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Report No. SFIM-AEC-ET-CR-95077
FINAL REPORT
Volume 2 of 4

Project Summary Report for Pilot-Scale Demonstration of Red Water Treatment by Wet Air Oxidation and Circulating Bed Combustion

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October 1995
Contract No. DACA31-91-D-0074
Task Order No. 0005

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Prepared for:

U.S. Army Environmental Center
Aberdeen Proving Ground, MD 21010-5401

DTIC QUALITY INSPECTED 5

FINAL

PROJECT SUMMARY REPORT

FOR

PILOT SCALE DEMONSTRATION OF RED WATER TREATMENT BY WET AIR OXIDATION AND CIRCULATING BED COMBUSTION

VOLUME 2 OF 4

USAEC Contract No. DACA 31-91-D-0074
Task Order No. 5

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Prepared by

IT Corporation
Cincinnati, Ohio

October 1995

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As part of the Army's ongoing research and development program related to red water (K047) treatment, the U.S. Army Environmental Center (USAEC) contracted IT Corporation to prepare conceptual designs and plans for pilot scale demonstrations of two treatment technologies: wet air oxidation (WAO) and circulating bed combustion (CBC). The project objectives included development of a Test Plan and a Health and Safety Plan for these demonstrations. The Project Summary Report presents the conceptual designs. This Project Summary Report and the Test Plan and Health and Safety Plan are intended to serve as guides for development of complete project plans when the technology demonstration program is implemented. Because red water is not currently available for testing and the test site (host facility) where the demonstrations will be conducted has not been identified, these documents are intended to be generic in nature.

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Preface

As part of the U.S. Army's ongoing program related to the research and development of red water treatment technologies, the U.S. Army Environmental Center (USAEC) contracted IT Corporation to prepare conceptual designs and plans for pilot-scale demonstrations of two treatment technologies: wet air oxidation (WAO) and circulating bed combustion (CBC). The project objectives also included development of a Test Plan and Health and Safety Plan for these demonstrations, and preparation of a Project Report. This Project Report is intended to summarize the conceptual designs, Test Plan, and Health and Safety Plan and to serve as a guide for activities when the next phase of this program (i.e., conducting the demonstrations) is implemented.

Red water is not currently generated by the U.S. Army or any other part of the U.S. Department of Defense nor has it been generated in the recent past. An accurate and complete database does not exist in regard to the chemical and physical nature of red water. Due to this lack of waste characterization data, it was not possible to complete an accurate analysis of the associated testing and treatment requirements. Additionally, the source of red water for testing and the location where the tests will be conducted (i.e., the host facility) have not been identified. Therefore, waste- and site-specific concerns and requirements cannot be accurately or completely addressed at this time. As a result, this phase of the investigation included completion of plans and conceptual designs. Completion of system designs and finalization of test and safety plans must be completed in the future prior to initiation of the demonstration program.

This Project Report outlines the current project status and identifies the steps which must be completed prior to conducting the demonstrations. These include: selecting a host facility, obtaining red water for the demonstrations, characterizing the red water, preparing final process and equipment designs, finalizing Health and Safety and Test Plans, and acquiring the test equipment. Because of the unique and largely undocumented nature of red water, once a source has been identified, a critical initial objective will be characterization of the physical and chemical nature of the waste and a review of the associated treatment requirements.

Table of Contents

Preface ii

List of Figures v

1.0 Introduction 1-1

1.1 Background 1-2

1.2 Scope and Objectives 1-3

1.3 Project Schedule 1-4

2.0 Regulatory Review 2-1

2.1 RCRA Facility Requirements 2-2

2.2 Liquid Effluents 2-4

2.2.1 TSDF Disposal of WAO Effluent 2-4

2.2.2 POTW Disposal of WAO Effluent 2-6

2.2.3 NPDES Discharge of WAO Effluent 2-7

2.3 Air Emissions 2-7

2.4 Solid Residuals 2-9

3.0 Results of Vendor Evaluations 3-1

3.1 Wet Air Oxidation 3-1

3.2 Circulating Bed Combustion 3-3

4.0 Conceptual Design 4-1

4.1 Wet Air Oxidation Demonstration Unit 4-1

4.1.1 Feed Preparation and Preheat 4-2

4.1.2 Reaction and Separation 4-2

4.1.3 Compressed Air 4-4

4.1.4 Facilities Support/Utility Requirements 4-4

4.1.5 Scale-Up Factors for Full-Scale Units 4-4

4.1.6 WAO Treatability Test Program 4-5

4.2 Circulating Bed Combustion Demonstration Unit 4-6

4.2.1 Feed System 4-8

4.2.2 Combustion System 4-8

4.2.3 Ash Handling System 4-10

4.2.4 Air Pollution Control System (APCS) 4-10

4.2.5 Facilities Support/Utility Requirements 4-10
4.2.6 Scale-Up Factors for Full-Scale CBC Units 4-10
4.2.7 CBC Treatability Test Program 4-11
5.0 Implementation Plan for Demonstrations 5-1
5.1 Review Technologies 5-1
5.1.1 Technology Identification and Screening 5-2
5.1.2 Technology Evaluation 5-3
5.2 Identify a Host Facility or Facilities 5-3
5.3 Identify a Source of Red Water 5-3
5.4 Characterize the Red Water 5-4
5.5 Update the Regulatory Review 5-4
5.6 Obtain the Necessary Permits 5-5
5.7 Prepare Final Designs for WAO and CBC Systems 5-6
5.8 Revise Test and Health and Safety Plans 5-6
5.9 Confirm Site Support Requirements 5-7
5.10 Fabricate, Deliver, and Install the WAO and CBC Systems 5-8
5.11 Complete Shake-Down Testing and Train Equipment Operators 5-8
5.12 Conduct the Pilot-Scale Demonstrations 5-8
5.13 Treat/Dispose Project Residuals 5-9
5.14 Evaluate Data and Document Results 5-9
6.0 References 6-1

Appendix A - Regulatory Overview for Pilot-Scale Demonstration and Full-Scale Treatment of Red Water (K047)
Appendix B - Wet Air Oxidation Conceptual Design Report
Appendix C - Circulating Bed Combustion Conceptual Design Report
Appendix D - Wet Air Oxidation Vendor Summary
Appendix E - Wet Air Oxidation Treatability Study Report
Appendix F - Circulating Bed Combustion Treatability Study Report

Appendix A is in Volume 1; Appendix B is in Volume 2; Appendix C is in Volume 3; and Appendices D, E, and F are in Volume 4.

List of Figures

Figure		Page
4-1	WAO Block Flow Diagram	4-3
4-2	CBC Test Unit Block Flow Diagram	4-7
4-3	CBC Test Unit Process Flow Diagram	4-9

APPENDIX B

WET AIR OXIDATION CONCEPTUAL DESIGN REPORT
(Prepared by Kenox Corporation)

KENOX CORPORATION

WET AIR OXIDATION PILOT PLANT

FOR

RED WATER

CONCEPTUAL DESIGN REPORT

Prepared For:

IT CORPORATION
Cincinnati, Ohio

Kenox Project No. ***UJ41014***
Purchase Order No. ***483392***

December 1994

Table of Contents

1.0. General Description 1
1.1. Introduction 1
1.2. Design Basis 3
1.2.1. Red Water Characteristics 3
1.2.2. Dilution of Feed 3
1.2.3. Design Conversion Levels and Feed Rates 4
1.2.4. pH Adjustment 4
1.2.5. Definitions of Kenox Inside Battery Limits 4
1.2.6. Design Inlet Battery Limit Conditions 4
1.2.7. Design Outlet Battery Limit Conditions 4
1.2.8. Material of Construction 5
1.2.9. Plot Area 5
1.2.10. Service Factor 5
1.3. Block Diagram 8
2.0. Process Description 9
2.1. Feed Preparation & Preheat 9
2.2. Reaction & Separation Sections 9
2.3. Compressed Air 9
3.0. Process Flow Diagram and P & IDs 10
4.0. Equipment List 15
5.0. Equipment Specifications 16
6.0. Utility Consumption 29
6.1. Electrical 29
6.2. Cooling water 29
7.0. General Arrangement Drawings 30
8.0. Electrical One Line Drawing 32
9.0. Mass & Energy Balance Outputs 33
9.1. Reaction Pathways 33
9.2. Reactor Process Conditions 34
9.3. Mass & Energy Balance 35
10.0. Pilot Plant Cost Estimates 39
10.1. Scope of Kenox Supply 39
10.2. Scope of IT Corporation Supply 39
10.3 Purchase Option 40

10.4 Lease Option 40
11.0. Operations & Safety Considerations 41
11.1. Introduction 41
11.2. Regulations and Guidelines 41
11.3. Emergency Shutdown System 42
11.4. Hazard Assessments 44
11.4.1. Waste Feed 44
11.4.2. Burn Hazards 44
11.4.3. Confined Space Entry 44
11.4.4. Sampling 45
11.4.5. Material Safety Data Sheets 46
12.0. Sampling Plan 72
12.1. Introduction 72
12.2. Sampling Equipment, Procedures and Locations 72
12.3. Analytical Procedures 72
12.4. Operational Parameters 72
13.0. Operations Manual 77
13.1. General Description 77
13.1.1. Manual Purpose 77
13.1.2. System Description 77
13.1.3. Key Operating Parameters 78
13.2. Start-Up Procedure 80
13.2.1. Start Up Cooling Water System 80
13.2.2. Activate Instrument Air System 80
13.2.3. System Water Fill 80
13.2.4. Increase System Temperature 81
13.2.5. Pressurize System 81
13.2.6. Introduction of Waste Water Feed Stream 82
13.3. Shutdown Procedure 84

List of Tables

Table 1.1 Red Water Characteristics. 6
Table 1.2 Composition of Red Water Solids 7
Table 4.1 Equipment List 15
Table 12.1 Sample Collection Locations and Equipment 75
Table 12.2 Summary of Analytical Requirements and Methods 76

SECTION 1.0.

GENERAL DESCRIPTION

1.0. GENERAL DESCRIPTION

1.1. INTRODUCTION

Red water is the waste water generated from the purification stage of the manufacturing process of 2,4,6-trinitrotoluene (TNT). During the purification stage, a sellite solution is added to the crude TNT to remove unsymmetrical isomers. The red water generated contains dinitrotoluene (DNT) sulfonated compounds and products of incomplete nitration of toluene to TNT (i.e. priority pollutants 2,4-DNT and 2,6-DNT).

Red water is currently classified by the EPA as an RCRA-regulated reactive hazardous waste (KO47). The feasibility of using Wet Air Oxidation (WAO) for the treatment of TNT red water was confirmed by the study which was performed by the Department of Civil Engineering at the University of Maryland, under contract with the U.S. Army Construction Engineering Research Laboratory. As a result, the U.S. Army Environmental Center (USAEC) has decided to investigate a piloting program to treat TNT red water in a Wet Air Oxidation system.

This document is prepared as part of the task entitled "Red Water Treatment Technology Test Plan and Site Preparation" for the USAEC. The objectives of this task are to prepare test and safety plans, determine the best conceptual designs, and prepare layouts for pilot scale Circulating Bed Combustors (CBCs) and WAO treatment systems. Due to the uncertainty of the pilot plant demonstration location, the units are designed to be transportable.

This design package presents the conceptual design, layout and cost estimate of a mobile Kenox Wet Air Oxidation pilot plant. Further process engineering and detailed design engineering is necessary prior to construction of the Kenox pilot plant.

The Kenox WAO system presented here is a transportable pilot plant consisting of a feed preparation and preheat section, reaction section and separation and pressure let down section. The red water is diluted and preheated in the feed preparation section and then mixed with air prior to entering the reaction section. The reactor system operates at 484 deg F and 1000 psia. Spent air and oxidized waste leaving the reactor system are cooled and fed into a two stage pressure let down and separation system prior to being discharged from the WAO system.

This design package contains the following major sections:

- **1.0 General Description** - Presents a brief introduction to the project and contents, the WAO design basis and a WAO block diagram.
- **2.0 Process Description** - Presents a process overview of the Kenox WAO system and a description of each key system section.

- **3.0 PFD and P&IDs Package** - Presents the Process Flow Diagram (PFD) and the Piping and Instrumentation Diagrams (P & IDs) for the WAO system.
- **4.0 Equipment List** - Presents a table of the key equipment components.
- **5.0 Equipment Specifications** - Presents the process specification sheets for each key WAO component.
- **6.0 Utility Consumption** - Presents the utility consumptions of the WAO system.
- **7.0 General Arrangement Drawings** - Presents the general arrangement plans for the WAO system.
- **8.0 Electrical One-Line Drawing** - Presents the electrical one-line drawing for the WAO system.
- **9.0 Mass & Energy Balance Outputs** - Presents the basis and results of mass and energy balances conducted for normal operations.
- **10.0 Pilot Plant Cost Estimate** - Presents the cost estimates for purchase and lease of Kenox WAO equipment.
- **11.0 Treatability Study** - Presents the autoclave procedures and results.
- **12.0 Operations & Safety Considerations** - Presents the health and safety considerations of the WAO operations.
- **13.0 Sampling Plan** - Presents the general process and emissions sampling procedures.
- **14.0 Operations Manual** - Presents a draft Kenox WAO operations manual.

1.2. DESIGN BASIS

In preparing this conceptual design, Kenox has relied to a significant extent on the experimental data, observations and results presented in the Phull (1992) and Hao (1993) reports and Kenox' preliminary treatability study on the TNT red water. Additional assumptions and considerations were also made in the absence of data. These assumptions and the literature review results require confirmation through an extended treatability study before the design of the system is to be finalized. The initial conceptual design basis and considerations are discussed below.

1.2.1. Red Water Characteristics

The manufacturing process of 2,4,6-trinitrotoluene (TNT) consists of two stages: (i) nitration of toluene to crude TNT and (ii) sellite purification to remove the unsymmetrical TNT isomers and other impurities. During the purification stage, the sodium sulfite (sellite) that is added to crude TNT, reacts selectively with the unsymmetrical TNT isomers to produce dinitrotoluene (DNT) sulfonated compounds. The waste water which is generated during this stage (also known as red water) contains the dinitrotoluene sulfonated compounds, products of incomplete nitration of toluene to TNT from the first stage and other complex byproducts formed during the nitration and purification stages.

Based on Radford Army Ammunitions Plant data on red water characteristics (forwarded by IT Corporation to Kenox, see Tables 1.1 and 1.2), red water in general has a COD range of 65,000 mg/l to 120,000 mg/l, a pH of 7.0 to 9.7 and contains 15 to 30 percent solids. Inorganic salts make up 45 wt% of the solids and nitrobodies make up the remaining 55 wt%.

This conceptual design assumes that dinitrotoluene sulfonated (DNTS) compounds constitute the major COD contributor in red water. Due to limited physical data available on DNTS, the mass and energy balance assumed the following sequence of reaction pathways: (1) removal of the sulfonic group from DNTS to form dinitrotoluene and sulfuric acid; and (2) oxidation of dinitrotoluene with air to produce carbon dioxide, water and nitrogen.

1.2.2. Dilution of Feed

The selection of the design pressure of the reactor system will have to take into account the overpressurization of the system in the event of an uncontrollable reaction. Kenox' preliminary evaluation indicated that the optimum system design pressure can be achieved at a feed concentration of 6 % COD.

1.2.3. Design Conversion Levels and Feed Rates

The Kenox pilot plant is designed to treat 1.5 USGPM of raw red water at a COD level of 120,000 mg/l. The incoming red water will be diluted to a COD level of 60,000 mg/l with a treated effluent recycle stream due to safety concerns and excessive evaporation in the Kenox reactors with the high incoming COD level. The design throughput after dilution of the feed stream is 3.0 USGPM. Experimental data reported in Phull's dissertation (1992), predict a COD conversion in the 85% range at WAO reaction conditions of 485 deg F .

1.2.4. pH Adjustment

Initial pH of the waste feed stream can have a significant impact on the performance of the oxidation reaction. In this Kenox design, a feed pH of 5 is required.

1.2.5. Definitions of Kenox Inside Battery Limits

The Kenox inside battery limits are defined as follows:

- Inlet of the Kenox unit: Feed to the suction of the waste feed pump, P-101.
- Outlet of the Kenox unit: Effluent from the discharge of the final effluent pump, P-105.
- Refer to the attached PFD in Section 3.0 for details on the definitions of Kenox inside battery limits.

1.2.6. Design Inlet Battery Limit Conditions

Raw Feed Flow, USGPM	1.5
pH	7.0 - 9.7
COD, mg/l (min/max)	65,000/120,000
Temperature, deg F	60
Compositions	see Tables 1.1 & 1.2

1.2.7. Design Outlet Battery Limit Conditions

pH	2.0 - 4.0
Temperature, deg F	107
Pressure, psia	50
COD, conversion	85%

1.2.8. Material of Construction

As reported in Phull's dissertation, the corrosivity of red water is aggravated under process conditions of high temperature, high pressures and low pH of oxidized solutions. Sulfonated nitroaromatics are expected to be more corrosive when subjected to WAO due to the formation of inorganic salts. On the basis of the corrosion testing performed by Phull, titanium is selected as the material of construction for Kenox reactors and associated equipment and piping when the process temperature exceeds 100 ^{o}F. For process effluent temperatures less than 100 ^{o}F, equipment and piping will be constructed from 316 stainless steel. pH adjustment on the rundown effluent from the Kenox unit, if required is not included in the design scope.

1.2.9. Plot Area

Due to the uncertainty of the pilot plant demonstration location, the unit is designed to be transportable and to be operable indoors or outdoors. The required minimum plot space for this Kenox unit is approximately 16' x 48'.

1.2.10. Service Factor

It is anticipated that the service factor for the Kenox system will be in the order of 90 %. Rotating equipment spare parts inventories are at the client's choice and judgment between the penalty for short term shutdown versus the cost of the spare equipment. However, Kenox recommends that spare parts for critical and long term delivery items be stored. A list of spare parts will be provided upon the completion of detailed engineering.

Table 1.1 Red Water Characteristics

Chemical Oxygen Demand, mg/L	65,000 - 120,000
Total Solids, %	15 - 30
Specific Gravity	1.1
Nominal Solids Heat Value	3,200 BTU/lb
Suspended Solids, mg/L	32
pH	7.0 - 9.7
Soluble Chloride, mg/L	70
Total Kjeldahl Nitrogen, mg/L	11,129
Nitrate Nitrogen, mg/L	1,739
Nitrite Nitrogen, mg/L	6,788
Ammonia Nitrogen, mg/L	150
Metals, mg/L	
Calcium	39 - 346
Iron	4.9 - 307
Magnesium	25 - 90
Potassium	42
Aluminum	2.1 - 10
Chromium	0.14 - 4.9
Barium	0.22 - 3.0
Copper	2.3
Cadmium	0.7
Silver	0.4
Zinc	6.4

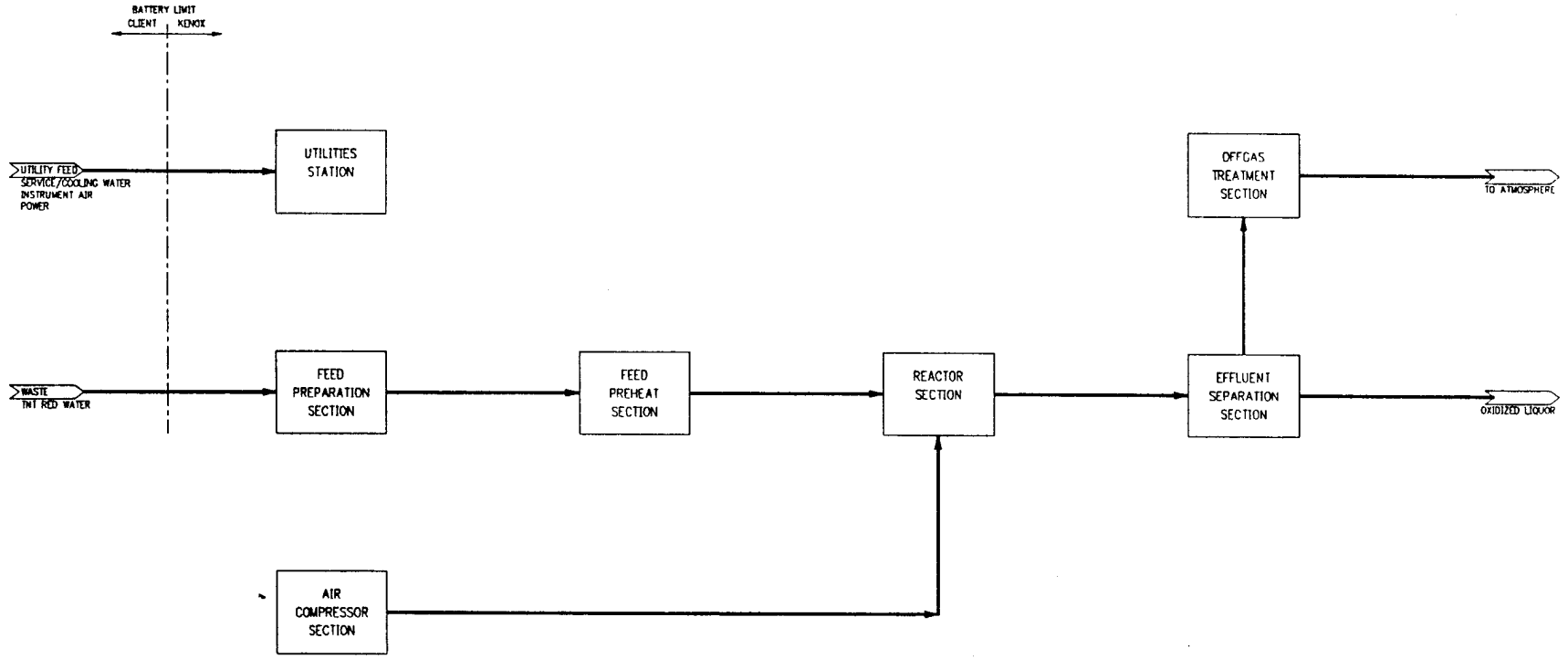
Reference: Radford Army Ammunitions Plant, 1988, "Review of Canadian Industries Limited's Boloeil Facility as a Candidate for a SRP Pilot Test."

Table 1.2 Composition of Red Water Solids

Inorganic Salts, wt%	
Na_2SO_3-Na_2SO_4	32.3
$NaNO_2$ (sodium nitrite)	11.2
$NaNO_3$ (sodium nitrate)	1.5
NAHS-Na_2S (sodium sulfide)	may be present
Sodium bicarbonate/carbonate	may be present
Subtotal Inorganic Salts, wt%	**45**
Nitrobodies, wt%	
Sodium sulfonate of 2,4,5 TNT	22.7
alpha - TNT - Sellite complex	16.2
Sodium sulfonate of 2,3,4 TNT	9.6
Sodium sulfonate of 2,3,5 TNT	2
Sodium sulfonate of 2,3,6 TNT	trace
2,4,6-TNBA (trinitrobenzoic acid) Na salt	1.0
White compound sodium salt *	1.0
TNBAL - bisulfite addition compound (trinitrobenzaldehyde)	1.0
TNBOH (trinitrobenzyl alcohol)	1.0
Sodium nitroformate	0.5
3,4 - DNBA (dinitrobenzoic acid) Na salt	trace
2,3 - DNBA (dinitrobenzoic acid) Na salt	trace
TNB (trinitrobenzene) - Sellite complex	trace
Dissolved 2,4-DNT (dinitrotoluene)	trace
Dissolved alpha - TNT (trinitrotoluene)	trace
Subtotal Nitrobodies, wt%	**55**

* "White compound" is believed to be 2,2-dicarboxy-3,3"5,5"-tetranitroazoxybenzene

Reference: Radford Army Ammunitions Plant, 1988, "Review of Canadian Industries Limited's Boloeil Facility as a Candidate for a SRP Pilot Test".



B	DEC 8 1994	CONCEPTUAL DESIGN	
rev no.	date	particulars	drawn / checked / appd

KENOX CORPORATION

BLOCK FLOW DIAGRAM
USAEC RED WATER TREATMENT TECHNOLOGY
TEST PLAN AND SITE PREPARATION PROJECT

designed by: B. MOLL	drawn by: B.W.	checked by: T. LE	
scale: NONE	date of issue: DEC. / 1994	resp.: TDL	appd: BAW
project no.: 941014	dwg no.: 941014-BD-130	rev.: 0	

CAD REF.: 1TB0130A.DWG

SECTION 2.0.

