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Flushing Liquor Decanter Tank Inspection
Dated: 2000

ENSPECT, Inc. *Engineering and Inspection Services*

R. O'Hesen

October 9, 2000

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

Subject: Chicago Coke Plant
By-Products Department
No. 1 Flushing Liquor Decanter Tank
Inspection & Engineering Services

Project No. 00-149

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 No. 1 Flushing Liquor Decanter Tank. The inspection was conducted on August 31, 2000. The insulation and jacketing was removed, and the exterior steelwork comprising the tank was sandblasted prior to the inspection.

Intent / Scope of Work

The intent of this project was to assess the overall condition of the subject decanter, based on the field data obtained by the inspection. The scope of work for this project consisted of a visual exterior inspection of the vertical shell plates, the stiffener angles, the nozzles on the vertical shell plates, the exposed portions of the floor plate, the access stairway to the top of the tank and the handrail system along the perimeter of the roof top. Ultrasonic thickness measurements were also taken on the vertical shell plate and related nozzles.

The scope also included an engineering review of the inspection findings along with preparation and submittal of this report to present the result of the inspection and engineering review, with recommendations for any remedial actions that may be required.

An interior inspection of the tank and inspection of the tank's roof was excluded from the scope of work for this project.

History / General Description

The No. 1 flushing liquor decanter tank was designed by the Wilputte Coke Oven Division and was erected in the mid-1950's. The tank is 11'-6" in height, 40'-3" in length and 12'-0" in width. The vertical shell plates and floor plates were constructed of 3/8" plate material.

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The tank is equipped with an internal flight guide frame, which is used to remove sludge from the tank.

Per discussions with Acme Steel personnel, the lower internal portion of the tank was previously lined with fiberglass, due to leakage problems that were being experienced.

Reference Drawings
37541
37542
37530 to 37535

General Findings
The following is a list of general findings (GF) for the conditions that were encountered by the inspection. For specific locations and descriptions of the findings, refer to the inspection drawings located in Attachment 1.

GF1 – Several areas of the tank's vertical shell plate were found to be rust gouged. The rust gouging was measured and the depth's ranged from 1/16" to 1/4", representing 16% to 66% section loss. In most cases, the gouging was encountered at the bottom of the vertical shell rate, adjacent to the floor plate.

GF2 – The exposed portion of the floor plate was found to be rusted thin and through at the western two-thirds (+/-) of the tank. Rust packing exists between the remnants of the floor plate and the top of the concrete foundation wall within this area.

NOTE: Per the Acme Steel Company, the floor plate has been repaired in the past by means of a steel plate and fiberglass overlay. However, documentation of the past repair efforts could not be obtained for review.

GF3 – Isolated areas of the vertical shell plate stiffener angles are significantly deteriorated.

GF4 – The north and south vertical shell plates have been reinforced from the exterior at the east end 5'-0" area, adjacent to the sludge chute. Thickness measurements of these reinforcing plates indicate deterioration exists within an isolated area and consists of:

- Reinforcing plate of north shell = 55% section loss
- Reinforcing plate of south shell = 28% section loss

GF5 – During the inspection, it was evident that leakage is occurring at five (5) nozzle locations.

GF6 – Isolated areas of the tank's vertical shell plate were found to be rust pitted with pit depths ranging from 1/32" to 1/16".

GF7 – 2" +/- diameter nozzles (currently capped) that have been added to the tank revealed thickness measurements of .150 to .160.

GF8 – With the exception of the above, the thickness measurements throughout the tank revealed little to no section loss.

GF9 – The stringer webs of the access stairs are rusted away adjacent to the stair tread connection areas. (Although the treads appeared to be secure at the time of the inspection, caution should be used when utilizing the stairs to access the tank and the stairs should be replaced as soon as possible).

GF10 – The platform at the top of the access stairway is in marginal condition where as:

- Rust packing exists between the checkered plate and the channel framing top flange. The checkered plate is loose, and thinning of the channel top flanges exists.

GF11 – Isolated areas of the handrail system around the perimeter of the roof are deficient due to rust deterioration.

GF12 – The exposed portions of the concrete foundation wall of the tank revealed minor hairline cracking at sporadic locations.

Engineering Review - Original Design

In order to ascertain the decanter's structural integrity, calculations were made on the inspected portions of the tank; that is the shell plate, angle stiffeners and exposed portions of the floor plate.

