06.12 - 09/01/96
02347

Operation and Maintenance Manual MCB Camp Lejeune Groundwater Treatment System

Volume I of VII

Submitted to:

DEPARTMENT OF THE NAVY
Contract No. N62470-93-D-3032

Submitted by:

OHM Remediation Services Corp.
A Subsidiary of OHM Corporation

5335 Triangle Parkway, Suite 450
Norcross, GA 30092

OHM Project No. 16032

November 1996

TABLE OF CONTENTS

Volume I

TABLE OF CONTENTS - CONTINUED

TABLE OF CONTENTS - CONTINUED

TABLES

TABLE OF CONTENTS - CONTINUED

TABLE OF CONTENTS - CONTINUED

P-300, P-302, P-304
P-100, P-102, P-104
SHALLOW GROUNDWATER PUMPS

P-101, P-103, P-105, P-301
DEEP MONITORING WELL PUMPS

P-120
JET MIXING PUMP

X-130
REACTION TANK

T-140
SLUDGE THICKENER

D-141
FILTER PRESS FEED PUMP

T-110
GROUNDWATER COLLECTION TANK

P-211 & 212
ACID FEED PUMP

P-110A/B
AIR STRIPPER FEED PUMP

X-131
CLARIFIER

P-143
SLUDGE BLOWDOWN PUMP

A-130
FLOCCULATION MIXER

T-145
HEAT TANK

X-132
POLYMER ADDITION SYSTEM

P-121
CAUSTIC FEED PUMP

K-200
AIR STRIPPER BLOWER

C-200
AIR STRIPPER

T-220
AIR STRIPPER EFFLUENT HOLDING TANK

P-220A/B
EFFLUENT PUMPS

F-220A/B/C
CARTRIGE FILTERS

X-220A/B
GRANULAR ACTIVATED CARBON FILTERS

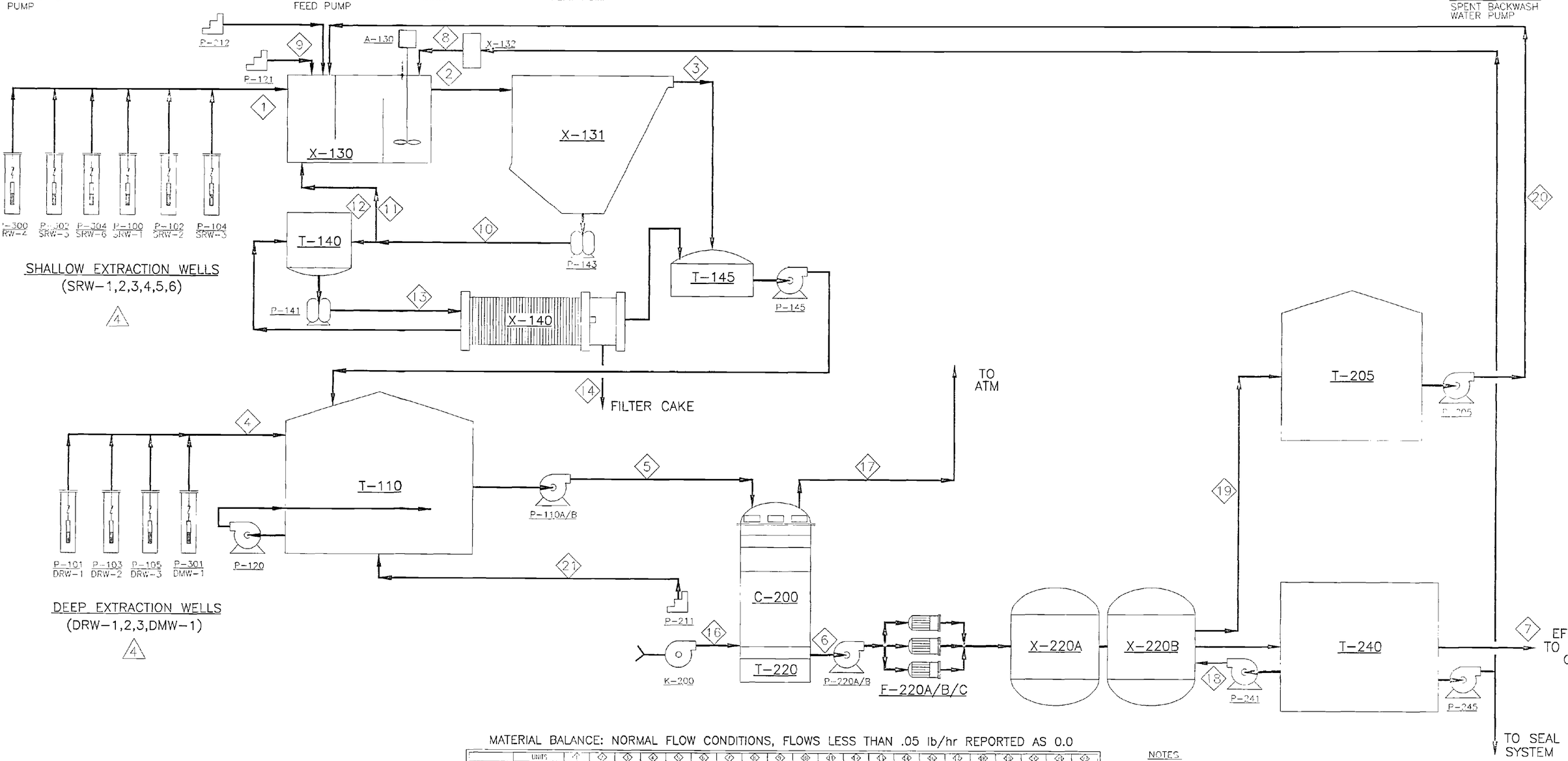
T-240
EFFLUENT HOLDING TANK

P-241
BACKWASH PUMPS

T-205
SPENT BACKWASH HOLDING TANK

P-245
REUSE WATER PUMP

P-205
SPENT BACKWASH WATER PUMP



MATERIAL BALANCE: NORMAL FLOW CONDITIONS, FLOWS LESS THAN .05 lb/hr REPORTED AS 0.0

	UNITS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
MASS FLOW	lb/hr	7497	8536	7516	224910	232426	232405	232405	6	15	1020	950	170	180	6	21060	21081	NOTE1	NOTE1	NOTE1	12	6
VOLUME FLOW	GPM (gph) (cfm)	15	17.1	15.1	450	465	465	465	[0.75]	[1]	2	1.7	0.3	3	NOTE2	(4680)	(4680)	200	200	5	[1.8]	25
TEMPERATURE	F	60	58	58	55	56	58	60	70	70	60	60	60	60	60	70	70	60	60	60	70	0
PRESSURE	psig (in WC)	15	0	0	25	40	40	0	1	1	10	5	5	100	0	(6)	0	20	5	10	10	0
pH	N/A	4.5	8.5	8.5	8.5	7.5	7.8	8.0	7.0	14	8.5	8.5	8.5	8.5	N/A	N/A	N/A	8.0	8.0	8.0	0	0
COMPOSITION														NOTE3								
WATER	lb/hr	7496.9	8452.2	7516	224889	232405	232405	232405	5	7.5	1009.8	841.5	168.5	178.2	4.2	N/A	N/A	NOTE1	NOTE1	NOTE1	0.84	0
VOCs	lb/hr	0.1	0.1	0.1	21.0	21.1	0	0	0	0	0	0	0	0	0	0	21	0	0	0	0	0
SUSPENDED SOLIDS	lb/hr	0	0.7	0	0	0	0	0	0	0	10.2	8.5	1.5	1.8	1.8	N/A	N/A	0	10	0.3	0	0

NOTES

1. THESE FLOWS OCCUR ONLY DURING BACKWASH APPROXIMATELY EVERY THREE MONTHS AND ARE NOT INCLUDED IN THE INFLUENT TO THE IRON REMOVAL SYSTEM
2. FILTER CAKE VOLUME IS 6ft PER BATCH, APPROXIMATELY ONE BATCH PER THREE DAYS
3. FLOW IS INTERMITTANT ON A BATCH BASIS QUANTITY SHOWN IS AVERAGE

02347HHBIX

THIS CONSTRUCTION DRAWING WAS BASED ON THE DESIGN DEVELOPED BY THE ARCHITECT/ENGINEER OF RECORD. BAKER ENGINEERS INC. NO WARRANTY IS EXPRESSED OR SHOULD BE IMPLIED FROM THIS DRAWING

OHM Remediation Services Corp.
Norcross, Georgia
A Subsidiary of OHM Corporation

SUBMITTED _____ PROJECT MANAGER DATE _____
APPROVED _____ SR. PROJECT ENGINEER DATE _____
APPROVED _____ DEPT. MANAGER DATE _____

AT FULL SCALE (IF NOT 2"=SCALE ACCORDINGLY)
CADD FILE P-1.DWG
DRAWN C. SCHUMACHER
DESIGNED D.RUBIN/K.MAK
CHECKED _____
CHECKED _____

REVISIONS

ZONE	REV.	DESCRIPTION	BY	DATE	APP
	1	ISSUE FOR REVIEW & APPROVAL	OHM	9/29/94	
	2	BAKER /LANTDIV REVIEW COMMENTS	BM	3/27/95	
	3	REVISED PER FIELD INSTALLATION	JAD	3/1/96	
	4	PHASE II WELLS ADDED	KM	4/11/96	
	5	RECORD DRAWINGS	KM	5/28/96	

DEPARTMENT OF THE NAVY NAVAL FACILITIES ENGINEERING COMMAND
ATLANTIC DIVISION
NAVAL STATION NORFOLK, VIRGINIA
LANTDIV RAC CONTRACT N62470-93-D-3032 DELIVERY ORDER NO. 0015
OPERABLE UNIT NO 2 MARINE CORPS BASE, CAMP LEJEUNE, N.C

PROCESS FLOW DIAGRAM
GROUNDWATER RECOVERY AND TREATMENT SYSTEM

DRAWING NUMBER P-1
SHEET NUMBER _ of _
DATE 3/27/96

MANUAL VALVES

- ANGLE VALVE
- BALL VALVE
- CLOSED BALL VALVE
- BUTTERFLY VALVE (OPEN)
- BUTTERFLY VALVE (CLOSED)
- CHECK VALVE
- DIAPHRAGM VALVE
- GATE VALVE
- GATE VALVE (CLOSED)
- GLOBE VALVE
- NEEDLE VALVE
- PLUG VALVE
- PLUG VALVE (CLOSED)
- ROTARY VALVE
- 3-WAY VALVE
- 4-WAY VALVE
- KNIFE GATE VALVE

NOTE

VALVES SHOWN SOLID ARE CLOSED (EXCEPT BUTTERFLY AND BALL)

CONTROL VALVES

- DIAPHRAGM ACTUATOR
- DIAPHRAGM ACTUATOR WITH POSITIONER (IA)
- ELECTRIC MOTOR ACTUATOR (M)
- HYDRAULIC ACTUATOR (H)
- PNEUMATIC ACTUATOR (P)
- PNEUMATIC CYLINDER ACTUATOR
- REGULATOR WITH EXTERNAL TAP
- SELF CONTAINED REGULATOR
- 2-WAY SOLENOID (S)
- 3-WAY SOLENOID (S)
- 4-WAY SOLENOID (S)

FC INDICATES "FAIL CLOSED"

FL INDICATES "FAIL LAST"

FO INDICATES "FAIL OPEN"

SAFETY RELIEFS

- PRESSURE SAFETY VALVE (PSV)
- RUPTURE DISK (PRESSURE)
- VACUUM SAFETY VALVE (PSV)
- VACUUM AND PRESSURE SAFETY VALVE

PIPING

- UTILITY PIPING
- SECONDARY PROCESS PIPING
- MAIN PROCESS PIPING
- LINE BREAK, PIPING OR INSTRUMENTATION
- INSULATED PIPING (COLD CONSERVATION) (CC)
- INSULATED PIPING (HEAT CONSERVATION) (HC)
- INSULATED PIPING (PERSONNEL PROTECTION) (PP)
- INSULATED AND ELECTRICAL TRACED PIPING (ET)
- INSULATED AND SOLVENT TRACED PIPING (LT)
- INSULATED AND STEAM TRACED PIPING (ST)
- INSULATED AND JACKETED PIPING
- FLANGED NOZZLE CONNECTION
- THREADED CAP OR CONNECTION
- IA — INSTRUMENT AIR SUPPLY AND FILTER/REGULATOR
- O — SIGHT GLASS
- T — TRAP
- AE — AIR ELIMINATOR
- D — POP DRAIN
- SP — SAMPLE PORT
- VB — VACUUM BREAKER
- BLIND FLANGE/FLANGES
- DIAPHRAGM SEAL
- DRAIN
- EDUCTOR
- EXPANSION JOINT
- FLEXIBLE CONNECTION
- HOSE CONNECTION
- REDUCER
- SLIP BLIND
- 190 — TIE-IN WITH ID NO
- VENT TO ATMOSPHERE
- "Y" STRAINER
- INLINE STRAINER

INSTRUMENTS

- PANEL MOUNTED INSTRUMENT
- REAR PANEL MOUNTED INSTRUMENT
- LOCALLY MOUNTED INSTRUMENT
- INSTRUMENT FURNISHED WITH EQUIPMENT
- DISTRIBUTED CONTROL DISPLAYED ON CRT
- DISTRIBUTED CONTROL NON DISPLAY FUNCTION
- DISTRIBUTED CONTROL BLIND FUNCTION
- DISTRIBUTED CONTROL MANUAL BACKUP
- DISTRIBUTED CONTROL H HIGH ALARM L LOW ALARM
- LEVEL GAUGE BOARD (WITH SEAL) (LG)
- LEVEL GAUGE BOARD (WITHOUT SEAL) (LG)
- ORIFICE PLATE (FE)
- RESTRICTING ORIFICE (RO)
- VORTEX SHEDDING FLOW TRANSMITTER (FT)
- ROTAMETER/PURGE METER (F)
- TARGET FLOW METER (FT)
- PITOT TUBE (OR ANNUBAR) (FE)
- TURBINE OR PROPELLER FLOW SENSOR (FE)
- MAGNETIC FLOW METER (SENSOR ELEMENT) (FE)

INSTRUMENTS

- OPEN CHANNEL FLOW (FLUMES, ETC.)
- POSITIVE DISPLACEMENT FLOW TOTALIZING INDICATOR (FQ)
- SONIC FLOW TRANSMITTER (DOPPLER OR TRANSIT TIME) (FT)
- FLOW STRAIGHTENING VANE (FX)
- TEMPERATURE ELEMENT (TE)
- TEMPERATURE ELEMENT FILLED SYSTEM (TE)
- VENTURI FLOW ELEMENT (FE)
- OUTPUT FROM INTERLOCK LOGIC IN PLC (I)
- INPUT TO INTERLOCK LOGIC IN PLC (I)
- OUTPUT FROM INTERLOCK LOGIC IN FIELD OR BY RELAY (I)
- INPUT TO INTERLOCK LOGIC IN FIELD OR BY RELAY (I)
- LOGIC FUNCTION S = SUM (OR)
- TRANSDUCER FUNCTION R = RESISTANCE I = CURRENT P = PNEUMATIC E = VOLTAGE (I/P)
- 001 AI — PLC ANALOG INPUT (001-050)
- 051 DI — PLC DIGITAL INPUT (051-100)
- 101 AO — PLC ANALOG OUTPUT (101-150)
- 151 DO — PLC DIGITAL OUTPUT (151-200)
- e — ENERGIZED
- de — DE-ENERGIZED
- S/S — START/STOP
- E/S — ENABLE/STOP
- HOA — HAND/OFF/AUTOMATIC
- PB — PUSH BUTTON EMERGENCY STOP
- CSO — CAR SEAL OPEN
- CSC — CAR SEAL CLOSED

INSTRUMENT SIGNALS

- CAPILLARY TUBING
- ELECTRICAL SIGNAL
- HYDRAULIC
- PNEUMATIC TUBING
- SOFTWARE

MISCELLANEOUS

- SIGNAL TRANSFER (A)
- CONSERVATION/BREATHING VENT
- VENDOR SUPPLIED PACKAGE
- INDUSTRIAL FLOOR SCALE
- CENTRIFUGAL PUMP WITH BASE OR BLOWER WITHOUT BASE
- METERING PUMP
- DOUBLE DIAPHRAGM AIR PUMP
- MOTOR DRIVEN AGITATOR OR MIXER (M)
- EXTRACTION WELL PUMP
- SUBMERSIBLE PUMP (M)
- FAN
- AIR COMPRESSOR

LINE CODE

102XXXXX-2"-GW

- 102XXXXX — LINE NUMBER
- 2" — PIPING SIZE
- GW — LINE CONTENTS
- PIPING SPECIFICATION

PROJECT ABBREVIATIONS

SYMBOL	SERVICE
AA	AMBIENT AIR
AC	SULFURIC ACID SOLUTION
BD	BLOWDOWN
BW	BACKWASH
CAR	ACTIVATED CARBON
GW	GROUNDWATER
IA	INSTRUMENT AIR
NAOH	SODIUM HYDROXIDE SOLUTION
A	PLANT AIR
PMR	POLYMER
PW	PROCESS WATER
SL	SLUDGE
TGW	TREATED EFFLUENT
V	VENT

INSTRUMENT FUNCTION IDENTIFICATION SYMBOLS

	1st LETTER	2nd LETTER	3rd LETTER	4th LETTER	LAST LETTER
A	ANALYZER	ALARM	ALARM	ALARM	ALARM
B	BURNER (FLAME)				
C	CONTROL (LOOP)	CONTROLLER	CONTROLLER		CONTROLLER
D	DENSITY	DIFFERENTIAL			DRIVE OPERATOR
E	VOLTAGE	ELEMENT			
F	FLOW	RATIO	FLOW	FLOW	
G	GAUGE	GAUGE			GLASS
H	HAND (MANUAL)		HIGH	HIGH	HIGH
I	AMPERES	INDICATOR			INDICATOR
J	POWER				MTR, PE & LCT
K	TIME (COUNT)				
L	LEVEL	LEVEL	LOW	LOW	LOW
M	MOISTURE				METER
N	USER'S CHOICE				
O	OPERATIONAL	ORIFICE			
P	PRESSURE	PRESSURE	PRESSURE		PNEUMATIC
Q	SPECIAL	INTEGRATE	INTEGRATE	INTEGRATE	INTEGRATE
R	RESTRICTING	RECORDER	RECORDER	RECORDER	RECORDER
S	SPEED/SOLENOID	SAFETY/SWITCH	SWITCH	SWITCH	SWITCH
T	TEMPERATURE	TEMPERATURE	TEMPERATURE		TRANSMITTER
U	MULTIVARIABLE	MULTIVARIABLE			MULTIVARIABLE
V	VIBRATION	VALVE	VALVE	VALVE	VALVE
W	WEIGHT				WELL
X	POSITION				
Y	USER'S CHOICE				
Z	UNCLASSIFIED				COMPUTER
pH	pH				

OHM Remediation Services Corp.
Norcross, Georgia
A Subsidiary of OHM Corporation

SUBMITTED _____ PROJECT MANAGER _____ DATE
APPROVED _____ SR. PROJECT ENGINEER _____ DATE
APPROVED _____ DEPT. HEAD _____ DATE

AT FULL SCALE (IF NOT 3 - SCALE ACCORDINGLY)
CADD FILE P-2.DWG
DRAWN J. LANGE/J. COLLINS
DESIGNED B. MATTHEWS
CHECKED _____
CHECKED _____

REVISIONS

ZONE	REV	DESCRIPTION	BY	DATE	APP
	0	ISSUE FOR COMMENT		8/4	
	1	ISSUE FOR REVIEW & APPROVAL	OHM	9/29/94	
	2	BAKER /LANTDIV REVIEW COMMENTS	BM	3/27/95	
	3	RECORD DRAWINGS	KM	6/28/96	

DEPARTMENT OF THE NAVY — NAVAL FACILITIES ENGINEERING COMMAND

ATLANTIC DIVISION

NAVAL STATION — NORFOLK, VIRGINIA

LANTDIV RAC CONTRACT N62470-93-D-3032 — DELIVERY ORDER NO. 0015

OPERABLE UNIT NO. 2 — MARINE CORPS BASE, CAMP LEJEUNE, N.C.

PIPING AND INSTRUMENTATION DIAGRAM

PIPING AND MECHANICAL SYMBOLS

DRAWING NUMBER P-2

SHEET NUMBER _ of

DATE 3/27/..


P-100
SRW-1 EXTRACTION PUMP
0 - 10 GPM
P-102
SRW-2 EXTRACTION PUMP
0 - 10 GPM
P-104
T-140
SLUDGE THICKENING TANK
X-140
PLATE AND FRAME FILTER PRESS
A-130
FLOCCULATION MIXER
VARIABLE SPEED DRIVE
X-131
INCLINED PLATE CLARIFIER
P-141
FILTER PRESS FEED PUMP
10 GPM @ 100 PSIG
AIR OPERATED DOUBLE DIAPHRAGM
X-132A
METAL SCAVENGER
METERING PUMP
X-132
LIQUID POLYMER FEED SYSTEM
BELOW GRADE
ABOVE GRADE
SPEC 02900
SPEC 15401
CALIBRATION COLUMN
POLYMER FEED SYSTEM
MAKE-UP WATER
FLOCCULATION MIXER ON/OFF
METAL SCAVENGER PUMP
IRON SCAVENGER CHEMICAL
COMPRESSED AIR
2" CAMLOCK FITTING
ABSORBENT
VENT
HORN
RED
OUTSIDE
INSIDE
50% NaOH
POLYETHYLENE CONTAINER (T-121)
1000 GAL
20115402-1"-NaOH
21915404-4"-SL
PARTIALLY TREATED WATER TO T-110 DRAWING NO. P-4
FILTER CAKE
FILTRATE
T-140
T-145
P-145
P-143
P-141
P-121
X-130
X-131
X-132A
X-140

NOTES

1. THIS SYSTEM HAVE COVERED TOPS AND FLANGED CONNECTIONS FOR VENTS
2. THIS VALVE TO BE LOCATED AT THE HIGHPOINT OF THE EXTRACTION SYSTEM IN EACH AREA, AND SHALL ACT AS AN AIR RELEASE VALVE
3. THIS LINE RECYCLES SLUDGE FROM THE CORE BLOW AT THE END OF THE CYCLE

THIS CONSTRUCTION DRAWING WAS BASED ON THE DESIGN DEVELOPED BY THE ARCHITECT/ENGINEER OF RECORD, BAKER ENGINEERS INC. NO WARRANTY IS EXPRESSED OR SHOULD BE IMPLIED FROM THIS DRAWING

OHM Remediation Services Corp.
Norcross, Georgia
A Subsidiary of OHM Corporation

ZONE	REV	DESCRIPTION	BY	DATE	APP
	0	ISSUE FOR DESIGN MODIFICATIONS	BM	6/27	
	1	ISSUE FOR REVIEW & APPROVAL	OHM	9/29/94	
	2	[illegible] REVIEW COMMENTS	BM	3/27/95	
	3	[illegible]	BM	1/29/95	
	4	[illegible]	GG	1/31/96	
	5	PHASE II WELLS	KM	4/11/96	
	6	[illegible]	KM	9/25/96	

AT FULL SCALE
CADD FILE
DRAWN J. LANGE/J. COLLINS
DESIGNED V. CODDARD
CHECKED
CHECKED
SUBMITTED / PROJECT MANAGER / DATE
APPROVED / DATE
APPROVED / DATE

DEPARTMENT OF THE NAVY — NAVAL FACILITIES ENGINEERING COMMAND
ATLANTIC DIVISION
NAVAL STATION — NORFOLK, VIRGINIA
LANTDIV RAC CONTRACT N62470-93-D-3032 — DELIVERY ORDER NO. 0015
OPERABLE UNIT NO. 2 — MARINE CORPS BASE, CAMP LEJEUNE, N.C.

PIPING AND INSTRUMENTATION DIAGRAM

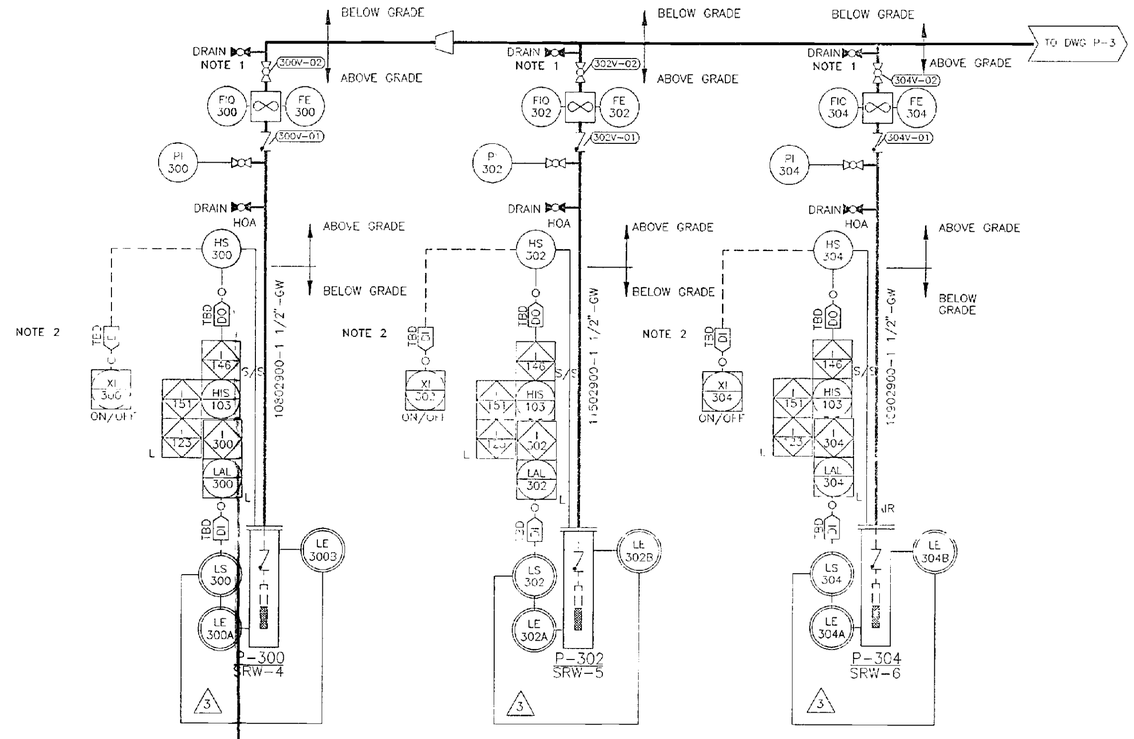
SHALLOW GROUNDWATER RECOVERY IRON REMOVAL

DRAWING NUMBER P-3

P-300
SRW-4 EXTRACTION PUMP
0 - 10 GPM

P-302
SRW-5 EXTRACTION PUMP
0 - 10 GPM

P-304
SRW-6 EXTRACTION PUMP
0 - 10 GPM



NOTES

1 REFER TO DRAWING P-3

2 DIGITAL INPUT AND OUT NUMBERS TO BE ASSIGNED BY PLC PROGRAMMER

THIS CONSTRUCTION DRAWING WAS BASED ON THE DESIGN DEVELOPED BY THE ARCHITECT/ENGINEER OF RECORD, BAKER ENGINEERS INC. NO WARRANTY IS EXPRESSED OR SHOULD BE IMPLIED FROM THIS DRAWING

OHM Remediation Services Corp.
Norcross, Georgia
A Subsidiary of OHM Corporation

SUBMITTED _____ PROJECT MANAGER DATE _____
APPROVED _____ SR. PROJECT ENGINEER DATE _____
APPROVED _____ DEPT. MANAGER DATE _____

AT FULL SCALE
(IF NOT, IT IS SCALED ACCORDINGLY)
CADD FILE \\EJEUNE\160321\RECORD\P3R1.DWG
DRAWN J. LANGE/J. COLLINS
DESIGNED V. CORDARO
CHECKED _____
CHECKED _____

REVISIONS

ZONE	REV	DESCRIPTION	BY	DATE	APP
	0	ISSUE FOR DESIGN MODIFICATIONS	BM	6/27	
	1	ISSUE FOR REVIEW & APPROVAL	OHM	9/29/94	
	2	BAKER/LANTDIV REVIEW COMMENTS	BM	3/27/95	
	3	ADDITIONAL PHASE II WELLS	KM	4/11/95	
	4	RECORD DRAWING	KM	7/16/95	

DEPARTMENT OF THE NAVY NAVAL FACILITIES ENGINEERING COMMAND
ATLANTIC DIVISION
NAVAL STATION NORFOLK, VIRGINIA
LANTDIV RAC CONTRACT N62470-93-D-3032 DELIVERY ORDER NO 0015
OPERABLE UNIT NO 2 MARINE CORPS BASE, CAMP LEJEUNE, N C

PIPING AND INSTRUMENTATION DIAGRAM

PHASE II
SHALLOW GROUNDWATER RECOVERY WELLS

DRAWING NUMBER P-3A
SHEET NUMBER _ OF _
DATE 4/11/96

P-211
93% H_2SO_4 FEED PUMP
5 G.P.H @ 10 PSIG
0.50 HP

P-212
93% H_2SO_4 FEED PUMP
5 GPH @ 10 PSIG
0.5 HP

P-101
DRW-1 EXTRACTION PUMP
30 GPM @ 200 FT TDH
5.0 HP

P-103
DRW-2 EXTRACTION PUMP
40 GPM @ 200 FT TDH
5.0 HP

P-105
DRW-3 EXTRACTION PUMP
40 GPM @ 200 FT TDH
5.0 HP

P-301
DMW-1 DEEP MONITORING WELL
150 GPM, 15 HP
(FUTURE EXTRACTION)

T-211
NaOH STORAGE TANK
2000 GALLONS

P-110A/B
AIR STRIPPER FEED PUMP
540 GPM @ 80 FT TDH
15.0 HP

P-120
JET MIXING PUMP
1250 gpm
10 HP

T-110
GROUNDWATER STORAGE TANK
ATM @ 150° F

P-025 & P-025A
BUILDING DRAINAGE PUMP
15 GPM @ 40 FT TDH
3 HP

P-115
CONTAINMENT AREA SUMP PUMP
10 GPM @ 30 FT TDH
3 HP

T-025
BUILDING DRAINAGE WET WELL

SPEC 02900 SPEC 15401
BELOW GRADE ABOVE GRADE

BELOW GRADE
ABOVE GRADE
DRAIN
NOTE 2
HOA
ON/OFF
S/S
ABOVE GRADE
BELOW GRADE
DRAIN
SP
2" CAMLOCK FOR TANKERS
ON/OFF
STOP
HOA
ON/OFF
STOP
BUILDING DRAINAGE AND SEAL WATER
TO X-130 FOR TREATMENT
PARTIALLY TREATED WATER FROM P-145 DRAWING NO. P-2
H_2SO_4 TO TANK X-170
30215403-1"-AC
14315401-3"-PW
OUTDOORS INDOORS
13515401-3"-PW
31415401-3"-PW
31515401-3"-PW
pH
JET MIXING HEADER
24" MW
T-110
13615401-8"-PW
14415401-8"-PW
OUTDOORS INDOORS
13715401-8"-PW
14115401-6"-PW
PROCESS WATER AIR STRIPPER DRAWING NO. P-2
BLDG WALL
INDOORS OUTDOORS
13815401-8"-PW
13915401-8"-PW
HORN
PED
VENT
ABSORBENT
OUTSIDE
3" DRAIN
93% H_2SO_4 (T-211) 2000 GAL
NOTE 3
NOTE 4
P-120
P-101(DRW-1)
P-103(DRW-2)
P-105(DRW-3)
P-301(DMW-1)
P-211
P-212
P-115
P-025 P-025A
P-110A
P-110B

NOTES

1 ALL INSTRUMENTS, VALVES, AND PIPING SHALL BE ENCLOSED IN AN ABOVE GROUND, LOCKABLE SHELTER AT EACH WELL HEAD FOR ALL EXTRACTION WELLS.

2 THIS VALVE TO BE LOCATED AT THE HIGHPOINT OF THE EXTRACTION SYSTEM IN EACH AREA, AND SHALL ACT AS AN AIR RELEASE VALVE.

3 SEE LAYOUT AND ISOMETRICS FOR REDUCER AND EXPANSION JOINT LOCATIONS.

4 SHUTDOWN PUMP P-120 ONE HOUR AFTER SHUTDOWN OF PUMPS P-110A/B. ONE HOUR DELAY NOT APPLICABLE ON LOW LEVEL SHUTDOWN.

5 DESIGN NOT FINALIZED FOR SANITARY WASTE PUMPING STATION WILL BE UPDATED WITH AS-BUILTS.

THIS CONSTRUCTION DRAWING WAS BASED ON THE DESIGN DEVELOPED BY THE ARCHITECT/ENGINEER OF RECORD, BAKER ENGINEERS INC. NO WARRANTY IS EXPRESSED OR SHOULD BE IMPLIED FROM THIS DRAWING

ZONE	REV	DESCRIPTION	BY	DATE	APP
	0	ISSUE FOR REVIEW & MODIFICATIONS	BM	6/27	
	1	ISSUE FOR REVIEW & APPROVAL	OHM	9/29/94	
	2	BAKER ATLANTIC REVIEW COMMENTS	BM	3/27/95	
	3	P&ID	BM	11/29/95	
	4	P&ID	CG	1/31/96	
	5	REVISED PER ELECTRICAL ENG.	KM	4/11/96	
	6	RECORD DRAWING	KM	9/25/96	

OHM Remediation Services Corp.
Norcross, Georgia
A Subsidiary of OHM Corporation

AT FULL SCALE
CADD FILE
DRAWN J. LANCE/W.C.
DESIGNED V. CORDARO
CHECKED
CHECKED

SUBMITTED — PROJECT MANAGER — DATE
APPROVED — OHM PROJECT ENGINEER — DATE
APPROVED — NAVY ENGINEER — DATE

DEPARTMENT OF THE NAVY — NAVAL FACILITIES ENGINEERING COMMAND

ATLANTIC DIVISION

NAVAL STATION — NORFOLK, VIRGINIA

LANTDIV RAC CONTRACT N62470-93-D-3032 — DELIVERY ORDER NO. 0015

OPERABLE UNIT NO. 2 — MARINE CORPS BASE, CAMP LEJEUNE, N.C.

PIPING AND INSTRUMENTATION DIAGRAM

DEEP GROUNDWATER RECOVERY AND EQUALIZATION SYSTEM

DRAWING NUM: P-4
SHEET NUMBER: — OF —
DATE: 3\27\96

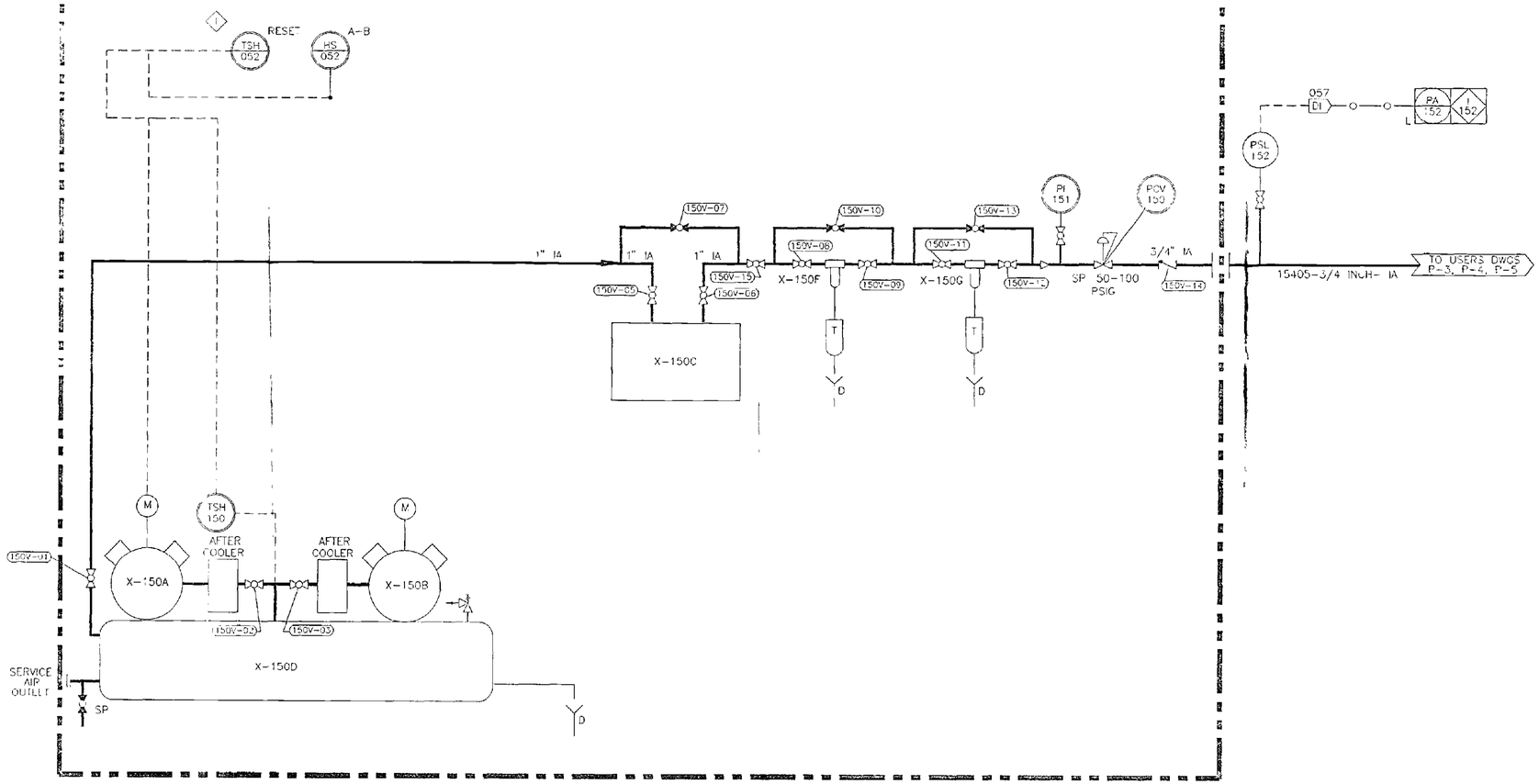
X-150 A/B
AIR COMPRESSOR
33 CFM @ 125 PSIG
OILLESS TWO STAGE RECIPROCATING
10 HP, 230/460/3/60 TEFC

X-150D
RECEIVER
150 PSIG

X-150C
REFRIGERATED
AIR DRYER

X-150F
OIL SEPARATOR
150 PSIG

X-150G
PARTICULATE
AIR FILTER
10 MICRON



THIS CONSTRUCTION DRAWING WAS BASED ON THE DESIGN DEVELOPED BY THE ARCHITECT/ENGINEER OF RECORD, BAKER ENGINEERS INC. NO WARRANTY IS EXPRESSED OR SHOULD BE INFERED FROM THIS DRAWING.

OHM Remediation Services Corp.
Norcross, Georgia
A Subsidiary of OHM Corporation

SUBMITTED _____ PROJECT MANAGER _____ DATE
APPROVED _____ SR. PROJECT ENGINEER _____ DATE
APPROVED _____ DEPT. MANAGER _____ DATE

AT FULL SCALE (IF NOT, SCALE ACCORDINGLY)
CADD FILE P-6.DWG
DRAWN J. LANGE
DESIGNED V. CORDARO
CHECKED
CHECKED

REVISIONS

ZONE	REV	DESCRIPTION	BY	DATE	APP
	0	ISSUE FOR DESIGN MODIFICATIONS	BM	6/27	
	1	ISSUE FOR REVIEW & APPROVAL	OHM	9/29/94	
	3	BAKER/LANTDIV REVIEW COMMENTS	BM	3/27/95	
	4	PHASE II WELLS	KM	4/11/95	
	5	RECORD DRAWING	KM	7/17/95	

DEPARTMENT OF THE NAVY NAVAL FACILITIES ENGINEERING COMMAND
ATLANTIC DIVISION
NAVAL STATION NORFOLK, VIRGINIA
LANTDIV RAC CONTRACT N62470-93-D-3032 DELIVERY ORDER NO. 0015
OPERABLE UNIT NO 2 MARINE CORPS BASE, CAMP LEJEUNE, N C

PIPING AND INSTRUMENTATION DIAGRAM

PLANT SERVICE SYSTEMS

DRAWING NUMBER P-6
SHEET NUMBER _ OF _
DATE 3/27/95


X-220A/B
CAC ADSORBERS
75 PSIG @150 F
T-205
BACKWASH WATER HOLDING TANK
ATM @ 150°F
P-205
SPENT BACKWASH
WATER PUMP
5 GPM @ 30FT TDH
P-220A/B
GAC ADSORBER FEED PUMPS
540 GPM @ 100'-0" TDH
20 HP
T-240
TREATED EFFLUENT HOLDING TANK
ATM @ 150°F
F-220A/B/C
CARTRIDGE FILTERS
150 PSIG @150 F
10 MICRON
P-245
REUSE WATER PUMP
3/4 HP
C-200
AIR STRIPPING COLUMN
6" FRP
K-200
AIR STRIPPING COLUMN FAN
5 HP
T-220
STRIPPER EFFLUENT HOLDING TANK
ATM @ 150°F
FRP
P-241
BACKWASH WATER PUMP
DUCTILE IRON/316SS
7.5 HP
X-220A
X-220B
T-240
T-205
T-220
C-200
K-200
P-241
P-245
P-205
P-220A
P-220B
F-220A/B/C
COMPRESSED AIR
BACKWASH INLET
EFFLUENT
RECYCLE LINE
PARSHALL FLUME
GRAVITY
BELOW GRADE
INDOORS
OUTDOORS
BACKWASH
STRAINER
TO POLYMER BLEND SYSTEM
SEAL WATER TO NORTH WALL INSERT "B" THIS DWG
SEAL WATER TO WEST WALL STATIONS FOR DISTRIBUTION
INSERT "A" THIS DWG
PROCESS WATER FROM P110 A/B DRAWING NO. P-4
INSERT "B"
NORTH WALL SEAL WATER STATION
INSERT "A"
WEST WALL SEAL WATER STATION
SEAL WATER TO PUMP
TO POLYMER PUMP
HOSE CONNECTION
TO ATM
PRIMING VALVE
ACID WASH
DRAIN
ABOVE ROOF
BACKWASH WATER TO REACTION TANK X-130 CHAMBER 1, DWG P-3
BACKWASH WATER TO REACTION TANK X-130 CHAMBER 2, DWG P-3
41215401-8"-TGW
41315401-8"-TGW
41615401-4"-TGW
41715401-6"-TGW
41815401-6"-TGW
42115401-3"-TGW
42215600-4"-V
43215401-4"-BW
43515401-8"-PW
3215401-8"-PW
41015401-3"-PW
40715401-8"-PW
40615401-8"-PW
40815401-6"-PW
40915401-8"-PW
43015401-6"-PW
40115401-1 1/2"-BW
40215401-1 1/2"-BW
40315401-3"-SL
40515600-4"-V
NOTES:
1. TANK T-220 SHALL BE SUPPLIED WITH COLUMN C-200. THIS WILL ACT AS A SUMP FOR THE COLUMN.
2. SHUTDOWN FAN K-200 W/ ADJUSTABLE TIME DELAY SHUTDOWN OF PUMPS P-110A/B.
3. THIS VALVE SHALL BE LOCATED A THE HIGH POINT AND SERVE AS AN AIR RELEASE VENT.
4. SEE LAYOUT AND ISOMETRICS FOR REDUCER AND EXPANSION JOINT LOCATION.
5. PRESSURE GUAGES NOT SHOWN FOR CLARITY.
THIS CONSTRUCTION DRAWING WAS BASED ON THE DESIGN DEVELOPED BY THE ARCHITECT/ENGINEER OF RECORD: BAKER ENGINEERS INC. NO WARRANTY IS EXPRESSED OR SHOULD BE IMPLIED FROM THIS DRAWING.

OHM Remediation Services Corp.
Norcross, Georgia
A Subsidiary of OHM Corporation

SUBMITTED ____ PROJECT MANAGER ____ DATE ____
APPROVED ____ SR. PROJECT ENGINEER ____ DATE ____
APPROVED ____ DATE ____

AT FULL SCALE (IF NOT 2" SCALE ACCORDINGLY)
CADD FILE ____
DRAWN J. LANGE
DESIGNED V. CORDARO
CHECKED
CHECKED

ZONE	REV	DESCRIPTION	BY	DATE	APP
	0	ISSUE FOR DESIGN MODIFICATIONS	BM	6/27	
	1	REVISED PER MEMO DATED 7/5/94	BM	7/5	
	2	ISSUE FOR REVIEW & APPROVAL	OHM	9/29/94	
	3	DAPER/LANTDIV REVIEW COMMENTS	BM	3/27/95	
	4	[illegible]	BM	11/28/95	
	5	REVISED PER ELECTRICAL ENG	KM	4/11/96	
	6	RECORD DRAWING	KM	9/25/96	

DEPARTMENT OF THE NAVY — NAVAL FACILITIES ENGINEERING COMMAND

ATLANTIC DIVISION

NAVAL STATION — NORFOLK, VIRGINIA
LANTDIV RAC CONTRACT N62470-93-D-3032 — DELIVERY ORDER NO. 0015
OPERABLE UNIT NO. 2 — MARINE CORPS BASE, CAMP LEJEUNE, N.C.

PIPING AND INSTRUMENTATION DIAGRAM

VOC REMOVAL SYSTEM

DRAWING NUMBER: P-5
SHEET NUMBER: _ OF
DATE: 6/27/

1.0 SYSTEM OPERATIONS

1.1 GENERAL PROCESS DESCRIPTION

In order to provide the reader with a general idea of the water treatment system, a brief description on this system is given below. A list of the major pieces of equipment associated with this system is given in Table 1.1. A set of process flow and instrumentation diagram drawings numbered P-1 through P-6 are attached in this section. The reader is encouraged to refer to these drawings from time to time.

1.1.1 Shallow Groundwater Influent Flow and Iron Removal System

Groundwater from the shallow wells is pumped to an iron removal system. The extracted groundwater enters the first chamber of the mix tank (X-130). The mix tank is a rectangular carbon steel tank containing baffles that separate the tank into three equal sized chambers. Each chamber is designed to yield approximately 30 minutes hydraulic detention time. In the mix tank, compressed air is allowed to gently bubble through the water to oxidize any ferrous iron to ferric iron, the pH of the water is adjusted with caustic to between 8.5 and 9.0, followed by a polymer solution and a metal scavenger chemical added at the last chamber to flocculate the solids.

The groundwater and flocculate flows by gravity to an inclined plate clarifier (X-131). In the clarifier, the flocculated solids are allowed to settle to the bottom, while the clarified water overflows a clarifier weir and drains by gravity to a head tank (T-145). The partially treated and clarified water is then pumped to the groundwater storage tank (T-110) by means of the supernatant transfer pump (P-145).

Sludge collected at the clarifier bottom is blown down intermittently to a sludge thickening tank (T-140) and further thickened by gravity separation. Solids from the sludge thickening tank is pumped intermittently to a filter press (X-140) for dewatering. The sludge cake is placed in a bulk container to be shipped to an appropriate off-site disposal facility.

1.1.2 Deep Groundwater Influent Flow

Groundwater from the deep aquifer wells is pumped directly to the groundwater storage tank (T-110) where it is combined with the clarified water from the shallow wells. In T-110, the water is equalized and the pH is adjusted with the addition of sulfuric acid. The water is then pumped via P-110A/B to the air stripper (C-200).

TABLE 1.1

clinstr1.lit

MAJOR EQUIPMENT LIST

MCB Camp Lejeune - Groundwater Treatment System
OHM Project #16032

Item ID #	Component	Item ID#	Component
C - 200	Air stripping column	T - 220	Stripper effluent holding tank
F - 220A/B/C	Cartridge filter	T - 240	Treated effluent holding tank
K - 200	Air stripper column fan	X - 130	Mix Tank
P - 025	Building drainage pump (wet well)	A - 130	Mixer
P - 025A	Building drainage pump (wet well)	X - 131	Inclined plate clarifier
P - 110A	Air stripper feed pump	X - 132	Liquid polymer feed system
P - 110B	Air stripper feed pump (back-up)	X - 132A	Metal scavanger/Coagulant pump
P - 115	Containment area sump pump	X - 140	Plate and frame filter press
P - 120	Jet mixing pump	X - 150A/B	Air compressors
P - 121	50% NaOH feed pump	X - 150C	Refrigerated air dryer
P - 141	Filter press feed pump	X - 150D	Compressed air receiver
P - 143	Sludge blowdown pump	X - 150F	Compressed air oil separator
P - 145	Supernatant transfer pump	X - 150G	Compressed air particulate filter
P - 205	Spent backwash water pump	X - 220A	GAC adsorber
P - 211	93% H_2SO4 feed pump	X - 220B	GAC adsorber
P - 212	93% H_2SO_4 feed pump	P - 100	SRW-1 shallow well pump
P - 241	Backwash water pump	P - 102	SRW-2 shallow well pump
P - 245	Reuse water pump	P - 104	SRW-3 shallow well pump
P - 220A	GAC adsorber feed pump	P - 300	SRW-4 shallow well pump
P - 220B	GAC adsorber feed pump (back-up)	P - 302	SRW-5 shallow well pump
T - 025	Building drainage wet well	P - 304	SRW-6 shallow well pump
T - 110	Groundwater storage tank	P - 101	DRW-1 deep well pump
T - 121	50% NaOH storage tank	P - 103	DRW-2 deep well pump
T - 140	Sludge thickening tank	P - 105	DRW-3 deep well pump
T - 145	Head tank	P - 301	DMW-1 monitoring well pump
T - 205	Backwash water holding tank		
T - 211	93% H_2 SO4 storage tank		

1.1.3 Air Stripping

Water from the groundwater storage tank (T-110) is pumped by means of air stripper feed pumps (P-110A/B) to the packed tower air stripper (C-200). The process water enters the top of the tower and flow by gravity, counter-current to the rising stripper air to the stripper effluent holding tank (T-220). The stripper air is discharged directly to the atmosphere.

