

Acme Coke  
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Chicago IL 60617



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Mill Water Discharge Pump Inspection  
Dated: 2000

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December 18, 2000

Mr. Robert J. Martello  
Division Engineer  
Acme Steel Company  
10730 Burley Avenue  
Chicago, IL 60617

**Subject:** Chicago Coke Plant  
Mill Water Pumps – Discharge Header  
Inspection & Engineering Services

**Project No. 00-198**

Dear Mr. Martello:

In regards to the above subject, we are submitting this report to present the results of the inspection and subsequent engineering review of the Mill Water Discharge Header. The inspection was conducted on November 24, and December 13, 2000.

**Intent / Scope of Work**

The intent of this project was to assess the overall condition of the subject header, based on the field data obtained by the inspection. The scope of work for this project consisted of a visual inspection of the Discharge Header Piping and associated supports. Ultrasonic thickness measurements were also taken on the Header.

The scope also included an engineering review of the inspection findings along with preparation and submittal of this report to present the results of the inspection and engineering review, with recommendations for any remedial actions that may be required. Per Acme Steel, the operating pressure of 50 psig was used for the engineering review to aid in determining the mechanical integrity of the subject headers. The engineering review includes calculations of pipe stresses due to internal pressure, hydraulic surges and support span loads.

**History / General Description**

The Coke Plant's requirements for non-contact cooling water and process make-up water, are supplied by a mill (river) water piping system. The system consists of a siphon line from the river, two pumps (one in service and one standby), and an underground distribution system. The pumps are located in the Powerhouse Building. The discharge of each pump is connected to an overhead header, which extends through the east wall of the Powerhouse, then connects to the underground piping for distribution. The Discharge Header located in the Powerhouse was installed new in 1977. This inspection was requested because the exterior surfaces of the header are corroded and the mechanical integrity is in question. Per Acme drawing C-4516, the header is a 20" diameter schedule 40 black steel pipe. The wall thickness for a schedule 40 pipe is .594 and .375 for a standard pipe. Based on the ultrasonic thickness measurements contained herein, the original wall thickness of the 20" header is most likely 0.375".

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Project No. 00-198

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## Reference Drawing

C-4516

## Inspection Findings

The following is a list of findings (F) for the conditions that were encountered during the inspection. For specific locations of the findings, refer to the inspection drawing attached.

**F1** – The exterior surfaces of the header piping is light to moderately rust layered with surface pitting of 1/16" to 1/8" in depth. This condition exists at approximately 90% of the piping surface area. Only approximately 5% to 10% of the protective coating is intact.

**F2** – Approximately 200 thickness measurements (consisting of 31 stations, plus nozzle locations) were taken on the header piping. The section loss broken down per station, ranged from 0% to 28% section loss, with a calculated overall section loss of 10.58%. The 28% section loss occurs just above the B & S connection to the underground piping (refer to U. T. Station 31). It should be noted that the measurements located at Stations 17 & 26 were erratic and the material is most likely comprised of cast iron. Therefore, these readings were excluded from the section losses noted above.

**NOTE:** The thickness measurements were taken within the areas where the protective coating was missing. The existing protective coating was not disturbed during the course of this inspection.

**F3** – Thickness measurements could only be obtained on the 4" and 12" valve nozzles at isolated areas (See Details 1, 2 & 3).

**F4** – At the exterior of the Powerhouse, a 3" area of the header is heavily rust layered just above the B. & S. connection to the under ground pipe. (Refer to U.T. Station 31).

**F5** – The connection area between the header and support beam is rust packed by 1/8" +/- and the top flange of the support beam between the guide angles is rusted with 33% +/- section loss. This occurs at all 4 supports. At this time, the pipe wall does not appear to be significantly rust gouged at the supports (based on visual inspection).

**F6** – The vertical leg of the header guide angles are deteriorated with approximately 33% section loss (at 3 supports). These 6 x 6 x 3/8 x 0'-6 long angles are stitch welded to the pipe and the support beam, and in most cases the welds to the pipe are cracked.

**F7** – The vertical leg of the header guide angles are deteriorated with approximately 66% section loss (at one support).

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**NOTE:** – During the course of the header inspection, severe deterioration of an access platform was observed. The platform is located at the northwest corner area of the Powerhouse, at the top of the stairway. This platform was not included in the scope of work for this project, however the condition was discussed with the Acme Steel Coke Plant engineer and it was recommended that the area be investigated in greater detail and that access be prohibited until corrective action is implemented. Per our site visit of December 13, 2000 Acme Steel has flagged off the area to prevent access.

