HOGENAKKAL WATER SUPPLY AND FLUOROSIS MITIGATION PROJECT

PACKAGE - I

Operation & Maintenance Manual

Volume 7(b)

Tenderer

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INDEX

No. Description

1. INTRODUCTION

The Purpose of this document is to portray complete scheme of Process, control & Operation of Hogenekkal Water supply and Fluorosis Mitigation Project. Entire system is fully automatic with Dedicated PLC at various locations & distributed PLC and SCADA system at central control room. A reliable and obstruction free data communication system is provided for continuous monitoring of the system at central control Room. **RAW WATER INTAKE:**

Raw water taken from upstream of Cauvery River is pumped to WTP which is located at a distance of 6.25Km. Entire Pumping station is controlled through Sophisticated PLC located at Control room at the vicinity of MCC room. Data from pumping station is passed to central control room which is located at filter Annex building of WTP through fiber optic cable.

160MLD WATER TREATMENT PLANT:

Raw water coming from Intake is treated at 160MLD Water treatment Plant. Entire WTP is fully automatic with redundant PLC envisaged at different stages of treatment and a Distributed control system located at Filter Annex building. Data from DCS is beamed to Dharmapuri control room for monitoring of the entire plant including Booster pumping station, Tapping point and Union reservoirs and rechlorination system.

TREATED WATER PUMPING STATION:

Treated water from WTP is collected at treated water reservoir located at vicinity of WTP from where it is pumped to Booster pumping station. Entire pumping station is controlled through sophisticated PLC located at MCC room of Treated water pumping station.Data from the treated water pumping station is communicated to WTP control room through fiber optic cable.

BOOSTER PUMPING STATION:

Treated water from treated water pumping station is collected at booster pumping station which is located at a distance of 1.5 Km from WTP. Entire pumping station is controlled through sophisticated PLC located at MCC room of Booster pumping station. Data from the treated water pumping station is communicated to WTP control room through fiber optic cable.

MASTER BALANCING RESERVOIR:

Treated water from booster pumping station is collected at WTP from where it is distributed to various unions of package-I, II, III, IV&V. Level and Flow in MBR is monitored and controlled through sophisticated PLC located at telemetry room. Data from MBR control room is communicated to WTP SCADA system through fiber optic cable.

2. REFERENCES:

1.	Dwg. No. 02600-TWAD-P1-CDG-DWG-C&I-4001	:	P&ID for Intake System
2.	Dwg. No. 02600-TWAD-P1-CDG-DWG-P-5003	:	P&ID for Clarifiers
3.	Dwg. No. 02600-TWAD-P1-CDG-DWG-5004	:	P&ID for filtration system
4.	Doc. No. 02600-TWAD-P1-CDG-DWG-5005	:	P&ID for Chlorination system
5.	Dwg. No. 02600-TWAD-P1-CDG-DWG-5006	:	P&ID for Treated water pumping station
6.	Dwg. No. 02600-TWAD-P1-CDG-DWG-5007	:	P&ID for Wash Water recovery tank
7.	Dwg. No. 02600-TWAD-P1-CDG-DWG-5008	:	P&ID for Sludge balancing tank and thickening for WTP
8.	Dwg. No. 02600-TWAD-P1-CDG-DWG-5009	:	P&ID for drying beds for WTP
9.	Dwg. No. 02600-TWAD-P1-CDG-DWG-5010	:	Chlorination Dosing system for WTP
10.	Dwg. No. 02600-TWAD-P1-CDG-DWG-5011	:	P&ID for Lime milk dosing system
11.	Dwg. No. 02600-TWAD-P1-CDG-DWG-5012	:	P&ID for Aluminum Dosing system
12	Dwg. No. 02600-TWAD-P1-CDG-DWG-C&I-4201	:	P&ID for Booster pumping station
13	Dwg. No. 02600-TWAD-P1-CDG-DWG-C&I-4301	:	P&ID for MBR
12.	Doc.No. 02600-TWAD-P1-CDG-DOC-C&I-402	:	Instrument schedule for Intake system
13.	Doc.No. 02600-TWAD-P1-CDG-DOC-C&I-403	:	Instrument schedule for WTP
14.	Doc.No. 02600-TWAD-P1-CDG-DOC-C&I-403	:	Instrument schedule for MBR
15.	Doc No: 02600-TWAD-P1-CDG-DOC-C&I-404	:	Instrument Schedule for Booster pumping station
16	Doc No: 02600-TWAD-P1-CDG-DOC-C&I-405	:	Instrument schedule for Master balancing reservoir
17	Doc No: 02600-TWAD-P1-DOC-CDG-C&I-423	:	PLC/SCADA Package I control system I/O list

18	Doc No: 02600-TWAD-P1-DOC-C&I-455	: Package II to V PLC I/O List
19	Doc No: O2600-TWAD-P1-DWG-C&I-4119	: Control system over view drawing
20	Doc No: O2600-TWAD-P1-DWG-CDG-C&I-4018	: Control & Automation equipments Location drawing RWPS
21	Doc No: O2600-TWAD-P1-DWG-CDG-C&I-4118	: Control & Automation equipments location drawing WTP
22	Doc No: O2600-TWAD-P1-DWG-CDG-C&I-4218	: Control & Automation equipments location drawing BPS
23	Doc No: O2600-TWAD-P1-DWG-CDG-C&I-4318	: Control & Automation equipments location drawing MBR

3. ABBREVIATIONS DICTIONARY:

RWPS: Raw Water Pumping Station

WTP: Water Treatment Plant

BPS: Booster Pumping Station

MBR: Master Balancing Reservoir

CCR: Central Control Room

MCC: Motor Control Center

MV: Medium Voltage

LV: Low Voltage

DB: Distribution Board

I/Os: Input/Outputs

CS: Control System

PLC: Programmable Logic Controller

CPU: Central Processor Unit

SCADA: supervisory control and data acquisition

HMI: Human Machine Interface

LCP: Local Control Panel

MLCP: Main Local Control Panel

LCS: Local Control Station

SP: Set Point

PV: Process Value

LOC/REM: Local/Remote

4. GENERAL:

4.1 OPERATION MODES DEFINITION:

a) For Starters

Hand: operation under operator requests.

Field: operation from LCSs based on manual requests and without interlocks from automation control system (hardwired logic at MCC)

MCC: operation from MCC based on manual requests and without interlocks from automation control system (hardwired logic at MCC)

Off: equipment out of service

DCS: operation based on signal generated by the automation control system.

Manual: operation request by operator from SCADA (LCP and/or CCR)

Auto: operation automatic request generated by DCS

b) For Others (i.e pneumatic valves)

Local: operation based on signal generated by the automation control system under operator requests from LCS

Remote: operation based on signal generated by the automation control system from remote

Manual: operation request by operator from SCADA (LCP and/or CCR)

Auto: operation automatic request generated by DCS

4.2 OPERATION MODES SELECTION:

a) For Starters

There will be installed a selector switch (Hand/ Off / DCS) for each starter at the MCC in order to select Hand or DCS mode.

In hand mode, for selecting operation from LCSs or MCC another selection switch will be installed at the MCC.

In DCS mode, for selecting operation manual or auto another selector switch will be installed at HMI page.

b) <u>For Others (</u> i.e pneumatic valves)

There will be installed a selector switch Loc/ Rem at the LCS. If the valve is motorized the loc/rem switch will be installed in the actuator itself.

In remote mode for selecting operation manual or auto another selector switch will be installed at HMI page.

4.3 LIST OF LCSs FOR HAND OPERATION at FIELD LOCATIONS:

LOCAL CONTROL STATIONS (LCS) LIST RWPS		
Designation	**LCS Description**	**Location**
01/02LCS1.A	Pumpwell 1 -pump 1	Raw water PS
01/02LCS1.B	Pumpwell 1 -pump 2	Raw water PS
01/02LCS1.C	Pumpwell 1 -submersible pump	Raw water PS
01/02LCS2.A	Pumpwell 2 -pump 3	Raw water PS
01/02LCS2.B	Pumpwell 2 -pump 4	Raw water PS
01/02LCS3.A	Pumpwell 3-pump 5	Raw water PS
01/02LCS3.B	Pumpwell 3 -pump 6	Raw water PS
01/02LCS3.C	Pumpwell 3 -submersible pump	Raw water PS
01/02LCS4	Valve 1 (in actuator)	Raw water PS
01/02LCS5	Valve 2 (in actuator)	Raw water PS
01/02LCS6	Valve 3 (in actuator)	Raw water PS
01/02LCS7	Valve 4 (in actuator)	Raw water PS
01/02LCS8	Valve 5 (in actuator)	Raw water PS
01/02LCS9	Valve 6 (in actuator)	Raw water PS
01/05LCS1	Compressor (in the auxiliar equipment)	Raw water PS
LOCAL CONTROL STATIONS (LCS) LIST WTP		
Designation	**LCS Description**	**Location**
CLARIFIERS		
02/04LCS1.A	Sludge Pumping chamber-pump 1	WTP
02/04LCS1.B	Sludge Pumping chamber-pump 2	WTP
02/04LCS2	Clarifiers 1 to 4 (valves operation)	WTP
02/04LCS3	Clarifiers 5 to 8 (valves operation)	WTP
FILTERS		
02/30LCS1.A	Air scour blowers -blower 1	WTP
02/30LCS1.B	Air scour blowers -blower 2	WTP
02/16LCS1.A	Wash water recovery tank : pumping to head plant -pump 1	WTP
02/16LCS1.B	Wash water recovery tank : pumping to head plant -pump 2	WTP
02/16LCS2.A	Wash water recovery tank : pumping to sludge balancing tank -pump 1	
02/16LCS2.B	Wash water recovery tank : pumping to sludge balancing tank -pump 2	
TREATED WATER PUMPING STATION		
02/07LCS1.A	Contact tank mixers -mixer 1	WTP
02/07LCS1.B	Contact tank mixers -mixer 2	WTP
02/23LCS1.A	Pre and Post chlorination pumps -prechlorination pump	WTP
02/23LCS1.B	Pre and Post chlorination pumps -postchlorination pump 1	WTP
02/23LCS1.C	Pre and Post chlorination pumps -postchlorination pump 2	WTP
02/32LCS1.A	Treated water to filtration wash water tank -pump 1	WTP
02/32LCS1.B	Treated water to filtration wash water tank -pump 2	WTP
02/32LCS2.A	Service water -pump 1	WTP
02/32LCS2.B	Service water -pump 2	WTP
02/13LCS1.A	Pumpwell 1 -pump 1	WTP
02/13LCS1.B	Pumpwell 1 -pump 2	WTP
02/13LCS1.C	Pumpwell 1 -submersible pump	WTP
02/13LCS2.A	Pumpwell 2 -pump 3	WTP
02/13LCS2.B	Pumpwell 2 -pump 4	WTP
02/13LCS3.A	Pumpwell 3-pump 5	WTP
02/13LCS3.B	Pumpwell 3 -pump 6	WTP
02/13LCS3.C	Pumpwell 3 -submersible pump	WTP
02/13LCS4	Valve 1 (in actuator)	WTP
02/13LCS5	Valve 2 (in actuator)	WTP
02/13LCS6	Valve 3 (in actuator)	WTP
02/13LCS7	Valve 4 (in actuator)	WTP
02/13LCS8	Valve 5 (in actuator)	WTP
02/13LCS9	Valve 6 (in actuator)	WTP
02/28LCS1	Compressor (in the auxiliar equipment)	WTP
CHEMICAL PLANT (HYDRATED LIME & ALUMINIUM SULPHATE)		
02/22LCS1	Mixer at lime milk preparation tank 1	WTP
02/22LCS2	Mixer at lime milk preparation tank 1	WTP
02/22LCS3.A	Lime milk pumps -pump 1	WTP
02/22LCS3.B	Lime milk pumps -pump 2	WTP
02/22LCS4.A	Saturated Aluminium sulphate pumps -pump 1	WTP
02/22LCS4.B	Saturated Aluminium sulphate pumps -pump 2	WTP
02/22LCS5	Mixer at Aluminium sulphate preparation tank 1	WTP
02/22LCS6	Mixer at Aluminium sulphate preparation tank 2	WTP
02/22LCS7.A	Aluminium sulphate pumps -pump 1	WTP
02/22LCS7.B	Aluminium sulphate pumps -pump 2	WTP
02/24LCS1	Mixer at lime saturator 1	WTP
02/24LCS2	Mixer at lime saturator 2	WTP

CHLORINE PLANT		
SLUDGE TREATMENT PLANT		
02/17LCS1	Sludge balancing tank mixer 1	WTP
02/17LCS2	Sludge balancing tank mixer 2	WTP
02/18LCS1.A	Sludge pumping to thickeners 1 -pump 1	WTP
02/18LCS1.B	Sludge pumping to thickeners 1 -pump 2	WTP
02/18LCS2.A	Sludge pumping to thickeners 2 -pump 1	WTP
02/18LCS2.B	Sludge pumping to thickeners 2 -pump 2	WTP
02/19LCS1	Sludge thickener 1	WTP
02/19LCS2	Sludge thickener 2	WTP
LOCAL CONTROL STATIONS (LCS) LIST BPS		
Designation	**LCS Description**	**Location**
03/03LCS1.A	Pumpwell 1 -pump 1	BPS
03/03LCS1.B	Pumpwell 1 -pump 2	BPS
03/03LCS1.C	Pumpwell 1 -submersible pump	BPS
03/03LCS2.A	Pumpwell 2 -pump 3	BPS
03/03LCS2.B	Pumpwell 2 -pump 4	BPS
03/03LCS3.A	Pumpwell 3-pump 5	BPS
03/03LCS3.B	Pumpwell 3 -pump 6	BPS
03/03LCS3.C	Pumpwell 3 -submersible pump	BPS
03/03LCS4	Valve 1 (in actuator)	BPS
03/03LCS5	Valve 2 (in actuator)	BPS
03/03LCS6	Valve 3 (in actuator)	BPS
03/03LCS7	Valve 4 (in actuator)	BPS
03/03LCS8	Valve 5 (in actuator)	BPS
03/03LCS9	Valve 6 (in actuator)	BPS
03/06LCS1	Compressor (in the auxiliar equipment)	BPS
LOCAL CONTROL STATIONS (LCS) LIST MBR		
Designation	**LCS Description**	**Location**
04/14LCS1	Inlet Valve 1 (in actuator)	MBR
04/14LCS2	Inlet Valve 2 (in actuator)	MBR
04/04LCS1	Outlet Valve 1 to pack.II (in actuator)	MBR
04/04LCS2	Outlet Valve 2 to pack.II (in actuator)	MBR
04/03LCS1	Outlet Valve 1 to pack.V (in actuator)	MBR
04/03LCS2	Outlet Valve 2 to pack.V (in actuator)	MBR

4.4 GENERAL COMMENTS:

Dry running protection, no flow protection,…when necessary, will be available in all modes.

In manual Hand mode all starters shall be operated from field LCSs located next to the motor and/or from MCC pushbuttons.

When motorized actuators are considered, the LCS shall be part of the equipment itself. However, in other valves or gates the LCS shall be a separated device next to the field equipments.

5. RAW INTAKE PUMPING STATION

5.1 PROCESS DESCRIPTION:

Raw water from upstream of Cauvery river located at 45 Km west of dharmapuri is channeled to three Raw water sumps located at Raw water pump house in the vicinity of Cauvery river. There are six raw water pumps which are vertical turbine type to deliver water to WTP which is located at 6.25Km distance through 1500mm dia pipeline. Intake screens are provided at inlet of each sump in order to remove large objects such as rags or stones present in the water that can be easily raked. An antihammer device is provided along with compressor to prevent head losses in the pipeline for non turbulent flow in the pipeline. Drainage pumps are provided in the sump to drain water during cleaning/servicing of the sump.

Pump Details:

Type	: Vertical turbine pumps with water lubricated bearings.
No of pumps	: 6Nos
No of working pumps	: 4Nos
No of standby pumps	: 2Nos
Total head of the pump	: 76 mtrs
Pressure across the pump	: 7.65Kg/cm²
Pump Discharge	: 1747 cu.m/hr
Velocity of the pump	: 1.5 m/sec max for suction
	: 2.5 m/sec max for discharge

Valves:

Delivery line of the vertical turbine pumps are connected to non return valve, a delivery isolating valve, and an automatic air inlet/release valve. Valve operation is done through hand wheel when it is operated manually.

Non return valves are designed for rapid closing as soon as forward flow stops.

Header Line:

All the pumps are connected by a common header line of 1200MM dia which is in turn connected to 1500MM dia raising main by using reducer. Total head across the header line is 78mtrs.

Wet well:

There are three wet wells with depth of 9mtr whose water level is 6.8mtrs. Diameter of each wet well is 5mtrs.

Surge protection:

An antihammer system is provided for surge protection across the pipe line in order to prevent head loss across the pipe line. The surge analysis should identify the most adverse and transient operational conditions. The analysis will include but not be limited to the following conditions:

1. Complete power failure to the pumping station with all duty pumps running at maximum capacity.
2. Start up of the pumps under the specified control system.
3. Shut down of the pumps under the specified control system.

The objective of the surge analysis is to recommend surge protection equipment which ensures maximum and minimum pressures under all conditions within allowable surge rating of the pipelines as indicated below.

1. Maximum pressures shall not exceed the capabilities of the pipes and fittings on the system.
2. Minimum pressures in the system shall not fall below atmospheric pressure and subsequently rise above atmospheric pressures again during the same transient event. Pressure below atmospheric pressure will only be permitted as the systems drain down through supply connections during extended periods of pump shutdown.