1.1.4 Cartridge Filtration and Granular Activated Carbon (GAC) Adsorption

The air stripper effluent water is pumped from the stripper effluent holding tank (T-220) by means of GAC adsorber feed pumps (P-220A/B) through a cartridge filtration system (F-220A/B/C) consisting of three filters connected in parallel. After which the water is sent through granular activated carbon (GAC) adsorbers (X-220A/B) to the treated effluent holding tank (T-240).

The GAC adsorbers will be backwashed manually based on differential pressure. Backwash water pump (P-241) sends the treated effluent water from the treated effluent holding tank (T-240) to the GAC adsorbers. The spent backwash water is directed to the backwash water holding tank (T-205). The cartridge filter elements will be changed manually as required based on differential pressure.

1.1.5 Treated Effluent Storage and Discharge

The treated effluent water is stored in the treated effluent holding tank (T-240) and is discharged by gravity to the designated outfall Wallace Creek. The treated water is also used to serve as pump mechanical packing gland seal water and for polymer dilution water by means of the reuse water pump (P-245).

1.2 OPERATING PRESTART

1.2.1 Pre-Startup Checklist

Prior to operating the remediation system, a number of items must be addressed. These items are summarized in this section and in the pre-start up check list provided in Table 1.2.1. The Plant Manager or Site Supervisor will have the responsibility of checking and dating, and/or completing these items prior to startup.

1.2.2 Security and Site Access

The treatment area and associated extraction wells within Site 82 are located within a secured chain-link fenced area. Only authorized personnel will be allowed in the exclusion zone, within the treatment building or well houses during the startup period. This list of authorized personnel will be determined by the Plant Manager.

TABLE 1.2.1

PRE-STARTUP CHECK LIST

MCB Camp Lejeune - Groundwater Treatment System

Date	Pre-Startup Item
	☐ HASP amended if needed to accommodate start-up tasks
	☐ Site personnel briefed on start-up procedures
	☐ Tanks, piping & valves inspected for mechanical completion
	☐ Check all piping connections and seals
	☐ Verbal notification to ROICC and RPM (as appropriate)
	☐ Health and Safety action items in Section 2.3 implemented
	☐ Electrical sub to verify all electrical supply connections
	☐ Main power distribution on
	☐ Ensure all HOA switches for motors are on "OFF" position
	☐ Pressure test of chemical feed lines completed
	☐ Check balance and lubrication of motors, blowers as appropriate
	☐ Building ventilation and lighting functional
	☐ Equipment identified/labeled
	☐ Process valves identified/labeled
	☐ Visually inspect intervals of all vessels; remove foreign objects
	☐ Temporary eyewash station and shower installed
	☐ Polymer mix station X-132 calibrated
	☐ Tank - 121 Charged with 50% NaOH
	☐ Tank - 211 charged with 93% H_2SO_4
	☐ pH meter calibrated using standards for X - 130
	☐ Jar test performed to determine starting polymer concentration
	☐ All sample ports and drains in closed position
	☐ Verify tags on pressure relief valves
	☐ Open cartridge filter housings and install cartridges, secure housing
	☐ Check and record base line flow meter readings
	☐ Check and record locally mounted pressure indicators for baseline readings
	☐ Obtained MSDS sheets for polymer, acid, caustic
	☐ Carbon cells charged with granular activated carbon (8,000 lbs ea.)
	☐ Tank T-240 filled with water for pump seal water
	☐ Ensure floor drains are not obstructed

1.2.3 Health and Safety

Emergency contacts and phone numbers for local fire, police, utilities, etc. are listed in the Site Specific HASP which will be maintained on-site. To help prevent slips, trips, and falls within the building, spare parts and equipment will be isolated from designated work areas. Dangerous areas within and outside the treatment building will be barricaded as necessary. Additionally, fire extinguishers will be located at various places within the building as determined by the Site Safety Officer or HASP. The following precautions will be implemented as appropriate.

- High voltage warning labels
- Hot warning labels
- Danger signs
- Parking bollards
- Eye wash or shower
- Marking of all acid, caustic, and polymer piping and tanks
- Maintain spill supplies
- Ensure all motor guards are securely in place

In addition, plant personnel must adhere to Standard Operating Procedures including Lockout/Tagout, Confined Space Entry, and others as appropriate for the tasks performed during the startup.

1.2.4 Key Contacts and Site Personnel

Various individuals from OHM, MCB Camp Lejeune, LANTDIV, NC DEHNR, and Stone & Webster, may be involved in the system startup. Table 1.2.2 lists the key contacts, title, and phone numbers for on-site and off-site personnel. Emergency contacts and phone numbers are provided in the HASP.

Several of the major equipment vendors will provide startup assistance to verify that equipment has been installed in accordance with manufacturer's recommendations and that equipment is functioning within the specified operating parameters. They will be available to provide startup assistance under the direction of the Plant Manager. Key Vendor contacts, phone numbers, and fax numbers for the major mechanical and electrical components are provided in Table 1.2.3.

TABLE 1.2.2

clinstr1.lit

KEY CONTACT LIST
MCB Camp Lejeune - Groundwater Treatment System
OHM Project #16032

Company/Agency	Contact	Title	Phone Number
OHM Site			910-451-2390
OHM Personnel	Jim Dunn	Project Manager	770-734-8072
	Alan Whitt	Project Supervisor	910-451-2599
	Randy Smith	Project Supervisor	910-451-2599
	Dwayne Currie	Deputy Program Manager	770-453-7707
	Phil Verbout	Sr. Electrical Engineer	713-775-7631
	Steve Grant	Site H & S Officer	910-451-2390
	Terry Whitt	Sr. Project Chemist	770-453-7686
	Greg Gilles	Technical Manager	770-453-7687
	Kai Mak	Sr. Project Engineer	770-453-7607
	Tom McCrory	Sr. Project Hydrogeologist	770-453-7663
	Angelo Liberatore	Reg. H & S Manager	770-453-7671
Stone & Webster	Chuck Lawrence	QC Engineer	615-755-9753
MCB Camp	Vann Marshburn	Supervising Engineer	910-451-2583
	Lt. Cheryl Hansen	A-ROICC	910-451-2581
	John Cotton	Construction Inspector	910-451-5006
LANTDIV	Kate Landman	RPM	804-322-4811
	Jerry Haste	COTR	804-444-8422
IRD/EMD	Neal Paul		910-451-5068
	Tom Morris		910-451-5068
NC DEHNR	Patrick Watters	Superfund RPM	910-353-3558
EPA-Region IV	Gena Townsend	RPM	404-347-3066
Southerland Electric	Scott Sosa	Project Manager	910-347-1754
Hatcher Construct.	Donald Hatcher	Owner/PM	910-285-7633
N.E. Construction	Tom DeLong	Project Manager	910-733-2801

TABLE 1.2.3

VENDOR CONTACT LIST

MCB Camp Lejeune - Groundwater Treatment System
OHM Project #16032

Company	Equipment	Contact	Phone / Fax Number
Industrial Sales	Valves, gauges, fittings, pumps	Gene Wells	910-763-5126 910-763-3207
P.R. Bradley & Assoc.	Meter pumps, Lightinng mixer	Mike Wolfe	770-998-1956 770-998-0119
Drillers Services Inc.	Wells, well pumps	Terry Yount	800-334-2308 704-322-7674
Industrial Plastics	Plastic pipe & fittings	Steve Bailey	770-844-7324 912-748-8327
Carolina Plastic Supply	HDPE pipe & fittings	Marc Davis	704-588-0541 704-588-5742
Goulds Pumps Inc.	Pumps	Joe Ruggiero	770-446-3369 770-446-3651
Boart Longyear	Downwell tubing	Bob Beyer	770-469-2720 770-498-2841
Palmer Manufacturing	FRP Tanks (T-110)	Scott Case	770-925-4855 770-925-4869
Northeast Construction	Buildings	Steve Straper	910-353-3558 910-353-3005
Proco Products		Sylvia Augusto	800-344-3246 209-943-0242
Atlanta Rod	Nuts/ bolts	Mary White	770-889-2136 706-356-2940
Hilti Corp.	Nuts/bolts, fastners	David Holloway	800-879-8000 800-879-7000
Eco Equip. Inc.	Jet mixer pump system	Steve Hart	770-345-2118 770-345-2699
Hertz Equipment		Steve Koroly	910-799-9751 910-395-2405
Fowler Manf.	Platforms	Doug Wolcott	904-246-4886 904-241-8056
Chet Adams	Elec. & Gas Heaters	E. Adams	919-851-6331 919-851-6371
Ingersall Rand	Air compressors	Gary Michael	770-936-6200 770-936-8210
R&W Construction	Tanks, structure steel	Wayne Pierce	910-455-1830 910-455-9163
Ladder Distr. Inc.		Carl Jocobsen	770-447-9057 770-447-9057
Cowen Supply	Piping hardware	Greg Southwell	404-351-6351 404-351-1259
C.M. Kemp Manf.	Dri-breather	Venita Gornew	410-761-5100 410-766-9105
Envirotrol	Carbon filter system	Tim Sokol	412-741-2030 412-741-2670
Pumping Systems Inc.	Diaphragm Air pumps	Michael Konopa	770-458-9555 770-455-9133
Filtration Tech.	Cartridge/Air filters	Scott Matthews	919-859-0124 919-859-0370
Gray Bar Elect.	Electric material supplies	Doyle Strickland	770-441-5580 770-446-7693

TABLE 1.2.3 (Cont.)

VENDOR CONTACT LIST

MCB Camp Lejeune - Groundwater Treatment System
OHM Project #16032

Company	Equipment	Contact	Phone / Fax Number	
Dewy Brothers	Manhole rings & covers	Pat Miller	800-931-9391	
Hercules Steel	Inffluent box	Claude Scott	910-488-5110	910-488-4040
National Environ. Systems	Air Stripper tower	Pixie Terreault	508-761-6611	508-761-6898
Saws controls	Ceramic Air diffusers	Larry Sears	770-993-4392	770-998-2430
Delta Sales	Eyewash stations	Gene Waters	770-934-9960	770-934-6865
Hugo Jahnz & Assoc.	Plastic tanks	Ansley Jimmerson	770-889-1732	770-887-7405
Engineered Fiberglass	FRP Well Building	Clarence Kazmir	770-475-2242	770-664-6906
Jenkins Gas & Oil	LP tank	Keith McGouden	910-455-1711	910-346-9404
George Selke Co.	HDPE tanks	Mike Callahan	770-925-4855	770-925-4869
Hoffman & Hoffman	Roof fans	Bill Poole	919-781-8011	919-787-6019
Tracon Inc.	Meter manhole		770-475-2242	770-664-6906
Parkson Corp.	Lamella separator	Larry Sears	770-993-4392	770-998-2430
Tindall Concrete	Concrete Manholes	Fred Bosket	864-576-3230	864-587-8828
J.L. Pierce Surveying	Surveyor	J. Pierce		
Semblex Inc.	Polymer feed system	Steve Hart	770-345-2118	770-345-2699
Netzsch Filter	Filter press	Robert N. Hanks	610-363-8010	610-363-0971
High Rise Service Co. Inc.	Acid containment area coating	Donnie Cannon	910-371-2325	
ISCO Inc.	Ultrasonic Effluent Flowmeter		800-228-4373	
Lightnin c/o Bradley & Assoc.	Mixer (A-130)	Mike Wolfe	404-998-1956	
Tencarva Machinery Co.	Service all Goulds Pumps	Scott Hudson	910-799-8800	910-799-8801
Utility Precast Inc.	Electric manholes	Tommy McClellan	704-596-6283	704-596-6289

Table 1.2.3 (Cont.)			
US Foundry & Manufacturing Corp.	Electrical manhole rings & cover	Steve Douglass	404-696-8810 404-696-9482
Worth Chemical Corp.	50% Caustic	Stan Tew	864-574-2785
KOCH Sulfur Products Co.	93% Sulfuric acid	Ray Wilson	800-414-2243
Betz Entec, Inc.	Polymer, metal scavenger chemicals	Barry Owings	919-783-7071 919-783-7093
Halliday Prods.	Alum access frame	Jim Cook	407-298-4470 407-298-4534
G.E. Supply	Transformer & Elec. Equip. Supplies	Dave Whinsile	404-840-4196
Bertsch Co.	Pipe fittings	Bunnie	419-666-6605 419-666-3344

TABLE 1.2.4

INSTRUMENTATION LIST
MCB Camp Lejeune - Groundwater Treatment System
OHM Project #16032

Item ID#	Type	Function
AE-130A	Analyzer element	pH measurement in X-130 chamber 1
AE-130B	Analyzer element	pH measurement in X-130 chamber 2
AIT-130A	pH transmitter	Transmitter for AE-130A
AIT-130B	pH transmitter	Transmitter for AE-130B
AE-200A	Analyzer element	pH measurement in T-110 outlet
AE-200B	Analyzer element	pH measurement in T-110 outlet
AE-200C	Analyzer element	pH measurement in T-110 outlet
AIT-200A	pH transmitter	Transmitter for AE-200A
AIT-200B	pH transmitter	Transmitter for AE-200B
AIT-200C	pH transmitter	Transmitter for AE-200C
FCV-110	Flow control valve	Air stripper feed flow control valve
FCV-220	Flow control valve	GAC adsorber feed flow control valve
FE-101	Flow element	Deep well pump P-101 discharge flow, DRW-1
FE-103	Flow element	Deep well pump P-103 discharge flow, DRW-2
FE-105	Flow element	Deep well pump P-105 discharge flow, DRW-3
FE-301	Flow element	Deep well pump P-301 discharge flow, DMW-1
FE-100	Flow element	Shallow well pump P-100, SRW-1
FE-102	Flow element	Shallow well pump P-102, SRW-2
FE-104	Flow element	Shallow well pump P-104, SRW-3
FE-300	Flow element	Shallow well pump P-300, SRW-4
FE-302	Flow element	Shallow well pump P-302, SRW-5
FE-304	Flow element	Shallow well pump P-304, SRW-6
FE-106	Flow element	Shallow well pumps combined discharge flow
FE-107	Flow element	Deep well pumps combined discharge flow
FE-110	Flow element	Air stripper feed flow
FE-200	Flow element	Air stripper blower K-200 air flow
FE-220	Flow element	Cartridge filter feed flow
FE-240	Flow element	Treated effluent to creek
FI-150	Flow indicator	Compressed air rotameter for mix tank X-130
FI-132	Flow indicator	Polymer dilution water flow indicator

Table 1.2.4 (cont.)

FIQ-101	Flow meter	Deep well pump P-101 discharge flow
FIQ-103	Flow meter	Deep well pump P-103 discharge flow
FIQ-105	Flow meter	Deep well pump P-105 discharge flow
FIQ-301	Flow meter	Deep well pump P-301 discharge flow
FIQ-100	Flow meter	Shallow well pump P-100 discharge flow
FIQ-102	Flow meter	Shallow well pump P-102 discharge flow
FIQ-104	Flow meter	Shallow well pump P-104 discharge flow
FIQ-300	Flow meter	Shallow well pump P-300 discharge flow
FIQ-302	Flow meter	Shallow well pump P-302 discharge flow
FIQ-304	Flow meter	Shallow well pump P-304 discharge flow
FIT-106	Flow transmitter	Shallow well pumps combined discharge flow
FIT-107	Flow transmitter	Deep well pumps combined discharge flow
FIT-110	Flow transmitter	Air stripper feed flow
FIT-220	Flow transmitter	Cartridge filter feed flow
FIT-240	Flow transmitter	Treated effluent to creek
LE-100A	Level element	SRW-1 well water low level
LE-100B	Level element	SRW-1 well water high level
LE-102A	Level element	SRW-2 well water low level
LE-102B	Level element	SRW-2 well water high level
LE-104A	Level element	SRW-3 well water low level
LE-104B	Level element	SRW-3 well water high level
LE-300A	Level element	SRW-4 well water low level
LE-300B	Level element	SRW-4 well water high level
LE-302A	Level element	SRW-5 well water low level
LE-302B	Level element	SRW-5 well water high level
LE-304A	Level element	SRW-6 well water low level
LE-304B	Level element	SRW-6 well water high level
LE-101A	Level element	DRW-1 well water low level
LE-101B	Level element	DRW-1 well water high level
LE-103A	Level element	DRW-2 well water low level
LE-103B	Level element	DRW-2 well water high level
LE-105A	Level element	DRW-3 well water low level
LE-105B	Level element	DRW-3 well water high level
LE-301A	Level element	DMW-1 well water low level
LE-301B	Level element	DMW-1 well water high level
LS-100	Level switch	SRW-1 well water level
LS-102	Level switch	SRW-2 well water level

3 of 5		Table 1.2.4 (cont,)
LS-104	Level switch	SRW-3 well water level
LS-300	Level switch	SRW-4 well water level
LS-302	Level switch	SRW-5 well water level
LS-304	Level switch	SRW-6 well water level
LS-101	Level switch	DRW-1 well water level
LS-103	Level switch	DRW-2 well water level
LS-105	Level switch	DRW-3 well water level
LS-301	Level switch	DMW-1 well water level
LG-205	Level gauge	Backwash water holding tank level
LG-220	Level gauge	Stripper holding tank T-220 water level
LIT-110	Level transmitter	Groundwater storage tank level
LIT-121	Level transmitter	Caustic storage tank level
LIT-131	Level transmitter	X-131 sludge level
LIT-145	Level transmitter	T-145 head tank level
LIT-211	Level transmitter	T-211 sulfuric acid level
LIT-220	Level transmitter	Stripper effluent holding tank level
LIT-240	Level transmitter	Treated effluent holding tank level
LSH-025	Level switch	Drainage sump T-025 level
LSH-110	Level switch	Groundwater storage tank high level
LSH-115	Level switch	Containment area sump T-115 high level
LSH-121	Level switch	Caustic tank T-121 level high
LSH-205	Level switch	Backwash water holding tank high level
LSH-211	Level switch	Acid tank T-211 level high
LSH-220	Level switch	Stripper tank T-220 level high
LSHH-110	Level switch	Groundwater storage tank high-high level
LSL-025	Level switch	Drainage sump T-025 level
LSL-110	Level switch	Groundwater storage tank low level
LSL-205	Level switch	Backwash water holding tank low level
LSL-115	Level switch	Containment area sump T-115 level
LSL-220	Level switch	Stripper tank T-220 level low
PCV-150	Pressure valve	Compressed air outlet pressure regulator
PDIT-220A	Pressure transmitter	Cartridge filter differential pressure
PDIT-220B	Pressure transmitter	GAC adsorber differential pressure
PI-100	Pressure indicator	SRW-1 well water discharge pressure
PI-102	Pressure indicator	SRW-2 well water discharge pressure
PI-104	Pressure indicator	SRW-3 well water discharge pressure
PI-300	Pressure indicator	SRW-4 well water discharge pressure

4 of 5		Table 1.2.4 (cont.)
PI-302	Pressure indicator	SRW-5 well water discharge pressure
PI-304	Pressure indicator	SRW-6 well water discharge pressure
PI-101	Pressure indicator	DRW-1 well water discharge pressure
PI-103	Pressure indicator	DRW-2 well water discharge pressure
PI-105	Pressure indicator	DRW-3 well water discharge pressure
PI-301	Pressure indicator	DMW-1 well water discharge pressure
PI-106	Pressure indicator	Combined shallow well water discharge pressure
PI-110	Pressure indicator	Air stripper inlet water pressure
PI-110A	Pressure indicator	Air stripper feed pump P-110A discharge pressure
PI-110B	Pressure indicator	Air stripper feed pump P-110B discharge pressure
PI-132	Pressure indicator	Polymer pressure
PI-151	Pressure indicator	Air compressor discharge pressure
PI-200	Pressure indicator	Air stripper inlet pressure from blower
PI-220A	Pressure indicator	Feed pump P-220A discharge pressure
PI-220B	Pressure indicator	Feed pump P-220B discharge pressure
PI-220C	Pressure indicator	Cartridge filter inlet pressure
PI-220D	Pressure indicator	Cartridge filter outlet pressure
PI-220E	Pressure indicator	X-220A inlet pressure
PI-220F	Pressure indicator	X-220B inlet pressure
PI-220G	Pressure indicator	Carbon absorber outlet water pressure
PI-220H	Pressure indicator	F-220A outlet pressure
PI-220I	Pressure indicator	F-220B outlet pressure
PI-220J	Pressure indicator	F-220C outlet pressure
PI-220K	Pressure indicator	F-220A inlet pressure
PI-220L	Pressure indicator	F-220B intlet pressure
PI-220M	Pressure indicator	F-220C intlet pressure
PI-245	Pressure indicator	P-245 outlet pressure
PIT-108	Pressure transmitter	Combined deep well water pressure
PS-200A	Pressure switch	Air stripper inlet pressure (low)
PS-200B	Pressure switch	Air stripper inlet pressure (high)
PSL-152	Pressure switch	Air compressor skid low discharge pressure
PSH-150	Pressure switch	Air compressor receiver tank pressure
PSV-220A	Pressure safety valve	X-220A carbon adsorber
PSV-220B	Pressure safety valve	X-220B carbon adsorber
TI-110	Temp indicator	Groundwater storage tank temperature
TI-200	Temp indicator	Air stripper column water temperature
TSH-150	Temp. Switch	Air compressor temperature switch

5 of 5		Table 1.2.4 (cont.)
WE-131	Weight element	Polymer weight
WI-131	Weight indicator	Polymer weight

PROCESS VALVE LIST

MCB Camp Lejeune - Groundwater Treatment System

OHM Project #16032

Item ID#	Type	Function
	DWG No. P-3:	**Shallow Groundwater Recovery - Iron Removal**
100V-01	Check Valve	P-100 (SRW-1) Back Flow Preventor
100V-02	Ball Valve	P-100 (SRW-1) Flow Shut off
102V-01	Check Valve	P-102 (SRW-2) Back Flow Preventor
102V-02	Ball Valve	P-102 (SRW-2) Flow Shut off
104V-01	Check Valve	P-104 (SRW-3) Back Flow Preventor
104V-02	Ball Valve	P-104 (SRW-3) Flow Shut off
121V-01	Ball Valve	P-121 Caustic Inlet Shut off
121V-02	Check Valve	P-121 Inlet Caustic Back Flow Preventor
121V-03	Ball Valve	T-121 Tanker Inlet Shut Off
121V-04	Ball Valve	P-121 Outlet Shut Off
121V-05	Ball Valve	P-121 Outlet Shut Off
130V-01	Ball Valve	X-130 Inlet to Chamber 2 Backwash Shut Off
130V-03	Ball Valve	X-130 Wet Well Inlet Shut off
130V-07	Ball Valve	X-130 Drain Shut off
130V-08	Ball Valve	X-130 Drain Shut off
132V-01	Ball Valve	X-132 Polymer Outlet Shut off
132V-02	Ball Valve	X-132 Inlet Polymer Shut off
132V-03	Ball Valve	X-132 Calibration Column Shut off
140V-01	Plug Valve	T-140 Sludge Discharge Shut off
141V-01	Ball Valve	P-141 Outlet Shut off
141V-02	Ball Valve	P-141 Sludge Blowdown Valve
141V-03	Auto Valve	P-141 Outlet Sludge Suppressor
141V-04	Ball Valve	X-140 Filtrate Outlet
141V-05	Ball Valve	X-140 Filtrate Outlet
143V-01	Auto Valve	P-143 Outlet Sludge Suppressor
143V-02	3-way Valve	(SV-143) Direct Sludge to Recycle or to T-140
143V-03	Plug Valve	P-143 Inlet Shut off
143V-04	Plug Valve	P-143 Outlet Shut Off
145V-01	Ball Valve	P-145 Inlet Shut off
145V-02	Check Valve	P-145 Outlet Back Flow Preventor
145V-03	Ball Valve	P-145 Outlet Flow Shut off
Note:	**Not all drain valves**	**are labeled. Not labeled drain valves are not**
	included in this list.	

TABLE 1.2.5 (Cont.)

Item ID#	Type	Function
145V-04	Ball Valve	LIT-145 Inlet Shut Off
150V-16	Ball Valve	X-130 Compressed Air Inlet to Aerator
150V-17	Ball Valve	X-140 Inlet Plant Air to Press
150V-18	Ball Valve	X-140 Inlet Plant Air Pressure Regulator for Core Blow
150V-19	Ball Valve	P-141 Inlet Plant Air to Pump
150V-20	Pres Regulator	P-141 Inlet Plant Air Pressure Regulation
150V-21	Ball Valve	T-140 Bottom Plant Air Purge Shut off
150V-22	Ball Valve	P-143 Compressed Air Inlet Shut Off
150V-23	Pres Regulator	P-143 Inlet Plant Air Pressure Regulation
150V-24	Ball Valve	X-140 Filtrate Line Blow Down
150V-25	Ball Valve	P-141 Inlet Plant Air Shut Off
	DWG No. P-3A	**Phase II Shallow Recovery Wells**
300V-01	Check Valve	P-300 (SRW-4) Back Flow Preventor
300V-02	Ball Valve	P-300 (SRW-4) Flow Shut Off
302V-01	Check Valve	P-302 (SRW-5) Back Flow Preventor
302V-02	Ball Valve	P-302 (SRW-5) Flow Shut Off
304V-01	Check Valve	P-304 (SRW-6) Back Flow Preventor
304V-02	Ball Valve	P-304 (SRW-6) Flow Shut Off
	DWG No. P-4:	**Deep Recovery Wells And Equalization System**
025V-01	Check Valve	Sump Pump P-025 Outlet Back Flow Preventor
025V-02	Check Valve	P-025A Back Flow Preventor
025V-03	Ball Valve	P-025 Outlet to T-110 Shut off
025V-04	Ball Valve	P-025 Outlet to X-130 Shut off
101V-01	Check Valve	P-101 (DRW-1) Outlet Back Flow Preventor
101V-02	Ball Valve	P-101 (DRW-1) Outlet Flow Shut off
103V-01	Check Valve	P-103 (DRW-2) Outlet Back Flow Preventor
103V-02	Ball Valve	P-103 (DRW-2) Outlet Flow Shut off
105V-01	Check Valve	P-105 (DRW-3) Outlet Back Flow Preventor
105V-02	Ball Valve	P-105 (DRW-3) Outlet Flow Shut off
301V-01	Check Valve	P-301 (DMW-1) Outlet Back Flow Preventor
301V-02	Ball Valve	P-301 (DMW-1) Outlet Flow Shut off
110V-01	Gate Valve	P-110A Inlet Shut off
110V-02	Check Valve	P-110A Outlet Back Flow Preventor
110V-03	Butterfly Valve	P-110A Outlet Flow Shut off
110V-04	Gate Valve	P-110B Inlet Shut off
110V-05	Check Valve	P-110B Outlet Back Flow Preventor

TABLE 1.2.5 (Cont.)

Item ID#	Type	Function
110V-06	Butterfly Valve	P-110B Outlet Shut off
110V-07	Butterfly Valve	Flow Control Valve FCV-110 Inlet Shut off
110V-08	Butterfly Valve	FCV-110 Outlet Shut off
110V-09	Butterfly Valve	FCV-110 Bypass Shut off
110V-10	Ball Valve	AE-200A Inlet Shut off
110V-11	Ball Valve	AE-200A Outlet Shut off
110V-12	Plug Valve	Tanker Connection to T-110 Shut off
110V-13	Gate Valve	T-110 Drain Shut off
110V-14	Ball Valve	T-110 Acid Inlet Shut off
110V-15	Ball Valve	AE-200B Inlet Shut off
110V-16	Ball Valve	AE-200B Outlet Shut off
115V-01	Check Valve	Sump Pump P-115 Outlet Back Flow Preventor
115V-02	Plug Valve	P-115 Outlet Shut off
115V-03	Ball Valve	T-115 Tanker Connection Shut Off
120V-01	Butterfly Valve	P-120 Inlet Jet Water Shut off
120V-02	Butterfly Valve	P-120 Outlet Jet Water Shut off
211V-01	Ball Valve	T-211 Acid Outlet Shut off from Tank
211V-02	Check Valve	P-211 Acid Inlet Back Flow Preventor
211V-03	Check Valve	P-212 Acid Inlet Back Flow Preventor
211V-04	Ball Valve	P-211 Acid Outlet Shut off from Pump
211V-05	Ball Valve	P-212 Acid Outlet Shut off from Pump
211V-06	Ball Valve	P-212 Outlet Shut Off
211V-07	Ball Valve	T-211 Tanker Connection Shut Off
	DWG No. P-5:	**VOC Removal System**
205V-01	Ball Valve	P-205 Inlet Shut off
205V-02	Check Valve	P-205 Outlet Back Flow Preventor
205V-03	Ball Valve	P-205 Outlet to X-130 Chamber 2 Shut off
205V-04	Ball Valve	T-205 Drain Shut off
205V-05	Ball Valve	LG-205 Level Gauge Lower Shut off
205V-06	Ball Valve	LG-205 Level Gauge Upper Shut off
205V-07	Ball Valve	P-205 Outlet to X-130 Chamber 1 Shut Off
220V-01	Butterfly Valve	T-220 Bottom Outlet Shut off
220V-01A	Check Valve	T-220 Outlet Backflow Preventor

TABLE 1.2.5 (Cont.)

Item ID#	Type	Function
220V-02	Gate Valve	P-220A Inlet Shut off
220V-03	Check Valve	P-220A Outlet Back Flow Preventor
220V-04	Butterfly Valve	P-220A Outlet Shut off
220V-05	Gate Valve	P-220B Inlet Shut off
220V-06	Check Valve	P-220B Outlet Back Flow Preventor
220V-07	Butterfly Valve	P-220B Outlet Shut off
220V-08	Ball Valve	Recycle to Air Stripper C-220 Shut Off Valve
220V-09	Ball Valve	P-220A/B Recycle Line Shut off
220V-10	Butterfly Valve	FCV-220 Inlet Shut off
220V-11	Butterfly Valve	FCV-220 Outlet Shut off
220V-12	Butterfly Valve	FCV-220 Bypass Shut off
220V-13	Butterfly Valve	F-220C Inlet Shut off
220V-14	Butterfly Valve	F-220B Inlet Shut off
220V-15	Butterfly Valve	F-220A Inlet Shut off
220V-16	Butterfly Valve	F-220C Outlet Shut off
220V-17	Butterfly Valve	F-220B Outlet Shut off
220V-18	Butterfly Valve	F-220A Outlet Shut off
220V-19	Butterfly Valve	F-220A/B/C Direct to T-240 Shut off
220V-20	Butterfly Valve	F-220A/B/C Outlet to GAC Shut off
220V-21	Butterfly Valve	X-220B Inlet Shut off
220V-22	Butterfly Valve	X-220A Inlet Shut off
220V-23	Butterfly Valve	X-220A Backwash Outlet Shut off
220V-24	Butterfly Valve	X-220B Backwash Outlet Shut off
220V-25	Check Valve	F-220A/B/C to GAC Backwash Back Flow
220V-26	Butterfly Valve	X-220A Bottom Drain Shut off
220V-27	Butterfly Valve	X-220B Bottom Drain Shut off
220V-28	Butterfly Valve	X-220B Shut off Backwash Inlet
220V-29	Butterfly Valve	X-220A Backwash Inlet Shut off
220V-30	Butterfly Valve	X-220B Outlet Shut off
220V-31	Butterfly Valve	X-220A Outlet Shut off
220V-32	Butterfly Valve	X-220A Bypass Shut Off
220V-33	Butterfly Valve	X-220B Bypass Shut Off
220V-34	Butterfly Valve	PSV-220A Bypass Shut Off
220V-35	Butterfly Valve	X-220A Carbon Fill Shut Off
220V-36	Butterfly Valve	X-220A Outlet Line Drain Shut Off
220V-37	Butterfly Valve	X-220B Carbon Fill Shut Off

Table 1.2.5 (Cont.)

Item ID#	Type	Function
220V-38	Butterfly Valve	PSV-220B Bypass Shut Off
220V-39	Butterfly Valve	X-220B Outlet Line Drain Shut Off
240V-01	Butterfly Valve	P-241 Inlet Shut Off
240V-02	Check Valve	P-241 Outlet Back Flow Preventor
240V-03	Butterfly Valve	P-241 Outlet Shut off
240V-04	Ball Valve	T-240 Bottom Drain Shut off
245V-01	Ball Valve	P-245 Inlet Shut off
245V-01A	Ball Valve	P-245 Inlet Shut Off
245V-02	Check Valve	P-245 Outlet Backflow Preventor
245V-03	Ball Valve	P-245 Strainer Inlet Shut off
245V-04	Ball Valve	P-245 Strainer Outlet Shut off
245V-05	Ball Valve	Seal Water Outlet to North Wall Station Shut off
245V-05A	Ball Valve	Seal Water Outlet to West Wall Station Shut off
245V-06	Ball Valve	P-245 Strainer Bypass Shut off
245V-07	Ball Valve	P-245 Outlet to Polymer System Shut off
	DWG No. P-6:	**Plant Service Systems**
150V-01	Ball Valve	Compressor Air Outlet Shut off
150V-02	Ball Valve	X-150A Aftercooler Outlet Shut off
150V-03	Ball Valve	X-150B Aftercooler Outlet Shut off
150V-05	Ball Valve	Air Dryer Inlet Shut off
150V-06	Ball Valve	Air Dryer Outlet Shut off
150V-07	Ball Valve	Air Dryer Bypass Shut off
150V-08	Ball Valve	Air Filter X-150f Inlet Shut off
150V-09	Ball Valve	X-150F Outlet Shut off
150V-10	Ball Valve	X-150F Bypass Shut off
150V-11	Ball Valve	Air Filter X-150g Inlet Shut off
150V-12	Ball Valve	X-150G Outlet Shut off
150V-13	Ball Valve	X-150G Bypass Shut off
150V-14	Check Valve	Compressed Air Back Flow Preventor
150V-15	Ball Valve	Air dryer outlet shut off

DAILY SAFETY MEETING LOG
(CONTINUATION PAGE)

Date:_____ Client:_____

Specific Location:_____ Job No._____

SAFETY TOPICS PRESENTED:

ATTENDEES:

Name Printed:	Signature:

1.2.5 Equipment Labels

All the major valves and tanks are labeled or tagged according to the revised piping and instrumentation diagrams (please note that most of the minor valves such as the drain valves, the pressure gauge inlet valves, etc. are shown on the P&IDs but are not labeled, and are therefore not included in the valve list). Tables 1.1, 1.2.4 and 1.2.5 provides the most recent list. The tags will provide a unique identifier for each component. This nomenclature will be used in subsequent sections of the startup procedures. Arrows showing the direction of flow will also be provided for the process piping. Following system startup, all above ground process water piping in the building will be painted a uniform color. Marking tape with arrows will be used to distinguish various process lines and flow direction. The following will be identified:

- Chemical feed piping
- Groundwater process piping.
- Backwash water process piping.
- Electrical supply and control conduit
- Compressed Air piping (Green)

1.2.6 Baseline Readings

Additional baseline measurements will be noted and recorded for several items if needed, some of which have been completed during the initial startup in Spring 1996. Baseline measurements will be used to measure cause and effect, to determine the operating status, and to evaluate progress. The primary items of interest include:

- Static water table elevations from selected extraction wells, permanent and temporary monitor wells in the remediation area (see OHM Aquifer Test Plan, 1/96)

- Water quality and contaminant levels of site extraction wells and monitor wells in the remediation area (Aquifer Test Plan)

- All baseline measurements identified in the Aquifer Test Plan which will determine initial groundwater pumping rates to the plant and predict cone of influence

- Pressure and flow readings on all local gauges in the well houses, pumps, and treatment equipment, and process piping

A startup logbook will be kept by the Site Supervisor or Equipment Specialist to record instrument readings, steps taken for repairs or corrective action, and other pertinent startup information.

1.3 GROUNDWATER TREATMENT SYSTEM STARTUP

1.3.1 Introduction and Purpose

The Camp Lejeune groundwater treatment plant treats the groundwater from two sources: the shallow aquifer and the deep aquifer. A well pump is installed in each well to extract and send the contaminated water to the water treatment plant. The common contaminant in the groundwater is organic contamination. Because the shallow groundwater contains a higher amount of iron and other metals contamination, an extra treatment step is implemented for the shallow groundwater. The pre-treated shallow groundwater is then combined with the deep aquifer groundwater in the groundwater storage tank T-110, equalized, and pH adjusted. The organic contaminant in the shallow and deep groundwater is then removed via air stripping, cartridge filter filtration and granulated carbon adsorption.

This section attempts to provide a more detailed step by step procedure and sequence towards the startup of the water treatment plant. However, the operator is strongly encouraged to refer to the vendors manual to become more familiar with each piece of equipment, their function, and individual operation and trouble shooting guide specific to that piece of equipment. The purpose of the procedures provided below is to link or integrate the individual pieces of equipment together to become an operating water treatment plant as a whole.

1.3.2 General Startup Sequence

Prior to getting involved with the detail step by step plant startup procedures, the following general startup sequence is provided in a summary form to help the reader understand the logic of the system startup. The reader should also refer to the P&ID drawings P-1 through P-6 for the system arrangement, piping, instrumentation, interlock logic, and valve numberings.

1. Prior to starting the water pumps, the operator should make sure the oil level in each pump is sufficient. Before any pump is turned on, the seal water to the mechanical seal packing must be turned on. Therefore, the seal water pump P-245 must be turned on first.

2. Next, startup the shallow aquifer pumps and pre-treatment system. Prior to starting the well pumps, the pump discharge line must be lined out, i.e., all shut off valves must be open all the way to the mix tank X-130.

3. To properly precipitate the metals in the shallow groundwater, caustic, polymer solution, metal scavenger and compressed air have to be turned on and introduced into the mix tank X-130.

4. The flocculated water leaves the mix tank and overflows into the clarifier. Sludge settles to the bottom of the clarifier and clarified water overflows to the head tank T-145. After a sufficient amount (water level above the T-145 low level set point) of water has accumulated in the head tank, turn on the supernatant transfer pump P-145 and transfer the pre-treated shallow groundwater to the storage tank T-110.

   NOTE: Due to the small capacity of the Head Tank T-145, the inflow and outflow from T-145 should be balanced by throttling the pump discharge valve 145V-03. The operator should try to maintain the water level in T-145 to preferable half full. Gradually throttle valve 145V-03 and observe the liquid level in T-145 and check the water level holds steady. If not, adjust 145V-03 until a steady water level is maintained. When P-145 is set to "auto," it will operate between the low level and high level and cycle "off" and "on" automatically. Note also that T-145 occasionally receives water from sump T-025 and Tank T-205.

5. Check that the water level in T-110 is above the low level set point. Start the T-110 jet mixing pump P-120 to equalize and mix the water coming from the shallow and the deep aquifers. Turn on the sulfuric acid system to adjust the water pH to 8.5 - 9.0.

6. Line out the deep aquifer well pump discharge valves, and extract the deep aquifer groundwater to the storage tank T-110.

7. Line out all the valves from the air stripper sump discharge to the cartridge filters, F-220A/B/C, the carbon filters, X-220A/B all the way to the treated effluent holding tank T-240.

8. Turn on the air stripper blower. After a sufficient amount of water has accumulated in the storage tank T-110, turn on the air stripper feed pump P-110A or B to introduce water to the top of the air stripper.

9. Allow approximately 1 to 2 minutes for the air stripper water to reach the stripper effluent holding tank T-220 prior to starting the GAC feed pump P-220A or B.

10. After passing through the GAC adsorbers X-220 A/B, the treated effluent water is directed to the treated effluent holding tank and will overflow by gravity to Wallace Creek. A Parshall Flume flow meter is installed in the effluent line to measure the quantity of water flowing to Wallace Creek. This flow meter is located outside the building while the meter recorder is installed in the control room.

1.3.3 Initial Startup

The primary sequence of steps for the initial startup is as follows:

1.3.3.1 Motor Rotation

- Ensure that all Hand-Off-Auto switches HOA for all pump motors are in the "off" position.

- Turn the HOA switch for all of the following pumps P-145, P-110A, P-110B, P-120, P-205, P-220A, P-220B, P-241, and P-245 to the "HAND" position for approximately 5 seconds. Check that the rotation of the motor is in the proper direction. If rotating is in reverse, turn off all power and switch any two incoming power leads to the motor.

1.3.3.2 Turn On Pump Seal Water

- Open ball valves 245V-01, 245V-01A, 245V-03, 245V-04, 245V-05 and 245V-05A for seal water flow to the seal water stations located in the west wall and the north wall. Line out (i.e., open) all the valves inlet to the seal water stations and outlet from the stations to the individual pumps.

- Close ball valve 245V-06 (by pass).

- Check connections of seal water lines to all pumps.

- Check that the water level in tank T-240 is above the low level as indicated by LIT-240 before the seal water pump can start (water level in T-240 should normally be at the weir level as the water overflows, but during initial startup or after a prolonged shutdown, T-240 water may be drained for some other purposes).

- Turn on pump P-245 switching HOA to 'AUTO" position at the local panel and start the pump.

- Check reading on local flow meters and pressure gauges mounted next to the pumps and at water seal stations.

- Check proper functioning of rotameter for each line; seal water flow to each pump should be approximately 1/2gpm; working pressure should be 15-20 psi above pump suction pressure plus 25% of the discharge pressure, or approximately 20 to 25 psi.

1.3.3.3 To Initiate Shallow Aquifer Influent Flow

- Before starting the shallow well pumps, open the well pump shut off valve 100V-02, 102V-02, etc., and line out the valves all the way to mix tank X-130.
- Close all sample ports and drain valves.
- Record readings on all flow totalizers.

1.3.3.4 Initiate Metals Precipitation

- Turn on air compressor
- Close drain 130V-07 on X-130.
- Close drains on the clarifier X-131, sludge tank T-140 and head tank T-145.
- Open ball valves 132V-01, 132V-02, and 245V-07 for polymer feed.
- Open X-130 chamber 3 drain valve 130V-08 for metal scavenger feed if required.
- Open ball valves 121V-01, 121V-04 and 121V-05 for caustic feed lines.
- Open ball valves 145V-01 and 145V-03 to allow treated water flow to T-110.
- Turn on the well pumps using the local "HOA" switch HS-100, HS-102 etc, by setting to"AUTO" and start the pumps using the telemetry.
- Observe water flow through flow meter FE-100, FE-102, etc.
- Begin pumping water from the well to X-130.
- Record time and flow rate via FE-100, FE-102 etc., rate should be approximately 5 gpm per well for the shallow wells.
- Throttle the flow locally with the hand valve 100V-02, 102V-02 etc to the desired flow from each well.
- Equalize flow rate into X-130 to approximately 30 gpm total using the hand valves.
- Slowly crack open ball valve 150V-16 to allow compressed air to flow into the diffuser in X-130.

- Record compressed air flow from rotameter FI-150. Compressed air flow should be approximately 5 cfm total

- Measure and record pH of water flowing into X-130.

- Turn HOA switch on caustic pump P-121 to "AUTO".

- Add caustic using P-121 to adjust pH to between 8.5 and 9.0 in X-130.

- Add diluted polymer from X-132 when water reaches the last chamber of X-130 by turning on the polymer feed pump X-132. Initial dosage should correspond to optimal jar test dosage in gallons per hour. Make sure polymer dilution water is flowing at the preset rate.

- Turn on the metal scavenger pump X-132A if this chemical is needed.

- Set P-145 HOA switch to "AUTO"; P-145 will pump effluent to T-110 on demand based on the preset tank level to be maintained; if not, switch to "HAND" for manual operation when tank is filling. (NOTE: Due to the small capacity of T-145, the water level should be balanced between inflow and outflow and maintain at half full.)

- Continue processing shallow aquifer well water

1.3.3.5 Initiate Deep Aquifer Influent Flow

- Line out the deep well pump discharge line by opening shut off valve 101V-02, 103V-02 etc. all the way to groundwater storage tank T-110.

- Close all sample ports and drain valves.

- Turn on the well pumps using the local "HOA" switch HS-101, HS-103 etc. by setting to"AUTO" and start the pumps using the telemetry.

- Observe water flow through flow meter FE-101, FE-103 etc.

- Record readings on flow totalizers.

- Throttle the flow from each well locally using the hand valve 101V-02, 103V-02, etc., to the desired flow. (Table 1.4.1 shows the desired flow from each well).

1.3.3.6 Flow Equalization in Groundwater Storage Tank

- Watch for the water level in tank T-110 when shallow and deep aquifer water begin flowing into the tank. When the level reaches above the low level indicated by LSL-110, open valves 120V-01 and 120V-02 and start the jet mixing pump P-120.

- The HOA switch on jet mix pump P-120 should be set to "AUTO".

- Allow water in T-110 to circulate; check function of jet mixing system

- Check pH in T-110 (probe on discharge line), using the three analyzers AE 200A/B/C installed. They will register the correct water pH after pump P-110 A or B is turned on.

- Set required pH on AICA-200 to between 7.5 and 8.0

- After P-110 A or B is turned on, line out all the valves 211V-01, 211V-04, 110V-14, etc. on the acid line to T-110. Add sulfuric acid with feed pump P-211 to lower pH to between 7.5 and 8.0. HOA switch for P-211 should be in "AUTO" position for automatic operation.

1.3.3.7 Air Stripper, Cartridge Filter, and Carbon Absorber Feed Preparation

- Close all drain valves and sample ports.

- Close gate valve 110V-04, and butterfly valve 110V-06 to isolate P-110B (backup).

- Open gate valve 110V-01, and butterfly valve 110V-03

- Check that the desired T-110 water level to control the operation of flow control valve FCV-110 has been preset. (Note FCV-110 will open or close to maintain the preset tank level.)

- Close butterfly valve 110V-09 on 6" bypass around FCV-110.

- Open ball valves on pump recycle line 110V-10 and 110V-11.

- Open ball valves on pump redundant pH recycle line 110V-15 and 110V-16.

- Start air stripper blower K-200 to air stripper.

- Close gate valve 220V-05, and butterfly valve 220V-07 to isolate P-220B (backup).

- Open butterfly valves 220V-01, 220V-04, gate valve 220V-02, and ball valve 220V-09 (recycle line).

- If P-220A/B intake line (from air stripper tank T-220 to pump inside building) is empty, this line has to be primed. Use a water hose to fill the intake line with water, open the air exit valve (inside building) to let air out.

- Check that the desired T-220 tank level to control the flow control valve FCV-220 has been preset. (Note: FCV-220 will open or close to maintain the preset tank level.)

- Close butterfly valve 220V-12 on 6" FCV bypass.

- Close off butterfly valves (220V-15 and 220V-18) to cartridge filter F-220A (standby) and open valves 220V-13, 220V-14, 220V-16 and 220V-17 to allow flow to two cartridge filters.

- Open butterfly valves 220V-20, 220V-21, 220V-22. (Flow to GAC adsorbers.)

- Close butterfly GAC bypass valve 220V-19.

- Close butterfly valves 220V-23, 220V-24 and all drain valves and sample ports on the GAC vessel.

- Open butterfly valves 220V-30 and 220V-31 (the normal flow to carbon adsorbers is from the top downward across the carbon bed).

- Close butterfly valves 220V-26, 220V-27, 220V-28, 220V-29, 220V-32, 220V-33, 220V-35, 220V-37, 220V-34 and 220V-38.

1.3.3.8 To begin the flow from T-110 to air stripper, cartridge filters and carbon adsorbers

- Check that water level in tank T-110 remains above jet mixing header. Jet mixer should be running; water level/height can be visualized outside of tank.

- Switch HOA switch on pump P-110A to "AUTO" position and start pump.

- Check that T-110 tank level is maintained at the desired level.

- Allow 1 to 2 minutes time elapse for P-110A outlet water to reach the air stripping tank T-220.

- As T-220 (air stripper sump) fills to approximately one half full, turn HOA switch on pump P-220A to "AUTO" position and start pump.

- Check that T-220 tank level is maintained at the desired level.

- Record all local pressure gauge readings around the pumps.

- Record and check that the pressure around the cartridge filters and the differential pressure across the filters PDIT-220A are normal.

- Record and check that the pressure around the carbon adsorbers PI-220E, PI-220F, PI-220G and the differential pressure across the adsorbers PDIT-220B are normal.

- Visually check that treated water is flowing into the treated effluent holding tank T-240. The treated water will overflow by gravity to Wallace Creek.

1.3.4 Normal Shut Down

Normal shut down will occur during operations due to various reasons such as to accommodate necessary repairs, or to conduct maintenance of the system. Normal shut down procedures will vary with the nature of the type and reason for shut down and can be divided into the following three cases. The reader should also refer to the P&ID drawings P-1 through P-6.

1.3.4.1 Normal Shut Down - Case 1 (Maintain tanks half full)

If it is desired to maintain the tanks half full of water after shut down, the procedure will be:

- Switch all process pump and well pump switches to the "OFF" position to stop the pumps and water flow. This can be done at the control panel or locally using the HOA switches.

- Turn off the pumps in the reverse order to which they are started.

- After all the well pumps and process pumps have stopped, check that the chemical feed pumps (caustic, acid, metal scavenger and polymer) are off. If not, shut them off using the control panel or manually.

- Shut off the air stripper fan K-200 (15 minutes after water flow to air stripper has stopped) from the control panel or locally using the HOA switch.

- If shut down will last for an extended period of time, shut off the tank T-110 jet mix pump and other pumps. Check that the spent backwash pump P-205, backwash pump P-241, sump pumps P-025/A and P-115 are off. The reuse water pump P-245 should be the last one to be turned off if it is not needed. Also shut off the air compressor if not required.

- If repair on equipment is needed, isolate power from the equipment and follow lockout/tagout procedure.

1.3.4.2 Normal Shut Down - Case 2 (Maintain tanks full)
If it is desired to maintain the tanks full of water after shut down, the procedure will be:

- Switch the GAC feed pump P-220 A/B to "OFF" position either from the control panel or locally using the HOA switch. Water will stop flowing into tank T-240. Stripper effluent holding tank T-220 will continue to receive water until the high level is reached and I-221 interlock initiates air stripper feed pump P-110 A /B to stop. The operator should check and make sure P-110A/B is stopped accordingly. If not, shut off P-110A/B manually.

- Tank T-110 will continue to receive water from the wells until a high level is reached that will interlock to shut down the shallow aquifer well pumps. Deep aquifer well pumps will continue to run until a high-high level is reached in T-110 and interlocks the deep aquifer well pumps to shut down.

- After all the well pumps and process pumps have stopped, check that the chemical feed pumps (caustic, acid, metal scavenger and polymer) are off. If not, shut them off using the control panel or manually.

- When the stripper tank T-220 reaches the high level shut off, the air stripper fan is interlocked to continue running for 5 minutes. Check that the stripper air blower is shut off after this period of time.