## **Engineering Review**

In order to ascertain the mechanical integrity of the header, an analysis of the header was performed to determine the pipe stresses resulting from internal pressure, hydraulic surges, and moments due to the span of the pipe. For the purpose of the analysis, the original wall thickness of the pipe was conservatively assumed to be 0.375 inch.

The analysis indicates that the stresses in the pipe are below 15% of the allowable and therefore the mechanical integrity of the piping is adequate at this time. The analysis considered the loading on the pipe to include an internal pressure of 50 psig, the pipe to be completely full of water, the dead load of the pipe, and a 10# / Lin. Ft. of debris loading. (Refer to the calculations attached).

## **Overview**

The results of this inspection and engineering review indicate that the mechanical integrity of the pipe is adequate at the present time. The thinned guide angles of the header (finding F6 & F7) should be scheduled for replacement during the year 2001. Based on practical experience, it is recommended that the new guide angles (adjacent to U.T. Station 6) be welded to the header and to the support. All other guide angles should be installed up against the wall of the header and welded to the support only. A cleaning and painting effort of the header and supports should also be implemented to deter further deterioration. This cleaning/coating effort should put special emphasis at the header to support locations along with the top flange of the supports. If a cleaning and painting program is not implemented in the near future, the need to implement additional repairs can be expected.

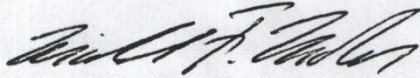
In conclusion, it is recommended that the Acme Steel Company review the data contained herein coupled with the anticipated life expectancy of the subject header, and implement an appropriate course of remedial action aimed at addressing the deficient conditions identified herein.

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Should you have any questions or comments, or should you require any further engineering assistance regarding this matter, please contact our office.

Very truly yours,



Michael F. Mohr  
Vice President  
Inspection Services

Attachments: Inspection Drawing and Calculations

Prep by RBP Date 12/11/00  
Chk'd by [Signature] Date 12-11-00



ENSPECT, Inc.  
Engineering and Inspection Services  
8896 Louisiana Street, Merrillville, IN 46410

SHT 1 OF 2  
Project No. 00-198

Client: ACME STEEL  
CHICAGO COKE PLANT

Description: UTILITIES DEPARTMENT  
MILL WATER PUMPS - DISCHARGE HEADER

PURPOSE: TO PERFORM AN ENGINEERING REVIEW OF THE SUBJECT PIPING BASED ON THE RESULTS OF AN INSPECTION PERFORMED DURING THE COURSE OF THIS PROJECT.

### PARAMETERS:

INTERNAL WATER PRESSURE 50 psig (PROVIDED BY ACME)

WATER LOAD - PIPE FULL

DEAD LOAD - SCH 40 PIPE

### STRENGTH OF PIPE:

STANDARD WEIGHT PIPE WILL BE USED AS A BASIS FOR OUR ANALYSIS. READINGS INDICATE ORIGINAL PIPE WALL THICKNESS WAS LIKELY .375"

CHECK HOOP STRESS IN PIPE DUE TO INTERNAL PRESSURE:

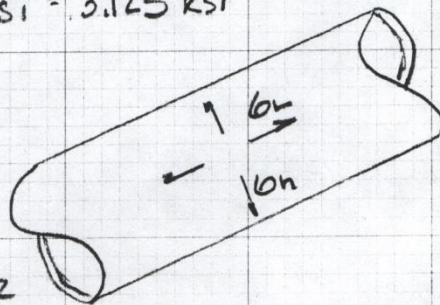
$$\sigma_h = \frac{pr}{t} = \frac{50 \text{ lb/in}^2 (20 \text{ in})}{0.32} = 3,125 \text{ psi} = 3.125 \text{ ksi}$$

$$\sigma_L = \frac{pA_{SUR}}{A_{PIPE}}$$

$$A_{SURFACE} = 290 \text{ in}^2 \text{ (from ASA TABLES)}$$

$$A_{PIPE} = \pi D t = (3.1415)(19.7)(.32) = 19.8 \text{ in}^2$$

$$\sigma_L = \frac{(50 \text{ psi})(290 \text{ in}^2)}{19.8 \text{ in}^2} = 732 \text{ psi} = .732 \text{ ksi}$$



Prep by RBP Date 12-11-00  
Chk'd by Jm Date 12-11-00



ENSPECT, Inc.  
Engineering and Inspection Services  
8896 Louisiana Street, Merrillville, IN 46410

SHT 2 OF 2  
Project No. 00-198

Client: ACME STL  
CHICAGO CONCRETE.