Since our review of the existing drawings could not identify the shell plate material type, an assumption concerning the shell plate's yield / tensile strength will coincide with the plate's eventual acceptability. Specifically, if one assumes a yield strength of 36 ksi, the shell plate can be judged acceptable. However, if one assumes a yield strength of 30 ksi, a very liberal approach would be necessary to gain acceptability of the shell plate. Therefore, based on our calculations and our field observations, it is reasonable to conclude the shell plate's yield strength meets or exceeds 36 ksi, and that the shell plate is acceptable as designed.

Though the angle stiffeners' material type is also not available on the drawings reviewed, our calculations indicate that the angle stiffeners' are adequate as designed with an accepted yield strength of 36 ksi. Taking into consideration the same

assumptions, the roof and floor plate systems can also be judged acceptable as designed.

Engineering Review and Evaluation of Current Conditions

Where applicable, API 653 "Tank Inspection, Repair, Alteration and Reconstruction" should be used to evaluate a tank's suitability for continued use when sufficient evidence exists that the physical condition of the tank has changed from its original condition. Since a strict interpretation of the standard would exclude its applicability in this case (a rectangular tank verses a circular tank for instance), one can still choose to use the standard, but only as a guide for such evaluations. Therefore, the following opinions are based on calculations and accepted engineering principles as they apply to this particular situation.

Shell Plate - Flushing liquor decanters of this type typically deteriorate from the exterior due to debris build-up / moisture entrapment along the sides of the tank. Deterioration from the interior is less likely, though can take the form of erosion from internal moving parts and/or corrosion from the presence of oxygen within the gas blanket above the liquid level. In this case, the inspection indicated the more common exterior deterioration from debris build-up / moisture entrapment, specifically near the base of the tank. In general, the deterioration observed in the form of pitting is of little concern since the pits are widely scattered and/or are of minimal depth. Gouging of the shell plate, on the other hand, was observed to exist in localized areas. The net shell plate thickness at these gouged areas results in a section loss of 16% to 66% with an approximate average of 25%. The result of these section losses is a calculated overstress in the shell plate.

Angle Stiffeners – Again, flushing liquor decanters of this type will typically utilize vertical shell stiffeners, as is the case here. The inspection revealed varying degrees of localized rust deterioration of the stiffeners. Where this deterioration has resulted in a section loss equal to or greater than 50% on the four-inch leg of the stiffener, the calculated stress on this portion of the stiffener exceeds the allowable. Specifically, this occurs at one stiffener on the west elevation and two stiffeners on the north elevation.

Bottom Plate – The exposed portion of the bottom plate was observed to be severely rust deteriorated generally along the north, south and west elevations of the tank. Again, this deterioration is common given the debris build-up / moisture entrapment previously mentioned. The plate's deterioration is of concern since the deterioration has compromised the

shell plate to bottom plate and the angle stiffener to bottom plate weld connections. Though this condition does not appear to be critical at this time, it is difficult to determine what effect this condition has on the overall integrity / serviceability of the tank, since the presence and condition of any interior welding is an unknown at this time, and the condition of the floor plate beyond the outer edge 2" area is unknown at this time.

Overview

The results of this inspection and engineering review, consistent with Acme Steel's proposed maintenance outage scheduled for the spring of 2001, indicate a need to implement a systematic rehabilitation effort. This effort should be implemented in two (2) phases consisting of: (For conceptual repairs of the tank, refer to drawing #3 located in Attachment 1).

Phase I

Address the deficiencies that can be repaired prior to the spring 2001 outage. This should consist of the following:

- Implement repairs as necessary to eliminate the leakage at five (5) nozzle locations.
- Replace the access stairs and its upper landing platform in-kind.
- Replace the deteriorated sections of the handrail system around the perimeter of the roof. (Or rope off the deteriorated areas as required to eliminate safety concerns, and replace the components during the spring 2001 outage.)

Phase 2

Address the deficiencies that can only be implemented once the tank has been taken out of operation. This should consist of the following:

- Replace the rust gouged areas of the vertical shell plates.
- Reinforce the 7 x 4 x 3/8 stiffener angles where deterioration of 50% or greater exists.
- Replace the bottom floor plate of the tank. Replacement of the floor plate is recommended due to the following:
  - It is reasonable to assume that the floor plate is deteriorated beyond the edge 2" area, due to the rust packed conditions observed. An internal inspection of this area would require the removal of the fiberglass lining in addition to the internal 3 x 3 angle welded to the shell and floor plate.