- If shut down will last for an extended period of time, shut off the tank T-110 jet mix pump and other pumps. Check that the spent backwash pump P-205, backwash pump P-241, sump pumps P-025/A and P-115 are off. The reuse water pump P-245 should be the last pump to be shut off if not required. Also shut off the air compressor if not needed.

- If repair on equipment is needed, isolate power from the equipment and follow lockout/tagout procedures.

In summary, once the GAC feed pump is stopped, the remaining pumps will cascade to shut down via high tank level interlocks. NOTE: This type of shutdown (keeping tanks full) is not recommended unless it is necessary.

1.3.4.3 Normal Shut Down - Case 3 (Maintain tanks at low level)
If it is desired to maintain the tanks at low level after shut down, the procedure will be:

- Switch the shallow well pumps to "OFF" position either from the control panel or locally using the HOA switch. Water will stop flowing into tank X-130. Head tank T-145 will stop receiving water while pump P-145 continues to run until the low level is reached and interlock pump P-145 to stop on low level.

- Switch the deep well pumps to "OFF" position either from the control panel or locally using the HOA switch. Water will stop flowing into tank T-110. Tank T-110 will stop receiving water while pump P-110 A/B continues to run until the low level is reached and interlock pump P-110 A/B to stop on low level. Jet mix pump P-120 will also interlock to stop.

- Tank T-220 will stop receiving water while P-220 A/B continues to run until a low level is reached in T-220 and interlocks pump P-220 A/B to shut down.

- After all the well pumps and process pumps have stopped, check that the chemical feed pumps (caustic, acid, metal scavenger and polymer) are off. If not, shut them off using the control panel or manually.

- When the stripper tank T-220 reaches the low level shut off, the air stripper fan is interlocked to continue running for 15 minutes. Check that the stripper air blower is shut off after this period of time.

- If shut down will last for an extended period of time, shut off the other pumps. Check that the spent backwash pump P-205, backwash pump P-241, sump pumps P-025/A and P-115 are off. The reuse water pump P-245 should be the last pump to be tuned off if not required. Also shut off the air compressor if not needed.

- If repair on equipment is needed, isolate power from the equipment and follow lockout/tagout procedures.

In summary, once the well feed pumps are stopped, the remaining pumps will cascade to shut down via low tank level interlocks.

1.3.5 Post Shutdown Procedures

- After the system is shut down, check that all the shallow and deep aquifer well pumps and all the process pumps are stopped.

- Check that the jet mix pump P-120, spent backwash pump P-205, backwash pump P-241, reuse water pump P-245, sump pumps P-025/A and P-115 are off. Also shut off the air compressor if not needed.

- Check that the air stripper fan K-200 is stopped.

- Check that the chemical feed pumps (caustic, acid, metal scavenger and polymer) have stopped.

- If repair on equipment is needed, isolate power from the equipment and follow lockout/tagout procedures.

- Close line shut off valve(s) if needed to isolate the equipment.

- If the extended shut down will last through cold weather and there is a potential for freezing, the pipe lines and tanks located outside the building should be drained. The heaters inside the building should be turned "on" and the building temperature maintained above freezing (40-50 °F).

1.3.6 Miscellaneous Equipment Startup And Shut Down

The following section provides the procedures for startup and shutdown of other equipment associated with the water treatment plant to perform the miscellaneous tasks.

1.3.6.1 Startup and Shut Down of Sludge Pump to T-140

The sludge that settles and builds up at the bottom of the clarifier needs to be checked periodically and removed from the clarifier to the sludge tank T-140. Generally, this can be checked with the two taps mounted at the bottom section of the clarifier. Open the tap and take a sample using a volumetric cylinder or a beaker or a clear plastic cup. Let the sample settle for 15 minutes. The sludge is thick enough to be drawn out to T-140 if after 15 minutes, the water to sludge volume is 50/50 on the top tap, and close to 100% on the bottom tap. The startup procedure would be:

- Open the plug valves 143V-03 and 143V-04.

- Manually turn the 3 way valve SV-143 (or 143V-02) to direct flow to T-140.

- Open ball valve 150V-22 to allow compressed air to operate the diaphragm pump P-143. Sludge should now be pumped to T-140. Visually check that sludge is flowing to T-140.

To shut down pump P-143:

- Close ball valve 150V-22 to stop the flow of compressed air to the pump. This will stop the pump operation.

- Close the plug valves 143V-03 and 143V-04 to isolate the line.

1.3.6.2 Startup and Shut Down of Filter Press (X-140)
The filter press will be operated manually when the sludge level in sludge tank T-140 is high. The filter press can be operated independently while the rest of the water treatment system is still treating water.

The filter press relies on compressed air to drive a hydraulic cylinder that in turn compresses the filter plates. The cylinder pressure has been preset. Consult the owner's manual if adjustment to the cylinder pressure is required. The start up sequence for the filter press is as follows:

- Open ball valves 140V-01 and 141V-01 to filter press and close recycle valve 141V-02.

- Open filtrate return valves 141V-04, and 141V-05.

- Close compressed air to filtrate return ball valve 150V-24, core blow valve 150V-18, and plate shifting/instrument panel ball valve 150V-17.

- Open ball valve for compressed air line to the filter press control panel.

- Fully extend the filter press drive cylinder rod to close the press by pushing down on the "extend" button.

- After the filter press plates are fully closed, start pump P-141 by opening ball valve 150V-19 and turning the feed pump control mounted on the filter press panel to "On" to admit compressed air to the diaphragm pump. Start pumping the sludge from T-140 to the filter press.

End of Filtration Cycle:

- The filter press will continue to operate until the filtration pressure or back pressure generated from the sludge cake equals the filter press pressure.
- When the maximum pressure is reached, stop P-141 by turning the feed pump control to "Off" to stop the flow of compressed air.
- Shut off feed by closing ball valve 141V-01.
- Open sludge return valve 141V-02.
- Open core blow compressed air valve 150V-18 to blow core sludge back to T-140. Average core blow time is between 1 to 3 minutes.
- After core blow is complete, close valve 150V-18.
- Open the filtrate air blow valve 150V-24 and 150V-25. The air will remove any remaining filtrate in the filtrate lines out of the bottom two filtrate ports. Average filtrate blow air time is between 1 to 3 minutes.
- After filtrate air blow is complete, close 150V-24.
- Position cake dumpster box under the filter plates.
- Press the "retract" push-button to open the filter press. The hydraulic cylinder will retract.
- Move each intermediate plate back one at a time against the end plate.

The next filtration cycle can be initiated when all of the filter cakes have been dropped.

1.3.6.3 Sludge Recycle

During initial startup, the amount of sludge generated is relatively small. Occasionally, it may be desirable to recycle the thin sludge settled at the bottom of the clarifier to the mix tank X-130 to act as seeds for further agglomeration until a thicker sludge is developed. The startup procedure for recycling the sludge is as follows:

- Open the plug valves 143V-03 and 143V-04.
- Manually turn the 3 way valve SV-143 (or 143V-02) to direct flow back to X-130.

- Open ball valve 150V-22 to allow compressed air to operate the diaphragm pump P-143. Sludge should now be pumped to X-130. Visually check that sludge is flowing to X-130.

To shut down pump P-143:

- Close ball valve 150V-22 to stop the flow of compressed air to the pump. This will stop the pump operation.

- Close the plug valves 143V-03 and 143V-04 if needed to isolate the line.

1.3.6.4 Backwash GAC Carbon Adsorber

When the pressure drop across the carbon adsorber as measured by PDIT-220B is high, the carbon bed needs to be backwashed to remove entrained particles. Generally, when the bed differential pressure is 5 to 10 psi higher than the initial pressure, it is an indication that a backwash cycle is needed. The startup procedure for the GAC backwash is as follows:

- Stop GAC feed pumps P-220 A/B. The rest of the water treatment system will cascade to shut down on high tank levels.

- Close GAC water feed valves 220V-20, 220V-21 and 220V-22.

- The GAC bypass valve 220V-19 should be closed.

- Close the treated water effluent valve 220V-30 and 220V-31.

- Open the backwash water inlet valve 220V-28, and 220V-29 to allow backwash flow from bottom of GAC bed upwards.

- Open the backwash water outlet valve 220V-23 and 220V-24. The backwash flow is upwards across the carbon bed. The spent backwash water will now be directed to the backwash water holding tank T-205. (Note: The above procedure involves backwashing the two carbon beds in parallel. To obtain a better backwash using a higher water flow, backwash one carbon bed at a time by isolating the other carbon bed using the appropriate valves).

- Open the backwash pump P-241 suction line and discharge line butterfly shut off valves 240V-01 and 240V-03.

- Shut off all sample port valves.

- Start the backwash water pump P-241 either locally using the HOA switch or in the control panel. The carbon bed can now be backwashed. A backwash cycle generally last for approximately 20 minutes.

- Check that the pump is operating normally and the discharge pressure via PI-241 is normal.

- After backwash is complete, stop the backwash pump P-241.

- Return the valves to their original normal operating positions, and start GAC feed pump P-220A/B and the water treatment system will be back on line for normal operation.

1.3.6.5 Backwash water to X-130

After a sufficient quantity of backwash water has accumulated in the backwash water holding tank T-205, the tank will need to be emptied to make room for future GAC backwash. This water will be sent manually to the mix tank X-130 by means of the spent backwash water pump P-205 and two backwash lines to either chamber 1 or chamber 2 of X-130. The procedure for startup of this pump and the corresponding line is as follows:

- Open the pump inlet shut off ball valve 205V-01.

- Line out the valves on the desired line to X-130 chamber 1 or 2.

- Make sure all sample ports are closed.

- Start the spent backwash pump P-205 either locally using the HOA switch or from the control panel and set to "auto".

- Check that the pump is operating normally, and the discharge pressure via PI-205 is normal.

- Pump P-205 will run automatically until a low level in tank T-205 is reached. The low level switch LSL-205 will shut off P-205 automatically.

After the transfer of backwash water to X-130 is complete, shut down P-205 as follows:

- Turn off P-205 using the local HOA switch or from the control panel.

- Close the pump inlet and outlet shut off ball valves 205V-01 and 205V-03 or 205V-07.

1.3.6.6 Transfer Water from Sump T-025

Sump T-025 receives water from the building drain and seal water discharge. High/low level float switches are installed in the sump to automatically switch the sump pump P-025 or P-025A (standby backup) on and off if the HOA switch is set in the "auto" mode. The sump water can be sent either to T-110 or to X-130. Because of the high potential that sand and soil particles can be washed down the drain to the sump, it is highly recommended that the sump water be sent to X-130 for clarification. The startup procedure for P-025 or P-025A is as follows:

- Close valve 025V-03 and open valve 025V-04 to direct sump water flow to X-130.
- Next to X-130, open the ball valve 130V-03 to admit water to X-130.
- Set the local HOA switch to "Auto," and the sump pump will be interlocked to turn on and off by the float level switches.
- If it is desired to operate the sump pump P-025 or P-025A manually, turn the HOA switch to "hand" position.

To shut off the sump pump P-025 or P-025A:

- Turn the HOA switch to "Off" position.
- Close the valve 025V-04 if it is desired to isolate the line.

1.3.6.7 Transfer Water from Sump T-115

Water collected in the containment sump T-115 is directed to tank T-110 via the sump pump P-115. High/low level float switches are installed in the sump to automatically switch the sump pump P-115 on and off if the HOA switch is set in the "auto" mode.

The startup procedure for P-115 is as follows:

- Open valve 115V-02 to direct sump water flow to T-110
- Set the local HOA switch to "Auto," and the sump pump will be interlocked to turn on and off by the float level switches.
- If it is desired to operate the sump pump P-115 manually, turn the HOA switch to "hand" position.

To shut off the sump pump P-115:

- Turn the HOA switch to "Off" position.
- Close the gate valve 115V-02 if it is desired to isolate the line.

1.4 NORMAL OPERATIONS AND CONTROLS

1.4.1 Normal Operations

After the water treatment plant has been started up, the plant can run automatically with the help of the instrumentation and controls build into the system. The flow to the water treatment plant is estimated to be a total of 290 gallons per minute (gpm) with 30 gpm from the shallow wells going to X-130, and 260 gpm from the deep wells. The expected flow from each well is shown in Table 1.4.1 as follows:

Table 1.4.1 - Expected Flow from Each Well

Well Designation (Well Pump)	*Expected Normal Flow, gpm*
Deep Aquifer Wells:	
DMW-1 (P-301)	150
DRW-1 (P-101)	30
DRW-2 (P-103)	40
DRW-3 (P-105)	40
Shallow Aquifer Wells:	
SRW-1 (P-100)	5
SRW-2 (P-102)	5
SRW-3 (P-104)	5
SRW-4 (P-300)	5
SRW-5 (P-302)	5
SRW-6 (P-304)	5

The water treatment plant is designed to treat the extracted groundwater to meet the effluent organics criteria as shown in Table 1.4.2. The estimated influent water quality is also shown in Table 1.4.2.

During normal operations, the operator should identify the total amount of water extracted from the wells by taking the readings from the flow elements (FE-100, FE-101 etc.) installed locally at the well head. The operator should then set the flow control valves FCV-110 and FCV-220 to match the total flow extracted from the wells. This will allow for a more stable operation and reduces the frequency of cycling the pumps "on" and "off" due to high and low tank levels.

Table 1.4.2 - Groundwater Treatment System Influent and Effluent Characteristics

Contaminant	*Influent Concentration (µg/L)*	*Required Effluent Concentration (µg/L)*
Acetone	262	--
Ethylbenzene	52	29
1,2-Dichloroethane	30	0.38
1,2-Dichloroethene	30,000	70
Lead	38	15
Manganese	50	50
Mercury	0.17	1.1
Tetrachloroethene	920	0.7
Trichloroethene	58,000	2.8
Vanadium	330	80
Vinyl Chloride	800	0.015

During normal operations, the treatment plant is automated with controls, interlocks and alarms. The process description and control philosophy presented below describes the process streams, flow rates, equipment sizes, and other process information. This document provides a description of the instrumentation and controls (I&C) for each part of the system and includes the measured variable and by what instrument it is measured, the logic needed by the Programmable Logic Controller (PLC) software to interpret the measured variables, the control actions and responses. The reader should refer to the P & ID drawings P-1 through P-6 for the system arrangement, piping, instrumentation, interlock logic, and valve numberings.

1.4.2 Instrumentation and Control System

The basis of the Instrumentation and Control System (I&C) is a Programmable Logic Controller (PLC) located in a central control station. Simple feedback pH control and

cascade shut down of process operations based on tank levels are the main control features. The PLC maintains the treatment process at a steady state and compensates for step changes that may be introduced to the system. The PLC station is not continually manned and capable of connection via telephone modem to a remote monitoring location. The PLC uses password entry codes for different levels of access. There is an operator level password, a supervisor level password, and a programmer level password. Changes in PLC programming can only be made by trained programmers.

All functions and equipment are designed to fail in a safe position. Manual restart of the entire system is required after power outages. A table summarizing the interlocks for this plant is provided in the attached Interlock Table 1.4.1.

The computer interface with the PLC includes an IBM compatible type 80486 DX computer with 256 color SVGA monitor, 24 pin dot matrix printer, mouse, modem, extended keyboard, and appropriate user-friendly graphical interface. This PLC station will be located in the GWTP office. It will provide a central location from which the process can be monitored, controlled, and modified when necessary. Also included at this station are the appropriate audible and visual alarms to alert the operators to changes in process parameters that are considered "critical." These "critical" alarms are also capable of transmission via modem and telephone lines to a remote monitoring location. Transmitting these signals to the remote monitoring location enables the appropriate personnel to immediately respond to "critical" treatment system alarms. All alarms, not specified herein as "critical," register and flash on the treatment system PLC monitor and must be addressed during the daily operation of the treatment system. The treatment system control station has the ability to log alarms and measure process parameters (e.g., flow rates, pressures, pH, etc.), as specified in this document. Reports of these parameters, as well as the date and time recorded, will be included as part of the O&M Manual.

1.4.3 Groundwater Extraction System

Groundwater underlying MCB Camp Lejeune Operable Unit 2 will be extracted and treated from two water bearing zones in a system with a design treatment capacity of 500 gallons per minute (gpm). Over 90 percent of the volume to be treated will originate from the more productive deeper water bearing zone, while approximately 10 percent contribution is expected from the shallow groundwater zone. Groundwater found in the upper water bearing zone is at a low pH and contains a significant quantity of iron and other inorganic compounds that could, over time, foul treatment equipment if these compounds are not removed. In addition, the groundwater in this zone as well as the deeper Castle Hayne Aquifer contains Volatile Organic Compounds (VOCs) at concentrations above the limits that the North Carolina Department of Environmental Health and Natural Resources (NC DEHNR) will allow to be discharged to Wallace Creek. This treatment plant is designed to

remove the VOCs below those limits and to remove the inorganic compounds that could foul the treatment equipment.

Groundwater from the upper water bearing zone is pumped by electric submersible pumps from extraction wells that are drilled to approximately 35 feet below land surface (BLS). Groundwater is pretreated to remove iron and other inorganics using neutralization, followed by flocculation, gravity separation and sludge dewatering.

TABLE 1.4.1
INTERLOCK TABLE
CAMP LEJEUNE WATER TREATMENT PLANT

Interlock No. & Description	Interlock Functions
I-110 (Low water level in T-110)	* Stop air stripper feed pumps P-110A/B * Stop jet mixing pump P-120 * Stop sulfuric acid pump P-211
I-121 (High pH in X-130)	* Stop caustic feed pump P-121
I-122 (High caustic level in Tank T-121)	* Send off an alarm.
I-123 (Low caustic level in tank T-121)	* Stop caustic feed pump P-121 * Stop all shallow well water pumps P-100, 102, 104 etc. * Stop polymer feed pump X-132 * Close polymer make-up water solenoid valve SV-243 * Stop spent backwash pump P-205.
I-145 (Low water level in head tank T-145)	* Stop supernatant transfer pump P-145.
I-146 (High water level in head tank T-145)	* Stop caustic feed pump P-121 * Stop all shallow well water pumps P-100, 102, 104 etc. * Stop polymer feed pump X-132 * Close polymer make-up water solenoid valve SV-243 * Stop spent backwash water pump P-205.
I-150 (High-high water level in T-110)	* Stop sulfuric acid feed pump P-211 * Stop all deep well pumps P-101, 103, 105 etc.
I-151 (High water level in T-110)	* Stop supernatant transfer pump P-145 * Stop all shallow well water pumps P-100, 102, 104 etc. * Stop polymer feed pump X-132 * Close polymer make-up water solenoid valve SV-243 * Stop spent backwash pump P-205.

INTERLOCK TABLE - CAMP LEJEUNE (continued):

I-152 (Compressed air X-150A/B pressure low, less than 60 psig)	* Stop GAC feed pumps P-220A/B.
I-200 (Air stripper blower K-200 low pressure)	* Stop air stripper feed pumps P-110A/B.
I-201 (T-110 pH low, less than 6.5)	* Stop sulfuric acid feed pump P-211.
I-205 (Backwash holding tank T-205 level high)	* Stop backwash water pump P-241.
I-206 (Backwash holding tank T-205 level low)	* Stop spent backwash pump P-205.
I-211 (Air stripper feed pump P-110A/B shut down)	* Stop sulfuric acid feed pump P-211.
I-212 (Sulfuric acid tank T-211 level low)	* Stop sulfuric acid feed pump P-211 * Stop all deep aquifer well pumps P-101, 103, 105 etc. * Stop supernatant transfer pump P-145.
I-213 (Sulfuric acid tank T-211 level high)	* Send off an alarm
I-220 (Stripper tank T-220 level low)	* Stop GAC feed pumps P-220A/B * Stop blower K-200 after 15 minutes time delay.
I-221 (Stripper tank T-220 level high)	* Stop air stripper feed pumps P-110A/B * Stop blower K-200 after 5 minutes time delay.
I-222 (Stripper tank T-220 level high-high)	* Stop blower K-200 immediately.
I-240 (Effluent tank T-240 level low)	After a 5 minute time delay, * Stop backwash pump P-241 * Stop reuse water pump P-245 * Stop GAC feed pumps P-220A/B * Stop air stripper feed pumps P-110A/B * Stop supernatant transfer pump P-145 * Stop spent backwash pump P-205

INTERLOCK TABLE - CAMP LEJEUNE (continued):

I-242 (Effluent tank T-240 level high)	* Stop GAC feed pumps P-220 A/B
I-245 (Reuse/Seal water pump stopped)	* Stop supernatant transfer pump P-145 * Stop air stripper feed pumps P-110A/B * Stop P-241 * Stop P-220A/B * Stop P-205

The pretreated water from the upper zone is combined in a collection tank with groundwater that is pumped from deep wells drilled to 110 feet BLS into the Castle Hayne Aquifer by electric pumps. The Castle Hayne Aquifer is a limestone aquifer that contains a high concentration of calcium carbonate and is at a higher pH (8.5 to 10) than the shallow groundwater.

The pH of the combined groundwaters is first reduced in the large equalization tank prior to further treatment in order to inhibit calcium carbonate scaling of the downstream piping and equipment. The combined water is subsequently pumped through a packed bed air stripping tower where the VOCs are removed. Water is then pumped through cartridge filters and Granular Activated Carbon (GAC) adsorbers for final polishing prior to discharge to Wallace Creek.

1.4.3.1 Shallow Groundwater Extraction System (Dwg P-3)

Equipment

Groundwater is extracted from wells drilled to approximately 35 feet below land surface (BLS) in the shallow, relatively low permeability zone and is pumped to the initial reaction chamber of the iron removal system, Item X-130 (See Section 4.0). The groundwater is pumped by six electric submersible pumps, P-100, P-102, P-104, P-300, P-302 and P-304. The six pumps have a combined capacity of up to 30 gpm. Each pump will pump at the recharge rate of the well attaining a maximum drawdown and capture zone.

Each extraction well is equipped with a check valve, Hand-Off-Auto switch, pressure indicator, ball valve, and a flow meter. Each check valve and flow meter is located above ground inside a prefabricated, heated and ventilated fiberglass structure. The groundwater from each shallow well ultimately discharges into a single 3-inch diameter HDPE header pipe that is connected to a carbon steel line near the initial reactor of the iron removal system, Item X-130 (See Section 4.0).

Instrumentation and Controls

Each discharge line and submersible pump has identical instrumentation and valving. For brevity, this discussion uses pump P-100 as an example. The pressure gauge, PI-100, is used for measuring the discharge pressure from the extraction well pump. A turbine type flow sensor, FE 100, is used to measure continuous flow and indicate the operating status of P-100. This information is displayed by F1Q-100. A ball valve is provided for the operator to manually adjust flow rates.

P-100 is equipped with a Hand-Off-Auto (HOA) Switch (HS-100) that controls the pump operation. This switch allows the pump operation mode to be set to manual (hand), off (switched off to override any other inputs), or automatic (controlled by the PLC). The pump normally operates in the automatic mode. The manual position is used during

system start-up and after pump maintenance to determine pump operating parameters. The off position is set during maintenance or repair operations to isolate the pump from the system PLC. HS-100 sends a digital input to the PLC that indicates if the pump is "on" or "off" via the position indicator XI-100, displayed on the PLC monitor.

In the automatic mode, operation of all extraction well pumps are controlled by the water level in the well via level switch LS-100 and by the water level in the head tank, T-145 via high level switch LIT-145. When the water level in the extraction well drops below the low level setpoint of LE-100A, LS-100 sends a digital input to the PLC which displays low level alarm LAL-100 on the monitor. LAL-100 then trips interlock input I-100 in the PLC software and sends a digital output signal back to HS-100 that stops the pump. When the extraction well water level rises above the low level setpoint, LS-100 is reset and LAL-100 is no longer displayed on the PLC monitor. When the extraction well recharges further and the water level rises to the high level setpoint of LE-100B, it causes pump P-100 to restart locally.

The shallow extraction well pumps are also controlled by the water level in the head tank, T-145. If the water level in T-145 rises above the height of high level switch, LIT-145, LIT-145 sends a digital input to the PLC through a dry contact and trips interlock output I-146 in the PLC software. The PLC then sends digital output signals to HS-100, HS-102, HS-104, HS-300, HS-302 and HS-304 which effectively stops pumps P-100, P-102, P-104, P-300, P-302, and P-304. If the water level in T-145 drops below the high level, interlock in the PLC software will automatically reset and the pumps will resume operation.

The shallow extraction well pumps are also controlled by the water level in Groundwater Storage Tank T-110 (see DWG P-4). If the water level in T-110 rises above the height of high level switch, LSH-110, LSH-110 sends a digital input to the PLC, which displays high level alarm, LAH-110. LAH-110 trips interlock output I-151 in the PLC software. The PLC then sends digital output signals to HS-100, HS-102, HS-104, HS-300, HS-302 and HS-304 stopping pumps P 100, P-102, P-104, P-300, P-302 and P-304. If the water level in T-110 drops below the level of LSH-110, interlock in the PLC software will automatically reset, and the pumps will resume operation. In the event that a total system shut down has occurred, or groundwater flow from this bank of pumps needs to be stopped, HIS-103 may be accessed by operators through the PLC interface to start or stop them.

The groundwater from each shallow well pump discharges into a single pipe header that connects to X-130. The flow through the shallow extraction well header is measured by an above-grade turbine flow meter FE-106 and displayed locally and transmitted to the PLC by flow indicating transmitter FIT-106. The flow rate is displayed on the PLC monitor by software module FI-106. The PLC also records the flow rate and displays the

instantaneous and total volume of groundwater to date in software modules FI-106 and FIQ-106, respectively.

1.4.3.2 Deep Aquifer Extraction System

Equipment

Groundwater is withdrawn from the Castle Hayne (deep) Aquifer from deep extraction wells drilled to approximately 110 feet BLS and pumped to the Groundwater Storage Tank T-110. The groundwater is pumped from the extraction wells by well pumps P-101, P-103, P-105 and P 301. The four well pumps have a total pumping capacity of 260 gpm. Each extraction well discharge pipe is equipped with a flowmeter, pressure gauge, and manual ball valve for adjusting the groundwater flow to the desired flow rate. Each meter and valve is located aboveground inside a prefabricated, heated and ventilated fiberglass structure. The groundwater from the extraction well pump discharges from a 4-inch line into a single 10-inch diameter HDPE pipe header that is connected to T-110. The piping after the butterfly valve is installed below the ground surface until it reaches the GWTP. At T-110, the pipeline is aboveground and insulated. A pressure transmitter (PIT-108) is located on the line above-grade prior to the connection to T 110.

Instrumentation and Control

Each well and discharge line contains identical instrumentation and valving. For brevity, this discussion uses pump P-101 as an example. The pressure gauge, PI-101, is used for measuring the discharge pressure from the extraction well pump to monitor if the pump is functioning according to its design parameters. A turbine flowmeter , FE-101 provides instantaneous and total flow measurements from P-101, displayed locally and represented by FIQ-101. This allows operators to adjust the flow rate with the manual ball valve. Instrumentation is connected to the appropriate valving to provide maintenance access.

The same control scheme is designed for each extraction well pump. P-101 is equipped with a Hand-Off-Auto (HOA) Switch (HS-101) that controls the pump operation. This switch allows the pump operation mode to be set to manual (hand), off (switched off to override any other inputs), or automatic (controlled by the PLC). The pump normally operates in the automatic mode. The manual position is used during system start-up and after pump maintenance to determine operating parameters. The off position is set during maintenance or repair operations to isolate the pump from the system PLC. HS-101 sends a digital input to the PLC that indicates if the pump is "on" or "off" via the position indicator XI-101, displayed on the PLC monitor.

In the automatic mode, operation of all extraction well pumps are controlled by the water level in the well via level switches LS-101 and by the water level in the Groundwater Storage Tank, T-110 via high-high level switch LSH-110. When the water level in the extraction well drops below the low level setpoint of LE-101A, LS-101 sends a digital input

to the PLC which displays low level alarm LAL-101 on the monitor. LAL-101 then trips interlock input I-101 in the PLC software which sends a digital output signal back to HS-101 that stops the pump. When the extraction well water level rises above the low level setpoint, LS-101 is reset and LAL-101 is no longer displayed on the PLC monitor. When the extraction well recharges further and the water level rises to the high level setpoint of LE-101B, it causes pump P-101 to restart locally.

If the level in T-110 continues to rise after the shallow groundwater pumps (P-100, P-102, P 104, P-300, P-302, and P-304) are stopped and the water level exceeds the height of high-high level switch, LSH-110, then LSH-110 provides a digital input to the PLC which displays high high level alarm LAHH-110. LAHH-110 also trips interlock input I-151 and I-150 in the PLC software. The PLC then sends a digital output signal back to HS-101, HS-103, HS-105 and HS-301 that stops all of them plus all the shallow well pumps through I-151 (a redundant interlock). When LAH-110 and LAHH-110 have been tripped the extraction system is shut down. If either of these alarms (LAH or LAHH) is tripped, then this pump bank must be reset through start/stop hand indicator switch HIS-100 for deep wells and HIS-103 for shallow wells. HIS-100 and HIS-103 are accessed by the operators through the PLC interface.

The groundwater from each of the deep well pumps discharges into a single pipe header that is connected to T-110. The pressure in this header is measured and transmitted to the PLC by pressure indicating transmitter PIT-108. The pressure is displayed on the PLC monitor by software module PIA-108. PIA-108 also provides a low pressure alarm, that is displayed on the PLC monitor. The flow through the deep well header is measured by an above-grade turbine flow meter FE-107 and displayed locally and transmitted to the PLC by flow indicating transmitter FIT 107. The flow rate is displayed on the PLC monitor by software module FI-107. The PLC also records the flow rate and displays the instantaneous and total volume of groundwater to date in software modules FI-107 and FIO-107, respectively.

1.4.4 Iron Removal System

The Iron Removal System is designed to remove the iron and other inorganic compounds from the shallow groundwater through oxidation/precipitation, flocculation, and mechanical solids/liquid separation. It consists of several integrated components. Major equipment items include a Mix Tank, Clarifier, Sludge Thickener, Sludge Dewatering Press, Head Tank, Chemical Feed System, and Instrumentation and Controls.

1.4.4.1 Mix Tank

Equipment

The Mix Tank, Item X-130, is a rectangular, painted, carbon steel tank containing baffles that separate the tank into three equal sized chambers that are each designed to yield

approximately 30 minutes hydraulic detention time at the maximum pumping rate of 21 gpm. The entire tank is covered, gasketed and vented through the roof. Neutralization, aeration and flocculation occur in this vessel.

Water extracted from the shallow extraction wells enter the first chamber of the iron removal system mix tank through a 3-inch diameter drop pipe. The first chamber is agitated and aerated by compressed air that is introduced at the bottom through fine bubble diffusers. The air flow rate is manually adjusted by a ball valve. The pH is adjusted between 8.5 and 9.0 with 50 percent by weight sodium hydroxide, NaOH. The sodium hydroxide is pumped from a 1,000-gallon high density polyethylene storage container by an adjustable speed chemical metering pump, Item P-121 rated at 5 gph. The pump is equipped with a Hand-Off-Auto (HOA) Hand Switch HS-121 that sends and receives digital signals from the PLC. The flow from this pump is controlled by PLC adjustment of the speed controller SC-121. At this pH, the iron that is in the ferrous (Fe++) state is oxidized to the ferric (Fe+3) state and will precipitate as ferric hydroxide, Fe(OH)3.

Water flows over a baffle into a stilling chamber where any fine bubbles adhering to particles and remaining in the liquid are released. De-aerated water flows under a baffle into the third chamber where a dilute polymer solution is added. The diluted polymer is added at a constant, manually adjustable rate and is prepared by an automatic mixing unit, Item X-132. X-132 draws concentrated polymer from a 55-gallon storage drum and mixes it with a slip stream of treated water that is pumped from the Treated Effluent Holding Tank, Item T-240 (see DWG P-5) by the Reuse Water Pump, Item P-245. The reaction chamber is stirred by a slow, manually adjustable speed agitator, Item A-130. The polymer assists the agglomeration of the fine particulates and the agitator creates enough movement to distribute the polymer and create a dense flocculate that will settle out rapidly in the clarifier. The water with precipitated and flocculated solids flows by gravity into a lamella clarifier, Item X-131.

Instrumentation and Controls

The pH in X-130 is to be maintained between 8.5 and 9.0. The pH is measured in the mix chambers by pH sensors AE-130A and B and transmitted to the PLC by pH indicating transmitters AIT-130A and B. The pH is displayed on the PLC monitor by software module AICA-130. Software module AICA-130 receives the pH measurement, displays the current pH, and controls the flow of the 50 percent NaOH solution to X-130 based on the selected pH analyzer. The system manufacturer PLC controls the caustic flow by sending an analog signal to the speed controller SC-121 of P-121. AICA-130 also displays high and low pH alarms when the pH reaches the alarm setpoints. When the low pH alarm setpoint is reached, the plant PLC displays the alarm, sends the alarm signal to the remote monitoring location via telephone lines, and lights the "common" alarm light. The high pH

alarm condition is not relayed to the remote monitoring location. The alarm is displayed on the PLC monitor. Both of these alarms are reset only when the pH of the groundwater returns within the setpoint range.

Compressed air flow to the initial chamber is manually controlled using a ball valve. The rate will be established and adjusted during the system start-up.

The speed controller of flocculation mixer A-130 sends a signal through a contact closure to the plant master PLC. A-130 operating status is displayed on the PLC monitor as XI-130.

1.4.4.2 Clarifier

Equipment

The flocculated water flows by gravity from X-130 to the Lamella Clarifier, Item X-131. The clarifier is an epoxy coated, carbon steel vessel with incline plates that allow gravity separation of the solids from the liquids in a relatively small area. The clarifier is designed to yield less than 3 milligrams per liter (mg/L) suspended solids at a flow rate of 21 gpm. Water flows out of the clarifier by gravity. Solids accumulate in a chamber at the bottom of the device and reach a concentration of one to two percent by weight. This sludge will be periodically removed from the clarifier manually at a rate between 1 and 5 gpm by a cast iron, air operated, double diaphragm Sludge Pump, Item P-143. Under normal operating conditions this pump will be shut off. Sludge can be recycled to the first chamber of the Reaction Tank, X-130 to concentrate suspended solids in the clarifier during startup. The sludge level in X-131 will be measured by a bubble type, level indicating transmitter LIT-131. (NOTE: The sludge bubbler gives a rough idea of sludge level and is not an accurate level measuring device). LIT-131 will transmit the sludge level measurement to the PLC monitor. A three way valve SV-143 can be manually adjusted to divert sludge from Sludge Pump P-143 to the Sludge Thickener, T-140 or back to Mix Tank, X-130.

Instrumentation and Controls

The Clarifier operation is not affected by low level, therefore low level control is not provided. The height of the Clarifier will be above the head tank T-145 and the clarifier overflow water drains by gravity to the head tank, therefore no other level control will be provided.

A pressure regulator, ball valve, and automatic surge valve are used to control the flow rate of the Sludge Pump, P-143. A manually adjusted three way valve (SV-143) is located in the sludge recycle line. In one position, the valve allows for the clarifier underflow to be recycled to X-130. In the other position, sludge will be pumped to the sludge thickener tank T-140.

1.4.4.3 Sludge Thickener

Equipment

The sludge Thickener, Item T-140, is a vertical, cylindrical HDPE tank that is 4 feet in diameter and six feet tall with a 30 degree sloped bottom and a dome top that is vented through the roof. This vessel is used to allow the sludge to further thicken to approximately 5 percent by weight solids prior to dewatering in the Sludge Filter Press, Item X-140. It is anticipated that sludge will be withdrawn and dewatered at a frequency equal to the sludge generation rate from the clarifier. Should the water level increase beyond the capacity of the tank, it will overflow to the clarifier X 131.

Instrumentation and Controls

The Sludge Thickener is not equipped with high level controls. Although it can overflow to X 131, it is designed to be manually emptied once every several days.

1.4.4.4 Sludge Dewatering Press

Equipment

The Sludge Filter Press, Item X-140, is a device used to reduce the volume and water content of the sludge produced by the iron removal system. It consists of a set of square glass filled polyethylene plates that have an embossed filtration surface recessed on either side and covered with filter cloth. The set of plates is compressed between a stationary and movable heavy metal heads. Ports allow the sludge to be pumped by an air operated, double diaphragm Filter Press Feed Pump, Item P-141, into the middle of each plate where the solids are retained on the filter cloth. The water that passes through the filter cloth is discharged to the Head Tank, Item T-145. The pump continues to run until solids completely fill the chamber and can no longer be compressed. Compressed air is used to blow the core back to the Sludge Thickener Tank (T-140) and to force the residual water remaining in the sludge cake after the fill cycle into the Head Tank, T-145. The filter press is then opened, the solids are dropped into a collection hopper, and the press is closed to await the next cycle.

Instrumentation and Controls

The Sludge Dewatering Press and feed pump are supplied complete with all controls necessary to operate them. The operation is batchwise and manual. Therefore, there is no provision to interface the operation with the plant PLC.

1.4.4.5 Head Tank

Equipment

The Head Tank, Item T-145, is a 500-gallon, closed top HDPE tank that is provided with a vent that extends above the roof. Clarified water overflows by gravity from the Clarifier, X-131, and is pumped by a ductile iron , horizontal centrifugal Supernatant Transfer Pump, Item P-145, rated at 30 gpm and 40 feet TDH to the Groundwater Collection Tank, Item T-

110 (see DWG P-4). Water discharges from the Supernatant Transfer Pump to a 2-inch diameter line that is equipped with a check valve and manual ball valve. The ball valve is used to adjust the flow from the Supernatant Transfer Pump.

Instrumentation and Controls

The Head Tank is equipped with a locally mounted pressure type level indicator transmitter LIT 145. LIT-145 transmits an analog signal to the PLC. The level in the Head Tank is displayed on the PLC monitor by software module LICA-145. When the low alarm set point is reached, interlock input I-145 is tripped which stops pump P-145. Under a high level alarm condition, interlock input I-146 is tripped which shuts off shallow extraction well pumps P-100, P-102, P 104, etc., caustic pump P-121, polymer dilution water valve SV-243, polymer feed pump X-132, and spent backwash water pump P-205. The desired tank level can be preset to maintain automatically at this level. When water level reaches this preset level, the pump will automatically start and draws water to below the level which stops the pump.

1.4.4.6 Chemical Storage

Equipment

The 50 percent NaOH used to neutralize the shallow groundwater is stored in a 1,000-gallon polyethylene container. The tank is supplied with 1-inch piping that allows the Caustic Supply Pump, P-121, to withdraw caustic from the polyethylene container. pH control and caustic addition controls were previously discussed in Section 1.4.4.1.

Concentrated polymer solution is supplied and stored in 55 gallon polyethylene drums. As discussed in Section 1.4.4.2, a polymer addition system is supplied that mixes the concentrated polymer with reuse water and delivers the diluted solution to the third compartment of the Reaction Tank, X-130.

Instrumentation and Controls

The NaOH storage container is equipped with a locally mounted pressure type level indicating transmitter, LIT-121. LIT-121 transmits the level measurement through an analog signal to the PLC monitor where it is displayed by module LICA-121. A low level condition will activate hand switch HS-121 and shut off Caustic Supply Pump P-121, and flow from the shallow extraction wells, P-100, P-102, P-104, etc., plus the polymer feed pump X-132, polymer make-up water valve SV-243, and the spent backwash pump P-205.

The polymer storage drum is mounted on a weigh scale, WE-131. Weigh indicator WI-131 provides a local display of the polymer and drum weight for the operator.

1.4.5 Groundwater Storage and Feed System

1.4.5.1 Groundwater Storage Tank and Feed Equipment

Groundwater Storage Tank T-110 is a vertical, cylindrical, fiberglass tank with a flat bottom and dome top. It is 12 feet in diameter and 26 feet high. The tank is located outside the water treatment system building. It has a design pressure of atmospheric at 150°F, and has a maximum capacity of approximately 22,000 gallons. The tank provides surge capacity for the treatment system, equalization of the influent groundwater and pH adjustment. Groundwater from the deep wells and the pretreated shallow wells are pumped into the tank through the conical top via separate dip pipes. Sulfuric acid (93 percent H2SO4) stored in the polyethylene storage container is used to adjust the pH by a diaphragm metering feed pump, P-211, to T-110 though a separate dip pipe. The Acid Pump is equipped with Hand-Off-Auto (HOA) Hand Switch, HS-211, that is used to control pump start/stop operation. T-110 can also receive water through the building drainage sump T-025 or the containment area collection sump T-115 adjacent to Tank T-110.

Agitation of T-110 is provided by a ductile iron jet mixing pump, Item P-120, that circulates 1,230 gpm of water through high velocity jets mounted at the base of T-110. The jet mixing pump is powered by a 10-hp motor.

Groundwater is pumped to the Air Stripper, Item C-200 (DWG P-5), from T-110 by Air Stripper Feed Pumps P-110A/B. P-110A/B are ANSI standard, horizontal centrifugal pumps capable of pumping 540 gpm of water at 80 feet TDH using a 15-hp, TEFC motor. The pumps are also equipped with Hand-Off-Auto (HOA) Hand Switches, HS-110A and HS-110B, that are used to control the pump operation. P-110A is the primary pump and P-110B serves as an installed spare to be used during maintenance or repair of P-110A. P110A and P110B are sized to accommodate a continuous flow rate of 540 gpm. To avoid excessive starting and stopping of pumps P110A/B and to provide constant flow to the air stripping tower, a continuous recycle loop for Tank T-110 is provided. The flow from these pumps is controlled by a flow control valve FCV-110.

1.4.5.2 Groundwater Storage and Feed System Instrumentation and Control

As mentioned earlier in this document, LSH-110 and LSH-110 provide alarms and appropriate interlocks to the groundwater extraction systems for high levels in T-110. T-110 is also equipped with differential pressure type level indicating transmitter LIT-110. LIT-110 measures and transmits the fluid level in the tank to the PLC where it is displayed by software module level indicator controller alarm LICA-110. This software module receives the level measurement, provides a software setpoint to the flow indicating controller alarm FICA-110, displays the current tank level, and displays low tank level alarm when the level reaches the low alarm setpoint.

The low level switch LSL-110 and/or the LICA-110 also provides a display and an alarm for low tank level when this setpoint is reached. When this alarm is tripped, the software provides interlock output signal I-110 to HS-110A or HS-110B, HS-211 and HS-120 stopping the pumps that are operating. The PLC software recognizes which pump is running by first analyzing the status of the software position indicators XI-120, XI-211, XI-110A and XI-110B. If I-110 is tripped, then the pump must be reset using the appropriate start/stop hand indicator switches, HIS-120, HIS-211, HIS-110A or HIS-110B. HIS-120, HIS-211, HIS-110A and HIS-110B are accessed by the operators through the PLC interface. Pumps 110A/B are also controlled by high level in the Stripper Effluent Holding Tank, Item T-220 (see DWG P-5). Interlock I-221 is tripped upon reaching a high level set point which stops P-110A/B. Pumps 110A/B are also controlled by the Low Pressure switch in the air supply duct to Air Stripper, C-200 (see DWG P-5). Low air pressure trips interlock I-200 which stops P-110A/B. T-110 is equipped with a local thermometer, TI-110, to monitor the tank liquid temperature.

The flow of groundwater from P-110A/B is measured by turbine flowmeter FE-110 and transmitted by flow indicating transmitter FIT-110 to the PLC where it is displayed by software module FICA-110. FICA-110 represents a flow indicator controller alarm. This software module receives the flow measurement and provides an analog output to FCV-110 to actuate the valve to meet the setpoint provided by LICA-110. (The operator sets the desired T-110 level to be maintained and FCV-110 will adjust.) FICA-110 also displays the current flow rate and a high and low flow alarm in the PLC at the respective alarm setpoints.

Flow rates will be optimized using pneumatically controlled butterfly valve FCV-110. The excess flow will be recycled back to T-110 via a 3-inch line.

Pressure gauges PI-110A and PI-110B are provided in the discharge line directly after each pump so that the pressure in the line can be measured in the field during operation of the pump. Pressure gauge PI-110 is provided in line directly following FCV-110 to verify that the valve is performing as specified. Readings from this gauge also are used to determine when maintenance or repair of the valve is needed.

The pH in T-110 is to be maintained between 7.5 and 8.0. The pH is measured in the pump suction line and the recycle line by pH sensors AE-200A/B/C and transmitted to the PLC by pH indicating transmitters AIT-200A/B/C. The pH measurement is displayed by software module AICA-200. The PLC also provides software selector switch HIS-200C. HIS-200C allows the operators to switch between pH sensors AE-200A, AE-200B and AE-200C. Since pH sensors tend to be high maintenance items, this allows a sensor to be taken out of service without shutting down the process. This software module receives the pH measurement, displays the current pH, and controls the flow of the 93 percent sulfuric acid

to T-110. AICA-200 controls the acid flow by sending an analog signal to the speed controller SC-211 on P-211. AICA-200 also displays high and low pH alarms when the pH reaches these respective alarm setpoints. When the low pH alarm setpoint is reached, the PLC displays the alarm, sends the alarm signal to the remote monitoring location via telephone lines, and activates the "common" alarm light. Interlock I-201 is tripped when the pH reaches 6.5 which stops the acid feed pump. Interlock I-201 resets when pH rises above 6.5 and P-211 restarts. The high alarm condition is not transmitted to the remote monitoring location, but is only displayed in the control panel and activates the "common" alarm light. Both of these alarms are reset only when the pH of the groundwater returns within the setpoint range.

Hand switch HS-211 allows operators to start and stop P-211 locally. Interlock I-211 is tripped when both P-110A/B are off. This interlock will stop P-211. When P-110A/B start, I-211 is reset and P-211 restarts.

1.4.5.3 Chemical Storage

The 93 percent sulfuric acid used to neutralize the combined groundwater is stored in a 2,000 gallon polyethylene tank within secondary containment inside the building. Acid Pump, P-211 rated at 5 gph is used to withdraw acid from the storage container through a 1-inch line. An identical pump P-212 rated at 5 gph has been installed as a precaution to manually pump sulfuric acid back to X-130 if required. The Acid Storage Tank T-211 has been sized appropriately for less frequent filling and to accommodate vacation or holiday periods when operators may not be available to replenish the supply.

1.4.6 Air Stripping System

1.4.6.1 Air Stripper Column and Equipment

Groundwater flows from the Air Stripper Feed Pump, P-110 A/B to the top of Air Stripper Column C-200 where it discharges to atmospheric pressure and flows onto the tower packing. The air stripper system removes VOCs from the groundwater by mass transfer to the air stream running counter current (upward) to the downward water flow. The air stream is then discharged to atmosphere. C-200 is a counter-current column that is approximately 5 feet in diameter and approximately 55 feet high along the straight sides. It contains approximately 45 feet of packing and has a design wind load of 100 mph. The stripper is sized to remove all volatile groundwater contaminants to below their discharge requirements. C-200 is constructed of Fiberglass Reinforced Plastic (FRP) and contains a LANTEC packing. The air stripper is located outside the water treatment building.

Stripping air is provided to C-200 by Air Stripping Column Fan K-200. K-200 is a centrifugal fan designed to provide approximately 4,680 cfm of air at 10 inches w.c. using a 5.0-hp, TEFC motor. The fan is constructed of FRP.

After groundwater reaches the bottom of the column packing and has been stripped by the air, it is collected in Stripper Effluent Holding Tank T-220. T-220 is a vertical, cylindrical, FRP tank with a flat bottom and top. It is approximately 8 feet in diameter and 5 feet high. The tank is located outside the treatment system building below C-200. T-220 supports C-200 and acts as the collection sump for the air stripper column. T-220 has a design pressure of atmospheric at 150°F and a total capacity of approximately 1,900 gallons.

Groundwater is pumped from T-220 by GAC Adsorber Feed Pumps P-220A/B. P-220A/B are horizontal centrifugal, ductile iron pumps with type 316 stainless steel impellers capable of pumping 540 gpm of water at 100 feet TDH using a 20-hp, TEFC motor. The pumps are also equipped with Hand-Off-Auto (HOA) Hand Switch HS-220A and HS-220B that control the pump operation. P-220A is the primary pump and P-220B serves as an installed spare to be used during maintenance or repair of P-220A. The groundwater is fed from these pumps to the Liquid GAC Adsorption System X-220A/B. This flow is controlled by flow control valve FCV-220. A continuous recycle at steady state conditions is provided for these pumps. The recycle flows back to T-220. The actual recycle rate will be determined by measuring the difference between influent flow rates from the extraction wells and the design pumping rate of 540 gpm for P-220A/B.

1.4.6.2 Air Stripper System Instrumentation and Control

C-200 is a static piece of process equipment that requires only monitoring of the air pressure in the column. Air pressure is measured in the duct connecting the fan outlet to the Air Stripper column. Hand Indicator Switch HIS-200D allows K-200 to be started, stopped, or reset from the treatment system PLC, while Position Indicator XI-200 is an interface signal that informs the treatment system PLC of the on/off status of K-200. The treatment system PLC also provides digital input signals to the air stripper control system from interlocks I-220 and I-221. I-220 shuts down K 200 after a 15-minute shut down of GAC Feed Pumps P-220A/B, based on low-low level in T 220. I-221 shuts down K-200 5 minutes after shut down of P-110A/B, based on high level in tank T-220. I-222 stops K-200 immediately when high-high level is reached. After either I-220, I-221 or I-222 has been tripped, K-200 must be reset using HIS-200D, which is accessed through the PLC interface.

A diaphragm pressure switch measures the air pressure in the duct. At the low pressure setting, the switch will send a digital input to the PLC which will trip interlock I-200 which will stop P-110 A/B. This will display on the PLC monitor as PA-200 and transmit a signal to the remote "common" alarm. The high pressure set point signals that the column is in need of cleaning. Since this condition is not critical, this signal is not transmitted to the remote location but is displayed as high pressure PA-200. A local pressure gauge, PI-200, (calibrated in inches water column) and a local air flow meter are also provided.

