

## PACIFIC GAS AND ELECTRIC COMPANY

COPY

Bureau of Tests and Inspection

August 3, 1949

MR. R. S. FULLER:

Attention: Mr. R. D. Smith

I am enclosing herewith a final report of the inspection of 30 inch pipe by Moody-Engineering Company at Consolidated Western Steel Co's. plant in Maywood, on our Order No. 7R 66858.

I am sure you, and possibly Mr. J. A. Love, would like to look this over before returning it for our file.

W. N. LINDBLAD

WNL:MLW  
Enclosure  
CC: JAL

MOODY ENGINEERING COMPANY

HIGHLAND BUILDING PITTSBURGH 6, PA.

July 19, 1949

RECEIVED  
JUL 20 1949

Pacific Gas & Electric Co.  
4245 Hollis Street  
Emeryville 8, California

Attention: Mr. W. N. Lindblad  
Chief of Bureau of Tests & Inspection

Inspection Order 7R-81743  
Purchase Order 7R-66858  
Consolidated Western Steel Corp.  
30" O.D. x 3/8" Wall Line Pipe

Gentlemen:

We wish to submit herewith our report, covering the supervision of manufacture and our inspection, in accordance with your Inspection Order No. 7R-81743, of:

3,222 pieces - 100,001.63 feet - 18.939 miles  
of 30" O.D. x 3/8" wall "Unionmelt"  
Electric Fusion Weld Steel Line Pipe;

supplied on your Purchase Order 7R-66858, placed with the Consolidated Western Steel Corporation, and shipped via auto truck to your coating and wrapping plant in Montebello, California, as designated in your shipping instructions issued to the manufacturer. Shipment of this pipe was made during the interval from March 11 to April 22, 1949.

Your order as placed with the manufacturer covered:

100,000 feet of Black Electric Welded Steel Pipe, 30" O.D. x .375" wall x 31' 2" length, to be fabricated in accordance with the P.G. & E. Specifications for pipe dated June 21, 1948.

The pipe supplied for this order was fabricated at the Maywood, California plant of the Consolidated Western Steel Corporation, at which plant our inspection of the pipe was conducted during its manufacture. This order was scheduled for production in conjunction with several other orders for the same size and quality of pipe, and therefore, the plates used in the manufacture of this pipe involved a greater number of heats of steel than would normally be required for an order for this quantity. The required results of the ladle analyses, check chemical analyses, and tension tests of all of the heats of steel for the 3/8" wall pipe are included in this report.

The major portion of the steel plates from which the pipe was made were supplied through the Columbia Steel Company, Los Angeles, California by the Geneva Steel Company, and rolled at their plant in Geneva, Utah. The balance of the plates were supplied by the Kaiser Company, Inc., and rolled at their plant in Fontana, California.

#### DETAILS OF PIPE MANUFACTURE:

The flat plates for fabrication into pipe enter the production line on a flat charge table. They pass under end squaring shears where the ends of the plates are cut square with the longitudinal edges.

As the plates leave the end shearing operation, they are passed between two planers, set parallel and back-to-back, where the longitudinal edges of each plate are simultaneously planed parallel to each other, and with a slight bevel of about five degrees. This bevel is just sufficient to insure definite closure contact of the inner edges when formed into a cylinder, which will tend to prevent "burn-through" as the outside longitudinal weld is made. The longitudinal edges of the plate are also chamfered at the outer corner to form a guide groove for the flexible weld head attachment of the Berkley Welding Units. This flexible weld head has been arranged to prevent off seam welds, and to centralize the weld properly over the long seam of each cylinder. The plates are finished planed to a width of 91-5/8", plus or minus 1/32", for this 30" O.D. x .375" wall pipe.

Following the planer operation, the plates pass through a set of edge break, or crimping rolls, and then to the pyramid rolls where they are formed into cylinders with the longitudinal edges aligned for the outside welding operation. The cylinders are then progressed through the Berkley Welding Units, where the longitudinal seam is automatically welded on the outside by the "Unionmelt" Electric Fusion method. A similar "Unionmelt" weld is also made along this seam on the inside by the Inside Welding Units. Each of these welds is regulated to penetrate to a minimum of 2/3 of the plate thickness from each side, thereby resulting in an overlap, or tie, of these two welds in the middle third of the wall thickness of the cylinder.

As now arranged, the Berkley Welding Units will not complete a sound solid weld to the very end of each longitudinal seam of each cylinder. It is characteristic of these units to allow the weld to crack about two to three inches at the leading end of the cylinder, and about four to eight inches at the trailing end of the weld. This condition is no doubt a result of the "spring-back" of the plate as the ends of the cylinders leave the retaining guides of the cage at the welding zone, and before the weld metal has had time to congeal sufficiently to restrain the uncontrolled stresses caused by the "spring-back" of the plate. The manufacturer does not cut any crop from the ends of the cylinders, therefore, it is necessary to repair, and complete each end of the longitudinal automatic weld before the cylinders pass to the inside long seam welders.

Lincoln Semi-Automatic squirt welders, which make a submerged arc weld, were used to complete the longitudinal weld at each end of the cylinder. Each end of each outside automatic weld was carefully cleaned by chipping before the Lincoln squirt weld was made to complete the outside long weld. These end welds were made against an inside flux back-up arrangement held in position in the pipe by an air pressure jack, or ram, which permitted the end welds to be regulated to give complete wall penetration.

Each outside end weld was back chipped on the inside of the seam to remove any chance of flux entrapment or pockets before this section of the inside was covered with a similar Lincoln Semi-Automatic weld at each end of the inside seam. Each of these end welds was started on a square steel tab placed at the end of the seam, and this tab was left attached to the cylinder for a starting area for the inside automatic weld.

The cylinders, with the end tabs attached, are progressed to the inside welding operation. The welding heads of the Inside Welding Units are suspended at the free end of a box girder arm of sufficient length to allow the head to extend through the cylinder as it is conveyed endwise on a carriage for this welding operation. The cylinder supports of the carriage are adjustable, so that the operator may vary the position of the inside weld to cover, or follow, the inner side of the previously made outside weld, which is used as a guide for locating the inside "Unionmelt" weld. At the completion of the inside weld, the travel of the supporting carriage is reversed to free the weld unit arm from the inside of the cylinder.

The welded cylinders then pass over a series of inspection and repair skids, where at this stage of manufacture, a shop inspection is made of the inside and outside of the cylinders

with especial attention being given to the condition of each of the welds. All defects discovered during this inspection are required to be eliminated by chipping before repairs are permitted. If not excessive, repairs are made by hand welding, otherwise the repair weld is made with a "Unionmelt" unit. Every effort is made to have all repairs completed before the cylinders are subjected to the expanding operation. It is standard practice to pre-heat all areas to be repaired to about 450 degrees before repair welds are made.

Each cylinder as formed and welded was smaller in diameter than the specified O.D. of the finished pipe; therefore, all cylinders passed by the shop inspection for further processing are conveyed to the End Belling Unit, and each end expanded mechanically to approximately the finished O.D. of the pipe. Each piece is then subjected to an internal hydrostatic pressure sufficient to stress the steel beyond its yield point, and increase the diameter until the outer surface of the cylinder is in direct contact with the inner surface of the retaining die of the expander unit, which is cylindrical, and bored to the proper diameter to produce pipe of the specified O.D.

The wall thickness of the pipe is not materially reduced by the expanding operation, since the length of the cylinders is shortened to compensate for the increase in diameter. The O.D. of the cylinders as formed and welded range from 29-37/64" to 29-39/64" for the finished 30" O.D. pipe.

Comparative tensile tests have been made on numerous heats of steel from which pipe has been manufactured by this process, and it has been determined that the yield strength of the steel has been increased by about 12,000 to 20,000 lbs per square inch by the internal expanding, or cold working operation. It is also established that this increase in yield strength is accomplished without the steel being transformed into a serious brittle condition if the chemistry of the plate as rolled is suitable for fabrication under this method of pipe manufacture.

The specified hydrostatic pressure test and hammer test are applied to each length of pipe directly following the expanding operation, and with the same equipment, but with the retaining dies released and open so that the pipe is not supported or restricted in any manner by the die section.

The balance of operations required in finishing the pipe as adapted by this manufacturer are similar to the conventional methods followed by other pipe manufacturers.

#### CHEMICAL AND PHYSICAL PROPERTIES OF STEEL:

Ladle and Check Chemical Analyses have been made on each heat of steel involved in the supply of pipe for this order.

Tension tests were also conducted on specimens cut from one length of finished pipe made from a plate selected from each heat of steel. One transverse tensile test was made on a specimen cut from the finished pipe across the weld, with the weld in the center of the specimen, to determine the ultimate strength of the steel. The weld re-inforcement metal was not removed for this test. Another transverse tensile test was made on a specimen cut from the same pipe, but 90 degrees from the weld, to determine the yield strength, ultimate strength, and percentage of elongation of the steel of the finished pipe after expansion.