PROCESS DESCRIPTION

2.0. PROCESS DESCRIPTION

The following process description refers to equipment shown on the PFD and P&IDs in Section 3.

2.1. FEED PREPARATION & PREHEAT

To prevent excessive evaporation in the Kenox reaction section, the maximum COD concentration for TNT red water to be processed in this WAO system is 6%. For TNT red water containing COD level above 6%, feed dilution is required before being introduced to the Kenox reactor. TNT red water from storage outside Kenox' battery limits is pumped at a rate of 1.5 USGPM by waste feed pump, P-101, to the feed drum, D-104. At the inlet of this drum, the waste is mixed with a treated Kenox effluent recycle stream which is delivered by the final effluent pump P-105, or service water via dilution feed pump P-102 to maintain the maximum COD in the feed at 6 %. This blending is performed by the flow ratio controller, FFRC-401.

The diluted feed is pumped from the feed drum by high pressure feed pump, P-103 to the inlet tubeside of feed/effluent exchanger, E-101 where it is preheated by the reactor system's effluents to the required inlet temperature to the Kenox reactor section. During start up, the electric heater E-102 will be used to heat the feed up to the desired reaction temperature.

2.2. REACTION & SEPARATION SECTIONS

The Kenox reaction section comprises of reactors connected in series. Compressed air is injected into the reactors to supply the required oxygen for the reaction. Reactor effluent is cooled to 104 deg F via the feed/effluent exchanger E-101 and the water cooler, E-103. Spent air and oxidized waste water leave the cooler and proceed to a two stage pressure let down and separation system, D-101 and D-102.

The off-gas, which at this point is mainly carbon dioxide, nitrogen and water vapor is vented to the atmosphere. The oxidized waste water is sent to the effluent drum, D-105. From the outlet of D-105, part of the oxidized waste water is recycled back via the effluent recycle pump, P-105 to the discharge of the feed waste pump, P-101. The other portion is pumped to the client's storage outside Kenox' battery limits.

2.3. COMPRESSED AIR

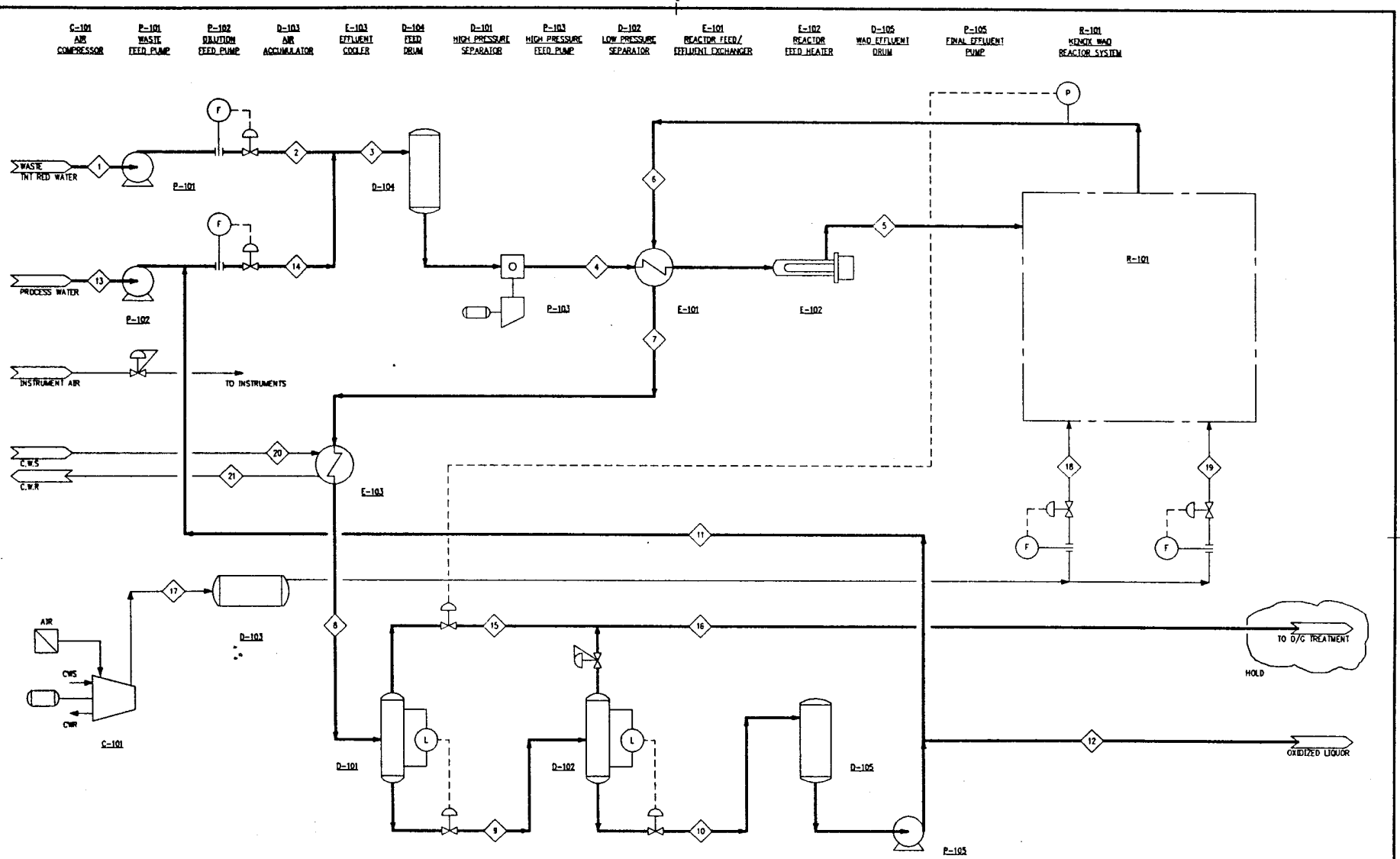
Air is supplied to the Kenox reactors by the reciprocating compressor, C-101. Compressed air leaving the compressor at 1050 psia flows to the air accumulator D-103. The total air flow to the Kenox reactors is controlled by an oxygen analyzer which measures the O_2 content of the offgas leaving the system.

SECTION 3.0.

PFD AND P&IDs PACKAGE

DRAWING INDEX

KENOX DRAWING NO.	CAD FILE NO.	DRAWING DESCRIPTION	REVISION NO.								
			A	B	C	0	1	2	3	4	5
MECHANICAL AND PIPING											
941014-FD-101	ITFD101B.DWG	PROCESS FLOW DIAGRAM	30/10/94	2/11/94							
941014-FD-102	ITFD102B.DWG	P&ID - WAO WASTE FEED PREPARATION	30/10/94	9/12/94							
941014-FD-103	ITFD103C.DWG	P&ID - WAO PREHEAT AND REACTOR SECTIONS	30/10/94	3/11/94	21/12/94						
941014-FD-104	ITFD104C.DWG	P&ID - EFFLUENT SEPARATION SECTION	30/10/94	3/11/94	21/12/94						
941014-FD-105	ITFD105C.DWG	UTILITY FLOW DIAGRAM	30/10/94	9/12/94	21/12/94						
941014-EL-110	ITEL110A.DWG	EQUIPMENT LAYOUT (ELEVATION 8'-6")	-	-	-	21/12/94					
941014-EL-111	ITEL111A.DWG	EQUIPMENT LAYOUT (ELEVATION 11'-6")	-	-	-	21/12/94					
941014-BD-130	ITBD130A.DWG	BLOCK FLOW DIAGRAM	-	-	-	9/12/94					
941014-SP-140	ITSP140A.DWG	BLOCK FLOW DIAGRAM - SAMPLING LOCATIONS	-	-	-	21/12/94					
ELECTRICAL											
941014-E-120	ITE120A.DWG	SINGLE LINE DIAGRAM	-	-	-	9/12/94					



STREAM NO.	1	2	3	4	5	6	7	8	9	10	11	12
DESCRIPTION	RAW RED WATER TO P-101	RAW RED WATER @ DISCH. OF P-101	DILUTED FEED TO D-104	HP FEED TO E-101	FEED TO R-101 SYSTEM	OXIDIZED RED WATER TO E-101	OXIDIZED RED WATER FROM E-101	OXIDIZED RED WATER FROM E-103	OXIDIZED RED WATER TO D-102	OXIDIZED RED WATER TO D-105	EFFLUENT RECYCLE TO P-102	OXIDIZED RED WATER
LIQUID & SOLIDS (LB/HR)	772	772	1544	1544	1544	1034	1499	1653	1491	1490	772	718
GAS (LB/HR)	-	-	-	-	-	973	508	354	-	-	-	-
TEMPERATURE (DEG. F)	80	80	85	81	382	483	403	104	107	107	107	107
PRESSURE (PSIA)	16.	25	25	1050	1000	990	980	970	50.	25.	53.	53.
STREAM NO.	13	14	15	16	17	18	19	20	21			
DESCRIPTION	PROCESS WATER	EFFLUENT RECYCLE @ DISCH. OF P-102	OFFGAS FROM D-101	TOTAL OFFGAS	AIR TO D-103	AIR TO R-101 SYSTEM	AIR TO R-101 SYSTEM	CWS TO E-103	CWR FROM E-103			
LIQUID & SOLIDS (LB/HR)	-	772	-	-	-	-	-	33935	33935			
GAS (LB/HR)	-	-	518	518	463	231.5	231.5	-	-			
TEMPERATURE (DEG. F)	80	107	85	85	255	255	255	68	86			
PRESSURE (PSI)	14.7	25	20	20	1050	1000	1000	60	50			

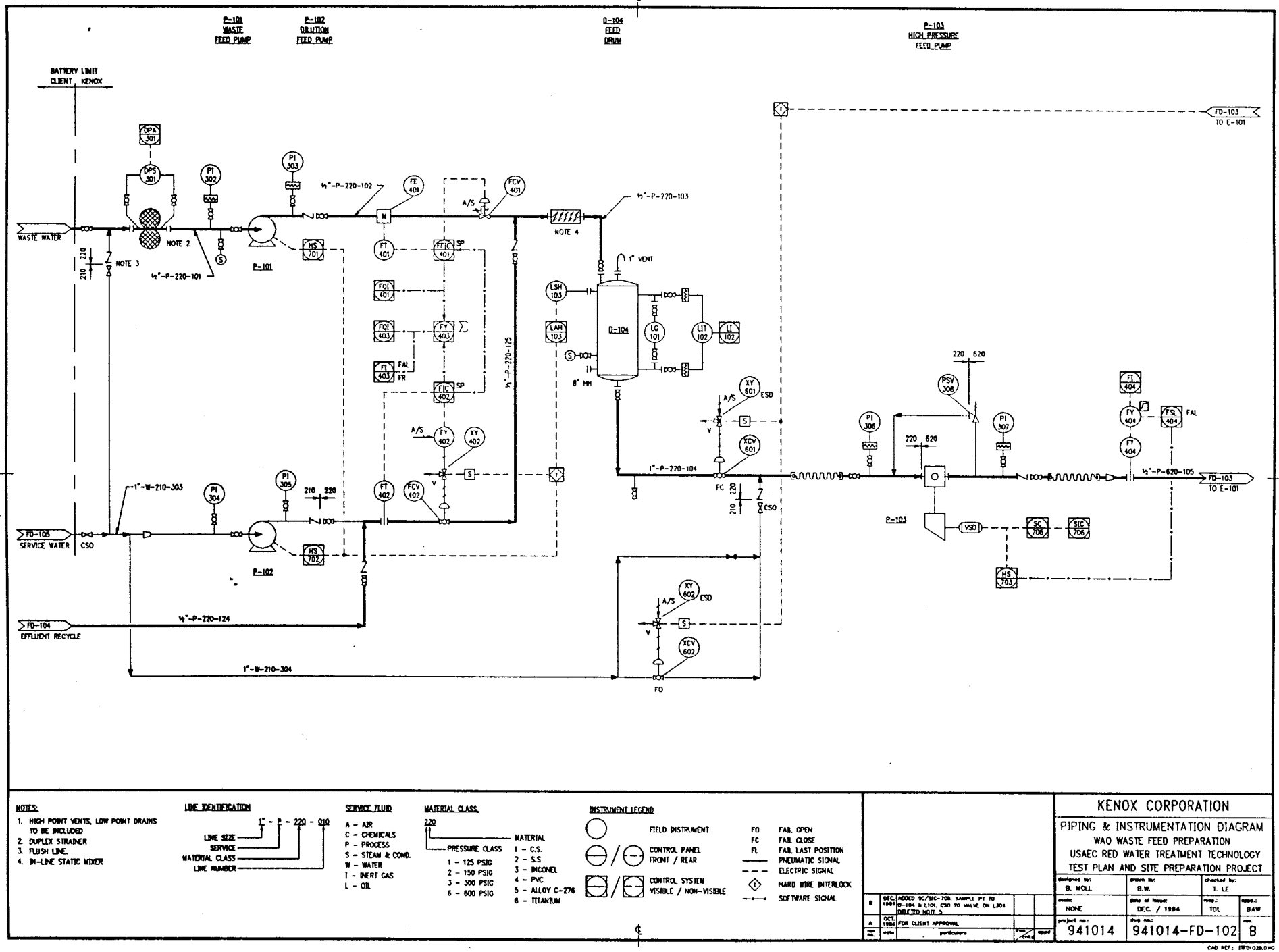
no.	date	particulars	dsn	appd
B	NOV 2 1994	M & M BALANCE ADDED		
A	OCT. 1994	PRELIMINARY		

KENOX CORPORATION

PROCESS FLOW DIAGRAM
USAEC RED WATER TREATMENT TECHNOLOGY
TEST PLAN AND SITE PREPARATION PROJECT

designed by:	drawn by:	checked by:
B. MOLL	BJW.	T. LE
scale: NONE	date of issue: DEC. / 1994	resp.: TDL
project no.: 941014	dwg no.: 941014-FD-101	rev.: B

CAD REF.: 1FD1018.DWG



NOTES:

1. HIGH POINT VENTS, LOW POINT DRAINS TO BE INCLUDED
2. DUPLEX STRAINER
3. FLUSH LINE.
4. IN-LINE STATIC MIXER

LINE IDENTIFICATION

1" - P - 220 - 010

- LINE SIZE
- SERVICE
- MATERIAL CLASS
- LINE NUMBER

SERVICE FLUID

- A - AIR
- C - CHEMICALS
- P - PROCESS
- S - STEAM & COND.
- W - WATER
- I - INERT GAS
- L - OIL

MATERIAL CLASS

220

- PRESSURE CLASS: 1 - 125 PSIG; 2 - 150 PSIG; 3 - 300 PSIG; 6 - 600 PSIG
- MATERIAL: 1 - C.S.; 2 - S.S; 3 - INCONEL; 4 - PVC; 5 - ALLOY C-276; 6 - TITANIUM

INSTRUMENT LEGEND

- FIELD INSTRUMENT
- CONTROL PANEL FRONT / REAR
- CONTROL SYSTEM VISIBLE / NON-VISIBLE
- FO FAIL OPEN
- FC FAIL CLOSE
- FL FAIL LAST POSITION
- PNEUMATIC SIGNAL
- ELECTRIC SIGNAL
- HARD WIRE INTERLOCK
- SOFTWARE SIGNAL

rev no.	date	particulars	drawn	appd
B	DEC. 1994	ADDED SC/SIC-706, SAMPLE PT TO D-104 & LIQ. CSO TO VALVE ON L304 DELETED NOTE 5		
A	OCT. 1994	FOR CLIENT APPROVAL		

KENOX CORPORATION

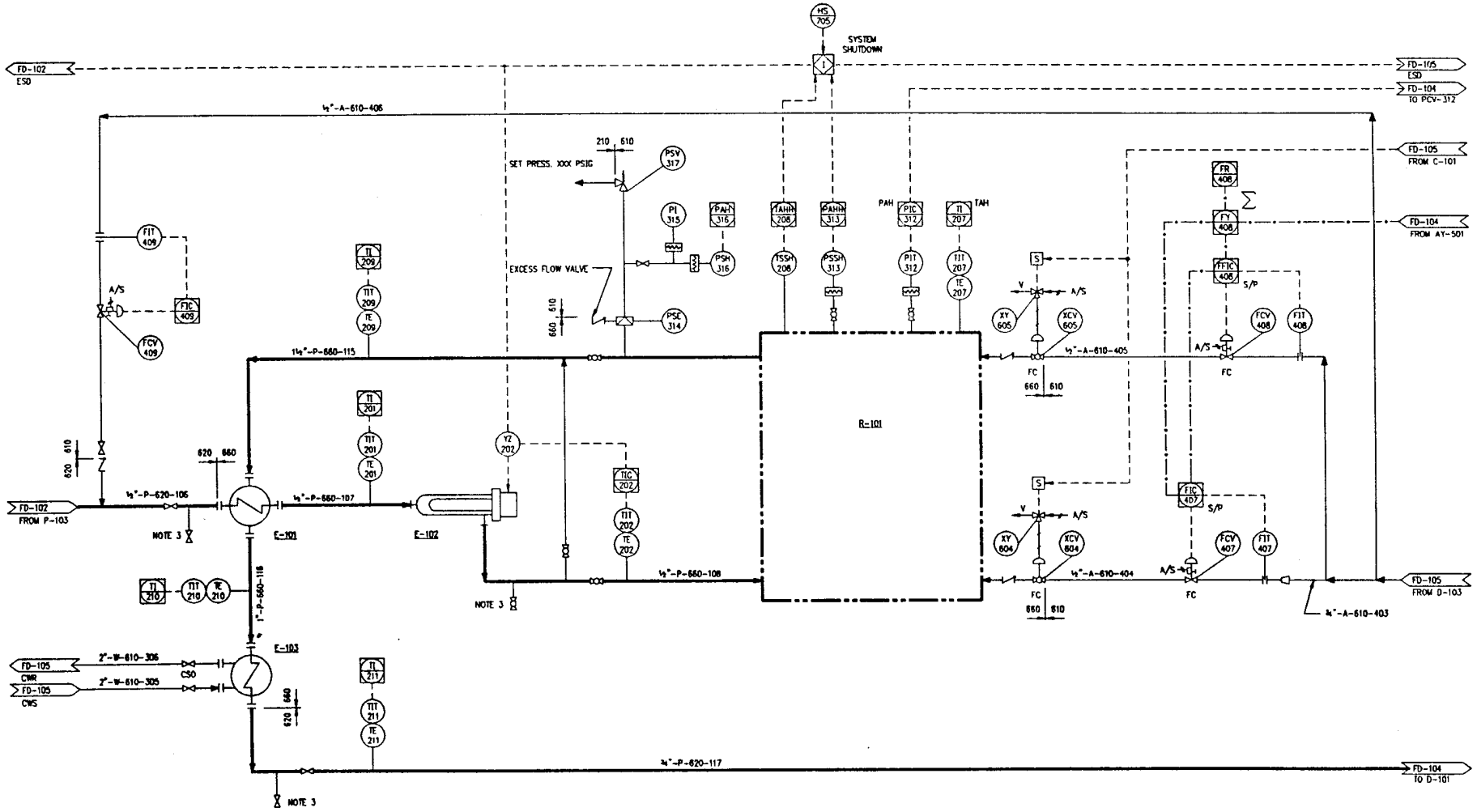
PIPING & INSTRUMENTATION DIAGRAM
WAO WASTE FEED PREPARATION
USAEC RED WATER TREATMENT TECHNOLOGY
TEST PLAN AND SITE PREPARATION PROJECT

designed by:	drawn by:	checked by:
B. MOLL	B.W.	T. LE

scale:	date of issue:	resp.:	appd.:
NONE	DEC. / 1994	TDL	BAW

project no.:	dwg no.:	rev.
941014	941014-FD-102	B

CAD REF: ITFD102B.DWG



NOTES:

1. HIGH POINT VENTS, LOW POINT DRAINS TO BE INCLUDED
2. DRAIN & SAMPLE POINT CONNECTION.
3. FLUSH CONNECTION.

LINE IDENTIFICATION

1" - P - 220 - 010

- LINE SIZE
- SERVICE
- MATERIAL CLASS
- LINE NUMBER

SERVICE FLUID

- A - AIR
- C - CHEMICALS
- P - PROCESS
- S - STEAM & COND.
- W - WATER
- I - INERT GAS
- L - OIL

MATERIAL CLASS

220

- PRESSURE CLASS
  - 1 - 125 PSIG
  - 2 - 150 PSIG
  - 3 - 300 PSIG
  - 6 - 600 PSIG
- MATERIAL
  - 1 - C.S.
  - 2 - S.S
  - 3 - INCONEL
  - 4 - PVC
  - 5 - ALLOY C-276
  - 6 - TITANIUM

INSTRUMENT LEGEND

- FIELD INSTRUMENT
- CONTROL PANEL FRONT / REAR
- CONTROL SYSTEM VISIBLE / NON-VISIBLE
- FO FAIL OPEN
- FC FAIL CLOSE
- FL FAIL LAST POSITION
- PNEUMATIC SIGNAL
- ELECTRIC SIGNAL
- HARD WIRE INTERLOCK
- SOFTWARE SIGNAL

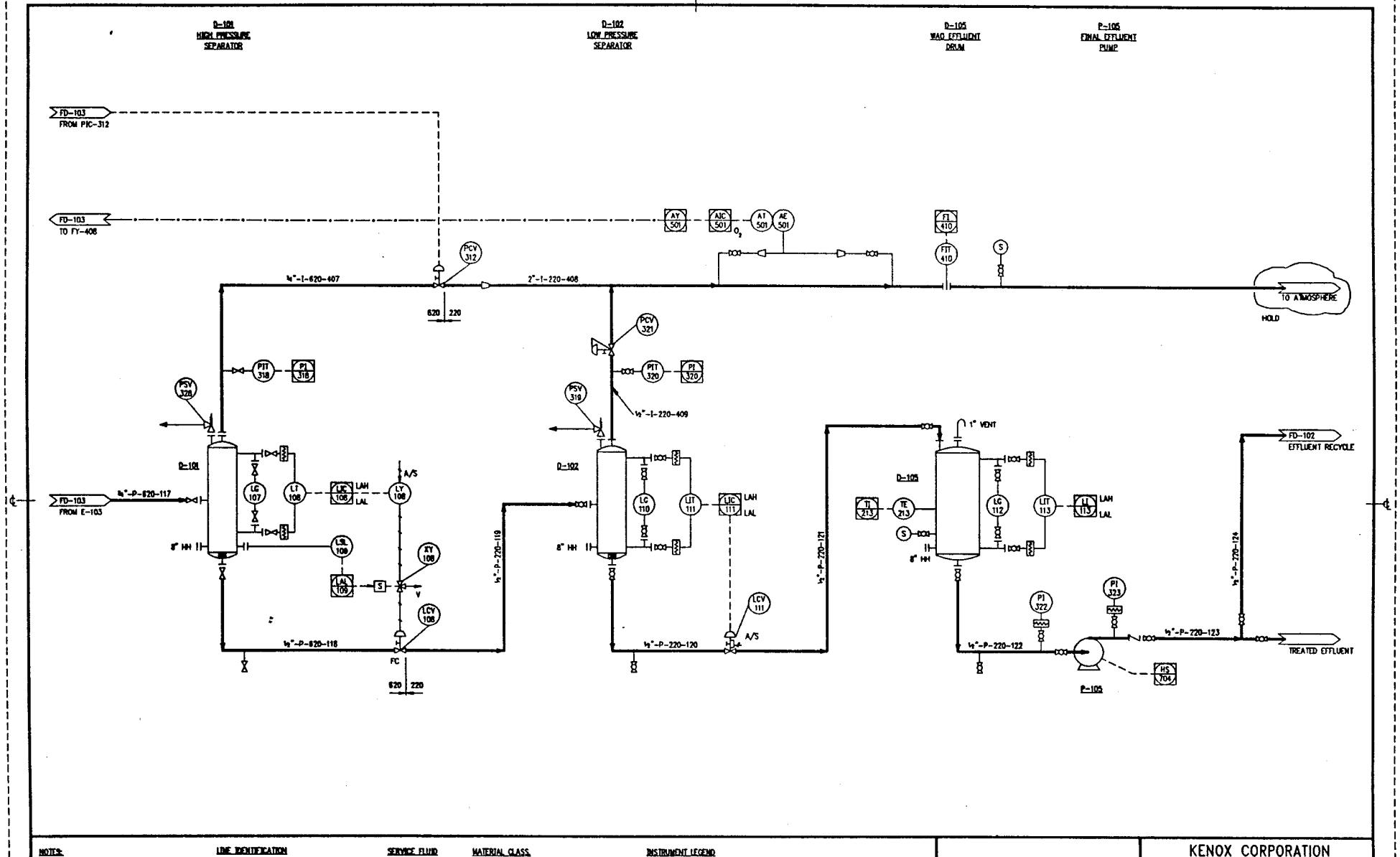
rev no.	date	particulars	dsn'd	appd
C	DEC 21 1994	ADDED PAH TO PIC-312 & TAH TO TI-207, PAHH-313 WAS PAAH ADDED ELECT. SIGNAL TO YZ-202		
B	NOV 3 1994	GENERAL REVISION		
A	OCT 1994	PRELIMINARY		