The instrumentation for the Stripper Effluent Holding Tank, Item T-220, is provided by OHM as part of the treatment system and not by the air stripper manufacturer. To control the level and help control the flow from T-220 to the Liquid GAC Adsorption System, T-220 is equipped with low and high level switches LSL-220 and LSH-220 along with differential pressure type level indicating transmitter LIT-220. LIT-220 measures and transmits the level in the tank to the PLC, where it is displayed by software module LICA-220. LICA-220 represents a level indicator controller alarm. This software module receives the level measurement, provides a software setpoint to LICA-220, displays the current tank level, and displays high and low tank level alarms when the levels reach alarm setpoints. The high alarm triggers I-221 and the low alarm triggers I-220. I-221 sends a digital output to stop P-110A/B, and I-220 sends a digital output to stop P-220A/B. A 15-minute time delay is programmed for I-220 and a 5-minute time delay for I-221 to stop K-200 in order to ensure proper treatment of any remaining liquid hold up before P-110 A/B is restarted. Tank T-220 level is maintained between the high and low levels during normal operation by cycling pumps P-110 A/B and P-220 A/B "on" and "off." The tank level should be maintained as steady as possible by throttling the control valves and minimize the cycling as much as possible. A high-high tank level (I-222) interlock is also provided to stop K 200 immediately if the water level rises to within 6 inches from the bottom of the air duct. This interlock helps to protect the air blower from water damage. If the blower K-200 is tripped, then the blower must be reset using the appropriate start/stop hand indicator switch, HIS-200D. Operator can access HIS-200D through the PLC interface.

Pressure gauges PI-220A and PI-220B are installed at the P-220A/B discharge to assist in diagnosing pressure associated problems. A turbine flowmeter, FE-220, measures the discharge flow rate which is transmitted and indicated locally by flow indicating transmitter FIT-220.

1.4.7 Cartridge Filters and Liquid Granular Activated Carbon (GAC) Adsorber System

1.4.7.1 Cartridge Filters

Equipment

Before groundwater flows to the Liquid GAC Adsorber System, it is prefiltered by Cartridge Filters F-220A/B/C, which are arranged in parallel. F-220A/B/C are in-line, 10 micron filters, 18 inches in diameter and 5 feet high each capable of handling 250 gpm at a design pressure of 75 psig at 150°F. These filters are constructed of 304 stainless steel. The spare replaceable filters are made of paper. These filters remove any particulate solids that may have come through the system. This helps to limit backwashing of the GAC vessels. The units are arranged in parallel so that the system may remain in operation during cartridge replacement.

Instrumentation and Controls

The only instrumentation associated with F-220A/B/C are local pressure gauges and High-high Differential Pressure Indicating Transmitter PDIT-220A. When the differential pressure across the filters exceeds 20 psi, PDIT-220A sends an analog output to PDIA-220A, which is displayed on the PLC monitor. This high alarm activates the "common" alarm light in the control room. Local indication of pressure on upstream and downstream sides of the filters is measured by Pressure Gauges PI-220 C and PI-220D, respectively.

1.4.7.2 GAC Adsorbers

Equipment

Groundwater flows from F-220A/B/C to the Liquid GAC Adsorber System X-220A/B where the remaining VOCs are adsorbed onto activated carbon. These two units are arranged as a parallel train. Each vessel is a vertical, cylindrical, carbon steel tank 8 feet in diameter with elliptical heads and a design pressure of 75 psig at 150°F. Each cell is loaded with 8,000 pounds of granular activated carbon. The system is located inside the treatment system building. The system is purchased as a self-contained system and comes skid mounted including all required interconnecting piping and valving so that the system can be manually backwashed. Groundwater flows from the GAC Adsorber System to the top of the Treated Effluent Storage Tank T-240. Backwash water from the GAC system is sent to Backwash Water Holding Tank T-205. These units are expected to require backwashing approximately once every 3 to 4 months of operation.

Instrumentation and Control

GAC Adsorber System X-220A/B is provided with a High-high Differential Pressure Indicating Transmitter PDIT-220B. When X-220A/B registers a 5 to 10 psi differential pressure above the initial pressure drop, the alarm is displayed on the PLC monitor to inform the operator that the GAC vessel(s) need to be backwashed.

Each vessel is equipped by the manufacturer with a locally mounted pressure gauge for manual readings and a pressure relief valve, PSV-220 A/B.

1.4.8 Effluent Storage and Discharge System

1.4.8.1 Effluent Storage Tank and Discharge Equipment

Treated Effluent Storage Tank T-240 is a vertical, cylindrical, cross linked high density polyethylene tank with a flat bottom and domed top. It is 12 feet in diameter and 12 feet high. The tank is located inside the treatment system building. It has a design pressure of atmospheric at 150°F, and has a capacity of approximately 12,500 gallons. The tank also provides backwash water for X-220A/B. Treated groundwater enters the tank through the domed top via a dip pipe.

The treated effluent discharges to Wallace Creek by gravity from the top of T-240. The effluent is also used for pump seal water and for the polymer addition system and is supplied to the appropriate areas by Reuse Water Pump P-245. P-245 is a centrifugal pump capable of pumping 10 gpm of water at 110 feet TDH using a .75-hp motor. The pump is also equipped with Hand Off-Auto (HOA) Hand Switch HS-245 that controls the pump. The flow from this pump to the polymer system is controlled by a solenoid valve (on/off type block valve) SV-243.

The effluent used for backwashing the GAC vessels is supplied by Backwash Water Pump P-241. P-241 is a centrifugal pump capable of pumping 200 gpm of water at 50 feet TDH using a 7.5-hp motor. The pump is also equipped with Hand-Off-Auto (HOA) Hand Switch HS-241 that controls the pump.

1.4.8.2 Effluent Storage Tank and Discharge Instrumentation and Control
T-240 uses differential pressure type, level indicating transmitter LIT-240 to monitor the tank level for use as permissive interlocks and to stop P-220A/B at a high-high level condition. LIT-240 measures and transmits the water level in the tank to the PLC where it is displayed by software module LIA-240. LIA-240 is a level indicator alarm. LIA-240 also provides a display and an alarm for low-low level, low level, high level, and high-high level when these setpoints are reached. When the low alarm on T-240 is tripped, the software provides interlock output signal I-240 which is a permissive interlock in the PLC. If I-240 is tripped, then pump P-241 is disabled and will not be allowed to start; however, if I-240 is tripped while P-241 is in operation, P-241 continues to complete its run cycle. It is then disabled and prevented from starting again. I-240 and the level alarm is reset when the level returns within the setpoint range.

When the high alarm is tripped, it is displayed in the PLC. When the high-high alarm is tripped, the software provides interlock output signal I-242 to HS-220A or HS-220B, stopping the GAC adsorber feed pump that is operating. The PLC software recognizes which pump is running by first analyzing the status of the software position indicators XI-220A and XI-220B. If I-242 is tripped, then the pump must be reset using the appropriate start/stop Hand Indicator Switch, either HIS-220A or HIS-220B. HIS-220A and HIS-220B are accessed by the operators through the PLC interface.

The gravity flow of groundwater discharging from T-240 is measured by Parshall flume FE-240 and transmitted to the PLC by flow indicating transmitter FIT-240 where it is displayed and totalized by software module FIQ-240. FIQ-240 represents a flow indicator totalizer which displays instantaneous flow and totalized flow.

A pressure gauge PI-241 is provided in the line directly after P-241 so that the pressure in the line can be monitored in the field during pump operation to determine if the pump is performing to design parameters.

1.4.9 Secondary and Utility Systems

1.4.9.1 Backwash Water Holding Tank

Backwash Water Holding Tank T-205 is a vertical, cylindrical, high density polyethylene tank with a flat bottom and domed top. It is 12 feet in diameter and 12 feet high. The tank is located inside the treatment system building. It has a design pressure of atmospheric at 150°F, a capacity of approximately 12,500 gallons, and is vented to atmosphere. T-205 provides surge capacity for backwash water from X-220A/B.

The treated effluent that periodically accumulates in T-205 is slowly pumped to the Iron Removal System Reaction Tank X-130 for removal of the suspended solids. The spent water can be pumped via two lines to either X-130 chamber 1 or chamber 2. The effluent from T-205 is pumped to X-130 by Spent Backwash Water Pump P-205. P-205 is a centrifugal pump capable of pumping 5 gpm of water at 40 feet TDH using a 1- hp motor. The pump is also equipped with a local Hand-Off-Auto (HOA) Hand Switch, HS-205, that controls the pump operation.

T-205 is equipped with level switches that are used to control P-205. P-205 can be started manually through the PLC interface using HIS-205. As backwash water from P-241 fills T-205 to the height of high level switch LSH-205, LSH-205 sends a signal to the PLC where it triggers PLC interlock I-205. I-205 then transmits a software signal to HIS-241, which then sends a signal to stop Backwash Water Pump P-241. P-205 then pumps the spent backwash water to the Iron Removal System for reprocessing by the system. I-205 is reset when the water level in the tank falls below LSH-205. The level in T-205 slowly falls until it reaches the mounting height of low level switch LSL-205. LSL-205 sends a signal to the PLC where it triggers PLC interlock I-206. I-206 then transmits a software signal to HIS-205, which then sends a signal to stop Spent Backwash Water Pump P-205. I-206 is reset when the tank level rises above the height of LSL 205. T-205 is also equipped with sight glass LG-205 for visually reading the tank level. The operating status of P-241 is displayed on the PLC monitor by position indicator XI-205.

Reuse Water Pump, P-245, provides seal water for pumps P-245 itself, P-241, P-220 A/B, P-110 A/B, P-145 and P-205, as well as water required by the Polymer Addition System. It is equipped with a position indicator, XI-245, and Hand -Off-Auto Switch, HS-245. When I-240 is tripped on low level in T-240, I-240 sends a signal after a 5-minute time delay to HIS-245 to stop P-245, and pumps P-241, P-220 A/B, P-110 A/B, P-145 and P-205 will be interlocked to stop upon the loss of the seal water. P-245 must then be started using HIS-245 at the PLC interface or using the local hand switch HS-245. If P-245 is

stopped, the other pumps (P-241, P-220 A/B, P-110 A/B, P-145, and P-205) will be interlocked to stop immediately.

1.4.9.2 Compressed Air System

The groundwater treatment system uses compressed air for several purposes including actuation of flow control and block (on/off) valves, and aeration in the Iron Removal System Reaction Tank. Compressed air is supplied from Air Compressor X-150. X-150 is a reciprocating-type, oil-less air compressor equipped with a 10-Hp motor. It is constructed of carbon steel and comes as a self contained unit which includes: a receiver tank (X-150D) with sufficient storage to minimize cycling of the compressor, a compressed air dryer (X-150C) to provide instrument quality air for plant service, an oil separator (X-150F), all required instrumentation and controls, and a local control panel. The rated capacity of Air Compressor X-150 is 33 CFM at 100 psig. The air compressor system local control panel is used to indicate air compressor trouble (e.g. high temperature, high pressure, etc.). The low air pressure switch, PSL-152 displays an alarm on the PLC monitor PA-152, transmits a signal via modem to the remote monitoring location lighting the "common" alarm and trips Interlock I-152. I-152 stops P-220A/B. This will induce a cascade total system shutdown. PSL-152 must be reset to enable the system to restart.

1.4.9.3 Building Drainage System and Containment Sump

The treatment system building is equipped with a floor drain system for drainage. T-025 is a 4-feet diameter precast concrete wet well located exterior to the GWTP on the north side of the building. It is used primarily to handle excess pump seal water and any washdown within the GWTP. Pump P-025 and P-025A (standby) serving the wet well can either pump to T-110 or to X-130, but preferably to X-130 due to the potential presence of solids in the water. The T-110 containment area collection sump identified as T-115 is also a precast concrete sump to manage liquids within the diked area exterior to the GWTP. Containment Area Sump Pump P-115 pumps accumulated liquids to Tank T-110.

Building Drainage Pump P-025, P-025A and Containment Area Sump Pump P-115 are submersible, centrifugal pumps, constructed of carbon steel. P-025 and P-025A are capable of pumping 15 gpm at 40 feet TDH using a 3 Hp motor. P-115 is capable of pumping 10 gpm at 30 feet TDH. These pumps send accumulated liquids to X-130 or to the Groundwater Collection Tank T-110 for processing through the treatment system.

T-025 and T-115 are equipped with ball-float-type, level switches that control pumps P-025, P 025A and P-115. As the level in T-025 rises to the high level setpoint of ball-float-type, high level switch LSH-025, it provides a contact closure to the treatment system PLC, which displays high level alarm LA-025. The PLC then provides a digital output to start/stop Hand Switch HS-025 that starts the pump and sends the sump liquid to X-130

or T-110. As the level falls to the low level setpoint of LSL-025, LSL-025 opens the contact closure, stopping P-025 or P-025A and resetting the LA-025.

As the level in T-115 rises to the high level setpoint of ball-float-type, low, high level switch LSH 115, it provides a contact closure to the treatment system PLC, which displays high level alarm LA-115. The PLC then provides a digital output to start/stop Hand Switch HS-115 that starts the pump and sends the sump liquid to T-110. As the level falls to the low level setpoint of LSL-115, LSL-115 opens the contact closure, stopping P-115 and resetting LA-115.

1.4.9.4 Sanitary Pump Station
At the current time, the ultimate discharge scenario for the sanitary sewer system has not been determined. The final design and process description will be deferred until these details become available. Therefore, this process description and control philosophy should be considered preliminary. This discussion also supersedes Process Drawing P-4 (dated 11/29/95) which will be updated upon completion of as-built drawings. Sewage will be pumped from the GWTP sewage collection station by a vertical grinder pump (not currently shown). It will likely be controlled by ball-float type low and high level switch. As the level in the sump rises to the high level setpoint of the ball-float-type, a high level switch will provide a contact closure to the treatment system PLC, which displays a high level alarm. The PLC will then provide a digital output to start/stop a Hand Switch that starts the pump and sends the sump liquid to a sump or manhole to be installed east of Piney Green Road which is connected to the base sewer system.

1.5 EMERGENCY OPERATIONS

1.5.1 Equipment Malfunction

A generalized emergency operation procedure is provided for the critical pieces of equipment used in the water treatment plant as follows:

1.5.1.1 Pump failure

- When a pump fails, the failed pump should be isolated by closing the inlet and outlet valves.
- Turn the failed pump HOA switch to the "off" position.
- If there is a standby pump (P-110 A/B and P-220 A/B), manually open the standby pump inlet and outlet valves.
- Turn the standby pump HOA switch to "auto" position and start the pump.

- Call for maintenance help to fix the pump if necessary.

1.5.1.2 Air Stripper Blower Failure

- If the air stripper blower K-200 fails, the low pressure interlock I-200 will shut down the air stripper feed pumps P-110 A/B automatically.

- The upstream equipment will shut down automatically upon high level in tank T-110, or the operator can choose to shut down each piece of equipment manually from the control panel or using the local HOA switch.

- Likewise, the downstream equipment will shut down automatically upon a low level in air stripper tank T-220, or the operator can choose to shut down each piece of equipment manually from the control panel or using the local HOA switch.

1.5.1.3 Water Tank Failure

- If a water tank fails, such as a crack has developed in the tank, the tank feed pumps should be shut off immediately. This can be done by turning the local HOA switch to "off" position, or turn off the pump from the control panel.

- Allow the tank discharge pump to continue to run to draw out the tank contents. The discharge pump will stop automatically on low tank level, or the operator may choose to shut off the discharge pump once the low level is reached.

- One exception is the spent backwash pump P-205. Because this pump draws the water from tank T-205 and recycles to the mix tank X-130, the operator should use caution not to overfill the other tanks.

1.5.1.4 GAC Carbon Filter Malfunction

- The most common cause for the GAC filter to malfunction is a high differential pressure across the filter bed due to particle plugage. The differential pressure can be restored by backwashing the filter bed. The backwash procedures are presented in Section 1.3 of this document.

- Another cause for the GAC filter to malfunction is the carbon bed has been exhausted such that there is no change in the water quality between the influent and effluent water. Under this case, the carbon will need to be replaced. Follow the manufacturer's manual on carbon replacement.

  Caution: If compressed air is used to draw or fill the carbon, the GAC filter pressure needs to be carefully monitored such that the GAC filter will not become overpressurized.

Before replacing the carbon, the water treatment system need to be shut down. Follow the normal shut down procedures provided in Section 1.3 of this document.

- If the GAC filter breaks, or a water line, or valve breaks around the GAC filter, isolate the filter by closing the incoming water feed valves 220V-20, 220V-21, and 220V-22. Proceed to shut off the GAC feed pumps P-220 A/B. The upstream equipment will shut down automatically upon high tank levels, or the operator may choose to shut down the system manually.

1.5.1.5 Cartridge Filter Malfunction

- The most common cause for the cartridge filter to fail is due to high differential pressure across the filter. There are three filters installed in parallel, only two are required during normal operations. The cartridge filter can be replaced by switching the water flow to the standby filter, and isolate the plugged filter by closing the inlet and outlet valves. Then open the filter top cover and replace with a new filter per the instructions provided in the manufacturer's manual.

- If a cartridge filter breaks, or a water line, or valve breaks around the filter, isolate the filter by closing the appropriate incoming water feed valve 220V-13, 220V-14, or 220V-15, and shut off the appropriate outlet valve 220V-16. 220V-17, or 220V-18.

- If the entire bank of filters need to be shut off, close all the inlet and outlet valves plus the valve on the main feed line 220V-11. Proceed to shut off the GAC feed pumps P-220 A/B. The upstream equipment will shut down automatically upon high tank levels, or the operator may choose to shut down the system manually.

1.5.1.6 Automatic Flow Control Valve Malfunction

- If the automatic flow control valve FCV-110 or FCV-220 fails, the operator can manually control the flow by using the bypass valve 110V-09 or 220V-12. Throttle the bypass valve slowly until the desired flow is obtained as indicated by the flow transmitter FIT 110 or FIT-220.

- If the operator desire to shut down the system, follow the normal shut down procedures presented in Section 1.3.

1.5.1.7 Caustic Tank Failure

- If a leak develops in the caustic tank T-121, the system needs to be shut down. Follow the normal shut down procedures provided in Section 1.3.

- The caustic will be contained within the containment walls. Call for expert help immediately on how to handle the leaked caustic.

- The leaked caustic should be pumped to empty containers under the supervision of expert help. Do not try to neutralize the caustic or hose down the caustic with water without the supervision of the expert. The operator should also refer to the safety precaution procedures.

1.5.1.8 Acid Tank Failure

- If a leak develops in the acid tank T-211, the system needs to be shut down. Follow the normal shut down procedures provided in Section 1.3.

- The acid will be contained within the containment walls. Call for expert help immediately on how to handle the leaked acid.

- The leaked acid should be pumped to empty containers under the supervision of expert help. Do not try to neutralize the acid or hose down the acid with water without the supervision of the expert. The operator should also refer to the safety precaution procedures.

  Caution: Do not hose down the acid with water because high temperature and even explosive situation can develop from the concentrated 93% sulfuric acid.

1.5.1.9 Air Compressor Failure

Refer to the section on Emergency Operations of Utility Systems

1.5.2 Emergency Shutdown Procedures

When an emergency situation exists such that the water treatment system needs to be shut down immediately, follow the procedures below:

- Press the "emergency stop" button mounted on the control panel, this will shut down all the equipment immediately.

- Another method, but not as preferable, is to cut off the main power from the electrical panel. The operator will lose control over the entire treatment system using this method.

- After the system is shut down, check that the chemical feed pumps (caustic, acid, metal scavenger, and polymer) are shut off. If not, turn them off manually.

1.5.3 Guidance on Emergency Operations of Utility Systems

1.5.3.1 Power Failure

- Upon power failure all equipment will stop, the well pumps will stop and no water will be transferred to tanks. The operator should prepare to re-start the system once the power comes back on.

- If the diaphragm pumps (P-141, P-143) are operating, they will continue to operate as long as there is compressed air available. The operator should turn off the air valve to stop the flow of compressed air and stop the diaphragm pumps until the power comes back on.

- When the power comes back on, be sure to restart the seal water pump P-245 first and follow the start up procedure in Section 1.3.

1.5.3.2 Potable Water Failure

- The water treatment plant does not require any outside source of potable water to operate, therefore, the treatment plant can continue to run as usual.

- Because the toilet facility requires potable water, the toilet should be closed off when the potable water is shut down.

1.5.3.3 Natural Gas Failure

- The water treatment plant does not require natural gas to operate, therefore, the treatment plant can continue to run as usual.

- The treatment building requires natural gas for heating in winter. If there is a potential for freezing weather while natural gas is off, the operator should prepare to bring in portable heaters to keep the building warm.

- The operator should not shut down the water treatment plant unless it is deemed necessary. If the treatment plant is to be shut down on freezing days, follow the shut down procedure for maintaining the tanks at low level in Section 1.3 and drain the lines.

1.5.3.4 Compressed Air Failure

- The water treatment plant requires compressed air to operate in the mix tank and certain instrumentations. Upon the loss of one air compressor, the operator should make sure the other redundant air compressor is functional and kicks in as designed. The water treatment plant can continue to operate as usual on one air compressor.

- If compressed air fails due to a break in a line, and results in a total loss of compressed air, the low air pressure interlock I-152 is designed to stop the system starting from the GAC feed pumps P-220 A/B. The rest of the system will cascade to shut down on high tank level. Follow the shut down procedures in Section 1.3 for Case 2 - shut down while maintaining the tanks full (not recommended unless necessary) or the operator can elect to use Case 1 - shut down the system while maintaining the tanks half full.

1.6 CRITICAL ALARMS AND AUTODIALER

Because the water treatment plant operator will not be present on-site 24 hours a day, an autodialer system is set up to alert the operator at a remote location when critical alarms do occur. A list of the critical alarms is given in Table 1.6.1. Each critical alarm is assigned to a specific channel in the autodialer. When a critical alarm is activated, the autodialer will start to ring the given list of phone numbers in the preset order of sequence until it is answered. The operator should immediately respond to the alarm and correct the situation.

Note: 1) The auto dialer override is located in control box mounted on wall.
2) Auto dialer time delay is set to 2 minutes.

Table 1.6.1 – Critical Alarms for Groundwater Treatment Plant	
Critical Alarms Descriptions	*Output*
Drawing No. P-3/3A	
X-130 Mix Tank pH level out of range	AICA-130 interlock I-121
X-132 Polymer pump stopped/off	XI-132
Shallow well low flow	FI-106
Drawing No. P-4	
T-110 pH out of range	AICA-200 interlock I-201
P-120 Jet mix pump stopped/off	XI-120
P-110A, Stripper feed pump stopped/off	XI-110A
P-110B, Stripper feed pump stopped/off	XI-110B
Deep well low flow	FI-107
Drawing No. P-5	
K-200 Stripper air blower off	XI-200
P-220A GAC feed pump stopped/off	XI-220A
P-220B GAC feed pump stopped/off	XI-220B
F-220A/B/C Cartridge filter pressure high	PDIA-220A
X-220A/B, GAC filter pressure high	PDIA-220B
P-245 Seal water pump stopped/off	XI-245
Drawing No. P-6	
X-150D Compressed air pressure low	PA-152 interlock I-152
Others	
PLC Failure	

2.0 MAINTENANCE AND TROUBLESHOOTING

2.1 INTRODUCTION

Prior to any maintenance or repair activity the equipment owners manual should be referenced. All proper safety precautions and measures should be carefully followed. The following maintenance and troubleshooting check lists and guides are not a replacement for the equipment owners manuals attached in Appendices II, III, IV and V. This section should be used as a supplemental guide for periodic maintenance and troubleshooting. Always refer to the owners manual prior to any maintenance, lubrication, or troubleshooting activities. A full listing of the owners manuals and associated equipment numbers are shown in the Table of Contents attached to each volume. A major equipment list and contact lists for vendors and personnel are also attached in each volume.

2.2 OPERATOR SERVICE REQUIREMENTS

It is each operators responsibility to inspect the equipment at the beginning of each shift. The applicable daily and weekly inspection sheet should be completed and any problems or changes in the normal operating conditions should be reported to the site supervisor. General equipment and machinery service requirements are outlined in the daily, monthly and six-month or greater maintenance and lubrication checklists presented in Tables 2.1, 2.2, and 2.3 respectively. Each operator should be familiar with the owners manual and any applicable safety requirements for any and all equipment they monitor or operate.

2.3 TROUBLESHOOTING

For troubleshooting the system, first refer to sections 1.4 and 1.5 for information on normal operating controls, emergency operations, interlock tables, and the instrumentation and controls. These sections should help to provide operating or shut down procedures and may even help to identify and locate the system malfunction(s). If the problem is an equipment malfunction, the specific equipment manual should be referenced. All equipment manuals are located in Appendices II, III, IV, and V. Each manual has a section on troubleshooting and repairs and a copy of the selected troubleshooting guide is given in Section 2.7. All proper lockout/tagout and applicable safety precautions should be followed during troubleshooting.

TABLE 2.1
DAILY MAINTENANCE AND LUBRICATION CHECK LIST
MCB Camp Lejeune - Groundwater Treatment System

Check ✓	Equipment Description	Work to be Performed	Required Lubricant or Tools
	Air dryer	Check operation of drain valve every 8-hour shift	None
	Air compressor	Check distance piece pressure gauge	None
	Air compressor	Check oil level, fill if needed	Compressor oil
	Air compressor	Check and drain condensate	None
	Siemans Motors (for Goulds pump)	Inspect and clean	Cleaning materials
	Filter Press	Inspect and clean dirt and sludge from piston rod and side rails	Cleaning materials
	Filter Press	Inspect filter plates and cloths and clean or pressure wash as needed	Pressure washer/cleaning materials
	Air Stripper	Inspect and clean motor	Cleaning materials
	Goulds Pumps	Check oil level	None
	General	Inspect all hoses, fittings, piping, etc. for leaks and repair as needed	None
	General	Inspect all exposed electrical for bare wires or water near lines.	None
	Carbon Cells	Inspect differential pressure	None
	Cartridge Filters	Inspect differential pressure and change filters at 20 psi differential	None

TABLE 2.2
MONTHLY MAINTENANCE AND LUBRICATION CHECK LIST
MCB Camp Lejeune - Groundwater Treatment System

Check ✓	Equipment Description	Work to be Performed	Required Lubricant or Tools
	Air dryer	Inspect/clean condenser coils	Cleaning supplies
	Air compressor	Inspect oil for contamination and clean as needed	Hand tools and disposal of used oil - Compressor oil
	Air compressor	Clean/replace breather trap filter element	Hand tools
	Air compressor	Inspect, clean or replace compressor valves	Hand tools
	Air compressor	Check belt tension	Hand tools
	Air compressor	Motor bearings - check and lubricate	Grease
	Siemens motors (for Goulds pump)	Check insulation resistance	Using approved method
	Filter Press	Clean and inspect	Cleaning tools
	Air Stripper	Lubricate blower bearings	Use good quality lithium-based grease conforming to NLGI Grade 2 consistency (Do NOT use "high temperature" grease)
	Air Stripper	Inspect packing	None
	Filter Press	Inspect hydraulic/air system for leaks. Clean system. Check oil level and fill as needed.	Cleaning supplies and oil (SAE 10 rated at 200 SUS @ 100°F or equal).
	Goulds Pumps	Inspect oil lubricated bearings: Change the oil every 3 months.	Oil ISO grade 68 (at 100°F), ISO grade 100 (>180°F), and synthetic (>350°F)

TABLE 2.3
6-MONTH OR GREATER MAINTENANCE AND LUBRICATION CHECK LIST
MCB Camp Lejeune - Groundwater Treatment System

Check ✓	Maintenance Frequency	Equipment Description	Work to be Performed	Required Lubricant or Tools
	Every 6 months	Air dryer	Disassemble/clean automatic drain valve	Hand tools
	Every 6 months	Air dryer	Disassemble/clean separator bowl	Hand tools
	Every 6 months	Air dryer	Inspect/clean condenser coils. Lubricate fan motors with 20 wt motor oil.	Hand tools
	Every 6 months	Siemens motors (for Goulds pump)	Lubricate bearings	Polyurea base and good grade of petroleum oil, No. 2 consistency, temp. range to +300°F
	Yearly	Filter press	Change oil	Drain and replace hydraulic oil. SAE 10, rated at 200 SUS @ 100°F or equal. Remove muffler/filter and clean in solvent
	Yearly	Filter press	Filter plates and cloths	Replace filter cloths depending on utilization and results. Average life is 1500 filtration cycles.
	Yearly	Goulds pump	System inspection	Check pump capacity, pressure, power. Dissemble pump and inspect.

2.4 ENVIRONMENTAL CONDITIONS

The system should be shut down immediately in any event that is deemed unsafe to personnel or could cause damage to the equipment. The following table summarizes some of the environmental conditions that could cause damage to the system and the suggested course of action for each.

Environmental Conditions	
Condition	*Course of Action*
Freezing Temperatures	Building temperature should be maintained at 40 to 50°F. If this temperature cannot be maintained, shut system down and drain all fluids. Try to repair heating problem.
Severe Weather (tornado, hurricane, etc.)	Shut system down, wait for severe weather to pass and then restart system.
Flooding	Shut system down, keep all electrical connections dry if possible.
Fire	Shut system down, evacuate building.

2.5 PREVENTIVE MAINTENANCE

Follow all maintenance and lubrication schedules, as provided in the owners manuals, located in Appendices II, III, IV and V. The daily and weekly checklists, Tables 2.4 and 2.5 respectively, are provided to help identify any potential problems. These checklists combined with a watchful eye can prevent system down time and increase system efficiency. Lubrication frequency and recommended lubricants are provided in Tables 2.2 and 2.3. Specific lubrication points are included in each owners manual and all manuals are located in Volumes II, III, IV and V.

2.6 CORRECTIVE MAINTENANCE

Prior to any corrective maintenance the appropriate owners manual should be referenced and all applicable safety procedures should be followed. The SYSTEM DOWN REPORT (Table 2.6) and/or the MAINTENANCE AND REPAIRS REPORT (Table 2.7) should be completed when any maintenance is performed. Document all maintenance and contact the Project Engineer and the Equipment Specialist prior to performing any corrective maintenance.

TABLE 2.4
DAILY CHECK LIST **Date:** _____

COMPONENT/ITEM	CHECK TO PERFORM	Time
Effluent Flow Meter (FE-240)	Totalizer flow reading, gallons _____	
Seal Water		
Pump 110 A	Pressure _____, should be between 15-20 psi	
Pump 110 A	Flow rate _____	
Pump 110 B	Pressure _____, should be between 15-20 psi	
Pump 110 B	Flow rate _____	
Pump 145	Pressure _____, should be between 15-20 psi	
Pump 145	Flow rate _____	
Pump 205	Pressure _____, should be between 15-20 psi	
Pump 205	Flow rate _____	
Pump 245	Pressure _____, should be between 15-20 psi	
Pump 245	Flow rate _____	
Pump 220A	Pressure _____, should be between 15-20 psi	
Pump 220A	Flow rate _____	
Pump 220B	Pressure _____, should be between 15-20 psi	
Pump 220B	Flow rate _____	
Pump 241	Pressure _____, should be between 15-20 psi	
Pump 241	Flow rate _____	

Initials of inspector: _____ Employee Number: _____

TABLE 2.4
DAILY CHECK LIST **Date:** _____

COMPONENT/ITEM	CHECK TO PERFORM	Time
Acid Tank, T-211	Acid level _____	
Caustic Tank, T-121	Caustic level _____	
Polymer Drum	Polymer weight _____	
Coagulent/Metal Scavanger Drum	Drum level _____	
Lamella Clarifier, X-131	Sludge level after 15 min. of settling Upper tap _____ Lower tap _____	
Mix Tank, X-130		
Diffuser Flow Rate, rotometer (air)	Flow _____, should be around 14 cfm	
Polymer Coagulation	Good _____ Fair _____ Bad _____	
pH Level	pH _____	
Building Drainage Wet Well	Water level _____, betweeen high and low	
Cartridge Filters		
Differential Pressure F-220 A	Differential _____ if > 20 psi change filter	
Differential Pressure F-220 B	Differential _____ if > 20 psi change filter	
Differential Pressure F-220 C	Differential _____ if > 20 psi change filter	
Carbon Filters		
Differential Pressure X-220 A	Differential _____ if > 10 psi report status	
Differential Pressure X-220B	Differential _____ if > 10 psi report status	

Initials of inspector: _____ Employee Number: _____

TABLE 2.4
DAILY CHECK LIST **Date:** _____

COMPONENT/ITEM	CHECK TO PERFORM	Time
Tank 145	Fluid level _____	
Tank 110	Fluid level _____	
Tank 220	Fluid level _____	
Tank 205	Fluid level _____	
Tank 240	Fluid level _____	
Pumps		
P-110A Pump Hour Meter	Hours _____	
P-110B Pump Hour Meter	Hours _____	
P-145 Pump Hour Meter	Hours _____	
P-205 Pump Hour Meter	Hours _____	
P-245 Pump Hour Meter	Hours _____	
P-220A Pump Hour Meter	Hours _____	
P-220B Pump Hour Meter	Hours _____	
P-241 Pump Hour Meter	Hours _____	
Acid pump, P-211	Pump speed _____, Stroke _____	
Acid pump, P-212	Pump speed _____, Stroke _____	
Caustic pump, P-121	Pump speed _____, Stroke _____	
Polymer pump, X-132	Pump speed _____, Stroke _____ Water flow _____, should be around 30 gpm.	
Scavenger pump, X-132A	Pump speed _____, Stroke _____	
Air Compressor	Pressure _____, should be 120 psi	

Initials of inspector: _____ Employee Number: _____

TABLE 2.5
WEEKLY CHECK LIST **Date:** _____

COMPONENT/ITEM	CHECK TO PERFORM	Time
Wells		
Well DRW - 1	Pressure _____ Flow Totalization _____	
Well DRW - 2	Pressure _____ Flow Totalization _____	
Well DRW - 3	Pressure _____ Flow Totalization _____	
Well SRW - 1	Pressure _____ Flow Totalization _____	
Well SRW - 2	Pressure _____ Flow Totalization _____	
Well SRW - 3	Pressure _____ Flow Totalization _____	
Well SRW - 4	Pressure _____ Flow Totalization _____	
Well SRW - 5	Pressure _____ Flow Totalization _____	
Well SRW - 6	Pressure _____ Flow Totalization _____	
Well DMW -1	Pressure _____ Flow Totalization _____	
Air Stripper		
Column Water Flow	High _____ Normal _____ Low _____	
Packing Color	Clean _____ Dirty _____ Very Dirty _____	
Blower Noise Level	Quiet _____ Vibrating & Noisy _____	
Effluent Flow Meter (FE-240)	Check and calibrate Parshall Flume and ultrasonic flow meter: Date _____, Time ____ Meter reading, gallons _____ Flume water level, inches _____ Calibration _____ Flow rate, gpm _____	
Filter Press		
Inlet Air Pressure	Pressure _____, normal is 80 - 100 psi	
Hydraulic Cylinder Pressure	Pressure _____, normal is 5600 psi	

Table 2.5 (continued):		
Calculate Chemical Usage:	Acid - Tank level decrease, inches_____ Equivalent volume used/week _____ Estimated next delivery date _____ Caustic - Tank level decrease, inches_____ Equivalent volume used/week _____ Estimated next delivery date _____ Polymer - Level decrease, inches_____ Equivalent volume used/week _____ Estimated next delivery date _____ Coagulant - Level decrease, inches_____ Equivalent volume used/week _____ Estimated next delivery date _____	

Initials of inspector: _____ Employee Number: _____

Table 2.6
System Down Report

Reporting Person

This form is to be completed whenever a system failsafe has triggered, whenever the system automatically shuts down; or whenever the system is manually shut down to perform maintenance, repairs, etc. Immediately upon noticing the system down, complete this form and contact the project engineer.

Two copies of this form should be made. One copy should go to the project engineer and the second to the project manager. The original should be kept in the on-site file.

Employee Name and Number: _____
Person Who Discovered the System Down

Manual Shut Down - Complete in Case of Manual Shut Down

Why was the system shut down? _____

Was the entire system shut down? Y/N Explain: _____

Describe the part of the system that were affected by shut down. _____

_____

Exact time and date of shut down: _____

Please give detailed information for the reasons the system was shut down: _____

_____

_____

Automatic Shut Down, Malfunction, or Failsafe Condition

When was the system discovered down? Date: _____ Time: _____

Please give detailed information for the reasons the system was down: _____

_____

What actions were taken to correct the problem? _____

_____

Wash the problem repairable and the system restarted for normal operation? Y/N _____

If the problem was not immediately repairable, what actions were taken to resolve the problem? _____

_____

Completed by Field Equipment Specialist

Were you able to restart the system? Y/N Restart time and date: _____
If no, what actions were taken? _____

What was the cause of the shut off? _____

Date and time the project engineer was notified: _____

Completed by Field Project Engineer

Date and time you reviewed this form? _____

Notes: _____

_____

Table 2.7
Maintenance and Repairs Report

Reporting Person

This form is to be completed whenever maintenance, repairs, filter changing, backwashing, etc., occurs to the system. Complete this form immediately upon completion of repairs.

Two copies of this form should be made. One copy should go to the project engineer and the second to the project manager. The original should be kept in the on-site file.

Employee Name and Number: _____

Person Who Performed/Supervised Repair/Maintenance

Description of Work

Date and time work started: Date: _____ Time: _____

Was the entire system shut down? Y/N

If yes, what was the time and date: Date: _____ Time: _____

If yes, was the system down report completed? Y/N _____

Description of work performed: _____

_____

_____

_____

_____

Date and time work started: Date: _____ Time: _____

Personnel, subcontractors, supplies, etc., used in repair or maintenance: _____

_____

_____

_____

_____

Work authorized by: _____

roject Engineer: _____ Date: _____

Equipment Specialist: _____ Date: _____

2.7 TROUBLESHOOTING GUIDES AND DIAGNOSTIC TECHNIQUES

This section contains selected troubleshooting guides and diagnostic techniques from the manuals of equipment on the site. These are to be used as supplements only and the owner's manual should always be referred to during troubleshooting. The selected troubleshooting guides attached in this section are:

- Air compressor
- Air dryer
- Carbon adsorbers
- Air stripper
- Polymer system
- Well pump submersible motors
- Filter press
- Goulds pumps

2.8 WIRING DIAGRAMS AND CONTROL DIAGRAMS

The wiring diagrams and control diagrams can be found assembled in separate stick files in the drawing rack and are not attached to these manuals.

TROUBLE SHOOTING GUIDES AND DIAGNOSTIC TECHNIQUES

SECTION VI
MAINTENANCE

⚠WARNING

This machine contains high pressure air which can cause injury or death from flying parts.

Always release pressure from compressor and air receiver before removing caps, plugs, fittings, covers; etc.

Hazardous voltage.

Can cause severe injury or death.

Disconnect main power before servicing compressor.

MAINTENANCE OPERATION	SERVICE INTERVAL				
	Operating Hours/Months - whichever comes first				
	500/3	1000/6	1500/9	2000/12	2500/15
COMPRESSOR					
Check Distance Piece Pressure Gauge	Daily				
Frame Oil Level - Check	Daily				
Air Inlet Filter - Inspect and Clean	Weekly				
Inspect Oil for Contamination —Change if necessary	Monthly				
Frame Oil - Change - Petroleum Lube	X	X	X	X	X
Unloader O-Rings -Teflon Lub on Unloader O-Ring	X	X	X	X	X
Compressor Valves - Inspect, Clean or Replace	X	X	X	X	X
Weather Trap Filter Element - Clean or Replace	X	X	X	X	X
Oil-Lube Rings -Inspect Teflon and Carbon Rings --Replace if necessary.				X	
Intercooler - Clean Exterior	Weekly				
Low Oil Level Switch - Check Operation	X	X	X	X	X
Operate Safety Valves - Manually	Weekly				
Clean Cylinder Cooling Fins	Weekly				
V-BELT DRIVE					
Belt Tension - Check	Monthly				
MOTOR					
Motor Bearings - Check and Lubricate				X	
Clean	Monthly —(Weekly in Dusty Locations)				
AFTERCOOLER					
Aircooled: Clean externally	Monthly — (Weekly in Dusty Locations)				
Clean air flow internally		X		X	
Watercooled: Check discharge water temp.-120°F max		X		X	
Check water flow rate	Weekly				
RECEIVER					
Drain Condensate - Manual	Daily				
Operate Safety Valves	Monthly				
GENERAL					
Tighten or check all bolts	Monthly				
Check for Unusual Noise and Vibration	Daily				
Inspect for Air Leaks	Monthly				

2. Confirm that condensate is discharging from the automatic drain valves.

3. Check ADV timing. See Automatic Drain Valve section for ADV adjustment procedure.

4. Check that the main electrical supply voltage matches the voltage specified on the dryer data plate.

5. Check customer-supplied circuit breakers or fuses. Reset or replace as required.

6. Check proper connection and support of compressed air lines to the dryer; check bypass valving system, if installed.

7. Ensure adequate ventilation for air-cooled dryers.

8. For water-cooled models, check that the water supply is connected to the water regulating valve on the condenser. Confirm that the cooling water supply meets the required flow and temperature (see Table 1).

9. Confirm that the inlet air temperature, pressure and airflow to the dryer meet the specified requirements (see Tables 10 and 11).

10. Confirm that the condensate lines from the automatic drain valve discharges into a collection tank or an environmentally approved disposal system.

11. After 30 minutes of operation, check the HIGH EVAP light or CHECK OPERATING CONDITIONS indicator. If this indicator is lit, turn the dryer off and call your local distributor.

12. If the CHECK OPERATING CONDITIONS indicator has turned off after 30 minutes of operation, check the following temperatures on the System Operation Monitor:

    - Refrigerant discharge (head) temperature should be within the range of 140°F to 220°F.
    - Refrigerant suction temperature should be within the range of 32°F to 55°F.

    If either temperature is out of range, see the Field Service Guide for correction.

The dryer is designed to run continuously. Let the dryer run when the demand for compressed air is interrupted; the dryer will not freeze up. If the supply power has been turned off for more than four hours, supply power to the dryer; warm up the crankcase heater (if applicable) for 4 hours before starting the dryer to vaporize any accumulated liquid refrigerant from the compressor oil.

SHUTDOWN

When the dryer must be shut down for maintenance or other reasons, use the following procedures.

If electrical repairs must be made:

1. Turn off the power switch.
2. Disconnect the main power supply.
3. Lock out and tag the power supply in accordance with OSHA requirements.

DANGER
Portions of the control circuit remain energized when the power switch is in the OFF position. Disconnect supply power to the dryer before performing maintenance on the electrical system.

If mechanical repairs must be made, vent the internal pressure of the dryer to atmospheric pressure.

Restart the dryer according to the start-up instructions.

MAINTENANCE

DXR Series dryers require little maintenance for satisfactory operation. Good performance can be expected if the following routine maintenance steps are taken.

DANGER
Dismantling or working on any component of the compressed air system under pressure may cause equipment failure and serious personal injury. Before dismantling any part of the dryer or compressed air system, completely vent the internal pressure to the atmosphere.

General

For continued good performance of your refrigerated dryer, all refrigeration system maintenance should be per-

rmed by a competent refrigeration mechanic. Before corrective maintenance is done during the warranty period, call your local distributor and proceed according to instructions. Refer to the warranty for limits of your coverage.

Daily Maintenance

Check the operation of the automatic drain valve at least once during each 8-hour shift. See the Field Service Guide for remedies to ADV malfunctions. See the Instrumentation section for ADV adjustment.

For models with the System Operation Monitor, check the following readouts.

- high evaporator temperature
- refrigerant suction temperature
- refrigerant discharge temperature
- alarm lights

Refer to the Instrumentation section and the Field Service Guide for further information.

Monthly Maintenance

For air-cooled condensers, inspect the condenser coils. Remove dust, dirt or other particles with a soft brush or with compressed air from an OSHA-approved air nozzle that limits its discharge pressure to 30 psig. If the coils are coated with oil, grease or other substances that reduce the cooling efficiency, clean the coil.

Service Due Indicator

On systems equipped with the System Operation Monitor the blue SERVICE DUE indicator will light after 4,500 hours (six months) of dryer operation. At this time, complete the following:

- Disassemble and clean automatic drain valve.
- Disassemble and clean separator bowl.
- For air-cooled condensers, inspect the condenser coils; clean if necessary. Lubricate fan motors with 20 wt motor oil.
- For water-cooled condensers, clean customer-supplied strainer.

To reset the SERVICE DUE INDICATOR:

1. Turn the power switch to the OFF position.
2. Hold down the PUSH TO TEST and CLOSED/OPEN buttons simultaneously.
3. Turn the power switch to the ON position.
4. Wait two seconds. Release the PUSH TO TEST and CLOSED/OPEN buttons. The indicator is now reset.

Ambient Air Filter

For units equipped with the optional ambient air filter (designated by the suffix F in the model number), inspect the filter element. If necessary, replace the element by lifting it out and slipping in a replacement. See the replacement parts lists for replacement element model numbers.

Returns to Manufacturer

If the dryer or a component of the dryer must be returned to the manufacturer, first call your local distributor for a return authorization number and shipping address. Your distributor will inform you whether the dryer or only a component must be returned. Mark the package with the return authorization number and ship freight prepaid as directed by your local distributor.

Automatic Drain Valve (ADV) Disassembly and Servicing

All DXR Series dryers have a timer-controlled automatic drain valve. The valve body is mounted on the frame bottom; a hose connects the valve body to the separator.

CAUTION
Do not disassemble ADV timer or attempt to repair electrical parts. Replace timer if defective.

The ADVs discharge condensate through a full-port drain opening. The valve body may need to be cleaned under conditions of gross particulate contamination.

To disassemble the ADV valve body for cleaning or other maintenance:

1. Turn power switch off.
2. Disconnect main power supply to dryer.

FIELD SERVICE GUIDE

PROBLEM	SYMPTOM(S)	POSSIBLE CAUSE	REMEDY
Water downstream of dryer.	No discharge from automatic drain valves (ADVs).	ADV failure or accumulation of dirt in ADV.	Dismantle ADV; clean, repair or replace. See Maintenance section.
	Inlet air temperature is outside normal range or reaches alarm set point.	Aftercooler malfunction.	Check aftercooler discharge temperature. Reduce temperature to 120°F max.; reduce airflow if temperature is above 100°F. (See Sizing Verification.)
	Liquid water entering dryer.	Aftercooler drain valve malfunction.	Dismantle aftercooler drain valve; clean, repair or replace.
	Excessive airflow (may also cause high pressure drop).	Dryer improperly sized.	Check airflow and dryer capacity (see Table 8). Reduce airflow or resize and replace dryer.
	Refrigerant compressor cut out by high refrigerant discharge pressure control.	1. Condenser fouled or clogged.	1. Clean condenser coils (see Maintenenace, Monthly).
		2. Fan motor stopped.	2. Repair or replace fan motor.
		3. Inlet air temperature too high.	3. Check aftercooler discharge temperature. Reduce temperature to 120°F max.; reduce airflow if temperature is higher than 100°F (see Airflow section).
		4. Air in refrigeration system.	4. Have refrigeration mechanic locate and repair leak. Recharge. Refer to data plate for refrigerant type and quantity.
		5. Ambient air temperature too high for air-cooled compressor.	5. Vent compressor room to outside.
		6. Aftercooler coolant air blowing on air-cooled condenser.	6. Baffle or vent to outside air.
	Compressor cuts out on internal overload.	1. Inadequate ventilation of air-cooled compressor.	1. Ensure adequate ventilation of the condensing unit (see Clearance). Motor will re-start automatically when compressor is cool.
		2. Insufficient cooling water for water-cooled compressor.	2. Ensure adequate cooling water (see Table 1). Motor will re- start automatically when compressor is cool.
		3. Leak in refrigeration system.	3. Locate leak. Repair and recharge. Motor will re-start automatically when compressor is cool.
		4. Incorrect adjustment of refrigeration control valves.	4. Call your local distributor.
	Compressor windings read open or shorted.	Compressor burned out.	Have refrigeration mechanic check and replace.
	HIGH EVAP light on.	1. Leak in refrigeration system.	1. Locate leak; repair and recharge.
		2. Improper adjustment of HGBV.	2. Remove cap from HGBV and screw out HGBV ½ turn with an allen wrench to lower suction temperature to the level listed in the Refrigerant Flow section.
		3. Air or noncondensables in refrigeration system. Possible leak in chiller.	3. Locate leak; repair and recharge. If chiller must be replaced, consult your local distributor.

PROBLEM	SYMPTOM(S)	POSSIBLE CAUSE	REMEDY
Water downstream of dryer.	Suction temperature higher than 65°F.	1. Improper adjustment of HGBV.	1. Remove cap from HGBV and screw out HGBV ½ turn with an allen wrench to lower suction temperature to the level listed in the Refrigerant Flow section.
		2. Inlet air temperature higher than 130°F.	2. Reduce aftercooler discharge temperature to design conditions (130°F max.).
		3. Excessive airflow	3. Check airflow and system capacity. Reduce airflow or resize and replace system.
		4. Leak in refrigeration system.	4. Locate leak; repair and recharge.
	Refrigerant discharge temperature lower than 140°F.	Low ambient temperature.	Consult your local distributor.
	Refrigerant discharge temperature higher than 250°F.	1. Condenser fouled or clogged.	1. Clean or replace condenser.
		2. Fan motor inoperative (air-cooled condensers only).	2. Replace fan motor.
		3. Incorrect fan cycling switch setting (air-cooled condensers only).	3. Consult your local distributor.
		4. Inlet air temperature too high.	4. Check temperature of inlet air. Reduce to design conditions.
		5. High ambient temperature.	5. Ventilate area.
		6. Incorrect water valve adjustment (water-cooled condensers only).	6. Adjust water valve to 210 psig. To decrease the pressure, turn the slotted square extension on the water regulating valve (at the compressor inlet) clockwise, increasing the water flow. To increase the pressure, turn the extension counterclockwise.
High pressure drop across dryer.	Inlet air temperature lower than 40°F.	Low ambient temperature.	Turn off dryer until ambient temperature exceeds required pressure dew point.
	Excessive airflow (may also cause water downstream of dryer).	Dryer improperly sized.	Check airflow and dryer capacity (see Table 8). Reduce airflow or resize and replace dryer.
	Dryer icing up.	Suction temperature lower than 32°F.	Adjust HGBV clockwise to raise to 33°F. Bypass the dryer while adjusting.
	Intermediate air temperature below 32°F.	Dryer icing up.	1. Adjust operating conditions to meet sizing conditions.
			2. Adjust HGBV to raise suction temperature to the level listed in the Refrigerant Flow section.
High suction temperature.	Intermediate air temperature too high. Frosting of compressor or no cooling. Refrigerant suction temperature too high.	1. Loss of refrigerant charge. Refrigerant compressor cycles on low pressure control.	1. Locate leak. Repair and recharge.
		2. Refrigerant filter/dryer plugged up.	2. Replace filter/dryer.
High suction temperature.	Refrigerant discharge temperature higher than 220°F. Refrigerant suction temperature higher than 65°F.	Water in refrigeration system. Leak in chiller or water-cooled condenser.	Locate leak. Repair leak or replace chiller or condenser.