The results of ladle and check chemical analyses made on the heats of steel from which the plates have been rolled for the manufacture of this pipe are as follows:

HEAT SYMBOL	HEAT NUMBER	ANALYSIS	P E R C E N T A G E				
			C	Mn	P	S	Si
AGK	21490	Ladle Check	.26	.91	.018	.033	.07
			.26	.94	.017	.021	-
AGL	21491	Ladle Check	.26	.97	.013	.035	.07
			.27	1.03	.015	.018	-
AGT	61713	Ladle Check	.25	.91	.012	.031	.04
			.27	.87	.017	.022	-
AGV	71733	Ladle Check	.25	1.04	.018	.023	.04
			.29	1.04	.013	.037	-
AHO	41549	Ladle Check	.27	1.09	.020	.032	.07
			.28	.93	.014	.035	-
AHP	41550	Ladle Check	.26	1.00	.015	.036	.08
			.27	.91	.013	.037	-
AHQ	61734	Ladle Check	.24	.93	.013	.025	.06
			.27	1.21	.013	.023	-
AHX	91068	Ladle Check	.27	1.06	.015	.036	.08
			.26	1.06	.020	.028	-
AHY	11085	Ladle Check	.26	.97	.012	.034	.07
			.27	.96	.015	.037	-
AHZ	11097	Ladle Check	.25	1.03	.014	.030	.10
			.27	1.01	.017	.023	-
AIK	91038	Ladle Check	.29	1.03	.013	.029	.08
			.32	1.04	.016	.026	-
AIL	51572	Ladle Check	.26	1.05	.017	.033	.08
			.24	1.00	.016	.032	-

<u>HEAT SYMBOL</u>	<u>HEAT NUMBER</u>	<u>ANALYSIS</u>	P E R C E N T A G E				
			<u>C</u>	<u>Mn</u>	<u>P</u>	<u>S</u>	<u>Si</u>
AIP	21511	Ladle	.26	.96	.016	.035	.08
		Check	.24	.90	.017	.023	-
AJA	81456	Ladle	.24	.91	.014	.028	.04
		Check	.22	.94	.015	.026	-
AJB	81458	Ladle	.26	1.07	.012	.027	.08
		Check	.26	1.16	.016	.023	-
AJC	21510	Ladle	.24	.99	.010	.039	.10
		Check	.26	1.01	.014	.032	-
AJD	41566	Ladle	.27	.99	.010	.030	.06
		Check	.27	1.04	.016	.040	-
AJE	41567	Ladle	.26	.91	.022	.042	.08
		Check	.22	.85	.015	.023	-
AJH	61746	Ladle	.24	.95	.012	.023	.06
		Check	.23	1.00	.017	.023	-
AJI	81457	Ladle	.26	1.02	.022	.027	.05
		Check	.27	1.06	.018	.029	-
AJJ	31494	Ladle	.26	1.01	.032	.043	.09
		Check	.24	1.04	.017	.031	-
AJK	81472	Ladle	.24	.91	.016	.030	.09
		Check	.22	1.00	.015	.023	-
AJL	31493	Ladle	.26	.99	.016	.032	.10
		Check	.25	1.04	.014	.037	-
AJM	61747	Ladle	.26	.94	.010	.030	.05
		Check	.26	1.00	.016	.027	-
AJN	21500	Ladle	.24	.87	.012	.036	.07
		Check	.25	.92	.018	.025	-
AJO	31495	Ladle	.26	.93	.017	.038	.10
		Check	.23	1.05	.017	.030	-
AJP	81475	Ladle	.25	.88	.013	.041	.08
		Check	.20	.87	.014	.043	-
AJQ	21509	Ladle	.25	.95	.032	.029	.07
		Check	.25	.87	.021	.026	-
AJS	61749	Ladle	.26	.92	.011	.032	.07
		Check	.28	1.00	.018	.028	-
AJT	11339	Ladle	.26	1.13	.035	.025	.07
		Check	.26	1.19	.018	.032	-

HEAT SYMBOL	HEAT NUMBER	ANALYSIS	P E R C E N T A G E				
			C	Mn	P	S	Si
AJU	21573	Ladle Check	.26	1.01	.019	.045	.05
			.27	1.00	.015	.035	-
AJV	31553	Ladle Check	.26	1.00	.019	.030	.07
			.28	1.01	.014	.037	-
AJW	11350	Ladle Check	.27	1.17	.010	.034	.06
			.29	1.12	.013	.037	-
AJX	91301	Ladle Check	.28	1.12	.025	.037	.09
			.32	1.14	.013	.049	-
AJY	1556	Ladle Check	.28	1.00	.013	.024	-
			.29	1.05	.014	.023	-
AJZ	91308	Ladle Check	.25	1.13	.024	.035	.09
			.30	1.17	.015	.040	-
AKF	61776	Ladle Check	.27	1.08	.017	.035	.08
			.25	1.01	.011	.035	-
AKM	21549	Ladle Check	.25	.99	.016	.031	.06
			.25	.95	.012	.032	-
AKP	61785	Ladle Check	.24	.91	.023	.032	.07
			.22	.92	.016	.032	-
ALM	41615	Ladle Check	.25	1.09	.013	.037	.09
			.25	1.05	.014	.040	-
ALO	91309	Ladle Check	.25	1.09	.024	.026	.10
			.29	1.12	.016	.032	-
ALV	71875	Ladle Check	.27	1.09	.010	.022	.06
			.27	1.15	.012	.026	-
ALY	31509	Ladle Check	.26	.99	.043	.036	.10
			.24	1.08	.018	.026	-
ALZ	91316	Ladle Check	.27	1.07	.022	.026	.08
			.27	1.06	.012	.032	-
AMA	11370	Ladle Check	.25	1.06	.016	.027	.07
			.27	.92	.015	.026	-
AMB	91310	Ladle Check	.25	1.03	.033	.028	.04
			.29	.98	.015	.029	-
AMC	81537	Ladle Check	.26	.97	.034	.028	.06
			.26	.95	.013	.029	-



HEAT SYMBOL	HEAT NUMBER	ANALYSIS	P E R C E N T A G E				
			C	Mn	P	S	Si
AMD	41619	Ladle Check	.25	1.09	.021	.035	.07
			.24	.92	.015	.029	-
AME	41618	Ladle Check	.25	.88	.010	.025	.06
			.25	.88	.015	.026	-
AMG	81534	Ladle Check	.26	1.05	.025	.035	.10
			.29	1.04	.014	.035	-
AMI	81535	Ladle Check	.27	1.08	.015	.032	.04
			.28	1.05	.012	.023	-
AMJ	31557	Ladle Check	.27	1.01	.016	.029	.04
			.28	.98	.015	.032	-
AMR	31559	Ladle Check	.28	.91	.015	.028	.09
			.23	.95	.013	.032	-
AMS	21577	Ladle Check	.25	.99	.017	.036	.05
			.23	1.08	.014	.032	-
AMT	51646	Ladle Check	.25	1.03	.022	.045	.10
			.25	.98	.014	.035	-
AMU	41617	Ladle Check	.24	.94	.022	.038	.10
			.24	.93	.014	.029	-
AMV	11373	Ladle Check	.25	1.04	.030	.024	.09
			.25	1.06	.017	.026	-
AMW	11372	Ladle Check	.28	1.04	.010	.022	.06
			.29	1.08	.017	.026	-
AMX	81533	Ladle Check	.25	1.02	.019	.030	.05
			.27	1.09	.015	.029	-
AMY	11376	Ladle Check	.27	1.06	.015	.022	.10
			.28	1.07	.015	.029	-
AMZ	91314	Ladle Check	.30	1.09	.039	.030	.06
			.29	1.23	.017	.023	-
ANL	51660	Ladle Check	.25	.97	.017	.040	.04
			.29	1.00	.014	.040	-
ANO	71904	Ladle Check	.28	.93	.017	.028	.07
			.29	1.00	.013	.029	-

HEAT SYMBOL	HEAT NUMBER	ANALYSIS	P E R C E N T A G E				
			C	Mn	P	S	Si
ANX	91344	Ladle Check	.26	1.03	.010	.024	.07
			.24	.99	.012	.032	-
ANY	51678	Ladle Check	.24	.98	.020	.036	.05
			.26	.96	.012	.032	-
AOB	21579	Ladle Check	.26	1.00	.018	.022	.08
			.27	1.12	.017	.023	-
AOC	31556	Ladle Check	.27	1.13	.019	.030	.07
			.28	1.28	.018	.026	-
AOD	71877	Ladle Check	.25	1.01	.010	.023	.07
			.24	1.07	.015	.029	-
AOE	81538	Ladle Check	.25	1.07	.013	.027	.05
			.25	1.00	.017	.026	-
AOH	31558	Ladle Check	.24	.88	.039	.032	.06
			.23	.99	.018	.026	-
AOI	41576	Ladle Check	.27	1.08	.039	.030	.06
			.28	1.19	.018	.026	-
AOJ	51649	Ladle Check	.26	.93	.025	.032	.05
			.27	.97	.016	.032	-
AOP	61797	Ladle Check	.27	.97	.023	.035	.07
			.27	1.04	.017	.026	-
AOV	41616	Ladle Check	.27	.97	.023	.035	.07
			.26	.96	.017	.037	-
AOW	11374	Ladle Check	.26	1.07	.017	.028	.05
			.31	1.05	.018	.032	-
AOX	21527	Ladle Check	.25	1.09	.024	.030	.09
			.24	1.17	.013	.029	-
AOY	41633	Ladle Check	.25	1.05	.010	.034	.10
			.27	.87	.015	.029	-
APE	21594	Ladle Check	.26	.95	.018	.029	.06
			.23	.99	.015	.024	-
APK	51668	Ladle Check	.26	1.03	.017	.035	.09
			.28	1.07	.014	.032	-
APP	31582	Ladle Check	.26	1.01	.015	.033	.07
			.25	1.10	.014	.026	-