5.2 CONTROL AND OPERATION:

Entire plant is controlled and monitored through dedicated redundant programmable logic control system located at control room of raw water pumping station next to MCC room:

LOCAL CONTROL PANELS (LCP) LIST RWPS		
DESIGNATION	**DESCRIPTION**	**LOCATION**
01/03GA1	RAW WATER PUMPING STATION LCP-PLC1A/1B & HMI	RWPS Control room

All necessary field instruments are provided for failsafe operation of the plant and continuous monitoring the process data through CCR SCADA system.

A touch screen panel with human machine interface (HMI) graphic pages provided on the PLC panel.

HMI touchscreen shall be used to obtain alarm annunciation for any abnormal conditions occurring on instruments and drives. All the analog and digital signals from these field instruments are terminated to the terminal blocks of LCP. From I/O modules the data is transferred to main Programmable Logic Controller CPUs via Ethernet CAT5e cable.

Vertical pumps Operation

Following permissive for pump to start shall be considered:

1. Level in the sump should not be low (<20%)
2. MCC Healthy
3. Discharge motor operated butterfly valve closed.

In manual DCS mode:

In DCS manual mode, the number of pumps running will be decided by the operator. From HMI page at LCPs and/or CCR the operator will start/stop the pumps.

In auto DCS mode:

Total number of vertical turbine pumps required for pumping raw water to the Water treatment plant is 6nos in which 4 are working and 2 are standby. Time duration for operation of each pump shall be 4 hrs. After four ours immediate pump will take over the operation. In auto mode automatic switchover of the pumps takes place 4 hrs of operation of each pump. This maximizes the life of the pump.

Drainage pumps Operation

In manual DCS mode:

In DCS manual mode, from HMI page at LCPs and/or CCR the operator will start/stop the pumps.

In auto DCS mode:

Not available.

Antihammer device and air compressors Operation

Antihammer device will work always in auto mode and according to the water level measured at the vessel it will start or stop the air compressor on duty. Operator shall introduce at HMI page the Level Setpoint to be kept at the antihammer vessel. The compressor on duty shall be selected by operator manually in local.

Automatic valves (motorized actuators) Operation

In manual LOCAL mode:

In local manual mode, the valve shall be opened and closed from its LCS under operator requests.

In manual REMOTE mode:

In manual remote mode, the valve shall be opened and closed from HMI page at LCPs and/or CCR under operator requests.

In auto REMOTE mode:

In auto remote mode, the valve shall be opened automatically with a time delay when the associated pump has been started. The time delay shall be a SP at HMI page whose value shall be fixed by operator.

Following main Controls/Indications/ alarms provided at HMI screens (at LCP and CCR):

Screen
From RWPS: Controls Instruments faceplate SP time to open impulsion butterfly valve after pump 1 starting SP time to open impulsion butterfly valve after pump 2 starting SP time to open impulsion butterfly valve after pump 3 starting SP time to open impulsion butterfly valve after pump 4 starting SP time to open impulsion butterfly valve after pump 5 starting SP time to open impulsion butterfly valve after pump 6 starting SP maximum flow to WTP SP Level at Antihammer device Standard controls Pumps Standard controls Valves Standard controls for MV 33KV Cabinets Standard controls for 6,6 KV Cabinets Standard controls for 6,6 KV FCMA Starters indications Level measurement at pump well 1 Level measurement at pump well 2 Level measurement at pump well 3 Low level warning pump well 1 High level warning pump well 1 Low level warning pump well 2 High level warning pump well 2 Low level warning pump well 3 High level warning pump well 3 PV time to open impulsion butterfly valve after pump 1 starting PV time to open impulsion butterfly valve after pump 2 starting PV time to open impulsion butterfly valve after pump 3 starting PV time to open impulsion butterfly valve after pump 4 starting PV time to open impulsion butterfly valve after pump 5 starting PV time to open impulsion butterfly valve after pump 6 starting Standard Indications for motors and valves Compressor related indications (running, stopped and failure) Antihammer (level indication) Pressure at the discharge

Flow measurment at the discharge
MFM measurements
Temperature scanner measurement pump 1
Temperature scanner measurement pump 2
Temperature scanner measurement pump 3
Temperature scanner measurement pump 4
Temperature scanner measurement pump 5
Temperature scanner measurement pump 6
Standard indications for MV 33KV Cabinets
Standard indications for 6,6 KV Cabinets
Standard indications for Transformers
Standard indications for 6,6 KV FCMA Starters
alarms
Low-low level alarm pump well 1
High-high level alarm pump well 1
Low-low level alarm pump well 2
High-high level alarm pump well 2
Low-low level alarm pump well 3
High-high level alarm pump well 3
Standard alarms for motors and valves
Standard alarms for MV 33KV Cabinets
Standard alarms for 6,6 KV Cabinets
Standard alarms for Transformers
Standard alarms for 6,6 KV FCMA Starters
Compressor failure
low flow pump 1
low flow pump 2
low flow pump 3
low flow pump 4
low flow pump 5
low flow pump 6
Pump 1 Valve fail to open after time delay
Pump 2 Valve fail to open after time delay
Pump 3 Valve fail to open after time delay
Pump 4 Valve fail to open after time delay
Pump 5 Valve fail to open after time delay
Pump 6 Valve fail to open after time delay

From WTP:

indications
Parshall Flume flow measurement
Tretaed water reservoir level
Treated water flow rate

Treated water volume alarms WTP Power failure alarm Overflow alarm

6. WATER TREATMENT PLANT

6.1 PROCESS DESCRIPTION:

Water taken from Cauvery River is pumped through intake pumping station and treated at 168MLD WTP. Drinking water is pumped to Booster pumping station through treated water pumping station. Entire system is completely automated with the help of dedicated programmable logic controller at different stages of treatment.

Raw water is treated at different stages whose sequence of operation is given as below

1. Water inlet
2. Clarification
3. filtration
4. Contact tank
5. Treated water storage and pumping
6. Used wash water recovery
7. Sludge treatment
8. Chemical Treatment

1. WATER INLET:

Raw water from Intake pumping station is delivered at water treatment plant through a pipeline which is terminated at inlet works of WTP, Parshall flume is provided at the inlet works to measure inlet flow. Design flow in the parshall flume shall be 7137m^3/h. Depth of the channel is approximately 2mtrs. Aluminum sulphate and clorine dosing is done in the down stream section of parshall flume for pretreatment of water.

Water is channeled to clarifiers after pretreatment for clarification purpose.

2. CLARIFICATION:

8 No of flat bottom sludge blanket clarifiers are provided for clarification raw water.

The design considers flat bottom clarifiers with top channels and trident distributors, outlet channels and the special sludge concentrating devices with height regulation, and automatic extraction though automatic valves.

Flow across each clarifier shall be 892m^3/hr and Total flow is 7,138m^3/hr. Turbidity of water at the outlet of clarifiers shall be 5NTU to 10NTU.

Sludge from clarifiers shall be collected at sludge pumping chamber through clarifier outlet channel.

Estimated sludge production from clarifiers is 384.1m^3/hr.

Clarified water is sent to next stage of treatment through a pipeline of 1700mm dia.

3. FILTRATION:

Clear water is further treated with 12nos of Rapid gravity sand filters with for more clear and safe water which aids in removal of taste, odor, and manganese.

Clear water from clarifiers is collected at each filter through a distribution channel. A solenoid operated sluice gate is provided at the inlet of each filter for allowing required amount of water for filtration.

The removal of particulate matter in a granular filter occurs in the following manner:

1. The quality of particles removed by a layer of filter medium is proportional to the concentration entering that layer.
2. Filter performance varies with time, first increasing and then decreasing.
3. The quantity of particles removed by a layer of filter medium equals the quantity accumulated in the filter pores.
4. A layer eventually reaches a point at which it no longer effectively clarifies the suspension and the concentration leaving equals that entering.
5. The equilibrium condition is reached first at the inlet layer and proceeds progressively through the filter in the direction of flow.

As the successive layers of the filters become saturated with removed material, the headloss through the bed will increase due to the constriction of the flow. If the headloss becomes excessive a partial vacuum may be created within the medium causing air bubbles to be formed from gases drawn from solution. Such "air-binding" further restricts the area of flow, increases velocity and headloss, and may cause particles to be carried from the filter.

Large particles which are strongly bound will tend to be removed in the upper layers of the filter, producing high headloss with little penetration of floc. This phenomenon will be particularly pronounced if the filter medium is fine. Finer suspended particles, particularly upon coarse filters, will tend to penetrate further into the bed, distributing the reduction in flow capacity and producing lower head losses for equivalent removal over equal time periods. Since deeper penetration is expected, coarse beds should logically be deeper, and these have been shown to be necessary. Consideration of the theory of filtration leads to the conclusion that it is the area of the filter media which is important, but since this is a function of particle size and bed depth, it follows that increasing the size of the medium will require an increase in depth.

Filter media used for rapid sand filters shall be silica sand.

The under drain system collects the filtered water from the sand and also distributes the wash water and air during the backwashing process. To be satisfactory, the under drains should collect and distribute water as evenly as possible, although this cannot always be done exactly because of the slight difference in head occurring at various points in the system. Hydraulic systems which provide for uniform distribution of water to uniform collection of water from an extensive area require that the headloss through the orifices be large in comparison to that in the main carriage system.

The filter design considers a modern design underdrain false bottom underneath the filter media, which will minimize this problem by using special distribution nozzles, including approx. 68 nozzles per square meter, with a total number of 93,600 nozzles in the Plant.

Filter backwash

Back wash of the filters will be triggered automatically when there is a head loss and be back up timer.

The method of cleaning filters shall be by simultaneous application of air and water followed by a water rinse.

Filter washing shall be automatic following manual initiation. Filter valves and penstocks which require to be operated as part of the wash sequence shall be fitted with pneumatic actuators of the double acting type.

Air blowers are provided for supply of air for backwash. Flow of air shall be 6800m³/hr.

Back wash water is supplied to the filters from elevated water tank with the help of two elevated water pumps. Capacity of elevated water pumps is 500m³/hr.

During back wash all other operations are terminated to avoid any interruption of back wash.

4. CONTACT TANK:

The contact tank is designed to provide a minimum effective contact time t of 30 minutes, between the time of entry into the tank and the time of discharge of disinfected water from the tank into the treated water reservoir, at the rated throughput. The effective contact time has been defined as the detention time at which 90% of the water passing through the contact tank is retained within the tank. The "C.t' value (= free chlorine residual concentration C mg/l at the end of the effective contact time txt minutes) will not be less than 15 mg.min/l.

5. TREATED WATER STORAGE AND PUMPING:

Treated water from constant head tank is collected at treated water Reservoir with two compartments designed for storage period of 1 hr. Outlet of the treated water reservoir is connected to the pump wells with help of sluice gates/penstocks. Treated water is delivered water to BPS which is located at 1.8Km distance through 1500mm dia pipeline .Treated water pumps is designed to house 6No of pumps whose Details are given as below:

Pump Details:

Type	: Vertical turbine pumps with water lubricated bearings.
No of pumps	: 6Nos
No of working pumps	: 4Nos
No of standby pumps	: 2Nos
Total head of the pump	: 109 mtrs

Pressure across the pump	: 10.9Kg/cm²
Pump Discharge	: 1727 cu.m/hr
Velocity of the pump	: 1.5 m/sec max for suction
	: 2.5 m/sec max for discharge

Valves:

Delivery line of the vertical turbine pumps are connected to non return valve, a delivery isolating valve, and an automatic air inlet/release valve.

Isolating valves at the delivery line of the pump is resilient-seated butterfly valve fitted with electric actuators. Valve operation is done through hand wheel when it is operated manually.

Non return valves shall be of the swing-check type, designed for rapid closing as soon as forward flow stops.

Header Line:

All the pumps are connected by a common header line of 1200MM dia which is in turn connected to 1500MM dia raising main by using reducer. Total head across the header line is 109mtrs. Material of construction of header line is MS.

Wet well:

There are three wet wells with depth of 7.3mtr whose water level is 4mtrs.

6. USED WASHWATER RECOVERY:

Used backwash water pumps

A 2000 m^3 volume used wash water holding tank has been provided. The tank is rectangular (37x12.5) in plan with the floor laid to a fall and terminating in a pump sump. The capacity of each compartment of the tank shall be adequate to store as a minimum, the wash water from two consecutive filter washes.

The used wash water shall flow into an inlet channel and then through penstocks into the compartment in use.

The inlet channel to the tank shall be provided with an overflow discharging to the site drainage system.

Each compartment shall have a floating draw-off arm which shall be design to remove settled water from the upper part of the tank. The floating arm shall be connected to the draw-off connection by an articulated pipe. A restraint system shall be provided to prevent excess movement of the floating draw-off arm and articulated pipe during filling and when the compartment is fully emptied.

Used wash water return

After a period of settling the supernatant shall be returned to the works inlet from the used washwater recovery tank at a rate not exceeding 5% of the raw water inflow to the treatment plant. The water remaining shall be pumped to the sludge balancing tank..

The washwater recovery pump house shall be arranged as a wet basement having a common wall with the washwater recovery tank.

Submerged pumps (one on duty, one stand by) shall be provided for supernatant.

Submerged pumps (one on duty, one stand by) shall be provided for sludge.

Operation of the pumps shall be controlled by level probes in each compartment of the used washwater recovery tank. Pumps shall be arranged for automatic changeover from duty to standby on the failure of the duty pump.

7. SLUDGE TREATMENT:

Sludge from different stages of treatment such as clarifiers and wash water recovery tank is treated before disposal to the drying beds, following works are included for the this purpose:

a) Sludge balance tanks
b) Thickener feed pumps
c) Sludge thickeners
d) Thickened sludge collection and disposal
e) Sludge drying beds.

Sludge balance tanks:

The function of the balance the intermittent sludge discharges from the clarifiers and from the used wash water recovery tank, to provide a well mixed uniform sludge to the thickeners and act as a sump for the thickener feed pumps. The tanks shall be sized to balance the intermittent flow while it is withdrawn at a steady rate and be sized to balance the intermittent flow while it is withdrawn at a steady rate and concentration to the thickeners.

One tank with two equal compartments of combined capacity adequate to balance sludge discharges shall be provided.

Submersible mixer shall be provided with level measuring equipment for pump control to ensure a minimum submergence required for the mixer is maintained to prevent dry running of the pumps and for clarifier and wash water recover tank desludge inhibit and alarm initiation.

Balance tank compartments shall be provided with an overflow discharge to the sludge drying beds.

A hydrant shall be provided on the tanks for washing down purposes.

Thickener feed pumps:

Pumps employed for sludge transfer to sludge thickener shall be located below the minimum sludge level in the wet well to ensure that they are fully primed and operate under positive suction head at all times. Drive from the motor pump shall be direct and motors shall be mounted at a suitable level to avoid the risk of flooding.

Pumps shall be of the vertical spindle volute type arranged to draw sludge directly from the tank. Pump volute casing shall have integral suction and delivery branches and shall be constructed to permit the removal of the rotating assembly without disturbing the branch connections.

Each thickener shall be employed to provide with two pumps (one duty, one standby). The duty pump of each pair of pumps shall be arranged to draw sludge from the two balance tanks separately and pumps to the respective thickener.

However the outlets of all the pumps shall be manifolded to allow two duty pumps feed one thickener when the other thickener is out of service for maintenance. Each feed pump shall have an output equivalent to at least the thickener scraper capacity.

Drain pumps are provided in the drain sump to collect and evacuate drainage in the pump area. There shall be two pumps arranged to operate on automatic level controls as duty and duty assist.

All drainage shall be discharged to the sludge balance tanks.

Sludge thickeners:

Two thickeners of the continuous flow type suitable to thicken the sludge feed to a concentration (15g/l) without the aid of polyelectrolyte shall be provided.

Thickeners are designed for continuous thickening of coagulant sludges with and without polyelectrolyte conditioning.

Thickener shall comprise a feed channel or pipe discharging to a central feed well a scraper mechanism driven by a fixed speed motor for moving sludge to a central hopper and a peripheral launder

Each thickener shall be provided with bypass facilities to allow part or all of the clarifiers sludge to be discharged directly to drying beds.

Thickeners shall be provided with access to the top of the thickener to enable cleaning of supernatant launders and operation and maintenance of scraper drive unit to be carried out.

Thickened sludge collection and disposal:

Sludge from the thickeners shall be discharged to the sludge drying beds by gravity. Each thickener sludge outlet pipe shall be provided with pneumatically operated valve arranged to operate on timer control. Each

power operated valve shall be provided with a guard valve. Valves shall be provided with access for maintenance. Where chambers are provided access shall be by stairs.

The thickeners by pass and the overflow from the site septic tank shall also be discharged to the sludge drying beds.

Supernatant from the sludge thickeners shall be discharged by gravity to a nallah.

Sludge drying beds:

Reusable type sludge drying beds shall be provided to accept sludge from the thickeners of concentration up to 15g/l without polyelectrolyte and 30g/l with polyelectrolyte.
The capacity of sludge depends on time to decant supernatant and rainfall and time to evaporate or drain water from the sludge and rainfall in the wettest month of the year.

8. CHEMICAL TREATMENT:

Aluminum sulphate preparation:

Aluminum sulphate will be delivered in approximately 17 to 20 Kg blocks. Aluminum sulphate shall be stored in the chemical building, transferred to saturator tanks and drawn by pumps as a saturated solution which shall then be diluted in stock tank is, transferred to constant head tank for metering under gravity to the point of application.

Coagulation is a physical and chemical reaction occurring between the alkalinity of the water and the coagulant added to the water, which results in the formation of insoluble flocs.

The best pH for coagulation usually falls in the range of pH 5 to 7. The proper pH range must be maintained for the coagulants to form flocs. Residual alkalinity in the water serves to buffer a pH change in the system and aids in the complete precipitation of the coagulant chemicals. The amount of alkalinity in the raw water is generally not a problem unless the alkalinity is very low. Alkalinity may be increased by adding lime or soda ash.