PROBLEM	SYMPTOM(S)	POSSIBLE CAUSE	REMEDY
Intermediate air temperature too high.	High suction temperature.	1. Loss of refrigerant charge. Refrigerant compressor cycles on low pressure control.	1. Locate leak. Repair and recharge.
		2. Refrigerant filter/dryer plugged up.	2. Replace filter/dryer.
No condensate from automatic drain valve (ADV).	Valve continuously venting.	1. Clogged diaphragm.	1. Clean diaphragm.
		2. Short in electrical component.	2. Check and replace connector or timer assembly.
	Valve not cycling	1. No electrical power.	1. Check and correct power supply and connections.
		2. Timer malfunction.	2. Replace timer assembly.
		3. Solenoid coil malfunction.	3. Replace solenoid coil.
		4. Clogged ports.	4. Clean ports.
	No response when test button is pushed.	1. No electrical power.	1. Check and correct power supply and connections.
		2. Timer malfunction.	2. Replace timer assembly.

Table 10
DIMENSIONS AND CONNECTION SIZES

MODEL NO.	MAX OPERATING PRESSURE (PSIG)	DIMENSIONS (inches)			IN-OUT CONNECTIONS (in NPT)
		W	H	D	
DXR75	250	35	35	21	1¼
DXR100	250	35	35	21	1½
DXR140	250	35	39	21	2
DXR180	250	34	40	36	2
DXR230	250	34	40	36	2½
DXR300	250	34	40	36	2½
DXR425	250	36	64	36	3
DXR550	250	36	64	36	3
DXR750	250	36	73	48	3
DXR1000	250	36	73	48	3

8.0 MAINTENANCE

The adsorbers are ASME rated pressure vessels, protected by safety valves to prevent their exposure to pressure in excess of 75 PSIG. An annual inspection of the exterior and interior of the vessels should be made. This can best be done during the carbon exchange since the interior can only be examined after the carbon is removed. At this time, the vessel lining should be examined for wear and the underdrain examined for possible damage. The vessel exterior can be examined at any time for signs of leakage or damage.

Pressure gauges have been installed and will enable the Operator to determine the pressure drop across each adsorber. If these readings are recorded regularly, the Operator will be able to tell when normal values are exceeded. This would indicate the possible accumulation of fines or dirt on the top of the carbon bed. Since this unit is preceded by pressure filters, it is unlikely that this should-occur. If it should, the adsorber should be backflushed as described Paragraph 3.4.

In the event that something should damage or break an underdrain nozzle, carbon would enter the underdrain and the adsorber effluent line. A fine mesh screen has been provided at the effluent nozzle at the bottom of the adsorber, to intercept the carbon in the event of a nozzle failure. This condition will be accompanied by a very rapid rise in pressure drop across the adsorber. Should this occur, the adsorber must be emptied of carbon and drained so the underdrain can be accessed and repairs made. Several spare nozzles have been provided with the system in case they are required. The other adsorber should be operated in single stage mode until repairs can be made.

Liquid relief valves are provided for the adsorber vessels. These valves are ASME approved for this service and are rated to relief within $\pm$ 3% of the 75 PSIG maximum allowable working pressure. It is recommended that the system be operated at 65 PSIG or less. Since the normal operating pressure should be less that 35 PSIG this allows a generous margin for operation.

VI.

Packing Maintenance

In order to avoid problems associated with fouled packing, the pack should be cleaned as a part of regular maintenance procedure. If the packing has become fouled or clogged, you may correct the situation by cleaning with an acid wash solution or by changing the packing. Refer to the acid supplier's recommendations for handling the acid solution. The entire system should be shut down prior to changing or cleaning the packing.

I. Cleaning Packing

Shut down water supply to the air stripper tower. Circulate an acid wash solution through the air stripper influent piping. The frequency and number of cleaning passes will depend on degree of packing fouling. Note that the blower should remain turned off during the cleaning process. Check your local regulations for disposal of the acid material. The following wash solutions are recommended: for iron oxide fouling, use a 3% muriatic acid solution; for calcium carbonate fouling, use a 3% to 5% polysodium phosphate solution; for biological fouling, use a 3% to 5% potassium permanganate solution.

II. Changing Packing

To remove fouled packing, unbolt the viewport (see air stripper blueprint for location). If the packing is too fouled to fall out smoothly, it may have to be "prodded" out with a pole. After packing has been removed, reassemble the viewport. Remove demister and/or dome top and dump in packing to the height shown on the air stripper blueprint.

VII.
Trouble Shooting

I. Misting

- Check water distribution spray pattern at tower top and make sure spray is hitting packing media and not the air stripper wall. Check to see if there is proper spacing as indicated on the air stripper blueprint.

- Check actual influent water flow rate with a flow meter and adjust flow rate to be in accordance design flow rate.

- Check to see if spray nozzle(s) is out of plumb and readjust if necessary. If using a pipe wrench, caution should be used in order to prevent piping damage.

- Check for excessive blower pressure or air flow rate using the magnehelic gauge and blower performance data located in the back of this manual. Adjust the blower damper as previously discussed to correct for excessive air flow rate and /or pressure.

II. Efficiency Loss

- Check operating conditions (flow rate, temperature, contaminant levels) against design parameters. Either adjust these conditions so that they are in accordance with initial design parameters or retrofit the system with necessary changes.

- Check for packing fouling. Refer to packing maintenance section of this manual.

- Check for water channeling down the inside wall of the air stripper by checking the water distribution pattern at the tower top.

III. Noisy Blower

- Check the condition of the motor bearings and replace or lubricate noisy bearings as per the motor manufacturer and/or National Environmental Systems.

- Check for a dented inlet screen mounted on the blower air inlet and the screen guard located on the end of the motor housing. To correct, remove the screen(s), correct any dents, and replace.

- On belt driven fans, check for rubbing between the fan wheel blades and the inlet cone of the blower air inlet (see the blower section of this manual for location of these components). To correct, loosen the bolts around the perimeter of the inlet cone section, adjust the inlet cone and tighten the bolts.

Section 8
Shutdown, Cleaning, Troubleshooting & Maintenance

8-A SHUTDOWN AND CLEANING

There are few moving parts within the PolyMax.

These are the metering pump, rotameter and solenoid valve.

Because of the unique and carefully planned design, maintenance is greatly simplified.

Shutdown and Cleaning

If PolyMax is used for one shift in a dewatering operation, flush and clean the unit before shutdown. Shut down the polymer concentrate pump by turning the pump off.

the PolyMax is shut down for extended weekends or longer periods of time, the PolyMax should be thoroughly flushed with clean water and drained.

There are two drain valves inside the PolyMax that allow draining of the unit and back flushing. These valves greatly assist in cleaning and draining the unit.

WARNING!

Test the cleaning solution one plans to use.

Some polymer concentrates will react with small amounts of water and plug the piping.

Mix a small sample of the polymer concentrate with various cleaning agents.

f the polymer concentrate dissolves, a cleaning solvent could be used. If the polymer concentrate "gels" and does not dissolve, one should try another cleaning solvent.

If water has to be used; again, test the polymer concentrate. If white, solid, stringy chunks are formed, use extra caution. Water should eventually clean the equipment.

CAUTION!

If water is used and reacts with the polymer concentrate, always dry the system completely.

The inlet polymer concentrate piping, metering pump, metering pump discharge valves and piping should be completely dry.

Household bleach, mineral oil, new motor oil, warm water, and concentrated salt solutions are cleaning solvents for some polymeric flocculating agents.

The polymer supplier may also have recommendations regarding the selection of cleaning solvents.

Avoid using strong organic solvents such as kerosene, acetone, xylene, or other types of strong organic solvents.

These types of solvents may, under certain circumstances, dissolve the PVC piping or other plastic components.

If you have questions about the compatibility of various solvents and the PolyMax, please call your Semblex

Representative or Semblex Direct.

Removal of Algae and Microbes

One of the best ways to clean the PolyMax clear acrylic detention chamber and in-line mixers is to fill the PolyMax completely with full strength household bleach.

Fill the unit and let stand for 3 to 4 hours. The bleach will kill the bacteria and algae growth on the walls.

The optional pump inlet calibration column may be used to feed the bleach solution through the metering pump.

After soaking the unit for several hours or overnight, thoroughly flush the PolyMax with clean water.

Removal of Polymer Solution and Residue

For short term shutdown over a weekend, flush the unit using dilution water.

To flush the PolyMax, stop the polymer metering pump and allow the dilution water to flow through the unit for 30 to 60 minutes or longer.

Observe water flowing through the unit. When the in-line mixers are clear, the unit is clean.

The diaphragm pump is turned off by turning the speed knob counter-clockwise until it clicks off or move the switch to "Off".

Flushing allows the mixed polymer to be removed from the unit. Use the two ball valves with red handles on the inside of the unit to backwash and drain.

For long term shutdown, consult the polymer manufacturer for the best way to remove the polymer from the metering pump. The unit should be flushed free of polymer and drained.

Removal of Polymer Concentrate from the Metering Pump

Remove the flexible inlet hose from the drum and insert into a bucket of mineral oil, warm water, new motor oil, or other polymer solvent. Pump the liquid through the metering pump and into the system.

Avoid adding water to the bulk polymer drum or polymer concentrate piping. Protect the drum from moisture or accidental spraying and rain water.

Small quantities of water will cause most emulsion or dispersion polymer concentrates to clot, gel and become stringy.

The solids can and will, sooner or later, plug the metering pump. The partially activated polymer will not activate and is wasted.

In high humidity areas, an optional polymer drum desiccant dryer is available from Semblex. The Part Number is PN 4180.

As the drum "breathes" from temperature changes, the dryer will adsorb the moisture in the air.

Open the drain valve, close the dilute polymer outlet valve, start the pump, and open the rotameter to flush and clean the polymer from the unit.

The drain valves inside the PolyMax allow back washing which greatly facilitates cleaning.

To Help Prevent Frequent Cleaning Problems:

An in-line strainer or filter for the inlet water line ahead of the PolyMax will help trap suspended solids. The suspended solids will coagulate and from a floc inside the PolyMax. This causes the floc to "stick" inside the PolyMax.

If non-potable water, recycled water, reclaimed water, or other type of reused water is used for dilution, trapping suspended solids is especially important.

If the PolyMax is located in direct sunlight, algae may build up within the labyrinth detention chamber.

If non-potable water must be used for dilution, direct sunlight will accelerate algae growth. The result could be a need for more frequent cleaning.

In a some areas, the potable inlet dilution water contains various dissolved solids; that is, "hard water".

Very few polymer concentrates may react with the dissolved minerals within the dilution water. A heavy, "lime scale" deposit may be formed within the unit.

These scales can be very difficult to remove safely. Should one need help or assistance, please contact the Semblex Representative in the area or Semblex Direct.

8-B PREVENTATIVE MAINTENANCE

Additional preventative maintenance and disassembly of various components is described in Section 10, Assembly Component Manuals.

General maintenance of components and principal items follows:

Inlet Water Solenoid Valve

It is not uncommon for the inlet water solenoid valve to plug with grit, scale, and dirt from the incoming water. The valve can be easily disassembled and grit cleaned from the diaphragm.

Slow bleeding of water through the valve, the valve not closing or opening, when energized, or no water flow (with all other valves open) are all symptoms of a plugged solenoid valve.

Rotameter

Grit, dirt, and particulates can likewise plug up and cause the flow adjustment valve and the ball in the rotameter to malfunction.

The rotameter can be partially removed from the front of the PolyMax by disconnecting the unions.

This allows enough room to move the rotameter a couple of inches away from the front panel for easy removal and cleaning.

Inlet Water Flow Switch

The flow switch is used to monitor the inlet water flow rate. Should the water flow fall below the set point, the polymer concentrate metering pump would shut off.

This feature avoids injection of raw polymer concentrate without enough dilution water and avoids plugging the mixing system.

Polymer Concentrate Mixing Piping

The PVC piping from the inlet mixing tee through the three in-line mixers and to the

inlet of the detention chamber is essentially a continuous mixing unit.

No maintenance is required unless concentrated polymer is allowed to sit for long periods of time. The polymer could partially dry and plug the piping.

All tees and ells downstream of the mixing tee contain special baffles that are ported to allow for drainage, mixing, and to prevent air binding.

If the unit becomes plugged, disassemble the piping using the convenient unions and clean thoroughly.

CAUTION!

Avoid losing the sealing o-ring in each union. To prevent leaks, the o-ring must be in place.

Soak the assemblies in cleaning solution or warm water. See Shutdown and Cleaning, this Section, for more information.

Call Semblex Direct for additional advice or for replacement parts.

Detention Chamber - Labyrinth

No maintenance is required except to keep the chamber clean and free of concentrated polymer.

Flushing with clear water upon shutdown will sufficiently clean the chamber and labyrinth.

See Shutdown and Cleaning, this Section, for more information.

Labyrinth Disassembly and Reassembly

Note the orientation of the labyrinth tubing before removal.

WARNING!

To avoid injury and damage to the unit, assemble the labyrinth tubing exactly as it was originally installed. All labyrinth tuging systems are installed with exactly the same orientation.

If the labyrinth is ever disassembled, care should be taken to insure that the tubing is not kinked or otherwise restricted. This is especially important to avoid reinstallation of the tubing.

The stainless steel rods that hold the labyrinth assembly together should be were factory tightened to about 5 to 10 ft. lb.

Upon reassembly, the rods should be tightened enough to hold the assembly togeather.

Test the labyrinth for leaks with water. Check the tube fittings should a leak be discovered.

Should you encounter problems or need additional information, please contact Semblex Direct.

WARNING!

If any polymer is spilled, immediately clean the floor or work area.

Polymer makes the work area and floor very slick!

Controls and Fuses

The electrical power for the unit is 120 volt,

60 Hz, single phase. The instrument lamps (bulbs) will eventually burn out requiring replacement.

Order replacement bulbs from your local electrical supply house or Semblex Direct.

The unit is fused. If the PolyMax is overloaded or short circuited, the power fuse could blow and would need replacing.

This fuse is located on the back of the electrical control panel inside the PolyMax.

The diaphragm type metering pump has a system of fuses within the metering pump. Should the pump fail to operate, check for power to the PolyMax. If the internal light and instrument lamps glow, the fuse within the diaphragm pump should be checked.

WARNING!

Follow plant safety rules before opening a pump control panel or any electrical enclosure!

8-C TROUBLESHOOTING GUIDE AND ABBREVIATED MAINTENANCE SCHEDULE

Note: The PolyMax has electrical overload protective devices. The entire unit is fused (See electrical schematic).

WARNING!

Follow plant safety rules before opening a pump control panel or any electrical enclosure!

The diaphragm type pump has overload internal fuses. If a fuse is burned out, replace with the same kind and type of fuse.

The following Troubleshooting Guide provides suggestions to solve problems.

Each major component manual also has a troubleshooting guide for the item.

As an example, the diaphragm pump manual also has useful information about solving diaphragm pump problems.

The PolyMax Abbreviated Maintenance Schedule also presents items to check periodically.

Again, more detailed information about the various system components is contained within the PolyMax Manual.

If additional information is needed, please contact the Semblex Representative which provided the equipment or, if preferred, contact Semblex Direct.

TROUBLESHOOTING GUIDE

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
No Water Flow	Inlet Valve Closed	Check Water Supply Valves
	No Electrical Power	Turn On Power Switch or Power Supply Defective Switch Fuse Burned Out Power Not Connected
	Clogged Solenoid	Check and Service Solenoid Check Solenoid Electrical
	Clogged Rotameter	Remove and Clean
Water Will Not Shut Off	Worn Solenoid Valve Parts	Rebuild or Replace the Solenoid Valve
	Clogged Solenoid Valve	Clean Solenoid Valve
Electrical Buzzing or Noisy	Supply Voltage Problem	Check Power Source - Should be 110 to 120 Volt
	Burned Out Relay Coil	Replace Relay
	Inlet Water Pressure	Water Pressur e Too High or Low
Rotameter Ball Sticks	Rotameter Partially Plugged	Disassemble and Clean the Rotameter
Piping Leaks	Missing O-Rings Union Loose	Replace O-Rings Hand Tighten Unions
Diaphragm Pump Doesn't Run	Inlet Water Flow Too Low	Increase Inlet Water Flow Rate
	No Power	PolyMax Plugged In? Turn On Pump Switch Test Pump Switch and Replace If Defective Internal Pump Fuse Burned Out Test Pump Electronics and Solenoid
Air Bubbles in Pump Discharge Line	Air Leak in Inlet Piping	Check for a Loose Fitting on the Inlet of the Pump Tighten Inlet Piping
Diaphragm Pump Runs, But at Reduced or No Output Capacity	Ruptured Diaphragm	Replace Pump Diaphragm
	Pump Diaphragm Chambers Plugged or "Solid Chunks" Visible in the Pump Head	Disassemble Pump Head and Clean Inspect and Clean Inlet and Outlet SS Ball and Springs Inspect and Clean Black Hypalon Seal Rings
	Pump Looses Prime or Air Bubbles Appear in the Acrylic Pump Head	Follow Pump Priming Instructions and Re-prime. Tiny Air Leaks in the Inlet Piping Cause Trouble PolyMax Location May be Too Far from the Polymer Supply The Polymer May be Too Viscous - Raise Polymer Source to the Same Elevation as the Pump Inlet.

POLYMAX ABBREVIATED MAINTENANCE SCHEDULE

ITEM OR COMPONENT	CHECK FOR	FREQUENCY	ACTION [1]
Check Polymer Supply	Level in drum or container	Daily	Plan for additional Polymer; change drums; refill container
Check PolyMax and Operating Area	Polymer leaks	Daily	Shut down unit, clean, repair leaks
Observe PolyMax	Proper mixing and control settings	Daily	Reset controls if needed
Inspect PolyMax Mixing Elements and Labyrinth	Build up of foreign materials	Weekly	Clean as required See O & M, Section 8
Check PolyMax Water Flow Switch	Shut Off of Polymer Metering Pump at Set Point	Monthly	See O & M, Section 8 & 10
Check Rotameter	Visible Contamination or Algae Growth	Monthly	Clean as required See O & M, Section 10, Rotameter
Check Solenoid Valve	Proper Operation, Tight Shut Off, Etc.	Monthly	Clean - repair as required. See O & M Section 10, solenoid valve
Metering Pump	Calibrate Pump At 25, 50, 75, & 100% Capacity	Quarterly	See O & M, Section 7, Calibration
Check Stock of Recommended Spare Parts	Still on site and available	Quarterly	Reorder if missing - See O & M, Section 9, for details
Check PolyMax Inlet Water	Potential for "Water Hammer" or Hydraulic Shock	Upon Installation and then Quarterly	Excess pressure surges may damage the equipment

1. See Section 10, Troubleshooting and Maintenance, PolyMax Operation and Maintenance Manual

2. If Non-Potable water is used, clean strainer (by others) weekly.

Section 9
Spare Parts Ordering Information

SPARE PARTS ORDERING INFORMATION

A Parts List is included in this Operation and Maintenance Manual. The information from the list is quite useful in ordering spare parts. Please feel free to photocopy the List for your use in requesting the current price of your selected parts.

Prompt service can be given for spare or replacement parts if Semblex has the following information:

1. The Manufacturer's name, model number, and serial number, if applicable. The Parts List includes most of the frequently requested items.

2. If a PolyMax Part Number can be located from the manual, the number is quite useful; however, we maintain extensive project records and the information can be retrieved from our files.

3. We will need the exact quantity requested of each item. Don't forget to order spares, if needed.

4. Order fulfillment information will be requested. To complete the order we will need:

   Preferred Shipping Carrier Information

   Regular Service, Second Day, or Overnight Delivery

   Bill To Address

   Shipping Address (Most Carriers Cannot Deliver to a Post Office Box Number)

   Purchase Order Number

5. Parts will be invoiced F.O.B., Springfield, MO, at the prices in effect at the time of shipment.

The Semblex Representative for your area will be happy to assist in obtaining prices and receiving purchase orders. Should you prefer, please contact Semblex Direct.

ORDER ADDRESS:

SEMBLEX
SPARE PARTS DEPARTMENT
1635 W. WALNUT STREET
SPRINGFIELD, MISSOURI 65806

TELEPHONE: 417-866-1035 FACSIMILE: 417-866-0235

Recommended Spare Parts

Qty.	Description	Part No.
2	Instrument light bulb *	4238
2	O-Ring for pipe unions *	4241
1	LMI pump repair kit	4138
1	Standard 40 watt incandescent light bulb	----

* Spare parts shipped with unit

Recommended spare fuses for unit are as follows:

QTY	DESCRIPTION	PART NO
2	Main line fuse	Buss MDL - 1-1/4", glass, dual element, size as noted on electrical drawing.
2	Diaphragm pump	Internal to pump, Littlefuse, 1-1/4", #312, glass, Buss cross reference - MTH, 1-1/4", non-time delay

Prompt service can be given on spare or replacement parts if the following information is provided:

1. Manufacturer's name, model number and serial number (if applicable). Semblex job number will also aid in expediting your order.
2. Part number, if given.
3. Exact quantity needed.
4. Type of transportation, purchase order number, bill to and ship to address.

All parts will be invoiced F.O.B. Springfield, Missouri, unless otherwise instructed at prices in effect at time of shipment.

Direct orders to:

Spare Parts Department

SEMBLEX
1635 W. Walnut Street
Springfield, Missouri 65806

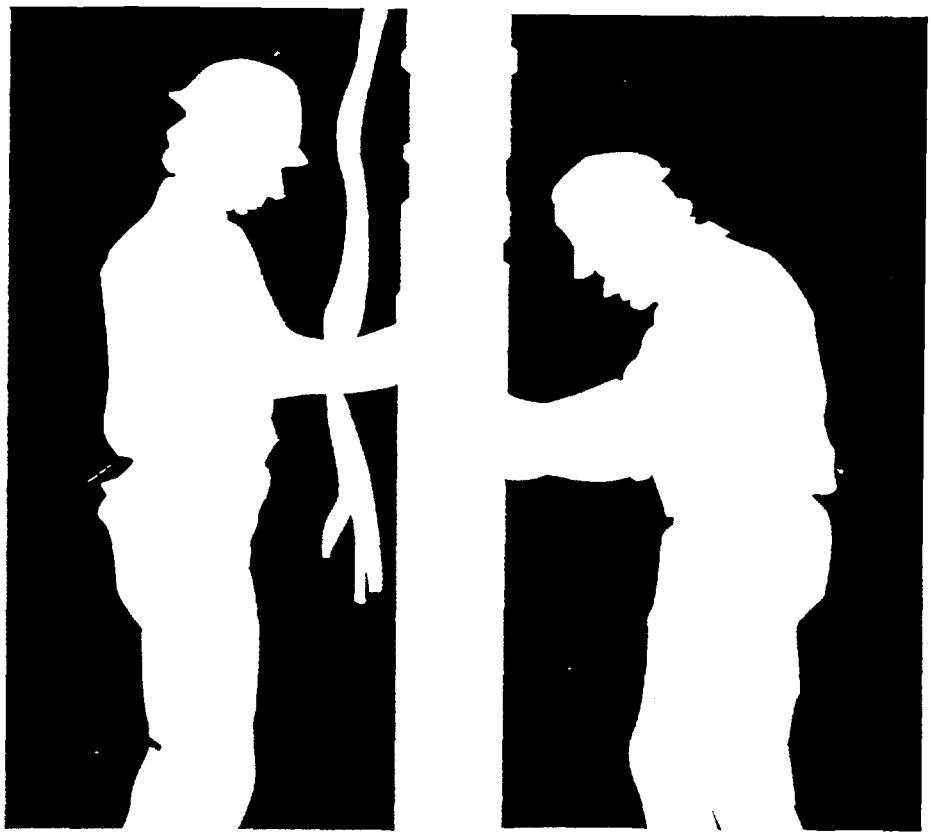
Telephone: (417) 866-1035
Facsimile: (417) 866-0235

SERVICE DATA
PAGE: 263SD
DATE: September 1, 1992
SUPERSEDES: 10/1/88

Submersible Motors

Application ■ Installation ■ Maintenance Manual

Water Well Motors, Single and Three Phase 60HZ, 4", 6" and 8" Diameter



Franklin Electric
QUALITY IN THE WELL

3 Month Inspections

- Check foundation and hold-down bolts for tightness.
- If pump has been left idle, check packing. Replace if required.
- Oil should be changed at least every 3 months (2000 hours) or more often if there are any adverse atmospheric conditions or other conditions which might contaminate or break down the oil, or if it is cloudy or contaminated as seen by inspection through the sight glass.
- Check shaft alignment and realign if required.

Annual Inspections

- Check pump capacity, pressure and power. If pump performance does not satisfy your process requirements, and process requirements have not changed, pump should be disassembled, inspected, and worn parts should be replaced, otherwise, a system inspection should be done.

MAINTENANCE OF BEARINGS

OIL LUBRICATED BEARINGS

WARNING

Pumps are shipped without oil. Oil lubricated bearings must be lubricated at the job site.

Remove fill plug (408H) and add oil until level is at the center of the sight glass (319). Replace fill plug (Fig. 18A). See Table 4.

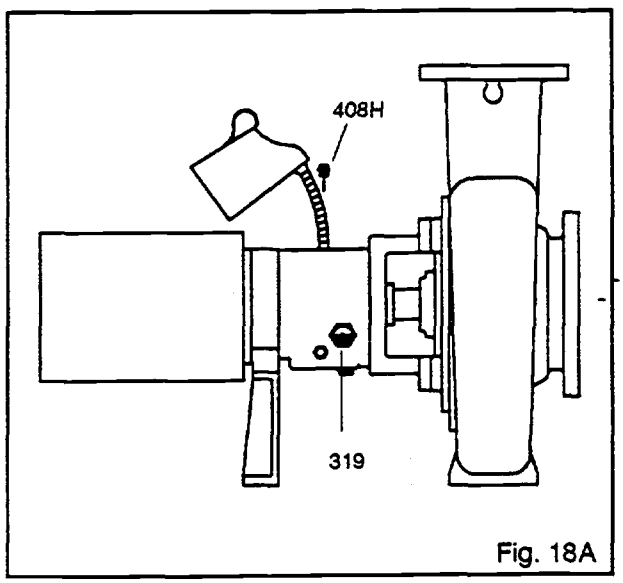


Fig. 18A

Change the oil after 200 hours for new bearings, thereafter every 2000 operating hours or 3 months (whichever comes first).

Table 4
Oil Volumes

Frame	Pints	ml
STX	1.0	400
MTX	2.6	1250
LTX	3.0	1400

A high quality turbine oil with rust and oxidation inhibitors should be used. For the majority of operational conditions, bearing temperatures will run between 120°F (50°C) and 180°F (82°C). In this range, an oil of ISO viscosity grade 68 at 100°F (40°C) is recommended. If bearing temperatures exceed 180°F (82°C) use ISO viscosity grade 100 with Bearing Frame cooling. See Table 5. For higher operating temperatures, pumpage above 350°F (177°C), synthetic lubrication is recommended.

Table 5
Lubricating Oil Requirements

	Pumpage temperature below 350°F (177°C)	Pumpage temperature above 350°F (177°C)
ISO Grade	VG 68	VG 100
Approx. SSU at 100°F (38°C)	300	470
DIN 51517	C68	C100
Kinem. viscosity at 100°F (40°C) mm^2/sec	68	100

Some acceptable lubricants are:

Exxon	Teresstic EP 68
Mobil	Mobil DTE 26 300 SSU @ 100°F (38°C)
Sunoco	Sunvis 968
Royal Purple	SYNFILM ISO VG 68 Synthetic Lube

GREASE LUBRICATED BEARINGS

Grease lubricated bearings are pre-lubricated at the factory. Regrease bearings every 2000 operating hours or 3 months.

Regrease Procedure:

NOTE: When regreasing there is danger of impurities entering the bearing housing. The grease container, the greasing device, and fittings, must be clean.

1. Wipe dirt from grease fittings.
2. Remove 2 grease relief plugs (408H) from bottom of frame.
3. Fill both grease cavities through fittings with recommended grease until fresh grease comes out of the relief holes. Reinstall grease relief plugs (408H).
4. Ensure frame seals are seated in bearing housing and if not press in place with drains located at the bottom .

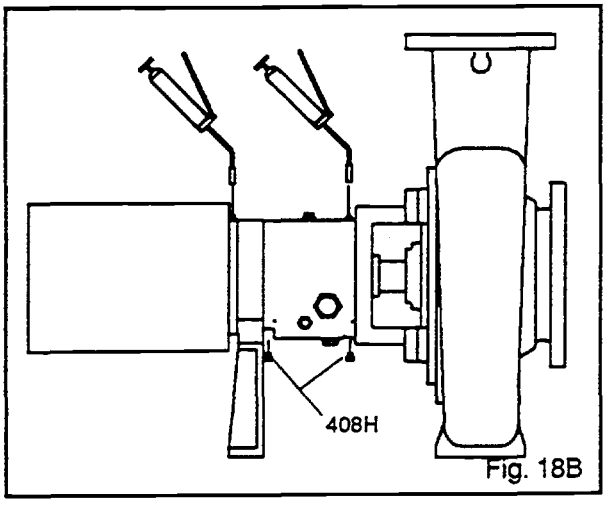


Fig. 18B

NOTE: The bearing temperature usually rises after regreasing due to an excess supply of grease. Temperatures will return to normal after pump has run and purged the excess from the bearings, usually two to four hours.

For most operating conditions a lithium based mineral oil grease of NLGI consistency No. 2 is recommended. This grease is acceptable for bearing temperatures of 5°F to 230°F (-15°C to 110°C). Bearing temperatures are generally about 20°F (18°C) higher than bearing housing outer surface temperature.

Table 6
Lubricating Grease Requirements

-	Pumpage temperature below 350°F (177°C)	Pumpage temperature above 350°F (177°C)
NLGI consistency	2	3
Mobil	Mobilux EP2	
Exxon	Unirex N2	Unirex N3
Sunoco	Multipurpose EP,	
SKF	LGMT 2	LGMT 3

5

CAUTION

Never mix greases of different consistency (NLGI 1 or 3 with NLGI 2) or different thickener. For example never mix a lithium base grease with a polyurea base grease.

Pumpage temperatures above 350°F (177°C) should be lubricated by a high temperature grease. Mineral oil greases should have oxidation stabilizers and a consistency of NLGI 3.

NOTE: If it is necessary to change grease type or consistency, the bearings must be removed and the old grease removed.

Overload Protection Of Three Phase Submersible Motors

The characteristics of submersible motors are different from standard motors and special overload protection is required. If the motor is stalled, the overload protector must trip within 10 seconds to protect the motor windings. The installer must use SUBTROL or the quick-trip protection shown in these tables. All recommended overload selections are of the ambient compensated type to maintain protection at high and low air temperatures.

All heaters and amp settings shown are based on total line amps. When a six-lead motor is used with a Wye-Delta starter, heaters carrying phase amps must be selected or adjusted based on motor amps divided by 1.732.

The tables below list the correct selection and settings for several manufacturers. Approval of other types may be requested by phoning the Franklin Electric Hotline at 800-348-2420.

Refer To Notes On Page 17.

Table 14 60 Hertz 4" Motors

HP	Volts	NEMA Starter Size	Heaters For Overload Relays			Adjustable Relays (Note 3)	
			Furnas (Note 1)	Allen Bradley	G.E. (Note 2)	See (Note 3) Set	Max
1/2	200	00	K31	J16	L380A	3.13	3.4
	230	00	K29	J15	L343A	2.76	3.0
	460	00	—	J8	L174A	1.38	1.5
	575	00	—	J5	—	1.10	1.2
3/4	200	00	K36	J19	L510A	4.23	4.6
	230	00	K33	J18	L463A	3.68	4.0
	460	00	K23	J11	L232A	1.84	2.0
	575	00	K21	J8	L193A	1.47	1.6
1	200	00	K37	J21	L618A	5.06	5.5
	230	00	K36	J19	L561A	4.42	4.8
	460	00	K26	J12	L282A	2.21	2.4
	575	00	K23	J10	L211A	1.75	1.9
1.5	200	00	K43	J24	L825A	6.81	7.4
	230	00	K41	J22	L750A	5.89	6.4
	460	00	K29	J15	L380A	2.94	3.2
	575	00	K27	J13	L310A	2.39	2.6
2	200	0	K50	J26	L111B	8.46	9.2
	230	0	K43	J25	L910A	7.36	8.0
	460	00	K33	J18	L463A	3.68	4.0
	575	00	K29	J15	L380A	2.94	3.2
3	200	0	K54	J29	L135B	11.2	12.2
	230	0	K52	J28	L122B	9.75	10.6
	460	0	K37	J20	L618A	4.88	5.3
	575	0	K33	J18	L463A	3.86	4.2
5	200	1	K61	J34	L220B	18.4	20.0
	230	1	K61	J32	L199B	16.0	17.4
	460	0	K49	J25	L100B	8.00	8.7
	575	0	K42	J23	L825A	6.44	7.0
7.5	200	1	K68	J38	L322B	27.0	29.3
	230	1	K67	J36	L293B	23.5	25.5
	460	1	K55	J29	L147B	11.8	12.8
	575	1	K52	J27	L122B	9.38	10.2
10	460	1	K61	J33	L220B	17.5	18.8
	575	1	K57	J31	L181B	14.0	15.0

Table 15 60 Hertz 6" Motors

HP	Volts	NEMA Starter Size	Heaters For Overload Relays			Adjustable Relays (Note 3)	
			Furnas (Note 1)	Allen Bradley	G.E. (Note 2)	Set	Max
5	200	1	K61	J34	L220B	18.4	20.0
	230	1	K61	J32	L199B	16.0	17.4
	460	0	K49	J25	L100B	8.0	8.7
	575	0	K42	J23	L825A	6.44	7.0
7.5	200	1	K68	J38	L322B	27.0	29.3
	230	1	K67	J36	L293B	23.5	25.5
	460	1	K55	J29	L147B	11.8	12.8
	575	1	K52	J27	L122B	9.38	10.2
10	200	2(1)	K72	J40	L426B	34.0	37.0
	230	2(1)	K70	J38	L390B	29.6	32.2
	460	1	K58	J32	L181B	14.8	16.1
	575	1	K55	J30	L147B	11.9	12.9
15	200	3(1)	K76	J43	L622B	50.1	54.5
	230	2	K75	J42	L520B	43.6	47.4
	460	2(1)	K64	J35	L265B	21.8	23.7
	575	2(1)	K61	J33	L220B	17.5	19.0
20	200	3	K78	J45	L787B	64.1	69.7
	230	3(1)	K77	J44	L710B	55.8	60.6
	460	2	K69	J38	L352B	27.9	30.3
	575	2	K64	J35	L293B	22.3	24.2
25	200	3	K86	J71	L950B	79.4	86.3
	230	3	K83	J46	L866B	69.0	75.0
	460	2	K72	J40	L426B	34.5	37.5
	575	2	K69	J37	L352B	27.6	30.0
30	200	4(1)	K88	J72	L107C	95.7	104.0
	230	3	K87	J71	L107C	83.2	90.4
	460	3(1)	K74	J41	L520B	41.6	45.2
	575	3(1)	K72	J39	L390B	33.3	36.2
40	460	3	K77	J44	L710B	57.0	62.0
	575	3	K74	J42	L593B	45.6	49.6
50	460	3	K83	J46	L866B	70.8	77.0
	575	3	K77	J44	L701B	56.7	61.6
60	460	4(1)	K87	J71	L107C	83.7	91.0
	575	4(1)	K78	J45	L787B	67.0	72.8

Table 16 60 Hertz 8" Motors

HP	Volts	NEMA Starter Size	Heaters For Overload Relays			Adjustable Relays (Note 3)	
			Furnas (Note 1)	Allen Bradley	G.E. (Note 2)	Set	Max
40	460(4)	3	K77	J44	L710B	57.0	62
	575	3	K74	J42	L593B	45.6	49.6
50	460(4)	3	K83	J46	L866B	70.8	77
	575	3	K77	J44	L710B	56.7	61.6
60	460(4)	4(1)	K87	J71	L107C	83.7	91
	575	4(1)	K78	J45	L787B	67.0	72.8
75	460(4)	4(1)	K89	J73	L126C	101	110
	575	4(1)	K86	J70	L950B	81.0	88
100	460(4)	4	K94	J76	L155C	136	148
	575	4	K87	J73	L142C	108	118
125	460(4)	5	K29	J15	L111B	173	189
	575	5	K26	J13	L910A	139	151
150	460(4)	5	K32	J17	L122B	203	221
	575	5	K28	J14	L100B	163	177
175	460(4)	5	K33	J18	L147B	230	250
	575	5	K31	J16	L111B	184	200
200	460(4)	5	K34	J20	L165B	263	286
	575	5	K32	J17	L135B	211	229

Notice: Warranty on three phase submersible motors is void unless Subtrol or proper quick trip ambient compensated protection is used in all three motor lines.

Overload Protection Of Three Phase Submersible Motors

Notes for Overload Protection Tables (Page 16)

Footnotes:

Note 1: Furnas intermediate sizes between NEMA starter sizes apply where (1) is shown in tables, size 1 3/4 replacing 2, 2 1/2 replacing 3, and 3 1/2 replacing 4. Heaters listed apply to Innova 45 designs and Defenite Purpose Class 16 starters through their available range, and to standard starters in larger sizes. Overload relay adjustments should be set no higher than 100%, unless necessary to stop nuisance tripping with measured amps in all lines below nameplate maximum.

Note 2: General Electric heaters are type CR123 usable only on type CR124 overload relays. Adjustment should be set no higher than 100%, unless necessary to stop nuisance tripping with measured amps in all lines below nameplate maximum.

Note 3: Adjustable overload relay amp settings apply to approved types listed below. Relay adjustment should be set at the specified SET amps, and only if tripping occurs with amps in all lines measured to be within nameplate maximum amps should the setting be increased, not to exceed the MAX value shown.

Note 4: Heaters shown for ratings requiring NEMA size 5 starters are all used with current transformers per manufacturer standards. Adjustable relays may or may not use current transformers depending on design.

Some approved types may only be available for part of the listed motor ratings. When relays are used with current transformers, relay setting is the specified amps divided by the transformer ratio.

Approved Adjustable Overload Relays

AEG Series: B17S, B27S, B27-2
ABB Type: RVH 40, RVH65, RVP160
Allen Bradley: Bulletin 193
Fanal Types: K7 or K7D through K400
Fuji Types: TR-OQ, TR-OQH, TR-2NQ, TR-3NQ, TR-6NQ, RCa 3737-1CQ & 1CQ11
Furnas Types: US15 48AG &48BG ESP100-Class 10 only
General Electric CR4G, GR7G
Klockner-Moeller Types: ZOO, Z1, Z4, PKZM1,PKZM3& PKZ2
Lovato RC9, RC22, & RC80
Asco-Delta Types: DQ, LR1-D, LR1-F & LR2-D
Sprecher and Schuh Types: CT, CT1, CTA 1, CT3K, CT3-12 thruCT3-42
Siemens Types: 3UA50, -52, -54, -58, -59, -62, -66, -MSP, 3VE
Square D Class 9065, Types: TD, TE, TF, TG, TJ, TK, TR, & TJE
Telemecanique Type: LR1-D, LR1-F, & LR2-D
Westinghouse Types: FT13, FT23, FT33, FT43, K7D, K27D, & K67D
Westmaster: OLWR00 and OLWT00 suffix D thru P

Other relay types from these and other manufacturers may or may not provide acceptable protection, and they should not be used without approval of Franklin Electric.

Notice: Warranty on three phase submersible motors is void unless Subtrol or proper quick trip ambient compensated protection is used on all three motor lines.

Power Factor Correction

In some installations, power supply limitations make it necessary or desirable to increase the power factor of a summersible motor. The table lists the capacitive KVAR required to increase the power factor of large Franklin three phase submersible motors to the approximate values shown at maximum input loading.

Capacitors must be connected on the line side of the overload relay, or overload protection will be lost.

Table 17 KVAR Required

Motor HP	Hertz	Motor P.F.	Required KVAR to P.F. .90	to P.F. .95	to P.F. 1.00
5	60	.82	1.2	2.1	4
7.5	60	.83	1.7	3.1	6
10	60	.85	1.5	3.3	7
15	60	.85	2.2	4.7	10
20	60	.87	1.7	5.0	12
25	60	.87	2.1	6.2	15
30	60	.87	2.5	7.4	18
40	60	.86	4.5	11	24
50	60	.85	7.1	15	32
60	60	.85	8.4	18	38
75	60	.87	6.3	18	43
100	60	.86	11	27	60
125	60	.85	17	36	77
150	60	.85	20	42	90
175	60	.88	9.6	36	93
200	60	.87	16	46	110

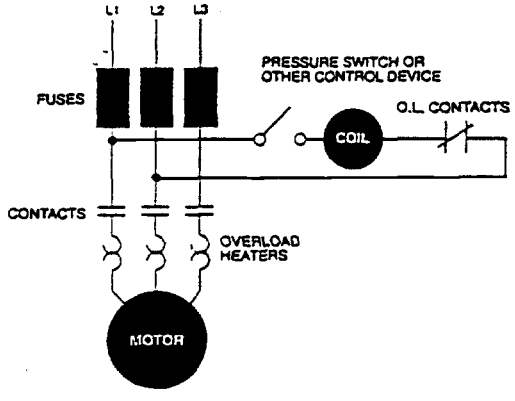
Three Phase Starter Diagrams

Three phase combination magnetic starters have two distinct circuits, a power circuit and a control circuit.

The power circuit consists of a circuit breaker or fused line switch, contacts, and overload heaters connecting incoming power lines, L1, L2, L3 and the three phase motor.

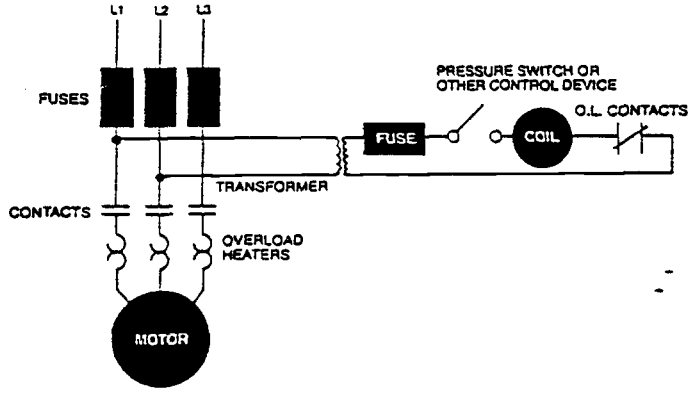
The control circuit consists of the magnetic coil, overload contacts and a control device such as a pressure switch. When the control device contacts are closed, current flows through the magnetic contactor coil, the contacts close, and power is applied to the motor. Hand-Off-Auto switches, start timers, level controls and other control devices may also be wired in series in the control circuit.

FIG 9 LINE VOLTAGE CONTROL



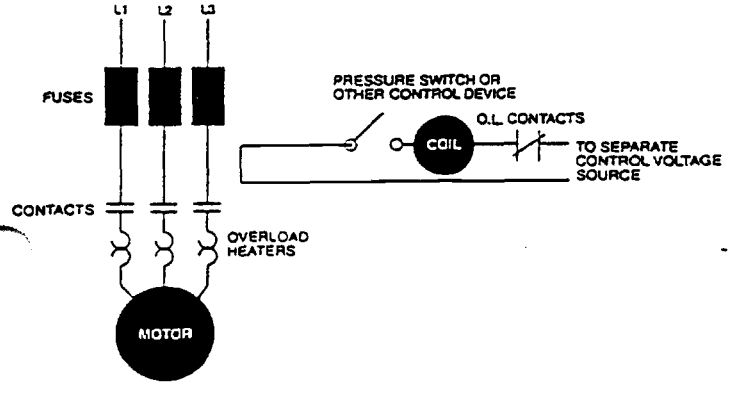
Probably the most common type of control encountered. Since the coil is connected directly across the power lines, L1 and L2, the coil voltage and frequency must match the line voltage.

FIG 10 LOW VOLTAGE TRANSFORMER CONTROL



Used when it is desirable to operate push buttons or other control devices at some voltage lower than the motor voltage. The transformer primary must match the line voltage and the coil voltage must match the secondary voltage of the transformer.

FIG 11 EXTERNAL VOLTAGE CONTROL



Control of a power circuit by a lower control circuit voltage can also be obtained by connecting to a separate control voltage source. The coil rating must match the control voltage source, such as 115 or 24 volts.

Three Phase Power Unbalance

A full three phase supply is recommended for all three phase motors, consisting of three individual transformers or one three phase transformer. So-called "open" delta or wye connections using only two transformers can be used, but are more likely to cause problems, such as poor performance overload tripping or early motor failure due to current unbalance.

Transformer ratings should be no smaller than listed in Table 2 on page 3 for supply power to the motor alone.

Phase designation of leads for CCW rotation viewing shaft end.

To reverse rotation, interchange any two leads.

Phase 1 or "A" – Black Motor Lead
Phase 2 or "B" – Yellow Motor Lead
Phase 3 or "C" – Red Motor Lead

NOTICE: Phase 1, 2 and 3 may not be L1, L2 and L3.

Checking and correcting rotation and current unbalance

1. Establish correct motor rotation by running in both directions. Change rotation by exchanging any two of the tree motor leads. The rotation that gives the most water flow is always the correct rotation.

2. After correct rotation has been established, check the current in each of the three motor leads and calculate the current unbalance as explained in 3 below.

If the current unbalance is 2% or less, leave the leads as connected.

If the current unbalance is more than 2%, current readings should be checked on each leg using each of the three possible hook-ups. Roll the motor leads across the starter in the same direction to prevent motor reversal.

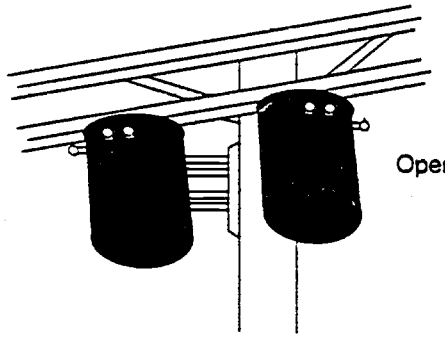
3. To calculate percent of current unbalance:
   A. Add the three line amp values together.
   B. Divide the sum by three, yielding average current
   C. Pick the amp value which is furthest from the average current (either high or low).
   D. Determine the difference between this amp value (furthest from average) and the average.
   E. Divide the difference by the average.
   Multipy the result by 100 to determine percent of unbalance.

4. Current unbalance should not exceed 5% at service factor load or 10% at rated input load. If the unbalance cannot be corrected by rolling leads, the source of the unbalance must be located and corrected. If, on the three possible hookups, the leg farthest from the average stays on the same power lead, most of the unbalance is coming from the power source. However, if the reading farthest from average moves with the same motor lead, the primary source of unbalance is on the "motor side" of the tarter. In this instance, consider a damaged cable, leaking splice, poor connection, or faulty motor winding.

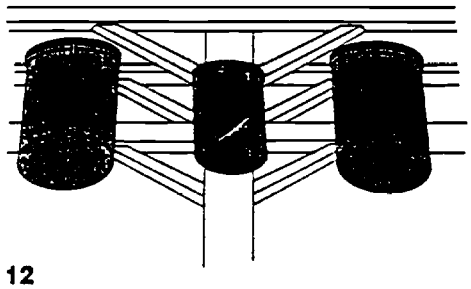
	Hookup 1	Hookup 2	Hookup 3
Starter Terminals	L1 L2 L3	L1 L2 L3	L1 L2 L3
	T1 T2 T3	T1 T2 T3	T1 T2 T3
Motor Leads	R B Y	Y R B	B Y R

Example:

R = 51 amps	Y = 50 amps	B = 50 amps
B = 46 amps	R = 48 amps	Y = 49 amps
Y = 53 amps	B = 52 amps	R = 51 amps
Total = 150 amps	Total = 150 amps	Total = 150 amps
÷ 3 = 50 amps	÷ 3 = 50 amps	÷ 3 = 50 amps
— 46 = 4 amps	— 48 = 2 amps	— 49 = 1 amps
4 ÷ 50 = .08 or 8%	2 ÷ 50 = .04 or 4%	1 ÷ 50 = .02 or 2%



Open Delta



Full Three Phase

FIG 12

Phase Converters

THE WARRANTY ON ALL FRANKLIN THREE PHASE SUBMERSIBLE MOTORS IS VOID IF OPERATED FROM SINGLE PHASE POWER THROUGH A PHASE CONVERTER UNLESS APPROVAL OF THE SYSTEM (IN WRITING) HAS BEEN OBTAINED FROM THE FRANKLIN ELECTRIC FIELD SERVICE DEPARTMENT.

There are a number of types of phase converters available. Each is intended to allow the use of a three phase motor on a single phase power line. Some of these designs present problems which can lead to motor failure.

Phase converters, with the exception of solid state models, create a "manufactured voltage" leg by the use of capacitors, winding taps or adjustable relays. In all of these arrangements, the voltage balance is critical to the current balance. Some phase converters may be well balanced at one point on the system operating curve. Submersible pumping systems often operate at differing points on the curve as water levels and operating pressures fluctuate. Other converters may be well balanced at varying loads, but their output may vary widely with fluctuations in the input voltage.

The following guidelines have been established for submersible installations to be warrantable when used with a phase converter.

1. Limit pump loading to rated horsepower. Do not load into motor service factor.
2. Maintain at least three feet per second motor cooling. Use a flow sleeve when necessary.
3. Use time delay fuses or circuit breakers in pump panel. Standard fuses or circuit breakers do not provide secondary motor protection.
4. Subtrol Plus may be used on electro mechanical type phase converters, however special connections are required. Consult Subtrol Plus Manual for connections of receiver and lightning arrestor.
5. Subtrol Plus will not work with electronic solid state phase converters.
6. Current unbalance must not exceed 10% under varying load conditions.
7. Report system parameters on Form 2207, Submersible Motor Installation Record.