- A practical means to reinforce this area (shell to floor) does not exist without an extensive amount of field burning and welding. (As previously mentioned in GF2, the floor plate has been laminated with steel plate and has been fiber-glassed in the past.)

In order to minimize costs and outage time, consideration should be given to the following in preparation for implementing Phase 2:

- Investigate previous repair efforts in an attempt to define how far up the fiberglass patching exists on the vertical shell plates. This information can be used to establish horizontal cut lines of the shell plate and will eliminate the costs associated with stripping the fiberglass lining for burning and welding purposes.
- In order to minimize field welding, fabricate the new floor plate in sections, complete with the shell plate, nozzles (where applicable) and interior guide angle already shop welded.
- Investigate options to temporarily support the tank in preparation for rehabilitation.
- Conduct an interior inspection of the north and south shell plates at the eastern end of the tank where existing reinforcing plates exist.

In conclusion, our recommendations are based on the results of our inspection, engineering review and Acme Steel's proposed maintenance outage scheduled for April, 2001. The probability of a structural related failure occurring prior to the proposed maintenance outage is low. However, deferring the necessary repairs outlined in this report beyond April 2001 will inevitably increase that probability.

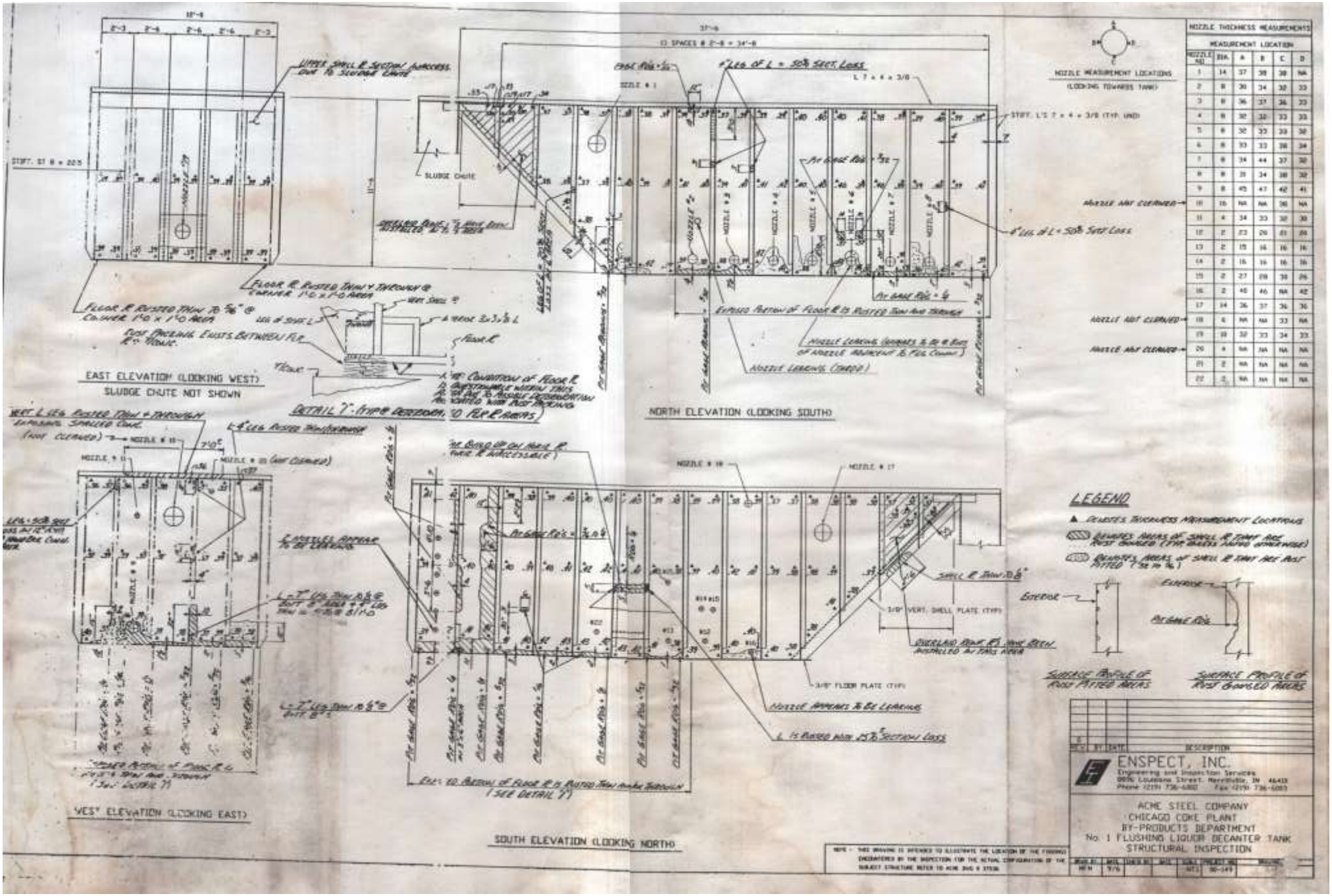
Therefore, it is recommended that the Acme Steel Company review the data contained herein coupled with the anticipated life expectancy of the subject decanter, then implement an appropriate course of remedial action aimed at addressing the deficient conditions identified herein.