KENOX CORPORATION

PIPING & INSTRUMENTATION DIAGRAM
WAO PREHEAT & REACTOR SECTIONS
USAEC RED WATER TREATMENT TECHNOLOGY
TEST PLAN AND SITE PREPARATION PROJECT

designed by:	drawn by:	checked by:
B. WOLL	B.W.	T. LE
scale: NONE	date of issue: DEC. / 1994	resp.: TDL	appd.: BAW
project no.: 941014	dwg no.: 941014-FD-103	rev.: C

CAD REF.: [illegible]



NOTES:

1. HIGH POINT VENTS, LOW POINT DRAINS TO BE INCLUDED

LINE IDENTIFICATION

1" - P - 220 - 010

- LINE SIZE
- SERVICE
- MATERIAL CLASS
- LINE NUMBER

SERVICE FLUID

- A - AIR
- C - CHEMICALS
- P - PROCESS
- S - STEAM & COND.
- W - WATER
- I - INERT GAS
- L - OIL

MATERIAL CLASS

220

- MATERIAL
- PRESSURE CLASS

PRESSURE CLASS	MATERIAL
1 - 125 PSIG	1 - C.S.
2 - 150 PSIG	2 - S.S
3 - 300 PSIG	3 - INCONEL
6 - 600 PSIG	4 - PVC
	5 - ALLOY C-276
	6 - TITANIUM

INSTRUMENT LEGEND

- FIELD INSTRUMENT
- CONTROL PANEL FRONT / REAR
- CONTROL SYSTEM VISIBLE / NON-VISIBLE

FO	FAIL OPEN
FC	FAIL CLOSE
FL	FAIL LAST POSITION
	PNEUMATIC SIGNAL
	ELECTRIC SIGNAL
	HARD WIRE INTERLOCK
	SOFTWARE SIGNAL

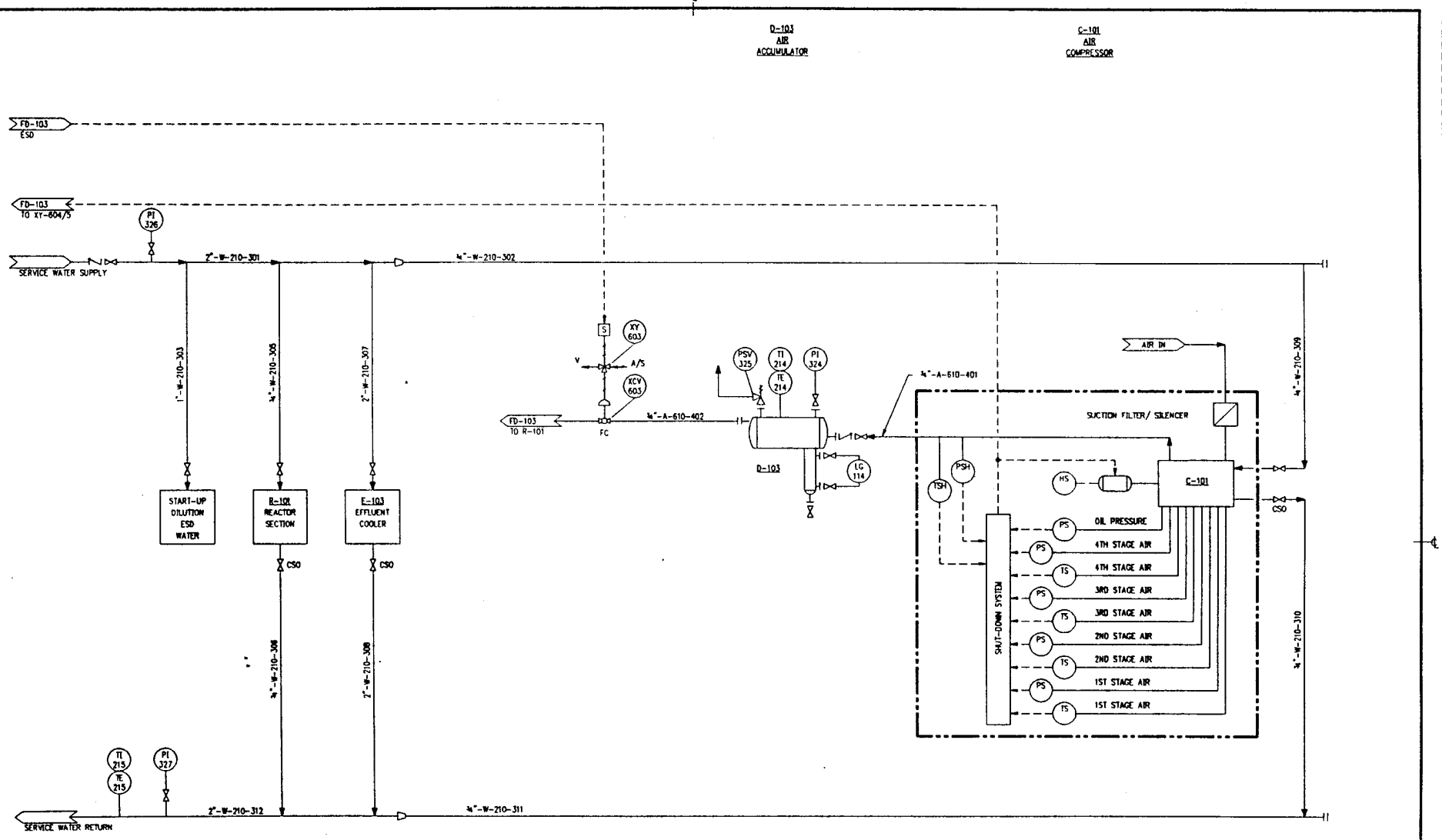
rev	date	particulars	drawn	appd
C	DEC 21 1994	ADDED SAMPLE PT S-108 & PSV-328, DELETED NOTE 2, INSTR. TAG # UPDATED		
B	NOV 3 1994	GENERAL REVISION		
A	OCT. 1994	PRELIMINARY		

KENOX CORPORATION

PIPING & INSTRUMENTATION DIAGRAM
EFFLUENT SEPARATION SECTION
USAEC RED WATER TREATMENT TECHNOLOGY
TEST PLAN AND SITE PREPARATION PROJECT

designed by:	drawn by:	checked by:
S. MOLL	B.W.	T. LE
scale: NONE	date of issue: DEC. / 94	resp.: TCL
project no.: 941014	dwg no.: 941014-FD-104	rev.: C

CAD REF.: 1YFD104C.DWG



NOTES:

1. HIGH POINT VENTS, LOW POINT DRAINS TO BE INCLUDED

LINE IDENTIFICATION

1" - P - 220 - 010

- LINE SIZE
- SERVICE
- MATERIAL CLASS
- LINE NUMBER

SERVICE FLUID

- A - AIR
- C - CHEMICALS
- P - PROCESS
- S - STEAM & COND.
- W - WATER
- I - INERT GAS
- L - OIL

MATERIAL CLASS

220

- PRESSURE CLASS
  - 1 - 125 PSIG
  - 2 - 150 PSIG
  - 3 - 300 PSIG
  - 6 - 600 PSIG
- MATERIAL
  - 1 - C.S.
  - 2 - S.S
  - 3 - INCONEL
  - 4 - PVC
  - 5 - ALLOY C-276
  - 6 - TITANIUM

INSTRUMENT LEGEND

- FIELD INSTRUMENT
- CONTROL PANEL FRONT / REAR
- CONTROL SYSTEM VISIBLE / NON-VISIBLE
- FO FAIL OPEN
- FC FAIL CLOSE
- FL FAIL LAST POSITION
- PNEUMATIC SIGNAL
- ELECTRIC SIGNAL
- HARD WIRE INTERLOCK
- SOFTWARE SIGNAL

rev	date	particulars	drawn	appd
C	DEC 21 1984	ADDED PI-326/7 & LINE DESIGN. NO! LINE 313 WAS 311, INSTR NO UPDATED		
B	DEC 1984	GENERAL REVISION		
A	OCT 1984	FOR CLIENT APPROVAL		

KENOX CORPORATION

UTILITY FLOW DIAGRAM

USAEC RED WATER TREATMENT TECHNOLOGY
TEST PLAN AND SITE PREPARATION PROJECT

designed by:	drawn by:	checked by:
B. MOLL	B.W.	T. LE
scale: NONE	date of issue: DEC. / 1984	resp.: TDL	appd.: BAW
project no.: 941014	dwg no.: 941014-FD-105	rev.: C

CAD REF.: 1TD105C.DWG

SECTION 4.0.

EQUIPMENT LIST

KENOX CORPORATION

EQUIPMENT LIST

CLIENT: IT CORPORATION

PROJECT: USAEC RED WATER TREATMENT TECHNOLOGY
TEST PLAN AND SITE PREPARATION PROJECT

ISSUE	DATE	CHKD.	APPR.	DESCRIPTION
0	NOV 30/94	BM	BAW	CONCEPTUAL DESIGN

TAG NO.	EQUIPMENT NAME	UNIT WEIGHT (LB.)	CAPACITY (SCFM)	DISCHARGE PRES.(PSIA)	MOTOR HP	MOTOR RPM	TYPE	MATERIAL	C.W. (USGPM)	POWER (KW)	REMARKS
C-101	AIR COMPRESSOR	7000	112	1050	100		4 STG. RECIP.	C.S.	12	60	
		WT. EMPTY (LB.)	SIZE I.D. X T/T	DESIGN PRES.(PSIA)	DESIGN TEMP. (°F)		INSULATION TYPE THK (IN.)	MATERIAL			
D-101	HIGH PRESSURE SEPARATOR	550	13" 4'-0"	1070	155		PP	316 S.S.	-	-	
D-102	LOW PRESSURE SEPARATOR	340	13" 4'-0"	75	160		PP	316 S.S.	-	-	
D-103	AIR ACCUMULATOR	600	14" 4'-0"	1160	310		HC	C.S.	-	-	
D-104	FEED DRUM	1250	40" 6'-0"	30	135		N	316 S.S.	-	-	
D-105	WAO EFFLUENT DRUM	1250	40" 6'-0"	30	160		N	316 S.S.	-	-	
		SURFACE AREA(SQ. FT.)	DUTY (K BTU/HR)	DESIGN PRES. SHELL	DESIGN PRES. TUBES	DESIGN TEMP. SHELL / TUBES	INSULATION TYPE THK (IN.)	MATERIAL SHELL / TUBES			
E-101	REACTOR FEED EFFLUENT EXCH.	24	431	1090	1160	535 / 415	HC	TI / TI	-	-	DOUBLE PIPE
E-102	REACTOR FEED HEATER	-	324	N/A	1160	N/A / 530	HC	N/A / TI	-	95	ELECTRIC HEATER
E-103	EFFLUENT COOLER	36	589	720	1080	140 / 455	PP	CS / TI	68	-	DOUBLE PIPE
		UNIT WEIGHT	NORMAL FLOW RATE (USGPM)	PRES. (PSIA) DISCH.	PRES. (PSIA) DIFF.	MOTOR HP / RPM	TYPE	MATERIAL WETTED PARTS			
P-101	WASTE FEED PUMP	75	1.5	46	30	0.75 / 3450	CENTRIFUGAL	316 S.S.	-	0.5	
P-102	DILUTION FEED PUMP	75	1.5	46	30	0.75 / 3450	CENTRIFUGAL	316 S.S.	-	0.5	
P-103	HIGH PRESSURE FEED PUMP	90	3	1050	1030	3 / 600	POSITIVE DISPL.	316 S.S.	-	1.6	DIAPHRAGM
P-105	FINAL EFFLUENT PUMP	75	3	53	35	1 / 3450	CENTRIFUGAL	316 S.S.	-	0.75	
		WT. EMPTY (LB.)	SIZE I.D. X T/T	DESIGN PRES.(PSIG)		DESIGN TEMP. (°F)	INSULATION TYPE THK (IN.)	MATERIAL			
R-101	REACTOR SECTION	6200		1100		535	HC	TITANIUM	15	4	

LEGEND:

INSULATION - HC - HEAT CONSERVATION
PP - PERSONNEL PROTECTION
AS - ANTI-SWEAT
N - BARE

SECTION 5.0.

EQUIPMENT SPECIFICATIONS

COMPRESSOR DATA SHEET

Equipment Name Air Compressor
Total Number Required One

DESIGN CONDITIONS		C-101	
Gas Handled		Air	
Std. Capacity	SCFM	112	
Weight Flow	lb/hr	510	
Critical Pressure	psia	547	
Critical Temperature	deg F	-221	
Relative Humidity			
Molecular Weight		28.8	
Inlet			
Pressure	psia	14.7	
Temperature	deg F	Ambient	
Cp/Cv		1.4	
Compressibility		1	
Inlet Volume	ACFM	113	
Outlet			
Pressure	psia	1050	
Temperature	deg F		
Cp/Cv			
Compressibility			
Discharge Volume	CFM		
Miscellaneous			
Adiabatic	kW		
BHP	kW		
Speed	rpm		

Compressor Connections	(1)	Motor				
Suction Size	in., Rating	Motor hp				
Discharge Size	in., Rating	Volts	460	Phase	3	Hertz 60
Cooling Water		Electrical Classification	Class I & II, Div. 1			
Inlet Temp.	68 deg F	**Materials**				
Differential Temperature	18 deg F	Casing				
Max. Allowable Pressure Drop	psi	Piston				
		Shaft				

Remarks:

1. Compressor vendor to confirm and supply all applicable information to fully complete data sheet.
2. Cooling is not required for final stage.
3. Compressor vendor to supply:
   - (i) Suction air filters and silencers
   - (ii) Pressure relief valves.
   - (iii) Local temperature and pressure gauges for all stages
   - (iv) Shutdown protection switches
   - (v) Compressor control system to be mounted in appropriate enclosure.
   - (vi) Motor starter with enclosure.

NO.	DATE	REVISION	BY	CHK.	APP.
0	11/22/94	For Quotation	BM		

PROJECT: **IT Corporation - TNT Redwater**

KENOX

CLIENT: **IT Corporation**

LOCATION:

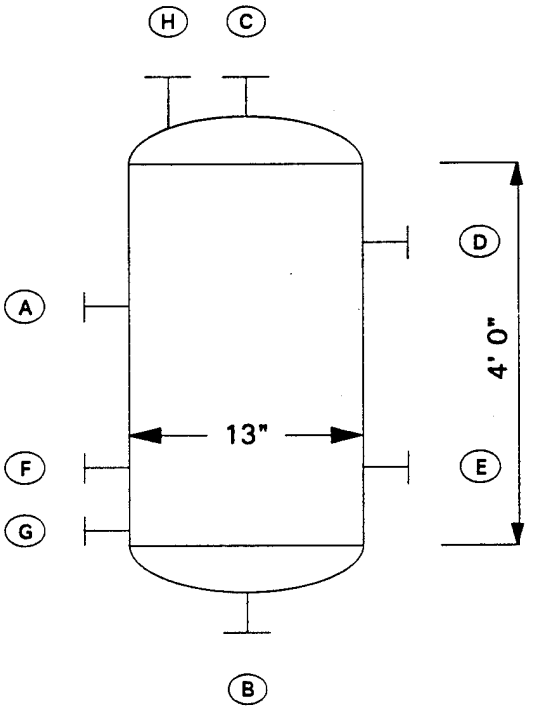
PROJECT NO.	DIVISION NO.
UJ41014	
EQUIPMENT NO.	REV.
C-101	0
SHEET 1 OF 1	

VERTICAL VESSEL DATA SHEET

Equipment Name:	**H. P. Separator**	
Total Number Required	1	
Design Data		
Max Operating Pressure	970	psia
Design Pressure	1070	psia
Max Operating Temperature	104	°F
Design Temperature	155	°F
Corrosion Allowance		in.
Radiography	Per ASME Code	
Stress Relieved		
Code	ASME Code (Latest Edition)	
Estmated Weight (Empty)		lb
Material Specification		
Shell -	316SS	
Internals -	Note (1)	
Lining -		
Supports -		
Insulation -	Personnel Protection	

Nozzle Schedule

Nozzle	Mark No.	Qty.	Size, in.	Rating
Inlet	A	1	0.75 in.	600# RF
Liquid Outlet	B	1	0.50 in.	600# RF
Vapor Outlet	C	1	0.75 in.	600# RF
Level Transmitter	D	1	1.50 in	600# RF
Level Transmitter	E	1	1.50 in	600# RF
Level Switch	F	1	1.0 in.	600# RF
Hand Hole	G	1	6.0 in.	600# RF
Relief Valve	H	1	1.0 in.	600# RF



Remarks:

1. Vortex breaker at liquid outlet to be provided.
2. Ellipsoidal heads.
3. Final complete data sheet subjected to Kenox approval.

PROJECT:						KENOX	PROJECT NO.	DIVISION NO.
IT Corporation - TNT Red Water							UJ41014	
							EQUIPMENT NO.	REV.
						CLIENT: IT Corporation	D-101	1
1	12/21/94	NOZZLE 'H' ADDED	BM			LOCATION:		
0	11/16/94	For Quotation	BM				SHEET 1 OF 1	
NO.	DATE	REVISION	BY	CHK.	APP.			

VERTICAL VESSEL DATA SHEET

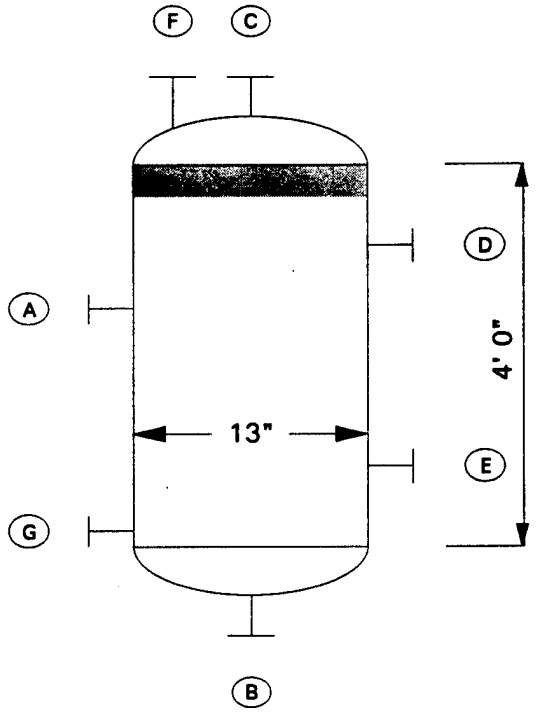
Equipment Name: L. P. Separator
Total Number Required 1

Design Data		
Max Operating Pressure	50	psia
Design Pressure	75	psia
Max Operating Temperature	107	°F
Design Temperature	160	°F
Corrosion Allowance		in.
Radiography	Per ASME Code	
Stress Relieved		
Code	ASME Code (Latest Edition)	
Estmated Weight (Empty)		lb

Material Specification	
Shell -	316SS
Internals -	Note (1,2)
Lining -	
Supports -	
Insulation -	Personnel Protection

Nozzle Schedule

Nozzle	Mark No.	Qty.	Size, in.	Rating
Inlet	A	1	0.50 in.	150# RF
Liquid Outlet	B	1	0.50 in.	150# RF
Vapor Outlet	C	1	0.50 in.	150# RF
Level Transmitter	D	1	1.50 in	150# RF
Level Transmitter	E	1	1.50 in	150# RF
Relief Valve	F	1	0.50 in.	150# RF
Hand Hole	G	1	6.0 in.	150# RF



Remarks:

1. Vortex breaker at liquid outlet to be provided.
2. Ellipsoidal heads.
3. Demister at vapor outlet to be provided.
4. Final complete data sheet subjected to Kenox approval.

PROJECT: IT Corporation - TNT Red Water

KENOX

PROJECT NO.	DIVISION NO.
UJ41014	
EQUIPMENT NO.	REV.
D-102	0

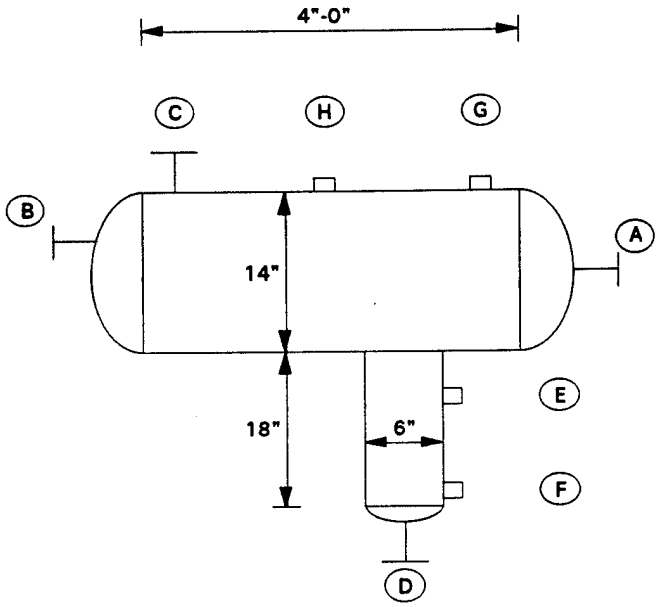
CLIENT: IT Corporation
LOCATION:

SHEET 1 OF 1

NO.	DATE	REVISION	BY	CHK.	APP.
0	11/16/94	For Quotation	BM		

HORIZONTAL VESSEL DATA SHEET

Equipment Name:	Air Accumulator		
Total Number Required	1		
Design Data			
Max Operating Pressure	1050		psia
Design Pressure	1160		psia
Max Operating Temperature	255	(1)	°F
Design Temperature	310	(1)	°F
Corrosion Allowance			in.
Radiography	Per ASME Code		
Stress Relieved			
Code	ASME Code (Latest Edition)		
Estmated Weight (Empty)			lb
Material Specification			
Shell -	Carbon Steel		
Internals -	None		
Lining -	None		
Supports -			
Insulation -	Heat Conservation		



Nozzle Schedule

Nozzle	Mark No.	Qty.	Size, in.	Rating
Inlet	A	1	0.75 in.	600# RF
Outlet	B	1	0.75 in.	600# RF
Safety Valve	C	1	0.75 in.	600# RF
Drain	D	1	0.75 in.	600# RF
Level Gauge	E	1	1.0 in.	3000# NPT
Level Gauge	F	1	1.0 in.	3000# NPT
Pressure Gauge	G	1	0.75 in.	3000# NPT
Temperature Gauge	H	1	1.0 in.	3000# NPT

Remarks:

1. To be verified with air compressor vendor.
2. Ellipsoidal heads.
3. Final complete data sheet subjected to Kenox approval.