Send to:
Franklin Electric
400 E. Spring Street, Bluffton, IN 46714
Attention: Field Service Department

Upon receipt and analysis of the data and installation details supplied on Form No. 2207, Franklin engineers will advise by letter if the installation will be covered by Franklin's warranty.

Reduced Voltage Starters

All Franklin three phase submersible motors are suitable for full voltage starting. Under this condition the motor speed goes from zero to full speed within one half second or less. The load current goes from zero to locked rotor amps, about 5 to 7 times running amps, and drops to running amps at full speed. This may dim lights, cause momentary voltage dips to other electrical equipment and shock load power distribution transformers.

Power companies often require soft starters or limit motor KVA load that may be started "directly on line". There are also times when it may be desirable to reduce motor starting torque. This lessens the stress on shafts, couplings, and castings as well as the supporting discharge piping. A "strong" voltage supply and very little cable voltage drop produces high starting torque. In otherwords, this is an installation that is electrically and mechanically "stiff". Reduced voltage starters are often used to reduce starting KVA or torque, and sometimes to slow the immedate acceleration of the water on start up to control upthrust and waterhammer.

With maximum recommended cable length where there is a 5% voltage drop in the cable, there will be about 20% reduced starting current and about 36% reduced starting torque compared to having rated voltage at the motor. On some installations this may be enough reduction in starting current so that reduced voltage starters may not be required.

Standard 3 Ø motors have three line leads so only resistance, autotransformers, or solid state reduced voltage starters may be used. The autotransformer type is preferred over resistance and solid state types because it draws lower line current for the same starting torque. Wye-Delta starters are used with six lead Wye-Delta motors. All Franklin 6" and 8" three phase motors are available in six lead Wye-Delta construction. Consult the factory for details and availability. Part winding starters are not usable with Franklin Electric submersible motors.

When reduced voltage starters are used it is recommended the motor be supplied with at least 55% of rated voltage to ensure adequate starting torque.

Most autotransformer starters have 65% and 85% taps. Setting the taps on these starters depends on the percentage of the maximum allowable cable length used in the system. If the cable length is less than 50% of the maximum allowable, either the 65% or 80% taps may be used. When the cable length is more than 50% of the allowable, the 80% tap should be used.

Solid state reduced voltage starters may be used with submersibles, but may not be usable with Subtrol-Plus. Consult the factory.

Both electromechanical and solid state starters have adjustable time delays for starting. Typically they are preset at 30 seconds. They must be set so the motor is at full voltage within two to three seconds maximum to prevent overload trip and unnecessary motor heating.

Open transition starters, which momentarily interrupt power during the starting cycle, are not recommended. Should the motor/pump rotating parts be passing through their critical speed, as low voltage is removed and high voltage applied, the resulting stresses can break shafts and couplings. Only closed transition starters which have no interruption of power during the starting cycle should be used.

Variable Speed Submersible Pump Operation, Inverter Drives

Franklin three phase submersible motors are operable from variable frequency inverter drives when applied within guidelines specified below. These guidelines are based on present Franklin information for inverter drives, lab tests and actual installations, and must be followed for warranty to apply to inverter drive installations.

1. Variable speed drives should be variable frequency, constant volts per Hertz type, and may have sine wave, pulse width modulated (PWM) or six-step waveshape. The base voltage should be name plate voltage and frequency of the motor.

2. Overcurrent protection in the inverter or separately furnished must trip within 10 seconds at 5 times motor maximum nameplate amps in any line, and ultimately trip within 115% of motor maximum nameplate amps in any line.

3. Any application below 30 Hertz or above 80 Hertz must be specifically approved by Franklin Engineering. Operation at lower frequency can cause motor bearing failure, and at higher frequency can raise internal hydraulic losses to an unacceptable level.

4. Pump load must be selected so motor maximum nameplate amps are not exceeded under all running conditions.

5. Franklin-specified water temperature and flow past the motor must be maintained at speeds which load the motor up to maximum nameplate amps. At reduced speeds and loading, cooling flow must be adequate to maintain equivalent motor temperature.

6. Franklin Subtrol protection systems are not usable on inverter driven installations. because the non-sinusolidal waveshape from the inverter prevents proper Subtrol operation. The waveshape also reduces motor efficiency, typically about two percentage points.

7. To confirm whether an installation or system design is acceptable and warrantable, full details should be submitted to Franklin on Form 2207 along with inverter specifications.

Send to:
Franklin Electric
400 E. Spring Street, Bluffton, IN 46714
Attention: Field Service Department

Upon receipt and analysis of the data and installation details supplied on Form No. 2207, Franklin engineers will advise by letter if the installation will be covered by Franklin's warranty.

Submersible Motors Inline Booster Systems

Franklin submersible motors are acceptable for booster pump (canned) applications provided the following conditions are taken into consideration in the system design.

1. **HORIZONTAL OPERATION:** Horizontal operation is acceptable as long as the pump transmits thrust to the motor and the entire assembly is supported sufficiently to prevent binding stresses.

2. The motor support assembly must not restrict the flow of cooling water around the full diameter of the motor. The motor supports must be on the motor endbell castings, and not on the stator shell.

3. **CONTROLS:** Franklin Subtrol-Plus is strongly recommended for all large submersibles. If Subtrol is not employed, properly sized ambient compensated quick-trip overloads must be utilized. In addition, a surge arrestor should be installed on all systems and properly grounded.

4. **WIRING:** Franklin lead assemblies are sized for submerged operation and may not be adequate for use in open air. Any wiring not submerged must comply with Franklin's cable charts.

5. **WATER TEMPERATURE:** The temperature of the water should be monitored at the inlet to each booster. When temperatures exceed 86°F (30°C), motor derating is required.

6. **INLET PRESSURE:** The inlet pressure on each booster should be monitored and not be allowed below the pump's specified Net Positive Suction Head Requirement (NPSHR). If NPSHR is unknown, at least 20 P.S.I. should be maintained at all times.

7. **DISCHARGE FLOW:** The flow rate for each pump should be monitored and never be allowed to drop below the minimum required to maintain cooling flow velocities. Pressure relieving valves should be employed to prevent running the pump at shut-off.

8. **DISCHARGE PRESSURE:** The discharge pressure should be great enough to prevent upthrust.

9. **CAN FLOODING:** An air bleeder valve must be employed on the booster can so total flooding may be accomplished prior to booster start-up.

IMPORTANT NOTES:

1. **HIGH PRESSURE TEST:** Motors intended for booster applications where the pressure exceeds 500 P.S.I. must be special ordered from the factory.

2. **STARTING:** Reduced voltage starting may be employed. This will reduce upthrust on start, starting current and mechanical stresses created by the motor's high starting torque. Reduced voltage starters, if used should accelerate the motor to full speed within two seconds. NOTE: Solid state reduced voltage starters are not compatible with Subtrol-Plus.

3. **DOCUMENTATION:** Form 2208. Submersible Booster Installation Record, must be completed for all Franklin submersible motor applied with inline booster pumps.

Send to:
Franklin Electric
400 E. Spring Street, Bluffton, IN 46714
Attn: Field Service Dept.

Upon receipt and analysis of the data and installation details supplied on Form No. 2207, Franklin engineers will advise by letter if the installation will be covered by Franklin's warranty.

NETZSCH
Filtration Systems

SECTION III: TROUBLESHOOTING AND MAINTENANCE

Chapter IX

PROCESS TROUBLESHOOTING

The following is a list of common operational problems associated with the Filter Press filtration process:

Problem	Cause	Remedy
Slurry leaking from plates	Low hydraulic pressure	Increase hydraulic pressure and check for leaks.
	Wrinkle or hole in filter cloth	Replace filter cloth.
	Sealing surface dirty	Use nylon cake scraper to remove cake from sealing surface.
	Possible plate warpage	Replace plate. Check pressure and temperature of system.
	Press is not square and level	Check alignment. See Chapter V.
Plate breakage	Solids build-up in slurry feed pipe causing pressure differential	Clean slurry feed pipe and plate feed hole.
	Solids build-up in filtrate holes - reducing flow	Clean filtrate holes in plate.
Plate pack has risen above side-rails during closing	Filter plates not aligned properly	Reshift plates against the headplate.
	Filter plate pack not square	Sealing surface of plates and cloths dirty - clean.
Cloudy filtrate	Holes in filter cloths	Replace filter cloths.
	Process changes	Consult Netzsch Incorporated.

NETZSCH
Filtration Systems

Slurry pump stalls, indicating the press is full. But when the press is opened, an egg shelled cake is formed	Clogged feed eye feed eyes.	Use cake scraper to clean.
	Filter cloths plugged	Clean or replace filter cloths as necessary.
	Process changes	Consult Netzsch Incorporated.
	Sludge pump air pressure is too low	Increase pressure accordingly.

Chapter X

FILTER PRESS TROUBLESHOOTING

Problem	Cause	Remedy
Loss of hydraulic pressure	Low air pressure	Increase air pressure to a minimum of 70 psig.
	Air leaks due to defective tube or fitting	Locate and replace.
	Low oil level	Check oil level and fill.
	Defective component which is worn or jammed due to contamination from improper filtered air supply	Clean component and check air filtering system.
	Hydraulic cylinder seals leaking	Replace seals.
Closure system will not reach system pressure	Low air pressure	Increase air pressure to reach desired hydraulic pressure.
	System relief valve set incorrectly or leaking.	Check schematic and repair.
	Hydraulic cylinder seals leaking	Replace seals.
	Air in hydraulic circuit	Purge trapped air, loosen hydraulic gauge during "retract" until air escapes.
	Cylinder extended to end of stroke	Check if filter plates were removed from plate pack.
	Hydraulic pump malfunction	Check manufacturer's manual for troubleshooting guide.
	Defective hydraulic pressure gauge	Check hydraulic pressure gauge calibration.
Hydraulic cylinder will not retract	Broken spring	Check hydraulic cylinder.
	Air/Oil circuit defective part	Check Air/Oil logic for defective

NOTE: Refer to the manufacturer's manual for further troubleshooting techniques. A pneumatic/hydraulic logic schematic is provided in Section 7.

Chapter XI

GENERAL MAINTENANCE

1. Air/Oil Hydraulic Closure System

   Note: It is very important in an air/oil hydraulic power unit to have contaminant removal devices such as air and oil filters.

   MONTHLY

   A. Check hoses for leaks.

   B. Wipe down all components to remove oil film or dirt.

   C. Check oil level and maintain to fill line on tank.

   YEARLY

   A. Drain and replace hydraulic oil. Oil should be SAE 10, rated at 200 SUS @ 100° F or equal.

   B. Remove muffler/filters and clean in solvent or cleaner.

2. Hydraulic Cylinder

   A. The hydraulic cylinder will be automatically lubricated by the hydraulic oil.

   B. Keep the piston rod free from dirt or sludge at all times.

3. Side Rails

   A. The PVC-lined side rails should always be clean to avoid wear damage to the filter plate handles.

4. Air Maintenance

A correct plumbing design of the inlet air supply is crucial to eliminate the majority of water, oil and particles from entering the filter press hydraulic power unit. This will extend the life of both hydraulic and pneumatic components. The air line to the hydraulic power unit should be plumbed from the top of the main line instead of the bottom. This will prevent water that has condensed and is sitting at the bottom of the main line from being drawn down into the filter press. An air dryer is recommended if extreme amounts of water are present. Air lubrication should not be used.

5. Filter Plates and Cloths

WEEKLY

A. Check filter plates sealing surfaces for slurry build-up. Clean as necessary.

B. Check filter cloth for slurry build-up. Pressure wash or pad wash cloths as process dictates.

YEARLY

A. Replace filter cloths depending on filter press utilization and process results. The average life of a filter cloth is approximately 1500 filtration cycles.

6. Filter Cloth Installation

In order to put a set of filter cloths on the filter plates, whether it be a new press or simply changing the filter cloths, the following steps should be taken. The design of the cloths used by Netzsch allows the mounting of the cloths without removing the filter plates from the press. The procedure is simple and takes little time to accomplish.

1. By laying on a flat surface, fold one section of cloth diagonally to create a diaper shape.
2. Fold edges so they overlap.
3. Roll carefully this folded portion, as tight as possible, into a cylinder.
4. Push this cylinder through center hole of filter plate.

5. Spread rolled cloth out on back side of plate. Turn cloths until grommets are properly positioned to plate.
6. Attach ties to cloths to secure cloths to plates. After closing the tie, force the remaining end of the tie back through the loop.
7. Apply end cloths as shown on attached drawing.
8. To remove cloths, simply undo ties and pull cloth through center hole.

7. Filter Cloth Cleaning Instructions

The filter cloths provided have been selected for your particular slurry application.

During the filtration process the filter cloth initially separates the solids from the liquid, thus, the filter cloth must maintain its porosity. Eventually, the filter cloth will become embedded with tiny minute particles. This will cause a "blinding effect" which leads to decreased filtration. The particles must be removed periodically to maintain an optimal filtration process.

There are several reasons why cleaning the filter cloths are required. Listed below are the main reasons for cleaning:

1. High use of Calcium Hydroxide
2. Long filtration cycles
3. Reduction cake solids
4. Initial high filtration pressure (40 - 50 psig)

Methods for Cleaning

1. Wash the filter plates and cloths with a portable high pressure cold water washer (1000 - 1500 psi at 5-15 GPM). A power wash with nozzle can be used to spray the plates and cloths. The high pressure washer will clean the surface of the plates and cloths but also the internal weave of the filter cloth.

   The frequency of cleaning is determined upon the process filtration application.

2. Manual Acid Wash - Wash the filter cloths and plates with water, either by hand or with a high pressure washer. Prepare a 5-10% solution of muratic acid in a polyethylene container.

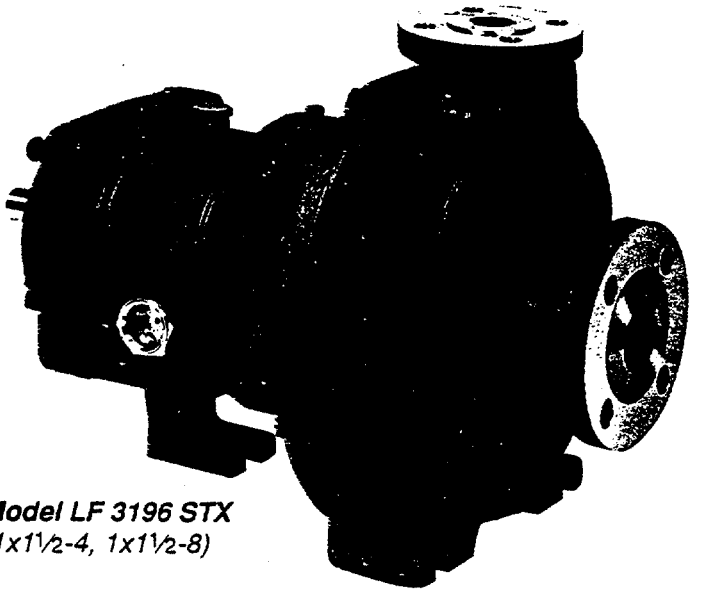
   Then "dipwash" the cloths and plates in the tank. This will probably require several hours to clean the internal weave of the cloth. Remove the plates and cloths and wash with water again.

   Continuous Acid Wash - A continuous acid recirculation wash system can be utilized by installing the proper feed and filtrate piping on the filter press. Consult Netzsch Incorporated for further details if required.

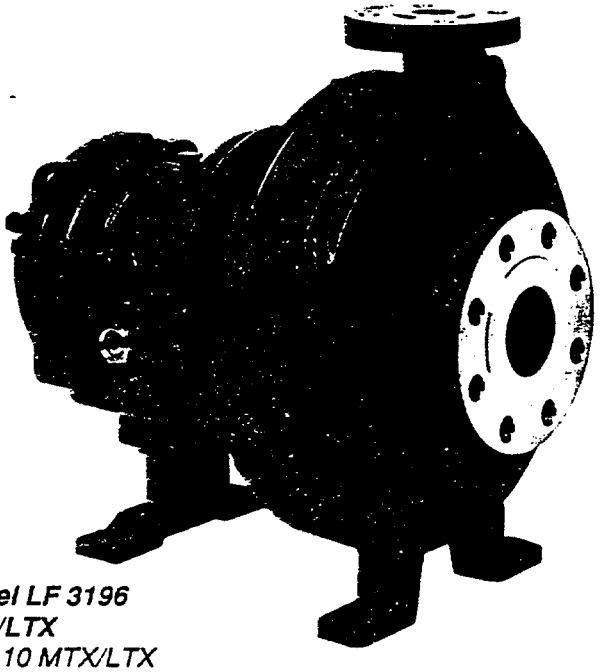
P-205 & P-245

GOULDS PUMPS

Installation, Operation and Maintenance Instructions



Model LF 3196 STX
(1x1½-4, 1x1½-8)



Model LF 3196
MTX/LTX
(1x2-10 MTX/LTX
1½x3-13 LTX)

Model LF 3196

PREVENTIVE MAINTENANCE

GENERAL COMMENTS

A routine maintenance program can extend the life of your pump. Well maintained equipment will last longer and require fewer repairs. You should keep maintenance records, this will help pinpoint potential causes of problems.

MAINTENANCE SCHEDULE

Routine Maintenance

- Bearing lubrication
- Seal Monitoring
- Vibration analysis
- Discharge pressure
- Temperature monitoring

Routine Inspections

- Check level and condition of oil through sight glass on bearing frame.
- Check for unusual noise, vibration and bearing temperatures.
- Inspect pump and piping for leaks.
- Check seal chamber/stuffing box leakage.
  - Mechanical Seal: Should be no leakage.
  - Packing: Excessive leakage requires adjustment or possible packing replacement. Refer to Section 4: Operation for packing gland adjustment.

3 Month Inspections

- Check foundation and hold-down bolts for tightness.
- If pump has been left idle, check packing. Replace if required.
- Oil should be changed at least every 3 months (2000 hours) or more often if there are any adverse atmospheric conditions or other conditions which might contaminate or break down the oil, or if it is cloudy or contaminated as seen by inspection through the sight glass.
- Check shaft alignment and realign if required.

Annual Inspections

- Check pump capacity, pressure and power. If pump performance does not satisfy your process requirements, and process requirements have not changed, pump should be disassembled, inspected, and worn parts should be replaced, otherwise, a system inspection should be done.

MAINTENANCE OF BEARINGS

OIL LUBRICATED BEARINGS

⚠ WARNING

Pumps are shipped without oil. Oil lubricated bearings must be lubricated at the job site.

Remove fill plug (408H) and add oil until level is at the center of the sight glass (319). Replace fill plug (Fig. 18A). See Table 4.

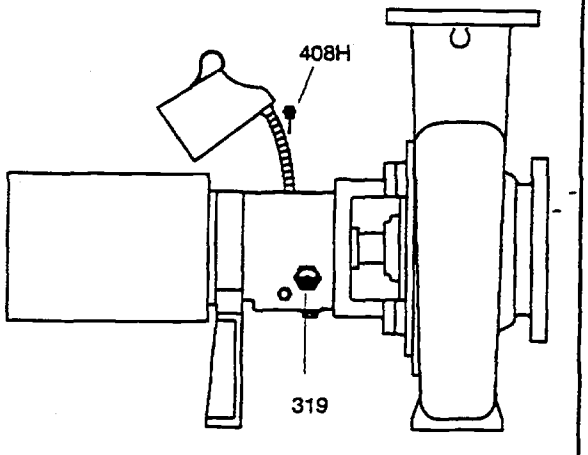


Fig. 18A

Change the oil after 200 hours for new bearings, thereafter every 2000 operating hours or 3 months (whichever comes first).

Table 4
Oil Volumes

Frame	Pints	ml
STX	1.0	400
MTX	2.6	1250
LTX	3.0	1400
XLT-X and X17	6.0	3000

A high quality turbine oil with rust and oxidation inhibitors should be used. For the majority of operational conditions, bearing temperatures will run between 120°F (50°C) and 180°F (82°C). In this range, an oil of ISO viscosity grade 68 at 100°F (40°C) is recommended. If bearing temperatures exceed 180°F (82°C) use ISO viscosity grade 100 with Bearing Frame cooling. See Table 5. For higher operating temperatures, pumpage above 350°F (177°C), synthetic lubrication is recommended.

Table 5
Lubricating Oil Requirements

	Pumpage temperature below 350°F (177°C)	Pumpage temperature above 350°F (177°C)
ISO Grade	VG 68	VG 100
Approx. SSU at 100°F (38°C)	300	470
DIN 51517	C68	C100
Kinem. viscosity at 100°F (40°C) mm^2/sec	68	100

Some acceptable lubricants are:

Exxon	Teresstic EP 68
Mobil	Mobil DTE 26 300 SSU @ 100°F (38°C)
Sunoco	Sunvis 968
Royal Purple	SYNFILM ISO VG 68 Synthetic Lube

GREASE LUBRICATED BEARINGS

Grease lubricated bearings are pre-lubricated at the factory. Regrease bearings every 2000 operating hours or 3 months.

Regrease Procedure:

NOTE: ***When regreasing there is danger of impurities entering the bearing housing. The grease container, the greasing device, and fittings, must be clean.***

1. Wipe dirt from grease fittings.
2. Remove 2 grease relief plugs (408H) from bottom of frame.
3. Fill both grease cavities through fittings with recommended grease until fresh grease comes out of the relief holes. Reinstall grease relief plugs (408H).
4. Ensure frame seals are seated in bearing housing and if not press in place with drains located at the bottom .

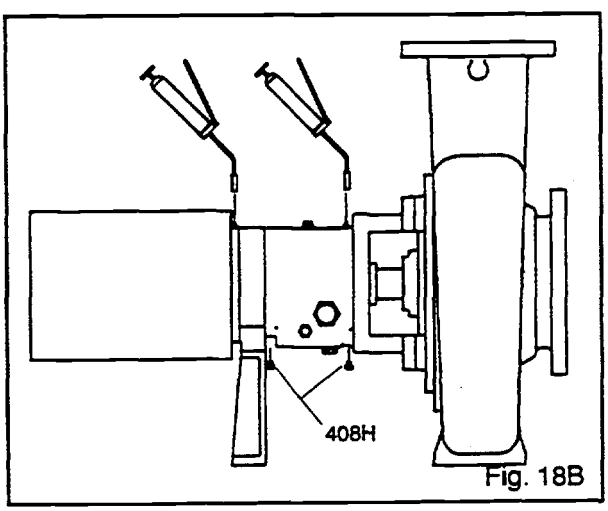


Fig. 18B

NOTE: ***The bearing temperature usually rises after regreasing due to an excess supply of grease. Temperatures will return to normal after pump has run and purged the excess from the bearings, usually two to four hours.***

For most operating conditions a lithium based mineral oil grease of NLGI consistency No. 2 is recommended. This grease is acceptable for bearing temperatures of 5°F to 230°F (-15°C to 110°C). Bearing temperatures are generally about 20°F (18°C) higher than bearing housing outer surface temperature.

Table 6
Lubricating Grease Requirements

	Pumpage temperature below 350°F (177°C)	Pumpage temperature above 350°F (177°C)
NLGI consistency	2	3
Mobil	Mobilux EP2	
Exxon	Unirex N2	Unirex N3
Sunoco	Mutipurpose EP,	
SKF	LGMT 2	LGMT 3

⚠ CAUTION

Never mix greases of different consistency (NLGI 1 or 3 with NLGI 2) or different thickener. For example never mix a lithium base grease with a polyurea base grease.

Pumpage temperatures above 350°F (177°C) should be lubricated by a high temperature grease. Mineral oil greases should have oxidation stabilizers and a consistency of NLGI 3.

NOTE: ***If it is necessary to change grease type or consistency, the bearings must be removed and the old grease removed.***

5

MAINTENANCE OF SHAFT SEALS

MECHANICAL SEALS

When mechanical seals are furnished, a manufacturer's reference drawing is supplied with the data package. This drawing should be kept for future use when performing maintenance and adjusting the seal. The seal drawing will also specify required flush liquid and attachment points. The seal and all flush piping must be checked and installed as needed prior to starting the pump.

The life of a mechanical seal depends on various factors such as cleanliness of the liquid handled and its lubricating properties. Due to the diversity of operating conditions it is, however, not possible to give definite indications as to its life.

⚠ WARNING

Never operate the pump without liquid supplied to mechanical seal. Running a mechanical seal dry, even for a few seconds, can cause seal damage and must be avoided. Physical injury can occur if mechanical seal fails.

PACKED STUFFING BOX

⚠ WARNING

Lock out driver power to prevent accidental start-up and physical injury.

The stuffing box is not packed at the factory and must be packed properly before operation of the pump. The packing is furnished in a box of fittings which accompany the pump. The packing used must be suitable for the pumpage. Make sure the stuffing box is clean. Examine shaft-sleeve for wear or scoring, replace if necessary.

Starting from the innermost ring, the packing is usually arranged as two packing rings, lantern ring, three packing rings, followed by the split gland (Fig. 14). Insert single packing rings by twisting as shown in Fig. 6. Press each ring to ensure proper compression in the stuffing box. Stagger joints 90°. Refer to Fig. 13A, 13B.

Lightly and evenly tighten the gland. Excessive tightening will result in premature failure of the packing and shaft sleeve. After packing it must be possible to rotate shaft by hand. Final adjustment of packing gland is made after pump is started.

DYNAMIC SEAL

Dynamic Seal Components

Repeller - The dynamic repeller effectively prevents leakage of pumpage through the stuffing box when the pump is operating under published acceptable conditions. Dynamic seal parts do not wear substantially to affect operation unless the service is particularly abrasive or corrosive. Refer to Section 6 for maintenance disassembly and repair.

A static seal is used to prevent leakage when the pump is shut down. This is either a lip seal, elastomeric face seal, or graphite packing. The lip and elastomeric face seal require no maintenance other than replacement when leakage becomes excessive. The packing should be installed as for stuffing box packing, and is a special type designed to run dry, so does not require an external flush.

IMPELLER CLEARANCE SETTING

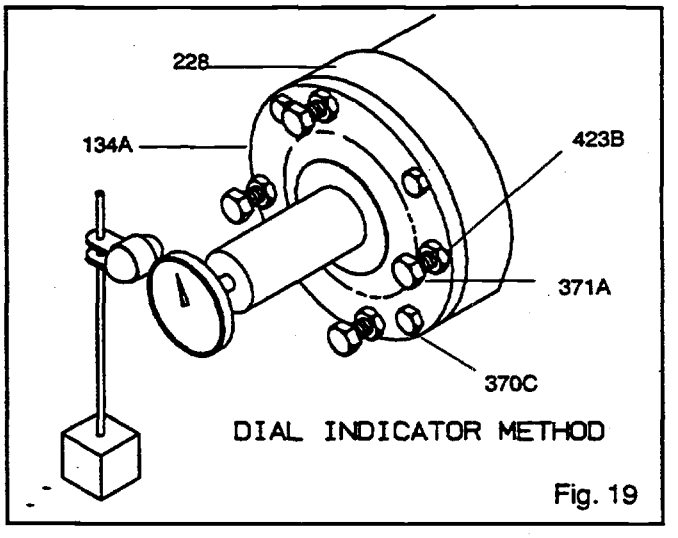
WARNING

Lock out driver power to prevent accidental startup and physical injury.

A change in pump performance may be noted over time by a drop in head or flow or an increase in power required. Performance can usually be renewed by adjusting the impeller clearance. Two techniques are given to set the impeller clearance, the dial indicator method and the feeler gauge method.

DIAL INDICATOR METHOD

1. Remove coupling guard. Refer to coupling guard instructions Appendix II.
2. Remove coupling.
3. Set indicator so that button contacts either the shaft end or against face of coupling (Fig. 19).
4. Loosen jam nuts (423B) on jack bolts (371A) and back bolts out about two turns.
5. Tighten each locking bolt (370C) evenly, drawing the bearing housing (134A) towards the bearing frame (228) until impeller contacts the casing. Turn the shaft to ensure contact is made.
6. Set indicator to zero and back locking bolt (370C) out about one turn.
7. Thread jack bolts (371A) in until they evenly contact the bearing frame. Tighten the jack bolts evenly (about one flat at a time) backing the bearing housing (134A) away from the bearing frame until the indicator shows the proper clearance per Table 3.
8. Evenly tighten locking bolts (370C), then jack bolts (371A) keeping indicator reading at proper setting.
9. Check shaft for free turning.
10. Replace coupling guard.



DIAL INDICATOR METHOD

Fig. 19

FEELER GAUGE METHOD

1. Remove coupling guard. Refer to coupling guard instructions in Appendix II.
2. Loosen jam nuts (423B) on jack bolts (371A) and back bolts out about two turns (Fig. 20).
3. Tighten locking bolts (370C) evenly, drawing bearing housing (134A) towards frame (228) until impeller contacts the casing. Turn shaft to ensure contact is made.
4. With a feeler gauge set the gap between the three locking bolts (370C) and bearing housing (134A) per impeller clearances in Table 3.
5. Evenly back out bearing housing (134A) using the three jack bolts (371A) until it contacts the locking bolts (370C). Evenly tighten jam nuts (423B).
6. Check shaft for free turning.
7. Replace coupling guard.

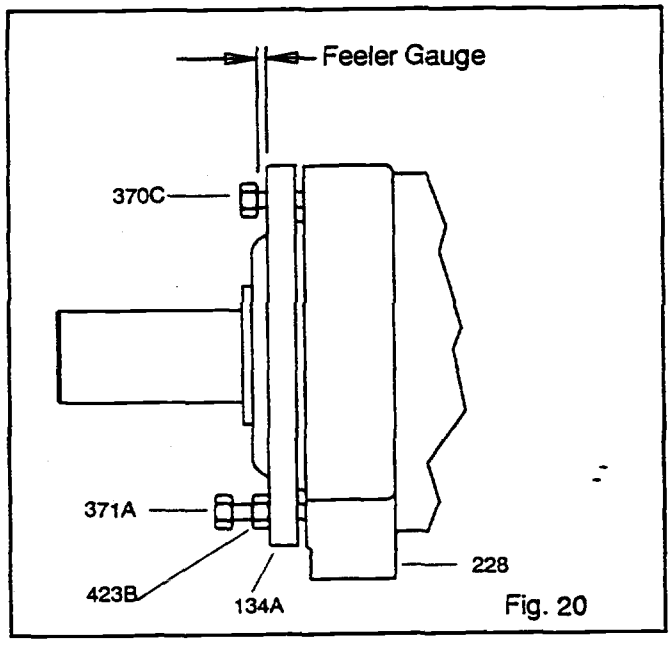


Fig. 20

Table 3 Impeller Clearances

COLD TEMPERATURE CLEARANCES FOR VARIOUS SERVICE TEMPERATURES	
200°F (93°C)	0.015 in. (0.38 mm)
250°F (121°C)	0.017 in. (0.43 mm)
300°F (149°C)	0.019 in. (0.48 mm)
350°F (177°C)	0.021 in. (0.53 mm)
400°F (204°C)	0.023 in. (0.58 mm)
Over 400°F (204°C)	0.025 in. (0.64 mm)

TROUBLE SHOOTING

Table 7
Troubleshooting Pump

PROBLEM	PROBABLE CAUSE	REMEDY
No liquid delivered.	Pump not primed.	Reprime pump, check that pump and suction line are full of liquid.
	Suction line clogged.	Remove obstructions.
	Impeller clogged with foreign material.	Back flush pump to clean impeller.
	Wrong direction of rotation.	Change rotation to concur with direction indicated by arrow on bearing housing or pump casing.
	Foot valve or suction pipe opening not submerged enough.	Consult factory for proper depth. Use baffle to eliminate vortices.
	Suction lift too high.	Shorten suction pipe.
Pump not producing rated flow or head.	Air leak thru gasket.	Replace gasket.
	Air leak thru stuffing box	Replace or readjust packing/mechanical seal.
	Impeller partly clogged.	Back flush pump to clean impeller.
	Worn suction sideplate or wear rings.	Replace defective part as required.
	Insufficient suction head.	Ensure that suction line shutoff valve is fully open and line is unobstructed.
	Worn or broken impeller.	Inspect and replace if necessary.
Pump starts then stops pumping.	Improperly primed pump.	Reprime pump.
	Air or vapor pockets in suction line.	Rearrange piping to elilminate air pockets.
	Air leak in suction line.	Repair (plug) leak.
Bearings run hot.	Improper alignment.	Re-align pump and driver.
	Improper lubrication.	Check lubricant for suitability and level.
	Lube cooling.	Check cooling system.
Pump is noisy or vibrates.	Improper pump/driver alignment.	Align shafts.
	Partly clogged impeller causing imbalance.	Back-flush pump to clean impeller.
	Broken or bent impeller or shaft.	Replace as required.
	Foundation not rigid.	Tighten hold down bolts of pump and motor or adjust stilts.
	Worn bearings.	Replace.
	Suction or discharge piping not anchored or properly supported.	Anchor per Hydraulic Institute Standards Manual recommendations
	Pump is cavitating.	System problem.
Excessive leakage from stuffing box.	Packing gland improperly adjusted.	Tighten gland nuts.
	Stuffing box improperly packed.	Check packing and repack box.
	Worn mechanical seal parts.	Replace worn parts.
	Overheating mechanical seal.	Check lubrication and cooling lines.
	Shaft sleeve scored.	Remachine or replace as required.
Motor requires excessive power.	Head lower than rating. Pumps too much liquid.	Consult factory. Install throttle valve, trim impeller diameter.
	Liquid heavier than expected.	Check specific gravity and viscosity.
	Stuffing packing too tight.	Readjust packing. Replace if worn.
	Rotating parts bind.	Check internal wearing parts for proper clearances.

3.0 SAFETY PRECAUTIONS AND STANDARD OPERATING PROCEDURES

3.1 INTRODUCTION

Proper safety measures should be followed while operating all equipment. The operator and any personnel in the work zone should read the site specific health and safety plan, be familiar with the O & M manual, and should be familiar with the manual of any and all equipment they will be working on or near. Proper personal protective equipment shall be worn at all times. Section 3.2 contains material data safety sheets, Section 3.3 contains standard operating procedures for health and safety, and the attached Appendices contains the equipment manuals, which contain specific safety requirements, for all of the major components.

3.2 MATERIAL SAFETY DATA SHEETS

The following are the MSDS sheets for chemicals present at the site. MSDS sheets are present for the following chemicals:

- Sulfuric Acid, Concentrated
- Sodium Hydroxide, 50% Liquid
- Polymeric Dithiocarbamate
- Coagulant
- Flocculent
- Activated Carbon
- Purtagohn
- Premium Unleaded Gasoline
- Diesel Fuel Oil No. 2-D

3.3 HEALTH AND SAFETY STANDARD OPERATING PROCEDURES

The proper health and safety procedures should be followed at all times. Presented in this section is a composition of many of the potential and common safety problems and the corresponding standard operating procedures. The following is a list of the SOPs attached in this section:

- Electrical Safety
- Slip, Trip, and Fall Prevention
- Lockout/Tagout
- Personal Lifting Safety

- Safety Showers and Eyewash Station
- Confined Space Entry

MATERIAL SAFETY DATA SHEET

Genium Publishing Corporation
One Genium Plaza
Schenectady, NY 12304-4690 USA
(518) 377-8854

Material Safety Data Sheets Collection:

Sheet No. 9
Sulfuric Acid, Concentrated

Issued: 10/77 Revision: D, 9/92

Section 1. Material Identification

Sulfuric Acid Concentrated (H_2SO_4) Description: Prepared by the "Cat-Ox" process; by the contact process (vanadium pentoxide catalyst) with sulfur, pyrite (FeS_2), hydrogen sulfide, or sulfur-containing smelter gases; and from gypsum (calcium sulfate). Sulfuric acid is by far the most widely used industrial chemical. Its uses include: in the manufacture of fertilizers, chemicals, nitrate explosives, parchment paper, glue, dyes and pigments; as an etchant, a lab reagent, an electrolyte in lead/acid batteries, a dehydrating agent in the manufacture of ethers and esters, and an alkylation catalyst; in the purification of petroleum, the refining of mineral and vegetable oils, the leather industry, the carbonization of wool fabrics, the recuperation of fatty acids from soapworks waste water, the production of rayon and film, the extraction of uranium from pitchblende, and pickling of metal; in electroplating baths, gas drying and nonferrous metallurgy; and to obtain glucose by the hydrolysis of cellulose.

Other Designations: CAS No. 7664-93-9, battery acid, BOV, Caswell No 815, dipping acid, electrolyte acid, hydrogen sulfate, matting acid, oil of vitriol, sulphuric acid, vitriol brown oil.

Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*(73) for a suppliers list.

Cautions: Handle concentrated sulfuric acid with extreme caution because it is corrosive to all body tissues. Vapor inhalation can cause severe lung damage. Skin or eye contact can produce severe burns; blindness may result.

R	1
I	3
S	4
K	0

NFPA

HMIS
H 3*
F 0
R 2
PPE†
* Chronic effects
† Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Sulfuric acid concentrated, 93-98% sulfuric acid; remainder is water. Impurities include nonvolatiles, 0.02-0.03 ppm; SO_2, 40-80 ppm; iron, 50-100 ppm; nitrate, 5-20 ppm.

1991 OSHA PEL
8-hr TWA: 1 mg/m³

1990 IDLH Level
80 mg/m³

1990 NIOSH REL
TWA: 1 mg/m³

1992-93 ACGIH TLVs
TWA: 1 mg/m³
STEL: 3 mg/m³

1990 DFG (Germany) MAK
TWA: 1 mg/m³
Category: Local irritants
Peak: 2 mg/m³, 5 min, momentary value †, 8 peaks per shift

1985-86 Toxicity Data*
Human, inhalation, TC_{Lo}: 3 mg/m³ for 24 weeks; toxic effects not yet reviewed.
Man, unreported route, LD_{Lo}: 135 mg/kg; toxic effects not yet reviewed.
Rat, oral, LD_{50}: 2140 mg/kg; toxic effects not yet reviewed.
Rabbit, eye: 100 mg rinse produced severe irritation.

* See NIOSH, *RTECS* (WS5600000), for additional toxicity data.
† The momentary value is a level which the concentration should never exceed.

Section 3. Physical Data

Boiling Point: 554 °F (290 °C); decomposes at 644 °F (340 °C) into sulfur trioxide and water.
Melting Point (100%): 50.65 °F (10.36 °C)
Vapor Pressure: <0.001 mm Hg at 20 °C
Saturated Vapor Density (air = 1.2 kg/m³): 1.2 kg/m³, 0.075 lbs/ft³
pH: 1 N sol = 0.3, 0.1 N sol = 1.2, 0.01 N sol = 2.1

Molecular Weight: 98.08
Density/Specific Gravity (96-98%): 1.841
Water Solubility: Soluble; reacts!*
Other Solubilities: Ethyl alcohol
Odor Threshold: 0.150 ppm

Appearance and Odor: Colorless (pure) to dark brown (impure), odorless, dense, oily liquid. Pure compound is a solid below 51 °F (11 °C).

* Sulfuric acid reacts violently with water with the evolution of heat. *Always add the acid to water or other diluent, not the water to acid!*

Section 4. Fire and Explosion Data

Flash Point: Not combustible	Autoignition Temperature: None reported	LEL: None reported	UEL: None reported

Extinguishing Media: Use extinguishing media appropriate to surrounding fire. Only use water if absolutely necessary and use with great caution. Water applied directly to sulfuric acid results in violent heat liberation and splattering of the material. Use water spray only to keep fire-exposed containers cool. **Unusual Fire or Explosion Hazards:** Sulfuric acid, a strong dehydrating agent, reacts with organic materials and produces enough heat ignition, chars wood, and may cause ignition of finely divided materials on contact. Reaction with metals may produce highly flammable, hydrogen gas. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighter's protective clothing is *not* effective. Stay away from ends of tanks. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Sulfuric acid is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Include acetic acid; acetone cyanohydrin; (acetone + nitric acid); (acetone + potassium dichromate); acetonitrile; acrolein; acrylonitrile; acrylonitrile + water; (alcohol + hydrogen peroxide); allyl alcohol; allyl chloride; ammonium hydroxide; 2-amino ethanol; ammonium; triperchromate; aniline; (bromates + metals); bromine pentafluoride; *n*-butyraldehyde; carbides; cesium acetylene carbide; chlorates; (chlorates + metals); chlorine trifluoride; chlorosulfonic acid; cuprous nitride; diisobutylene; (dimethylbenzylcarbinol + hydrogen peroxide); epichlorohydrin; ethylene cyanohydrin; ethylene diamine; ethylene glycol; ethylene imine; fulminates; hydrochloric acid; hydrogen; iodine heptafluoride; (indene + nitric acid); iron; isoprene; lithium silicide; mercuric nitride; mesityl oxide; powdered metals; (nitric acid + glycerides); *p*-nitrotoluene; pentasilver trihydroxydiaminophosphate; perchlorates; perchloric acid; (permanganates + benzene); (1-phenyl-2-methylpropryl alcohol + hydrogen peroxide); phosphorus; phosphorus isocyanate; picrates; potassium *tert*-butoxide; potassium chlorate; (potassium permanganate + potassium chloride); (potassium permanganate + water); beta-propiolactone; propylene oxide; pyridine; rubidium acetylene carbide; silver permanganate; sodium; sodium carbonate; sodium chlorate; sodium hydroxide; steel; styrene monomer; (toluene + nitric acid); vinyl acetate; and water. **Conditions to Avoid:** Water, combustibles, heat, ignition sources, and other incompatibles. **Hazardous Products of Decomposition:** Thermal oxidative decomposition of sulfuric acid can produce sulfur oxides.

Section 6. Health Hazard Data

Carcinogenicity: The IARC,(164) NTP,(169) and OSHA(164) do not list sulfuric acid as a carcinogen. However, a number of studies have associated exposures to sulfuric acid or to acid mists in general with laryngeal cancer. In 50 confirmed cases there was an approximately four-fold increased risk among highly exposed individuals relative to matched controls. It is not known if sulfuric acid can act as a direct carcinogen, as a promoter, or in combination with other substances.(167) **Summary of Risks:** Concentrated sulfuric acid is a severe respiratory tract, skin, and eye irritant.

Continue on next page

Section 6. Health Hazard Data, *continued*

Exposure can result in severe burns, tissue damage, scarring, functional inhibition, and blindness if splashed in the eye. Although ingestion is unlikely, it may cause severe injury and death. **Medical Conditions Aggravated by Long-Term Exposure:** Chronic respiratory, gastrointestinal, ...ous, skin or eye diseases. **Target Organs:** Respiratory system, eyes, skin, and teeth. **Primary Entry Routes:** Inhalation, skin and eye ...act. **Acute Effects:** Vapor or mist inhalation causes coughing, sneezing, nose irritation and nose bleeds, reflex bronchospasm, shortness of ...eath, pulmonary edema (fluid in lungs), emphysema, and permanent changes in pulmonary function. Ingestion causes corrosion of the mucous membranes of mouth, throat, and esophagus; and epigastric pain with nausea and vomiting of mucoid and "coffee ground" material. Skin contact produces severe burns; initially the zone of contact is bleached and turns brown prior to the formation of a clearly defined ulcer. These wounds are slow in healing and may cause extensive scarring that results in functional inhibition. If burns are extensive, the outcome may prove fatal. Circulatory collapse with clammy skin, weak and rapid pulse, shallow respirations, and scanty urine may follow ingestion or skin contact. Circulatory shock is often the immediate cause of death. Eye contact produces deep corneal ulceration, kerato-conjunctivitis, palpebral lesions, and possible blindness. **Chronic Effects:** Chronic effects may include dental erosion, conjunctivitis, tracheobronchitis, emphysema, stomatitis (inflammation of the mouth mucous membranes), gastritis (inflammation of stomach mucous membranes), and dermatitis. **FIRST AID Eyes:** *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult an ophthalmologist immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Use a 2% sodium bicarbonate solution to further neutralize any H_2SO_4 on the skin. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless otherwise advised, have that *conscious and alert* person drink 1 to 2 glasses of water or milk to dilute. *Do not* induce vomiting! Do not attempt to neutralize the acid with sodium bicarbonate. **Note to Physicians:** Monitor arterial blood gases, chest x-ray, and pulmonary function tests if respiratory tract irritation or respiratory depression is evident. Treat dermal irritation or burns with standard topical therapy.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel of spill, evacuate all unnecessary personnel, remove all ignition sources, and provide adequate ventilation. Cleanup personnel should wear fully-encapsulating, vapor-protective clothing to protect against inhalation and skin or eye contact. Keep water and combustibles away from release. Stop or control leak if this can be done without undue risk. Neutralize small spills with sodium bicarbonate or a mixture of soda ash/slaked lime (50/50) and place into sealed containers for disposal. If a neutralizing agent is not available, absorb spilled sulfuric acid with vermiculite, dry sand, or earth. *Never* use organic material (e.g., sawdust) to absorb spill. For large spills, dike far ahead to contain for later disposal. Follow applicable OSHA regulations (29 CFR 1910.120). Report any release in excess of 1000 lbs. **Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Neutralize waste water pH between 5.5 and 8.5. Follow applicable Federal, state, and local regulations.

Aquatic Toxicity: LC_{50} (saltwater, prawns): 42.5 ppm for 48 hrs; lethal (freshwater, bluegill): 24.5 ppm/24 hr.

EPA Designations

Listed as a RCRA Hazardous Waste (40 CFR 261.33): Characteristic of corrosivity

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 1000 lb (454 kg) [* per CWA, Sec. 311(b)(4)]

Listed as a SARA Extremely Hazardous Substance (40 CFR 355), TPQ: 1000 lbs.

Listed as a SARA Toxic Chemical (40 CFR 372.65)

OSHA Designations

...d as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

...tion 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For concentrations < 25 mg/m^3 use any powered, air-purifying respirator with acid gas cartridge(s) in combination with a high-efficiency particulate filter. For concentrations < 50 mg/m^3, use any chemical cartridge respirator with a full facepiece and acid gas cartridge(s) in combination with a high-efficiency particulate filter. For concentrations < 80 mg/m^3, use any supplied air-respirator with a full facepiece and operated in pressure-demand or other positive-pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. If respirators are used, OSHA requires a respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent skin contact. H_2SO_4 has a minor to moderate effect on neoprene or rubber.[131] **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes and launder before reuse. Remove this material from your shoes and clean personal protective equipment. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in clearly labelled, steel containers in a cool [below 50 °F (10 °C)], dry, well-ventilated location on an acid-resistant cement floor and away from direct sunlight, combustibles, and other reactive materials. Separate from carbides, chlorates, fulminates, nitrates, picrates, and powdered metals. Protect storage containers against damage and water. Use non-sparking tools near sulfuric acid carboys, drums, tank cars, or metal storage tanks because of the possible production of hydrogen during storage. Use hand pumps for the decanting and emptying of carboys. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. Total enclosures of processes and the mechanization of handling procedures are the most effective measures to prevent contact with sulfuric acid. Protect electrical installations against the corrosive action of acid vapors. **Administrative Controls:** Consider preplacement and periodic physical examinations with emphasis on the respiratory tract (including pulmonary function tests), skin, eyes, and teeth.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Sulfuric acid
DOT Hazard Class: 8
ID No.: UN1830
...T Packaging Group: II
... Label: Corrosive
...cial Provisions (172.102): A3, A7, B2, B83, B84, N34, T9, T27

Packaging Authorizations
a) Exceptions: 173.154
b) Non-bulk Packaging: 173.202
c) Bulk Packaging: 173.242

Quantity Limitations
a) Passenger, Aircraft, or Railcar: 1L
b) Cargo Aircraft Only: 30L

Vessel Stowage Requirements
a) Vessel Stowage: C
b) Other: 14

MSDS Collection **References:** 26, 73, 89, 100, 101, 103, 124, 126, 127, 131, 132, 139, 140, 148, 149, 153, 159, 163, 164, 167, 171, 174, 180
Prepared by: MJ Wurth, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** AC Darlington, MPH

Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8854

Material Safety Data Sheets Collection:

Sheet No. 3A
Sodium Hydroxide, 50% Liquid

Issued: 10/77 Revision: B, 11/91

Section 1. Material Identification 36

Sodium Hydroxide, 50% Liquid (NaOH), Description: Derived by electrolysis of sodium chloride brines, by reacting calcium chloride with sodium carbonate, or by electrolytic production using the diaphragm cell. Sodium hydroxide often contains minimal amounts of sodium chloride, sodium carbonate, sodium sulfate, sodium chlorate, iron, or nickel. Used in making plastics to dissolve casein; in treating cellulose in making rayon and cellophane; in explosives, dyestuffs, electrolytic extraction of zinc, reclaiming rubber, tin plating, oxide coating, etching and electroplating, laundering and bleaching, pulp and paper manufacture; in vegetable oil refining; in peeling fruits and vegetables in the food industry; to hydrolyze fats and form soaps; and in veterinary medicine as a disinfectant.

R 0
I 2
S 4
K 0

NFPA

HMIS
H 3
F 0
R 1
PPG*
* Sec. 8

Other Designations: CAS No. 1310-73-2; Aetznatron; Collo-Grillrein; Collo-Tapette; Feurs Rohp; Lewis-Red Devil Lye; soda lye; soda, lye solution; sodium hydrate solution; sodium hydroxide solution; white caustic solution.
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*[73] for a suppliers list.

Cautions: Sodium hydroxide is moderately toxic by ingestion and inhalation and can be seriously corrosive to eyes, skin, and mucous membranes.

Section 2. Ingredients and Occupational Exposure Limits

Sodium hydroxide, ca 50% water solution

1990 OSHA PEL
Ceiling: 2 mg/m³

1991-92 ACGIH TLV
Ceiling: 2 mg/m³

1990 DFG (Germany) MAK
2 mg/m³

1990 IDLH Level
250 ppm

1990 NIOSH REL
Ceiling: 2 mg/m³

1985-86 Toxicity Data*
Monkey, eye: 1% solution applied over 24 hr produced severe irritation
Rabbit, eye: 1% solution applied to the eye caused severe irritation
Grasshopper, parenteral: 20 µl produced cytogenic mutations

* See NIOSH, *RTECS* (WB4905000), for additional irritation, mutation and toxicity data.

Section 3. Physical Data

Boiling Point: 284 °F (140 °C)
Freezing Point: 53.6 °F (12 °C)
Viscosity: 50 cP at 68 °F (20 °C)
pH (0.5 % solution): 13
Molecular Weight: 40.01
Specific Gravity: 1.53 at 77 °F (25 °C)
Water Solubility: Completely soluble in water
Other Solubilities: Soluble in alcohol, methanol and glycerol; insoluble in acetone and ether

Appearance and Odor: An odorless, clear liquid.