Description: Utilities Dept.  
Mill Water Pumps - Discharge Header

### CHECK BENDING STRESS DUE TO SUPPORT SPACING

$$\text{WEIGHT OF WATER} = \frac{290 \text{ in}^2}{144 \frac{\text{in}^2}{\text{ft}^2}} = 2.01 \text{ ft}^2 \times 62 \frac{\#}{\text{ft}^2} = 125 \text{ p/f}$$

$$\text{DEAD LOAD OF PIPE} = 79 \frac{\#}{\text{L.F.}}$$

$$\text{DUST \& MISC} = 10 \frac{\#}{\text{L.F.}}$$

$$\text{TOTAL UNIFORM LOAD} = 125 \frac{\#}{\text{ft}} + 79 \frac{\#}{\text{ft}} + 10 \frac{\#}{\text{ft}} = 214 \frac{\#}{\text{L.F.}}$$

ASSUME PIPE IS 3 CONTINUOUS SPANS

$$M_{\text{MAX}} = .080 (.214 \frac{\text{K}}{\text{ft}}) 23.25^2 = 9.25 \text{ ft-k}$$

$$I_{\text{PIPE}} = .049087 (20^4 - 19.25^4) = 1113 \text{ in}^4$$

$$S = \frac{1113}{10} = 111.3 \text{ in}^3$$

$$b_m = \frac{9.25(12)}{111.3} = 1.0 \text{ ksi}$$

$$\text{COMBINED STRESS WITH } b_L + b_m = 1.0 + .732 = 1.73 \text{ ksi}$$

ASSUME 30 ksi YIELD & 45 ksi ULTIMATE

USING A FACTOR OF SAFETY OF 3 ALLOWABLE = 15 ksi

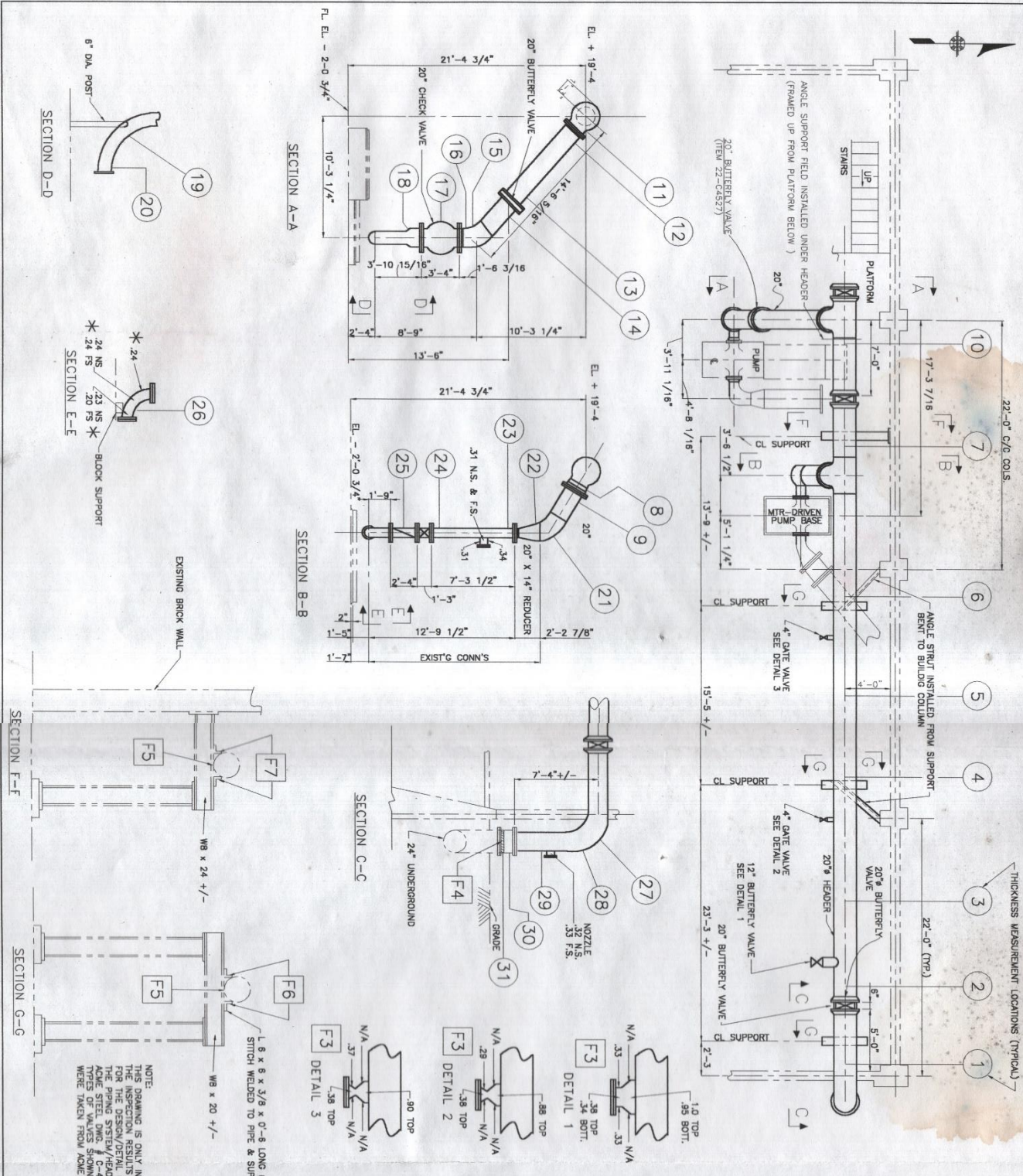
Back-Check Principle Stresses:

$$\sigma_s = \left[ \left( \frac{1.73}{2} \right)^2 + 3.12^2 \right]^{1/2} = 3.24 < 0.4(35) = 14 \text{ ksi}$$

$$\sigma_T = \frac{1.73}{2} + 3.24 = 4.1 \text{ ksi} < 0.6(35) = 21 \text{ ksi}$$

>> 1.73 ksi.

∴ PIPE IS OK



**THICKNESS MEASUREMENT LOCATIONS (TYPICAL)**

STA.	A	B	C	D	E	F	G	H
1	.34	.29	.36	.32	.35	.34	.33	.37
2	.36	.36	.35	.34	.31	.34	.33	.33
3	.38	.36	.30	-	-	-	.36	.35
4	.35	.35	.36	.31	.33	.32	.35	.32
5	.32	.31	.35	.31	.37	.32	.29	.31
6	.33	.34	.34	-	-	.33	.33	.32
7	.37	.37	.26	-	-	.36	.34	-
8	.47	.48	-	-	-	.46	.46	-
9	.36	.33	-	-	-	.34	.33	-
10	.33	.32	.34	.32	.30	.30	.32	.28
11	.45	.40	.46	.38	.27	.39	N/A	.46
12	-	-	.36	.29	.29	.32	.32	-
13	.30	.34	-	.34	.25	.25	.30	.33
14	.35	.34	-	.27	.32	.28	.31	.27
15	.29	.28	-	-	.34	.37	.32	-
16	.28	.29	.33	.30	.36	.32	.28	.28
17	.27	.22	.27	.24	.28	-	.32	-
18	.38	-	.34	.37	.33	.39	.38	.34
19	.33	-	.34	.33	.35	.34	.34	.28
20	.31	-	.30	-	.33	-	.35	-
21	.37	.38	.38	-	-	-	.37	.37
22	.39	.44	.44	-	-	-	.36	.36
23	.33	.34	.34	-	-	-	-	-
24	.30	.33	.31	.31	.30	.31	.31	.32
25	.31	-	.30	-	.30	-	.30	-
26	.23	-	.17	-	-	-	.30	-
27	.43	.40	.39	.39	.38	.38	.37	.39
28	.38	.38	.39	.42	.39	.36	.40	.40
29	.37	.33	.37	.38	.36	.38	.38	.39
30	.32	.32	.32	.33	.31	.32	.30	.34
31	.23	.29	.28	.29	.27	.28	-	.26

\* DENOTES WHERE MEASUREMENTS WERE ERRANT. THE SUBJECT MATERIAL IS MOST LIKELY DISTORTION.

**THICKNESS MEASUREMENT LOCATIONS**

SECTION	DESCRIPTION	DATE	INSPECTOR
SECTION A-A	20" BUTTERFLY VALVE		
SECTION B-B	20" X 14" REDUCER		
SECTION C-C	24" UNDERGROUND		
SECTION D-D	6" DIA. POST		
SECTION E-E	BLOCK SUPPORT		
SECTION F-F	EXISTING BRICK WALL		
SECTION G-G	L 6 x 6 x 5/8 x 0'-6 LONG (TYP) STITCH WELDED TO PIPE & SUPPORT		

**NOTE:**  
THIS DRAWING IS ONLY INTENDED TO CONVEY THE INSPECTION RESULTS OF THE HEADER. FOR THE DESIGN/DETAIL CONFIGURATION OF THE STEEL SYSTEM, CONSULT THE DESIGN TYPES OF VALVES SHOWN ON THIS DWG. WERE TAKEN FROM AISC STEEL DWG-C-451B.

**ENFSPECT, INC.**  
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**ACWE STEEL COMPANY - COKE PLANT**  
UTILITY DEPT. - POWER HOUSE  
MILL WATER DISCHARGE HEADER  
2000 INSPECTION