PROJECT:						KENOX	PROJECT NO.	DIVISION NO.
IT Corporation - TNT Red Water							UJ41014	
							EQUIPMENT NO.	REV.
						CLIENT: IT Corporation	D-103	0
0	11/21/94	For Quotation		BM		LOCATION:		
NO.	DATE	REVISION		BY	CHK. APP.		SHEET 1 OF 1	

VERTICAL VESSEL DATA SHEET

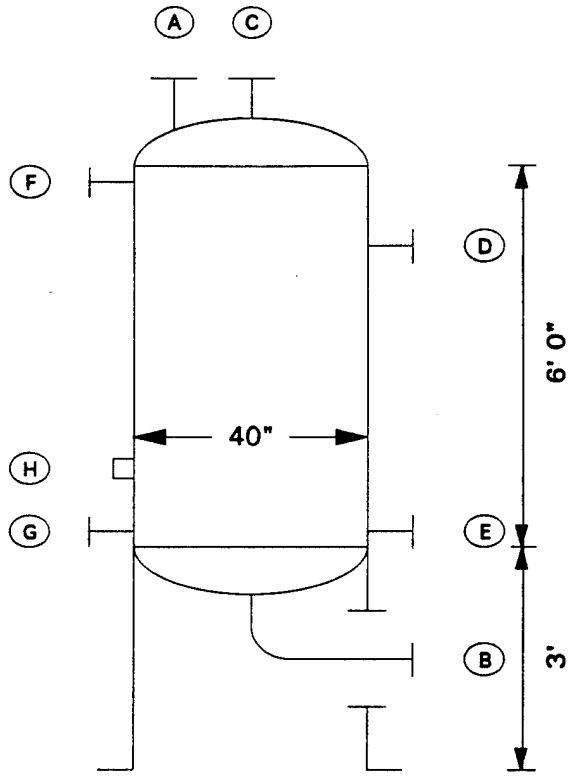
Equipment Name: Feed Drum
Total Number Required 1

Design Data		
Max Operating Pressure	15	psia
Design Pressure	30	psia
Max Operating Temperature	85	°F
Design Temperature	135	°F
Corrosion Allowance		in.
Radiography	Per ASME Code	
Stress Relieved		
Code	ASME Code (Latest Edition)	
Estmated Weight (Empty)		lb

Material Specification	
Shell -	316SS
Internals -	Note (1)
Lining -	
Supports -	Carbon Steel (skirt)
Insulation -	No

Nozzle Schedule

Nozzle	Mark No.	Qty.	Size, in.	Rating
Inlet	A	1	0.50 in.	150# RF
Outlet & Drain	B	1	1.0 in.	150# RF
Vent	C	1	1.0 in.	150# RF
Level Gauge	D	1	1.50 in	150# RF
Level Gauge	E	1	1.50 in	150# RF
Level Switch	F	1	1.0 in.	150# RF
Hand Hole	G	1	8.0 in.	150# RF
Sample Point	H	1	0.75 in.	3000# NPT



Remarks:

1. Vortex breaker at liquid outlet to be provided.
2. Ellipsoidal heads.
3. Final complete data sheet subjected to Kenox approval.

PROJECT: IT Corporation - TNT Red Water

KENOX

PROJECT NO.	DIVISION NO.
UJ41014	
EQUIPMENT NO.	REV.
D-104	1

CLIENT: IT Corporation
LOCATION:

SHEET 1 OF 1

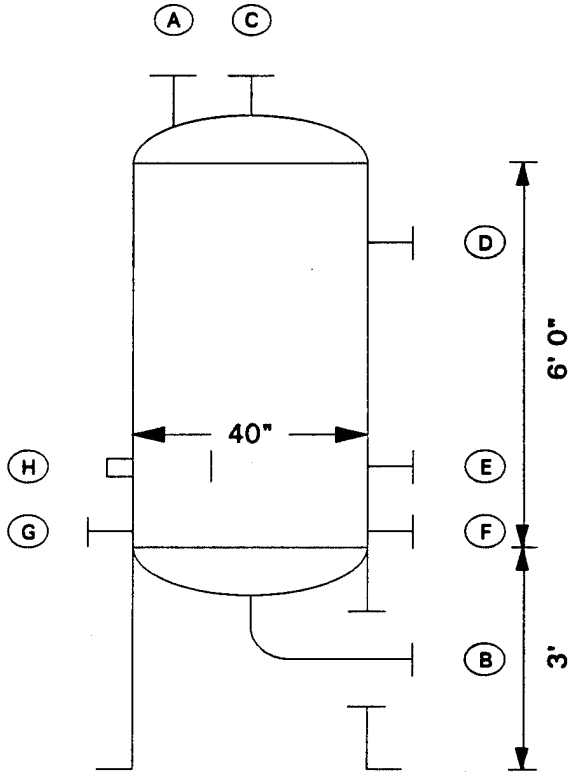
NO.	DATE	REVISION	BY	CHK.	APP.
1	12/22/94	Nozzle 'H' added	BM		
0	11/16/94	For Quotation	BM		

VERTICAL VESSEL DATA SHEET

Equipment Name:	**WAO Effluent Drum**	
Total Number Required	1	
Design Data		
Max Operating Pressure	15	psia
Design Pressure	30	psia
Max Operating Temperature	107	°F
Design Temperature	160	°F
Corrosion Allowance		in.
Radiography	Per ASME Code	
Stress Relieved		
Code	ASME Code (Latest Edition)	
Estmated Weight (Empty)		lb
Material Specification		
Shell -	316SS	
Internals -	Note (1)	
Lining -		
Supports -	Carbon Steel (skirt)	
Insulation -	No	

Nozzle Schedule

Nozzle	Mark No.	Qty.	Size, in.	Rating
Inlet	A	1	0.50 in.	150# RF
Outlet & Drain	B	1	1.0 in.	150# RF
Vent	C	1	1.0 in.	150# RF
Level Gauge	D	1	1.50 in	150# RF
Level Gauge	E	1	1.50 in	150# RF
Level Switch	F	1	1.0 in.	150# RF
Hand Hole	G	1	8.0 in.	150# RF
Sample Point	H	1	0.75 in.	3000# NPT



Remarks:

1. Vortex breaker at liquid outlet to be provided.
2. Ellipsoidal heads.
3. Final complete data sheet subjected to Kenox approval.

NO.	DATE	REVISION	BY	CHK.	APP.
1	12/21/94	Nozzle 'H' added	BM		
0	11/16/94	For Quotation	BM		

PROJECT: **IT Corporation - TNT Red Water**

KENOX

CLIENT: **IT Corporation**

LOCATION:

PROJECT NO.	DIVISION NO.
UJ41014	
EQUIPMENT NO.	REV.
D-105	1
SHEET 1 OF 1	

HEAT EXCHANGER DATA SHEET

E-101 REACTOR FEED/EFFLUENT EXCHANGER

Size	Type:	Double Pipe	(Horiz/Vert)	Horiz.	Connected In
Surf/Unit		Shells/Unit		Eff. Surf/Shell	ft2

PERFORMANCE OF ONE UNIT

			SHELL SIDE		TUBE SIDE	
Fluid Name			Oxidized Wastewater		Feed	
Fluid Quantity, Total		lb/h	2007		1544	
			IN	OUT	IN	OUT
Vapour		lb/h	1043	646		
Liquid		lb/h	964	1361	1544	1544
Steam		lb/h				
Water		lb/h				
Noncondensible		lb/h				
Temperature		°F	483	403	61	362
Density	Liquid/ Vapour + NC	lb/cf	53.00/2.52	55.45/3.01	66.67/	57.52/
Viscosity	Liquid/ Vapour + NC	cP	0.10/0.02	0.10/0.02	1.27/	0.10/
Molecular Weight	Liquid/ Vapour + NC					
Molecular Weight, Noncondensible						
Specific Heat	Liquid/ Vapour + NC	Btu/lb°F	1.19/0.44	1.08/0.33	0.91/	1.00/
ThermalConductivity	Liquid/ Vapour + NC	Btu/hrft-F	0.34/0.03	0.37/0.02	0.34/	0.38/
Latent Heat		Btu/lb				
Inlet Pressure		psia	990		1050	
Velocity		ft/s				
Pressure Drop, Allow/Calc		psi	10/		20/	
Fouling Resistance		hft2°F/Btu	0.002		0.002	

Heat Exchanged 430577 Btu/h ;MTD (Corrected) 213 °F

Transfer Rate Service Clean Btu/hft2°F

CONSTRUCTION OF ONE SHELL

		SHELL SIDE	TUBE SIDE	SKETCH
Design / Test Pressure	psig	1090/	1160/	
Design Temperature	°F	535	415	
No of Passes per Shell				
Corrosion Allowance	in			
Connection in (Size & Rating)		600#	600#	
Connection out (Size & Rating)		600#	600#	

Tube No ; OD	Thickn	Length	Pitch
Tube Type Plain		Material	Titanium
Shell Titanium ;ID	in; OD in	Shell Cover	(Integ.)
Channel or Bonnet		Channel Cover	
Tubesheet - St		Tubesheet - Fl	
Floating Head Cover		Impingement Protection	yes
Baffles - Cross	; Type Vert/Seg	; %Cut(Area)	; Spacing c/c in
Baffles - Long -		Seal Type	
Supports - Tube	U Bend	Type	
Bypass Seal Arrangement		Tube - Tubesheet Joint	
Expansion Joint		Type	
pv2 - Inlet Nozzle	-Bundle Entrance	- Bundle exit	
Gaskets - Shellside		- Tubeside	
- Floating Head			
Code	ASME Section VIII, Div I latest issue		
Weight/ Shell	Filled with Water	Bundle	Lb.

Remarks: (1) : Exchanger Vendor to confirm and supply all applicable information to fully complete data sheet.

(2): Material: Shellside = Titanium; Tubeside = Titanium

NO.	DATE	REVISIONS	BY	CHK.	APP.
0	94/11/21	Initial	BM		

PROJECT:
IT Corporation - TNT Redwater

KENOX

CLIENT:
IT Corporation

LOCATION:

PROJECT NO.	DIVISION NO.
UJ41014	
EQUIPMENT SPEC. NO.	REV.
E-101	0
SHEET 1 OF 1	

ELECTRIC HEATER

Equipment Name		**Reactor Feed Heater**			
Line, Size / Spec.		0.5 in. / 660			
Duty, KW:		95			
Fluid Name		TNT Red Water			
Fluid Quantity, Total	lb/hr	772			
Vapour	lb/hr				
Liquid	lb/hr	772			
Steam	lb/hr				
Water	lb/hr				
Noncondensible	lb/hr				
Temperature	Deg F	In: 61		Out: 480	
Inlet Pressure	psia	1050	Allowable Pressure Drop, psi:		20
Specific Gravity		1.07			
Viscosity, Liquid	cp	1.28			

CONSTRUCTION

Design Pressure ,psia		1160		
Design Temperature , Deg F		530		
Flange Size, in:			Rating:	
Material, Shell:	Titanium	Note (7)	Element:	Ti, non-direct contact. See Note (4).
Voltage				
Wattage				
Length, mm				
Wall Sheath thickness, mm				
Welded Elements :				
Built-in Thermostat well - Note 5	☐	No	☒	Yes, Length,mm: I.D.,mm :
Vented or Stilted Housings required				
Built-in Thermocouples				
Passivated sheet required ?				
Moisture resistant terminal housing required?				
Code				
Class:	I & II	Division : 1		Group :
Manufacturer:				
Model Number:				

Remarks:

1) Equipment vendor to insert all applicable data to fully complete data sheet.
2) Final data sheet is subject to Kenox approval.
3) Auto ignition temperature 295 to 330 deg C.
4) Heating elements to be capsulated so that process fluid does not come in contact with the elements.
5) Vendor to supply temperature trip on power supply for element high temperatures.
6) Operation of the heater will be intermittent.
7) Shell to be supplied by Kenox.

NO.	DATE	REVISION	BY	CHK.	APP.
0	11/22/94	For Quotation	BM		

PROJECT: **IT Corporation - TNT redwater**

KENOX

CLIENT: **IT Corporation**

LOCATION:

PROJECT NO.	DIVISION NO.
UJ41014	
EQUIPMENT NO.	REV.
E-102	0
SHEET 1 OF 1	

HEAT EXCHANGER DATA SHEET

Equipment Name	**EFFLUENT COOLER**				
	Type: Double Pipe	(Horiz/Vert)	HORIZ	Connected In	
Surf/Unit	ft2 Shells/Unit			Eff. Surf/Shell	ft2

PERFORMANCE OF ONE UNIT

			SHELL SIDE		TUBE SIDE	
Fluid Name			Cooling Water		Oxidized Waste Water	
Fluid Quantity, Total		lb/h	33935		2007	
			IN	OUT	IN	OUT
Vapour		lb/h			646	516
Liquid		lb/h			1361	1491
Steam		lb/h				
Water		lb/h	33935	33935		
Noncondensible		lb/h				
Temperature		°F	68	86	403	104
Density	Liquid/ Vapour + NC	lb/cf	63.13	62.66	55.45/3.01	64.66/5.18
Viscosity	Liquid/ Vapour + NC	cP	1	0.797	0.1/0.02	0.76/0.02
Molecular Weight	Liquid/ Vapour + NC					
Molecular Weight, Noncondensible						
Specific Heat	Liquid/ Vapour + NC	Btu/lb°F	0.97	0.97	1.078/0.331	0.946/0.27
ThermalConductivity	Liquid/ Vapour + NC	Btu/hrft-F	0.349	0.357	0.374/0.023	0.359/0.017
Latent Heat		Btu/lb				
Inlet Pressure		psia	60		980	
Velocity		ft/s				
Pressure Drop, Allow/Calc		psi	10/		10/	
Fouling Resistance		hft2°F/Btu	0.001		0.002	

Heat Exchanged	588919	Btu/h	;MTD (Corrected)	129	°F
Transfer Rate	Service		Clean		Btu/hft2°F

CONSTRUCTION OF ONE SHELL

		SHELL SIDE	TUBE SIDE	SKETCH
Design / Test Pressure	psig	720/	1080/	
Design Temperature	°F	140	455	
No of Passes per Shell				
Corrosion Allowance	in			
Connection in (Size & Rating)		600#	600#	
Connection out (Size & Rating)		600#	600#	

Tube No	; OD	Thickn	Length	Pitch	in
Tube Type	Plain		Material	Titanium	
Shell	Carbon Steel ;ID	in; OD in	Shell Cover	Carbon Steel	(Integ.)
Channel or Bonnet			Channel Cover		
Tubesheet - Stationary			Tubesheet - Floating		
Floating Head Cover			Impingement Protection	yes	
Baffles - Cross	; Type		; %Cut(Area)	; Spacing c/c	in
Baffles - Long	-		Seal Type		
Supports - Tube	U Bend		Type		
Bypass Seal Arrangement			Tube - Tubesheet Joint		
Expansion Joint			Type		
pv2 - Inlet Nozzle	-Bundle Entrance		- Bundle exit		
Gaskets -	Shellside		- Tubeside		
-	Floating Head				
Code	ASME Section VIII, Div I latest issue		; TEMA Class ,	R	
Weight/ Shell	Filled with Water		Bundle		Lb.

Remarks: (1) : Exchanger Vendor to confirm and supply all applicable information to fully complete data sheet.
(2): Material: Shellside = Carbon Steel; Tubeside = Titanium

PROJECT: **IT Corporation - TNT Redwater**						**KENOX**	PROJECT NO. **UJ41014**	DIVISION NO.
							EQUIPMENT SPEC. NO.	REV.
						CLIENT: **IT Corporation**	**E-103**	
0	11/21/94	Initial	BM			LOCATION:		
NO.	DATE	REVISIONS	BY	CHK.	APP.		SHEET 1 OF 1	

CENTRIFUGAL PUMP DATA SHEET

Equipment Name P-101 - Waste Feed Pump
Total Number Required One

Design Data					Motor				
Service	Raw Wastewater				Motor hp				
Erosion/Corrosion					Volts 460 Phase 3 Hertz 60				
		Min.	Norm	Max.	Electrical Classification Class I & II; Div. 1				
Pump Temperature	F		60						
Specific Gravity			1.08						
Viscosity	cP		1.2078						
Vapour Pressure	psia		14.7		**Turbine**				
Flow Rate	lb/hr		772		Inlet Steam Temp.				F
Solids Percent	Notes 2 & 3	15		30	Inlet Steam Pressure				psia
Pressure for Max. Flow					Exhaust Steam Temp				F
Suction Press.			16	psia	Exhaust Steam Pressure				psia
Discharge Pressure			46	psia					
Diff. Press.			30	psi					
Diff.Head			64	ft					
Min. NPSHA			5	ft					
Hyd hp	0.04 bhp								
Materials					**Pump Connections**				
API Spec 610					Suction Size , Rating Cl. 3000 NPT				
Case			316SS		Discharge Size , Rating Cl. 3000 NPT				
Shaft			316SS						
Impeller			316SS						
Packing Type									
Mechanical Seal Type									

Remarks: 1) Supplier to insert all applicable data to fully complete the data sheet.
2) Total Suspended Solids: 1% maximum.
3) Consider solids abrasive.

NO.	DATE	REVISION	BY	CHK.	APP.
0	11/11/94	For Quotation	BM		

PROJECT: **IT Corporation - TNT Redwater**

KENOX

CLIENT: **IT Corporation**
LOCATION:

PROJECT NO.	DIVISION NO.
UJ41014	
EQUIPMENT NO.	REV.
P-101	0
SHEET 1 OF 1	

CENTRIFUGAL PUMP DATA SHEET

Equipment Name P-102 - Dilution Feed Pump

Total Number Required One

Design Data				
Service	Service Water			
Erosion/Corrosion				
		Min.	Norm	Max.
Pump Temperature	F		60	
Specific Gravity			1.015	
Viscosity	cP		1.1197	
Vapour Pressure	psia		14.7	
Flow Rate	lb/hr/GPM		1544/3	
Solids Percent			0	

Pressure for Max. Flow		
Suction Press.	16	psia
Discharge Pressure	46	psia
Diff. Press.	30	psi
Diff.Head	68	ft
Min. NPSHA	5	ft
Hyd hp	0.07 bhp	

Materials	
API Spec 610	
Case	316SS
Shaft	316SS
Impeller	316SS
Packing Type	
Mechanical Seal Type	

Motor					
Motor hp					
Volts	460	Phase	3	Hertz	60
Electrical Classification	Class I & II; Div. 1				

Turbine	
Inlet Steam Temp.	F
Inlet Steam Pressure	psia
Exhaust Steam Temp	F
Exhaust Steam Pressure	psia

Pump Connections		
Suction Size	, Rating	Cl. 3000 NPT
Discharge Size	, Rating	Cl. 3000 NPT

Remarks: 1) Supplier to insert all applicable data to fully complete the data sheet.

PROJECT: **IT Corporation - TNT Redwater**

KENOX

PROJECT NO.	DIVISION NO.
UJ41014	
EQUIPMENT NO.	REV.
P-102	0

CLIENT: **IT Corporation**

LOCATION:

SHEET 1 OF 1

NO.	DATE	REVISION	BY	CHK.	APP.
0	11/11/94	For Quotation	BM		

POSITIVE DISPLACEMENT PUMP DATA SHEET

Equipment Name P-103 High Pressure Feed Pump
Total Number Required One

Design Data					
Service	Raw Waste Water				
Erosion/Corrosion					
		Min.	Norm	Max.	
Pump Temperature	F		60		
Specific Gravity			1.065		
Viscosity	cP		1.206		
Vapour Pressure	psia		14.7		
Flow Rate	lb/hr		1544		
Solids Percent	Notes 2 & 3	15		30	

Pressure for Max. Flow		
Suction Press.	20	psia
Discharge Pressure	1050	psia
Diff. Press.	1030	psi
Diff.Head	2224	ft
Min. NPSHA	5	ft
Hyd hp 2.3 bhp		

Materials	
Displacement Chamber	316SS
Casing	316SS
Plunger Piston	
Diaphragm	
Check valves & Seats	316SS
Shaft	
Packing Type	
Mechanical Seal Type	

Motor	
Motor hp	
Volts 460 Phase 3 Hertz 60	
Electrical Classification	Class I, II Div.1
Variable Speed Drive Required:	Yes

Turbine	
Inlet Steam Temp.	F
Inlet Steam Pressure	psia
Exhaust Steam Temp	F
Exhaust Steam Pressure	psia

Pump Connections	
Suction Size	in.
Discharge Size	in.

Notes:

1) Supplier to insert all applicable data to fully complete the data sheet.
2) Total Suspended Solids: 1 % maximum.
3) Consider solids abrasive.

NO.	DATE	REVISION	BY	CHK.	APP.
0	11/11/94	For Quotation	BM		

PROJECT: **IT Corporation - TNT Redwater**

KENOX

CLIENT: **IT CORPORATION**

LOCATION:

PROJECT NO.	DIVISION NO.
UJ41014	
EQUIPMENT NO.	REV.
P-103	0

SHEET 1 OF 1

CENTRIFUGAL PUMP DATA SHEET

Equipment Name P-105 - Final Effluent Pump
Total Number Required One

Design Data					Motor				
Service	Oxidized Wastewater				Motor hp				
Erosion/Corrosion					Volts	460 Phase	3	Hertz	60
		Min.	Norm	Max.	Electrical Classification		Class I & II; Div. 1		
Pump Temperature	F		107						
Specific Gravity			1.03						
Viscosity	cP		0.733						
Vapour Pressure	psia		25		**Turbine**				
Flow Rate	lb/hr	772		1544	Inlet Steam Temp.				F
Solids Percent	Notes 2 & 3	15		30	Inlet Steam Pressure				psia
Pressure for Max. Flow					Exhaust Steam Temp				F
Suction Press.			18	psia	Exhaust Steam Pressure				psia
Discharge Pressure			53	psia					
Diff. Press.			35	psi					
Diff.Head			78	ft					
Min. NPSHA			5	ft					
Hyd hp	0.08 bhp								

Materials		Pump Connections		
API Spec 610		Suction Size	, Rating	Cl. 3000 NPT
Case	316SS	Discharge Size	, Rating	Cl. 3000 NPT
Shaft	316SS			
Impeller	316SS			
Packing Type				
Mechanical Seal Type				

Remarks:
1) Supplier to insert all applicable data to fully complete the data sheet.
2) Total Suspended Solids: 1% maximum.
3) Consider solids abrasive.

PROJECT:						KENOX	PROJECT NO.	DIVISION NO.
IT Corporation - TNT Redwater							**UJ41014**	
							EQUIPMENT NO.	REV.
						CLIENT:		
						IT Corporation	**P-105**	0
0	11/11/94	For Quotation	BM			LOCATION:		
NO.	DATE	REVISION	BY	CHK.	APP.		SHEET 1 OF 1	

SECTION 6.0.

UTILITY CONSUMPTION

6.0. UTILITY CONSUMPTION

6.1. ELECTRICAL

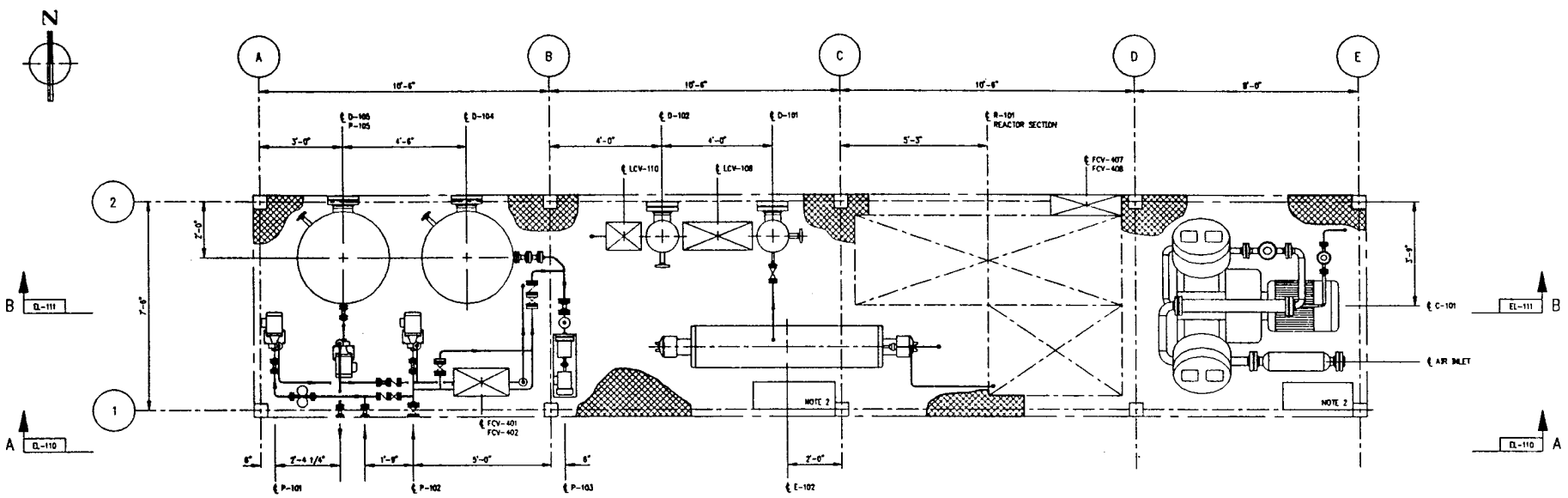
• Waste Feed Pump, KW	0.5
• Dilution Feed Pump, KW	0.5
• High Pressure Feed Pump, KW	1.6
• Final Effluent Pump, KW	0.75
• Air Compressor, KW	60
• Electric Heater, KW	95
• Reactor Section, KW	4

6.2. COOLING WATER

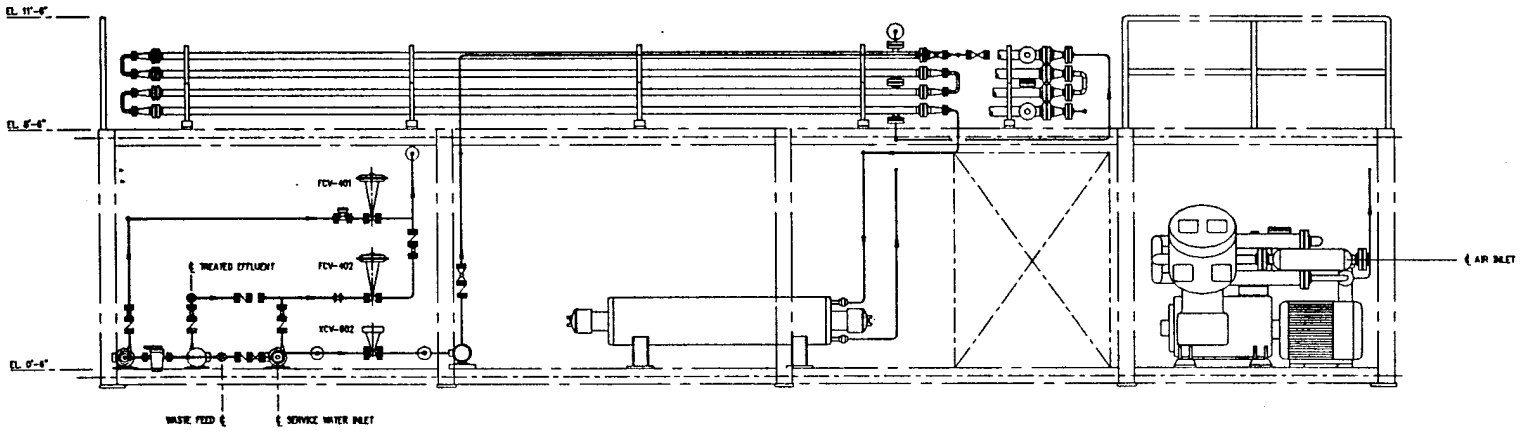
• Effluent Cooler, USGPM	68
• Air Compressor, USGPM	12
• Reactor Section, USGPM	15

SECTION 7.0.