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,

James M. Kirk, P.E.
Vice President
Engineering Services

Attachment 1: Inspection and Conceptual Repair Drawings



NOZZLE THICKNESS MEASUREMENTS					
	MEASUREMENT LOCATION				
NOZZLE NO.	DIA.	A	B	C	D
1	14	37	38	38	NA
2	8	30	34	32	33
3	8	36	37	36	33
4	8	32	32	33	33
5	8	32	33	33	32
6	8	33	33	38	34
7	8	34	44	37	32
8	8	31	34	38	32
9	8	45	47	42	41
10	16	NA	NA	36	NA
11	4	34	33	32	30
12	2	23	26	21	20
13	2	15	16	16	16
14	2	16	16	16	16
15	2	27	28	30	26
16	2	40	46	NA	42
17	14	36	37	36	36
18	6	NA	NA	33	NA
19	10	32	33	34	33
20	4	NA	NA	NA	NA
21	2	NA	NA	NA	NA
22	3	NA	NA	NA	NA

NOZZLE NOT CLEANED

NOZZLE NOT CLEANED

NOZZLE NOT CLEANED

NO.	BY	DATE	DESCRIPTION

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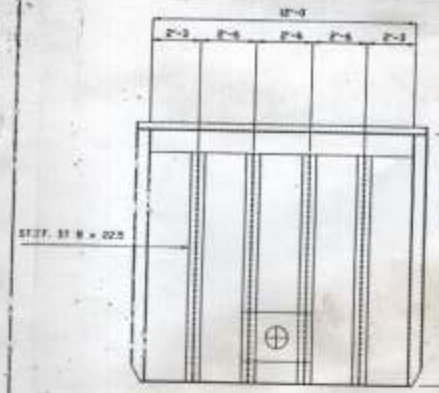
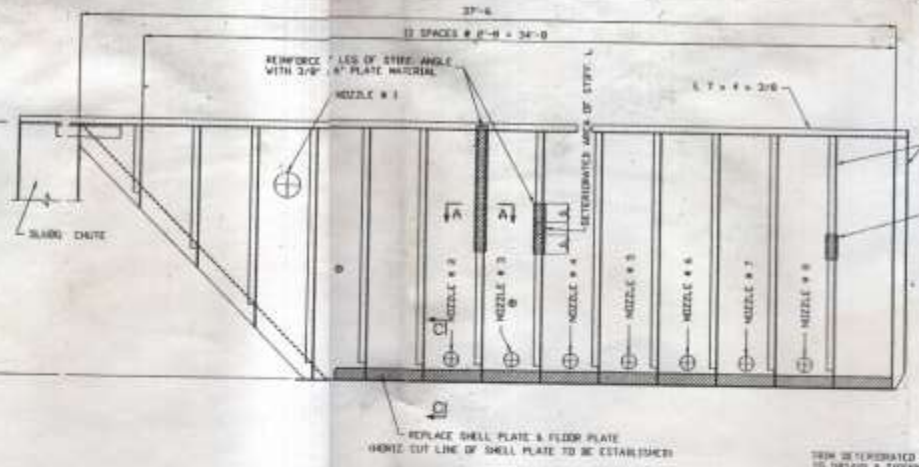
ACME STEEL COMPANY
CHICAGO COKE PLANT
BY-PRODUCTS DEPARTMENT
No. 1 FLUSHING LIQUOR DECANTER TANK
STRUCTURAL INSPECTION