HEAT SYMBOL	HEAT NUMBER	ANALYSIS	P E R C E N T A G E				
			C	Mn	P	S	Si
APR	91351	Ladle Check	.27	1.08	.010	.029	.08
			.25	1.02	.016	.023	-
APS	11369	Ladle Check	.24	1.01	.013	.029	.07
			.24	.99	.017	.029	-
APT	91349	Ladle Check	.25	1.02	.013	.026	.04
			.22	1.00	.020	.023	-
APU	81577	Ladle Check	.26	1.04	.018	.025	.06
			.27	.99	.016	.032	-
APV	91362	Ladle Check	.25	.93	.010	.031	.04
			.30	1.07	.017	.037	-
APW	81568	Ladle Check	.25	1.09	.011	.032	.08
			.29	1.10	.014	.037	-
APX	71909	Ladle Check	.28	.98	.019	.032	.07
			.28	.99	.014	.026	-
APY	91372	Ladle Check	.25	.93	.014	.026	.07
			.25	.93	.015	.023	-
APZ	91371	Ladle Check	.27	1.04	.015	.028	.06
			.25	1.03	.015	.026	-
AQB	11386	Ladle Check	.26	1.00	.014	.019	.05
			.27	.98	.016	.026	-
AQF	91335	Ladle Check	.27	1.04	.014	.025	.08
			.26	1.04	.012	.029	-
AQG	81555	Ladle Check	.26	.97	.015	.034	.06
			.24	.98	.013	.026	-
AQM	81513	Ladle Check	.25	1.09	.022	.031	.06
			.24	1.01	.013	.032	-
AQP	11416	Ladle Check	.26	1.03	.023	.025	.07
			.29	.95	.015	.026	-
AQU	81586	Ladle Check	.26	.99	.016	.031	.04
			.26	.92	.012	.029	-
AQX	31614	Ladle Check	.26	.97	.010	.028	.06
			.23	.87	.013	.032	-
ARA	31609	Ladle Check	.26	1.07	.011	.027	.07
			.25	1.08	.014	.026	-

HEAT SYMBOL	HEAT NUMBER	ANALYSIS	P E R C E N T A G E				
			C	Mn	P	S	Si
ARB	91365	Ladle Check	.24	.92	.014	.034	.05
			.24	.94	.014	.029	-
ARC	91363	Ladle Check	.27	1.07	.013	.034	.08
			.27	1.12	.013	.020	-
ARD	21620	Ladle Check	.27	.97	.015	.030	.07
			.25	.95	.014	.026	-
ARE	51677	Ladle Check	.28	.96	.013	.036	.06
			.27	.96	.012	.029	-
ARF	11400	Ladle Check	.25	1.02	.018	.022	.08
			.27	.99	.013	.032	-
ARK	11397	Ladle Check	.26	.87	.021	.026	.06
			.27	.85	.013	.023	-
AEL	81594	Ladle Check	.25	1.03	.016	.028	.09
			.25	1.06	.014	.029	-
ARN	71922	Ladle Check	.25	.91	.011	.029	.05
			.26	.87	.014	.029	-
ARO	91376	Ladle Check	.25	.91	.012	.029	.06
			.23	.92	.013	.026	-
ARF	31618	Ladle Check	.26	.96	.010	.033	.08
			.26	.90	.016	.029	-
ARQ	11428	Ladle Check	.25	1.02	.027	.028	.07
			.25	.96	.015	.023	-
ARR	71934	Ladle Check	.27	.91	.020	.025	.04
			.28	.93	.012	.026	-
ARS	91375	Ladle Check	.25	.93	.021	.025	.08
			.26	1.06	.017	.032	-
ART	31635	Ladle Check	.24	.99	.018	.034	.08
			.26	.96	.017	.035	-
ARU	61836	Ladle Check	.25	1.00	.017	.034	.04
			.26	.96	.017	.035	-
ARV	11440	Ladle Check	.27	1.07	.010	.030	.08
			.24	1.00	.015	.026	-
ARW	41648	Ladle Check	.25	.91	.012	.035	.09
			.26	.89	.018	.035	-

HEAT SYMBOL	HEAT NUMBER	ANALYSIS	P E R C E N T A G E				
			C	Mn	P	S	Si
ARX	41651	Ladle	.24	.92	.017	.029	.10
		Check	.26	.90	.016	.043	-
ARY	61851	Ladle	.24	.97	.023	.037	.05
		Check	.26	.94	.016	.032	-
ARZ	51711	Ladle	.24	1.03	.020	.034	.04
		Check	.25	1.08	.015	.029	-
ASA	71920	Ladle	.26	.95	.012	.029	.05
		Check	.26	.95	.012	.026	-
ASC	21644	Ladle	.26	1.06	.018	.033	.08
		Check	.26	1.04	.015	.035	-
ASD	71948	Ladle	.25	1.07	.019	.043	.10
		Check	.26	1.09	.016	.037	-
ASE	21652	Ladle	.26	.85	.018	.028	.07
		Check	.25	.89	.018	.029	-
ASF	71949	Ladle	.25	.94	.010	.029	.07
		Check	.27	1.07	.018	.035	-
ASH	31631	Ladle	.25	1.02	.022	.041	.10
		Check	.23	.94	.018	.032	-
ASN	61858	Ladle	.26	1.05	.010	.034	.08
		Check	.30	1.07	.017	.037	-
ASO	21659	Ladle	.26	1.00	.025	.031	.09
		Check	.25	1.02	.015	.035	-
ASQ	11442	Ladle	.26	1.04	.019	.027	.07
		Check	.26	1.03	.013	.029	-
ASV	71953	Ladle	.27	.97	.019	.024	.05
		Check	.28	.93	.017	.032	-
ASY	31627	Ladle	.27	1.01	.019	.036	.09
		Check	.30	1.22	.012	.032	-
ATA	21648	Ladle	.28	1.09	.018	.023	.10
		Check	.31	1.13	.018	.026	-
ATB	31625	Ladle	.25	.98	.020	.024	.08
		Check	.24	.98	.017	.026	-
ATC	41654	Ladle	.26	.95	.024	.034	.09
		Check	.25	.93	.018	.026	-

HEAT SYMBOL	HEAT NUMBER	ANALYSIS	P E R C E N T A G E				
			C	Mn	P	S	Si
ATD	41647	Ladle Check	.24	1.06	.014	.033	.09
			.26	1.04	.019	.029	-
ATE	61838	Ladle Check	.27	1.08	.010	.036	.05
			.25	1.06	.017	.026	-
ATF	91399	Ladle Check	.25	.96	.028	.030	.10
			.24	.95	.016	.046	-
ATG	41646	Ladle Check	.27	.91	.022	.034	.10
			.20	.92	.014	.032	-
ATH	21639	Ladle Check	.24	1.01	.010	.029	.07
			.21	1.02	.017	.029	-
ATI	31629	Ladle Check	.27	1.01	.021	.036	.07
			.26	1.00	.017	.026	-
ATJ	31634	Ladle Check	.26	.80	.012	.037	.05
			.25	.85	.013	.029	-
ATL	31654	Ladle Check	.26	.95	.011	.031	.10
			.25	.95	.015	.023	-
ATP	91361	Ladle Check	.27	1.04	.020	.027	.08
			.29	1.03	.014	.026	-
ATQ	91401	Ladle Check	.25	.98	.018	.029	.10
			.25	.95	.016	.026	-
ATT	41693	Ladle Check	.24	1.04	.017	.043	.10
			.25	1.07	.013	.035	-
ATX	21695	Ladle Check	.25	1.05	.022	.034	.04
			.26	1.08	.013	.029	-
ATY	21631	Ladle Check	.26	.99	.029	.030	.06
			.23	.93	.015	.036	-
ATZ	91382	Ladle Check	.27	.98	.020	.025	.07
			.29	.98	.013	.033	-
AUE	61859	Ladle Check	.24	.94	.020	.033	.08
			.26	.97	.016	.029	-
AUG	31617	Ladle Check	.28	.97	.018	.032	.05
			.29	1.00	.020	.035	-
AUO	21662	Ladle Check	.25	.92	.025	.032	.05
			.23	.90	.018	.023	-
AUR	61830	Ladle Check	.26	1.04	.017	.029	.08
			.23	1.01	.017	.035	-