GENERAL ARRANGEMENT DRAWINGS



PLAN VIEW (EL. 8'-6")



ELEVATION A-A

NOTES:

1. PIPING ARRANGEMENT ILLUSTRATES PROCESS AND COMPRESSED AIR PIPING ONLY, SPECIFICALLY TO ASSIST IN DETERMINING THE BEST SUITED LOCATIONS FOR EQUIPMENT AND C.V. SETS. VENTS, DRAINS AND UTILITY PIPING ARE NOT SHOWN.
2. ELECTRICAL PANELS FOR E-102 & C-101, NOT SHOWN ON ELEV. A-A FOR CLARITY.
3. UPPER LEVEL HAND RAIL IS DISCONTINOUS ALONG COLUMN LINE 1.

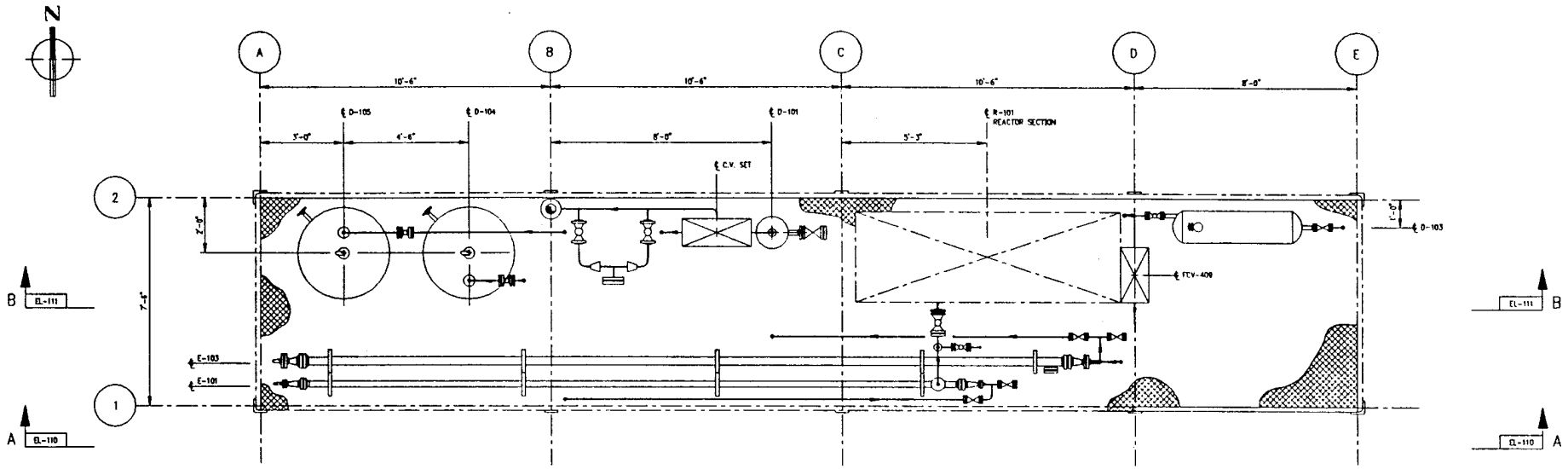
rev no.	date	particulars	dsn'r	chkd	appd
0	DEC. 21 1994	PRELIMINARY - CONCEPTUAL DESIGN			

KENOX CORPORATION

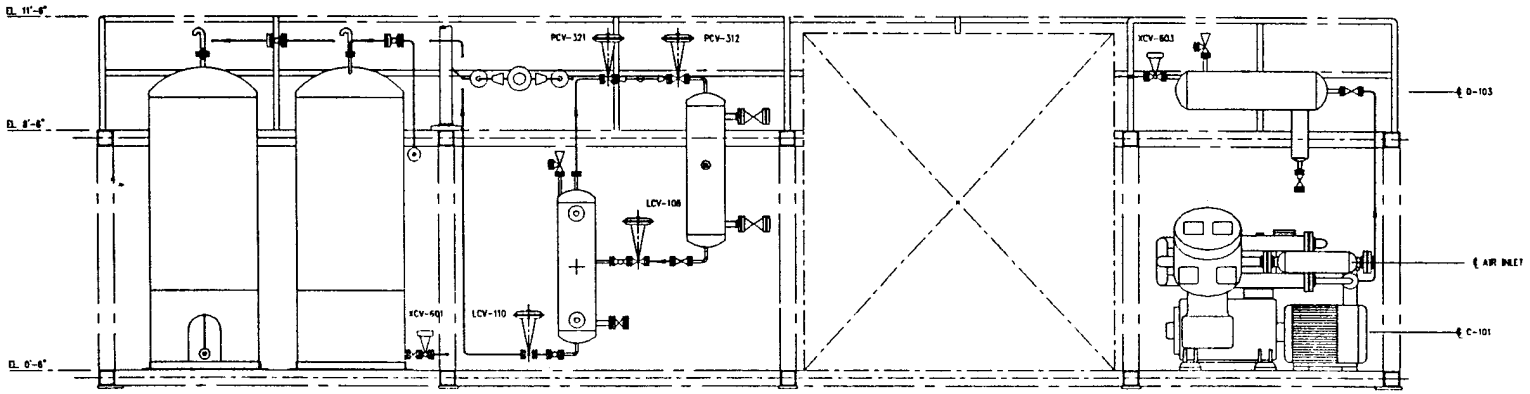
EQUIPMENT LAYOUT (ELEVATION 8'-6")
USAEC RED WATER TREATMENT TECHNOLOGY
TEST PLAN AND SITE PREPARATION PROJECT

designed by:	drawn by:	checked by:
B.W.	B.W.	B. MOLL
scale: NONE	date of issue: DEC. / 1994	chkd:	appd: BAW
project no.: 941014	dwg no.: 941014-EL-110	rev. 0

CAD REF.: ITEL110ALD.WC



PLAN VIEW (EL. 11'-6")



ELEVATION B-B

NOTES:

1. PIPING ARRANGEMENT ILLUSTRATES PROCESS AND COMPRESSED AIR PIPING ONLY, SPECIFICALLY TO ASSIST IN DETERMINING THE BEST SUITED LOCATIONS FOR EQUIPMENT AND C.V. SETS. VENTS, DRAINS AND UTILITY PIPING ARE NOT SHOWN.
2. UPPER LEVEL HAND RAIL IS DISCONTINOUS ALONG COLUMN LINE 1.

rev no.	date		drawn	appd
0	DEC 31 1994	PRELIMINARY – CONCEPTUAL DESIGN		

KENOX CORPORATION

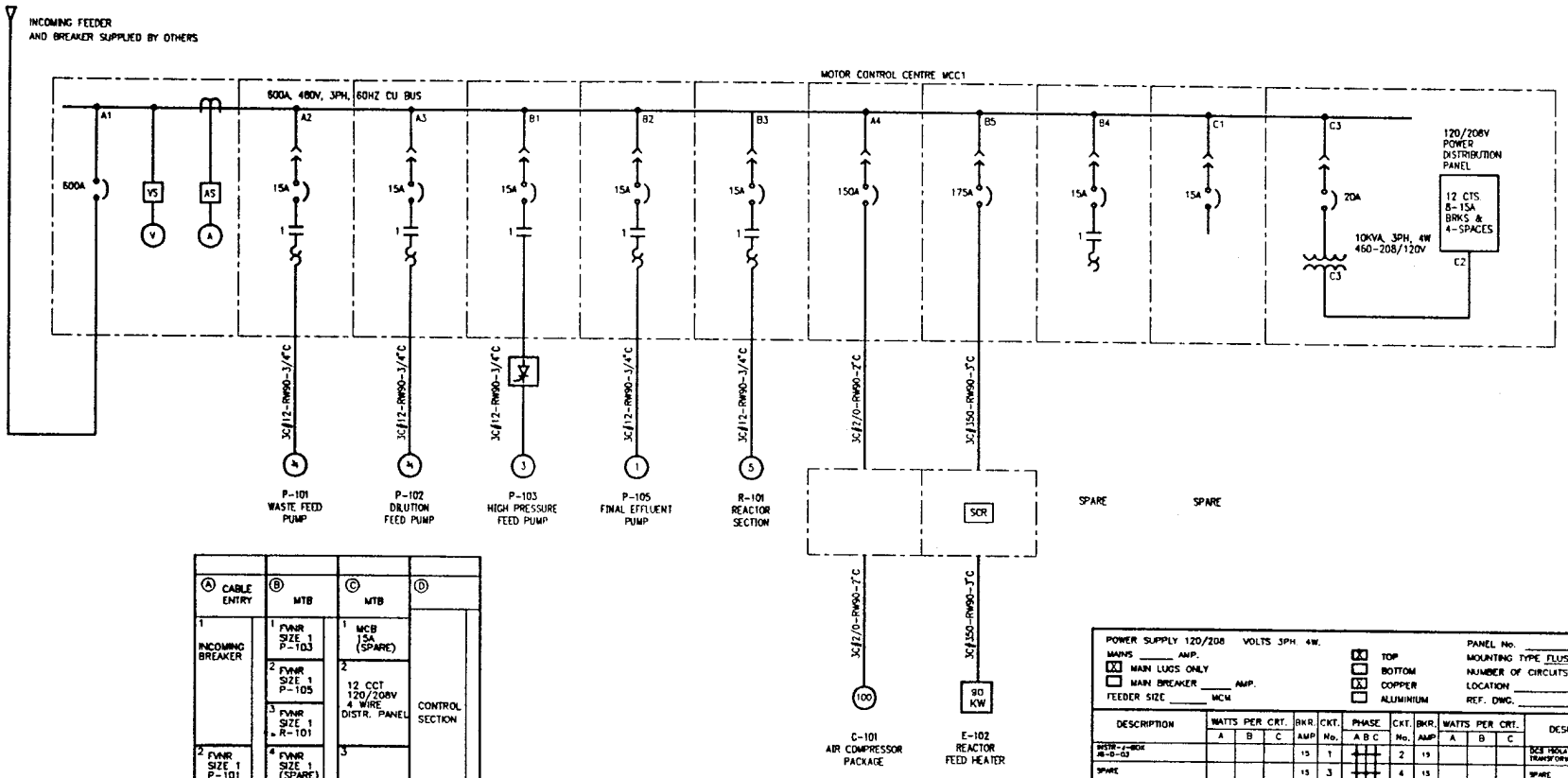
EQUIPMENT LAYOUT (ELEVATION 11'-6")
USAEC RED WATER TREATMENT TECHNOLOGY
TEST PLAN AND SITE PREPARATION PROJECT

designed by:	drawn by:	checked by:	
B.W.	B.W.	B. MOLL	
scale: NONE	date of issue: DEC. / 1994	resp.	appd: BAW
project no.: 941014	dwg no.: 941014-EL-111		rev.: 0

CAD REF - STELTECH DWG

SECTION 8.0.

ELECTRICAL ONE LINE DRAWING



Ⓐ CABLE ENTRY	Ⓑ MTB	Ⓒ MTB	Ⓓ
1 INCOMING BREAKER	1 FVNR SIZE 1 P-103	1 MCB 15A (SPARE)	CONTROL SECTION
2 FVNR SIZE 1 P-101	2 FVNR SIZE 1 P-105	2 12 CCT 120/208V 4 WIRE DISTR. PANEL	
3 FVNR SIZE 1 P-102	3 FVNR SIZE 1 R-101	3 MCB 20A	
4 MCB 150A C-101	4 FVNR SIZE 1 (SPARE)		
	5 MCB 175A E-102	10 KVA TRANSF. 460 120/208	

MCC-ELEVATION

POWER SUPPLY 120/208 VOLTS 3PH. 4W.
MAINS ____ AMP.
☒ MAIN LUGS ONLY
☐ MAIN BREAKER ____ AMP.
FEEDER SIZE ____ MCM

☒ TOP ☐ BOTTOM ☒ COPPER ☐ ALUMINIUM

PANEL No. ____
MOUNTING TYPE FLUSH IN MCC
NUMBER OF CIRCUITS 8@15A, 4 SP
LOCATION ____
REF. DWG. ____

DESCRIPTION	WATTS PER CRT. A	B	C	BKR. AMP	CKT. No.	PHASE A B C	CKT. No.	BKR. AMP	WATTS PER CRT. A	B	C	DESCRIPTION
DISTR.-PANEL 45-D-03				15	1		2	15				SCR HOLDING TRANSFORMER 5KVA
SPARE				15	3		4	15				SPARE
SPARE				15	5		6	15				SPARE
SPARE				15	7		8	15				SPARE
SPACE					9		10					SPACE
SPACE					11		12					SPACE

NOTES :

TOTAL PHASE 'A'	WATTS
TOTAL PHASE 'B'	WATTS
TOTAL PHASE 'C'	WATTS
TOTAL LOAD	WATTS

120/208 POWER DISTRIBUTION PANEL SCHEDULE

GENERAL NOTES:

1. ALL CONDUIT SHALL BE RIGID GALVANIZED STEEL WITH A MINIMUM SIZE 3/4" UNLESS OTHERWISE NOTED.
2. ALL SINGLE CONDUCTER CABLES SHALL BE STRANDED COPPER, XLPE RW90.
3. MINIMUM SIZE FOR POWER CABLE SHALL BE #12AWG UNLESS OTHERWISE NOTED.
4. MINIMUM SIZE FOR CONTROL CABLE SHALL BE #14AWG UNLESS OTHERWISE NOTED.
5. MOTOR CONTROL CENTRE SHALL BE FREE STANDING EEMAC 1A FULLY GASKETED.
6. THE ASSEMBLY SHALL BE EEMAC CLASS II TYPE "C" WIRING.
7. EACH STARTER SHALL BE FVNR, SINGLE SPEED, 3PHASE, 60HZ, WITH MOTOR CIRCUIT PROTECTORS (MCP).
8. MAGNETIC CONTACTOR COIL SHALL BE RATED 120VAC WITH THREE(3) THERMAL OVERLOAD DEVICES HAVING TEMPERATURE COMPENSATED HEATERS AND CONTROL TRANSFORMERS 460-120V, 1 PHASE, 60HZ, WITH RATING OF 50VA ABOVE STANDARD.
9. EEMAC SIZE 1 STARTERS SHALL BE ACCEPTED AS MINIMUM.
10. ALL FEEDER BREAKERS SHALL BE 460V, 3PHASE, 60HZ, 3POLE, THERMAL MAGNETIC.
11. ALL BUSES AND CURRENT CARRYING PARTS SHALL BE COPPER, BRACED FOR MINIMUM 40000AMPS R.M.S., SYMETRICAL ON SHORT CIRCUIT.

LEGEND:

- DISCONNECT DEVICE FOR DRAWOUT EQUIPMENT
- CIRCUIT BREAKER MANUALLY OPERATED
- 1 FULL VOLTAGE NON-REVERSING COMBINATION STARTER NUMERAL INDICATES STARTER SIZE
- THERMAL ELEMENT
- DISCONNECT SWITCH
- (3) 3PHASE S.C. INDUCTION MOTOR NUMERAL INDICATES H.P. RATING
- (40 KW) EQUIPMENT, NUMERAL INDICATES KW RATING
- VARIABLE FREQUENCY CONTROLLER
- CL CURRENT LIMIT FUSE

rev no.	date	particulars	dsn	chkd	appd
0	DEC 9 1994	PRELIMINARY			

KENOX CORPORATION

SINGLE LINE DIAGRAM

USAEC RED WATER TREATMENT TECHNOLOGY
TEST PLAN AND SITE PREPARATION PROJECT

designed by:	drawn by:	checked by:
B.W	B.W	T. LE
scale: NONE	date of issue: DEC. / 1994	resp.	appd. BAW
project no.: 941014	dwg no.: 941014-E-120	rev. 0

CAD REF.: ITL120A.DWG

SECTION 9.0.

MASS & ENERGY BALANCE OUTPUTS

9.0. MASS & ENERGY BALANCE OUTPUTS

9.1. REACTION PATHWAYS

The process modelling of the mass and energy balances for a Kenox WAO plant treating red water assumed that dinitrotoluene sulfonated compounds constitute the major COD contributor in the red water. Reaction pathways used in the process model were based on those proposed by Phull (1992) from his experimental work on the wet air oxidation of 5-nitro-o-toluene sulfonic acid (NTSA), a sulfonated aromatic similar in structure to dinitrotoluene sulfonates.

Due to limited physical data available on DNTS, the following simplified sequence of reaction pathways were assumed: (1) removal of the sulfonic group from DNTS to form dinitrotoluene and sulfuric acid and (2) oxidation of the dinitrotoluene with oxygen to produce carbon dioxide, water and nitrogen. Mass balances for sulfur and nitrogen from Phull's kinetic experiments (1992) confirm the validity of the simplified reaction pathways. The experiments indicated sulfur initially present was almost stoichiometrically converted to sulfates. For the nitrogen balance, a significant amount of nitrogen was present in the reactor offgas with an absence of nitrite and nitrate in the aqueous phase.

Reaction 1:

$$CH_3C_6H_2(NO_2)_2SO_3H + H_2O \text{ -------> } CH_3C_6H_3(NO_2)_2 + H_2SO_4$$

(DNTS) **(dinitrotoluene)** **(sulfuric acid)**

Reaction 2:

$$CH_3C_6H_3(NO_2)_2 + 13/2\ O_2 \text{ -------> } 7CO_2 + 3H_2O + N_2$$

(dinitrotoluene)

Experimental data reported in Phull's dissertation (1992), predict a COD conversion in the 85% range at an oxidation reaction temperature of 485 deg F.

Recommended analyses to be conducted during the pilot plant test stage to confirm the effluent characteristics are documented in Section 13.

9.2. REACTOR PROCESS CONDITIONS

Process conditions assumed for the reactors in the process simulation model are: 484 deg F reaction temperature and 1000 psia operating pressure. The raw red water feed needed to be diluted to 6% to prevent excessive evaporation in the reactors resulting from the exothermic heat of reaction released during the oxidation reaction.

SECTION 9.3.

MASS & ENERGY BALANCE OUTPUT

USAEC - RED WATER: MASS & ENERGY BALANCE KENOX WAO

Hyprotech's Process Simulator HYSIM - Licensed to Kenox Corporation
Date 94/11/22 Version C2.50 Case Name TEST1000.SIM
Time 15:34:49 Prop Pkg PRSV

DESIGN BASE CASE: RAW RED WATER FEED @ 12% COD; DILUTED TO 6%

Stream		2	3	4	5	6
Description		FEED	FEED2	HPFEED1	OUTE101TS	INE101SS
Vapour frac.		0.0000	0.0000	0.0000	0.0000	0.4850
Temperature	F	60.0000*	59.7532	60.7666	361.8664	483.4641
Pressure	psia	25.0000*	25.0000	1050.0000*	1000.0000	990.0001
Molar Flow	lbmole/hr	36.8230	77.3206	77.3206	77.3206	94.8622
Mass Flow	lb/hr	772.0500*	1544.1000	1544.1000	1544.1000	2007.3319
LiqVol Flow	USGPM	1.4674	2.9672	2.9672	2.9672	4.1547
Enthalpy	Btu/hr	-588750.2051	-1.22435E+06	-1.21847E+06	-787902.3763	-78511.3665
Density	lb/ft3	67.4165	66.4393	66.6680	57.5167	4.6516
Mole Wt.		20.9665	19.9701	19.9701	19.9701	21.1605
Std Density	lb/ft3	67.4113	---	66.5454	66.5454	---
H2O	lb/hr	647.3350*	1367.7251	1367.7251	1367.7251	1390.5592
Nitrogen	lb/hr	0.0000*	0.0011	0.0011	0.0011	368.5172
Oxygen	lb/hr	0.0000*	0.0004	0.0004	0.0004	18.6829
CO2	lb/hr	0.0000*	0.2705	0.2705	0.2705	130.4247
H2SO4	lb/hr	43.6500*	90.6462	90.6462	90.6462	90.6747
35NitroToluel	lb/hr	81.0650*	85.4566	85.4566	85.4566	8.4732
Total:	lb/hr	772.0500*	1544.1000	1544.1000	1544.1000	2007.3319

USAEC - RED WATER: MASS & ENERGY BALANCE KENOX WAO

Hyprotech's Process Simulator HYSIM - Licensed to Kenox Corporation
Date 94/11/22 Version C2.50 Case Name TEST1000.SIM
Time 15:34:49 Prop Pkg PRSV

DESIGN BASE CASE: RAW RED WATER FEED @ 12% COD; DILUTED TO 6%

Stream No.		7	8	9	10	11
Description		OUTE101SS	OUTE103SS	WAOEFFLP	WAOEFF	RCYCLEFF
Vapour frac.		0.2531	0.1760	0.0004	0.0000	0.0000
Temperature	F	403.2996	104.0000*	106.7507	106.7507	106.7507*
Pressure	psia	980.0001	970.0000	50.0000*	25.0000	50.0000*
Molar Flow	lbmole/hr	94.8622	94.8622	78.1686	78.1346	40.4976*
Mass Flow	lb/hr	2007.3319	2007.3319	1490.9379	1489.5666	772.0500
LiqVol Flow	USGPM	4.1547	4.1547	2.8969	2.8936	1.4997
Enthalpy	Btu/hr	-509088.2830	-1.09800E+06	-1.16006E+06	-1.16021E+06	-601346.9909
Density	lb/ft3	8.3965	16.3581	54.8231	64.4474	64.4473
Mole Wt.		21.1605	21.1605	19.0734	19.0641	19.0641
Std Density	lb/ft3	---	---	---	65.6963	65.6963
H2O	lb/hr	1390.5592	1390.5592	1389.9085	1389.8936	720.3901*
Nitrogen	lb/hr	368.5172	368.5172	0.1698	0.0022	0.0011*
Oxygen	lb/hr	18.6829	18.6829	0.0237	0.0008	0.0004*
CO2	lb/hr	130.4247	130.4247	1.6878	0.5220	0.2705*
H2SO4	lb/hr	90.6747	90.6747	90.6747	90.6747	46.9962*
35NitroToluel	lb/hr	8.4732	8.4732	8.4732	8.4732	4.3916*
Total:	lb/hr	2007.3319	2007.3319	1490.9379	1489.5666	772.0500