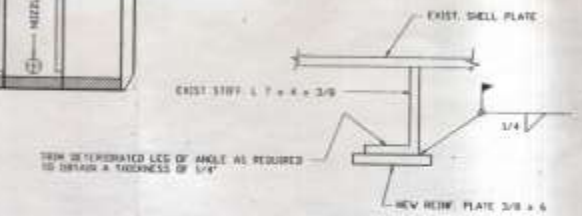
DRAWN BY	DATE	CHECKED BY	DATE	SCALE	PROJECT NO.	DRAWING
MEN	9/96			NTS	96-149	



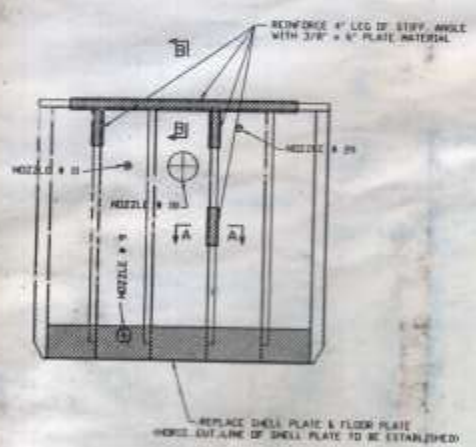
EAST ELEVATION (LOOKING WEST)
SLUDGE CHUTE NOT SHOWN



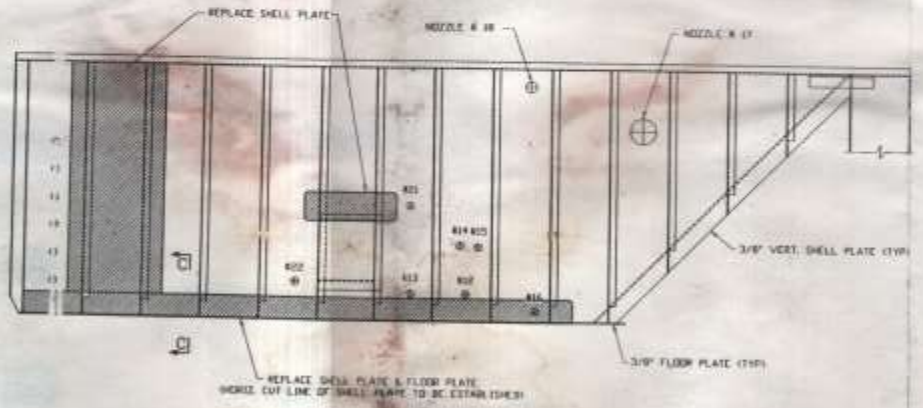
NORTH ELEVATION (LOOKING SOUTH)



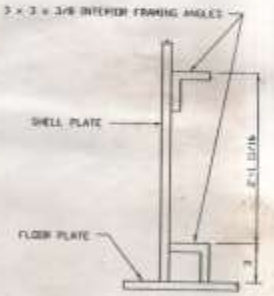
SECTION A-A (SHOWN)
SECTION B-B (SIMILAR)



WEST ELEVATION (LOOKING EAST)



SOUTH ELEVATION (LOOKING NORTH)



SECTION C-C
SHOWING INTERIOR FRAMING ANGLES

CONCEPTUAL REPAIRS ONLY
NOT FOR CONSTRUCTION

NOTE - THIS DRAWING IS INTENDED TO ILLUSTRATE THE LOCATION OF THE FINDINGS ENCOUNTERED BY THE INSPECTION FOR THE ACTUAL CONFIGURATION OF THE SUBJECT STRUCTURE REFER TO ACME DWG # XXXX