Section 4. Fire and Explosion Data

Flash Point: None reported	Autoignition Temperature: None reported	LEL: None reported	UEL: None reported

Extinguishing Media: Although noncombustible, when in contact with moisture or water sodium hydroxide, 50% liquid, can generate enough heat to ignite surrounding combustibles. If possible without risk, remove containers from area. Use extinguishing agents suitable for surrounding fire. For small fire, use dry chemical, carbon dioxide (CO_2), or regular foam. Avoid using water spray since water reacts with sodium hydroxide to generate substantial heat. If you must use water, be sure it is as cold as possible. For large fires, use fog or regular foam.
Unusual Fire or Explosion Hazards: Sodium hydroxide solution can become very hot when in contact with water.
Special Fire-fighting Procedures: Since fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Also, wear fully protective clothing. Structural firefighters' protective clothing provides limited protection. Apply cooling water to sides of fire-exposed containers until fire is well out. *Do not* splatter or splash this material. Stay away from ends of tanks. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Sodium hydroxide solution is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur. Violent polymerization can occur when in contact with acrolein or acrylonitrile. Since sodium hydroxide readily absorbs water and carbon dioxide from air, keep containers tightly closed.
Chemical Incompatibilities: Since it generates large amounts of heat when in contact with water, sodium hydroxide may steam and splatter. It reacts with mineral acids to form corresponding salts, and with weak-acid gases like hydrogen sulfide, sulfur dioxide and carbon dioxide. Sodium hydroxide can be very corrosive to metals such as aluminum, tin, and zinc, as well as alloys such as steel, and may cause formation of flammable hydrogen gas. An increase in temperature and pressure occurs in closed containers when sodium hydroxide is mixed with acetic anhydride, glacial acetic acid, chlorohydrin, chlorosulfonic acid, ethylene cyanohydrin, glyoxal, oleum, 36% hydrochloric acid, 48.7% hydrofluoric acid, 70% nitric acid, or 96% sulfuric acid.
Conditions to Avoid: Avoid generation of sodium hydroxide mists, and contact with water, metals, and the chemicals listed above.
Hazardous Products of Decomposition: Thermal oxidative decomposition of sodium hydroxide can produce toxic sodium oxide (Na_2O) and peroxide (Na_2O_2) fumes.

Section 6. Health Hazard Data

Carcinogenicity: In 1990 reports, the IARC, NTP, and OSHA do not list sodium hydroxide as a carcinogen (see Chronic Effects).
Summary of Risks: Sodium hydroxide solution is toxic by mist inhalation, ingestion, or direct skin or eye contact. Damage is immediate and without prompt medical attention can become permanent. This strong, corrosive alkaline solution dissolves any living tissue it contacts.
Medical Conditions Aggravated by Long-Term Exposure: None reported.
Target Organs: Eyes, digestive tract, respiratory system, and skin.
Primary Entry Routes: Ingestion, inhalation, and skin and eye contact.
Acute Effects: Ingestion causes immediate burning of mouth, esophagus, and stomach; painful swallowing; excessive salivation; edematous (excess fluid in surrounding tissue) lips, chin, tongue, and pharynx covered with exudate (fluid oozed from swollen tissue); esophageal edema (swelling from fluid buildup in esophagus walls that can prevent swallowing within hours); edematous, gelatinous, and necrotic (localized tissue

Continue on next page

Section 6. Health Hazard Data, *continued*

death) mucous membranes; vomiting (sometimes coffee grounds-like material due to digestive hemorrhage); rapid, faint pulse; and cold, clammy skin. Death commonly occurs due to shock, asphyxia (oxygen loss due to interrupted breathing), or pneumonia by the second or third day after ing[illegible]. Mist inhalation can cause many burns, temporary hair loss (in nasal passages since sodium hydroxide breaks down keratin), and p[illegible]ulmonary edema (fluid in lungs). Skin contact causes slippery, soapy feeling that is usually not painful for 3 min after contact—even t[illegible]skin damage begins immediately. It causes burns, keratin (hair and nails) destruction, and intracellular edema (excess fluid in skin cells), with damage progressing to severe burns, tissue corrosion, deep ulcerations, and permanent scarring if not washed off immediately. The cornea begins to corrode on contact. Disintegration and sloughing of conjunctival and corneal epithelium may progress to temporary or permanent corneal opacification (cloudiness, becoming impervious to light) or symblepharon (adhesion of lid to eyeball).
Chronic Effects: Dermatitis may result after repeated exposure to dilute solutions. Cases of squamous cell carcinoma (malignant tumors of epithelial origin) of the esophagus are reported 12 to 42 years after ingestion, although it is unclear whether the cancer resulted from scar formation caused by tissue destruction or directly from the chemical's possible carcinogenicity.
FIRST AID: Emergency personnel should protect against contamination.
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. *Do not* allow victim to keep his eyes tightly shut. *Warning!* Although splashed in only one eye, sodium hydroxide may affect the other eye's sight if prompt medical attention is not received. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of cold water for at least 15 min. *Be aware* that this substance can become very hot when in contact with water. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have that *conscious and alert* person drink 1 to 2 glasses of water followed by vinegar or fruit juice to neutralize the poison. *Do not* induce vomiting.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Note to Physicians: Perform endoscopy in all suspected cases of sodium hydroxide ingestion. Perform blood analysis to determine if dehydration, acidosis, or other electrolyte imbalances have occurred.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, isolate hazard area, deny entry, and stay upwind of spills. Cleanup personnel should protect against vapor inhalation and skin or eye contact. Use water spray to disperse vapors but do not spray directly on spills. Absorb small liquid spills with fly ash or cement powder. Neutralize spill with vinegar or dilute acid. Perlite and Cellosolve WP 3H (hydroxyethyl cellulose) are recommended for vapor suppression and containment of 50% sodium hydroxide solutions. Place material in suitable container (sodium hydroxide corrodes steel at temperatures above 60 °C) for later disposal. For large wet spills, dike flow using soil, sand bags, foamed polyurethane, or foamed concrete to contain for later disposal. Follow applicable OSHA regulations (29 CFR 1910.120).
Environmental Transport: In solid form, sodium hydroxide is not mobile, although it very easily absorbs moisture. Once liquid, sodium hydroxide rapidly leaches into the soil, possibly contaminating water sources.
Environmental Degradation: Ecotoxicity values (as 100% NaOH): TLm, mosquito fish, 125 ppm/96 hr (fresh water); TLm, bluegill, 99 mg/48 hr (tap water).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
Li[illegible]a RCRA Hazardous Waste (40 CFR 261.22): Characteristic of corrosivity
I[illegible]a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1000 lb (454 kg) [* per Clean Water Act, Sec. 311 (b)(4)]
S[illegible]xtremely Hazardous Substance (40 CFR 355): Not listed
SARA Toxic Chemical (40 CFR 372.65): Not listed
OSHA Designations
Sodium hydroxide is listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Since contact lens use in industry is controversial, establish your own policy.
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. Select the respirator based on its suitability to provide adequate worker protection for the given working conditions, level of airborne contamination, and presence of sufficient oxygen. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent any skin contact.
Ventilation: Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL and IDLH values (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder contaminated work clothing before wearing. Remove this material from your shoes and clean personal protective equipment.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Avoid physical damage to containers. Store in dry, well-ventilated area away from water, acids, metals, flammable liquids and organic halogens. Keep containers tightly closed since sodium hydroxide can decompose to sodium carbonate and carbon dioxide upon exposure to air. Since corrosion occurs easily above 140 °F (60 °C), do not store or transport in aluminum or steel containers when temperatures are near this level. Store containers in rooms equipped with trapped floor drains, curbs, or gutters.
Engineering Controls: To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control hazardous airborne contaminants and to maintain concentrations at the lowest practical level.
Other Precautions: Institute preplacement and periodic medical exams of exposed workers emphasizing the eyes, skin and respiratory tract. Consider a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Educate employees to the possible hazards in using sodium hydroxide.

Transportation Data (49 CFR 172.101, .102)

D[illegible]ipping Name: Sodium hydroxide, liquid *or* solution
D[illegible]zard Class: Corrosive material
I[illegible]JN1824
DOT Label: Corrosive
DOT Packaging Exceptions: 173.244
DOT Packaging Requirements: 173.249

IMO Shipping Name: Sodium hydroxide, solution
IMO Hazard Class: 8
ID No.: UN1824
IMO Label: Corrosive
IMDG Packaging Group: II

MSDS Collection **References:** 26, 38, 73, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 139, 140, 143, 146, 148, 149, 153, 159, 161, 163
Prepared by: M Gannon, BA; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** W Silverman, MD; **Edited by:** JR Stuart, MS

BETZ MATERIAL SAFETY DATA SHEET

BETZ

EFFECTIVE DATE: 27-MAR-1996
PRINTED DATE: 07-JUN-1996

1) CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME : BETZ ENTEC E632

PRODUCT APPLICATION AREA: WASTE TREATMENT ADDITIVE.

COMPANY ADDRESS:
Betz Water Management Group, Division Betz Laboratories,Inc.
200 Witmer Road Horsham , PA 19044
Information phone number (215) 773-6131

EMERGENCY TELEPHONE (HEALTH/ACCIDENT): (800)-877-1940 (USA)

2) COMPOSITION / INFORMATION ON INGREDIENTS

Information for specific product ingredients as required by the U.S. OSHA HAZARD COMMUNICATION STANDARD is listed. Refer to additional sections of this MSDS for our assessment of the potential hazards of this formulation.

HAZARDOUS INGREDIENTS:

CAS#	CHEMICAL NAME
NOT ASSIGNED	POLYMERIC DITHIOCARBAMATE Potential irritant

No component is considered to be a carcinogen by the National Toxicology Program, the International Agency for Research on Cancer, or the Occupational Safety and Health Administration at OSHA thresholds for carcinogens.

CONTINUED

3) HAZARDS IDENTIFICATION

****

EMERGENCY OVERVIEW

WARNING

May cause moderate irritation to the skin. Severe irritant to the eyes. Mists/aerosols may cause irritation to upper respiratory tract.

DOT hazard is not applicable
Emergency Response Guide is not applicable
Odor: Strong; Appearance: Orange, Liquid

Fire fighters should wear positive pressure self-contained breathing apparatus(full face-piece type). Proper fire-extinguishing media: dry chemical, carbon dioxide, foam or water

****

POTENTIAL HEALTH EFFECTS

ACUTE SKIN EFFECTS:
Primary route of exposure; May cause moderate irritation to the skin.

ACUTE EYE EFFECTS:
Severe irritant to the eyes.

ACUTE RESPIRATORY EFFECTS:
Mists/aerosols may cause irritation to upper respiratory tract.

INGESTION EFFECTS:
May cause gastrointestinal irritation.

TARGET ORGANS:
No evidence of potential chronic effects.

MEDICAL CONDITIONS AGGRAVATED:
Not known.

SYMPTOMS OF EXPOSURE:
May cause redness or itching of skin, irritation, and/or tearing of eyes (direct contact).

4) FIRST AID MEASURES

SKIN CONTACT:
Remove contaminated clothing. Wash exposed area with a large quantity of soap solution or water for 15 minutes.
EYE CONTACT:
Immediately flush eyes with water for 15 minutes. Immediately contact a physician for additional treatment.
INHALATION:
Remove victim from contaminated area to fresh air. Apply appropriate first aid treatment as necessary.
INGESTION:
Do not feed anything by mouth to an unconscious or convulsive victim. Do not induce vomiting. Immediately contact physician. Dilute contents of stomach using 3-4 glasses milk or water.

5) FIRE FIGHTING MEASURES

FIRE FIGHTING INSTRUCTIONS:
Fire fighters should wear positive pressure self-contained breathing apparatus (full face-piece type).
EXTINGUISHING MEDIA:
dry chemical, carbon dioxide, foam or water
HAZARDOUS DECOMPOSITION PRODUCTS:
Thermal decomposition (destructive fires) yields elemental oxides.
FLASH POINT:
> 200F P-M(CC)

6) ACCIDENTAL RELEASE MEASURES

PROTECTION AND SPILL CONTAINMENT:
Ventilate area. Use specified protective equipment. Contain and absorb on absorbent material. Place in waste disposal container. Flush area with water. Wet area may be slippery. Spread sand/grit.
DISPOSAL INSTRUCTIONS:
Water contaminated with this product may be sent to a sanitary sewer treatment facility,in accordance with any local agreement,a permitted waste treatment facility or discharged under a permit. Product as is - Incinerate or land dispose in an approved landfill.

7) HANDLING AND STORAGE

HANDLING:
Alkaline. Corrosive(Eyes). Do not mix with acidic material.
STORAGE:
Keep containers closed when not in use. Protect from freezing. Do not store at elevated temperatures.

CONTINUED

8) EXPOSURE CONTROLS/PERSONAL PROTECTION

EXPOSURE LIMITS

CHEMICAL NAME

POLYMERIC DITHIOCARBAMATE
PEL (OSHA): NOT DETERMINED
TLV (ACGIH): NOT DETERMINED

ENGINEERING CONTROLS:
adequate ventilation
PERSONAL PROTECTIVE EQUIPMENT:
Use protective equipment in accordance with 29CFR 1910 Subpart I
RESPIRATORY PROTECTION:
A RESPIRATORY PROTECTION PROGRAM THAT MEETS OSHA'S 29 CFR 1910.134 AND ANSI Z88.2 REQUIREMENTS MUST BE FOLLOWED WHENEVER WORKPLACE CONDITIONS WARRANT A RESPIRATOR'S USE.
USE AIR PURIFYING RESPIRATORS WITHIN USE LIMITATIONS ASSOCIATED WITH THE EQUIPMENT OR ELSE USE SUPPLIED AIR-RESPIRATORS.
If air-purifying respirator use is appropriate, use a respirator with organic vapor cartridges and dust/mist prefilters.
SKIN PROTECTION:
neoprene gloves-- Wash off after each use. Replace as necessary.
EYE PROTECTION:
splash proof chemical goggles

9) PHYSICAL AND CHEMICAL PROPERTIES

Specific Grav. (70F)	1.128	Vapor Pressure (mmHG)	~ 18.0
Freeze Point (F)	25.00	Vapor Density (air=1)	< 1.00
Viscosity (cps 70F)	40	% Solubility (water)	100.0

Odor	Strong	
Appearance	Orange	
Physical State	Liquid	
Flash Point (F)	> 200	P-M(CC)
pH As Is (approx.)	12.3	
Evaporation Rate (Ether=1)	< 1.00	

NA = not applicable ND = not determined

PRODUCT NAME : BETZ ENTEC E632
EFFECTIVE DATE: 27-MAR-1996

10) STABILITY AND REACTIVITY

STABILITY:
Stable under normal storage conditions.
HAZARDOUS POLYMERIZATION:
Will not occur.
INCOMPATIBILITIES:
May react with strong oxidizers.
DECOMPOSITION PRODUCTS:
Thermal decomposition (destructive fires) yields elemental oxides.
BETZ INTERNAL PUMPOUT/CLEANOUT CATEGORIES:
"B"

11) TOXICOLOGICAL INFORMATION

Oral LD50 RAT:	>500 mg/kg
NOTE - Estimated value	
Dermal LD50 RABBIT:	>1,000 mg/kg
NOTE - Estimated value	

12) ECOLOGICAL INFORMATION

AQUATIC TOXICOLOGY

Fathead Minnow 96 Hour Static Acute Bioassay
pH of test solutions was adjusted to a level of 6-9.

LC50: 195 mg/L
No Effect Level: 62.5 mg/L

Daphnia magna 48 Hour Static Acute Bioassay
pH of test solutions was adjusted to a level of 6-9.

LC50: 240 mg/L
No Effect Level: 62 mg/L

BIODEGRADATION
No Data Available.

13) DISPOSAL CONSIDERATIONS

If this undiluted product is discarded as a waste, the US RCRA hazardous waste identification number is :
Not applicable.

Please be advised; however, that state and local requirements for waste disposal may be more restrictive or otherwise different from federal regulations. Consult state and local regulations regarding the proper disposal of this material.

14) TRANSPORT INFORMATION

DOT HAZARD:	Not Applicable
UN / NA NUMBER:	Not applicable
DOT EMERGENCY RESPONSE GUIDE #:	Not applicable

15) REGULATORY INFORMATION

TSCA:
All components of this product are listed in the TSCA inventory.
CERCLA AND/OR SARA REPORTABLE QUANTITY (RQ):
No regulated constituent present at OSHA thresholds
SARA SECTION 312 HAZARD CLASS:
Immediate(acute)
SARA SECTION 302 CHEMICALS:
No regulated constituent present at OSHA thresholds
SARA SECTION 313 CHEMICALS:
No regulated constituent present at OSHA thresholds

CALIFORNIA REGULATORY INFORMATION

CALIFORNIA SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT (PROPOSITION 65) CHEMICALS PRESENT:

No regulated constituent present at OSHA thresholds

MICHIGAN REGULATORY INFORMATION

No regulated constituent present at OSHA thresholds

16) OTHER INFORMATION

NFPA/HMIS	CODE TRANSLATION	
Health	2	Moderate Hazard
Fire	1	Slight Hazard
Reactivity	0	Minimal Hazard
Special	NONE	No special Hazard
(1) Protective Equipment	B	Goggles,Gloves

(1) refer to section 8 of MSDS for additional protective equipment recommendations.

CHANGE LOG

	EFFECTIVE DATE	REVISIONS TO SECTION:	SUPERCEDES
MSDS status:	01-NOV-1995		** NEW **
	02-NOV-1995		01-NOV-1995
	06-NOV-1995	12	02-NOV-1995
	27-MAR-1996	2,8	06-NOV-1995

BETZ MATERIAL
SAFETY DATA SHEET

BETZ

EFFECTIVE DATE: 29-AUG-1995
PRINTED DATE: 07-JUN-1996

1) CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME : BETZ ENTEC E660

PRODUCT APPLICATION AREA: COAGULANT.

COMPANY ADDRESS:
Betz Water Management Group, Division Betz Laboratories,Inc.
200 Witmer Road Horsham , PA 19044
Information phone number (215) 773-6131

EMERGENCY TELEPHONE (HEALTH/ACCIDENT): (800)-877-1940 (USA)

2) COMPOSITION / INFORMATION ON INGREDIENTS

Information for specific product ingredients as required by the OSHA HAZARD COMMUNICATIONS STANDARD is listed. Refer to additional sections of this MSDS for our assessment of the potential hazards of this formulation.

HAZARDOUS INGREDIENTS:

This product is not hazardous as defined by OSHA regulations.

No component is considered to be a carcinogen by the National Toxicology Program, the International Agency for Research on Cancer, or the Occupational Safety and Health Administration at OSHA thresholds for carcinogens.

3) HAZARDS IDENTIFICATION

****

EMERGENCY OVERVIEW

CAUTION

May cause moderate irritation to the skin. May cause moderate irritation to the eyes. Mists/aerosols may cause irritation to upper respiratory tract.

DOT hazard is not applicable
Emergency Response Guide is not applicable
Odor: Mild; Appearance: Red-Brown, Liquid

Fire fighters should wear positive pressure self-contained breathing apparatus(full face-piece type). Proper fire-extinguishing media: Dry chemical, carbon dioxide, foam or water.

****

POTENTIAL HEALTH EFFECTS

ACUTE SKIN EFFECTS:
Primary route of exposure; May cause moderate irritation to the skin.

ACUTE EYE EFFECTS:
May cause moderate irritation to the eyes.

ACUTE RESPIRATORY EFFECTS:
Mists/aerosols may cause irritation to upper respiratory tract.

INGESTION EFFECTS:
May cause gastrointestinal irritation with possible nausea, vomiting, abdominal discomfort and diarrhea.

TARGET ORGANS:
No evidence of potential chronic effects.

MEDICAL CONDITIONS AGGRAVATED:
Not known.

SYMPTOMS OF EXPOSURE:
May cause redness or itching of skin.

4) FIRST AID MEASURES

SKIN CONTACT:
Remove contaminated clothing. Wash exposed area with a large quantity of soap solution or water for 15 minutes.
EYE CONTACT:
Immediately flush eyes with water for 15 minutes. Immediately contact a physician for additional treatment.
INHALATION:
Remove victim from contaminated area to fresh air. Apply appropriate first aid treatment as necessary.
INGESTION:
Do not feed anything by mouth to an unconscious or convulsive victim. Do not induce vomiting. Immediately contact physician. Dilute contents of stomach using 3-4 glasses milk or water.

5) FIRE FIGHTING MEASURES

FIRE FIGHTING INSTRUCTIONS:
Fire fighters should wear positive pressure self-contained breathing appartus (full face-piece type).
EXTINGUISHING MEDIA:
Dry chemical, carbon dioxide, foam or water.
HAZARDOUS DECOMPOSITION PRODUCTS:
Thermal decomposition (destructive fires) yields elemental oxides.
FLASH POINT:
> 200F P-M(CC)

6) ACCIDENTAL RELEASE MEASURES

PROTECTION AND SPILL CONTAINMENT:
Ventilate area. Use specified protective equipment. Contain and absorb on absorbent material. Place in waste disposal container. Flush area with water. Wet area may be slippery. Spread sand/grit.
DISPOSAL INSTRUCTIONS:
Water contaminated with this product may be sent to a sanitary sewer treatment facility,in accordance with any local agreement,a permitted waste treatment facility or discharged under a permit. Product as is - Incinerate or land dispose in an approved landfill.

7) HANDLING AND STORAGE

HANDLING:
Normal chemical handling.
STORAGE:
Keep containers closed when not in use. Do not freeze. If frozen, thaw and mix completely prior to use.

8) EXPOSURE CONTROLS/PERSONAL PROTECTION

EXPOSURE LIMITS

This product is not hazardous as defined by OSHA regulations.

ENGINEERING CONTROLS:
Adequate ventilation.
PERSONAL PROTECTIVE EQUIPMENT:
Use protective equipment in accordance with 29CFR 1910 Subpart I
RESPIRATORY PROTECTION:
A respiratory protection program that meets OSHA's 29 CFR 1910.134 and ANSI Z88.2 requirements must be followed whenever workplace conditions warrant a respirator's use. Use air-purifying respirators within use limitations associated with the equipment or else use supplied air-respirators. If air-purifying respirator use is appropriate, use a respirator with dust/mist filters.
SKIN PROTECTION:
Rubber gloves. Wash off after each use. Replace as necessary.
EYE PROTECTION:
Splash proof chemical goggles.

9) PHYSICAL AND CHEMICAL PROPERTIES

Specific Grav. (70F)	1.125	Vapor Pressure (mmHG)	~ 18.0
Freeze Point (F)	35.00	Vapor Density (air=1)	< 1.00
Viscosity (cps 70F)	1160	% Solubility (water)	100.0

Odor	Mild
Appearance	Red-Brown
Physical State	Liquid
Flash Point (F)	> 200 P-M(CC)
pH As Is (approx.)	2.2
Evaporation Rate (Ether=1)	< 1.00

NA = not applicable ND = not determined

10) STABILITY AND REACTIVITY

STABILITY:
Stable
HAZARDOUS POLYMERIZATION:
Will not occur.
INCOMPATIBILITIES:
May react with strong oxidizers.
DECOMPOSITION PRODUCTS:
Thermal decomposition (destructive fires) yields elemental oxides.
BETZ INTERNAL PUMPOUT/CLEANOUT CATEGORIES:
"A"

11) TOXICOLOGICAL INFORMATION

Oral LD50 RAT:	>5,200 mg/kg
Dermal LD50 RABBIT:	>5,200 mg/kg
Skin Irritation Score RABBIT:	0.17
Eye Irritation Score RABBIT:	6.3

NOTE - 6.3 maximum at 24 hours. Completely reversible at day 7.

Ames Assay BACTERIA:	Negative

NOTE - Negative both with and without metabolic activation.

Non-Ames Mutagenicity MOUSE:	Negative

NOTE - Mouse Micronucleus Cytogenetic Assay

12) ECOLOGICAL INFORMATION

AQUATIC TOXICOLOGY

Fathead Minnow 96 Hour Static Renewal Bioassay

LC50: 2 mg/L
No Effect Level: .6 mg/L

Daphnia magna 48 Hour Static Renewal Bioassay

LC50: 307 mg/L
No Effect Level: 89 mg/L

Ceriodaphnia 48 Hour Static Renewal Bioassay

LC50: 1.7 mg/L
No Effect Level: .63 mg/L

BIODEGRADATION

COD (mg/gm):	440
TOC (mg/gm):	230
BOD-5 (mg/gm):	34
BOD-28 (mg/gm):	60

13) DISPOSAL CONSIDERATIONS

If this undiluted product is discarded as a waste, the US RCRA hazardous waste identification number is :
Not applicable.

Please be advised; however, that state and local requirements for waste disposal may be more restrictive or otherwise different from federal regulations. Consult state and local regulations regarding the proper disposal of this material.

14) TRANSPORT INFORMATION

DOT HAZARD:	Not Applicable
UN / NA NUMBER:	Not applicable
DOT EMERGENCY RESPONSE GUIDE #:	Not applicable

15) REGULATORY INFORMATION

TSCA:
All components of this product are listed in the TSCA inventory.
CERCLA AND/OR SARA REPORTABLE QUANTITY (RQ):
No regulated constituent present at OSHA thresholds
SARA SECTION 312 HAZARD CLASS:
Product is non-hazardous under Section 311/312
SARA SECTION 302 CHEMICALS:
No regulated constituent present at OSHA thresholds
SARA SECTION 313 CHEMICALS:
No regulated constituent present at OSHA thresholds

CALIFORNIA REGULATORY INFORMATION

CALIFORNIA SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT (PROPOSITION 65) CHEMICALS PRESENT:

No regulated constituent present at OSHA thresholds

MICHIGAN REGULATORY INFORMATION

No regulated constituent present at OSHA thresholds

16) OTHER INFORMATION

NFPA/HMIS	CODE TRANSLATION	
Health	2	Moderate Hazard
Fire	1	Slight Hazard
Reactivity	0	Minimal Hazard
Special	NONE	No special Hazard
(1) Protective Equipment	B	Goggles,Gloves

(1) refer to section 8 of MSDS for additional protective equipment recommendations.

CHANGE LOG

	EFFECTIVE DATE	REVISIONS TO SECTION:	SUPERCEDES
MSDS status:	22-AUG-95	REVISED FORMAT	

BETZ MATERIAL SAFETY DATA SHEET

BETZ

EFFECTIVE DATE: 01-NOV-1995
PRINTED DATE: 07-JUN-1996

1) CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME : BETZ ENTEC 690

PRODUCT APPLICATION AREA: FLOCCULANT.

COMPANY ADDRESS:
Betz Water Management Group, Division Betz Laboratories,Inc.
200 Witmer Road Horsham , PA 19044
Information phone number (215) 773-6131

EMERGENCY TELEPHONE (HEALTH/ACCIDENT): (800)-877-1940 (USA)

2) COMPOSITION / INFORMATION ON INGREDIENTS

Information for specific product ingredients as required by the U.S. OSHA HAZARD COMMUNICATION STANDARD is listed. Refer to additional sections of this MSDS for our assessment of the potential hazards of this formulation.

HAZARDOUS INGREDIENTS:

CAS#	CHEMICAL NAME
64742-47-8	ISOPARAFFINIC PETROLEUM DISTILLATE Combustible liquid; irritant
12125-02-9	AMMONIUM CHLORIDE Irritant (eyes)
84133-50-6	ALCOHOLS,C12-14-SECONDARY,ETHOXYLATED Irritant (eyes)

No component is considered to be a carcinogen by the National Toxicology Program, the International Agency for Research on Cancer, or the Occupational Safety and Health Administration at OSHA thresholds for carcinogens.

3) HAZARDS IDENTIFICATION

****

EMERGENCY OVERVIEW

CAUTION

May cause moderate irritation to the skin. May cause dermatitis. May cause moderate irritation to the eyes. Mists/aerosols may cause irritation to upper respiratory tract.

DOT hazard is not applicable
Emergency Response Guide is not applicable
Odor: Slight Hydrocarbon; Appearance: White To Off-White, Emulsion

Fire fighters should wear positive pressure self-contained breathing apparatus(full face-piece type). Proper fire-extinguishing media: Dry chemical, carbon dioxide, foam or water.

****

POTENTIAL HEALTH EFFECTS

ACUTE SKIN EFFECTS:
Primary route of exposure; May cause moderate irritation to the skin. May cause dermatitis.

ACUTE EYE EFFECTS:
May cause moderate irritation to the eyes.

ACUTE RESPIRATORY EFFECTS:
Mists/aerosols may cause irritation to upper respiratory tract.

INGESTION EFFECTS:
May cause gastrointestinal irritation with possible nausea, vomiting, diarrhea, incoordination, mental confusion, dizziness and lethargy.

TARGET ORGANS:
Prolonged or repeated exposures may cause CNS depression and/or defatting-type dermatitis.

MEDICAL CONDITIONS AGGRAVATED:
Not known.

SYMPTOMS OF EXPOSURE:
May cause redness or itching of skin.

4) FIRST AID MEASURES

SKIN CONTACT:
Remove contaminated clothing. Wash exposed area with a large quantity of soap solution or water for 15 minutes.
EYE CONTACT:
Immediately flush eyes with water for 15 minutes. Immediately contact a physician for additional treatment.
INHALATION:
Remove victim from contaminated area to fresh air. Apply appropriate first aid treatment as necessary.
INGESTION:
Do not feed anything by mouth to an unconscious or convulsive victim. Do not induce vomiting. Immediately contact physician. Dilute contents of stomach using 3-4 glasses milk or water.

5) FIRE FIGHTING MEASURES

FIRE FIGHTING INSTRUCTIONS:
Fire fighters should wear positive pressure self-contained breathing apparatus (full face-piece type).
EXTINGUISHING MEDIA:
Dry chemical, carbon dioxide, foam or water.
HAZARDOUS DECOMPOSITION PRODUCTS:
Thermal decomposition (destructive fires) yields elemental oxides.
FLASH POINT:
> 200F P-M(CC)

6) ACCIDENTAL RELEASE MEASURES

PROTECTION AND SPILL CONTAINMENT:
Ventilate area. Use specified protective equipment. Contain and absorb on absorbent material. Place in waste disposal container. Flush area with water. Wet area may be slippery. Spread sand/grit.
DISPOSAL INSTRUCTIONS:
Water contaminated with this product may be sent to a sanitary sewer treatment facility,in accordance with any local agreement,a permitted waste treatment facility or discharged under a permit. Product as is - Incinerate or land dispose in an approved landfill.

7) HANDLING AND STORAGE

HANDLING:
Normal chemical handling.
STORAGE:
Keep containers closed when not in use. Protect from freezing. Product forms an unusable solid that can not be thawed, even at room temperature, if subjected to freezing conditions.

8) EXPOSURE CONTROLS/PERSONAL PROTECTION

EXPOSURE LIMITS

CHEMICAL NAME

ISOPARAFFINIC PETROLEUM DISTILLATE
PEL (OSHA): 400 PPM
TLV (ACGIH): NOT DETERMINED

AMMONIUM CHLORIDE
PEL (OSHA): NOT DETERMINED
TLV (ACGIH): 10 MG/M3; STEL-20MG/M3 (AS FUME)

ALCOHOLS,C12-14-SECONDARY,ETHOXYLATED
PEL (OSHA): NOT DETERMINED
TLV (ACGIH): NOT DETERMINED

ENGINEERING CONTROLS:
Adequate ventilation to maintain air contaminants below exposure limits.

PERSONAL PROTECTIVE EQUIPMENT:
Use protective equipment in accordance with 29 CFR 19 10 Subpart I

RESPIRATORY PROTECTION:
A respiratory protection program that meets OSHA's 29 CFR 1910.134 and ANSI Z88.2 requirements must be followed whenever workplace conditions warrant a respirator's use. Use air-purifying respirators within use limitations associated with the equipment or else use supplied air-respirators. If air-purifying respirator use is appropriate, Use a respirator with organic vapor cartridges.

SKIN PROTECTION:
Nitrile gloves. Wash off after each use. Replace as necessary.

EYE PROTECTION:
splash proof chemical goggles

9) PHYSICAL AND CHEMICAL PROPERTIES

Specific Grav. (70F)	1.025	Vapor Pressure (mmHG)	~ 18.0
Freeze Point (F)	< 23.00	Vapor Density (air=1)	> 1.00
Viscosity (cps 70F)	2400	% Solubility (water)	1.0

Odor	Slight Hydrocarbon
Appearance	White To Off-White
Physical State	Emulsion
Flash Point (F)	> 200 P-M(CC)
pH 0.5% Sol. (approx.)	4.1
Evaporation Rate (Ether=1)	< 1.00

NA = not applicable ND = not determined

15) REGULATORY INFORMATION

TSCA:
All components of this product are listed in the TSCA inventory.
CERCLA AND/OR SARA REPORTABLE QUANTITY (RQ):
Treat as oil spill
SARA SECTION 312 HAZARD CLASS:
Immediate(acute);Delayed(Chronic)
SARA SECTION 302 CHEMICALS:
No regulated constituent present at OSHA thresholds
SARA SECTION 313 CHEMICALS:
No regulated constituent present at OSHA thresholds

CALIFORNIA REGULATORY INFORMATION

CALIFORNIA SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT (PROPOSITION 65) CHEMICALS PRESENT:

No regulated constituent present at OSHA thresholds

MICHIGAN REGULATORY INFORMATION

No regulated constituent present at OSHA thresholds

16) OTHER INFORMATION

NFPA/HMIS	CODE	TRANSLATION
Health	2	Moderate Hazard
Fire	1	Slight Hazard
Reactivity	0	Minimal Hazard
Special	NONE	No special Hazard
(1) Protective Equipment	B	Goggles,Gloves

(1) refer to section 8 of MSDS for additional protective equipment recommendations.

CHANGE LOG

	EFFECTIVE DATE	REVISIONS TO SECTION:	SUPERCEDES
MSDS status:	01-NOV-95		** NEW **

10) STABILITY AND REACTIVITY

STABILITY:
Stable
HAZARDOUS POLYMERIZATION:
Will not occur.
INCOMPATIBILITIES:
May react with strong oxidizers.
DECOMPOSITION PRODUCTS:
Thermal decomposition (destructive fires) yields elemental oxides.
BETZ INTERNAL PUMPOUT/CLEANOUT CATEGORIES:
"B"

11) TOXICOLOGICAL INFORMATION

Oral LD50 RAT:	>2,000 mg/kg
NOTE - Estimated value	
Dermal LD50 RABBIT:	>2,000 mg/kg
NOTE - Estimated value	

12) ECOLOGICAL INFORMATION

AQUATIC TOXICOLOGY
No Data Available.

BIODEGRADATION

No Data Available.

13) DISPOSAL CONSIDERATIONS

If this undiluted product is discarded as a waste, the US RCRA hazardous waste identification number is :
Not applicable.

Please be advised; however, that state and local requirements for waste disposal may be more restrictive or otherwise different from federal regulations. Consult state and local regulations regarding the proper disposal of this material.

14) TRANSPORT INFORMATION

DOT HAZARD:	Not Applicable
UN / NA NUMBER:	Not applicable
DOT EMERGENCY RESPONSE GUIDE #:	Not applicable

MATERIAL SAFETY DATA SHEET

DATE August 1985

CALGON
CALGON CARBON CORPORATION

PRODUCT NAME OL ACTIVATED CARBON

SECTION I

MANUFACTURER'S NAME	Calgon Carbon Corporation	EMERGENCY TELEPHONE NO.	412-787-6700
ADDRESS	P.O. Box 717 Pittsburgh, PA 15230-0717		
CHEMICAL NAME AND SYNONYMS	Carbon	FORMULA	C

SECTION II HAZARDOUS INGREDIENTS

PRINCIPAL HAZARDOUS COMPONENT (S)	CAS #	% BY WEIGHT	ORAL LD_{50}	DERMAL LD_{50}	TLV (Units) ACGIH	OSHA	OTHER
Chemical Name: Carbon Common Name: Activated Carbon	7440-44-0	100%	>10g/Kg* (rat)	--	N/A	N/A	N/A
Chemical Name Common Name							
Chemical Name Common Name							
Chemical Name Common Name							
Chemical Name Common Name							

*No animal mortalities during course of 14-day study.

CAUTION!! Wet activated carbon removes oxygen from air causing a severe hazard to workers inside carbon vessels and enclosed or confined spaces. Before entering such an area, sampling and work procedures for low oxygen levels should be taken to ensure ample oxygen availability, observing all local, state, and federal regulations.

This product is non-hazardous according to the definitions for "health hazard" and "physical hazard" provided in the OSHA Hazard Communication Law (29 CFR part 1910).

SECTION III PHYSICAL DATA

BOILING POINT (° F)	N/A	SPECIFIC GRAVITY (H_2O=1)	2.3g/cc real density
VAPOR PRESSURE (mmHg.)	N/A	PERCENT VOLATILE BY VOLUME (%)	N/A
VAPOR DENSITY (AIR=1)	N/A	pH	N/A
SOLUBILITY IN WATER	insoluble	OTHER packing density	0.4 to 0.7g/cc

APPEARANCE AND ODOR black particulate solid

While this information and recommendations set forth herein are believed to be accurate as of the date hereof, CALGON CARBON CORPORATION MAKES NO WARRANTY WITH RESPECT HERETO AND DISCLAIMS ALL LIABILITY FROM RELIANCE THEREON.

STABILITY	STABLE	X	CONDITIONS TO AVOID	None
	UNSTABLE			

INCOMPATABILITY (Materials to Avoid) Strong oxidizers such as ozone, liquid oxygen, chlorine, permanganate, etc.

RDOUS DECOMPOSITION UCTS

Carbon monoxide may be generated in the event of fire.

SECTION VII SPILL OR LEAK PROCEDURES

REPORTABLE QUANTITIES (RQ) IN LBS OF EPA HAZARDOUS SUBSTANCES IN PRODUCT

1. N/A
2. _____
3. _____

NOTIFY EPA OF PRODUCT SPILLS EQUAL TO OR EXCEEDING N/A LBS.

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED

Sweep up unused carbon and discard in refuse container or repackage.

WASTE DISPOSAL METHOD

Dispose of unused carbon in refuse container. Dispose of in accordance with local, state, and federal regulations.

SECTION VIII HANDLING & STORAGE

PROTECTIVE GLOVES	EYE PROTECTION
Rubber gloves recommended	Safety glasses or goggles recommended

OTHER PROTECTIVE CLOTHING Not required

RATORY PROTECTION A NIOSH approved particulate filter respirator is recommended if excessive dust is generated.

VENTILATION	LOCAL EXHAUST	OTHER
	Recommended	
	MECHANICAL (General) Recommended	

STORAGE & HANDLING

CAUTION!! Wet activated carbon removes oxygen from air causing a severe hazard to workers inside carbon vessels and enclosed or confined spaces. Before entering such an area, sampling and work procedures for low oxygen levels should be taken to ensure ample oxygen availability, observing all local, state, and federal regulations.

OTHER PRECAUTIONS

Wash thoroughly after handling. Exercise caution in the storage and handling of all chemical substances.

PREPARED BY S. D. Cifrulak

SECTION IV FIRE AND EXPLOSION HAZARD DATA

(Method Used) N/A

GUISHING MEDIA: If involved in fire, flood with plenty of water.

CIAL FIRE FIGHTING PROCEDURES: None

UNUSUAL FIRE AND EXPLOSION HAZARDS: Contact with strong oxidizers such as ozone, liquid oxygen, chlorine, permanganate, etc. may result in fire.

SECTION V HEALTH HAZARD DATA

EFFECT OF OVEREXPOSURE

A. ACUTE

1. INGESTION

The product is non-toxic through ingestion. The acute oral LD_{50} (rat) is >10g/Kg.

2. INHALATION

The acute inhalation LC_{50} (rat) is >64.4 mg/ℓ (nominal concentration) for activated carbon.

3. DERMAL EXPOSURE

a. TOXIC

Non-toxic

b. IRRITATION

The product is not a primary skin irritant. The primary skin irritation index (rabbit) is 0.

c. SENSITIZATION

None

Material Safety Data Sheet

May be used to comply with OSHA's Hazard Communication Standard, 29 CFR 1910.1200. Standard must be consulted for specific requirements.

U.S. Department of Labor
Occupational Safety and Health Administration
(Non-Mandatory Form)
Form Approved
OMB No. 1218-0072

IDENTITY (As Used on Label and List)

Note: Blank spaces are not permitted. If any item is not applicable, or no information is available, the space must be marked to indicate that.

Section I

Manufacturer's Name: Down East Chemical Co.	Emergency Telephone Number: 919-448-3781 or 919-577-2345
Address (Number, Street, City, State, and ZIP Code): P.O. Box 926, Jacksonville, N.C. 28540	Telephone Number for Information: 910-347-2424
	Date Prepared: January 2, 1990
	Signature of Preparer (optional)

Section II — Hazardous Ingredients/Identity Information

Hazardous Components (Specific Chemical Identity; Common Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% (optional)
Surfactant- NP-9 (not hazardous) nonylphenol polyethylene glyiolether				
Poly Tangent B 500 (not hazardous) nonylphenoxyepoxethoxy ethenol				
water				
Acid Blue #9 Dye (non hazardous) ammomium, (Ethyl 4- Dethyl) M-Sulfobenzyl Aminoalpha, O-Sulfoshina-benzylidene-2, 5, Cyclohexodien, 1-Ylidine,M-Sulfonyl, Hydroxide, inner salt, diamnium, salt CI Acid #9				
Case reg. #3844-45-9				
Bubble gum, cherry or floral fragrance-not applicable				
Industmial cherry, bubble gum orfloral				

Section III — Physical/Chemical Characteristics

Boiling Point: 100 Degrees F		Specific Gravity (H_2O = 1): 1.025	
Vapor Pressure (mm Hg.): 76 Degrees		Melting Point: 06 degrees F	
Vapor Density (AIR = 1): 1.15		Evaporation Rate (Butyl Acetate = 1): 1.1	
Solubility in Water: 100%			

Appearance and Odor: Blue, Cherry, bubble gum or floral

Section IV — Fire and Explosion Hazard Data

Flash Point (Method Used)	Flammable Limits	LEL	UEL
not applicable	non-flamable		

Extinguishing Media: not applicable

Special Fire Fighting Procedures: not applicable

Unusual Fire and Explosion Hazards: none

(Reproduce locally)

OSHA 174, Sept. 1985

Marathon Oil Company

MATERIAL SAFETY DATA SHEET PAGE 1 OF

PRODUCT NAME: PREMIUM UNLEADED GASOLINE
MARATHON MSDS NO: 114MAR001

THE FOLLOWING INFORMATION IS FURNISHED SUBJECT TO THE DISCLAIMER ON THE BOTTOM OF THIS FO

SECTION 1 - PRODUCT IDENTIFICATION

PRODUCT NAME: PREMIUM UNLEADED GASOLINE

SYNONYMS:
GASOLINE, PREMIUM UNLEADED; PREMIUM UNLEADED GASOLINE; SUPER UNLEADED GASOLINE; SUPER-M LEAD FREE GASOLINE

MANUFACTURER / DISTRIBUTOR:
MARATHON OIL COMPANY
539 SOUTH MAIN STREET
FINDLAY, OH
45840
EMERGENCY PHONE NUMBERS:
(419) 422-2121 (MARATHON)
(800) 424-9300 (CHEMTREC)

CHEMICAL FAMILY: PETROLEUM HYDROCARBON
CHEMICAL FORMULA: MIXTURE
CAS NO: MIXTURE
PRODUCT CODE:

SECTION 2 - PHYSICAL PROPERTIES

BOILING POINT	MELTING POINT	SPECIFIC GRAVITY(H2O=1)
90-437 F	N.A. F	0.71-0.77
% SOLUBILITY IN WATER	VAPOR DENSITY(AIR=1)	VAPOR PRESSURE
NEGLIGIBLE	3-4	414-776 MM HG @ 100F

PH INFORMATION: PH: N.A. AT CONC.
APPEARANCE: RED OR CLEAR LIQUID ODOR: GASOLINE ODOR

SECTION 3 - FIRE AND EXPLOSION HAZARD DATA

FLASH POINT	AUTOIGNITION TEMP	EXPLOSIVE LIMITS (% BY VOLUME IN AIR)
-50 F	C.A. 495 F	LOWER/UPPER: 1.4/ 7.6

NFPA CLASSIFICATION: HEALTH: 2 FIRE: 4 REACTIVITY: 1 OTHER:

EXTINGUISHING MEDIA:

CLASS B FIRE EXTINGUISHING MEDIA SUCH AS HALON, CO2, OR DRY CHEMICAL CAN BE USED. FIRE FIGHTING SHOULD BE ATTEMPTED ONLY BY THOSE WHO ARE ADEQUATELY TRAINED.

SPECIAL FIRE FIGHTING INSTRUCTIONS:

FLASHBACK MAY OCCUR ALONG VAPOR TRAIL. AVOID USE OF SOLID WATER STREAMS. WATER MAY BE INEFFECTIVE IN EXTINGUISHING LOW FLASH POINT FIRES, BUT CAN BE USED TO COOL EXPOSED SURFACES. AVOID EXCESSIVE WATER SPRAY APPLICATION.

SECTION 3 - FIRE AND EXPLOSION HAZARD DATA (CON'T)

STABILITY: THE MATERIAL IS STABLE AT 70 F, 760MM PRESSURE
CONDITIONS TO AVOID:

HAZARDOUS DECOMPOSITION PRODUCTS:
CARBON MONOXIDE, ALDEHYDES, AROMATIC HYDROCARBONS

INCOMPATIBLE MATERIALS:
STRONG OXIDIZERS

HAZARDOUS POLYMERIZATION: WILL NOT OCCUR

SECTION 4 - PRODUCT COMPOSITION AND EXPOSURE LIMITS

EXPOSURE LIMITS FOR PRODUCT:	TLV			SOURCE
PREMIUM UNLEADED GASOLINE	300.00	PPM	(8 HR TWA)	ACGIH
	500.00	PPM	(STEL)	ACGIH
	300.00	PPM	(8 HR TWA)	OSHA
	500.00	PPM	(STEL)	OSHA

COMPONENTS:	PERCENT RANGE	TLV			SOURCE
SATURATED HYDROCARBONS (PARAFFINS & CYCLOPARAFFINS)	55.00- 70.00	0.00		( )	
UNSATURATED HYDROCARBONS (OLEFINS)	1.00- 10.00	0.00		( )	
AROMATIC HYDROCARBONS (INCLUDING BENZENE, TOLUENE, XYLENES, ETHYLBENZENE AND TRIMETHYL BENZENES)	20.00- 40.00	0.00		( )	
ETHYL BENZENE	1.00- 3.00	100.00	PPM	(8 HR TWA)	ACGIH
		125.00	PPM	(STEL)	ACGIH
		100.00	PPM	(8 HR TWA)	OSHA
		125.00	PPM	(STEL)	OSHA
1,2,4-TRIMETHYLBENZENE	2.00- 5.00	25.00	PPM	(8 HR TWA)	ACGIH
		25.00	PPM	(8 HR TWA)	OSHA
TOLUENE	3.00- 15.00	100.00	PPM	(8 HR TWA)	ACGIH
		150.00	PPM	(STEL)	ACGIH
		100.00	PPM	(8 HR TWA)	OSHA
		150.00	PPM	(STEL)	OSHA
XYLENE	5.00- 15.00	100.00	PPM	(8 HR TWA)	ACGIH
		150.00	PPM	(STEL)	ACGIH
		100.00	PPM	(8 HR TWA)	OSHA
		150.00	PPM	(STEL)	OSHA

SECTION 6 - SPECIAL PROTECTION INFORMATION (CON'T)

RESPIRATORY PROTECTION:

APPROVED ORGANIC VAPOR CHEMICAL CARTRIDGE OR SUPPLIED AIR RESPIRATORS SHOULD BE WORN FOR EXPOSURES EXCEEDING THE TLV OR STEL. OBSERVE RESPIRATOR PROTECTION FACTOR CRITERIA CITED IN ANSI Z88.2 (1980). SELF-CONTAINED BREATHING APPARATUS SHOULD BE USED FOR FIRE FIGHTING.

PROTECTIVE GLOVES:

NEOPRENE, NITRILE, VITON OR PVA GLOVES FOR REPEATED OR PROLONGED SKIN EXPOSURE.

OTHER PROTECTIVE EQUIPMENT:

USE EXPLOSION-PROOF EQUIPMENT.

SECTION 7 - SPILL OR LEAK PROCEDURES

ENVIRONMENTAL EFFECTS:

LIQUID CAN BE TOXIC TO AQUATIC LIFE.

STEPS TO BE TAKEN IN CASE OF SPILL, LEAK OR RELEASE:

KEEP PUBLIC AWAY. SHUT OFF SOURCE OF LEAK IF POSSIBLE TO DO SO WITHOUT HAZARD. ELIMINATE ALL IGNITION SOURCES. ADVISE NATIONAL RESPONSE CENTER (800-424-8802) IF PRODUCT HAS ENTERED A WATER COURSE. ADVISE LOCAL AND STATE EMERGENCY SERVICES AGENCIES, IF APPROPRIATE. CONTAIN LIQUID WITH SAND OR SOIL. RECOVER AND RETURN FREE LIQUID TO SOURCE. USE SUITABLE SORBENTS TO CLEAN UP RESIDUAL LIQUID.

WASTE DISPOSAL METHOD:

DISPOSE OF CLEANUP MATERIALS IN ACCORDANCE WITH APPLICABLE LOCAL, STATE AND FEDERAL REGULATIONS.

SECTION 8 - HANDLING AND STORAGE PRECAUTIONS

PRODUCT SHOULD BE HANDLED AND STORED IN ACCORDANCE WITH INDUSTRY ACCEPTED PRACTICES. IN THE ABSENCE OF SPECIFIC LOCAL CODE REQUIREMENTS, NFPA OR OSHA REQUIREMENTS SHOULD BE FOLLOWED. USE APPROPRIATE GROUNDING AND BONDING PRACTICES. STORE IN PROPERLY CLOSED CONTAINERS THAT ARE APPROPRIATELY LABELED. DO NOT EXPOSE TO HEAT, OPEN FLAME, OXIDIZERS OR OTHER SOURCES OF IGNITION. AVOID SKIN CONTACT. EXERCISE GOOD PERSONAL HYGIENE INCLUDING REMOVAL OF SOILED CLOTHING AND PROMPT WASHING WITH SOAP AND WATER.