Hyprotech's Process Simulator HYSIM - Licensed to Kenox Corporation
Date 94/11/22 Version C2.50 Case Name TEST1000.SIM
Time 15:34:49 Prop Pkg PRSV

DESIGN BASE CASE: RAW RED WATER FEED @ 12% COD; DILUTED TO 6%

Stream No.		12	15	16	17	18
Description		PRODUCT	OFFGAS1	OFFGAS	AIRTOTAL	AIRTOR101
Vapour frac.		0.0000	1.0000	1.0000	1.0000	1.0000
Temperature	F	106.7507	64.6701	64.7622	255.0000*	255.0000
Pressure	psia	50.0000	20.0000*	20.0000	1000.0000*	1000.0000
Molar Flow	lbmole/hr	37.6370	16.6936	16.7276	16.0624	8.0312
Mass Flow	lb/hr	717.5166	516.3940	517.7653	463.2300*	231.6150
LiqVol Flow	USGPM	1.3938	1.2578	1.2612	1.0704	0.5352
Enthalpy	Btu/hr	-558871.0148	62059.7502	62207.5463	78070.0490	39035.0245
Density	lb/ft3	64.4474	0.1101	0.1102	3.7205	3.7205
Mole Wt.		19.0641	30.9337	30.9528	28.8394	28.8394
Std Density	lb/ft3	65.6963	---	---	---	---
H2O	lb/hr	669.5046	0.6506	0.6655	0.0000*	0.0000
Nitrogen	lb/hr	0.0011	368.3473	368.5150	356.6871*	178.3435
Oxygen	lb/hr	0.0004	18.6592	18.6820	106.5429*	53.2715
CO2	lb/hr	0.2514	128.7369	129.9028	0.0000*	0.0000
H2SO4	lb/hr	43.6775	0.0000	0.0000	0.0000*	0.0000
35NitroToluel	lb/hr	4.0815	0.0000	0.0000	0.0000*	0.0000
Total:	lb/hr	717.5166	516.3940	517.7653	463.2300*	231.6150

Hyprotech's Process Simulator HYSIM - Licensed to Kenox Corporation
Date 94/11/22 Version C2.50 Case Name TEST1000.SIM
Time 15:34:49 Prop Pkg PRSV

DESIGN BASE CASE: RAW RED WATER FEED @ 12% COD; DILUTED TO 6%

Stream No.		19	20	21
Description		AIRTOR102	CWIN	CWOUT
Vapour frac.		1.0000	0.0000	0.0000
Temperature	F	255.0000	68.0000*	86.0000*
Pressure	psia	1000.0000	60.0000*	50.0000
Molar Flow	lbmole/hr	8.0312	1883.6746	1883.6746
Mass Flow	lb/hr	231.6150	33934.5875	33934.5875
LiqVol Flow	USGPM	0.5352	67.9084	67.9084
Enthalpy	Btu/hr	39035.0245	-2.77338E+07	-2.71449E+07
Density	lb/ft3	3.7205	63.1274	62.6571
Mole Wt.		28.8394	18.0151	18.0151
Std Density	lb/ft3	---	63.3284	63.3284
H2O	lb/hr	0.0000	33934.5874*	33934.5874
Nitrogen	lb/hr	178.3435	0.0000*	0.0000
Oxygen	lb/hr	53.2715	0.0000*	0.0000
CO2	lb/hr	0.0000	0.0000*	0.0000
H2SO4	lb/hr	0.0000	0.0000*	0.0000
35NitroToluel	lb/hr	0.0000	0.0000*	0.0000
Total:	lb/hr	231.6150	33934.5875	33934.5875

SECTION 10.0.

PILOT PLANT COST ESTIMATES

10.0. PILOT PLANT COST ESTIMATE

10.1. SCOPE OF KENOX SUPPLY

Kenox shall supply IT Corporation's client with the following services and equipment:

- Basic Process Engineering Design Package.
- Detailed engineering, procurement, manufacturing/fabrication and assembly of the total Kenox skid mounted system.
- Kenox' skid mounted system includes all equipment as per the equipment list in Section 4, fabrication and installation of piping within the skid battery limit and instrumentation.
- Separate trailer unit to contain DCS and MCC.
- All vessels and piping within the skid battery limits requiring insulation will be insulated.
- All electrical equipment and materials within the skid arrangement to be pre-installed and terminated at junction boxes.
- Operating and maintenance manuals.

10.2. SCOPE OF IT CORPORATION SUPPLY

IT Corporation or its client shall supply the following equipment and services:

- Foundation and drainage system to accommodate Kenox skid mounted system.
- All utility connections to and from Kenox system.
- Unpacking and locating the skid in the designated area.
- Electrical interconnecting wiring and conduit between skid mounted Kenox supplied junction boxes and Kenox supplied trailer unit.
- Power feed to Kenox disconnect switch at power distribution panel.
- Appropriate system registration with governing State authorities.

10.3. PURCHASE OPTION

The price for a fully operational skid mounted plant capable of treating TNT red water in a continuous operation at the rate of 3 USGPM delivered CIF Toronto, Ontario, Canada is $ 1,900,000 US - 5% + 15 %. This price is valid for 90 days from the date of this proposal.

The cost of shipment, insurance, transportation to IT Corporation or its client and all applicable federal and state taxes and permits will be on the account of the purchaser.

The price quoted includes the scope of supply by Kenox Corporation as outlined in Section 10.1.

10.4. LEASE OPTION

The cost schedule for the leasing option is outlined below:

- 4 equal payments of $225,000 US
- first payment due upon signing of the purchase order
- second payment due on delivery of the equipment to the site
- third payment due 90 days after delivery of the equipment to the site
- fourth payment due 120 days after delivery of the equipment to the site
- the cost of shipment, insurance, transportation to IT Corporation or its client and return to Kenox and all applicable federal and state taxes and permits will be on the account of the purchaser.
- operations and maintenance costs not included

The leasing cost and terms are valid for 90 days from the date of this proposal.

Kenox will be pleased to provide additional information, if required, at the time the contract is negotiated.

SECTION 11.0.

OPERATIONS & SAFETY CONSIDERATIONS

11.0. OPERATIONS & SAFETY CONSIDERATIONS

11.1. INTRODUCTION

This section presents a description of special health and safety precautions related to the operations and sampling of a Kenox Wet Air Oxidation system for the treatment of red water.

11.2. REGULATIONS AND GUIDELINES

All activitities conducted during the wet air oxidation of red water must be in compliance with applicable requirements of the following publications:

- 29 Code of Federal Regulations (CFR) 1926, Construction Industry, OSHA Safety and Health Standards
- 29 CFR 1910, General Industry OSHA Safety and Health Standards
- 29 CFR 1910.120, OSHA Final Rule dated March 6, 1989, "Hazardous Waste Operations and Emergency Response"
- NIOSH/OSHA/USCG/EPA, "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities,", October 1985
- American Conference of Government Industrial Hygienists (ACGIH), "Threshold Limit Values and Biological Exposure Indices", 1989 - 1990, or most current version
- U.S. Department of Health and Human Services, (DHHS) "NIOSH Sampling and Analytical Methods," DHHS (NIOSH) Publication 84-100
- ANSI, Emergency Eyewash and Shower Equipment, Z41.1 (1983)
- ANSI, Protective Footwear, Z358.1 (1981)
- ANSI, Practice for Occupational and Educational Eye and Face Protection, Z87.1 (1968)
- ASTM D4687, Vol. 11.04, Standard Guide for General Planning of Waste Sampling, ASTM, Philadelphia, PA.

11.3. EMERGENCY SHUTDOWN SYSTEM

The prime area of concern is the reaction of the excess oxygen in the reactor system with an inadvertent introduction of an excess of oxidizable chemicals or a material (such as a combination of copper, iron and cobalt) that could act as a catalyst and increase the rate of reaction. The rapid oxidation would result in an increase in the reaction temperature and a corresponding increase in pressure. However, the pressure increase would be mitigated by the pressure control valve PCV-312 opening in response to the pressure surge.

The system is equipped with two levels of alarm. The first alarm, with indication on the CRT, warns of high temperature or high pressure in the system prior to activation of the Emergency Shutdown System.

The second alarm on high temperature or high pressure reading in the reactor system will trigger the Emergency Shutdown System. If the temperature sensor, TSHH-208, on the the reactor system's outlet line senses a temperature over 500 ^{O}F (Note: this setting can be changed) or the high pressure sensor, PSHH-313, on the reactor system's outlet line senses a pressure over 1050 psig (resulting from a rapid pressure rise or a malfunction of pressure control valve, PCV-312) , the WAO system will go into automatic shutdown as follows:

1. High temperature alarm is sounded with an indication on the CRT in the control room as to which sensor has activated the shutdown.

2. The microprocessor control unit will automatically initiate the following steps simultaneously:

    - Air to system is stopped by the closing of the emergency shutdown valve XCV-603 located on the outlet line from the air accumulator, D-103.

    - If the electric heater E-102 is in use, a signal will be sent to shut down the heater to prevent any additional heat from being introduced into the system.

    - The waste water feed to the system is stopped by closing of the feed shutdown valve XCV-601 located upstream of the high pressure feed pump, P-103.

    - Service water is introduced to the system by the full opening of the valve XCV-602 located upstream of P-103.

The operator should proceed as follows:

- Acknowledge the alarm.

- Lower the pressure on the system to 900 psig by resetting PCV-312.
- Increase the flow through the high pressure pump, P-103 to 4 USGPM.

All the above steps can be done from the CRT in the control room.

If the pressure and temperature sensors fail to respond or a fault occurs in the control system, then the pressure will be relieved via the safety relief valve PSV-317. A high pressure alarm, PAH-316 would indicate that either the relief valve has been activated or that the rupture disc is leaking. The relief valve will discharge to the atmosphere via a safe location. If the relief valve is activated then the operator should immediately implement the shutdown of the facility via pushing button HS-XXX on the panel or an equivalent icon on the CRT. The rupture disc PSE-314 should be replaced, relief valve settings rechecked and lines between the rupture disc and the safety valve cleaned to remove any residual waste lodged against PSH-316 and PI-315.

11.4. HAZARD ASSESSMENT

11.4.1 Waste Feed

Explosion Potential - Red water has a solids content of 15% and a solids heat content of 3200 BTU/lb. As the initial raw waste stream will be diluted with a recycle effluent stream and a very high reactor recycle stream prior to entering the reactor system (exceeding the 20:1 dilution factor), the effects of temperature and pressure excursions resulting from a detonation type of reaction is negligible. Section 11.3 discusses the Emergency Shutdown System in place to handle temperature and pressure excursions.

Contaminated Surfaces - The raw red water will be pumped to the feed drum from the client's storage tank located outside Kenox' battery limits. In the unlikely event that red water is spilled or leaked, it should be cleaned using wet methods and not be allowed to dry. If it is allowed to dry, the concentrated solids must be considered as explosive and susceptible to initiation by impact, friction, heat or electrostatic charge.

11.4.2 Burn Hazards

All equipment with surface temperatures over 100 deg F have been provided with insulation for personnel protection.

11.4.3 Confined Space Entry

The WAO system shall be evaluated during detailed engineering to determine if any spaces are permit required confined space. A permit required confined space is a space that:

- Contains or has the potential to contain a hazardous atmosphere
- Contains a material that has a potential for engulfing an entrant
- Is configured such that an entrant could be trapped or asphyxiated
- Contains any other safety or health hazard.

A sign reading, "DANGER - PERMIT - REQUIRED CONFINED SPACE, DO NOT ENTER" will be posted at the entrance to any confined space.

11.4.4 Sampling

Red water may present potential inhalation and skin contact hazards during the sampling and sample handling activities. Appropriate personal protective equipment should be worn (i.e. safety glasses, hand protection, apron). Material Safety Data Sheets on some major components of red water are presented in Section 11.4.5.

SECTION 11.4.5.

MATERIAL SAFETY DATA SHEETS

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* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
*                                  M S D S                                *
*                                                                         *
*       Canadian Centre for Occupational Health and Safety                *
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
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*** IDENTIFICATION ***

MSDS RECORD NUMBER : 347777
PRODUCT NAME(S) : TNT
PRODUCT IDENTIFICATION : EXP 0032

*** MANUFACTURER INFORMATION ***

MANUFACTURER : ICI Canada Inc
ADDRESS : 90 Sheppard Avenue East
Box 200 Station "A"
North York Ontario
Canada M2N 6H2
Telephone: 416-229-7000
Telex: 06986505
Fax: 416-229-7752
EMERGENCY TELEPHONE NO. : 800-561-3636

*** MATERIAL SAFETY DATA ***

ICI Canada Inc.
P.O. Box 200, Station "A"
North York, Ontario
Canada, M2N 6H2

TNT

Date Issued: 91 06 06

MATERIAL SAFETY DATA SHEET

Index: EXP 0032/91B

FOR EMERGENCIES INVOLVING CHEMICAL SPILL OR RELEASE, CALL THE ICI CANADA TRANSPORTATION EMERGENCY RESPONSE SYSTEM AT 1-800-561-3636.

PRODUCT IDENTIFICATION

Product Name: TNT
Chemical Name: 2,4,6-Trinitrotoluene
Synonyms: Methyltrinitrobenzene, alpha-TNT, Nitropel, TNT (TY1 Flake) (Military Grade), TNT (Flake), Triton, Trinitrotoluol, Trotyl, Tolite, Trinitrotoluene.
Chemical Family: High Explosives.
Molecular Formula: (NO2)3C6H2CH3
Product Use: Blasting agent. Manufacture of packaged explosives and primers (cast explosive).

REGULATORY SECTION

Controlled Products Regulations Classification: This product is an explosive and is not regulated by WHMIS.

OSHA Hazard Communicat (29CFR 1910.1200) Classification: Irr... ...eye, skin and respiratory tract); skin sensitizer; explosive.

CANADIAN TDG ACT SHIPPING DESCRIPTION

Shipping Name: Trinitrotoluene (or TNT)
Shipping Class/Division: 1.1D
Product Identification No (PIN): UN0209
Packing Group: II

U.S. DOT Classification: Refer to the "Code of Federal Regulations."

Other Regulations: Not available.

Read the entire MSDS for the complete hazard evaluation of this product.

HAZARDOUS INGREDIENTS OF PRODUCT

Hazardous Ingredients	%(w/w)	ACGIH TLV	CAS No.
Trinitrotoluene	98-100	0.5 mg/m3	118-96-7

PHYSICAL PROPERTIES

Physical State: Solid.
Appearance and Odour: Pale yellow flakes or prills; practically odourless.
Odour Threshold: Not applicable.
Boiling Range (Deg. C): Decomposes at 270.
Melting/Freezing Point (Deg. C): 80.65 (pure TNT)
Vapour Pressure: 0.053 mmHg (@ 85 Deg. C).
Specific Gravity: 1.645 (crystals); 1.47 (molten) (water = 1).
Vapour Density: Not available.
Bulk Density: 0.94 g/cc
Evaporation Rate: Not applicable.
Solubility: 0.013 g/100 g of water at 20 Deg. C. Sparingly soluble in alcohol; soluble in benzene, toluene and acetone.
% Volatile by Volume: Not applicable.
pH: Not applicable.
Coefficient of Water/Oil Distribution: Not available.
Sensitivity to Mechanical Impact: One of the least sensitive of the high explosives. More sensitive in the liquid form than the solid.
Rate of Burning: Not available.
Explosive Power: 439 kJ/100 g
Sensitivity to Static Discharge: Not available.

REACTIVITY DATA

Stability:
Under Normal Conditions: Stable.
Under Fire Conditions: Flammable.
Hazardous Polymerization: Will not occur.
Conditions to Avoid: Excessive heat, situations where product may be

confined, and prolonged exposure to sunlight.
Materials to Avoid: Strong oxidizers and reducing agents, alkaline materials and mineral acids.
Hazardous Decomposition or Combustion Products: When heated to decomposition, it emits toxic nitrogen oxide (NOx) fumes. Its combustion products include large amounts of black smoke and nitrogen oxide fumes (NOx).

FIRE AND EXPLOSION DATA

Flash Point (Deg. C) (Method): Not available.
Autoignition Temperature: Approx. 295-330 Deg. C.
Flammability Limits in Air (%): LEL: Not applicable.
UEL: Not applicable.

Fire Extinguishing Media: See below.

Fire Fighting Procedures: DO NOT FIGHT FIRES INVOLVING EXPLOSIVE MATERIALS. Immediately evacuate all personnel from the area.

Other Fire or Explosion Hazards: Not applicable.

TOXICOLOGICAL AND HEALTH DATA

Recommended Exposure Limit: See "HAZARDOUS INGREDIENTS OF PRODUCT" Section.

Toxicological Data:

Trinitrotoluene LD50 (oral,rat) = 795 mg/kg (1)

Carcinogenicity Data: The ingredient(s) of this product is (are) not classified as carcinogenic by ACGIH (American Conference of Governmental Industrial Hygienists) or IARC (International Agency for Research on Cancer), not regulated as carcinogens by OSHA (Occupational Safety and Health Administration), and not listed as carcinogens by NTP (National Toxicology Program).

Reproductive Effects: No information is available and no adverse reproductive effects are anticipated.

Mutagenicity Data: No information is available and no adverse mutagenic effects are anticipated.

Teratogenicity/Fetotoxicity Data: No information is available and no adverse teratogenic/embryotoxic effects are anticipated.

Synergistic Materials: None known.

EFFECTS OF EXPOSURE WHEN:

. Inhaled: Product is irritating to the nose, throat and respiratory tract. May cause central nervous system (CNS) depression, liver damage, kidney damage and methemoglobinemia. See "Other Health Effects" Section.

. In contact with the skin: This product may cause irritation due to

abrasive action. Prolonged and repeated contact may lead to dermatitis. May be absorbed through intact skin. May cause skin sensitization or other allergic responses. See "Other Health Effects" Section.

. In contact with the eyes: This product causes irritation, redness and pain. Prolonged and repeated contact may cause cataracts.

. Ingested: Ingestion of large amounts may cause nausea, gastrointestinal upset and abdominal pain. May cause central nervous system (CNS) depression, liver damage, kidney damage and methemoglobinemia. See "Other Health Effects" Section.

Other Health Effects: Initial manifestation of methemoglobinemia is cyanosis, characterized by navy blue, almost black lips, tongue, and mucous membranes, with skin colour being slate gray. Further manifestation is characterized by headache, weakness, dyspnea, dizziness, stupor, respiratory distress and death due to anoxia.

Signs and symptoms of kidney damage generally progress from oliguria, to blood in the urine, to total renal failure.

If ingested, Nitrates may be reduced to nitrites by bacteria in the digestive tract. Signs and symptoms of nitrite poisoning include cyanosis (due to methemoglobin formation), nausea, dizziness and increased heart rate.

CNS depression is characterized by headache, dizziness, drowsiness, nausea, vomiting and incoordination. Severe overexposures may lead to coma and possible death due to respiratory failure.

Sensitization is the process whereby a biological change occurs in the individual because of previous exposure to a substance and, as a result, the individual reacts more strongly when subsequently exposed to the substance. Once sensitized, an individual can react to extremely low airborne levels, even below the TLV, or to skin contact.

FIRST AID PROCEDURES WHEN:

. Inhaled: Move victim to fresh air. Give artificial respiration ONLY if breathing has stopped. Give cardiopulmonary resuscitation (CPR) if there is no breathing AND no pulse. Obtain medical attention IMMEDIATELY.

. In contact with the skin: Flush skin with running water for a minimum of 20 minutes. Start flushing while removing contaminated clothing. If irritation persists, repeat flushing. Obtain medical attention IMMEDIATELY.

. In contact with the eyes: Immediately flush eyes with running water for a minimum of 20 minutes. Hold eyelids open during flushing. If irritation persists, repeat flushing. Obtain medical attention IMMEDIATELY.

. Ingested: If victim is alert and not convulsing, rinse mouth out and give 1/2 to 1 glass of water to dilute material. DO NOT induce vomiting. If spontaneous vomiting occurs, have victim lean forward with head down to avoid breathing in of vomitus, rinse mouth and administer more water. Obtain medical attention IMMEDIATELY.

Emergency Medical Care: Alcohol use may cause enhanced response to effects

of TNT exposure. Individuals deficient in glucose-6-phosphate dehydrogenase may be at greater risk. Medical conditions that may be aggravated by exposure to this product include cardiovascular diseases and liver, blood and kidney disorders.

PREVENTATIVE MEASURES

Recommendations listed in this section indicate the type of equipment which will provide protection against overexposure to this product. Conditions of use, adequacy of engineering or other control measures, and actual exposures will dictate the need for specific protective devices at your workplace.

Engineering Controls: Local exhaust ventilation required, if the product itself is handled.

Respiratory Protection: A NIOSH/MSHA-approved air-purifying respirator equipped with combined dust, mist, fume/organic vapour cartridges for concentrations up to 5 mg/m3 TNT. An air-supplied respirator if concentrations are higher or unknown.

Skin Protection: Gloves and protective clothing made from cotton should be impervious under conditions of use. The use of coveralls is recommended.

Eye Protection: Safety glasses with side shields are recommended to prevent eye contact.

Other Personal Protective Equipment: Locate safety shower and eyewash station close to chemical handling area.

Handling Procedures and Equipment: This product is an explosive and should only be used under the supervision of an experienced blaster.

Storage Temperature (Deg. C): See below.

Storage Requirements: Dry, secure magazine that is properly grounded. Do not expose to temperatures above 35 Deg. C.

Other Precautions: Use only with adequate ventilation and avoid breathing dusts/vapours. Avoid contact with eyes, skin or clothing. Wash thoroughly with soap and water after handling. Wash contaminated clothing thoroughly before re-use.

ENVIRONMENTAL PROTECTION DATA

Steps to be Taken in the Event of a Spill or Leak: Stop and contain spill. Wet spilled material and sweep up into strong plastic bags or plastic containers. Keep the material wet. Avoid use of metal tools. Be careful to avoid shock, friction and sparks. Notify applicable government authority if release is reportable or could adversely affect the environment.

Environmental Effects: Harmful to aquatic life at low concentrations. A concentration of 1.5 mg/L is toxic to fish. Can be dangerous if allowed to enter drinking water intakes. Product has an unaesthetic appearance and can be a nuisance.

Deactivating Chemicals: None known.

Waste Disposal Methods: Do not dispose of waste with normal garbage to sewer systems. Burn under supervision of an expert at a government approved explosive burning ground or destroy, by detonation in boreholes, with explosives in accordance with applicable local, provincial and federal regulations. Call upon the services of an ICI Technical Representative.

ADDITIONAL INFORMATION AND SOURCES USED

1. RTECS-Registry of Toxic Effects of Chemical Substances, On-line search, Canadian Centre for Occupational Health and Safety RTECS database, Vol I-V, 1985-1986 edition, Doris V. Sweet, Ed., National Institute for Occupational Safety and Health, U.S. Dept. of Health and Human Services, Cincinnati, 1987.
2. U.S. Dept. of Health and Human Services, NIOSH/OSHA Occupational Health Guidelines for Chemical Hazards, NIOSH, U.S. Dept. of Labour, 1978.
3. Explosives, R. Meyer, 2nd Edition, 1981, Verlag Chemie.
4. M.W. Nay et al, J. Wat. Pollut. Control Fed., 1974, Volume 46, 485-497.
5. Formula Book - Explosives, C-I-L Inc., Explosives, Research and Technical Department, current Editon.
6. Chemistry and Technology of Explosives, Vol. 1, T. Vrbanski, Pergamon Press, 1983.
7. Windholz, Martha, Ed., The Merck Index, 10th ed., Merck and Co. Inc., Rahway, New Jersey, 1983.
8. Sax, N. Irving, Dangerous Properties of Industrial Materials, 7th ed., Van Nostrand Reinhold Co., New York, 1989.

The information contained herein is offered only as a guide to the handling of this specific material and has been prepared in good faith by technically knowledgeable personnel. It is not intended to be all-inclusive and the manner and conditions of use and handling may involve other and additional considerations. No warranty of any kind is given or implied and ICI Canada Inc. will not be liable for any damages, losses, injuries or consequential damages which may result from the use of or reliance on any information contained herein. This Material Safety Data Sheet is valid for three years.

