0.05	0.3	2.4	18.1	13.2	2.4	0.25	0.030	0.012	
₫F	C-5,I-6	Button #2	0.05	0.3	2.4	18.1	13.2	2.4	0.25	0.029	0.011	
C	C-5,I-6	Button #2	0.04	0.3	2	18.3	13.3	2.4	0.24	0.031	0.018	
FL Wet	C-5,I-6 C-5,I-6	Button #1 Button #1		0.3	1.9 2.0	10.4	400	-0.4	<u> </u>	0.000	0.040	
<u> </u>	C-5,1-0	DUROTI #1		0.3	2.0	18.4	13.3	2.4		0.03	0.012	re-run after PM
ab	I.D.	Sample	С	Si	Mn	Cr	Ni	Mo	N	P	s	
	A-1	Reported	0.04	0.4	2.4	18.2	13.3	2.4	0.26	<u> </u>	-	
	A-1	Cast on sample	7	0.5	2.1	18.0	13.4	2.4	7	0.034	0.009	
	A-1	Cast on sample	0.06	0.6	1.6	18.1	13.7	2.4	0.25	0.027	0.009	
4F	A-1	Cast on sample	*	0.6	1.6	18.2	13.5	2.4	*	0.028	0.009	re-run after PM
-1-	LD	C1										
ab AF	I.D. C-4	Sample	C 0.04	Si 0.4	Mn	Cr	Ni	Mo	N	P	S	
AF AF	C-4	Reported	0.04	0.4	2.5	18.2	13.2	2.2	0.26	.030**	.014**	
C	C-4	Cast on sample Cast on sample	0.04	0.6 0.6	1.9 1.5	17.9 17.8	13.5 13.6	2.3 2.4	<u> </u>	0.007	0.013	
	C-4	Cast on sample	U.U4 *	0.6	1.5	18.2	13.6	2.4	0.25	0.000	0.012	re-run after PM
- 11		Cast on sample		0.0	1.4	10.2	13.0	2.4		0.001	0.009	ne-run aner PIVI
ab	I.D.	Sample	С	Si	Mn	Cr	Ni	Mo	N	P	S	
AF	C-1	Reported	0.06	0.5	2.7	18.1	13.1	2.2	0.27		0.014**	
ĀF	C-1	Cast on sample	*	0.7	2.2	18.1	13.1	2.2		0.021	0.010	
IC .	C-1	Cast on sample	0.06	0.7	1.8	18.3	13.4	2.4	0.24	0.021	0.014	
AF	C-1	Cast on sample	*	0.7	1.9	18.3	13.2	2.4	•	0.02:4	0.013	re-run after PM
ab	I.D.	Sample	С	Si	RA m	C-	NI:	P.C.	A.I			
ĀF	C-2	Reported	0.06	0.5	Mn 2.8	Cr 18.0	Ni 13.2	Mo 2.3	0.26	P 0.023**	S 0.018**	
	C-2	Cast on sample	3.00	0.8	2.2	18.1	13.4	2.3	0.20	0.030	0.012	
	10-2			2.4					1		, ~. ~ 12-	1
AF /C	C-2	Cast on sample	0.07	0.9	1.6 1.6	18.2	13.7	2.2	0.23	0.0::3	0.014	re-run after PM

ь I.D	).	Sample	c	Si	Mn	Cr	Ni	Мо	N	P	S	
IF C		Reported	0.04	0.4	2.5	18.2	13.3	2.3	0.25	0.023	0.013**	
F C-	3	Cast on sample	•	0.6	1.9	18.0	13.3	2.4	*	0.027	0.010	
C -	3	Cast on sample	0.06	0.6	1.6	18.3	13.7	2.4	0.24	0.023	0.009	
vF C-	3	Cast on sample	*	0.6	1.6	18.1	13.5	2.4	*	0.023	0.011	re-run after PM
st Heat pou												
b I.D		Sample	C	Si	Mn	Cr	Ni	Мо	N	P	S	
F	24424	Reported	0.054	0.4	2.8	18.1	12.94	2.21	0.27	0.02)	0.010	[
F	24424	Keel bar	-	0.4	2.2	18.2	13.2	2.2	*	0.013	0.010	re-run after PM
ot analyzed										<u> </u>		
analyzed by	y wet che	emistry.								T		
		nd N were analyzed	at CAF a	nd at W	C by Lec	i. o Analy	zer, P+S	analyze	d on sp	ectromet	er.	



## Carondelet Division

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August 16, 2005

Report on Alloy Specification Development of Contaminants Limits

MetalTek International was requested to comment on the limits set for the contaminants, specifically Sulfur and Phosphorus, in its specification recommendation to PPPL for the NCSX program. This is the result of that investigation.

In review of the data and efforts in the 2.1.2 Task (Alloy Selection) under the prototype contract, several items were of note relative to the alloy chemistry development:

- In the onset, Alloy#1, a less alloyed variant of 316ss, was considered; however, the concern within PPPL and MetalTek was the effects of water quenching on the alloy during solution anneal (e.g. dimensional control and residual stresses).
- 2.) The limits for P and S in the Alloy #1 were set to comply with standard CF8M (cast "316ss") limits of 0.04% maximum for both.
- 3.) In order to eliminate water quench, a second alloy was funded under the scope of the 2.1.2 Task. This alloy was successful and has been referred to as "Stellaloy."
- 4.) The limits for P and S in the Alloy #2 were set to comply with standard limits for CF8M, again 0.04% maximum.
- 5.) Heats were made for each alloy, with both P and S well below the 0.04% maximum limits; however, one heat showed P above the 0.015% ultimately recommended.
- 6.) Based on review of the testing, MetalTek International Research recommended a chemical composition range for the ultimate 2.1.2 task. This range incorporated restrictions on the P and S at 0.015% maximum limits. Insufficient review of this recommendation against historic chemical analyses and those reported in the task was performed, resulting in the recommendation to PPPL to use the lower limits.

In essence, insufficient review of available data outside the recommendation of the MetalTek International Research group resulted in the proposal of a specification beyond the limits of the planned production processes.

Joe Edwards/Chuck Ruud

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