HEAT SYMBOL	HEAT NUMBER	ANALYSIS	P E R C E N T A G E				
			C	Mn	P	S	Si
AVE	31684	Ladle Check	.25	.94	.018	.033	.09
			.27	.98	.016	.032	-
AVF	51737	Ladle Check	.24	.87	.019	.039	.07
			.26	.90	.017	.037	-
AVH	81608	Ladle Check	.27	1.06	.020	.031	.10
			.28	1.11	.012	.035	-
AVJ	11496	Ladle Check	.27	1.02	.020	.025	.09
			.30	1.03	.018	.029	-
AVN	21710	Ladle Check	.24	.92	.023	.029	.04
			.25	.99	.015	.032	-
AVO	31695	Ladle Check	.26	.99	.013	.038	.08
			.27	1.05	.012	.037	-
AVP	91449	Ladle Check	.26	1.07	.025	.035	.10
			.26	1.06	.015	.029	-
AVS	41716	Ladle Check	.24	.94	.022	.038	.10
			.27	.98	.014	.039	-
AWA	21682	Ladle Check	.25	.95	.022	.030	.08
			.28	1.00	.015	.036	-
AWB	61879	Ladle Check	.27	1.04	.037	.042	.10
			.28	1.00	.013	.039	-
AWC	71988	Ladle Check	.26	1.04	.045	.039	.06
			.28	1.01	.017	.033	-
AWS	41721	Ladle Check	.25	.95	.016	.038	.07
			.26	1.08	.015	.035	-
AWW	61917	Ladle Check	.26	1.03	.021	.036	.09
			.25	1.02	.017	.029	-
AWX	31702	Ladle Check	.25	1.04	.019	.038	.10
			.29	1.07	.015	.036	-
AWZ	11479	Ladle Check	.25	.95	.015	.026	.04
			.25	.91	.016	.029	-
AXE	61919	Ladle Check	.27	1.12	.019	.040	.07
			.27	1.14	.017	.039	-
AXQ	61939	Ladle Check	.22	1.09	.027	.040	.09
			.22	1.12	.014	.046	-

HEAT SYMBOL	HEAT NUMBER	ANALYSIS	P E R C E N T A G E				
			C	Mn	P	S	Si
AXR	21740	Ladle Check	.24	.95	.018	.035	.04
			.26	.94	.014	.030	-
AYA	61922	Ladle Check	.25	1.05	.035	.040	.08
			.26	1.03	.016	.035	-
AYB	72035	Ladle Check	.25	1.07	.013	.032	.10
			.25	.97	.015	.035	-
AYC	41738	Ladle Check	.25	.97	.017	.039	.08
			.27	1.01	.012	.042	-
AYD	61918	Ladle Check	.27	1.06	.026	.042	.08
			.25	1.01	.015	.035	-
AYK	21742	Ladle Check	.25	.93	.022	.033	.09
			.29	.91	.012	.039	-
AYS	11541	Ladle Check	.25	.96	.015	.033	.08
			.25	.95	.015	.027	-
AYT	72059	Ladle Check	.25	1.08	.018	.040	.07
			.25	1.08	.015	.035	-
AYU	31736	Ladle Check	.26	1.07	.012	.039	.07
			.30	1.10	.015	.036	-
AYZ	41758	Ladle Check	.25	1.05	.024	.040	.09
			.30	1.07	.016	.026	-
AZA	81678	Ladle Check	.26	1.08	.015	.039	.09
			.27	1.01	.014	.029	-
AZC	81660	Ladle Check	.24	1.05	.017	.038	.08
			.27	1.04	.016	.033	-
AZD	41756	Ladle Check	.27	1.08	.017	.035	.10
			.28	1.11	.016	.035	-
AZE	91486	Ladle Check	.26	1.03	.021	.035	.10
			.30	1.01	.014	.036	-
AZF	72060	Ladle Check	.24	.95	.014	.038	.05
			.26	.97	.012	.029	-
AZG	21743	Ladle Check	.25	.95	.014	.035	.07
			.29	1.02	.014	.033	-
AZH	41774	Ladle Check	.26	1.02	.016	.033	.13
			.28	1.02	.015	.029	-



HEAT SYMBOL	HEAT NUMBER	ANALYSIS	P E R C E N T A G E				
			C	Mn	P	S	Si
AZI	11553	Ladle Check	.24 .27	.85 .92	.015 .015	.030 .033	.04 -
AZJ	72086	Ladle Check	.24 .29	1.03 .98	.011 .016	.040 .036	.13 -
AZX	72071	Ladle Check	.26 .27	.94 .96	.018 .017	.033 .030	.04 -
BAA	70095	Ladle Check	.25 .27	1.01 1.08	.012 .012	.034 .036	.06 -
BAB	52948	Ladle Check	.22 .26	.94 .98	.014 .017	.032 .023	- -
BAC	70093	Ladle Check	.25 .26	.89 .98	.017 .014	.031 .029	- -
BAD	52947	Ladle Check	.24 .26	.91 .96	.010 .014	.029 .039	.03 -
BAP	31765	Ladle Check	.26 .27	1.03 1.09	.010 .015	.040 .039	.07 -
BAS	21760	Ladle Check	.22 .28	.96 1.07	.010 .013	.038 .046	.08 -
BAY	11569	Ladle Check	.26 .29	1.03 1.13	.022 .017	.037 .036	.09 -
BBC	61965	Ladle Check	.27 .25	1.04 .97	.012 .013	.030 .026	.07 -
BBH	41801	Ladle Check	.26 .27	1.14 1.17	.025 .014	.041 .039	.10 -
BBJ	91535	Ladle Check	.25 .26	1.03 1.03	.023 .019	.033 .030	.06 -
BBM	71882	Ladle Check	.24 .28	.98 1.00	.013 .016	.030 .039	.10 -
BBN	91536	Ladle Check	.24 .25	.98 1.04	.022 .015	.030 .029	.07 -
BBO	41802	Ladle Check	.24 .29	1.02 1.11	.020 .015	.039 .035	.07 -
BBP	71991	Ladle Check	.25 .28	.98 .99	.012 .015	.032 .033	.06 -

HEAT SYMBOL	HEAT NUMBER	ANALYSIS	P E R C E N T A G E				
			C	Mn	P	S	Si
BBQ	31783	Ladle Check	.27	.91	.018	.028	.06
			.28	.99	.014	.039	-
BBU	41827	Ladle Check	.25	1.00	.017	.038	.07
			.25	1.04	.014	.038	-
BBY	81701	Ladle Check	.26	.85	.017	.036	.06
			.28	.91	.015	.033	-
BBZ	91532	Ladle Check	.25	1.01	.018	.040	.10
			.25	1.05	.017	.036	-
BCA	11576	Ladle Check	.26	1.02	.018	.035	.08
			.26	1.09	.015	.033	-
BCB	31775	Ladle Check	.24	1.01	.022	.037	.07
			.28	.95	.016	.035	-
BCC	81699	Ladle Check	.25	1.00	.010	.039	.06
			.26	1.05	.014	.039	-
BCD	81592	Ladle Check	.26	.92	.012	.030	.09
			.25	.96	.015	.033	-
BCE	31774	Ladle Check	.28	1.00	.012	.037	.07
			.26	.99	.014	.039	-
BCF	21786	Ladle Check	.26	1.06	.013	.036	.09
			.32	.98	.015	.039	-
BDD	21758	Ladle Check	.24	1.03	.016	.038	.08
			.24	1.00	.015	.033	-
KME	70188	Ladle Check	.25	1.04	.019	.027	-
			.29	.97	.015	.033	-
KMF	23311	Ladle Check	.26	.95	.019	.025	-
			.29	1.04	.012	.029	-
KMK	13174	Ladle Check	.22	.89	.020	.028	-
			.23	1.03	.013	.033	-
KML	62613	Ladle Check	.25	.92	.015	.024	-
			.26	1.00	.016	.036	-
KMN	23312	Ladle Check	.24	.91	.013	.025	-
			.22	1.03	.014	.033	-
KMO	70192	Ladle Check	.24	.95	.023	.023	-
			.24	1.09	.015	.036	-

HEAT SYMBOL	HEAT NUMBER	ANALYSIS	P E R C E N T A G E				
			C	Mn	P	S	Si
KMP	70191	Ladle Check	.25	.96	.020	.026	-
			.24	1.05	.013	.029	-
KMQ	53017	Ladle Check	.26	1.01	.020	.030	-
			.30	1.14	.015	.030	-
KMR	23303	Ladle Check	.25	.95	.018	.026	-
			.27	1.01	.013	.029	-
KMS	43166	Ladle Check	.24	.92	.020	.030	-
			.25	.98	.015	.029	-
KNF	13192	Ladle Check	.25	.85	.013	.028	-
			.27	1.05	.014	.036	-
KNG	70218	Ladle Check	.25	.98	.020	.031	-
			.30	1.13	.014	.027	-
KNH	53044	Ladle Check	.25	.97	.021	.045	-
			.28	1.07	.015	.036	-
KNI	70217	Ladle Check	.25	.94	.027	.035	-
			.28	1.02	.013	.027	-
KNJ	62653	Ladle Check	.26	.88	.015	.030	-
			.30	1.00	.014	.036	-
KNK	62636	Ladle Check	.27	.94	.015	.027	-
			.30	1.11	.015	.024	-
KNO	70207	Ladle Check	.24	.85	.016	.024	-
			.27	1.07	.015	.033	-
KNR	23327	Ladle Check	.25	.93	.019	.022	-
			.27	.95	.015	.030	-
KNT	13191	Ladle Check	.25	.87	.018	.025	-
			.26	.92	.016	.033	-
KNU	52948	Ladle Check	.22	.94	.014	.032	-
			.27	1.06	.014	.039	-
KNV	70093	Ladle Check	.25	.89	.017	.031	-
			.27	1.05	.016	.033	-
KNW	13200	Ladle Check	.25	.85	.022	.030	-
			.26	.97	.016	.024	-
<del>KNX</del>	62637	Ladle Check	.25	.93	.018	.034	.05
			.28	1.00	.016	.027	-