NO.	BY	DATE	DESCRIPTION
1			

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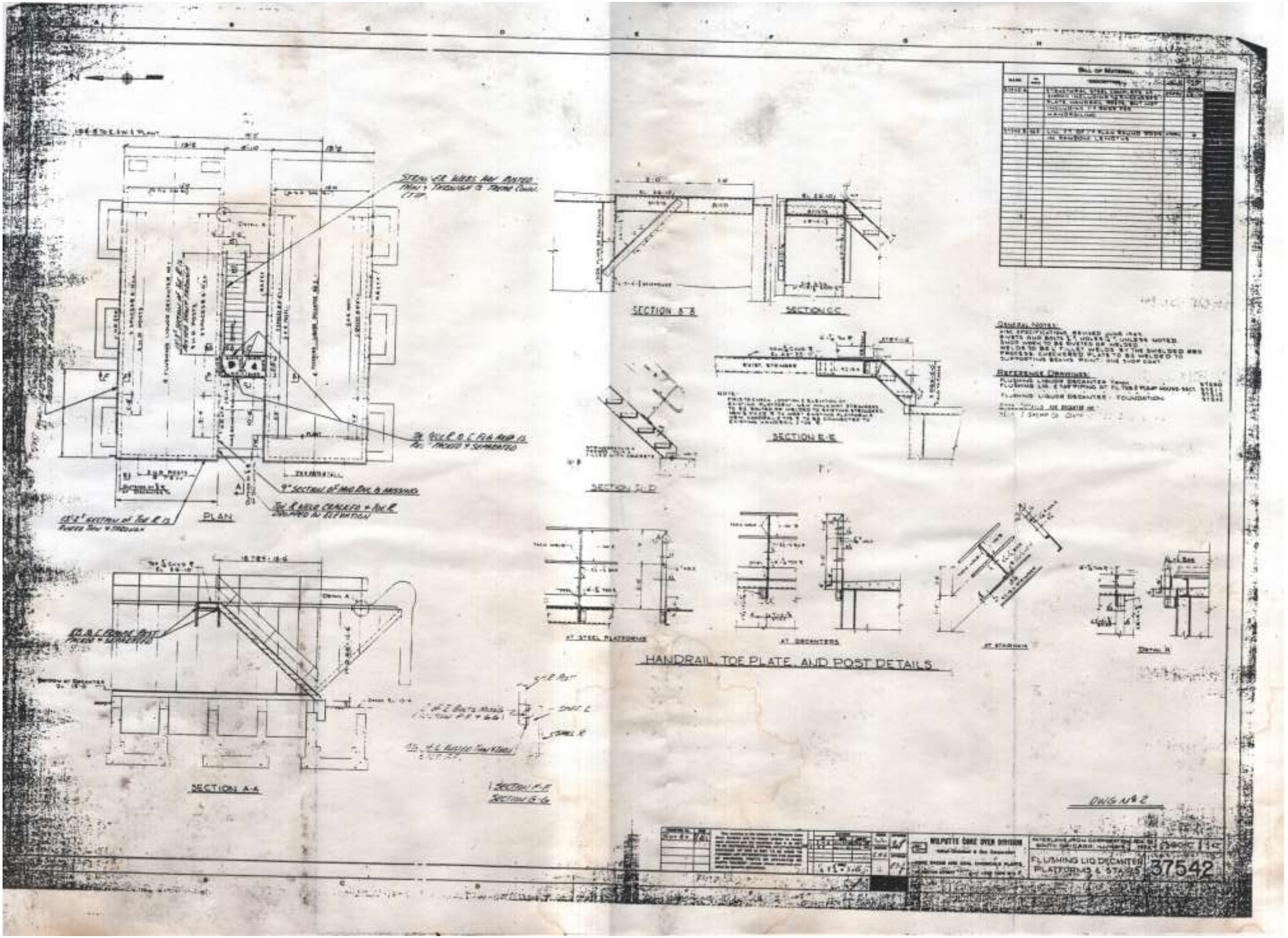
ACME STEEL COMPANY
CHICAGO COKE PLANT
BY-PRODUCTS DEPARTMENT
No. 1 FLUSHING LIQUOR DECANTER TANK
CONCEPTUAL REPAIRS

DRAWN BY	DATE	CHECKED BY	DATE	SCALE	PROJECT NO.	DRAWING NUMBER
MFH	9/6			NTS	00-149	3


PLAN
SECTION A-A
SECTION B-B
SECTION C-C
SECTION D-D
SECTION E-E
AT STEEL PLATFORMS
AT DECANTERS
AT STAIRWAYS
HANDRAIL, TOE PLATE, AND POST DETAILS
WILPUTTE COKE OVEN DIVISION
FLUSHING LIQ DECANTER PLATFORMS & STAIRS
37542