Evaluation of these water quality indicators help to select the type of chemical coagulants to be used at a particular water treatment plant or to change the type of coagulant normally used if significant changes in pH and alkalinity occur in the raw water.

Saturator

A total of two saturators constructed in concrete each of aluminum sulphate storage capacity of not less than 16 t are provided. The effective volume of a tank (excluding the gravel layer and free board) is not less than 38,000 liters. The tanks shall be lined with fiber reinforced plastic.

Saturated Solution Recirculation and Transfer

Two pumps (one duty, one standby) are provided for recirculation and transfer of a saturated solution and the pumps are of the centrifugal horizontal type. The pumps will be arranged to draw a saturated solution of aluminium sulphate from any selected saturator downstream of the strainer and return to the same saturator.

Each pump is sized to turn over the solution in a saturator (making an allowance for the solid present) in less than 2.5 hours. The pumps also transfer the solution from one saturator to another. The capacity of each pump is 20 m^3/h. The same pumps shall be used to transfer aluminium sulphate from the saturators to the stock tanks.

Stock Tanks

The saturated solution containing approximately 70% w/v (700 g/l) of solid as 15.2% w/w Al_2O_3 will be diluted in the stock tanks to a concentration of 10% w/v (100 g/l).

The dilution process comprises transfer of a known volume of saturated solution to the stock tank followed by the addition of water to the maximum level in the tank and mixing of the contents.

Two GRP lined concrete tanks each of working capacity 20,000 liters are provided. Each tank shall be equipped with a mixer. The tanks shall be arranged to operate on a rotational batch basis. The estimated holding period for a single tank at the maximum demand is about eight hours.

Diluted Solution Feed to Constant Head Tank

Two feed pumps (one duty, one standby) of the centrifugal type arranged to draw the chemical from any one of the selected stock tanks and feed a constant head tank are provided.

Constant Head Tank

One constant head tank of fiber reinforced plastic construction and of capacity 1,000 litres are provided. The tank shall be arranged to operate as a constant head tank by providing a supply of aluminium sulphate solution in excess of the maximum outflow from the tank for the coagulation process and discharging the excess as overflow to the stock tanks.

Aluminium Sulphate Dosing

Aluminium sulphate solution from the constant head tank shall be conveyed to the point of application by gravity. The point of application shall be provided with a minimum of one duty variable area flow meter. The capacity of the flow meters shall not be less than 2,380 l/h, and shall be graduated in 50 l/h major divisions and 5 l/h minor divisions.

Lime Milk dosing:

Hydrated lime is widely used to adjust the pH of water to prepare it for further treatment. Lime is also used to combat "red water" by neutralizing the acid water, thereby reducing corrosion of pipes and mains from acid waters. The corrosive waters contain excessive amounts of carbon dioxide. Lime precipitates the CO2 to form calcium carbonate, which provides a protective coating on the inside of water mains.

The plant for lime storage, handling, slurry and solution preparation, metering, and transfer shall be provided. Lime will be of the hydrated type consisting 92% w/w $Ca(OH)_2$ and will be delivered to the works in 50 kg bags. Lime shall be stored in the chemical building, manually emptied into tanks for preparing 5% w/v (50 g/l) slurry and then transferred by pumps to lime saturators for metering to the points of application.

Slurry Preparation Tank

Two vertical concrete tanks has been designed. The concentration of lime slurry prepared in the tanks will be 5% w/v (50 g/l) and the working capacity of a tank will be 31,000 liters. The estimated holding period of a single tank at maximum demand, (combined maximum dose x maximum flow) is about eight hours.

Each tank shall be provided with a cover complete with a dust filter sock and a hinged access hatch. A bag loader sized for taking bags up to 50 kg capacity shall be provided on each tank. Tanks shall be equipped with slow speed paddle type or similar mixers for mixing lime and keeping lime in suspension.

The tanks shall be provided with a water supply. Water inlet and slurry outlet shall be provided with isolating valves. A valve drain shall also be provided on each tank.

Each slurry tank is provided with level electrodes for level monitoring.

Slurry Transfer Pumps

Lime slurry transfer pumps will be of the open impeller centrifugal type. Two pumps (one duty, one standby) each of capacity 20 m^3/h will be provided. Each pump is arranged to draw lime from any selected slurry tank and pump separately to a selected saturator. Each delivery pipe is provided with a magnetic flow meter with local and remote indication.

Pumps are provided with pressure gauges. Flushing connections are provided on pumps, pump suction manifold, pump delivery saturator manifolds and the manifolds at each saturator.

Saturator

Saturators shall be designed to prepare a saturated solution of lime. The concentration of a saturated solution is about 1.53 g/l at 30ºC. In practice, the concentration of lime that can be expected from a saturator is estimated to be about 85% of the theoretical value.

Lime Injection

Lime solution from the saturators serving each dosing point is combined as applicable and metered to the point of application by gravity. The point of application is provided with a minimum of one duty variable area flow meter.

Chlorine

Prechlorination:

Pre chlorination is the application of chlorine to water prior to any unit treatment process. The point of application as well as dosage will be determined by the objectives *viz.;* control of biological growths in raw water conduits, promotion, of improved coagulation, prevention of mud ball anti slime formation in filters, reduction of taste, odor and color and minimizing the post chlorination dosage when dealing with heavily polluted water.

Postchlorination

Post chlorination is the application of chlorine to water before it enters the Treated water reservoir distribution system to control of biological growths.

Chlorine is drawn as a gas from drums and metered under vacuum, mixed with water in ejectors and transferred to the points of application.

Plant for storage, metering and dosing of chlorine is provided and contained in a fully segregated self-contained building.

6.2 CONTROL AND OPERATION:

Entire plant is completely automated with manual over ride facility (LCSs). Entire plant is controlled locally via LCPs with redundant PLC's provided at various buildings associated with treatment process:

LOCAL CONTROL PANELS (LCP) LIST WTP		
DESIGNATION	**DESCRIPTION**	**LOCATION**
02/30GA1	WATER TREATMENT PLANT CENTRAL CONTROL PANEL (At control Building CCR) -PLC1A/1B	WTP: at CCR in Filtering
02/23GA1	WTP: CLARIFICATION PLANT LOCAL CONTROL PANEL (LCP)-PLC2A/2B & HMI	WTP: at MCC electrical
02/30GA2	WTP: FILTERING PLANT MAIN LOCAL CONTROL PANEL (MLCP)-PLC3A/3B & HMI	WTP: at MCC electrical
02/06GA1	WTP: Auxiliary Control Panel Filter n.1 (ALCP)-PLC3.1 & HMI	WTP: at filtering gallery
02/06GA2	WTP: Auxiliary Control Panel Filter n.2 (ALCP)-PLC3.2 & HMI	WTP: at filtering gallery
02/06GA3	WTP: Auxiliary Control Panel Filter n.3 (ALCP)-PLC3.3 & HMI	WTP: at filtering gallery
02/06GA4	WTP: Auxiliary Control Panel Filter n.4 (ALCP)-PLC3.4 & HMI	WTP: at filtering gallery
02/06GA5	WTP: Auxiliary Control Panel Filter n.5 (ALCP)-PLC3.5 & HMI	WTP: at filtering gallery
02/06GA6	WTP: Auxiliary Control Panel Filter n.6 (ALCP)-PLC3.6 & HMI	WTP: at filtering gallery
02/06GA7	WTP: Auxiliary Control Panel Filter n.7 (ALCP)-PLC3.7 & HMI	WTP: at filtering gallery
02/06GA8	WTP: Auxiliary Control Panel Filter n.8 (ALCP)-PLC3.8 & HMI	WTP: at filtering gallery
02/06GA9	WTP: Auxiliary Control Panel Filter n.9 (ALCP)-PLC3.9 & HMI	WTP: at filtering gallery
02/06GA10	WTP: Auxiliary Control Panel Filter n.10 (ALCP)-PLC3.10 & HMI	WTP: at filtering gallery
02/06GA11	WTP: Auxiliary Control Panel Filter n.11 (ALCP)-PLC3.11 & HMI	WTP: at filtering gallery
02/06GA12	WTP: Auxiliary Control Panel Filter n.12 (ALCP)-PLC3.12 & HMI	WTP: at filtering gallery
02/21GA1	WTP: TREATED WATER PLANT LOCAL CONTROL PANEL (LCP)-PLC4A/4B & HMI	WTP: at MCC electrical
02/22GA1	WTP: CHEMICAL PLANT LOCAL CONTROL PANEL (LCP)-PLC5A/5B & HMI	WTP: at MCC electrical
02/22GA2	WTP: SLUDGE TREATMENT PLANT LOCAL CONTROL PANEL (LCP)-PLC6A/6B & HMI	WTP: at MCC electrical
02/23GA2	WTP: CHLORINATION PLANT LOCAL CONTROL PANEL (LCP)-PLC7A/7B & HMI	room in chlorination building
DESIGNATION	**DESCRIPTION**	**LOCATION**
05/01GA1	DHARMAPURI CCR CONTROL PANEL-PLC1A/1B	

All the analog and digital signals from field instruments are terminated to the terminal blocks of LCPs. From I/O modules the data is transferred to main Programmable Logic Controller CPUs via Ethernet CAT5e cable.

At each LCP associated to a process zone the necessary HMI screens are provided to monitor critical plant states and alarms during fault and abnormal conditions. Besides, information necessary to the overall running of the treatment works shall be presented in the CCR in the filter building.

Data from each PLC is monitored and controlled from CCR SCADA system located at filter building for centralized control and monitoring. Communication between LCP redundant controller and CCR SCADA is via fiber optic redundant cable.

Additionally, **f**ilter washing shall be controlled individually by the ALCDs dedicated PLCs with a redundant link to the MLCP for control of common filter wash facilities as described above. These ALCDs shall be equipped with non redundant PLCs, one HMI screen and pushbuttons and lights facilities in the front part for main manual operations.

Automation level:

Following automatic operations are provided with the help of local PLC's and central control room DCS system.

1. Automatic desludging of clarifiers
2. Automatic filter flow control
3. Automatic filter washing following manual initiations
4. Automatic changeover of the chlorine drums
5. Automatic operation of chlorine building ventilation system
6. Automatic operation of wash water supply pumps, used wash water transfer pumps and thickener feed pumps
7. Automatic desludging of sludge thickeners
8. Automatic operation of some drain pumps as specified.

Local Control Panels configuration:

Each LCP shall contain control relays and dedicated I/O modules and redundant PLCs. Each LCP shall also contain panel front controls, indication and alarms by means of HMI screens to enable the operator to operate plant locally. Besides, as mentioned in point 3 of this document, the hand mode shall be also available from MCC or LCS in the event of failure of central SCADA or communication network.

Instrumentation analogue transmitters, trip amplifiers, signal conditioning devices and relays shall be operated from a 24volt DC power units backed up by the uninterrupted power supply.
The marshalling section of the LCP shall contain the termination facilities for each external connection and distribution boards for 230V AC and 24VDC supplies to each item of internally mounted and association external equipment. Each supply circuit shall be protected by an MCB with auxiliary contacts.

6.2.1 CLARIFICATION:

Clarification plant is controlled with help of LCP at MCC room of chlorination building where clarification MCC is installed. Clarification LCP shall be provided with its own independent redundant control system.
There have been foreseen 8 clarifiers with 12 valves each for desludging. At the sludge pumping chamber two (1+1 standby) submersible pumps are installed with low-low, low and high level switches in the tank. The pump on duty will be selected at HMI page.
At the outlet of the clarifying system to the filters there will be Flow and Turbidity measurement.

Desludging valves system

Desludging of clarifiers is fully automatic and shall be designed to carry out both intermittent and continuous desludging. Automatic control of eccentric type pneumatically operated desludging valve is provided with necessary multi range adjustable timers for setting duration and interval for each valve.

The automatic desludging shall be provided with manual override facilities both of a discharge sequence and for the operation of individual valves. Two control units LCSs next to clarifiers are provided with local push button controls for local manual operation.

LCS 1: valves operation clarifiers 1 to 4
LCS 2: valves operation clarifiers 5 to 8

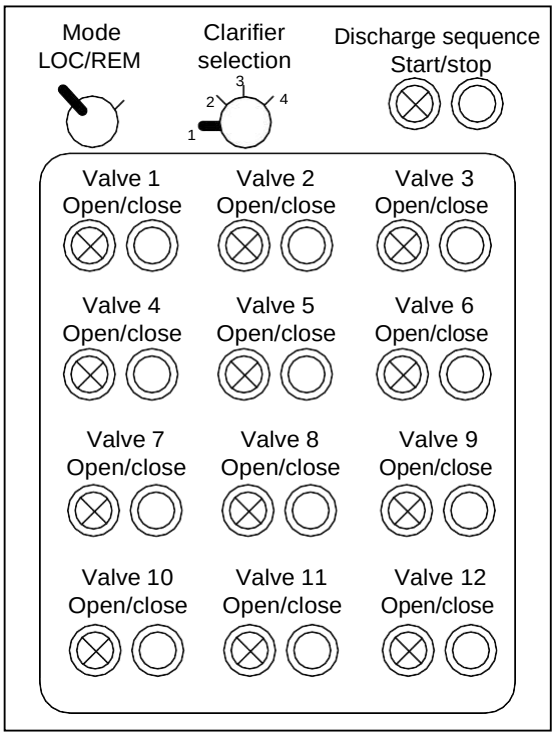
At each LCS two selectors shall be provided in order to:

Two positions selector switch: for LOC/REM mode selection
Four positions selector switch: for selection of clarifier to be operated

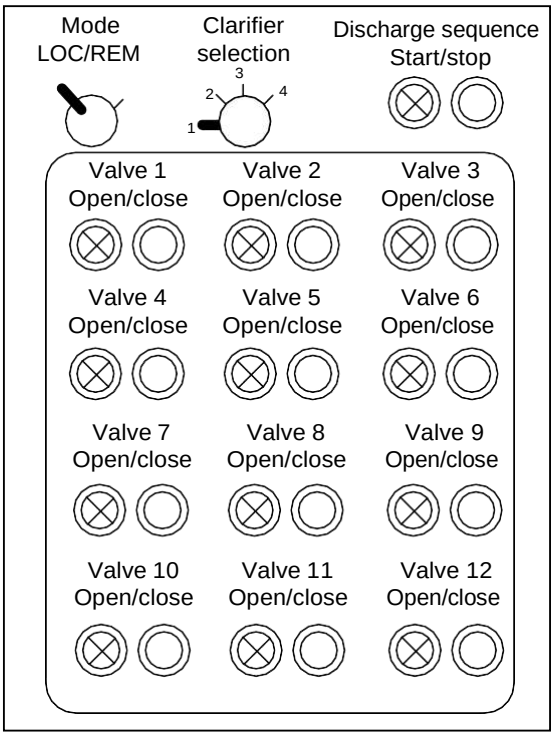
In manual LOCAL mode:

In local manual mode, the valves of each clarifier will be able to be operated individually or initiate a discharge sequence under operator request from LCS pushbuttons.

CLARIFIERS 1 TO 4 (VALVES OPERATION)



CLARIFIERS 5 TO 8 (VALVES OPERATION)



In manual REMOTE mode:

In remote manual mode, the valves of each clarifier will be able to be operated individually or initiate a discharge sequence under operator request from HMI page at LCP and/or CCR.

In auto REMOTE mode:

The desludging system in auto mode will be time-controlled system. At the HMI there will be available time Set points for each valve (SP Time ON and SP time off) and according to these time presets the valves will open and close automatically.
Desludging system will be inhibited in case of high-high level at sludge balance tank.

Sludge pumping chamber

Sludge from clarifiers is collected at sludge pumping chamber where conductivity electrodes are provided low and high alarms. When level in the sludge pumping chamber is High, inhibits the desludging valves and same will be annunciated at the LCP and CCR.
At the outlet of the clarifying system to the filters there will be Flow and Turbidity measurement.

In manual DCS mode:

In DCS manual mode, from HMI page at LCPs and/or CCR the operator will start/stop the pumps. Sludge pumping system will be inhibited in case of high-high level at sludge balance tank.

In auto DCS mode:

In auto mode the pump selected as duty will be started according to the level in the sludge chamber. When high level switch is reached, the pump will be automatically started. When low level is reached, the pump will be automatically stopped. Sludge pumping system will be inhibited in case of high-high level at sludge balance tank.