The results of tensile tests made on specimens cut from the finished pipe, selected from each heat of steel used in the manufacture of this pipe are as follows:

HEAT SYMBOL	HEAT NUMBER	TYPE TEST	YIELD POINT lbs/sq/in	TENSILE STR. lbs/sq/in	ELONG. % in 2"	LOCATION OF FRACTURE
AGK	21490	TW* TT	-- 66,666	79,892 74,722	- 31.0	Plate -
AGL	21491	TW TT	-- 73,854	84,636 84,366	- 28.0	Plate -
AGT	61713	TW TT	-- 75,000	82,133 80,851	- 28.0	Plate -
AGV	61733	TW TT	-- 69,918	84,324 78,320	- 32.0	Plate -
AHO	41549	TW TT	-- 72,928	87,671 82,872	- 28.0	Plate -
AHP	41550	TW TT	-- 67,671	80,706 79,452	- 30.0	Weld -
AHQ	61734	TW TT	-- 67,302	81,370 76,294	- 31.0	Plate -
AHX	91068	TW TT	-- 71,657	84,800 82,085	- 30.0	Plate -
AHY	11085	TW TT	-- 72,826	83,333 80,978	- 30.0	Plate -
AHZ	11097	TW TT	-- 73,224	85,474 82,513	- 28.0	Plate -
AIK	91038	TW TT	-- 72,237	89,189 84,097	- 30.0	Plate -
AIL	51572	TW TT	-- 70,509	87,061 80,965	- 30.0	Plate -
AIP	21511	TW TT	-- 74,456	82,972 78,260	- 28.0	Plate -
AJA	81456	TW TT	-- 62,864	79,365 72,148	- 30.0	Plate -
AJB	81458	TW TT	-- 69,189	80,540 75,945	- 33.0	Plate -
AJC	21510	TW TT	-- 72,752	85,714 83,651	- 28.0	Weld -

Note: (\*) TW - Transverse test across weld.  
TT - Transverse test 90 degrees from weld

<u>HEAT SYMBOL</u>	<u>HEAT NUMBER</u>	<u>TYPE TEST</u>	<u>YIELD POINT lbs/sq/in</u>	<u>TENSILE STR. lbs/sq/in</u>	<u>ELONG. % in 2"</u>	<u>LOCATION OF FRACTURE</u>
AJD	41566	TW TT	-- 75,766	84,122 83,286	- 27.0	Plate -
AJE	41567	TW TT	-- 69,589	83,561 80,547	- 25.0	Plate -
AJH	61746	TW TT	-- 67,663	79,729 77,808	- 31.0	Plate -
AJI	81457	TW TT	-- 74,659	86,486 83,923	- 30.0	Plate -
AJJ	31494	TW TT	-- 74,520	83,333 83,013	- 27.0	Weld -
AJK	81472	TW TT	-- 61,968	83,466 76,861	- 30.0	Plate -
AJL	31493	TW TT	-- 66,576	81,989 76,550	- 30.0	Plate -
AJM	61747	TW TT	-- 75,956	86,225 85,792	- 26.0	Plate -
AJN	21500	TW TT	-- 68,918	82,210 78,378	- 28.0	Plate -
AJO	31495	TW TT	-- 66,756	80,540 74,262	- 30.0	Plate -
AJP	81475	TW TT	-- 68,817	84,964 76,881	- 30.0	Plate -
AJQ	21509	TW TT	-- 70,194	81,147 77,994	- 28.0	Plate -
AJS	61749	TW TT	-- 71,273	85,597 83,468	- 31.0	Plate -
AJT	11339	TW TT	-- 76,756	89,518 88,648	- 28.0	Plate -
AJU	21573	TW TT	-- 72,654	86,522 84,986	- 28.0	Plate -
AJV	31553	TW TT	-- 73,770	84,239 80,054	- 31.0	Plate -

<u>HEAT SYMBOL</u>	<u>HEAT NUMBER</u>	<u>TYPE TEST</u>	<u>YIELD POINT lbs/sq/in</u>	<u>TENSILE STR. lbs/sq/in</u>	<u>ELONG. % in 2"</u>	<u>LOCATION OF FRACTURE</u>
AJW	11350	TW TT	-- 73,614	77,866 86,015	- 28.0	Weld -
AJX	91301	TW TT	-- 80,310	90,961 91,450	- 27.0	Weld -
AJY	1556	TW TT	-- 61,428	88,115 88,571	- 28.0	Weld -
AJZ	91308	TW TT	-- 70,588	87,466 84,224	- 30.0	Plate -
AKF	61776	TW TT	-- 67,741	84,450 76,075	- 30.0	Plate -
AKM	21549	TW TT	-- 72,628	84,010 83,197	- 30.0	Plate -
AKP	61785	TW TT	-- 68,170	83,733 73,740	- 30.0	Plate -
ALM	41615	TW TT	-- 75,338	88,980 82,655	- 28.0	Plate -
ALO	91309	TW TT	-- 71,390	85,522 78,074	- 31.0	Plate -
ALV	71875	TW TT	-- 73,829	86,065 85,675	- 30.0	Plate -
ALY	31509	TW TT	-- 74,796	87,601 83,468	- 30.0	Plate -
ALZ	91316	TW TT	-- 77,358	87,602 87,602	- 28.0	Plate -
AMA	11370	TW TT	-- 59,681	84,718 80,371	- 30.0	Plate -
AMB	91310	TW TT	-- 64,705	87,061 84,760	- 28.0	Weld -
AMC	81537	TW TT	-- 74,462	83,914 84,408	- 28.0	Weld -
AMD	41619	TW TT	-- 67,904	84,880 77,718	- 32.0	Plate -
AME	41618	TW TT	-- 64,498	78,706 74,796	- 32.0	Plate -
AMG	81534	TW TT	-- 68,206	86,648 82,880	- 30.0	Plate -

<u>HEAT SYMBOL</u>	<u>HEAT NUMBER</u>	<u>TYPE TEST</u>	<u>YIELD POINT lbs/sq/in</u>	<u>TENSILE STR. lbs/sq/in</u>	<u>ELONG. % in 2"</u>	<u>LOCATION OF FRACTURE</u>
AMI	81535	TW TT	-- 79,508	85,792 86,885	-- 28.0	Plate -
AMJ	31557	TW TT	-- 67,671	84,782 78,082	-- 32.0	Plate -
AMR	31559	TW TT	-- 73,297	84,283 82,561	-- 30.0	Plate -
AMS	21577	TW TT	-- 63,492	81,940 84,126	-- 27.0	Plate -
AMT	51646	TW TT	-- 74,603	84,224 81,216	-- 28.0	Plate -
AMU	41617	TW TT	-- 68,253	79,947 76,985	-- 30.0	Weld -
AMV	11373	TW TT	-- 72,580	85,215 80,107	-- 30.0	Weld -
AMW	11372	TW TT	-- 65,053	85,135 83,870	-- 26.0	Plate -
AMX	81533	TW TT	-- 75,200	82,446 84,533	-- 30.0	Weld -
AMY	11376	TW TT	-- 75,405	87,062 85,135	-- 30.0	Plate -
AMZ	91314	TW TT	-- 76,566	95,121 86,920	-- 30.0	Plate -
ANL	51660	TW TT	-- 59,568	86,178 80,323	-- 32.0	Weld -
ANO	71904	TW TT	-- 61,273	84,533 80,371	-- 30.0	Plate -
ANX	91344	TW TT	-- 63,926	85,365 83,023	-- 30.0	Weld -
ANY	51678	TW TT	-- 60,638	80,697 77,925	-- 30.0	Plate -
AOB	21579	TW TT	-- 74,005	86,253 84,084	-- 30.0	Weld -
AOC	31556	TW TT	-- 73,458	90,348 87,400	-- 30.0	Plate -