Date Issued: 91 06 06
Date Revised: 91 06 06
MSDS Index No: EXP 0032/91B

Prepared By: Safety, Health and Environment (416) 229-8252

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*                             M S D S                             *
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*     Canadian Centre for Occupational Health and Safety          *
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*** IDENTIFICATION ***

MSDS RECORD NUMBER : 690925
PRODUCT NAME(S) : DNT Mixture
Dinitrotoluene Mixture
PRODUCT IDENTIFICATION : MSDS NUMBER: CEC00012
DATE OF MSDS : 1992-11-07

*** MANUFACTURER INFORMATION ***

MANUFACTURER : DuPont Canada, Inc
ADDRESS : Post Office Box 2200
Streetsville
Mississauga Ontario
Canada L5M 2H3
Telephone: 800-387-2122 (Product Information)
EMERGENCY TELEPHONE NO. : 613-348-3616 (Transport, 24 HOURS)
613-348-3616 (Medical, 24 HOURS)

*** SUPPLIER/DISTRIBUTOR INFORMATION ***

SUPPLIER/DISTRIBUTOR : DuPont Canada, Inc
ADDRESS : Post Office Box 2200
Streetsville
Mississauga Ontario
Canada L5M 2H3
Telephone: 800-387-2122 (Product Information)
EMERGENCY TELEPHONE NO. : 613-348-3616 (Transport, 24 HOURS)
613-348-3616 (Medical, 24 HOURS)

*** MATERIAL SAFETY DATA ***

Dinitrotoluene Mixture
CEC00012 Revised 7-NOV-1992 Printed 3-FEB-1994

CHEMICAL PRODUCT/COMPANY IDENTIFICATION

Material Identification

CAS Number : 25321-14-6
Formula : CH3C6H3(NO2)2
CAS Name : Benzene, methyl dinitro
Grade : Technical

Tradenames and Synonyms

DNT Mixture

Company Identification

MANUFACTURER/DISTRIBUTOR
DuPont Canada, Inc.
P.O. BOX 2200
STREETSVILLE
MISSISSAUGA, ONTARIO L5M 2H3

PHONE NUMBERS
Product Information : 1-800-387-2122
Transport Emergency : 1-613-348-3616 (24 HOURS)
Medical Emergency : 1-613-348-3616 (24 HOURS)

COMPOSITION/INFORMATION ON INGREDIENTS

Components

Material	CAS Number	%
*2,4-Dinitrotoluene	121-14-2	76
*2,6-Dinitrotoluene	606-20-2	19
Other Mono/Di/Tri-nitrotoluene isomers		5

* Regulated as a Toxic Chemical under Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR part 372.

HAZARDS IDENTIFICATION

Potential Health Effects

Harmful if inhaled or absorbed through skin; causes cyanosis. Symptoms may be delayed. Causes irritation.

Inhalation 1-hour LC50: >2.87 mg/l in rats - Data is
Skin absorption ALD: >1,000 mg/kg in rabbits for
Oral LD50: 177 mg/kg in rats 2,4-DNT

(HAZARDS IDENTIFICATION - Continued)

2,4-DNT is an eye and skin irritant. Toxic effects described in animals from short exposures include nonspecific effects such as reduced weight gain, methemoglobinemia and effects on the central nervous system, the reproductive system, and the bone marrow. In tests with laboratory animals, technical grade 2,4-DNT has carcinogenic activity. Tests for mutagenic activity in bacterial and mammalian cell cultures have been inconclusive, with positive results in some studies, and negative results in others. Tests in animals demonstrate no developmental activity. 2,4-DNT produce testicular degeneration and decreased spermatogenesis in rats, mice, and dogs. Reduction in male fertility occurs in dominant lethal studies in rats.

2,6-DNT is a skin irritant, is not an eye irritant, and is a skin sensitizer in tests with laboratory animals. Toxic effects described in animals from exposure include methemoglobinemia, decreased spermatogenesis, testicular atropy, anemia, paralysis and tremors. Tests with 2,6-DNT in some animals demonstrte carcinogenic activity, while tests for mutagenic activity in bacterial and mammalian cell cultures have been inconclusive with positive results in some studies, and negative results in others.

Human health effects of overexposure may initially include: reduction of the blood's oxygen carrying capacity with cyanosis (bluish discoloration), weakness, or shortness or breath by methemoglobin formation; abnormal blood forming system function with anemia; red blood cell destruction; nonspecific discomfort, such as nausea, headache or weakness; temporary nervous system depression with anaesthetic effects such as dizziness, headache, confusion, incoordination, and loss of consciousness; temporary lung irritation effects with cough, discomfort, difficulty breathing, or shortness of breath; or joint pain. All isomers appear to be able to significantly permeate the skin. There are no reports of human sensitization. Individuals with preexisting diseases of the cardiovascular system or bone marrow may have increases susceptibility to the toxicity of excessive exposures.

Carcinogenicity Information

The following components are listed by IARC, NTP, OSHA or ACGIH as carcinogens. A "P" indicates a proposed carcinogen.

Material	IARC	NTP	OSHA	ACGIH
Dinitrotoluene Mixture				X
2,4-Dinitrotoluene				X

Du Pont controls the following materials as potential carcinogens: 2,4-Dinitrotoluene.

FIRST AID MEASURES

First Aid

In case of contact: Immediately flush eyes or skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Call a physician. Wash clothing before reuse and destroy contaminated shoes.

If inhaled: Remove to fresh air. If not breathing, give artificial respiration, preferably mouth-to-mouth. If breathing is difficult, give oxygen. Call a physician.

If swallowed: Induce vomiting immediately by giving two glasses of water and sticking finger down throat. Call a

physician. Never give anything by mouth to an unconscious person.

Note to Physician: Absorption of this product into the body leads to the formation of methemoglobin which, in sufficient concentration, causes cyanosis. In case of skin absorption, symptoms may be delayed. Since reversion of methemoglobin to hemoglobin occurs spontaneously after termination of exposure, moderate degrees of cyanosis need be treated only by supportive measures such as bed rest and oxygen inhalation. Thorough cleansing of the entire contaminated area of the body including scalp and nails is of utmost importance. If cyanosis is severe, intravenous injection of methylene blue, 1 mg/kg body weight, may be of value. Cyanocobalamin (Vitamin B-12), 1 mg intramuscularly, will speed recovery. Intravenous fluids and blood transfusions may be indicated in very severe exposures.

FIRE FIGHTING MEASURES

Flammable Properties

Flash Point	: 173 C (343 F)
Method	: SFCC
Flammable limits in Air, % by Volume	
LEL	: *
UEL	: *
Autoignition	: * C
Autodecomposition	: 270 C (518 F)

*Not available

Fire and Explosion Hazards:

OSHA Class III B Combustible Material. Will burn. Fire or high temp., above 270 C (518 F), and confined material will cause an explosion (see also Decomposition).

(FIRE FIGHTING MEASURES - Continued)

Extinguishing Media

Water, Dry Chemical.

Carbon dioxide (CO2)

Fire Fighting Instructions

Evacuate personnel to a safe area. Flood with water. Cool tank/container with water spray.

Do not attempt to fight large or advanced fires; material will explode if confined and heated above 270 C. Fight smaller fires with unmanned or remotely activated equipment. Run-off from fire control may cause pollution.

ACCIDENTAL RELEASE MEASURES

Safeguards (Personnel)

NOTE: Review FIRE FIGHTING MEASURES and HANDLING (PERSONNEL) sections before proceeding with clean-up. Use appropriate PERSONAL PROTECTIVE EQUIPMENT during clean-up.

Accidental Release Measures

Evacuate area - admission should be limited to trained personnel wearing full protective equipment. If molten, dike, soak up with sand or other non-combustible absorbant and allow to freeze. Place solid material in a covered steel drum for disposal. Use non-sparking tools. Comply with Federal, State, and local regulations on reporting releases.

HANDLING AND STORAGE

Handling (Personnel)

Do not breathe vapor or mist. Do not breathe dust. Do not get on skin. Do not get on clothing. Do not get in eyes. Wash thoroughly after handling.

Use only with adequate ventilation.

Storage

Store in a well ventilated place.

Keep away from heat, sparks, and flame. Keep drums upright and tightly closed.

EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls

Use in a totally closed system. Ventilation should be provided to keep concentration below the exposure limits.

Personal Protective Equipment

Eye/Face	: Coverall chemical splash goggles. Safety glasses (side shields); full-length face shield.
Respirator	: Air supplied respirator. Suitable respiratory protection & chem. proof suit w/hood.
Additional	: Butyl rubber apron and footwear

Protective Gloves: Neoprene or butyl gauntlet- lined if handling hot material.

Exposure Guidelines

Exposure Limits

Dinitrotoluene Mixture

PEL	(OSHA)	: 1.5 mg/m3, 8 Hr. TWA, Skin
TLV	(ACGIH)	: 0.15 mg/m3, 8 Hr. TWA, A2, Skin
AEL *	(Du Pont)	: None Established

Other Applicable Exposure Limits

2,4-Dinitrotoluene

PEL	(OSHA)	: 1.5 mg/m3, 8 Hr. TWA, Skin
TLV	(ACGIH)	: 1.5 mg/m3, 8 Hr. TWA, Skin Notice of Intended Changes (1993-1994) 0.15 mg/m3, 8 Hr. TWA, A2, Skin
AEL *	(Du Pont)	: 0.15 mg/m3, 8 & 12 Hr. TWA, Skin <5% 2,6-DNT

2,6-Dinitrotoluene

PEL	(OSHA)	: 1.5 mg/m3, 8 Hr. TWA, Skin
TLV	(ACGIH)	: 0.15 mg/m3, 8 Hr. TWA, A2, Skin
AEL *	(Du Pont)	: None Established

* AEL is Du Pont's Acceptable Exposure Limit. Where governmentally imposed occupational exposure limits which are lower than the AEL are in effect, such limits shall take precedence.

PHYSICAL AND CHEMICAL PROPERTIES

Physical Data

Vapor Pressure	: _<1 mm/Hg @ 100 C (212 F)
Vapor Density	: 6.3 (Air = 1)
Evaporation Rate	: _<1 O
Solubility in Water	: _<1 WT% @ 22 C (72 F)
Odor	: Distinctive Nitro Aromat.
Form	: Solid/Molten
Color	: Medium Yellow
Specific Gravity	: 1.32 @ 57C ..

pH Information: Not available
Appearance: Crystalline/Clear Oil
Boiling Point, 760 mmHg:Starts decomposing at 250 C (482 F)
Freezing Point: 56 C (133 F) dry basis

STABILITY AND REACTIVITY

Incompatibility with Other Materials

Incompatible with strong oxidizers and caustics.

Polymerization

Polymerization will not occur.

Other Hazards

Instability: Unstable above 250 C (482 F). Will explode if confined and heated above 270 C (518 F).

Decomposition: May release hazardous Nitrogen Oxide (Nox) gases. Solid DNT is more sensitive to decomposition than liquid DNT. Contamination by foreign material, especially gritty substances, may considerably lower the decomposition temperature and increase the sensitivity of DNT to decomposition and explosion.

TOXICOLOGICAL INFORMATION

No Information Available

ECOLOGICAL INFORMATION

Ecotoxicological Information

Aquatic Toxicity

The product is moderately toxic (96-hr LC50 = 1 - 50 mg/l).

DISPOSAL CONSIDERATIONS

Waste Disposal

Comply with Federal, State, and local regulations. If approved, may be incinerated using special techniques, or removed to hazardous material landfill licensed for carcinogenic materials.

TRANSPORTATION INFORMATION

Shipping Information

DOT

Proper Shipping Name	:	Dinitrotoluene, Solid; Dinitrotoluene, Molten
Hazard Class	:	ORM-E

I.D. No. (UN/NA) : Solid = 2038; Molten = 1600

DOT/IMO
Proper Shipping Name : Dinitrotoluenes, Solid; Dinitrotoluenes, Molten
Hazard Class : Poison B, 6.1
UN No. : Solid = 2038; Molten = 1600
DOT/IMO Label : Poison
Special Information : Flash Point: 173 C
Packing Group : II

Reportable Quantity : 1000 lb

Shipping Containers

T/cars, T/trucks, steel drums

Shipping Information -- Canada

TDG
Proper Shipping Name : DINITROTOLUENE SOLID
PIN No. : UN 2038
TDG Class : 6.1 (9.2)
TDG Packing Group : II

REGULATORY INFORMATION

U.S. Federal Regulations

TSCA Inventory Status : Reported/Included.

Canadian Regulations

CLASS D Division 1 Subdivision B - Toxic Material/Acute Lethality.

CLASS D Division 2 Subdivision A - Very Toxic Material. Carcinogen, Reproductive Toxin.

CLASS D Division 2 Subdivision B - Toxic Material. Skin or Eye Irritant, Skin Sensitizer.

OTHER INFORMATION

NFPA, NPCA-HMIS

NPCA-HMIS Rating
Health : 2
Flammability : 1
Reactivity : 1

Personal Protection rating to be supplied by user depending on use conditions.

Additional Information

For further information, see "Dinitrotoluene Mixture" Data Sheet.

Title III Classifications:

Acute Health	-	Yes
Chronic Health	-	Yes
Fire Hazard	-	No
Reactivity	-	Yes
Pressure	-	Yes

The data in this Material Safety Data Sheet relates only to the specific material designated herein and does not relate to use in combination with any other material or in any process.

Responsibility for MSDS	:	CHEMICALS & PIGMENTS
Address	:	MISSISSAUGA, ONTARIO
Telephone	:	416-821-3300

# Indicates updated section.

End of MSDS

M S D S

Canadian Centre for Occupational Health and Safety

*** IDENTIFICATION ***

MSDS RECORD NUMBER : 691088
PRODUCT NAME(S) : Sodium Nitrite Solution
PRODUCT IDENTIFICATION : MSDS NUMBER: CEC00191
DATE OF MSDS : 1993-10-28

*** MANUFACTURER INFORMATION ***

MANUFACTURER : DuPont Canada, Inc
ADDRESS : Post Office Box 2200
Streetsville
Mississauga Ontario
Canada L5M 2H3
Telephone: 800-387-2122 (Product Information)
EMERGENCY TELEPHONE NO. : 613-348-3616 (Transport, 24 HOURS)
613-348-3616 (Medical, 24 HOURS)

*** SUPPLIER/DISTRIBUTOR INFORMATION ***

SUPPLIER/DISTRIBUTOR : DuPont Canada, Inc
ADDRESS : Post Office Box 2200
Streetsville
Mississauga Ontario
Canada L5M 2H3
Telephone: 800-387-2122 (Product Information)
EMERGENCY TELEPHONE NO. : 613-348-3616 (Transport, 24 HOURS)
613-348-3616 (Medical, 24 HOURS)

*** MATERIAL SAFETY DATA ***

CHEMICAL PRODUCT/COMPANY IDENTIFICATION

Material Identification

Corporate MSDS Number : DU002807
Formula : $NaNO_2$ (in water)
CAS Name : NITROUS ACID, SODIUM SALT
Grade : TECHNICAL; OXIDIZING SALT SOLUTION

Company Identification

MANUFACTURER/DISTRIBUTOR
DuPont Canada, Inc.

P.O. BOX 2200
STREETSVILLE
MISSISSAUGA, ONTARIO L5M 2H3

PHONE NUMBERS
Product Information : 1-800-387-2122
Transport Emergency : 1-613-348-3616 (24 HOURS)
Medical Emergency : 1-613-348-3616 (24 HOURS)

COMPOSITION/INFORMATION ON INGREDIENTS

Components

Material	CAS Number	%
TECHNICAL GRADE:		
SODIUM NITRITE	7632-00-0	41
WATER	7732-18-5	59
OXIDIZING SALT SOLUTION:		
SODIUM NITRITE	7632-00-0	40
SODIUM CARBONATE	497-19-8	2
SODIUM NITRATE	7631-99-4	10
WATER	7732-18-5	48

DSL: REPORTED/INCLUDED

HAZARDS IDENTIFICATION

Potential Health Effects

Harmful or fatal if swallowed. Harmful if inhaled. Overexposure by inhalation or ingestion may cause reduced oxygen carrying capacity of blood. Causes skin and eye irritation.

HUMAN HEALTH EFFECTS:

(HAZARDS IDENTIFICATION - Continued)

Human health effects of overexposure to the product by skin or eye contact may include skin irritation with discomfort or rash; or eye irritation with discomfort, tearing, or blurring of vision. Sodium nitrite has been infrequently associated with skin sensitization in humans. By inhalation, irritation of the upper respiratory passages with coughing may occur. By inhalation or ingestion, the effects may include low blood pressure with headache and fainting, or nonspecific discomfort such as nausea or weakness. Overexposure may also cause methemoglobinemia (reduced oxygen carrying capacity of the blood) with cyanosis (bluish discoloration of the skin), possibly progressing to dizziness, incoordination, shortness of breath, increased pulse rate, and loss of consciousness.

Sodium nitrite can also react with certain amines forming compounds which may cause cancer, mutations, or other toxicity. These compounds, known as nitrosamines, can be formed in acidic environments such as that found in the stomach. Since many medications and chemicals contain an amine group, simultaneous exposure to nitrites should be avoided.

Carcinogenicity Information

None of the components present in this material at concentrations equal to or greater than 0.1% are listed by IARC, NTP, OSHA or ACGIH as a carcinogen.

FIRST AID MEASURES

First Aid

INHALATION

If inhaled, remove to fresh air. If not breathing give artificial respiration. If breathing is difficult, give oxygen. Call a physician.

SKIN CONTACT

In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing. Call a physician. Wash clothing before reuse.

EYE CONTACT

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Call a physician.

INGESTION

If swallowed, immediately give two glasses of water and induce vomiting. Call a physician. Never give anything by mouth to an unconscious person.

(FIRST AID MEASURES - Continued)

Notes to Physicians

Absorption of this product into the body leads to the formation of methemoglobin which, in sufficient concentration, causes cyanosis. Since reversion of methemoglobin to hemoglobin occurs spontaneously after termination of exposure, moderate degrees of cyanosis need to be treated only by supportive measures such as bed rest and oxygen inhalation. Thorough cleansing of the entire contaminated area of the body including scalp and nails is of utmost importance. Cyanocobalamin (Vitamin B-12), 1 mg intramuscularly, will speed recovery. Intravenous fluids and blood transfusions may be indicated in very severe exposures.

FIRE FIGHTING MEASURES

Flammable Properties

Autodecomposition : 490 C (914 F) after drydown

Will not burn.

Fire and Explosion Hazards:

Strong oxidizer when water is removed. Combustible materials may catch fire more easily after being wet with sodium nitrite and dried. Product intensifies combustion of other materials. Fires are difficult to extinguish. See "Decomposition".

Extinguishing Media

As appropriate for combustibles in area.

Fire Fighting Instructions

Flood with water.

ACCIDENTAL RELEASE MEASURES

Safeguards (Personnel)

NOTE: Review FIRE FIGHTING MEASURES and HANDLING (PERSONNEL) sections before proceeding with clean-up. Use appropriate PERSONAL PROTECTIVE EQUIPMENT during clean-up.

(ACCIDENTAL RELEASE MEASURES - Continued)

Accidental Release Measures

Flush spill area with plenty of water. Comply with Federal, State, and local regulations on reporting releases. The Superfund reportable discharge for sodium nitrite is 100 lbs.

HANDLING AND STORAGE

Handling (Personnel)

Do not take internally. Keep from contact with clothing and other combustible materials. Avoid contact with eyes and skin. Avoid breathing vapors or mist. Avoid breathing dust from dried-down product. Wash thoroughly after handling.

Storage

Do not store with acids, ammonium salts, cyanides, amines or reducing agents.

EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls

Good general ventilation should be provided to minimize contact with vapors, or dust from dried-down product.

Personal Protective Equipment

Eye/Face	: Coverall chemical splash goggles.
Protective Gloves	: Rubber gloves.

If product is allowed to dry and dusty conditions exist, use NIOSH/MSHA approved respiratory protection.

Exposure Guidelines

Applicable Exposure Limits

SODIUM NITRITE

PEL (OSHA)	: None Established
TLV (ACGIH)	: None Established
AEL * (Du Pont)	: 2 mg/m3, 8 Hr. TWA, respirable dust
WEEL (AIHA)	: None Established

(Continued)

PEL (OSHA)	: None Established
TLV (ACGIH)	: None Established
AEL * (Du Pont)	: 2 mg/m3, 8 Hr. TWA, respirable dust
WEEL (AIHA)	: None Established

SODIUM CARBONATE

PEL (OSHA)	: None Established
TLV (ACGIH)	: None Established
AEL * (Du Pont)	: 5 mg/m3, 8 Hr. TWA

* AEL is Du Pont's Acceptable Exposure Limit. Where governmentally imposed occupational exposure limits which are lower than the AEL are in effect, such limits shall take precedence.

PHYSICAL AND CHEMICAL PROPERTIES

Physical Data

Solubility in Water	: 100 WT% Technical and Oxidizing Salt Solution
Odor	: Odorless
Form	: Clear liquid

	Technical	Oxidizing Salt Solution
Color	Pale Yellow	Straw Colored
Boiling Pt., 760 mmHg	115 deg C (239 deg F)	114.5 deg C (238 deg F)
Freezing Point	-1 deg C (30 deg F)	~10-20 deg C (50-68 deg F)
Specific Gravity	1.32 at 16 deg C (60 deg F)	~1.4/16 deg C (34/60 deg F)
Vapor Pressure at		
25 deg C	17 mmHg	~50 mmHg
38 deg C	35 mmHg	~90 mmHg
Vapor Density (Air=1)	Less than 1	Less than 1
pH Information	8.9	9
Evaporation Rate	Greater than 1	Greater than 1

STABILITY AND REACTIVITY

Chemical Stability

Unstable with heat after dry down.

Decomposition

Decomposes with heat.

Decomposition temperature is 490 deg C (914 deg F) after drydown to produce oxygen and toxic nitrogen gases.

Polymerization

Polymerization will not occur.

Other Hazards

Incompatibility : Incompatible with acids, ammonium salts, amines, activated carbon, cyanides, and reducing agents. May react with secondary or tertiary amines to form nitrosamines (Certain nitrosamines are cancer-suspect agents.).

TOXICOLOGICAL INFORMATION

No Information Available

ECOLOGICAL INFORMATION

Ecotoxicological Information

Aquatic Toxicity

96-hour LC50, minnows: >100 mg/L

DISPOSAL CONSIDERATIONS

Waste Disposal

Comply with Federal, State, and local regulations. If approved, flush to waste treatment system.

TRANSPORTATION INFORMATION

Shipping Information

DOT

Proper Shipping Name	: Hazardous Substance, Liquid, N.O.S.*
Hazard Class	: ORM-E
I.D. No. (UN/NA)	: NA No: 9188
DOT Label(s)	: None
Special Information	: *Not regulated in packages containing less than 300 lbs.
DOT Placard	: None

DOT/IMO

Proper Shipping Name	: Not regulated as a hazardous material.
Hazard Class	: Not regulated.
Reportable Quantity	: 100 lb

Shipping Containers

T/C, T/T, sample bottles

Shipping Information -- Canada

TDG

Proper Shipping Name	: OXIDIZING SUBSTANCES N.O.S. LIQUID (SODIUM NITRITE, SODIUM NITRATE, SODIUM CARBONATE)
PIN No.	: UN 1479
TDG Class	: 5.1, (9.2)
TDG Packing Group	: II

REGULATORY INFORMATION

U.S. Federal Regulations

TSCA Inventory Status : Reported/Included.

Canadian Regulations

CLASS C Oxidizing Material

CLASS D Division 1 Subdivision B - Toxic Material/Acute Lethality.

CLASS D Division 2 Subdivision B - Toxic Material. Skin or Eye Irritant.

OTHER INFORMATION

Additional Information

Title III Classifications:

Acute Health	-	Yes
Chronic Health	-	Yes
Fire Hazard	-	No
Reactivity	-	No
Pressure	-	No

For further information, see Du Pont's "Sodium Nitrite" Data Sheet.

The data in this Material Safety Data Sheet relates only to the specific material designated herein and does not relate to use in combination with any other material or in any process.