Following main Controls/Indications/ alarms provided at HMI screens and LCSs:

At LCSs:

Front panel 2	**(Clarifiers 1 to 4)**
	Control facilities
	LCS Loc/Rem selector switch
	Button Lamp test
	Clarifier 1-2-3-4 selector switch
	Buttons discharge sequence star/stop
	Buttons open/close valve 1
	Buttons open/close valve 2
	Buttons open/close valve 3
	Buttons open/close valve 4
	Buttons open/close valve 5
	Buttons open/close valve 6
	Buttons open/close valve 7
	Buttons open/close valve 8
	Buttons open/close valve 9
	Buttons open/close valve 10
	Buttons open/close valve 11
	Buttons open/close valve 12
	Indication facilities
	Discharge sequence running light
	Openes light Valve 1
	Openes light Valve 2
	Openes light Valve 3
	Openes light Valve 4
	Openes light Valve 5
	Openes light Valve 6
	Openes light Valve 7
	Openes light Valve 8
	Openes light Valve 9
	Openes light Valve 10
	Openes light Valve 11
	Openes light Valve 12
Front panel 2	**(Clarifiers 5 to 8)**
	Control facilities
	LCS Loc/Rem selector switch
	Button Lamp test
	Clarifier 1-2-3-4 selector switch
	Buttons discharge sequence star/stop

	Buttons open/close valve 1
	Buttons open/close valve 2
	Buttons open/close valve 3
	Buttons open/close valve 4
	Buttons open/close valve 5
	Buttons open/close valve 6
	Buttons open/close valve 7
	Buttons open/close valve 8
	Buttons open/close valve 9
	Buttons open/close valve 10
	Buttons open/close valve 11
	Buttons open/close valve 12
	Indication facilities
	Discharge sequence running light
	Openes light Valve 1
	Openes light Valve 2
	Openes light Valve 3
	Openes light Valve 4
	Openes light Valve 5
	Openes light Valve 6
	Openes light Valve 7
	Openes light Valve 8
	Openes light Valve 9
	Openes light Valve 10
	Openes light Valve 11
	Openes light Valve 12

At LCPs:

Screen	
	Control facilities
	Reset alarms
	Standard controls for Pumps
	Standard controls for Valves
	Instruments faceplate
	Timer SPs per each valve at each clarifier
	Sludge pumping chamber pump selection
	Discharge sequence star/stop
	Indication facilities
	Standard Indications for pumps and valves
	Timer PVs per each valve at each clarifier
	High level Sludge pumping chamber
	Low level Sludge pumping chamber

	Flow and turbidity at clarification oulet Parshall Flume flow measurement Discharge sequence running Sludge pumping chamber pump selected **Alarm facilities** MCC Power failure alarm Sludge balance tank Overflow alarm Low-low level Sludge pumping chamber High turbidity at clarification outlet alarm

6.2.2 FILTRATION (FILTERS):

Each filter shall be provided with the following automated equipment:

1. Pneumatic open/close type inlet penstock
2. Pneumatic open/close type wash out valve.
3. Pneumatic open/close type wash inlet valve.
4. Pneumatic open/close type air inlet vlave.
5. Pneumatic modulating open/close filtered water outlet valve.
6. ALCD.

Following instruments are provided for each filter:

1. Water level measurement by ultrasonic level transmitter.
2. Pressure in the filter bed measurement.

Besides, there are some common services equipment:

1. Two air scour blowers.
2. Wash water two compartment tank. At HMI page the selection of the compartment(s) to be used shall be available. It shall be possible to operate with compartment 1/compartment2/both.
3. Wash water supply regulated valve
4. MLCP with HMI panel for filter common equipments local operation and dedicated redundant PLC location.

And common services instrumentation:

1. Pressure transmitter at outlet of air blowers.
2. Pressure switch for pressure low alarm at the outlet of air blowers.
3. Pressure switch for pressure high alarm at the outlet of air blowers.
4. At filters discharge:
    - Low-low and High-High level switches
    - Ultrasonic level
    - Turbidity measurement
5. Low-low/low/high/high-high level switches Wash water tank compartment 1
6. Low-low/low/high/high-high level switches Wash water tank compartment 2
7. Wash water supply to filters flow measurement

The filtration plant operation shall be monitored and controlled from the following locations as described below:

1. Individual filter auxiliary local control desks (ALCD)
2. Filters main local control panel(MLCP)
3. CCR SCADA system

For describing the operation and control of filters we shall explain it divided into the following parts:

Filters 1. LOCAL-REMOTE operation:

Filters 2. IN SERVICE/OUT OF SERVICE filter stages:

Filters 3. WASH SEQUENCE DETAIL:

Filters 4. INDICATIONS, ALARMS AND CONTROLS:

Filters 1. LOCAL-REMOTE operation:

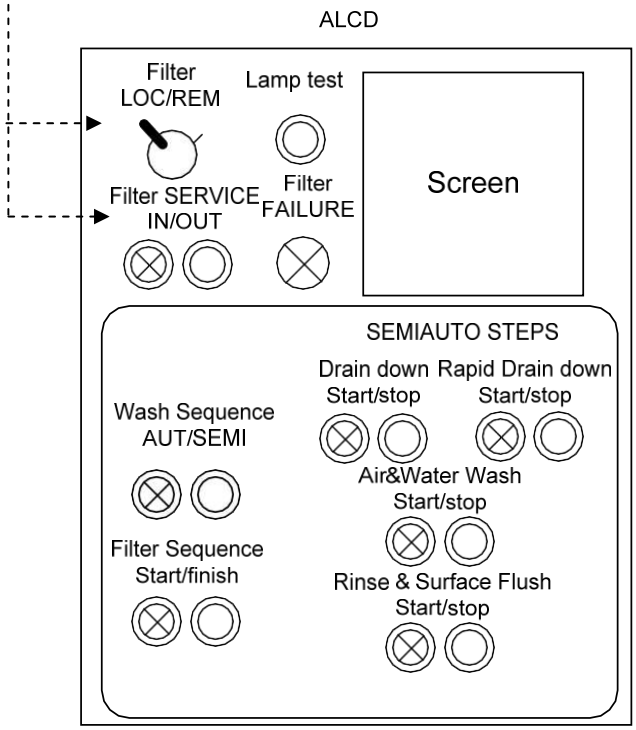
Selection of operation mode is made only from one selector switch at ALCD at each filter: "FILTER:LOC-REM":

- Selector in LOC position: filter in local mode. Operator will operate the filter from ALCD facilities.
- Selector in REM position: filter in remote mode. Operator will operate the filter from MLCP or CCR at the HMI pages.

Filters 2. IN SERVICE/OUT OF SERVICE filter stages:

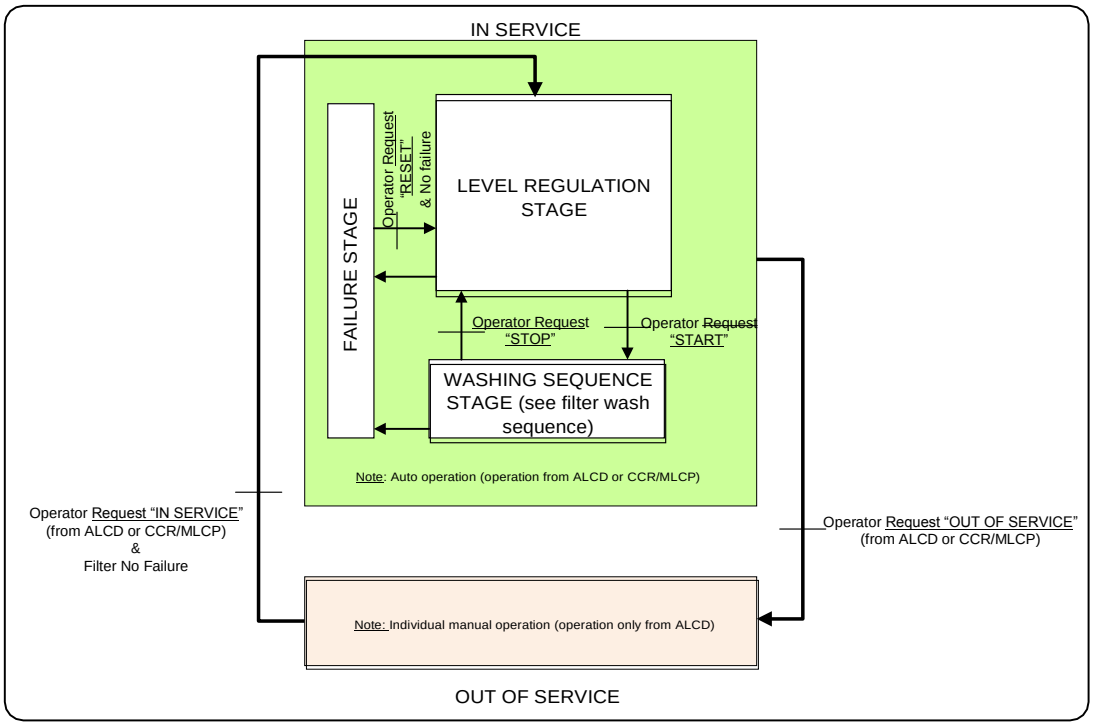
Selection:

- FROM ALCD: If ALCD in **LOC** mode ⦵ Filter in Service/Out of service locally shall be chosen with ***two pushbuttons*: "IN SERV" and "OUT OF SERVICE"**
- FROM CCR/MLCP HMI: If ALCD in **REM** mode ⦵ Filter in Service/Out of service remotely shall be chosen ***with two pushbuttons at HMI screen*: "IN SERV" and "OUT OF SERVICE"**



2.b Filter Stages description:

FILTER STAGES DIAGRAM



- **Selection IN SERVICE**: filter and all its valves in auto mode. Open and close orders are generated by PLC initiated by few manual operation requests. Three stages shall be available for the filter:

  - LEVEL REGULATION STAGE:

    in the moment that filter is switched to IN SERVICE position, the filter shall enter in LEVEL REGULATION STAGE (SEE FILTER STAGES DIAGRAM). In this stage the filter is in normal operation with outlet valve regulating the level according to SP fixed at HMI Screens and PV of Level.

    The level in the channel and filters will tend to rise and fall when plant flow increases or decreases respectively. Hence the control system shall be arranged to open or close all of the individual filter outlet flow control valves.

    The filter level controller shall have an analogue input process variable of filter level and an operator set point to set the desired level in each filter.

As filters become progressively clogged in service individual outlet valve shall be opened automatically to maintain the desired "set point "filter level. Equal flow through all filters in service shall be provided by the filter inlet weirs arranged for equal flow distribution.

When a filter is taken out of operation the remaining filter outlet valves shall then open to offset the change in level.

- WASHING STAGE :
  while filter is in level regulation stage the operator can start manually the Wash sequence from ALCD facilities "START" pushbutton ⦿ In this situation filter shall enter in WASHING SEQUENCE STAGE (SEE FILTER WASH SEQUENCE and FILTER STAGES DIAGRAM).
  When operator stops manually the wash sequence from ALCD facilities "STOP" pushbutton ⦿ In this situation filter shall enter back in LEVEL REGULATION STAGE (SEE FILTER STAGES DIAGRAM).

- FAILURE STAGE.:
  while filter is in level regulation stage or washing sequence stage, a failure can occurs ⦿ In this situation filter shall enter in FAILURE STAGE.
  When failure disappears and operator "Reset" the failure from ALCD pushbutton facility ⦿ In this situation filter shall enter again in LEVEL REGULATION STAGE (SEE FILTER STAGES DIAGRAM).

- **Selection OUT OF SERVICE**: filter and all its valves in manual mode. This position is selected for operating manually from ALCD each valve individually with facilities at ALCDs HMI.

Filters 3. WASH SEQUENCE DETAIL :

3.a Sequence in SEMIAUTO or FULL AUTO modes:

Wash sequence can be executed:

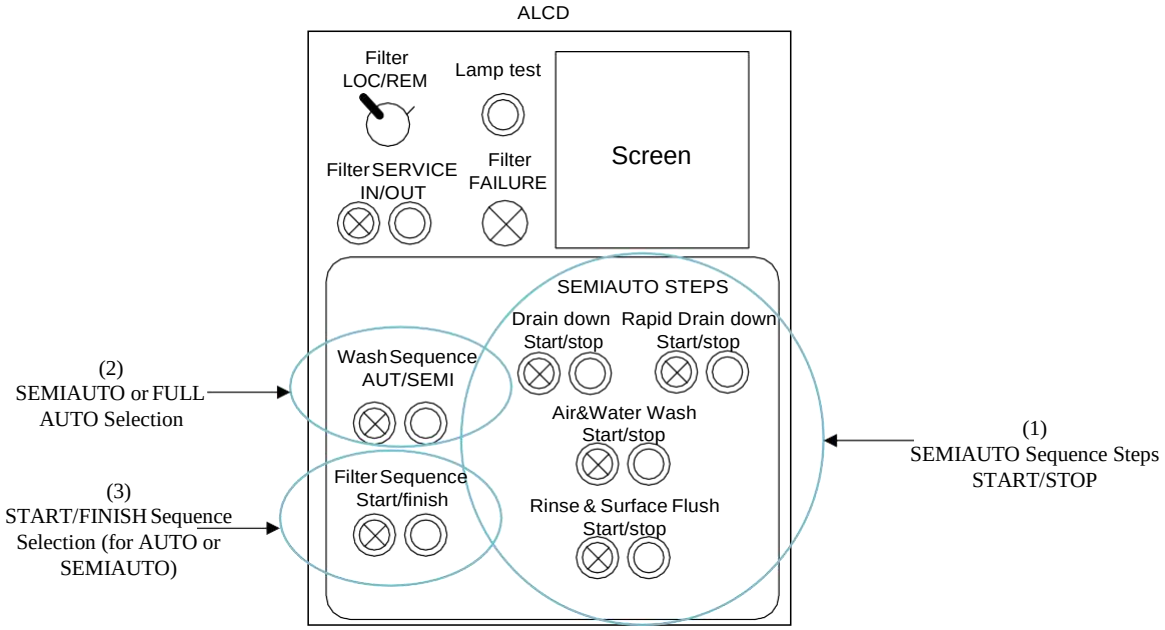
- **In FULL AUTO mode**: manual operator "START" request shall initiate the sequence from the beginning to the end and manual operator "STOP" request shall finish the sequence (see (3) at ALCD drawing).
- **In SEMI AUTO mode**: manual operator "START" request shall initiate the sequence but step by step. For skipping from one step to the next one, operator manual request is required:
  1. Drain down
  2. Washing (air&water)
  3. Rinse & Surface Flush
  4. Finish

  in this case, pushbutton facilities (see (1) at ALCD drawing) shall be available at ALCD and CCR/MLCP HMI pages.

3.b SEMIAUTO or FULL AUTO Selection:

Wash sequence auto/semiauto selection can be made from:

- FROM ALCD: If ALCD in **LOC mode and FILTER "IN SERVICE**" ⊙ Filter sequence in full auto/semiauto locally shall be chosen with ***two pushbuttons*: "AUTO" and "SEMIAUTO"** (see (2) at ALCD drawing)
- FROM CCR/MLCP HMI: If ALCD in **REM mode and FILTER "IN SERVICE** ⊙ Filter sequence in full auto/semiauto remotelly shall be chosen ***with two pushbuttons at HMI screen*: "AUTO" and "SEMIAUTO"**



3.c Sequence description

See the wash sequence GRAFCET below:

State 1: DRAIN DOWN

1. inlet penstock: Close
2. Outlet reg.valve: Stop regulation and mantain position

State 2: RAPID DRAIN DOWN

1. inlet penstock: Close
2. Outlet reg.valve: Stop regulation and close
3. Washout valve: Open

State 3: AIR & WATER WASH

1. Outlet reg.valve: Close totally
2. Air blower: Start
3. Filter Air inlet valve: Open
4. Washout valve: Open

Wait: SP_time_delay (1) for application of washwater (HMI page and/or Local Screen)

5. Filter washwater inlet valve: Open

Wait: SP_time (2) for application of air&washwater (HMI page and/or Local Screen)

6. Air blower: Stop
7. Filter Air inlet valve: Close

State 4: RINSE & SURFACE FLUSHING

1. Filter washwater inlet valve: Open
2. Other washwater supply valves:Open
3. Inlet penstock: Open

Wait: SP_time_delay (3) for Rinsing (HMI page and/or Local Screen)

3. Filter washwater inlet valve: Close
4. Other washwater supply valves:Close
5. Inlet penstock: Close

State 5: RESET

1. Reset time counters

State 6: FILTER RE-START

1. Inlet penstock: Open
2. Outlet reg.valve: Start level regulation (to Regulation Stage)

Filters 4. INDICATIONS, ALARMS AND CONTROLS:

At ALCD:

Front panel	
	Control facilities
	ALCD Loc/Rem selector switch
	Button Lamp test
	Buttons filter In service / Out of service
	Buttons Wash sequence Auto / Semi auto
	Buttons Washing sequence Start/finish
	Buttons drain-down step Start/Stop
	Buttons rapid drain-down step Start/Stop
	Buttons air/water wash step Start/Stop
	Buttons rinse & surface flush wash step Start/Stop
	Indication facilities
	Filter In service light
	Wash sequence in Auto light
	Washing sequence running light
	Draining-down step running light
	Rapid draining-down step running light
	Air/water washing step running light
	Rinse & surface flush washing step running light
	Alarms facilities
	Filter Failure light
Screen	
	Control facilities
	Reset alarms
	Instruments faceplate
	Standard controls for Blowers
	Standard controls for Valves
	Selection Blower on duty
	Selection Wash water tank compartment on duty
	SP time delay 1
	SP time delay 2
	SP time delay 3
	SP Filter Wash level
	SP filter level
	Indication facilities
	Standard Indications for blowers and valves
	Wash water recovery tank capacity enough for accepting drain down water
	Blower on duty selected
	Wash water tank compartment selected
	Filter outlet regulation valve position measurement
	Filter Level measurement
	Filter pressure measurement
	Clarified flow rate measurement

	Wash water supply regulation valve position measurement Wash water supply flow rate measurement Filtered water turbidity measurement Filtered water common channel level measurement Filtered water common channel low level warning Filtered water common channel high level warning Level measurement at wash water tank compartment 1 Wash water tank compartment 1 low level warning Wash water tank compartment 1 high level warning Level measurement at wash water tank compartment 2 Wash water tank compartment 2 low level warning Wash water tank compartment 2 high level warning Wash air pressure measurement Filter timer delay 1 count down Filter timer delay 2 count down Filter timer delay 2 count down Filter run time since last wash Filter wash sequence count down time **Alarms facilities** Standard alarms for blowers and valves Filter High head loss alarm PLC failure PLC communications failure Wash water tank compartment 1 low-low level alarm Wash water tank compartment 1 high-high level alarm Wash water tank compartment 2 low-low level alarm Wash water tank compartment 2 high-high level alarm Blower running and low pressure alam How pressure alam High turbidity at filtered water outlet alarm Filter High level alarm Wash water recovery tank capacity not enough for accepting drain down water

4.b At MCLP:

Screen
Control facilities Reset alarms Instruments faceplate Standard controls for Blowers Standard controls for Pumps Standard controls for Valves Selection Blower on duty Selection Wash water tank compartment on duty Wash water tank outlet regulation parameters SP time delay 1 filter wash seq (for each filter)

SP time delay 2 filter wash seq (for each filter)
SP time delay 3 filter wash seq (for each filter)
SP Filter Wash level filter wash seq (for each filter)
SP filter level filter wash seq (for each filter)
Buttons filter In service / Out of service (for each filter)
Buttons Wash sequence Auto / Semi auto (for each filter)
Buttons Washing sequence Start/finish (for each filter)
Buttons drain-down step Start/Stop (for each filter)
Buttons rapid drain-down step Start/Stop (for each filter)
Buttons air/water wash step Start/Stop (for each filter)
Buttons rinse & surface flush wash step Start/Stop (for each filter)
Wash water recovery tank pumping to head plant: duty pump selection
Wash water recovery tank pumping to sludge balance tank: duty pump selection
Post chlorination duty pump selection

Indication facilities

Standard Indications for blowers, pumps and valves
Wash water recovery tank capacity enough for accepting drain down water
Blower on duty selected
Wash water tank compartment selected
Filter outlet regulation valve position measurement (for each filter)
Filter Level measurement (for each filter)
Filter pressure measurement (for each filter)
Clarified flow rate measurement
Wash water supply regulation valve position measurement
Wash water supply flow rate measurement
Filtered water turbidity measurement
Filtered water common channel level measurement
Filtered water common channel low level warning
Filtered water common channel high level warning
Level measurement at wash water tank compartment 1
Wash water tank compartment 1 low level warning
Wash water tank compartment 1 high level warning
Level measurement at wash water tank compartment 2
Wash water tank compartment 2 low level warning
Wash water tank compartment 2 high level warning
Wash air pressure measurement
Filter timer delay 1 count down filter wash seq (for each filter)
Filter timer delay 2 count down filter wash seq (for each filter)
Filter timer delay 3 count down filter wash seq (for each filter)
Filter run time since last wash (for each filter)
Filter wash sequence count down time (for each filter)
Filter in service/out of nservice indications (for each filter)
Filter wash sequence in auto/semiauto indications (for each filter)
Washing sequence running indication(for each filter)
Draining-down step running indication(for each filter)
Rapid draining-down step running indication (for each filter)

Air/water washing step running indication(for each filter)
Rinse & surface flush washing step running indication(for each filter)
Levels at waste wash water recovery tank
Parshall Flume flow measurement
Wash water recovery tank pumping to head plant: duty pump selected
Wash water recovery tank pumping to sludge balance tank: duty pump selected
Post chlorination duty pump selected
Chlorine measurement
PH measurement

Alarms facilities

Standard alarms for blowers, pumps and valves
Filter in failure (for each filter)
PLC failure
PLC communications failure
Wash water tank compartment 1 low-low level alarm
Wash water tank compartment 1 high-high level alarm
Wash water tank compartment 2 low-low level alarm
Wash water tank compartment 2 high-high level alarm
Blower running and low pressure alam
Wash air High pressure alam
High turbidity at filtered water outlet alarm
Filter High level alarm (for each filter)
Filter High head loss alarm (for each filter)
Wash water recovery tank capacity not enough for accepting drain down water
Sludge balance tank Overflow alarm
MCC Power failure alarm
Chlorine very high level
PH very high level
Wash water tank being used reaches the low level and pumping from treated water reservoir are stopped a warning will be generated
Wash water tank being used reaches the low level and any filter is being washed a warning will be generated
Wash water tank being used reaches the High-High level and pumping from treated water reservoir are running a warning will be generated
Wash water tank being used reaches the low-low level the flow regulation will be inhibited and an alarm will be generated
High level at wash water recovery tank and pump (water or sludge) is stopped one warning shall be generated at HMI.
High-high level at wash water recovery tank and pump (water or sludge) is stopped one alarm shall be generated at HMI.
Low level at wash water recovery tank and pump (water or sludge) is running one warning shall be generated at HMI.
Low-low level at wash water recovery tank and pump (water or sludge) is running one alarm shall be generated at HMI.
Sludge pump running and high level is detected at balancing tank (with sludge centrifugal pumps stopped) one alarm shall be generated. In this

way the operator knows that centrifugal pump has to be started

6.2.3 FILTRATION (COMMON SERVICES):

There are some common services equipment at filtration plant:

1. Two air scour blowers.
2. Wash water two compartment tank. At HMI page the selection of the compartment(s) to be used shall be available. It shall be possible to operate with compartment 1/compartment2/both.
3. Wash water supply regulated valve
4. MLCP with HMI panel for filter common equipments local operation and dedicated redundant PLC location.

And common services instrumentation:

1. Pressure transmitter at outlet of air blowers.
2. Pressure switch for pressure low alarm at the outlet of air blowers.
3. Pressure switch for pressure high alarm at the outlet of air blowers.
4. At filters discharge:
    - Low-low and High-High level switches
    - Ultrasonic level
    - Turbidity measurement
5. Low-low/low/high/high-high level switches Wash water tank compartment 1
6. Low-low/low/high/high-high level switches Wash water tank compartment 2
7. Wash water supply to filters flow measurement

Air scour blowers:

The air scour blower on duty shall be selected remotely at HMI page from MLCP and/or CCR. Local selection shall be also available at LCS next to blowers.

In manual DCS mode:

In DCS manual mode, from HMI page at MLCP and/or CCR the operator will start/stop the blower on duty.

In auto DCS mode:

In auto mode the blower selected as duty will be started according to the filters wash sequence detailed above. In automatic mode the pre selected duty blowers shall be operated from each ALCD during the wash sequence.

In all modes the blowers shall be stopped (with certain delay) in case of high pressure detection.

Filter Wash water tank:

The flow regulating valve at wash water tank outlet shall be operated:

- manually from MLCP and/or CCR HMI pages under operator requests (Remote MAN mode)
- automatically by the control system according to the flow measurement and the flow SP fixed at HMI page (Remote AUTO mode)

Flow regulation will be inhibited when Low-low level of compartment(s) selected is reached at the wash water tank.

Used Wash water recovery tank:

There has been foreseen one wash water recovery tank divided into two compartments. At HMI page the selection of the compartment(s) to be used shall be available. It shall be possible to operate with compartment 1/compartment2/both.

Each compartment shall be provided with an ultrasonic level transmitter to measure the level in the used wash water holding tank. The ultrasonic level transmitter (LIT-208-1 & LIT-208-2) shall provide volt-free contacts for the high and low level alarms and to inhibit rapid drain down or filter wash. The level for filter wash inhibit shall be set such that if the inhibit level is reached during a rapid drain down or a filter wash each process is allowed to continue to a conclusion. The inhibit level shall be set on the assumption that both the compartments are available. The overflow and low low level conductivity probe be set to operate outside the limits of the ultrasonic level settings to avoid spurious pump trips.

Used Wash water recycled pumping station to head plant:

Water from WWR tank is pumped to head plant using two pumps (1+1).

In manual DCS mode:

In DCS manual mode, from HMI page at LCP and/or CCR the operator will start/stop the pump on duty.

In auto DCS mode:

In auto mode the pumps will be started according to level at wash water recovery tank. When high level is reached the pump shall be started and when low level is reached the pump shall be stopped.

Used Wash water recycleds pumping station to sludge balancing tank:

Sludge from WWR tank is pumped to sludge balancing tank using another two pumps (1+1).

In manual DCS mode:

In DCS manual mode, from HMI page at LCP and/or CCR the operator will start/stop the pump on duty.

In auto DCS mode:

In auto mode the pumps will be started according to level at wash water recovery tank. When high level is reached the pump shall be started and when low level is reached the pump shall be stopped.

6.2.4 TREATED WATER PUMPING STATION

Entire plant is controlled and monitored through dedicated redundant programmable logic control system located at control room of treated water pumping station next to MCC room.
All necessary field instruments are provided for failsafe operation of the plant and continuous monitoring the process data through CCR SCADA system.
A touch screen panel with human machine interface (HMI) graphic pages provided on the PLC panel.
HMI touchscreen shall be used to obtain alarm annunciation for any abnormal conditions occurring on instruments and drives. All the analog and digital signals from these field instruments are terminated to the terminal blocks of LCP. From I/O modules the data is transferred to main Programmable Logic Controller CPUs via Ethernet CAT5e cable.

Vertical pumps Operation

Following permissive for pump to start shall be considered:

4. Level in the sump should not be low (<20%)
5. MCC Healthy
6. Discharge motor operated butterfly valve closed.

In manual DCS mode:

In DCS manual mode, the number of pumps running will be decided by the operator. From HMI page at LCPs and/or CCR the operator will start/stop the pumps.

In auto DCS mode:

Total number of vertical turbine pumps required for pumping raw water to the Water treatment plant is 6nos in which 4 are working and 2 are standby. Time duration for operation of each pump shall be 4 hrs. After four ours immediate pump will take over the operation. In auto mode automatic switchover of the pumps takes place 4 hrs of operation of each pump. This maximizes the life of the pump. The number of pumps running will be fixed by the control system according the flow input allowed by the BPS taking into account the flow measured to MBR and also the level measurement at BPS tanks.

Drainage pumps Operation

In manual DCS mode:

In DCS manual mode, from HMI page at LCPs and/or CCR the operator will start/stop the pumps.

In auto DCS mode:

Not available.

Antihammer device and air compressors Operation

Antihammer device will work always in auto mode and according to the water level measured at the vessel it will start or stop the air compressor on duty. Operator shall introduce at HMI page the Level Setpoint to be kept at the antihammer vessel. The compressor on duty shall be selected by operator manually in local.

Automatic valves (motorized actuators) Operation

In manual LOCAL mode:

In local manual mode, the valve shall be opened and closed from its LCS under operator requests.

In manual REMOTE mode:

In manual remote mode, the valve shall be opened and closed from HMI page at LCPs and/or CCR under operator requests.

In auto REMOTE mode:

In auto remote mode, the valve shall be opened automatically with a time delay when the associated pump has been started. The time delay shall be a SP at HMI page whose value shall be fixed by operator.

Treated water pumping to wash water filtration tank

In manual DCS mode:

In DCS manual mode, from HMI page at LCPs and/or CCR the operator will start/stop the pumps.

In auto DCS mode:

The pumps shall be started/stopped by the control system according to the level at the wash water filtration tank and always checking that treated water level is not under low level. When level goes under medium

level is detected at wash water filtration tank, the pump will be started and when level reaches high limit, the pump will be stopped.

Following main Controls/Indications/ alarms provided at HMI screens:

Screen
From TWPS: Controls Instruments faceplate SP time to open impulsion butterfly valve after pump 1 starting SP time to open impulsion butterfly valve after pump 2 starting SP time to open impulsion butterfly valve after pump 3 starting SP time to open impulsion butterfly valve after pump 4 starting SP time to open impulsion butterfly valve after pump 5 starting SP time to open impulsion butterfly valve after pump 6 starting SP Level at Antihammer device Standard controls Pumps Standard controls Valves Standard controls for MV 33KV Cabinets Standard controls for 6,6 KV Cabinets Standard controls for 6,6 KV FCMA Starters indications Level measurement at pump well 1 Level measurement at pump well 2 Level measurement at pump well 3 Low level warning pump well 1 High level warning pump well 1 Low level warning pump well 2 High level warning pump well 2 Low level warning pump well 3 High level warning pump well 3 PV time to open impulsion butterfly valve after pump 1 starting PV time to open impulsion butterfly valve after pump 2 starting PV time to open impulsion butterfly valve after pump 3 starting PV time to open impulsion butterfly valve after pump 4 starting PV time to open impulsion butterfly valve after pump 5 starting PV time to open impulsion butterfly valve after pump 6 starting Standard Indications for pumps and valves Compressor related indications (running, stopped and failure) Antihammer (level indication) Pressure at the discharge

Flow measurment at the discharge
MFM measurements
Temperature scanner measurement pump 1
Temperature scanner measurement pump 2
Temperature scanner measurement pump 3
Temperature scanner measurement pump 4
Temperature scanner measurement pump 5
Temperature scanner measurement pump 6
Standard indications for MV 33KV Cabinets
Standard indications for 6,6 KV Cabinets
Standard indications for Transformers
Standard indications for 6,6 KV FCMA Starters
alarms
Low-low level alarm pump well 1
High-high level alarm pump well 1
Low-low level alarm pump well 2
High-high level alarm pump well 2
Low-low level alarm pump well 3
High-high level alarm pump well 3
Standard alarms for motors and valves
Standard alarms for MV 33KV Cabinets
Standard alarms for 6,6 KV Cabinets
Standard alarms for Transformers
Standard alarms for 6,6 KV FCMA Starters
Compressor failure
low flow pump 1
low flow pump 2
low flow pump 3
low flow pump 4
low flow pump 5
low flow pump 6
Pump 1 Valve fail to open after time delay
Pump 2 Valve fail to open after time delay
Pump 3 Valve fail to open after time delay
Pump 4 Valve fail to open after time delay
Pump 5 Valve fail to open after time delay
Pump 6 Valve fail to open after time delay

From Contact tank:
Controls
Instruments faceplate
Standard controls for mixers
indications

	Standard indications for mixers Treated water outlet 1 Chlorine measurement Treated water outlet 1 Turbidity measurement Treated water outlet 2 Chlorine measurement Treated water outlet 2 Turbidity measurement alarms Standard alarms for mixers Treated water outlet 1 high Chlorine alarm Treated water outlet 1 highTurbidity alarm Treated water outlet 2 high Chlorine alarm Treated water outlet 2 highTurbidity alarm
	From WTP: indications Parshall Flume flow measurement
	From BPS: controls SP maximum level at BPS sump 1 SP maximum level at BPS sump 2 indications Water outlet flow to MBR Status of pumps Level at measurement BPS sump 1 Level at measurement BPS sump 2 Low level warning at BPS sump 1 High level warning at BPS sump 1 Low level warning at BPS sump 2 High level warning at BPS sump 2 alarms BPS Power failure alarm Overflow alarm Low-low alarm level at BPS sump 1 High-high level alarm at BPS sump 1 Low-low alarm level at BPS sump 2 High-high level alarm at BPS sump 2

6.2.5 SLUDGE TREATMENT:

Clarification plant is controlled with help of LCP at MCC room of Chemical building where sludge tretament MCC is installed. Sludge treatment LCP shall be provided with its own independent redundant control system. The local control panel shall be provided with all necessary controls, state indication and alarms for routine monitoring, commissioning, manual and automatic operation, testing and maintenance of the sludge plant.

Sludge treatment plant shall comprise of two sludge balancing tanks (1+1) with one mixer and level measurement each, two sludge transfer pumps (1+1) per each thickener, two sludge thickeners and two open/close type purge valves (one per thickener). Besides, one flow meter is installed at the pumps discharge in order to measure the sludge flow to each thickener.
The balancing tank on duty will be selected at the HMI page (SERVICE-OUT OF SERVICE). The thickeners on duty will be selected at HMI page and three options will be available: THICK.1-THICK2-BOTH.
The sludge transfer pump on duty shall be selected at HMI page by the operator.

Sludge balance tanks:

In manual DCS mode:

In DCS manual mode, operator will start/stop the mixer from HMI page at LCP and/or CCR. For remote manual operation the related sludge balancing tank must be IN SERVICE for start/stop operation.

In auto DCS mode:

When the sludge balancing tank is selected at HMI page as IN SERVICE, at the HMI there will be available the Level Set point at which the mixer has to be started. According to the level SP at HMI, when the level is reached at the balancing tank the mixer will be started. When the low level is reached the mixer will be stopped.

The overflow and low low level conductivity probes (LS-210-1, LS-210-2) are set to operate outside the limits of the ultrasonic level settings to avoid spurious pump trip.

In all mode of operation the mixer shall be tripped, when a low level is detected. The operating range of levels in the sludge balance tanks shall be selected to ensure that the mixer remains submerged with the minimum required water depth all the time.

The sludge balance tank No ½ level shall be used to generate a clarifier desludge inhibit for the clarifier LCP when inadequate volume is available for desludging operation, the process is allowed to continue to a conclusion. The inhibit level shall be set on the assumption that both the compartment are available.

Thickener feed pumps:

Under normal operation, the four thickeners feed pumps shall be arranged as two sets of duty/standby pumps with each set configured to discharge to individual sludge thickeners. When a sludge thickener is out of service the normally closed valve in the pump discharge manifold will be opened manually to enable the two duty pumps to discharge to a common sludge thickener.

In manual DCS mode:

In DCS manual mode, operator will start/stop the pump selected as on duty from HMI page at LCP and/or CCR. For remote manual operation the related sludge balancing tank must be IN SERVICE for start/stop operation.

In auto DCS mode:

When the sludge balancing tank related is selected at HMI page as IN SERVICE, in auto mode the pump selected as duty will be started according to the level in the sludge balancing tank. When medium level is reached, the pump will be automatically started. When low level is reached, the pump will be automatically stopped.

Thickener

The scrapers shall be arranged to run continuously and shall be protected by a torque switch.
In manual DCS mode:

In DCS manual mode, operator will start/stop the thickeners from HMI page at LCP and/or CCR. Both thickeners can run at the same time. For remote manual operation the thickener must be IN SERVICE for start/stop operation.

In auto DCS mode:

When the thickener is selected at HMI page as IN SERVICE, in DCS auto mode the thickeners will be started according to sludge transfer pumps status. When sludge pump starts the thickeners will be started automatically. When the pump is stopped the thickeners will be stopped automatically.
The purge valves at the thickeners will be opened and closed according to time SPs to be included at HMI pages.