<u>HEAT SYMBOL</u>	<u>HEAT NUMBER</u>	<u>TYPE TEST</u>	<u>YIELD POINT lbs/sq/in</u>	<u>TENSILE STR. lbs/sq/in</u>	<u>ELONG. % in 2"</u>	<u>LOCATION OF FRACTURE</u>
AOD	71877	TW TT	-- 70,731	84,905 78,590	- 30.0	Plate -
AOE	81538	TW TT	-- 72,460	85,638 81,283	- 30.0	Plate -
AOH	31558	TW TT	-- 69,272	88,891 77,358	- 32.0	Plate -
AOI	41576	TW TT	-- 80,810	92,432 91,891	- 25.0	Plate -
AOJ	51649	TW TT	-- 70,026	82,446 79,840	- 28.0	Plate -
AOP	61797	TW TT	-- 66,481	87,052 85,041	- 25.0	Weld -
AOV	41616	TW TT	-- 70,410	85,520 78,904	- 30.0	Plate -
AOW	11374	TW TT	-- 77,628	86,178 86,522	- 28.0	Plate -
AOX	21527	TW TT	-- 66,402	87,608 83,862	- 29.0	Plate -
AOY	41633	TW TT	-- 67,925	80,965 78,975	- 29.0	Plate -
APE	21594	TW TT	-- 72,432	87,643 79,459	- 30.0	Plate -
APK	51668	TW TT	-- 61,185	86,827 79,515	- 32.0	Plate -
APP	31582	TW TT	-- 62,077	82,198 77,922	- 32.0	Plate -
APR	91351	TW TT	-- 59,733	83,110 79,200	- 32.0	Weld -
APS	11369	TW TT	-- 63,925	83,733 77,188	- 31.0	Plate -
APT	91349	TW TT	-- 61,866	80,428 75,733	- 32.0	Weld -
APU	81577	TW TT	-- 66,843	85,066 84,085	- 31.0	Weld -



<u>HEAT SYMBOL</u>	<u>HEAT NUMBER</u>	<u>TYPE TEST</u>	<u>YIELD POINT lbs/sq/in</u>	<u>TENSILE STR. lbs/sq/in</u>	<u>ELONG. % in 2"</u>	<u>LOCATION OF FRACTURE</u>
APV	91362	TW TT	-- 57,908	83,606 79,088	- 30.0	Plate -
APW	81568	TW TT	-- 62,880	87,052 78,947	- 32.0	Weld -
APX	71909	TW TT	-- 58,666	83,957 82,133	- 32.0	Plate -
APY	91372	TW TT	-- 62,972	83,018 80,270	- 32.0	Plate -
APZ	91371	TW TT	-- 66,310	85,752 84,491	- 31.0	Weld -
AQB	11386	TW TT	-- 60,962	86,956 79,145	- 30.0	Plate -
AQF	91335	TW TT	-- 63,934	87,704 83,333	- 31.0	Plate -
AQG	81555	TW TT	-- 67,540	86,807 79,842	- 27.0	Plate -
AQM	81513	TW TT	-- 64,595	84,700 81,621	- 33.0	Plate -
AQP	11416	TW TT	-- 60,752	80,547 77,150	- 31.0	Plate -
AQU	81586	TW TT	-- 64,960	83,606 81,401	- 30.0	Weld -
AQX	31614	TW TT	-- 62,735	82,384 82,841	- 30.0	Weld -
ARA	31609	TW TT	-- 66,133	85,597 80,533	- 30.0	Plate -
ARB	91365	TW TT	-- 61,765	80,913 72,995	- 32.0	Plate -
ARC	91363	TW TT	-- 66,219	88,978 85,790	- 25.0	Plate -
ARD	21620	TW TT	-- 61,702	80,053 76,861	- 32.0	Weld -
ARE	51677	TW TT	-- 66,666	85,444 79,570	- 32.0	Plate -

<u>HEAT SYMBOL</u>	<u>HEAT NUMBER</u>	<u>TYPE TEST</u>	<u>YIELD POINT lbs/sq/in</u>	<u>TENSILE STR. lbs/sq/in</u>	<u>ELONG. % in 2"</u>	<u>LOCATION OF FRACTURE</u>
ARF	11400	TW TT	-- 66,295	88,705 85,236	- 30.0	Plate -
ARK	11397	TW TT	-- 61,021	80,592 81,182	- 30.0	Plate -
ARL	81594	TW TT	-- 63,492	84,800 82,540	- 32.0	Plate -
ARN	71922	TW TT	-- 63,538	83,018 80,160	- 30.0	Plate -
ARO	91376	TW TT	-- 60,790	82,352 77,105	- 30.0	Plate -
ARP	31618	TW TT	-- 61,968	81,300 78,723	- 32.0	Plate -
ARQ	11428	TW TT	-- 63,636	79,076 78,610	- 31.0	Weld -
ARR	71934	TW TT	-- 62,303	83,246 81,152	- 31.0	Plate -
ARS	91375	TW TT	-- 63,517	83,155 78,215	- 31.0	Plate -
ART	31635	TW TT	-- 64,462	83,287 80,165	- 25.0	Plate -
ARU	61836	TW TT	-- 61,064	82,825 76,190	- 26.0	Plate -
ARV	11440	TW TT	-- 63,114	85,792 81,420	- 27.0	Plate -
ARW	41648	TW TT	-- 58,953	83,380 78,237	- 30.0	Plate -
ARX	41651	TW TT	-- 58,402	85,277 77,961	- 30.0	Plate -
ARY	61851	TW TT	-- 61,021	83,783 79,838	- 31.0	Plate -
ARZ	51711	TW TT	-- 63,487	85,753 82,288	- 30.0	Plate -
ASA	71920	TW TT	-- 59,510	84,468 76,358	- 32.0	Plate -

<u>HEAT SYMBOL</u>	<u>HEAT NUMBER</u>	<u>TYPE TEST</u>	<u>YIELD POINT lbs/sq/in</u>	<u>TENSILE STR. lbs/sq/in</u>	<u>ELONG. % in 2"</u>	<u>LOCATION OF FRACTURE</u>
ASC	21644	TW TT	-- 66,578	83,516 78,779	- 29.0	Plate -
ASD	71948	TW TT	-- 63,588	81,720 77,045	- 32.0	Plate -
ASE	21652	TW TT	-- 60,326	83,197 76,630	- 27.0	Plate -
ASF	71949	TW TT	-- 56,806	82,894 74,345	- 33.0	Plate -
ASH	31631	TW TT	-- 66,486	82,320 79,730	- 30.0	Plate -
ASN	61858	TW TT	-- 56,335	83,277 77,088	- 31.0	Plate -
ASO	21659	TW TT	-- 61,232	77,348 83,957	- 28.0	Weld -
ASQ	41442	TW TT	-- 65,517	86,216 80,371	- 28.0	Plate -
ASV	71953	TW TT	-- 66,666	86,792 85,937	- 31.0	Plate -
ASY	31627	TW TT	-- 67,904	92,432 92,307	- 26.0	Weld -
ATA	21648	TW TT	-- 68,450	89,893 87,027	- 28.0	Plate -
ATB	31625	TW TT	-- 63,760	85,135 79,019	- 26.0	Plate -
ATC	41654	TW TT	-- 67,374	87,131 85,411	- 25.0	Plate -
ATD	41647	TW TT	-- 62,972	87,533 87,027	- 30.0	Plate -
ATE	61838	TW TT	-- 63,517	89,066 84,514	- 29.0	Plate -
ATF	91399	TW TT	-- 62,601	87,637 81,842	- 31.0	Plate -
ATG	41646	TW TT	-- 60,857	85,215 80,160	- 30.0	Plate -

<u>HEAT SYMBOL</u>	<u>HEAT NUMBER</u>	<u>TYPE TEST</u>	<u>YIELD POINT lbs/sq/in</u>	<u>TENSILE STR. lbs/sq/in</u>	<u>ELONG. % in 2"</u>	<u>LOCATION OF FRACTURE</u>
ATH	21639	TW TT	-- 65,425	83,520 78,723	- 30.0	Plate -
ATI	31629	TW TT	-- 59,836	83,513 78,688	- 34.0	Plate -
ATJ	31634	TW TT	-- 61,600	82,887 78,668	- 31.0	plate -
ATL	31654	TW TT	-- 62.021	80,601 77,049	- 32.0	Plate -
ATP	91361	TW TT	-- 58,445	83,888 78,552	- 34.0	Weld -
ATQ	91401	TW TT	-- 69,633	88,251 87,958	- 29.0	Weld -
ATT	41693	TW TT	-- 59,730	88,767 81,621	- 29.0	Weld -
ATX	21695	TW TT	-- 60,870	84,426 82,336	- 30.0	Weld -
ATY	21631	TW TT	-- 56,486	83,611 76,216	- 31.0	Plate -
ATZ	91382	TW TT	-- 60,158	86,178 83,377	- 31.0	Weld -
AUE	61859	TW TT	-- 59,259	85,638 78,511	- 32.0	Plate -
AUG	31617	TW TT	-- 60,317	85,676 83,068	- 28.0	Weld -
AUO	21662	TW TT	-- 58,225	85,751 80,156	- 30.0	Plate -
AUR	61830	TW TT	-- 62,765	83,554 82,978	- 29.0	Weld -
AVE	31684	TW TT	-- 62,903	89,256 86,560	- 26.0	Weld -
AVF	51737	TW TT	-- 53,278	77,030 73,497	- 34.0	Plate -
AVH	81608	TW TT	-- 61,096	89,890 84,073	- 31.0	Weld -