Responsibility for MSDS	:	CHEMICALS & PIGMENTS
Address	:	MISSISSAUGA, ONTARIO
Telephone	:	416-821-3300

# Indicates updated section.

End of MSDS

M S D S

Canadian Centre for Occupational Health and Safety

*** IDENTIFICATION ***

MSDS RECORD NUMBER : 756024
PRODUCT NAME(S) : SODIUM NITRATE
PRODUCT IDENTIFICATION : 06SDNA
DATE OF MSDS : 1994-06-09

*** MANUFACTURER INFORMATION ***

MANUFACTURER : GRACE DEARBORN INC
ADDRESS : 3451 ERINDALE STATION ROAD
MISSISSAUGA ONTARIO
CANADA L5C 2S9
EMERGENCY TELEPHONE NO. : 905-279-2222 (OFFICE HOURS)
613-996-6666 (AFTER HOURS)

*** MATERIAL SAFETY DATA ***

 Version #: 3.00

MATERIAL SAFETY DATA SHEET: SODIUM NITRATE

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1) PRODUCT IDENTIFICATION: SODIUM NITRATE

PRODUCT USE: COMMODITY CHEMICAL

MANUFACTURER:
GRACE DEARBORN INC.
3451 ERINDALE STATION ROAD
MISSISSAUGA, ONTARIO
L5C 2S9

EMERGENCY PHONE:

OFFICE HOURS: 905-279-2222

AFTER HOURS: 613-996-6666

TRANSPORTATION OF DANGEROUS GOODS CLASSIFICATION:
SODIUM NITRATE 5.1 UN1498 III
WHMIS CLASSIFICATION:
CLASS C: CLASS D DIVISION 2 SUBDIVISION B

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2) INGREDIENTS:

Chemical Name.	CAS #	TLV(mg/m3)	LD50(mg/Kg
SODIUM NITRATE	7631-99-4	N/E	2000C
	%RANGE-(60.0- 100.0)		

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3) PHYSICAL DATA:

Physical state..... SOLID
Odour threshold..... N/D
Specific gravity..... 1.28
Density..... N/D
pH..... 1% = 7 - 8
Solubility in water.. 73
Appearance and odour..

Freezing point.(Deg.C)N/A
Boiling point..(Deg.C)N/A
Vapour pressure.....N/A
Vapour density(air=1).N/A
Evaporation rate.....N/A
Coeff. of water/oil...N/D

WHITE PELLETS, ODOURLESS

4) FIRE AND EXPLOSION HAZARD DATA:
CONDITIONS OF FLAMMABILITY:
NON-FLAMMABLE
EXTINGUISHING MEDIA: WATER X
FOAM X CO2 X
Other : DRY CHEMICAL
SPECIAL PROCEDURES:
TREAT AS A CLASS A FIRE.
MODERATE WHEN MIXED WITH ORGANIC MATTER - EXPLODES WHEN
HEATED OVER 1000 DEGREES C - OXIDIZING AGENTS.
FLASH POINT: (Deg. C PMCC) NONE
FLAMMABLE LIMITS IN AIR % BY VOLUME: LOWER N/D UPPER N/D
AUTO IGNITION TEMP: (Deg. C) N/D
HAZARDOUS COMBUSTION PRODUCTS:N/D
EXPLOSION DATA:
SENSITIVITY TO IMPACT..... :NONE KNOWN
SENSITIVITY TO STATIC DISCHARGES..:NONE KNOWN

5) REACTIVITY DATA:
STABILITY (NORMAL COND.) STABLE X UNSTABLE
CONDITIONS TO AVOID:
AVOID EXTREME HEAT ABOVE 1000 DEGREES C
CONDITIONS OF REACTIVITY:
N/D
INCOMPATIBILITY: (MATERIALS TO AVOID)
ORGANIC MATERIALS
HAZARDOUS DECOMPOSITION PRODUCTS:
N/D

6) TOXICOLOGICAL PROPERTIES:
ROUTE OF ENTRY: SKIN CONTACT X ABSORBED BY SKIN EYE CONTACT X
INHALATION X INGESTION X
EFFECTS OF ACUTE EXPOSURE
MAY CAUSE IRRITATION TO SKIN AND EYES. AVOID PROLONGED AND/
OR REPEATED CONTACT.
MAY CAUSE DISCOMFORT, NAUSEA OR VOMITING IF INGESTED.
MAY CAUSE IRRITATION TO UPPER RESPIRATORY TRACT IF INHALED.
EFFECTS OF CHRONIC EXPOSURE:
N/D
Oral rat LD50mg/Kg.(calc.):>2000 Exposure limits..... :N/D
Irritancy..... :N/D Sensitization.....:N/D
Synergistic Mat..... :NONE KNOWN
Carcinogenicity..... :NONE KNOWN
Reproductive Eff..... :NONE KNOWN
Teratogenicity..... :NONE KNOWN
Mutaginicity..... :NONE KNOWN

7) PREVENTIVE MEASURES
PERSONAL PROTECTIVE EQUIPMENT:
EYE PROTECTION:X GLOVES:X CLOTHING:X
RESPIRATORY PROTECTION:
DUST MASK
VENTILATION REQUIREMENTS:
MECHANICAL (GENERAL)
SPILL AND LEAK PROCEDURES:
PICK UP DRY SPILLS AND RETURN TO CONTAINER. FLUSH
REMAINDER TO DRAIN WITH EXCESS WATER.
WASTE DISPOSAL:
USE AN APPROVED SCAVENGER SERVICE.
HANDLING PROCEDURES:
WEAR CHEMICAL GOGGLES AND RUBBER GLOVES.
USE PERSONAL PROTECTIVE CLOTHING.
STORAGE REQUIREMENTS:
STORE AWAY FROM ORGANICS IN DRY FIREPROOF BINS.
WOOD AND PAPER BAGS SATURATED WITH SODIUM NITRATE SHOULD
BE REMOVED FROM PREMISES.
SPECIAL HANDLING INFORMATION:
NONE

8) FIRST AID MEASURES:
WASH CONTAMINATED AREA THOROUGHLY WITH SOAP AND WATER. LAUNDER CLOTHING BEFORE REUSE. FLUSH EYES WITH FLOWING WATER FOR 15 MINUTES AND GET MEDICAL ATTENTION. IF INGESTED, INDUCE VOMITING AND GIVE LARGE QUANTITIES OF WATER AND GET MEDICAL ATTENTION IMMEDIATELY.
GASTRIC LAVAGE MAY BE REQUIRED.

9) OTHER INFORMATION:
NONE

10) PREPARATION INFORMATION
PREPARED BY: T.R.Erwin.
GRACE DEARBORN INC.
P.O. BOX 3060 STATION A.
MISSISSAUGA ONTARIO. L5A 3T5
DATE PREP./REV. 1994.06.01
PRINT DATE: 1994.06.09
PHONE: 905-279-2222
FAX: 905-279-0020
N/D-No Data N/A-Not Applicable N/E-Not Established <-Less >-Greater
A=Oral rat LD50 B=Oral rat LD low C=oral LD50/LD low other animal
D=Estimated 1000 E=Arbitrary 2000 F=Other Route Prefix C=Ceiling limit

SECTION 12.0.

SAMPLING PLAN

12.0. SAMPLING PLAN

12.1. INTRODUCTION

This section describes the general process liquid and gas sampling procedures to be used including: the analytical parameters, typical locations and methods. The sampling and monitoring procedures described in this section have been selected to determine the properties and compositions of the feed stream, oxidized effluent stream and the off gases, thereby demonstrating the performance of the Wet Air Oxidation system.

12.2. SAMPLING EQUIPMENT, PROCEDURES AND LOCATIONS

The sampling equipment, procedures and locations are summarized in Table 12 -1. Figure 12-1 shows the incoming red water sampled at point 1; diluted red water sampled at point 2; oxidized effluent sampled at point 3 and offgases sampled at point 4. No sampling points were provided within the reactor system to minimize safety hazards associated with the cooling and pressure let down of hot samples.

12.3. ANALYTICAL PROCEDURES

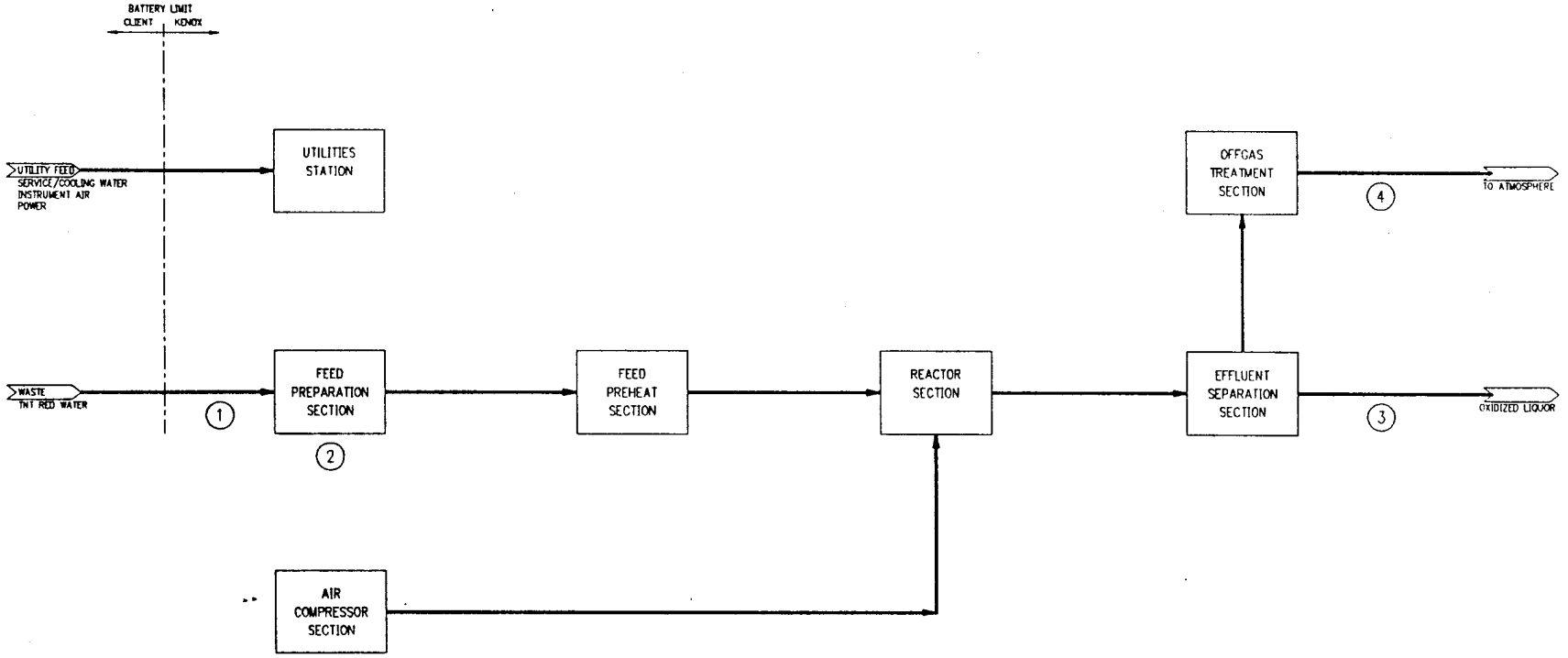
The analyses planned for the samples are listed in Table 12 - 2.

12.4. OPERATIONAL PARAMETERS

The operational parameters to be monitored by the DCS system include:

- pH of diluted red water to reactor system
- Level in feed drum
- Differential pressure across duplex strainer
- Flow of raw red water
- Flow of effluent recycle stream
- Flow of diluted red water to reactor system
- Temperature of feed at the tubeside outlet of the feed/effluent exchanger
- Temperature and pressure on the outlet line of the reactor system
- Temperature of oxidized effluent at the outlet of the feed/effluent exchanger
- Temperature of oxidized effluent at the outlet of the water cooler
- Level in high pressure separator
- Level in low pressure separator
- Pressure on vapour line of high pressure separator
- Pressure on vapour line of low pressure separator

- Temperature of oxidized waste water in effluent drum
- Level in effluent drum
- Air flows to the reactor system
- Air flow to the inlet of the feed/effluent exchanger
- Oxygen content in the offgas line
- Total offgas flow rate



KENOX CORPORATION

BLOCK FLOW DIAGRAM
SAMPLING LOCATIONS
USAEC RED WATER TREATMENT TECHNOLOGY
TEST PLAN AND SITE PREPARATION PROJECT

designed by:	drawn by:	checked by:
B. MOLL	BJW	T. LE

scale:	date of issue:	mng:	appd:
NONE	DEC. / 1994	TDL	BAW

project no.:	dwg no.:	rev.
941014	941014-SP-140	0

rev no.	date	particulars	drawn	checked	appd
0	DEC 21 1994	CONCEPTUAL DESIGN			

CAD REF.: 1TSP140A.DWG

Table 12 -1 : Sample Collection Locations and Equipment

Fig. 12-1 Loc'n	Description	Access	Equipment	General Procedure
1	Raw Red Water	Tap	Glass Bottle	Hourly Grab Sample
2	Diluted Red Water	Tap	Glass Bottle	Hourly Grab Sample
3	Oxidized Effluent	Tap	Glass Bottle	Hourly Grab Sample
4	Offgases	Port	Bag Sample	Hourly Grab Sample

Table 12 - 2 : Summary of Analytical Requirements and Methods

SAMPLE	ANALYSIS	METHOD
Raw Red Water/ Diluted Red Water/ Oxidized Effluent	pH	SM No. 4500-H^+
	COD	SM No. 5220 "D"
	TOC	SM No. 5310 "B"
	Total Volatile Solids	SM No. 2540
	Total Solids	SM No. 2540
	Chlorides	ASTM D4327-91
	DNT sulfonates	Gas Chromatography
	alpha - TNT	Gas Chromatography
	2,4 DNT	Gas Chromatography
	2,6 DNT	Gas Chromatography
	1,3,5 TNB	Gas Chromatography
	1,3 DNB	Gas Chromatography
	Nitrite	SM No. 4500 - NO_2
	Nitrate	SM No. 4500 - NO_3
	Sulfate	ASTM D4327-91
Offgases	CO	Gas Chromatography
	CO_2	Gas Chromatography
	NO	Infrared Spectrophotometry
	NO_2	Electrochemical Sensor
	N_2	Gas Chromatography
	NH_3	Infrared Spectrophotometry
	O_2	Gas Chromatography
	SO_2	Infrared Spectrophotometry

"ASTM" refers to Annual Book of ASTM Standards, Water and Environmental Technology, Section II, American Society for Testing and Materials.
"SM" refers to Standard Methods for the Examination of Water and Wastewater, 18th Edition, 1992.

SECTION 13.0.

OPERATIONS MANUAL

13.0. OPERATIONS MANUAL

13.1. GENERAL DESCRIPTION

13.1.1 MANUAL PURPOSE

This manual provides instructions for the operations and maintenance of the red water WAO pilot plant.

13.1.2 SYSTEM DESCRIPTION

This section discusses the objectives, process equipment and process flow of the treatment system for red water. The pilot plant consists of the following processes :

- Kenox Wet Air Oxidation (WAO) system
- Utility systems.

KENOX WAO System

The operating flow rate of the WAO system which is comprised of red water and recycled effluent is 3 USGPM. Refer to Process Flow Diagram (PFD) in Section 3 for the following flow description.

Incoming TNT red water from the local storage tank is delivered to the Kenox feed drum D-104 via a dual strainer and the waste feed pump P-101. An excess differential pressure reading from local PDI-301 indicates the basket is plugged. The flow should be directed to the other basket and the plugged screen should be removed and replaced by a clean screen.

At the inlet of feed drum D-104, the TNT red water is blended with a treated effluent stream from the final effluent pump P-105 at a ratio that has been preset in the flow ratio controller, FFRC-401. The diluted feed is pumped from the feed drum by high pressure feed pump, P-103 to the tubeside of the feed/effluent exchanger E-101. In this exchanger, the feed stream temperature is heated to the required reactor inlet temperature by the reactors' effluents.

The Kenox reactor system comprises of reactors connected in series. Compressed air is injected into the reactors to supply the required oxygen for the reaction.

The combined oxidized liquid and spent air is withdrawn from the reactors and cooled to 104 ^{o}F via E-101 and the water cooler E-103. Gases and oxidized waste water leave the cooler E-103 and proceed to a two stage pressure let down and separation system, D-101 and D-102.

The off-gas, which at this point is mainly carbon dioxide , nitrogen and water vapor is vented to the atmosphere. Part of the oxidized waste water is recycled back via the effluent recycle pump, P-105 to the inlet of the feed drum, D-104 and the other portion is discharged.

Compressed air is supplied to the Kenox reactors by the reciprocating compressor C-101. Compressed air leaving the compressor flows to the air accumulator D-103 before entering the Kenox reactors. The total air flow to the Kenox reactors is controlled by an oxygen analyzer which measures the O_2 content of the off gas leaving the system.

UTILITY SYSTEMS

Instrument air is assumed to be available on site.

Cooling water is assumed to be available on site. The cooling water supply/return system is shown in Dwg. No. 941014-FD-105.

13.1.3 KEY OPERATING PARAMETERS

The primary control for any Wet Air Oxidation system including "Kenox" is

- Feed Rate
- Oxygen Flow (Air Demand)
- Pressure in Reactors
- Reaction Temperature

Feed Rate

The feed to the Kenox System is limited by the size of the reactors and by the COD level to a lesser extent as there is a correlation between the flow rate and residence time.

Oxygen Flow

Excess oxygen is analyzed by AT-501 (Dwg. No. 941014-FD-104) located on the gas line releasing to the vent stack. Test runs will determine the optimum air supply requirements to the reactors.

Reactor Pressure

The pressure must be set so as to prevent boil-off and maintain a liquid phase in the reactors. The reaction enthalpy is used for heating up the liquid and oxygen containing gas feeds to the reaction temperature, evaporation of water up to the vapour-liquid equilibrium and compensation for heat losses from the reactors. This pressure is maintained by PCV-312 located on the vapor exit from separator D-101.

Reaction Temperature

The temperature is the most important process variable in the WAO process as it determines the rate of the oxidation reaction. The required temperature is determined by the chemical composition of the waste water and the desired conversion efficiency. For low COD heat must be added via the electric heater.

13.2. START-UP PROCEDURE

13.2.1 START UP COOLING WATER SYSTEM

- Open valve on the 2" main cooling water line to the pilot plant.

- Open cooling water supply and cooling water return isolation valves to the following equipment:
  1. Air compressor, C-101
  2. Reactor Effluent Cooler, E-103
  3. Reactor System

13.2.2 ACTIVATE INSTRUMENT AIR SYSTEM

- Open all air supply valves to pneumatic instruments.

- Start up instrument air system. Check if pressure setting on valve PRV-XXX on the instrument air line is at 90 psig.

13.2.3 SYSTEM WATER FILL

- Activate process control system.

- Open suction and discharge valves around high pressure feed pump, P-103.

- Open all manual in-line process valves around the following equipment: E-101, E-102, reactor system, E-103, D-101, D-102 and inlet to D-105.

- Open service water supply isolation valves and XCV-602 by-pass valve to allow water flow to suction of P-103.

- Set reactor pressure controller, PIC-312 on the reactors to 590 psig.

- Start pump P-103. Adjust the variable speed drive to maintain a flow of 4 USGPM as indicated by FT-404.

- The following equipment will fill with water:

  a) Tube side of exchanger E-101
  b) Reactors
  c) Shell side of exchanger E-101
  d) Tube side of E-103
  e) H.P. Separator, D-101

- After D-101 fills to the 50 % level, open control valve, LCV-108, manually to allow water flow to L.P. Separator, D-102. Maintain 50 % level in D-101.

- Fill L.P. Separator, D-102 to the 50 % level and open LCV-110 manually to allow flow to D-105. Maintain 50 % level in D-102. **Caution:** do not overfill D-102. Oxygen analyzer AT-501 must not be in contact with water.

- Allow D-105 to fill to 50% level.

- Open discharge valve at the outlet of D-105 , suction and discharge valves around effluent recycle pump, P-105 and valve to allow water to leave the system.

- Start pump, P-105.

13.2.4 INCREASE SYSTEM TEMPERATURE

- Adjust P-103 VSD to maintain a flow rate of 3 USGPM.

- Set temperature controller TIC-202 to 484 ^{O}F.

- Refer to electric heater, E-102, start-up procedure in the vendor's manual and start heater.

- Reactor system temperature, TI-209 should stabilize at 484 deg F.

13.2.5 PRESSURIZE SYSTEM

- Once the reactor temperature reaches 484 deg F , the system pressure, PI-312, will be approximately 590 psig.

- Open all manual in-line valves between the air compressor and the reactor system.

- Refer to compressor start-up procedure in vendor's manual.

- Start air compressor C-101.

- Oxygen analyzer controller AIC-501 should be set on override to allow full air flow into the reactor system.

- Set air flow controller FIC-407 at 232 lbs/hr and air flow ratio controller FFIC-408 to proportion the second air flow in the range of 50% of the total air flow. (FIC-407/408 to be operated manually).

- Increase the pressure set point on pressure controller, PCV-312 in increments of 100 psig until the system stabilizes at 985 psig.

- Check system for leaks while raising pressure. It is expected that the reactor temperature will drop slightly when air is first admitted to the reactors.

- System stabilized at 985 psig - check discharge pressure on the high pressure feed pump; pressure gauge PI-307 should read 1035 psig plus.

- Check all level instruments for appropriate settings.

13.2.6 INTRODUCTION OF WASTE WATER FEED STREAM

Once the reactor system stabilizes at 484 ^{o}F:

- Set the flow ratio control FFRC-401 such that flows of effluent recycle stream and feed waste meet the dilution factor.

- Open all manual valves on discharge of P-105 to allow recycle stream to flow to D-104.

- Start waste feed pump, P-101. Check PI-303 for discharge pressure. Reading should be approximately 30 psig.

- Observe FI-401 and FI-402, the flow ratio should agree with the dilution factor as set by FFRC-401.

- Allow D-104 to fill to 50 % level.

- Open manual discharge valve on D-104.

- Set oxygen analyzer, AT-501 at 5 % excess O_2.

- Close all service water valves leading to the suction of P-103.

- Change air flow ratio controller FFIC-408 from manual to automatic mode (i.e. flow of air now on AIC-501 control).

- Optimize as necessary feed flow rate, FIC-407, FIC-408 and TI-209 to maintain temperature around 484 ^{o}F.

- Monitor reactor inlet temperature of waste water stream, TI-202 and reactor outlet temperature, TI - 209.

- Take a sample of the oxidized waste water periodically and have it analyzed for COD concentration and pH.

13.3. SHUTDOWN PROCEDURE

For a planned shutdown, waste water from the feed tank and partially oxidized waste water remaining in the system will be processed. After the processing of the waste, the system will be completely flushed so that all contaminated piping components are thoroughly cleaned and free of TNT red water.

The level of waste water in the feed drum will be decreased to the minimum operating level before commencing with the shutdown procedures. This will shorten the shutdown duration as well as save energy costs associated with operating the electric heater, E-102.

- Open service water isolation valve to waste water feed line no. 101. Close waste water feed valve to stop the flow of raw waste into drum D-104. This will allow service water to flush the incoming feed line.

- Adjust flow ratio controller FFIC-401 to allow 100 percent flow from P-101 and no flow of the effluent recycle stream.

This can be considered as time, T = 0 hr. (i.e. no contaminated liquid is being fed to D-104). Assuming the flow rate is 3 USGPM and D-104 is full, the approximate shutdown time is equal to 4 hours (i.e. 1.5 hours system liquid retention plus 2.5 hours D-104 volume).

As the feed from D-104 becomes increasingly dilute and the demand for COD decreases, the requirement for air will diminish and system temperatures will start to fall. As a result, air flow control valves FCV-407/8 will automatically close responding to the high oxygen level measured from the oxygen analyzer.

- Shutdown air compressor C-101 (refer to compressor operating manual). Control valves XCV-604/5 will close automatically cutting off the supply of air to the reactor system.

- Set temperature controller TIC-202 to 20 ^{o}C. Electric heater, E-102 will automatically return to 'Stand by' mode. All system temperatures will gradually fall.

- Decrease the set point of pressure controller PIC-312 in increments of 100 psi to slowly 'walk' the system pressure down.

At time T = 4 hours or later, adjust flow ratio controller FFIC-401 to allow rinse water discharged from P-105 to flush the effluent recycle line into D-104. After a few minutes reset FFIC-401 to 100 % flow from P-101.

- Shutdown P-101.

- When the water in D-104 has reached the desired level shutdown P-103. The water remaining in D-104 can be used to dilute the next batch of raw waste.

- Shutdown P-105. The water left in the system can remain there until the next start-up. If maintenance is required, vent, drain and/or isolate as required.