Following main Controls/Indications/ alarms provided at HMI screens (LCP and CCR):

Screen	
	Control facilities Reset alarms Instruments faceplate Standard controls for Pumps Standard controls for Valves Selection Sludge transfer pump on duty thickener 1 Selection Sludge transfer pump on duty thickener 2 Selection Sludge balancing tank compartment 1 Inservice/Out of service Selection Sludge balancing tank compartment 2 Inservice/Out of service SP Level of balance tank compartment 1 for mixers running SP Level of balance tank compartment 2 for mixers running Open time SP for purge valves in thickener 1 Close time SP for purge valves in thickener 1 Open time SP for purge valves in thickener 2 Close time SP for purge valves in thickener 2 Compartment 1 Level SP for inhibit desludging Compartment 2 Level SP for inhibit desludging *From Sludge pumping chamber* Standard controls for Pumps Selection Sludge transfer pump on duty *From Swash water recovery tank*

Standard controls for Pumps
Selection Sludge transfer pump on duty

Indication facilities

Standard Indications for pumps and valves
Sludge transfer pump on duty thickener 1 selected
Sludge transfer pump on duty thickener 2 selected
Sludge balancing tank compartment 1 Inservice
Sludge balancing tank compartment 2 Inservice
Level measurement of balance tank compartment 1
Level measurement of balance tank compartment 2
High level at balance tank compartment 1 warning
Low level at balance tank compartment 1 warning
High level at balance tank compartment 2 warning
Low level at balance tank compartment 2 warning
Open time PV (count down timer) for purge valves in thickener 1
Close time PV (count down timer) for purge valves in thickener 1
Open time PV (count down timer) for purge valves in thickener 2
Close time PV (count down timer) for purge valves in thickener 2
Flow measurement sludge to thisckener 1
Flow measurement sludge to thisckener 2

From Sludge pumping chamber

Standard Indications for pumps
Low level at sludge chamber
Sludge transfer pump on duty selected

From Swash water recovery tank

Standard Indications for pumps
level measurement at sludge wash water recovery tank 1
level measurement at sludge wash water recovery tank 2
Low level at sludge wash water recovery tank 1 warning
High level at sludge wash water recovery tank 1 warning
Low level at sludge wash water recovery tank 2 warning
High level at sludge wash water recovery tank 2 warning
Sludge transfer pump on duty selected

Alarms facilities

Standard alarms for blowers, pumps and valves
High-high level at balance tank compartment 1 alarm
Low-Low level at balance tank compartment 1 alarm
High-high level at balance tank compartment 2 alarm
Low-Low level at balance tank compartment 2 alarm
PLC failure
PLC communications failure
Sludge balance tank Overflow alarm

	MCC Power failure alarm When compartment 1 in service and measured level is 10% below SP for inhibiting desludging an alarm shall be generated When compartment 2 in service and measured level is 10% below SP for inhibiting desludging an alarm shall be generated *From Sludge pumping chamber* Low-low level at sludge chamber alarm High-High level at sludge chamber alarm *From Swash water recovery tank* Low-low level at sludge wash water recovery tank 1 alarm High-high level at sludge wash water recovery tank 1 alarm Low-low level at sludge wash water recovery tank 2 alarm High-high level at sludge wash water recovery tank 2 alarm

6.2.6 CHEMICAL TREATMENT:

Aluminum sulphate dosing and lime milk dosing is provided with a common LCP at MCC room of Chemical building where chemical treatment MCC is installed. Chemical treatment LCP shall be provided with its own independent redundant control system. The local control panel shall be provided with all necessary controls, state indication and alarms for routine monitoring, commissioning, manual and automatic operation, testing and maintenance of the sludge plant.

Hydrated Lime plant:

In lime milk dosing system there have been installed two lime milk preparation tanks with one mixer each (1+1), two lime milk pumps (1+1) and two lime saturators. Besides, ultrasonic level measurement and low-low level switch are available at each tank and one flow meter at the discharge of the pumps to the saturators. This system will be controlled fully manually from LCP and LCSs although all indications are available at SCADA system.

Each items of plant shall be provided with Local Control Stations to enable the operators to perform the following sequence of operation:

1. The slurry tank shall be partly filled with water by opening the water supply valve.

2. The operator shall then start the slurry tank preparation mixer from the Local Control Station or through MCC or LCP screen.
3. The tank shall be charged with lime by emptying the required number of whole bags using the bag loader provided.
4. Fill the tank with water to maximum water level.
5. The operator shall then select the available slurry preparation tank, open the selected slurry transfer pump suction and delivery isolating valves and start the selected pump to deliver slurry to the associated saturator.
6. Necessary commands shall be provided to stop start duty/stand by slurry transfer pumps adjacent to the appropriate saturator.
7. When the lime slurry in the saturator is at the appropriate level the operator shall open the water supply valve and set the flow rate by manually adjusting the flow control valve to maintain flow rate. The dosing rate will be set by a variable area flow meters.
8. Conductivity meters shall be provided to verify the concentration of the saturated solution.

Lime milk preparation tanks

In manual DCS mode (local):

In DCS manual mode at LCP there is installed one selector switch in order to select manually by the operator the lime milk preparation tank to be on duty. Lime milk tanks need to be filled manually with water and lime by operator. Secondly, the operator starts the mixer selected from the LCS or the LCP.
Remote manual control is not required

In auto DCS mode:

No auto mode is considered.

Lime milk pumps

In manual DCS mode (local):

At LCP there is installed one selector switch in order to select manually by the operator the lime pump to be on duty. By means of LCSs and/or LCPs the operator will start/stop the pump selected.
Remote manual control is not required

In auto DCS mode:

No auto mode is considered.

The quantity pumped to the saturator shall be measured by an electromagnetic flow meter (FIT-213-1, FIT-213-2). At the LCP the flow shall be displayed and the quantity shall be counted by two counters one without reset and one with manual reset.

Lime saturators

In manual DCS mode (local):

At LCP there is installed one selector switch in order to select manually by the operator the saturators to be on duty. It is possible only to have selected two saturators at the same time: one working normally and the other preparing the saturated lime solution. By means of LCSs and/or LCPs the operator will start/stop the saturator selected.
When lime milk at saturators reaches the appropiate level the operator shall open the water supply valve and set the flow rate manually adjusting the outlet valve also manually. The dosing rate will be set by means of one variable area flowmeter at the lime outlet. Conductivity meters will be used for verifying the concentration of the saturated solution.
Remote manual control is not required.

In auto DCS mode:

No auto mode is considered.

Aluminum sulphate plant:

In Aluminium sulphate dosing system there have been installed two saturator tanks (1+1), two transfer/recirculation pumps (1+1) from saturators to preparation tanks, two preparation tanks (1+1) and two head pumps (1+1). Besides, level measurement and low-low level switch are available at each preparation tank and one low-low level switch at each saturator tank.
The aluminium sulphate prepared solution will be stored at one head tank with level measurement.
This system will be controlled fully manually from LCP and LCSs although all indications are available at SCADA system.

Each item of plant shall be provided with Local Control Stations to enable the operators to perform the following sequence of operation:

1. The saturated solution shall be prepared by partly filling the saturators with water followed by manually charging the saturators with the required quantity of aluminum sulphate. The tank shall then be filled to the maximum level by manually opening the water supply valve until the float valve stops the supply.
2. The operator shall manually set the valves to recirculate to the same saturator for pre determined period for mixing. When the valves are set the operator shall start one of the saturator solution recirculation / transfer pumps from a Local Control Station pushbutton start/stop device which shall be positioned adjacent to the operating platform.
3. The operator shall then set the valves to transfer saturated solution to the stock tanks.
4. The operator shall stop the recirculation/ transfer pump when required level is reached in the stock tank. Water shall then be added to the stock tank until the maximum level is reached. The operator shall then start the mixer. The stock tank shall be displayed on the LCS to enable the transfer pumps to be started and stopped at the required level and to start/stop the mixer.
5. When the stock tank /s are filled the operator shall start the constant head tank feed pumps from local LCS. The excess flow into the constant head tank shall be arranged to be returned to the duty stock tank. The pumps will be stopped automatically when low level in the stock tank is detected.
6. The dosing rate shall be set manually through variable area flow meter.

Dosing flow rate (FE-212-1, FE-212-2) is set in the variable area flow meter at the outlet of the dosing tank.

Aluminium sulphate saturator tanks

In manual DCS mode (local):

At LCP there is installed one selector switch in order to select manually by the operator the Aluminium sulphate saturator tank to be on duty. Saturator tank need to be filled manually with water and aluminium sulphate by operator. Remote manual control is not required

In auto DCS mode:

Auto mode is not required

Pumps from saturators to preparation tanks (transfer pumps)

In manual DCS mode (local):

At LCP there is installed one selector switch in order to select manually by the operator the transfer pump to be on duty. After filling the saturator up to the top level with the float valve and manually set the valves to recirculate, the operator will start/stop the transfer pump selected from the LCS or/and the LCP.
After certain time recirculating with the transfer pump, the operator will set the valves for transferring saturated solution to the preparation tanks and the operator will stop the pump when the required level is reached at preparation tank.

Remote manual control is not required

In auto DCS mode:

Auto mode is not required

Aluminium sulphate preparation tanks

In manual DCS mode (local):

When the transfer pump is stopped, the operator manually will fill the tank with water until the maximum level and start the mixer from the LCP and/or LCS. Therefore, the mixer is stopped and started manually by operator according to preparation tank level indication.
Remote manual control is not required

In auto DCS mode:

Auto mode is not required

Head pumps and head tank

In manual DCS mode (local):

After filling preparation tank, the operator will start/stop the head pump selected (at LCP) from LCSs and/or LCP.
Dosing rate is manually set by a variable area flowmeters (one is used as backup).
Remote manual control is not required

In auto DCS mode:

Auto mode is not required

Following main Controls/Indications/ alarms provided at HMI screens (LCP and CCR):

Screen	
	Control facilities Reset alarms *From Lime milk dosing system* Instruments faceplate Standard controls for Pumps and mixers *From Aluminium sulphate dosing system* Instruments faceplate Standard controls for Pumps and mixers

Indication facilities

From Lime milk dosing system

Standard Indications for pumps and mixers
Lime milk preparation tank selected
Lime pump selected
Level measurement of Lime milk preparation tank 1
High level at Lime milk preparation tank 1 warning
Low level at Lime milk preparation tank 1 warning
Level measurement of Lime milk preparation tank 2
High level at Lime milk preparation tank 2 warning
Low level at Lime milk preparation tank 2 warning
Flow measurement lime milk to saturator 1
Flow measurement lime milk to saturator 2

From Aluminium sulphate dosing system

Standard Indications for pumps and mixers
Aluminium sulphate saturator tank selected
Aluminium sulphate preparation tank selected
Aluminium sulphate pump to preparation tank selected
Aluminium sulphate head pump selected
High level at Aluminium sulphate preparation tank 1 warning
Low level at Aluminium sulphate preparation tank 1 warning
High level at Aluminium sulphate preparation tank 2 warning
Low level at Aluminium sulphate preparation tank 2 warning
Level measurement of Aluminium sulphate preparation tank 1
Level measurement of Aluminium sulphate preparation tank 2
High level at Aluminium sulphate dosing tank warning
Low level at Aluminium sulphate dosing tank warning
Level measurement of Aluminium sulphate dosing tank

From Others at WTP

Raw water flow measurement
Clarified water flow measurement
WTP outlet water flow measurement
WTP outlet water quality data (turbidity, Ph,..)
Raw water flow restored warning
Clarified water flow restored warning

Alarms facilities

PLC failure
PLC communications failure
MCC Power failure alarm

From Lime milk dosing system

Standard alarms for pumps and mixers
High-high level at Lime milk preparation tank 1 alarm

	Low-low level at Lime milk preparation tank 1 alarm High-high level at Lime milk preparation tank 2 alarm Low-low level at Lime milk preparation tank 2 alarm *From Aluminium sulphate dosing system* Standard alarms for pumps and mixers Low-low level Aluminium sulphate sturator tank 1 alarm Low-low level Aluminium sulphate sturator tank 2 alarm High-high level at Aluminium sulphate preparation tank 1 alarm Low-low level at Aluminium sulphate preparation tank 1 alarm High-high level at Aluminium sulphate preparation tank 2 alarm Low-low level at Aluminium sulphate preparation tank 2 alarm High-high level at Aluminium sulphate dosing tank alarm Low-low level at Aluminium sulphate dosing tank alarm Low flow at Aluminium sulphate pump 1 alarm Low flow at Aluminium sulphate pump 2 alarm *From Others at WTP* No raw water flow alarm No clarified water flow alarm

Following main Controls provided at LCP front panel

Front panel	Control facilities
	selector switch for lime milk preparation tank selection selector switch for lime pump selection selector switch for aluminium sulphate saturator tank selection selector switch for aluminium sulphate preparation tank selection selector switch for pump to preparation tank selection selector switch for head pump selection

6.2.7 CHLORINATION:

Chlorination plant is controlled with help of LCP at MCC room of Chlorination building where chlorination MCC is installed. LCP shall be provided with its own independent redundant control system. The local control panel shall be provided with all necessary controls, state indication and alarms for routine monitoring, commissioning, manual and automatic operation, testing and maintenance of the chlorination plant.

Automatic functioning of the following process will be provided

1. Drum change over
2. Chlorine plant ventilation.

Chlorine drum change over:

The basis of chlorine change over shall be by pressure in the liquid chlorine manifolds measures by pressure switch at the common discharge of the cylinders. Each manifold are provided with pressure indicators.

The control to be provided for drum changeover shall include:

1. Change over AUTO and MANUAL selector switch
2. FULL indicator to inform which drum bank is full
3. Drum selector switch to enable the selection of drum between the DUTY and STANDBY.

With the changeover mode switch set to AUTO the motorized valve of the bank of duty chlorine drums shall be opened.

When the pressure in the liquid chlorine manifold falls to a pre-set low value the changeover from the empty drum to the full drum bank shall be initiated and the changeover panel shall satisfy the following functions.

1. Close the motorized valve of the bank that has just become empty
2. Open the motorized valve of the standby bank of drums.

1. If the low pressure in the manifold is sustained after the changeover has been completed a changeover failure alarm shall be annunciated on the local control panel and at the CCR.

Chlorine dosing plant:

Controls provided for the chlorine dosing plant are:

1. Start/Stop push button for operation of pre-chlorination motive water pump.
2. Start/Stop push button for operation of the ventilation plant.

3. Start/Stop push buttons for operation of post-chlorination motive water pump sets.
4. Raw water flow, clarified water flow and works outlet flow to enable the operator to manually set the dosing rates.
5. Motive water pump set selector switches.

Start/Stop operation and the disinfection chlorine dosing rate of the post and prechlorinators shall be manual. The local control panel shall display all flow rates necessary to enable the operator to set the dosing rated from within the chlorinator room.

On failure of one of the post-chlorine chlorinators on low or high vacuum or motive water pump sets, the standby unit shall be started manually from the local control panel and the failure condition shall annunciate an alarm at the local control panel and at the CCR. Operation of changeover valves shall be carried out manually on the plant.

An alarm shall be displayed on the LCP to indicate no works thorough put to warn the operator to shut-down the chemical dosing system until flow is restored.

Chlorine plant ventilation:

At MCC the chlorine ventilation shall be provided with DCS/MANUAL/OFF selector switch for the ventilation system. The LCP shall monitor and display the condition of the chlorine leak detector panel in both manual and DCS mode.

Prior to an operator entering the chlorine drum store or chlorinator room the ventilation shall be switched to DCS mode. When DCS mode is selected, from LCP operator shall select MAN/AUTO mode:

1. In DCS manual mode the ventilation fan will run continuously until a chlorine leak level high is sensed by the leak level ‘high’ is sensed by the leak detection system in the respective area the corresponding ventilation system shall stop if running. A high level leak shall inhibit the manual starting of the ventilation system in the respective area.
2. In DCS automatic mode the ventilation fans will run when a low level chlorine leak is detected and will stop when a high level chlorine leak is detected.

Following main Controls provided at LCP front panel

Front panel
Control facilities
Lamp test
Reset alarms
Drum change over MAN/AUTO selection
Drum on duty selection
Indication facilities
Valve drum 1 open
Valve drum 2 open
Drum change over sequence running
Chlronine leak detection low 1
Chlronine leak detection low 2
Alarms facilities
Chlronine leak detection high 1
Chlronine leak detection high 2
Vacuum regulator/pressure relief valve fault
Chlorine vacuum high and low alarms

Following main Controls/Indications/ alarms provided at HMI screens (LCP and CCR):

Screen
Control facilities
Reset alarms
Instruments faceplate
Standard controls for motors and valves
SP pressure chlorine for changeover
Post chlorination duty pump selection
Indication facilities
Standard indications for motors and valves
Post chlorination duty pump selected
Drum bank 1 full
Drum bank 2 full
Drum change over in Auto
Drum change over in manual
Drum on duty selected
Drum change over sequence running

Manifold pressure Chlronine leak detection low 1 Chlronine leak detection low 2 *From Others at WTP* Raw water flow measurement Clarified water flow measurement WTP outlet water flow measurement WTP outlet water quality data (turbidity, Ph,..) **Alarms facilities** PLC failure PLC communications failure MCC Power failure alarm Standard alarms for motors and valves Change over failure alarm Chlronine leak detection high 1 Chlronine leak detection high 2 Vacuum regulator/pressure relief valve fault Chlorine vacuum high and low alarms

6.2.8 CENTRAL CONTROL ROOM:

Entire data from different outstations and WTP PLC's shall be monitored at central control room SCADA system which is located at Filter room Water treatment plant.

Following medium of communication will be provided in order to communicate data from various remote locations:

1. Raw water pumping station fiber optic cable as main and fall back modes of communication.
2. Water treatment plant: data from various local control panels communicated to the CCR via Fiber optic cable.
3. Booster pumping station fiber optic cable as main and fall back modes of communication.
4. Master balance Reservoir fiber optic cable as main and fall back modes of communication.
5. Package II to V: VSAT as main mode of communication and GSM Communication as a fall back communication.
6. Dharnapuri CCR: VSAT as main mode of communication and GSM Communication as a fall back communication.