SECTION 5 - POTENTIAL HEALTH EFFECTS (CON'T)

ADDITIONAL TOXICITY INFORMATION:

TWO YEAR INHALATION TOXICITY STUDIES WITH FULLY VAPORIZED GASOLINE (67, 292 & 2056 PPM) PRODUCED KIDNEY DAMAGE AND KIDNEY TUMORS IN MALE RATS BUT NOT IN FEMALE RATS OR MALE AND FEMALE MICE. FEMALE MICE DEVELOPED A SLIGHTLY HIGHER INCIDENCE OF LIVER TUMORS COMPARED TO CONTROLS AT THE HIGHEST EXPOSURE LEVEL. RESULTS FROM SUBSEQUENT SCIENTIFIC STUDIES SUGGEST THAT THE KIDNEY DAMAGE AND PROBABLY THE KIDNEY TUMOR RESPONSE ARE UNIQUE TO THE MALE RAT. THE BIOLOGIC SIGNIFICANCE OF THE MOUSE LIVER TUMOR RESPONSE IN TERMS OF HUMAN HEALTH IS QUESTIONABLE.

REPEATED OR PROLONGED EXPOSURE TO BENZENE EVEN AT RELATIVELY LOW CONCENTRATIONS MAY CAUSE SERIOUS INJURY TO BLOOD-FORMING ORGANS. SIGNIFICANT CHRONIC EXPOSURE TO BENZENE VAPOR HAS BEEN REPORTED TO PRODUCE VARIOUS BLOOD DISORDERS, RANGING FROM ANEMIA TO LEUKEMIA (CANCER) IN MAN. BENZENE PRODUCED TUMORS IN RATS AND MICE IN LIFETIME CHRONIC TOXICITY STUDIES, BUT THE RESPONSE HAS NOT BEEN CONSISTENT ACROSS SPECIES, STRAIN, SEX OR ROUTE OF EXPOSURE. ANIMAL STUDIES ON BENZENE HAVE DEMONSTRATED IMMUNE TOXICITY, TESTICULAR EFFECTS AND ALTERATIONS IN REPRODUCTIVE CYCLES, EVIDENCE OF CHROMOSOMAL DAMAGE OR OTHER CHROMOSOMAL CHANGES, AND EMBRYO/FETOTOXICITY, BUT NOT TERATOGENICITY.

EMERGENCY FIRST AID PROCEDURES

EYE:

FLUSH EYES WITH LARGE AMOUNTS OF WATER FOR AT LEAST 15 MINUTES. IF SYMPTOMS OR IRRITATION OCCUR, CALL A PHYSICIAN.

SKIN:

WASH WITH SOAP AND LARGE AMOUNTS OF WATER. REMOVE CONTAMINATED CLOTHING. IF SYMPTOMS OR IRRITATION OCCUR, CALL A PHYSICIAN.

INHALATION:

MOVE PERSON TO FRESH AIR. IF NOT BREATHING OR IF NO HEARTBEAT, GIVE ARTIFICIAL RESPIRATION OR CARDIOPULMONARY RESUSCITATION (CPR). IMMEDIATELY CALL A PHYSICIAN.

INGESTION:

DO NOT INDUCE VOMITING. DO NOT GIVE LIQUIDS. IMMEDIATELY CALL A PHYSICIAN.

SECTION 6 - SPECIAL PROTECTION INFORMATION

VENTILATION:

LOCAL OR GENERAL EXHAUST REQUIRED IN ENCLOSED AREAS OR WITH INADEQUATE VENTILATION.

PRODUCT NAME: PREMIUM UNLEADED GASOLINE
MARATHON MSDS NO: 114MAR001

SECTION 4 - PRODUCT COMPOSITION AND EXPOSURE LIMITS (CON'T)

COMPONENTS:	PERCENT RANGE	TLV			SOURCE
METHYL TERTIARY BUTYL ETHER	.01- 15.00	0.00		( )	
BENZENE	.50- 3.50	10.00	PPM	(8 HR TWA)	ACGIH
		1.00	PPM	(8 HR TWA)	OSHA
		5.00	PPM	(STEL)	OSHA

OSHA ACTION LEVEL 0.50 PPM (8 HR TWA)

***
COMPLEX MIXTURE OF PARAFFINIC, CYCLOPARAFFINIC, OLEFINIC AND AROMATIC HYDROCARBONS (PREDOMINANTLY C4-C12).
***
CONTAINS SMALL AMOUNTS OF DYE AND OTHER ADDITIVES (<0.02%) WHICH ARE NOT CONSIDERED HAZARDOUS AT THE CONCENTRATIONS USED.

SECTION 5 - POTENTIAL HEALTH EFFECTS

EYE:

EYE IRRITATION MAY RESULT FROM CONTACT WITH THE LIQUID OR EXPOSURE TO VAPOR CONCENTRATIONS ABOVE THE TLV.

SKIN:

PROLONGED OR REPEATED LIQUID CONTACT CAN DEFAT THE SKIN AND LEAD TO IRRITATION AND/OR DERMATITIS.

INHALATION:

EXPOSURE TO VAPOR CONCENTRATIONS EXCEEDING 1000 PPM CAN CAUSE RESPIRATORY IRRITATION, HEADACHE, DIZZINESS, NAUSEA AND LOSS OF COORDINATION. HIGHER CONCENTRATIONS MAY CAUSE LOSS OF CONSCIOUSNESS, CARDIAC SENSITIZATION, COMA AND DEATH RESULTING FROM RESPIRATORY FAILURE.

INGESTION:

INGESTION MAY RESULT IN NAUSEA, VOMITING, DIARRHEA AND RESTLESSNESS. ASPIRATION (BREATHING) OF VOMITUS INTO THE LUNGS MUST BE AVOIDED AS EVEN SMALL QUANTITIES IN THE LUNGS CAN PRODUCE CHEMICAL PNEUMONITIS AND PULMONARY EDEMA/HEMORRHAGE.

PRODUCT NAME: PREMIUM UNLEADED GASOLINE
MARATHON MSDS NO: 114MAR001

SECTION 9 - HAZARD WARNING

DANGER!

EXTREMELY FLAMMABLE

HARMFUL OR FATAL IF SWALLOWED

CONTAINS BENZENE WHICH MAY CAUSE
CANCER OR BE TOXIC TO BLOOD-FORMING ORGANS.

SECTION 10 - COMMENTS.

Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8854

Material Safety Data Sheets Collection:

Sheet No. 470
Diesel Fuel Oil No. 2-D

Issued: 10/81 Revision: A, 11/90

Section 1. Material Identification

Diesel Fuel Oil No. 2-D Description: Diesel fuel is obtained from the middle distillate in petroleum separation; a distillate oil of low sulfur content. It is composed chiefly of unbranched paraffins. Diesel fuel is available in various grades, one of which is synonymous with fuel oil No. 2-D. This diesel fuel oil requires a minimum Cetane No. (efficiency rating for diesel fuel comparable to octane number ratings for gasoline) of 40 (ASTM D613). Used as a fuel for trucks, ships, and other automotive engines; as mosquito control (coating on breeding waters); and for drilling muds.

Other Designations: CAS No. 68334-30-5, diesel fuel.

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*™ for a suppliers list.

Cautions: Diesel fuel oil No. 2-D is a skin irritant and central nervous depressant with high mist concentrations. It is an environmental hazard and moderate fire risk.

NFPA: R 1, I -, S 2, K 2

HMIS: H, F, R, PPG * Sec.

Section 2. Ingredients and Occupational Exposure Limits

Diesel fuel oil No. 2-D*

1989 OSHA PEL	1990-91 ACGIH TLV	1988 NIOSH REL	1985-86 Toxicity Data‡
None established	Mineral Oil Mist TWA: 5 mg/m³† STEL: 10 mg/m³	None established	Rat, oral, LD_{50}: 9 g/kg produces gastrointestinal (hypermotility, diarrh effects

* Diesel fuel No. 2-D tends to be low in aromatics and high in paraffinics. This fuel oil is complex mixture of: 1) >95% paraffinic, olefinic, naphthenic, and aromatic hydrocarbons, 2) sulfur (<0.5%), and 3) benzene (<100 ppm). [A low benzene level reduces carcinogenic risk. Fuel oils can be exempted under the benzene standard (29 CFR 1910.1028)]. Although low in the fuel itself, benzene concentrations are likely to be much higher in processing areas.
† As sampled by nonvapor-collecting method.
‡ Monitor NIOSH, *RTECS* (HZ1800000), for future toxicity data.

Section 3. Physical Data

Boiling Point Range: 340 to 675 °F (171 to 358 °C)
Viscosity: 1.9 to 4.1 centistoke at 104 °F (40 °C)
Specific Gravity: <0.86
Water Solubility: Insoluble

Appearance and Odor: Brown, slightly viscous liquid.

Section 4. Fire and Explosion Data

Flash Point: 125 °F (52 °C) min. | **Autoignition Temperature:** >500 °F (932 °C) | **LEL:** 0.6% v/v | **UEL:** 7.5% v/v

Extinguishing Media: Use dry chemical, carbon dioxide, or foam to fight fire. Use a water spray to cool fire exposed containers. Do not use a forced water spray directly on burning oil since this will scatter the fire. Use a smothering technique for extinguishing fire.

Unusual Fire or Explosion Hazards: Diesel fuel oil No. 2-D is a OSHA Class II combustible liquid. Its volatility is similar to that of gas oil. Vapors may travel to a source of ignition and flash back.

Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and full protective clothing. If feasible, remove containers from fire. Be aware of runoff from fire control methods. Do not release to sewers or waterways due to pollution and fire or explosion hazard.

Section 5. Reactivity Data

Stability/Polymerization: Diesel fuel oil No. 2-D is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.

Chemical Incompatibilities: It is incompatible with strong oxidizing agents; heating greatly increases the fire hazard.

Conditions to Avoid: Avoid heat and ignition sources.

Hazardous Products of Decomposition: Thermal oxidative decomposition of diesel fuel oil No. 2-D can produce various hydrocarbons and hydrocarbon derivatives, and other partial oxidation products such as carbon dioxide, carbon monoxide, and sulfur dioxide.

Section 6. Health Hazard Data

Carcinogenicity: Although the IARC has not assigned an overall evaluation to diesel fuels as a group, it has evaluated occupational exposures in petroleum refining as an IARC probable human carcinogen (Group 2A). It has evaluated distillate (light) diesel oils as not classifiable as human carcinogens (Group 3).

Summary of Risks: Although diesel fuel's toxicologic effects should resemble kerosine's, they are somewhat more pronounced due to additives such as sulfurized esters. Excessive inhalation of aerosol or mist can cause respiratory tract irritation, headache, dizziness, nausea, vomiting, and loss of coordination, depending on concentration and exposure time. When removed from exposure area, affected persons usually recover completely. If vomiting occurs after ingestion and if oil is aspirated into the lungs, hemorrhaging and pulmonary edema, progressing to renal involvement and chemical pneumonitis, may result. A comparative ratio of oral to aspirated lethal doses may be 1 pt vs. 5 ml. Aspiration may also result in transient CNS depression or excitement. Secondary effects may include hypoxia (insufficient oxygen in body cells), infection, pneumatocele formation, and chronic lung dysfunction. Inhalation may result in euphoria, cardiac dysrhythmias, respiratory arrest, and CNS toxicity. Prolonged or repeated skin contact may irritate hair follicles and block sebaceous glands, producing a rash of acne pimples and spots, usually on arms and legs.

Medical Conditions Aggravated by Long-Term Exposure: None reported.

Target Organs: Central nervous system, skin, and mucous membranes.

Primary Entry Routes: Inhalation, ingestion.

Acute Effects: Systemic effects from ingestion include gastrointestinal irritation, vomiting, diarrhea, and in severe cases central nervous system depression, progressing to coma or death. Inhalation of aerosols or mists may result in increased rate of respiration, tachycardia (excessively rapid heart beat), and cyanosis (dark purplish discoloration of the skin and mucous membranes caused by deficient blood oxygenation).

Chronic Effects: Repeated contact with the skin causes dermatitis.

FIRST AID

Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.

Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. If large areas of the body have been exposed or if irritation persists, get medical help immediately. Wash affected area with soap and water.

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, *do not induce vomiting* due to aspiration hazard. Contact a physician immediately. Position to avoid aspiration.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Gastric lavage is contraindicated due to aspiration hazard. Preferred antidotes are charcoal and milk. In cases of severe aspiration pneumonitis, consider monitoring arterial blood gases to ensure adequate ventilation. Observe the patient for 6 hr. If vital signs become abnormal or symptoms develop, obtain a chest x-ray.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, evacuate area for large spills, remove all heat and ignition sources, and provide maximum explosion-proof ventilation. Cleanup personnel should protect against vapor inhalation and liquid contact. Clean up spills promptly to reduce fire or vapor hazards. Use a noncombustible absorbent material to pick up small spills or residues. For large spills, dike far ahead to contain. Pick up liquid for reclamation or disposal. Do not release to sewers or waterways due to health and fire and/or explosion hazard. Follow applicable OSHA regulations (29 CFR 1910.120). Diesel fuel oil No. 2-D spills may be environmental hazards. Report large spills.

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

RCRA Hazardous Waste (40 CFR 261.21): Ignitable waste

CERCLA Hazardous Substance (40 CFR 302.4): Not listed

SARA Extremely Hazardous Substance (40 CFR 355): Not listed

SARA Toxic Chemical (40 CFR 372.65): Not listed

OSHA Designations

Air Contaminant (29 CFR 1910.1000, Subpart Z): Not listed

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).

Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, use a NIOSH-approved respirator with a mist filter and organic vapor cartridge. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*

Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.

Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations that promote worker safety and productivity. Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[107]

Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Use and storage conditions should be suitable for a OSHA Class II combustible liquid. Store in closed containers in a well-ventilated area away from heat and ignition sources and strong oxidizing agents. Protect containers from physical damage. To prevent static sparks, electrically ground and bond all containers and equipment used in shipping, receiving, or transferring operations. Use nonsparking tools and explosion-proof electrical equipment. No smoking in storage or use areas.

Engineering Controls: Avoid vapor or mist inhalation and prolonged skin contact. Wear protective rubber gloves and chemical safety glasses where contact with liquid or high mist concentration may occur. Additional suitable protective clothing may be required depending on working conditions. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Practice good personal hygiene and housekeeping procedures. Do not wear oil contaminated clothing. At least weekly laundering of work clothes is recommended. Do not put oily rags in pockets. When working with this material, wear gloves or use barrier cream.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Fuel oil

DOT Hazard Class: Combustible liquid

ID No.: NA1993

DOT Label: None

DOT Packaging Exceptions: 173.118a

DOT Packaging Requirements: None

MSDS Collection **References:** 1, 6, 7, 12, 73, 84, 101, 103, 126, 127, 132, 133, 136, 143, 146

Prepared by: MJ Allison, BS; Industrial Hygiene Review: DJ Wilson, CIH; Medical Review: AC Darlington, MD; Edited by: JR Stuart, MS

STANDARD OPERATING PROCEDURES

1. OBJECTIVE

OHM Remediation Services Corp. (OHM) personnel performing work on electrical systems and equipment will follow standards set by the National Electrical Code (NEC) and OSHA in selection of materials and methods of installation and maintenance. Only qualified personnel will work on electrical systems and equipment.

2. PURPOSE

This procedure specifies the requirements for electrical equipment and methods and is an overview of the requirements of 29 CFR 1910, Subpart S-Electrical. If work is to be performed on any electrical circuit, lockout/tagout may be required. Refer to the Lockout/Tagout procedure.

3. GENERAL REQUIREMENTS

3.1 No electrical work should be done on an energized circuit.

3.2 Only approved electricians will be permitted to work on electrical equipment or permanent electrical wiring.

3.3 Use proper clearance and grounding procedures. All electrical circuits and equipment shall be de-energized and lockout/tagout accomplished before maintenance or repair work is started.

3.4 Single-phase electric hand tools and other single-phase portable electrical equipment must be approved by a recognized testing agency, and all exposed non-current-carrying metal parts must be grounded, or be double insulated.

3.5 Before each use, portable electrical appliances are to be examined for obvious deficiencies in the appliance, cord, and plug. If any deficiency is noted, the appliance is not to be used.

3.6. Extension cords are to be kept clean, dry, free of kinks, and protected from oil, hot or sharp surfaces, and chemicals. Extension cords used outdoors shall be Ground Fault Circuit Interrupter (GFCI) protected. All extension cords shall be free from damage and are not to be placed across aisles, through doors, through holes in a wall, or in areas where the cord may be damaged or become a tripping hazard. Extension cords must not be placed in walkways, or on stairs or steps where the cords may pose a tripping hazard.

4. PORTABLE ELECTRICAL EQUIPMENT

4.1 Double insulated portable industrial type electric tools meeting the requirements of the Underwriters Laboratory are authorized for use (ground wire not required). Where such a system is employed, the equipment must be distinctly marked.

4.2 Portable electrical tools not provided with special insulating or grounding protection are not intended for use in damp, wet or conductive location (persons standing on the ground or on metal floors).

4.3 All portable electrical appliances and equipment where the non-current carrying metal parts are exposed to contact by personnel shall be grounded by continuous conductor of adequate capacity from the device to a grounded receptacle. The site safety officer shall resolve any question which arises as to whether or not a particular appliance should be grounded.

4.4 Grounding of receptacles shall be accomplished in one of two ways:

- A built-in ground wire of green color may be attached to the ground pole of the receptacle.
- The conduit system, if installed in an approved manner, may be relied upon for grounding of a receptacle serving single phase appliances with ratings up to 230 volts.

4.5 At outside locations all single-phase 15 and 20 ampere receptacle outlets operating at 230 volts or less which are not a part of the permanent wiring of the building or structure must have GFCI for personnel protection. The GFCI should be located at the power source so that all extension cords and tools are protected by the GFCI.

The outlet box for portable extension cords for outdoor use shall be of weatherproof type maintained in good condition.

5. ELECTRICAL GUARDING

5.1 Suitable access and working space shall be provided and maintained about all electric equipment to permit ready and safe operation and maintenance of such equipment.

5.2 The dimension of the working space is the direction of access to energized parts in switchboards, control panels, fused switches, circuit breakers, panel boards, motor controllers, and similar equipment which require examination, adjustment, servicing, or maintenance while energized, shall not be less that 36" in depth (30" for installations built prior to 1981) and the side being 30" or the width of the equipment, whichever is greater.

5.3 The working space shall not be used for storage purposes. The "keep clear" area may be identified with suitable floor markings and/or posting of signs or decals on the equipment.

5.4 Energized parts of electrical equipment operating at 50 volts or more shall be guarded against accidental contact by the use of approved cabinets or enclosures.

5.5 Entrance to rooms and other guarded location containing exposed energized parts shall be marked with a conspicuous warning sign forbidding unqualified persons to enter.

5.6 Temporary covers, warning signs, and/or barricades are to be used when it is necessary to remove covers of electrical panels during construction, major refurbishment, or for the purpose of providing temporary power to an area.

5.7 All openings in boxes, enclosures, or fittings shall be effectively guarded or closed to afford protection substantially equivalent to that of the wall of the box, enclosure, or fitting.

5.8 All electrical components over 230 volts shall have signs stating "High Voltage" 240 volts.

6. EXTENSION CORD REQUIREMENTS

6.1 Extension cords are designed for and will be used for TEMPORARY USE ONLY! All other electrical connections will be made permanent by proper construction methods.

6.2 Use of indoor extension cords greater then 50 feet in length is to be discouraged. All extension cords shall include a grounding conductor within the cable jacket and shall be equipped at each end with either explosion-proof or non-explosion-proof three-wire, grounded receptacles and plugs (but not with one of each), depending on the location and intended use. (No "hybrid", ungrounded or external ground wire extension cords are allowed.)

6.3 If a cord is damaged, it shall be shortened or replaced by an electrician - never patched with electrical tape.

6.4 Cords shall be protected against contact with oil, hot surfaces and chemicals.

6.5 Cords must not be hung over nails or other sharp edges or placed where vehicles may run over them.

7. ELECTRICAL FUSE REQUIREMENTS

7.1 Circuits must be de-energized by lockout and tagout procedures before attempting to replace fuses.

7.2 Bridging of fuses or circumventing the normal operation of circuit breakers is prohibited.

7.3 Blown fuses shall not be replaced with fuses having a higher amperage or voltage rating. Fuses should be replaced in kind to maintain proper circuit protection.

7.4 Use a fuse puller to remove fuses.

8. ASSURED ELECTRICAL GROUNDING REQUIREMENTS

8.1 This program provides the minimum requirements for an assured equipment grounding conductor program and reflects the requirements of 29 CFR 1910.304. It also applies to circuits and equipment not attached to a permanent building or structure.

8.2 OHM and its contractors will implement either a written assured equipment grounding conductor program or use GFCI's when using temporary wiring (cords and plugs) in field work using any temporary electrical power source.

8.3 Cords and equipment will be inspected prior to each use for damage or missing parts. Equipment which is found to be defective will be taken out of service and repaired.

8.4 The Assured Equipment Grounding Conductor Program will include the following:

- This written program.
- Designation of a competent person(s) to implement the program.
- Visual inspection of cords on a daily basis for deformed and missing pins, insulation damage, and indications of possible internal damage. Equipment found damaged or defective will be removed from service and repaired or expended.
- Cords and electrical circuits will be tested for the following:
  - Electrical grounding continuity
  - Correct attachment of grounding conductor
- Tests outlined above shall be performed before the first use, before being returned to use after repair, after possible damage (such as being run over by a vehicle), and at least every three mouths.
- The tests outlined above must be recorded and cords which have been tested identified.

1. OBJECTIVE

All OHM Remediation Services Corp. (OHM) employees and contractors shall attempt to identify and eliminate situations where injuries or "near misses" could occur from slip, trip, or fall hazards.

2. PURPOSE

This procedure describes work practices that will reduce or eliminate slips, trips, and falls and thereby reduce or prevent the injuries associated with these types of accidents. The intent is to prevent injuries and maintain an efficient and healthy workforce.

3. REQUIREMENTS

3.1 Personnel shall keep the working area clean and orderly. Tools must not be left lying on the floor or decking where they present tripping hazards during a job or after a job is completed.

3.2 Small, loose items such as, disconnected joints of pipe, wood chips, other small objects and debris shall not be left lying around in any place, particularly in areas where personnel walk.

3.3 Walkways and grating shall be kept in good condition. Openings in walkways shall be repaired immediately, if possible. If not immediately repaired, the section must be roped off or closed until repairs can be made.

3.4 Holes in gratings shall be covered or surrounded by an adequate guard rail.

3.5 Oil spills and slippery spots shall be cleaned up immediately.

3.6 Extra precautions must be taken when walking on steel decking or catwalks during wet weather.

3.7 Personnel shall not take dangerous shortcuts. They shall avoid jumping from elevated places.

3.8 Personnel must always position themselves properly when using tools.

3.9 Personnel shall not walk or climb on piping, valves, fittings or any other equipment not designed as walking surfaces.

3.10 Stairways, walkovers or ramps shall be installed where personnel must walk or step over equipment in the course of their normal duties.

1. OBJECTIVE

This procedure shall be used by OHM Remediation Services Corp. (OHM) personnel to ensure that the machine or equipment being worked on is isolated from all potential hazardous energy sources, and locked out or tagged out before an employee performs any servicing or maintenance activity where that unexpected energization, start-up or release of energy could cause an injury. Energy sources can be electrical, mechanical, hydraulic, pneumatic, chemical, thermal, or other energy.

2. PURPOSE

This procedure establishes the minimum safety requirements to ensure the proper deactivation of movable, electrically energized, pressurized equipment and systems, and systems containing hazardous materials prior to repairing, cleaning, oiling, adjusting, or similar work. This procedure complies with the requirements in 29 CFR 1910.147.

3. REQUIREMENTS

This procedure applies to all equipment that receives energy from electrical power, hydraulic fluid under pressure, compressed air, steam, energy stored in springs, potential energy from suspended parts, or any other source that may cause unexpected movement when it is necessary to perform work on that system. It also applies to similar functions performed on systems containing hazardous materials.

4. DEFINITIONS

4.1 Lockout - The placement of a lockout device on an energy isolating device, in accordance with this procedure, ensuring that the energy isolating device and the equipment being controlled cannot be operated until the lockout device is removed. The lockout device can be key operated or a combination device.

4.2 Tagout - The placement of a tagout device on an energy isolating device, in accordance with this procedure, to indicate that the energy isolating device and the equipment being controlled may not be operated until the tagout device is removed by the authorized person who originally placed the tagout device in position.

4.3 Authorized employee. A person who locks or implements a tagout system procedure on machines or equipment to perform the servicing or maintenance on that machine or equipment.

5. PROGRAM ELEMENTS

Prior to initiating any repairs, modifications and/or adjustments to operating equipment, these steps will be followed.

5.1 The immediate supervisor with jurisdiction over the equipment and all affected employees will be notified that the energy sources are to be deactivated.

5.2 All sources of power that must be locked out, blocked or released will be identified by the immediate Supervisor and the employee who will work on the equipment.

5.3 In order to ensure that the equipment cannot be re-energized while maintenance activities are performed, the employee will lockout / blank out all potential energy sources. (The employees will be assigned padlocks with their names or identification numbers affixed to the locks. The locks will be individually keyed to prevent another employee from removing the lock inadvertently.) If more than one employee is assigned to work on the equipment, a multi-lockout hasp will be used so that all employees working on the equipment can apply their locks and ensure their safety.

5.4 A tagout device will be affixed to all components or systems de-energized to indicate that lockout has been performed.

Prior to performing any work activities, the employee will operate the start and stop controls on the equipment to ensure that the equipment has been properly deactivated. After the test, the equipment must be in neutral or off.

5.5 After the servicing and/or maintenance is complete and the equipment is ready for normal operations, check the area around the machine or equipment. After all tools have been removed from the machine or equipment, guards have been reinstalled, remove all lockout or tagout devices. Operate the energy isolating devices to restore energy to the machine or equipment.

6. SPECIAL CONDITIONS

During certain operations it may be necessary to energize the equipment for a short period of time. Employees in the immediate area will be notified and directed to stay clear of the equipment. If the operation is to be deactivated again, the employee should repeat steps 5.3 to 5.6 of this procedure before work resumes.

In some instances work will carry over to another shift. The maintenance supervisor shall affix a department lock to the equipment to ensure that it is not energized during the transition. During subsequent slight operations, employees will ensure that steps 5.2 to 5.6 are complete before work resumes on the equipment.

If the work is completed and a lock remains on the equipment, it shall not be removed until the employee responsible for the lock is found or the supervisor of the employee investigates and ascertains that the equipment is safe to operate. Unauthorized removal of a lock will subject the violator to disciplinary action up to dismissal.

7. TRAINING

Initial and annual training will be given to all employees to ensure that the purpose and function of this energy and control program are understood.

8. PERIODIC INSPECTION

Corporate health and safety will conduct an annual audit of the energy control program to ensure that the requirements of their procedures are being followed. A record of annual audits will be kept to comply with the certification requirement of periodic inspections.

1. OBJECTIVE

All OHM Remediation Services Corp. (OHM) employees will use the proper lifting techniques and will utilize mechanical means when an objects' weight or bulk cannot be safely lifted by manual means.

2. PURPOSE

This procedure provides the proper lifting technique to be used by OHM employees. By utilizing proper technique, OHM employees can avoid debilitating lower back injuries.

3. REQUIREMENTS

3.1 Use mechanical material handling equipment whenever practical; however, mechanical lifting equipment shall be used only by qualified personnel.

3.2 If the material must be lifted manually, the following procedures apply:

3.2.1 Make certain that the load lifted can be safely handled. Consider the size, weight, and shape of the load. If necessary, get help.

3.2.2 Warm up for the lift by bending, stretching, and turning.

3.2.3 Do not attempt to lift more than 60 pounds.

3.2.4 Ensure proper lifting technique as follows.

- Place feet about shoulder width apart.
- Place one foot alongside the object being lifted and the other foot in front of the object.
- Bend at the knees to grasp the load.
- Maintain slight arch in the back when positioning over load.
- Draw the load close to the body, keeping the arms and elbows tucked into the side of the body.

- Take a firm hold on the load with the palms of the hands, not just the fingers.
- Maintain same slight arch in the back.
- Lift gradually, using your leg muscles. Make sure you draw the load close to your body.
- Do not twist the body when lifting. If you have to change direction, turn with your feet, not your trunk.
- Carry the object close to the body and watch where you are going. Do not carry objects in a manner that obstructs your vision.
- Avoid throwing or dropping objects. When lowering, maintain a firm grip. Watch out for pinching of the fingers. Use your leg muscles to lower the object by bending at the knees and keeping your back straight.

1. OBJECTIVE

OHM Remediation Services Corp. (OHM) shall provide suitable facilities for quick drenching or flushing of the eyes and body within the work area for immediate emergency use where the eyes or body of any person may be exposed to injurious chemicals.

2. PURPOSE

This procedure describes the types and locations of safety showers and eyewash stations and addresses the requirements found in 29 CFR 1910.151(c) and the American National Standards ANSI Z358.1-1990 for emergency eyewash and shower equipment.

3. REQUIREMENTS

3.1 EYEWASH STATIONS - Eyewash stations shall be located throughout company facilities and job sites for emergency first aid in case of chemical splashes to the eyes and skin. The general requirement for emergency eyewash stations are as follows:

- Flush both eyes simultaneously
- Freeze protection when possibility of freezing conditions exist
- No sharp projections in operating area of unit
- Nozzles protected from airborne contaminants
- Self-contained unit shall be constructed of materials that will not corrode in the presence of flushing fluid
- Unit shall deliver not less than 0.4 gpm for 15 minutes.
- Valves must have "stay open" feature allowing both hands free to open eyelids

- Valves must be capable of being turned on in 1 second or less
- Valve activator shall be large enough to be easily located and operated by user.

Installation Requirements:

- Unit is positioned so water nozzles are 33-45 inches from the floor and 6 or more inches from the wall
- Supply line for plumbed units shall provide an uninterrupted supply of potable water at a minimum of 30 lbs. per square inch of pressure.
- Eyewash units shall be in an accessible location, located no further than 100 feet from the hazard. Where strong caustics or acids are present, the distance should be 10 feet or less.
- Identify location with a highly visible sign in a well lit area.

3.2 DRENCH SHOWERS - Drench showers shall be located throughout company facilities and at project sites for emergency use in case of chemical splash to the face, head and/or body. The general requirement for drench showers is as follows:

- The height of the drench shower had should be at least 82 inches and not more than 96 inches from standing level.
- The water spray pattern should be a minimum of a 20 inch diameter, 60 inches from standing level.
- The center of the water spray should be 16 inches from any obstruction
- The drench shower should deliver 30 gallons per minute, meeting the water spray pattern.
- The control valve should stay on once activated, and should be able to be activated from "off" to "on" in one second.

- Drench showers should be located 10 seconds or 100 feet from the hazard. In situations where strong caustics or acids are present, the distance should be 10 feet or less.

- The drench shower should be identified with a sign and should be located in a well lit, brightly painted area.

3.3 INSPECTION - To simplify the maintenance and record-keeping, an individual at the project site or department should be assigned the task of checking all eyewash devices on a weekly schedule and records of those inspections be kept on the device. The flushing solution should also be checked and replaced per the manufacturer's instructions. Trash or debris should be removed from any eyewash basins at this time.

3.4 MAINTENANCE - Each plumbed emergency eyewash device should be activated weekly to test the equipment and flush plumbed lines of any bacterial or sediment build-up. For self-contained eyewash units, follow the manufacturer's instructions. ANSI Standards recommend that all emergency eyewash devices be checked on a weekly basis in order to ensure proper working conditions as well as adequate levels of flushing solution.

1. OBJECTIVE

OHM Remediation Services Corp. (OHM) shall enforce this procedure as a means of protecting the health and safety of workers while entering, working in, and exiting confined spaces. Before entry, the worker will be made aware of the hazards of confined space work and the safe work practices necessary.

2. PURPOSE

The purpose of this procedure is to establish confined space entry standards for all OHM employees. This procedure meets and exceeds the guidelines in the Occupational Safety and Health Administration (OSHA) proposed Confined Space Entry standard 29 CFR 1910.146.

3. PROCEDURE

3.1 Permitting - All "permit required confined space" entries will be proceeded by the completion of a confined space entry permit. The OHM confined space entry permit follows this procedure.

3.2 Written Rescue Procedure - Prior to any confined space work, a site specific written rescue plan will be developed that addresses minimum requirements.

3.2.1 Rescue

- The equipment required to rescue an unconscious victim must be in-place before the first person enters the confined space.
- A trained stand-by person will be assigned to each confined space with a fully charged SCBA or airline and egress unit.
- The stand-by is to keep life lines clear, to maintain contact with all workers within the confined space and to summon help if needed.
- The stand-by must never enter the confined space unless relieved by rescue assistance.
- The stand-by may attempt rescue by lifeline while waiting for rescue assistance.

4. PERMIT SYSTEM

All confined space entry permits will address the following:

- Location
- Hazards-Isolation
- Lockout / Tagout
- PPE and special equipment
- Air monitoring requirements and results of such monitoring
- Personal monitoring
- Training required
- Stand-by persons to be present as alternates
- Communication procedures
- Emergency / rescue procedures
- Confined space classification
- Posting of notification

6. TRAINING

OHM will train employees involved in confined space entry and confined space rescue on the hazards associated with confined space work. This training will, as a minimum, cover the following:

- Hazard recognition
- Emergency entry and exit
- Respirator use
- First aid
- Lock-out procedures
- Safety equipment
- Rescue drills
- Permit system
- Work practices
- Communication requirements

7. TESTING AND MONITORING

7.1 Initial Monitoring - Entry into a confined space is prohibited until initial testing of the atmosphere for oxygen content and toxic gas concentration is conducted from the outside. Initial monitoring gives critical information concerning oxygen level, flammability and toxicity hazards.

7.2 Hot Work - All hot work is prohibited in confined space where monitoring indicates that there are flammable compounds in excess of 10% of the Lower Explosive Limit (LEL). The monitoring device will be intrinsically safe for flammable atmospheres or explosion proof. If hot work must be performed in the confined space, a hot work permit must be completed. Cutting gas cylinders and welding machines will not be taken into confined space.

7.3 Calibration - All monitoring equipment will be calibrated before each use and those calibrations will be logged in the equipment records. The calibration record will be kept for a minimum of one year from the date of measurement.

7.4 Oxygen Requirement - The percent oxygen for entry will not be less than 19.5% for confined space entry without supplied air respirators. If elevated (greater than 22%) oxygen levels are detected, the confined space must be ventilated prior to any "hot work". Any oxygen reading above or below 20.9% will be reported to the site safety officer before further entry is attempted.

7.5 Permissible Exposure Limits (PEL) - OHM employees will be provided with and will be required to properly use protective clothing and respiratory protective equipment when contaminants in the atmosphere reach or exceed the PEL. The personal protective equipment (PPE) selected will reduce exposure to contaminants to acceptable levels.

8. LABELING AND POSTING

8.1 Any signs warning of dangers in the work area will be in English and the predominant language of any non-English reading workers.

8.2 All entrances to confined spaces at OHM facilities and on-going projects will have appropriate signs posted. The signs should include the following, if applicable:

Danger
Confined Space Entry
Entry by Permit Only

The following statements shall be added where necessary:

Respirator Required for Entry
Lifeline Required for Entry
Hot Work Permitted
or
No Hot Work

8.3 Emergency numbers will be conspicuously posted near the work area or at the telephone nearest the work area.

9. SAFETY EQUIPMENT AND PPE

The site safety officer or site supervisor will determine and list on the confined space permit the necessary safety equipment and PPE. The site supervisor will ensure that the safety equipment is properly used and is maintained in the proper working condition. These items may include, but are not limited to:

- Eye / face protection
- Head protection
- Foot protection
- Protective clothing
- Hearing protection
- Respiratory protection
- Safety bells/Alarms
- Harnesses
- Lifelines
- Wrist harnesses
- Life jackets
- Fall nets
- Barricades
- Retrieval systems

10. WORK PRACTICES

10.1 Purge and Ventilation - During purge and ventilation procedures, blower controls will be a safe distance from the confined space. Initial testing is to be conducted prior to purge/ventilation to determine what precautions are necessary. If a flammable atmosphere exists, all electrical equipment must be intrinsically safe or explosion proof. Continuous ventilation will be required when welding or painting in a confined space, or where a toxic atmosphere may form from desorption from walls, or evaporation of chemicals. Ventilation systems must not prevent egress from the area or interfere with communications.

10.2 Isolation / Lock-out / Tag-out - Each confined space will have isolation procedures specifically developed. The confined space must be completely isolated from all systems by physical disconnect, block and bleed, or blanking and tagging. Electrical systems must be de-energized and locked-out. All systems should be checked for stored energy before any entry into confined space is attempted.

10.3 Cleaning - Cleaning procedures will be reviewed and approved by the qualified person. Initial cleaning will be conducted from outside the tank whenever possible to minimize exposures to employees. Cleaning may be accomplished by flushing with water or chemical cleaners. At times the use of a "Butterworth" cleaning head may be required. In any case, gross material must be removed before entry is performed.

11. EQUIPMENT AND TOOLS

All equipment that is used in confined space will be inspected and as a minimum, will meet the following requirements:

- Hand tools will be kept clean and in proper working condition.
- Electric tools, equipment and lighting will be intrinsically safe or explosion proof for flammable atmospheres and be equipped with ground fault circuits interrupters (GFCI).
- Extension cords will be industrial quality, 3 wire and 12 gauge as a minimum.
- Cylinders of compressed gas will never be taken into a confined space, with the exception of SCBA tanks or life saving equipment.
- Ladder and scaffolding will meet or exceed OSHA requirements in 29 CFR 1910.25-28.

OHM Corporation

CONFINED SPACE ENTRY PERMIT

Project No._____ Permit No._____

Good on this Date Only:_____ From: a.m. p.m._____ To: a.m. p.m._____

Location:_____ Description of Task:_____

Workers Authorized to Enter	Work Monitors	Rescue Personnel
_____	_____	_____
_____	_____	_____
_____	_____	_____

EMPLOYEE PRE-ENTRY BRIEFING

Pre-Entry Briefing Conducted by: _____ (Name) _____ (Date)

CONFINED SPACE PREPARATION

1. Is Illumination Adequate?	YES_____	NO_____	
2. Must Electrical Devices be Intrinsically Safe or Explosion Proof?	YES_____	NO_____	
3. Are Non-Sparking Tools Required?	YES_____	NO_____	
4. Are GFCI's In Use?	YES_____	NO_____	
5. Have All Power Cords and Tools Been Visually Inspected?	YES_____	NO_____	N/A_____
6. Fire Extinguisher Available at Entrance.	YES_____	NO_____	TYPE_____
7. Eye Wash/Safety Shower Available.	YES_____	NO_____	N/A_____
8. Is Rescue SCBA Available?	YES_____	NO_____	N/A_____
9. Work Area Isolated with Signs/Barriers?	YES_____	NO_____	N/A_____
10. All Energy Sources Locked/Tagged Out?	YES_____	NO_____	N/A_____
11. All Input Lines Capped/Blinded?	YES_____	NO_____	N/A_____
12. Vessel Contents Drained/Flushed/Neutralized?	YES_____	NO_____	N/A_____
13. Vessel Cleaned/Purged?	YES_____	NO_____	N/A_____
14. Ventilation Provided 30 Minutes Before Entry?	YES_____	NO_____	N/A_____
15. Communication Requirements	VISUAL_____	VOICE_____	RADIO_____
16. Level of Respiratory Protection.	B_____	C_____	D_____
17. Type of Chemical Protective Clothing Required.	TYVEK_____	SARAN_____	ACID_____
18. Type of Glove Material Required.	NITRILE_____	PVC_____	ACID_____

PRE-ENTRY ATMOSPHERIC TESTING

	Reading:	Time:	Initials:
1. Test for Oxygen Content:	_____ % O_2	_____	_____
2. Test for Flammable Concentration:	_____ % LEL	_____	_____
3. Test for Toxic Concentration:	_____ ppm of _____ (TLV = _____)	_____	_____
4. Continuous Monitoring Required?	YES_____ NO_____		

EMERGENCY/RESCUE PROCEDURES

1. Is a Site Specific Rescue Plan Required?	YES_____	NO_____
2. Are Personnel Trained for Confined Space Rescue Available?	YES_____	NO_____
3. If NO, Has an Outside Agency Been Notified?	YES_____	NO_____

4. Outside Rescue Agency Name:_____ Phone No._____

ENTRY/EGRESS REQUIREMENTS

1. Are Ladders Required for Entry?	YES_____	NO_____
2. Are Vertical Extraction/Rescue Devices Required?	YES_____	NO_____
3. Is Fall Protection Required?	YES_____	NO_____

OTHER POTENTIAL HAZARDS

1. Noise	YES_____	NO_____	CONTROL_____
2. Heat Stress	YES_____	NO_____	CONTROL_____
3. Cold Stress	YES_____	NO_____	CONTROL_____
4. Biological Agents	YES_____	NO_____	CONTROL_____

SUBCONTRACTOR NOTIFICATION

Contractor Notified of: Permit Conditions _____ Potential Hazards _____ N/A _____

PERMIT AUTHORIZATION

I certify that I have inspected the work area for safety and reviewed all safety precautions recorded on this permit.

Permit Authorized by (Signature): _____

4.0 PERFORMANCE SAMPLING AND MONITORING

4.1 INTRODUCTION

Performance of the groundwater treatment system will be measured against the established effluent discharge criteria identified in the site Record of Decision and/or the Base-wide NPDES permit. Both the effluent criteria for discharge to Wallace Creek and the aquifer cleanup goals are provided in Table 4.1.

Table 4.1 – Effluent Treatment Criteria and Remediation Goals

Groundwater Contaminant of Concern	*Effluent Discharge Limits (µg/L)*	*Remedial Goal (µg/L)*
1,2-Dichloroethane	113,000	0.38
Trans-1,2Dichloroethene	100	70
Ethylbenzene	430	29
Tetrachloroethane	0.8	0.7
Trichloroethane	92.4	2.8
Vinyl Chloride	525	0.015*
Arsenic	50	50
Barium	1,400	1,000
Beryllium	0.117	4
Chromium	20	50
Lead	25	15
Manganese	3,500	50
Mercury	0.025	1.1
Vanadium	6,000	80

Notes: Reference - Record of Decision CTO-0133
µg/L = microgram per liter
*Below level of quantification

The Quality Assurance Project Plan (QAPP) for Soil and Groundwater at Operable Unit No. 2 was submitted June 28, 1994. At that time, the sampling and analysis for this phase of the project was not defined. This section provides the addendum to that plan for the monitoring wells, recovery wells and groundwater treatment plant sampling and analysis.

Monthly sampling events are scheduled to measure performance of the treatment plant. Quarterly and annual events will be conducted in conjunction with a monthly event and will

Table 4.2 – Performance Sampling Summary

Sample Type	*Matrix*	*Sampling Frequency*	*Approx. No. of Samples*	*Sampling Method*	*Sampling Equipment*	*Sample Containers*	*Preservatives*	*TAT*[1]	*QC Level*	*Required Analysis*	*Analytical Method*[2]	*Holding Time*[3]
Influent (Shallow Wells)	GW	Once per period	1	Grab	Tap	2x40ml VOA	HCL<pH2/4C	7 days	NEESA Level C	Select volatiles	8021A	14 days
						1x500ml plastic	HNO3<pH2/4C	7 days	NEESA Level C	Ba,Be, Cr, Mn, V, Fe, As, Pb, Hg	6010,7060,7421, 7470	6 months (Hg 28 days)
						1x1L glass	Cool 4°C	7 days	NEESA Level C	TDS/TSS	EPA 160.1/160.2	7 days
Influent (deep wells)	GW	Once per period	1	Grab	Tap	2x40ml VOA	HCL<pH2/4C	7 days	NEESA Level C	Select volatiles	8021A	14 days
						1x500ml plastic	HNO3<pH2/4C	7 days	NEESA Level C	Ba,Be, Cr, Mn, V, Fe, As, Pb, Hg	6010,7060,7421, 7470	6 months (Hg 28 days)
						1x1L glass	Cool 4°C	7 days	NEESA Level C	TDS/TSS	EPA 160.1/160.2	7 days
Air Stripper Effluent (T-220)	GW	Once per period	1	Grab	Tap	2x40ml VOA	HCL<pH2/4C	7 days	NEESA Level C	Select volatiles	8021A	14 days
		Sample metals only if present above effluent limits in influent	1	Grab	Tap	1x500ml plastic	HNO3<pH2/4C	7 days	NEESA Level C	Ba,Be,Cr,Mn,V, Fe,As,Pb,Hg	6010,7060,7421, 7470	6 months (Hg 28 days)
Final Effluent	GW	Once per period	1	Split	Tap	2x40ml VOA	HCL<pH2/4C	7 days	NEESA Level C	Select volatiles	8021A	14 days
						1x500ml plastic	HNO3<pH2/4C	7 days	NEESA Level C	Ba,Be,Cr,Mn,V, Fe,As,Pb,Hg	6010,7060,7421, 7470	6 months (Hg 28 days)
QA/QC Samples												
Blank		One per VOA cooler	1	Trip blank	From lab	2x40ml VOA	Cool 4°C	7 days	As needed	Select volatiles	8021A	14 days
Duplicate		One per project	1	Duplicate	Tap	2x40ml VOA	HCL<pH2/4C	7 days	As needed	Select volatiles	8021A	14 days
						1 x 500ml plastic	HNO3,pH2/4C	7 days	As needed	Ba,Be,Cr,Mn,V, Fe,As,Pb,Hg	6010,7060, 7421,7470	6 months (Hg 28 days)

*Definitive data Standard QC

Notes:

1) Calendar days
2) USEPA SW-846 methods unless otherwise specified
3) Begins from the date of collection in the field

measure levels of contamination in the aquifer. Table 4.2 summarizes the sampling and analysis scheduled during all events. This table replaces Table 3.1 in the June 1994 QAPP. Table 4.3 summarizes the analytes of concern and the laboratory required detection limits. Some detection limits may not be achieved when high levels of one or more analytes are present in the samples. Table 4.4 summarizes the sampling events schedule for the monitoring wells. All samples will be sent to a NEESA certified laboratory for a Level C data package.

Table 4.3 – Laboratory Reporting Limits

Contaminant of Concern	*Method Number*	*Laboratory Required Reporting Limit (µg/l)*
1,2-Dichloroethane	8021	0.2
Trans-1,2-Dichloroethene	8021	2.0
Ethylbenzene	8021	2.0
Tetrachloroethane	8021	0.4
Trichloroethane	8021	1.5
Vinyl Chloride	8021	<1.0
Arsenic	7060	15
Barium	6010	50
Beryllium	6010	2
Chromium	6010	15
Lead	7421	5
Manganese	6010	15
Mercury	7470	0.2
Vanadium	6010	20
Iron	6010	50

Table 4.4 – Monitoring Wells				
Previous Location ID	*AutoCAD ID (Map)*	*New GIS Location ID*	*Sampling Frequency*	*Associated Sample ID**
6-GW1S	6GW1S	06-GW01	Quarterly	06-GW01-96C
6-GW1DW	6GW1D	06-GW01DW	Quarterly	06-GW01DW-96C
6-GW1DW	6GW1D	06-GW01DA	Annually	06-GW01DA-96
6-GW1DB	6GW1DB	06-GW01DB	Annually	06-GW01DB-96
6-GW27DW	6GW27D	06-GW27DW	Quarterly	06-GW27DW-96C
6-GW27DA	6GW27DA	06-GW27DA	Annually	06-GW27DA-96
6-GW28S	6GW28S	06-GW28	Quarterly	06-GW28-96C
6-GW28DW	6GW28D	06-GW28DW	Quarterly	06-GW28DW-96C
6-GW32	6GW32	06-GW32	Quarterly	06-GW32-96C
6-GW33	6GW33	06-GW33	Quarterly	06-GW33-96C
6-GW34	6GW34	06-GW34	Quarterly	06-GW34-96C
6-GW40DW	6GW40DW	06-GW40DW	Annually	06-GW40DW-96
6-GW40DWA	6GW40DWA	06-GW40DWA	Quarterly	06-GW40DWA-96C

*Quarterly sample IDs for 3rd quarter 1996 (round C), annual samples denoted by year only. All water levels must be accompanied by new location ID (column III).

4.2 SAMPLING PROCEDURE

Select the sample point per the project requirements. The tap should be opened for 2 to 3 minutes or for sufficient time to permit clearing line; a smooth-flowing water stream at moderate pressure without splashing should be obtained. Wear clean sample gloves. Then without changing the water flow (which could dislodge some particles in the tap), collect the samples. Regardless of the type of sample bottle being used, the bottle cap should not be placed on the ground or in a pocket. Hold the bottle in one hand and the cap in the other, using care not to touch the inside of the cap. Avoid contaminating the sample bottle with fingers or permitting the faucet to touch the inside of the bottle. When filling any container, care should be taken so splashing drops of water from the ground do not enter into either the bottle or cap.

Fill the two 40-ml volatile vials first. Tilt the vial at a 45° angle to the flow so that the water flows down the wall of the container. Preserve the sample as required. Preservatives can be added to the sample container before sampling if desired. Fill the container until an inverted meniscus is seen over the top of the vial. Seal the vial. Invert container and tap. If bubbles are present, add more water. Label, attach custody seal, placed into a ziplock bag, and put the sample on ice.

Fill the TSS and TDS (when required) container next, keeping the turbulence to a minimum. Then fill the metal containers. Add preservatives as required. Label, attach custody seal, place into a ziplock bag and put the sample on ice. Record the information in the field logbook and complete the chain-of-custody form. The samples will be packaged and shipped to the laboratory for 48-hour sample turnaround time (TAT) for preliminary data. Effluent results will be obtained from a NEESA certified laboratory before proceeding with the aquifer test to verify compliance with the effluent limits.

4.3 QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) SAMPLES

When sampling for volatiles, the required trip blanks should be sent from the laboratory and accompany the sample shipment back to the laboratory. One trip blank will be included in each shipment that contains volatile analysis. One duplicate sample will be collected and analyzed.