<u>HEAT SYMBOL</u>	<u>HEAT NUMBER</u>	<u>TYPE TEST</u>	<u>YIELD POINT lbs/sq/in</u>	<u>TENSILE STR. lbs/sq/in</u>	<u>ELONG. % in 2"</u>	<u>LOCATION OF FRACTURE</u>
AVJ	11496	TW TT	-- 62,235	90,217 82,978	-- 28.0	Plate -
AVN	21710	TW TT	-- 56,720	79,670 76,344	-- 33.0	Plate -
AVO	31695	TW TT	-- 59,140	84,595 79,838	-- 32.0	Weld -
AVP	91449	TW TT	-- 60,107	91,712 81,401	-- 30.0	Plate -
AVS	41716	TW TT	-- 62,942	83,520 79,019	-- 28.0	Plate -
AWA	21682	TW TT	-- 59,466	83,740 81,866	-- 30.0	Weld -
AWB	61879	TW TT	-- 59,630	85,145 78,627	-- 30.0	Plate -
AWC	71988	TW TT	-- 63,115	86,885 81,693	-- 29.0	Weld -
AWS	41721	TW TT	-- 58,870	86,850 80,913	-- 30.0	Weld -
AWW	61917	TW TT	-- 63,440	79,255 86,290	-- 28.0	Weld -
AWX	31702	TW TT	-- 60,270	89,645 81,891	-- 30.0	Weld -
AWZ	11479	TW TT	-- 63,779	83,689 82,939	-- 29.0	Plate -
AXE	61919	TW TT	-- 58,839	87,500 79,947	-- 32.0	Weld -
AXQ	61939	TW TT	-- 57,142	81,671 76,190	-- 34.0	Weld -
AXR	21740	TW TT	-- 60,000	82,596 81,095	-- 28.0	Plate -
AYA	61922	TW TT	-- 61,942	86,968 82,415	-- 30.0	Plate -
AYB	72035	TW TT	-- 60,547	86,660 81,917	-- 30.0	Plate -

<u>HEAT SYMBOL</u>	<u>HEAT NUMBER</u>	<u>WALL SIZE</u>	<u>YIELD POINT lbs/sq/in</u>	<u>TENSILE STR. lbs/sq/in</u>	<u>ELONG. % in 2"</u>	<u>LOCATION OF FRACTURE</u>
AYC	41738	TW TT	-- 55,790	81,697 80,000	- 30.0	Weld -
AYD	61918	TW TT	-- 62,534	75,561 84,848	- 28.0	Weld -
AYK	21742	TW TT	-- 57,452	87,362 80,758	- 32.0	Plate -
AYS	11541	TW TT	-- 54,768	82,336 75,476	- 33.0	Plate -
AYT	72059	TW TT	-- 56,951	81,671 77,807	- 31.0	Weld -
AYU	31736	TW TT	-- 63,611	87,297 90,835	- 28.0	Plate -
AYZ	41758	TW TT	-- 64,750	84,210 86,422	- 31.0	Weld -
AZA	81670	TW TT	-- 59,416	87,967 82,758	- 25.0	Plate -
AZC	81660	TW TT	-- 55,497	86,898 77,225	- 32.0	Plate -
AZD	41756	TW TT	-- 58,445	85,405 83,914	- 28.0	Weld -
AZE	91486	TW TT	-- 60,762	87,710 82,288	- 30.0	Plate -
AZF	72060	TW TT	-- 55,795	84,254 74,932	- 32.0	Plate -
AZG	21743	TW TT	-- 62,041	81,216 82,198	- 30.0	Weld -
AZH	41774	TW TT	-- 63,215	90,476 83,106	- 30.0	Plate -
AZI	11553	TW TT	-- 59,250	85,175 79,892	- 31.0	Weld -
AZJ	72086	TW TT	-- 64,041	88,980 84,073	- 29.0	Weld -
AZX	72071	TW TT	-- 59,890	87,123 81,593	- 24.0	Plate -
BAA	70095	TW TT	-- 60,215	86,178 80,376	- 29.0	Plate -

<u>HEAT SYMBOL</u>	<u>HEAT NUMBER</u>	<u>TYPE TEST</u>	<u>YIELD POINT lbs/sq/in</u>	<u>TENSILE STR. lbs/sq/in</u>	<u>ELONG. % in 2"</u>	<u>LOCATION OF FRACTURE</u>
BAB	52948	TW TT	-- 64,921	84,905 83,769	- 26.0	Weld -
BAC	70093	TW TT	-- 60,309	88,533 82,216	- 28.0	Weld -
BAD	52947	TW TT	-- 58,157	91,364 81,052	- 29.0	Plate -
BAP	31765	TW TT	-- 54,301	82,479 73,655	- 33.0	Plate -
BAS	21760	TW TT	-- 59,668	83,471 77,624	- 26.0	Weld -
BAY	11569	TW TT	-- 61,702	84,759 86,170	- 28.0	Plate -
BBC	61965	TW TT	-- 58,713	84,594 82,841	- 29.0	Weld -
BBH	41801	TW TT	-- 61,066	88,739 83,466	- 28.0	Plate -
BBJ	91535	TW TT	-- 61,333	84,718 82,400	- 29.0	Plate -
BBM	71882	TW TT	-- 64,032	83,557 80,653	- 32.0	Weld -
BBN	91536	TW TT	-- 61,578	82,841 81,052	- 31.0	Weld -
BBO	41802	TW TT	-- 61,141	85,286 82,250	- 30.0	Plate -
BBP	71991	TW TT	-- 55,764	81,550 75,871	- 30.0	Plate -
BBQ	31783	TW TT	-- 55,882	85,294 81,016	- 30.0	Plate -
BBU	41827	TW TT	-- 63,072	86,991 80,323	- 25.0	Plate -
BBY	81701	TW TT	-- 57,692	80,494 78,571	- 30.0	Weld -
BBZ	91532	TW TT	-- 59,065	83,333 81,083	- 30.0	Plate -

<u>HEAT SYMBOL</u>	<u>HEAT NUMBER</u>	<u>TYPE TEST</u>	<u>YIELD POINT lbs/sq/in</u>	<u>TENSILE STR. lbs/sq/in</u>	<u>ELONG. % in 2"</u>	<u>LOCATION OF FRACTURE</u>
BCA	11576	TW	--	86,956	-	Plate
		TT	66,666	81,029	30.0	-
BCB	31775	TW	--	82,933	-	Plate
		TT	64,379	82,321	30.0	-
BCC	81699	TW	--	84,196	-	Plate
		TT	56,873	78,975	30.0	-
BCD	81592	TW	--	87,771	-	Plate
		TT	65,405	85,135	27.0	-
BCE	31774	TW	--	86,027	-	Plate
		TT	60,055	81,542	30.0	-
BCF	21786	TW	--	84,972	-	Plate
		TT	58,904	84,657	27.0	-
BDD	21758	TW	--	85,215	-	Weld
		TT	60,589	80,965	26.0	-
KME	70188	TW	--	89,545	-	Plate
		TT	61,038	83,806	30.0	-
KMF	23311	TW	--	92,572	-	Plate
		TT	72,797	88,082	24.0	-
KMF	23311	TW	--	90,245	-	Plate
		TT	60,677	89,843	30.0	-
KMK	43174	TW	--	86,216	-	Plate
		TT	59,466	80,000	30.0	-
KML	62613	TW	--	86,702	-	Weld
		TT	60,668	84,061	31.0	-
KMN	23312	TW	--	85,945	-	Weld
		TT	61,111	81,481	30.0	-
KMO	70192	TW	--	90,190	-	Plate
		TT	65,425	86,170	29.0	-
KMP	70191	TW	--	86,807	-	Weld
		TT	60,206	80,878	31.0	-
KMQ	53017	TW	--	80,687	-	Plate
		TT	56,417	78,342	30.0	-
KMR	23303	TW	--	88,767	-	Plate
		TT	60,800	82,133	30.0	-



<u>HEAT SYMBOL</u>	<u>HEAT NUMBER</u>	<u>TYPE TEST</u>	<u>YIELD POINT lbs/sq/in</u>	<u>TENSILE STR. lbs/sq/in</u>	<u>ELONG. % in 2"</u>	<u>LOCATION OF FRACTURE</u>
KMS	43166	TW TT	-- 66,321	89,572 83,678	- 23.0*	Plate (*Broke near gage mark.)
KNF	13192	TW TT	-- 55,216	81,770 80,152	- 29.0	Weld -
KNG	70218	TW TT	-- 55,801	87,988 86,740	- 29.0	Plate -
KNH	53044	TW TT	-- 61,325	86,376 87,016	- 29.0	Plate -
KNI	70217	TW TT	-- 59,139	82,655 83,064	- 30.0	Weld -
KNJ	62653	TW TT	-- 64,190	95,238 93,103	- 30.0	Plate -
KNK	62636	TW TT	-- 61,455	91,644 92,183	- 27.0	Weld -
KNO	70207	TW TT	-- 57,534	98,439 80,821	- 30.0	Plate -
KNR	23327	TW TT	-- 56,315	85,378 81,578	- 33.0	Weld -
KNT	13191	TW TT	-- 58,981	86,898 83,378	- 30.0	Plate -
KNU	52948	TW TT	-- 57,600	87,837 80,000	- 30.0	Plate -
KNV	70093	TW TT	-- 56,010	85,479 82,513	- 32.0	Plate -
KNW	13200	TW TT	-- 59,836	85,635 82,513	- 28.0	Plate -
KNX	62637	TW TT	-- 58,485	84,840 80,939	- 31.0	Weld -

The results of the chemical analyses and tensile tests meet with the requirements of your specifications, dated June 21, 1948, issued to cover the manufacture of this pipe.