Necessary Modems and Routers are provided to Connect VSAT and GSM terminals to Central control DCS.

Besides the above mentioned LCP with their own redundant controllers, following control equipments will be provided to control and monitor data at CCR:

1. One hot Standby dedicated Main Controller is allocated for collecting data from Package-II to V sites.
2. Data from Dharmapuri CCR shall be directly interfaced to the CCR SCADA Servers, as Dharmapuri CCR can be considered as an extension of WTP supervision and control room.
3. LCP at RWPS, lCP at BPS and LCP at MBR are connected via fiber optic Ethernet network between them and with WTP also. Data to/from RWPS, BPS, MBR and WTP shall be interfaced by this Ethernet fiber optic network.
4. One hot standby dedicated Main Controller is allocated at Dharmapuri CCR for future use.

Work station provided in the Central Control Room:

1. 2Nos Desk top computers for web server store and data from various remote LCPS. A tape drive will be provided which is capable of back up data up to 800GB. These data servers are connected to Redundant LAN Ethernet with other work stations with SCADA soft ware.
2. 2 Nos complete workstations with SCADA Soft ware which will serve as Operator work station. Work station equipped with 2 Visual Display units Industrial Grade 22" Colour LCD Monitor.
3. 1 Nos of Engineering work stations with 22" LCD Monitor.
4. 2 Nos of industrial printers one is A3 color laser jet for printing Alarms or events and another is A4 color laser type for report printing.
5. 1 No of 3 LCD panel front projectors of resolution 1280X720 and illumination lumen not less than 1500 with fixed frame screen 100 inches. This projector accepts VGA, HDMI and LAN inputs as source of display images.

Work station provided in Dharmapuri Central Control Room:

1. 2 Nos complete workstations with SCADA Soft ware which will serve as Operator work station. Work station equipped with 2 Visual Display units Industrial Grade 22" Colour LCD Monitor.

Entire system is so designed that a total failure of the central operating station at CCR shall not prevent the continued operation of the plant on automatic control from the LCPS. Manual control of the plant shall be available at all times on failure of the LCP and/or the central operating station.

HMI VDU mimics displays:

HMI shall give pictorial representation of all HMI VDU images forming a clear, live, display covering the entire works. These displays shall give a pictorial representation of each section of the works showing the numerical value of each measurement within that section and the status of each component such as

- Machines running, stopped, failed and unavailable ("unavailable" means unavailable for SCADA i.e. unavailable for LCP automatic or SCADA Manual control.),
- Valves Open, closed, failed, % open (for modulating valves), no flow and unavailable for SCADA, i.e. unavailable for lCP automatic or SCADA Manual control,
- Circuit breakers open, closed tripped on fault.
- Instruments flow, level, pressure, temperature and all other readings for water quality.

As a minimum, the following HMI VDU mimic pages shall be prepared:

- Site plan showing the raw water pumping stations, water treatment plant booster pumping station inlet sump of the booster pumping station, master balancing reservoir at MADAM and all associated pipeline in Package-I of the project.
- Site plan showing the trunk main and tapping point branches of the treated water pipelines, union reservoirs, Panchayat reservoirs and booster pumping stations of package-II
- Site plan showing the trunk main and tapping point branches of the treated water pipelines, union reservoirs, panchayat reservoirs and booster pumping station of package-III

- Site plan showing the trunk main and tapping point branches of the treated water pipelines, union reservoirs, panchayat reservoirs and booster pumping station of package-IV
- Site plan showing the trunk main and tapping point branches of the treated water pipelines, union reservoirs, panchayat reservoirs and booster pumping station of package-V
- Intake works and raw water pumping station overview of package-I.
- Electrical supply system of the Intake work and raw water pumping station.
- Intake works with bar screens and penstocks.
- Raw water pumping station
- Water treatment plant
- Treated water pumping station
- Electrical supply system of the water treatment plant and the treated water pumping station.
- Booster pumping station
- Electrical supply system of the water treatment plant and the treated water pumping station.
- Booster pumping station
- Electrical supply system at the booster pumping station
- Master balancing reservoir at MADAM
- Healthy /Fault status of all processors and communication network at the outstation LCPs and the regional telemetry panel in the CCR.
- HMI VDU mimics pages for packages II to V
- Spare HMI VDU mimic pages.

All instruments with signals being acquired by the SCADA system will be shown in the above HMI Pages, with their real time measured parameters will be displayed adjacent to the symbols in process diagram. Graphical representation of sump level rising and falling shall be configured and shown in the HMI pages. The trend, historian, event log, alarm log, printing and hyperlink to other mimic pages shall be accessible at each of the HMI mimic pages.

The status of the electrical distribution network (e.g. the close/open status of circuit breakers). The current, power factor, power and apparent loads taken at each incomer feed shall be shown in each of the electrical supply system HMI pages mentioned above.

7. BOOSTER PUMPING STATION

7.1 PROCESS DESCRIPTION:

Clear water from treated water pumping station is pumped to Booster pumping station through raising main of 1500MM dia which is collected at sump with two compartments and pumped to Master balancing reservoir located at a distance of 4.1Kms through 6No of vertical turbine pumps.

Pump Details:

Type	: Vertical turbine pumps with water lubricated bearings.
No of pumps	: 6Nos
No of working pumps	: 4Nos
No of standby pumps	: 2Nos
Total head of the pump	: 143 mtrs
Pressure across the pump	: 14.3Kg/cm²
Pump Discharge	: 1726 cu.m/hr
Velocity of the pump	: 1.5 m/sec max for suction
	: 2.5 m/sec max for discharge

Valves:

Two Nos of butter fly valves are provided at the inlet of booster pumping station in order to distribute water equally to two compartments of sump. Water is distributed to wet wells through a channel.

Delivery line of the vertical turbine pumps are connected to non return valve, a delivery isolating valve, and an automatic air inlet/release valve.

Isolating valves at the delivery line of the pump is resilient-seated butterfly valve fitted with electric actuators.

Valve operation is done through hand wheel when it is operated manually.

Non return valves shall be of the swing-check type, designed for rapid closing as soon as forward flow stops.

Header Line:

All the pumps are connected by a common header line of 1200MM dia which is in turn connected to 1500MM dia raising main by using reducer. Total head across the header line is 143mtrs. Material of construction of header line is MS.

Wet well:

There are three wet wells with depth of 9mtr whose water level is 6.8mtrs. Diameter of each wet well is 5mtrs.

Surge protection:

An antihammer system is provided for surge protection across the pipe line in order to prevent head loss across the pipe line. The surge analysis should identify the most adverse and transient operational conditions. The analysis will include but not be limited to the following conditions:

1. Complete power failure to the pumping station with all duty pumps running at maximum capacity.
2. Start up of the pumps under the specified control system.
3. Shut down of the pumps under the specified control system.

The objective of the surge analysis is to recommend surge protection equipment which ensures maximum and minimum pressures under all conditions within allowable surge rating of the pipelines as indicated below.

7. Maximum pressures shall not exceed the capabilities of the pipes and fittings on the system.
8. Minimum pressures in the system shall not fall below atmospheric pressure and subsequently rise above atmospheric pressures again during the same transient event. Pressure below atmospheric pressure will only be permitted as the systems drain down through supply connections during extended periods of pump shutdown.

Surge vessels of the capacities 75m³ shall be provided along with standby vessel of same type and size.

7.2 CONTROL AND OPERATION:

Entire plant is controlled and monitored through dedicated redundant programmable logic control system located at control room of booster pumping station next to MCC room. All necessary field instruments are provided for failsafe operation of the plant and continuous monitoring the process data through CCR SCADA system.

A touch screen panel with human machine interface (HMI) graphic pages provided on the PLC panel.

HMI touchscreen shall be used to obtain alarm annunciation for any abnormal conditions occurring on instruments and drives. All the analog and digital signals from these field instruments are terminated to the terminal blocks of LCP. From I/O modules the data is transferred to main Programmable Logic Controller CPUs via Ethernet CAT5e cable.

Vertical pumps Operation

Following permissive for pump to start shall be considered:

9. Level in the sump should not be low (<20%)
10. MCC Healthy
11. Discharge motor operated butterfly valve closed.

In manual DCS mode:

In DCS manual mode, the number of pumps running will be decided by the operator. From HMI page at LCPs and/or CCR the operator will start/stop the pumps.

In auto DCS mode:

The number of pumps running will be fixed by the control system according the flow input allowed by the MBR taking into account the flow measured to packages II and V and also the level measurement at MBR. Level SP at each MBR compartment shall be fixed at HMI page by operator. These level SP could be even different depending on the day time.

Drainage pumps Operation

In manual DCS mode:

In DCS manual mode, from HMI page at LCPs and/or CCR the operator will start/stop the pumps.

In auto DCS mode:

Not available.

Antihammer device and air compressors Operation

Antihammer device will work always in auto mode and according to the water level measured at the vessel it will start or stop the air compressor on duty. Operator shall introduce at HMI page the Level Setpoint to be kept at the antihammer vessel. The compressor on duty shall be selected by operator manually in local.

Automatic valves (motorized actuators) Operation

In manual LOCAL mode:

In local manual mode, the valve shall be opened and closed from its LCS under operator requests.

In manual REMOTE mode:

In manual remote mode, the valve shall be opened and closed from HMI page at LCPs and/or CCR under operator requests.

In auto REMOTE mode:

In auto remote mode, the valve shall be opened automatically with a time delay when the associated pump has been started. The time delay shall be a SP at HMI page whose value shall be fixed by operator.

Following main Controls/Indications/ alarms provided at HMI screens (at LCP and CCR):

Screen
From BPS: Controls Selection of sump on duty Instruments faceplate SP time to open impulsion butterfly valve after pump 1 starting SP time to open impulsion butterfly valve after pump 2 starting SP time to open impulsion butterfly valve after pump 3 starting SP time to open impulsion butterfly valve after pump 4 starting SP time to open impulsion butterfly valve after pump 5 starting SP time to open impulsion butterfly valve after pump 6 starting SP Level at Antihammer device Standard controls Pumps Standard controls Valves Standard controls for MV 33KV Cabinets Standard controls for 6,6 KV Cabinets Standard controls for 6,6 KV FCMA Starters indications Sump on duty Low level warning at compartment 1 High level warning at compartment 1 Low level warning at compartment 2 High level warning at compartment 2 Level measurement at pump well 1 Level measurement at pump well 2 Level measurement at pump well 3

Low level warning pump well 1
High level warning pump well 1
Low level warning pump well 2
High level warning pump well 2
Low level warning pump well 3
High level warning pump well 3
PV time to open impulsion butterfly valve after pump 1 starting
PV time to open impulsion butterfly valve after pump 2 starting
PV time to open impulsion butterfly valve after pump 3 starting
PV time to open impulsion butterfly valve after pump 4 starting
PV time to open impulsion butterfly valve after pump 5 starting
PV time to open impulsion butterfly valve after pump 6 starting
Standard Indications for motors and valves
Compressor related indications (running, stopped and failure)
Antihammer (level indication)
Pressure at the discharge
Flow measurment at the discharge
MFM measurements
Temperature scanner measurement pump 1
Temperature scanner measurement pump 2
Temperature scanner measurement pump 3
Temperature scanner measurement pump 4
Temperature scanner measurement pump 5
Temperature scanner measurement pump 6
Standard indications for MV 33KV Cabinets
Standard indications for 6,6 KV Cabinets
Standard indications for Transformers
Standard indications for 6,6 KV FCMA Starters
alarms
Low-low level alarm at compartment 1
High-high level alarm at compartment 1
Low-low level alarm at compartment 2
High-high level alarm at compartment 2
Low-low level alarm pump well 1
High-high level alarm pump well 1
Low-low level alarm pump well 2
High-high level alarm pump well 2
Low-low level alarm pump well 3
High-high level alarm pump well 3
Standard alarms for motors and valves
Standard alarms for MV 33KV Cabinets
Standard alarms for 6,6 KV Cabinets

Standard alarms for Transformers Standard alarms for 6,6 KV FCMA Starters Compressor failure low flow pump 1 low flow pump 2 low flow pump 3 low flow pump 4 low flow pump 5 low flow pump 6 Pump 1 Valve fail to open after time delay Pump 2 Valve fail to open after time delay Pump 3 Valve fail to open after time delay Pump 4 Valve fail to open after time delay Pump 5 Valve fail to open after time delay Pump 6 Valve fail to open after time delay
From MBR: Controls SP maximum level at MBR MBR Compartment on duty selection indications MBR Compartment 1 level measurement MBR Compartment 2 level measurement Water to package II flow rate Water to package V flow rate MBR Compartment on duty alarms High-high level at MBR Compartment 1 Low-low level at MBR Compartment 1 High-high level at MBR Compartment 2 Low-low level at MBR Compartment 2 MBR Power failure alarm
From WTP: indications Treated water reservoir Compartment 1 level measurement Treated water reservoir Compartment 2 level measurement Treated water flow rate Treated water volume Treated water Compartment on duty alarms WTP Power failure alarm High-high level at Treated water Compartment 1 Low-low level at Treated water Compartment 1

High-high level at Treated water Compartment 2 Low-low level at Treated water Compartment 2

8. MASTER BALANCING RESERVOIR

8.1 PROCESS DESCRIPTION:

Treated water from Booster pumping station is collected at two compartments of Master balancing reservoir for distribution of water to various locations.
At the inlet of each compartment an isolating valve is provided. For connecting package II treated water transmission trunk main (DN 1000 MS pipe) from the outlet of each compartment of the balancing reservoir, an outlet isolating valve shall be provided. For connecting to Package V treated water transmission trunk main (1500MM MS Pipe) from the outlet of each compartment of the balancing reservoir an outlet valve shall be provided.

At each compartment an ultrasonic level transmitter (LIT-401-1, LIT-401-2) shall be installed for measuring the water level at that compartment of the reservoir. These level signals shall be acquired by the LCP. Flow across the package-II and Package-V trunk main is totalized and transmitted to the LCP with the help of electromagnetic flow meter (FIT-406-1, FIT-406-2).

8.2 CONTROL AND OPERATION:

Entire MBR is controlled and monitored through dedicated redundant programmable logic control system located at Telemetry and control room of MBR. All necessary field instruments are provided for failsafe operation of the plant and continuous monitoring the process data through CCR SCADA system.
A touch screen panel with human machine interface (HMI) graphic pages provided on the PLC panel.
HMI touchscreen shall be used to obtain alarm annunciation for any abnormal conditions occurring on instruments and drives. All the analog and digital signals from these field instruments are terminated to the terminal blocks of LCP. From I/O modules the data is transferred to main Programmable Logic Controller CPUs via Ethernet CAT5e cable.

Automatic valves (motorized actuators) Operation

In manual LOCAL mode:

In local manual mode, the valve shall be opened and closed from its LCS under operator requests.

In manual REMOTE mode:

In manual remote mode, the valve shall be opened and closed from HMI page at LCPs and/or CCR under operator requests.

In auto REMOTE mode:
No auto remote mode is required.

Following main Controls/Indications/ alarms provided at HMI screens (at LCP and CCR):

Screen
Signals From MBR: Controls Instruments faceplate Standard controls for Valves SP maximum level at MBR MBR Compartment on duty selection Indications MBR Compartment 1 level measurement MBR Compartment 2 level measurement MBR Compartment on duty Water to package II flow rate Water to package II flow volume Water to package V flow rate Water to package V flow volume High level at MBR Compartment 1 warning Low level at MBR Compartment 1 warning High level at MBR Compartment 2 warning Low level at MBR Compartment 2 warning Standard Indications for valves MFM Measurement Alarms High-high level at MBR Compartment 1 Low-low level at MBR Compartment 1 High-high level at MBR Compartment 2 Low-low level at MBR Compartment 2 MBR Power failure alarm Standard alarms for valves

Signals From BPS:

Indications

Level measurement at compartment 1
Level measurement at compartment 2
Level measurement at pump well 1
Level measurement at pump well 2
Level measurement at pump well 3
Low level warning pump well 1
High level warning pump well 1
Low level warning pump well 2
High level warning pump well 2
Low level warning pump well 3
High level warning pump well 3
Low level warning at compartment 1
High level warning at compartment 1
Low level warning at compartment 2
High level warning at compartment 2
BPS water pump 1 ON
BPS water pump 2 ON
BPS water pump 3 ON
BPS water pump 4 ON
BPS water pump 5 ON
BPS water pump 6 ON

Alarms

Low-low level alarm pump well 1
High-high level alarm pump well 1
Low-low level alarm pump well 2
High-high level alarm pump well 2
Low-low level alarm pump well 3
High-high level alarm pump well 3
Low-low level alarm at compartment 1
High-high level alarm at compartment 1
Low-low level alarm at compartment 2
High-high level alarm at compartment 2

Signals From Pennagaran BPS:

Indications

Power supply healthy
Pennagaram outlet pressure measurement
Pennagaram outlet flow measurement
Standard indications for pumps
Standard indications for Low voltage incomers

Alarms:
Standard alarms for pumps
Battery charger failure
Standard alarms for Low voltage incomers

9. CONCLUSION

Hence Entire plant is so designed and controlled to satisfy following requirements:

1. Providing safe drinking water and producing required quantity by avoiding wastage of water.
2. Acquisition , processing and storage of data to facilitate management of the works
3. Rationalization of man power, whilst maintaining an adequate level of security of the water supply and the works.