With regard to the transverse tensile tests made on the pipe with the weld in the middle of the specimen, in some cases the location of the fracture is recorded as being in the weld. The weld re-inforcement metal is not removed from the specimen for this test; therefore, these breaks recorded as in the weld are in reality in the weld zone at the edge of the weld metal. The most critical areas of this pipe appears to be in the plate metal about 1/2" to 3/4" either side of the longitudinal weld. If it were practical to stress relieve the metal at these locations after inside welding, and before expanding the pipe, the physical properties of the metal might be considerably improved.

INTERNAL HYDRAULIC EXPANSION OPERATION:

The expansion of this pipe from the as-rolled and welded diameter to the specified finished pipe diameter is a very critical operation. This is especially true relative to the metal in and adjacent to the weld zone. The most critical areas appear to be in the repaired places in the longitudinal weld, and usually at the end repairs. In some instances, these critical areas are not sufficiently strong or ductile to withstand the strain of the expanding stress, and they rupture under the internal expanding pressure or test pressure conditions. In most cases, the rupture indicates a defect, or weak structure in the weld section, which appears to be the starting point of the break.

It is very seldom that a break starts in the plate, and in such cases there have been nicks or scratches in the plate to reduce its effective thickness, thereby reducing its strength.

The ratio of failures to the total number of lengths of pipe expanded in the production of pipe for this order is as follows:

Total Number Expanded - - - - -	3259 pieces
Number of Failures - - - - -	29 pieces
Percentage of Failures - - - - -	0.88 percent

The ruptured portion of the pipe is in most cases cut off, and the balance of the section is used to make up jointers. All jointers are subjected to the expanding and test conditions after the girth weld has been completed and chipped flush on the outside.

HYDROSTATIC PRESSURE TEST:

Each length of pipe was subjected to an internal hydrostatic pressure test in the equipment utilized for expanding the pipe to the finished diameter. At the completion of the expanding operation, the pressure inside the pipe was lowered to the specified test pressure of 1,170 lbs per square inch, and maintained for at least ten seconds while the retaining dies were open. At this time, the hammer test was applied to each length of pipe at each end near the weld while the pipe was subjected to the full test pressure.

If the pipe withstood the expanding and test pressures satisfactorily, the pressure was further reduced to about 400 to 500 lbs per square inch, and an inspector walked along the pipe to examine the weld for pinhole or sweat leaks. All lengths considered to be satisfactory under test conditions were passed for end finishing and final inspection.

END FINISH OF PIPE:

Each end of each length of pipe was beveled to an angle of 30 degrees to the vertical axis of the pipe, and finished with a 1/16" vertical face, plus or minus 1/32".

The inside weld re-inforcement metal was chipped flush with the inside surface of the pipe for a distance of approximately 6 inches from each end.

INSPECTION:

A careful supervision of all shop inspection and hydrostatic pressure testing was maintained during the operation of the plant. A general observance of all plant proceedings and operations was also maintained while the pipe was being produced for this order. Particular attention was given the weld procedure, any changes or developments made by the shop to improve their methods of satisfactorily completing this vitally important part of the fabrication of the pipe.

Each length of finished pipe was carefully inspected for manufacturing, steel or surface defects. Inspectors passed through the inside of each piece of pipe for its entire length in making their final inspection. Especial attention was given to the examination of the longitudinal welds, both inside and outside for defects characteristic of the "Unionmelt" type of fusion weld. The inside and outside surfaces of each length was thoroughly examined to insure freedom from seams, scabs, pits, or other steel defects which might have been present in the steel at the time the plate was rolled.

The ends of the pipe were carefully examined for satisfactory bevel and finish. The thickness of the wall of the pipe was checked with "No-go" gauges to be certain that all sections were in excess of the minimum tolerance permitted by the specifications. The ends of the pipe were also examined for evidence of

of laminations in the plate which would cause trouble in the field, and impair the strength or service of the pipe.

The squareness of the ends was checked at frequent intervals to be certain that the ends of the pipe were finished at 90 degrees to the longitudinal axis of the pipe, and to insure true alignment of the sections in the field for welding.

The O.D. of the pipe was checked by measurement with an O.D. tape at very frequent intervals to be certain that the size of the pipe was maintained within satisfactory limits for mating and field assembly. The O.D. of the pipe covered by this report was held within the limits of the specifications of:

30-3/32" Maximum O.D.  
29-31/32" Minimum O.D.

The use of a ring gauge in checking the size and roundness of the ends has proven impractical, since the ends of the pipe are about 1/4" to 3/8" out of round. Pipe of this wall thickness does not retain the shape of the bore of the retaining die of the expander unit. The ovate condition of the ends is not excessive, and the use of an internal line-up clamp facilitates the ease and speed of assembly, as it rounds out the matching ends of the pipe for tacking or stringer bead welding in field alignment.

LENGTH RANGE:

The length range of the pipe supplied on this order varies as follows:

Maximum Length - - - - - 31.28 feet  
Minimum Length - - - - - 28.06 feet  
Average Length - - - - - 31.037 feet

REJECTIONS:

As a result of our inspection, a number of serious defects were discovered in some lengths of pipe offered for application to your order. These defective pieces were permanently rejected, and not permitted to be repaired for shipment. A list of these lengths, showing the cause for rejection, follows:

<u>No. Pieces</u>	<u>Cause of Rejection</u>
3	Excessive repairs to longitudinal weld.
5	Unsatisfactory repairs.
3	Numerous deep pits and scabs.
2	Poor repairs to inside weld.
3	Offset longitudinal seam.
2	Damaged and scratched, outside surface.
<u>1</u>	Large O.D.
19	Total

In addition to the above permanent rejections, a number of lengths of pipe were found with minor defects, which were temporarily rejected. These defects were repaired to our satisfaction, the lengths re-tested as required, and accepted for application to this order on subsequent inspection. A list of these temporary rejections, and the method of repair, follows:

<u>Number</u>	<u>Cause of Rejection and Method of Repair</u>
2	Dented - balled or pressed out.
5	Scabs, inside surface - ground out.
7	Scabs, inside surface - chipped and welded.
11	Scabs, outside surface - ground out.
4	Scabs, outside surface - chipped and welded.
3	Pits, inside surface - chipped and welded.
6	Pits, outside surface - chipped and welded.
9	Undercut welds, inside weld - chipped and welded.
12	Undercut welds, outside weld - chipped and welded.
21	Pinholes in weld - chipped and welded.
17	Crack in weld, inside weld - chipped and welded.
9	Cracks in weld, inside weld - ends cut off.
7	Cracks in weld, outside weld - chipped and welded.
16	Damaged ends - ends cut off.
47	Unsatisfactory bevel - re-beveled.
22	Offset longitudinal seam at ends - cut off.
19	Unsatisfactory repairs to weld - end cut off.
4	Off seam welds - chipped flush and re-welded.
21	Thin wall from grinding - ends cut off.
<u>2</u>	Small O.D. - re-expanded.
244	Total

SHIPMENT:

Each length of pipe accepted for application to this order was stamped with our acceptance mark "ME" near the longitudinal weld on the outside surface at one end. A shipment serial number was assigned to each piece, and painted on the inner surface of each end, together with the length, the O.D., and the wall thickness. The wall thickness was indicated by the number 12 (12/32"). The pipe was shipped free of coating of any kind, and the beveled ends were not covered.

Shipment of the pipe was made by motor truck from the Maywood, California plant of the manufacturer to your coating and wrapping plant in Montebello, California, as follows:

SUMMARY OF SHIPMENTS  
Purchase Order 7R-66858  
Consolidated Western Steel Corporation

<u>Date of Shipment</u>	<u>Shipment Number</u>	<u>Trucks</u>	<u>Pieces</u>	<u>Footage</u>
March 11	1- 19	19	114	3,544.67
March 12	20- 33	14	84	2,609.00
March 14	34- 65	32	192	5,962.40
March 15	66- 83	18	108	3,347.21
March 16	84-153	70	420	13,045.46
March 18	154-218	65	390	12,066.83
March 21	219-231	13	78	2,409.78
March 22	232-237	6	36	1,121.27
March 23	238-242	5	30	927.87
March 24	243	1	6	185.04
March 25	244	1	6	186.77
March 30	245	1	6	185.93
March 31	246	1	4	120.35
April 7	247-258	12	72	2,236.84
April 8	259-295	37	222	6,905.29
April 11	296-299	4	24	746.33
April 12	300-306	7	42	1,302.93
April 13	307-375	69	414	12,879.69
April 14	376-394	19	114	3,543.24
April 15	395-403	9	54	1,681.71
April 18	404-408	5	20	621.02
April 19	409-469	61	363	11,253.69
April 20	470-539	70	420	13,024.87
April 21	540	1	2	62.29
April 22	541	1	1	31.15
	Totals	541	3222	100,001.63

CONCLUSION:

The 30" O.D. x 3/8" wall "Unionmelt" Electric Welded Steel Line Pipe covered by this report has been carefully inspected by us, and having found it to be in accordance with your order, and your specifications (6-21-48), as noted herein, it was accepted for shipment subject to your shipping instructions.

Yours very truly,

MOODY ENGINEERING CO.

*W. H. Webb*

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W. H. Webb

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