Date:

Location: Raw Water Pumping Station at Hogenakkal

TIME	River Level (MSL) in Mtr	Pump Sump Level in Meters			33 KV Panel				6.6 KV Panel				Freq in Hz		PUMP 1		PUMP 2		PUMP 3		PUMP 4		PUMP 5		PUMP 6		Header Pressure Kgf/cm^2	Flow in m3	Remarks
					1		2		1		2		1	2	Pump Status	Current in Amps	Pump Status	Current in Amps	Pump Status	Current in Amps	Pump Status	Current in Amps	Pump Status	Current in Amps	Pump Status	Current in Amps			
		1	2	3	Voltage in KV	Current in Amps	Voltage in KV	Current in Amps	Voltage in KV	Current in Amps	Voltage in KV	Current in Amps																	
6:00																													
7:00																													
8:00																													
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4:00																													
5:00																													
6:00																													

TOTALISER INITIAL READING (M3) = 0
TOTALISER FINAL READING (M3) = 0
TOTAL QUANTITY OF WATER PUMPED (M3) = 0

Tenderer

Chief Engineer, TWAD, Vellore

Contractor : IVRCL-CADAGUA Hogenakkal Water Treatment Company Pvt Ltd

Date:

Location: Treated Water Pumping Station at WTP

TIME	Treated Water Reservoir level in Mtr		Pump House Sump Level in Meters			33 KV Panel				6.6 KV Panel				Freq in Hz		PUMP 1		PUMP 2		PUMP 3		PUMP 4		PUMP 5		PUMP 6		Header Pressure Kgf/cm²	Flow in m3	Remarks
						1		2		1		2																		
	1	2	1	2	3	Voltage in KV	Current in Amps	Voltage in KV	Current in Amps	Voltage in KV	Current in Amps	Voltage in KV	Current in Amps	1	2	Pump Status	Current in Amps	Pump Status	Current in Amps	Pump Status	Current in Amps	Pump Status	Current in Amps	Pump Status	Current in Amps	Pump Status	Current in Amps			
6:00																													
7:00																													
8:00																													
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3:00																													
4:00																													
5:00																													
6:00																													

TOTALISER INITIAL READING (M3) = 0

TOTALISER FINAL READING (M3) = 0

TOTAL QUANTITY OF WATER PUMPED (M3) = 0

Te

Date:

Location: Booster Pumping Station

TIME	Booster Reservoir level in Mtr		Pump House Sump Level in Meters			33 KV Panel				6.6 KV Panel				Freq in Hz		PUMP 1		PUMP 2		PUMP 3		PUMP 4		PUMP 5		PUMP 6		Header Pressure Kgf/cm^2	Flow in m3	Remarks
						1		2		1		2																		
	1	2	1	2	3	Voltage in KV	Current in Amps	Voltage in KV	Current in Amps	Voltage in KV	Current in Amps	Voltage in KV	Current in Amps	1	2	Pump Status	Current in Amps	Pump Status	Current in Amps	Pump Status	Current in Amps	Pump Status	Current in Amps	Pump Status	Current in Amps	Pump Status	Current in Amps			
6:00																														
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6:00																														

TOTALISER INITIAL READING (M3) = 0
TOTALISER FINAL READING (M3) = 0
TOTAL QUANTITY OF WATER PUMPED (M3) = 0

Tenderer

Chief Engineer, TWAD, Vellore

160 MLD WATER TREATMENT PLANT- WATER QUALITY (TDS, AMMONIA & PHOSPHATE)

Time (HRS)	RAW WATER			TREATED WATER			REMARKS
	TDS mg/L	AMMONIA mg/L	PHOSPHATE mg/L	TDS mg/L	AMMONIA mg/L	PHOSPHATE mg/L	
ALLOWABLE LIMIT	-	-	-	500 mg/L	Nil	Nil	
6:00							
8:00							
10:00							
12:00							
14:00							
16:00							
18:00							
20:00							
22:00							
0:00							
2:00							
4:00							
6:00							

PROCESS CHEMIST	DY PLANT MANAGER	PLANT MANAGER	TWAD

Tenderer

Chief Engineer, TWAD, Vellore

TAMILNADU WATER SUPPLY & DRAINAGE BOARD

HOGENAKKAL WATER SUPPLY AND FLUOROSIS MITIGATION PROJECT

160 MLD WATER TREATMENT PLANT-WATER QUALITY REPORT

Sample Timings (Hrs)	RAW WATER							DOSED WATER		CLARIFIED WATER				FILTERED WATER			TREATED WATER											
	pH	TURBIDITY NTU	CONDUCTIVITY µs/cm	ALKALINITY mg/L as CaCO3	COLOUR Hazen Unit	IRON mg/L as Fe	TOTAL COLIFORM (No/100ml)	pH	ALKALINITY mg/L as CaCO3	pH	TURBIDITY NTU	CLARIFIER PERFORMANCE (%)	ALUMINIUM mg/L as Al	TURBIDITY NTU	FILTER PERFORMANCE (%)	ALUMINIUM mg/L as Al	pH	TURBIDITY NTU	PLANT PERFORMANCE (%)	ALKALINITY mg/L as CaCO3	COLOUR Hazen Unit	CHLORINE mg/L as Cl		ALUMINIUM mg/L as Al	MANGANESE mg/L as Mn	IRON mg/L as Fe	TOTAL COLIFORM (No/100ml)
																						FREE	TOTAL				
Guaranteed Values	≤8.80	≤25.20	≤ 600	≤ 350		≤ 1.00					10.0*/5.00*	%	< 0.50	< 1.00 NTU	%	< 0.30	7.00-8.50	< 1.00 NTU	%	< 200	≤ 5	≥ 0.50		< 0.30 /0.03	< 0.10 /0.05	< 0.3 /0.1	Nil
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10:00																											
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PROCESS CHEMIST	DY PLANT MANAGER	PLANT MANAGER	TWAD

Tenderer

Chief Engineer, TWAD, Vellore

Hogenakkal Water Supply and Fluorosis Mitigation Project (Package - I)

Location: WTP

Date:	Aluminium Sulphate			Lime					Chlorine				
	Blocks	Flow 1	Flow 2	Bags	Lime Milk Flow1	Lime Milk Flow2	Saturated lime flow 1	Saturated lime flow 2	Tonners	Pre-Cl Rot.	Post-Cl Rot.	Pre-Cl Press.	Post-Cl Press.
Time	(Ud)	m^3/h	m^3/h	(Ud)	m^3/h	m^3/h	m^3/h	m^3/h	(Ud)	kg/h	kg/h	bar	bar
6.00													
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4.00													
5.00													
6.00													

	Aluminium Sulphate Dosing				Lime Dosing			
CHEMICALS	Recirc./Transfer pumps		Head Pumps		Lime Milk Pumps		Milk Lime Flow	
	1	2	1	2	1	2	1	2
FROM								
TO								
TOTAL (h)								

CHLORINATION	Booster pumps			NaOH recirculation pumps		Scrubber Blowers	
	1	2	3	1	2	1	2
FROM							
TO							
TOTAL (h)							

LIME MILK FLOW METER II READING		
@ 06.00 Hrs		
DATE	TWAD	
	FINAL	
	INITIAL	
TOTAL		

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Chief Engineer, TWAD, Vellore

Hogenakkal Water Supply and Fluorosis Mitigation Project (Package - I)

Location: WTP-Filtration

Date:												
	Filter 1	Filter 2	Filter 3	Filter 4	Filter 5	Filter 6	Filter 7	Filter 8	Filter 9	Filter 10	Filter 11	Filter 12
Time	On/Off	On/Off	On/Off	On/Off	On/Off	On/Off	On/Off	On/Off	On/Off	On/Off	On/Off	On/Off
6.00												
7.00												
8.00												
9.00												
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6.00												

Remarks

On/Off: INTRODUCE VALVE OPENING VALUE. Off when valve is 70% opened - backwash is started . On when filter is operating - backwash is finished

W. W.FLOW M. READING @ 06.00 H		
DATE	TWAD	
	FINAL	
	INITIAL	
TOTAL		

Filters operating	
Filters washed	
Filters in maintenance	
No. of filters operating	
No. of filters washed	
Average filter rate	
Max. hourly rate	
Total water filtered	
Total wash water	
Percent of water filtered	
Average time of wash (min)	

Blowers Det.	Date:	
Blower	1	2
FROM		
TO		
TOTAL (h)		

Tenderer

Chief Engineer, TWAD, Vellore

Hogenakkal Water Supply and Fluorosis Mitigation Project (Package - I)

Location: WTP-Filtration

Date:	WWRT I	WWRT II
	LT	LT
Time	cm	cm
6.00		
7.00		
8.00		
9.00		
10.00		
11.00		
12.00		
13.00		
14.00		
15.00		
16.00		
17.00		
18.00		
19.00		
20.00		
21.00		
22.00		
23.00		
0.00		
1.00		
2.00		
3.00		
4.00		
5.00		
6.00		

WWRT

WWRT	PUMPS			
	Supernatant		Sludge	
Pump	1	2	1	2
FROM				
TO				
Total				

	SLUDGE TANK	
Mixer	1	2
FROM		
TO		
Total		

CLARIFIERS SLUDGE	Sludge	
Pump	1	2
FROM		
TO		
Total		

THICKENING	Sludge			
Pump	1	2	3	4
FROM				
TO				
Total				

	Sludge			
Pump	1	2	3	4
FROM				
TO				
Total				

	Thickeners	
Scraper	1	2
FROM		
TO		
Total		

DRYING BEDS	1	2	3	4	5	6	7	8
Full								
Empty								
Kg extracted								

6. CHEMICALS

MSDS OF THE PRODUCTS

MATERIAL SAFETY DATA SHEET

TRADE NAME :	Aluminium Sulphate
OTHER NAMES :	Ferric Alum; Alum Sulphate; Cake Alum.
U.N. NO. :	None Allocated
DG CLASS :	None Allocated.
SUB RISK :	None Allocated
HAZCHEM :	None Allocated
POISON SCHEDULE :	None Allocated
USES :	Tanning; Metallurgy; Pulp & Paper; Textiles; Water Treatment.

PHYSICAL DESCRIPTION/ PROPERTIES

Appearance, odour : White Kibbled, odourless.

Melting Point : Decomposes at 775°C

Boiling Point : Not Available

Specific Gravity (20°C) : Not Available

Vapour Density (air=1) : Not Available

Vapour Pressure (20°C) : Not Available

Flash Point (Closed cup) : Not Available

Flammability Limits (%) : Not Available **pH**

(5% solution) : 2.6 max

Solubility in water (g/L) : Soluble

Stability and Reactivity : Stable under normal temperatures and pressures. On contact with moisture is readily hydrolysed to sulphuric acid. Corrosive to metals in the presence of moisture.

INGREDIENTS

Chemical Name CAS Number Proportion

Aluminium Sulphate 10043-01-3 >99.0%

HEALTH HAZARD INFORMATION

HEALTH EFFECTS

No adverse health effects expected if the product is handled in accordance with this Safety Data Sheet and the product label. Symptoms that may arise if the product is mishandled are:

ACUTE EFFECTS -

SWALLOWED: Ingestion of large amounts may result in serious injury. If swallowed may lead to oral and gastrointestinal irritation and local tissue damage. Nausea, vomiting, diarrhoea and gastrointestinal bleeding may follow.

EYE: Exposure to eyes may result in irritation and acid burns.

SKIN: Dust may cause irritation to skin.

INHALED: Inhalation of dust may cause irritation to the respiratory tract due to sulphuric acid formed by moist tissues. Symptoms may include coughing and shortness of breath.

CHRONIC EFFECTS: REPEATED OR PROLONGED CONTACT WITH DILUTE SOLUTIONS MAY CAUSE SKIN IRRITATION.

FIRST AID

SWALLOWED: If conscious give water to drink. Seek immediate medical attention.

EYE: Immediately irrigate with copious quantities of water for at least 15 minutes. Eyelids to be held open. Seek medical advice.

SKIN: Wash with soap & water. Remove contaminated clothing, launder clothes before reuse. If irritation persists seek medical advice.

INHALED: Remove victim from exposure to fresh air immediately. If not breathing apply artificial respiration. If breathing is difficult give oxygen. Seek immediate medical advice.

ADVICE TO DOCTOR

Treat symptomatically.

TOXICITY

No information available.

PRECAUTIONS FOR USE

Exposure standard of Soluble salts as Aluminium: TWA: 2mg/m3

ENGINEERING CONTROLS

A system of local and/or general exhaust ventilation is recommended to keep exposure levels below the recommended exposure standard. If condition of use creates dusty environment, local exhaust ventilation is recommended.

PERSONAL PROTECTION

Avoid skin and eye contact and inhalation of dust. Wear overalls, eye protection & gloves. Use chemical safety goggles or face shield where dusting or splashing of solutions is possible. Use a dust mask or dust/mist respirator. Always wash hands before smoking, eating, drinking or using the toilet.

FLAMMABILITY

Not flammable.

SAFE HANDLING INFORMATION

STORAGE AND TRANSPORT

Not defined as a Dangerous Good by the Australian Code for the Transport of Dangerous Goods by Road and Rail.

Store in a cool dry place. Store in well ventilated area. Keep container tightly closed. Protect from physical damage. Keep away from moisture and incompatible materials.

SPILLS

Wear protective equipment to prevent skin and eye contamination and inhalation of dust. Sweep up but avoid generating dust. Collect and place in suitably labelled containers.

DISPOSAL

Refer to State Land Waste Management Authority.

FIRE/EXPLOSION HAZARDS

Non combustible product. Use extinguishing media appropriate for surrounding fire.

When heated to decomposition may produce oxides of sulphur. Fire fighters to wear self-contained breathing apparatus if risk of exposure to vapour or products of combustion.

Not considered to be an explosion hazard.

MATERIAL SAFETY DATA SHEET (CAUSTIC SODA LYE)

I. PRODUCT IDENTIFICATION

Chemical Name : Sodium Hydroxide
Trade Name : Caustic Soda Lye
Synonyms : Liquid Caustic Soda, Caustic, Soda Lye, Lye Solution

II. COMPOSITION / INGREDIENTS

Sodium Hydroxide, % : 47 – 48.5 % by weight
Chemical Formula : NaOH
Molecular Weight : 40 g/mole
CAS Registry No. : 1310-73-2

III. HAZARDS IDENTIFICATION

THIS PRODUCT MAY BE : corrosive, toxic and a major potential hazard upon contact to skin and eyes.
TOXICITY ROUTES OF EXPOSURE : Ingestion can cause severe burning and pain in lips, mouth, tongue, throat and stomach. Death can result from ingestion.
OVEREXPOSURE : Causes burns and scarring.
Can cause serious damage to all body tissues contacted.
CANCER INFORMATION : Not applicable
MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Chronic eye or skin conditions

IV. FIRST AID MEASURES

SKIN : Remove contaminated clothing and immediately wash skin for a minimum of 15 minutes. Call or see a physician.
EYES : Immediately flush eyes with large amount of water,occasionally lifting the upper and lower eyelids and rotating the eyeballs. Continue flushing for a minimum of 15 minutes. See a physician.
INHALATION : Remove to fresh air. If breathing stops, administer artificial respiration. See a physician.
INGESTION : DO NOT induce vomiting. If person is conscious, give 2 or more glasses of water. If unconscious, never give anything by mouth. See a physician immediately.

V. FIRE FIGHTING MEASURES

Autoignition Point : Not Applicable
Flammability/Explosive limits : Not Applicable
Fire/Explosion Hazards: Contact with strong acids may generate enough heat to ignite combustibles.
Fire Prevention : Not Applicable

VI. ACCIDENTAL RELEASE MEASURES

IN CASE OF SPILL OR RELEASE : Completely contain spilled material with dikes, sandbags, etc., and prevent run off into the ground or surface waters or sewers. Recover as much caustic material as possible into containers for disposal. Add water and neutralize remaining caustic material with dilute hydrochloric acid, citric acid or another solid acidic material to a pH between 6 and 9. Collect neutralized caustic with a dry sorbent. Flush residual neutralized waste to the drain with excess water.

VII. HANDLING AND STORAGE

Storage Requirements: Keep container tightly closed.
FOR SMALL VOLUMES : Maybe stored in plastic jugs.
FOR LARGE VOLUMES ; Store in steel storage tanks.
INCOMPATIBLE MATERIALS : Store away from acids.

VIII. EXPOSURE CONTROLS AND PROTECTION

Adequate ventilation needed. TLV C : 2 mg/m3
Protective Equipment for the eyes and skin : Goggles, respirator, disposable latex/ rubber apron, PVC rain suit, rubber boots with pant legs over boots.
Precautionary Hygiene/control measures :
Avoid contact with skin, eyes, and clothing.
Do not breathe mist or vapor. Wash thoroughly after handling. Safety showers and eye wash fountains should be available in storage and handling area.

IX. PHYSICAL AND CHEMICAL PROPERTIES

STATE **:** liquid
APPEARANCE : colorless or slightly turbid
ODOR : Irritating
BOILING POINT : 145 0C for ~50% NaOH Solution
FLASH POINT ; Not determined
SOLUBILITY IN : WATER: Nil

X. STABILITY AND REACTIVITY

Stable under normal handling conditions. Materials and conditions to avoid (incompatibility) are:
- Chlorinated hydrocarbons, acetaldehyde, acrolein, aluminum, chlorine triflouride, hydroquinone, maleic anhydride, and phosphorous pentoxide. - Dilution with water evolves large quantity of heat. Hazardous decomposition & combustion product = none Hazardous polymerization will not occur.

XI. TOXICOLOGICAL INFORMATION

Effects from skin contact – Contact with skin can cause severe burns with deep ulcerations. Contact with solution or mist can cause multiple burns with temporary loss of hair at burn site.
Effects from eye contact – Liquid in the eye can cause severe destruction and blindness. These effects can occur rapidly affecting all parts of the eye. Mist can cause irritation with high concentration causing destructive burns.

XII. ECOLOGICAL INFORMATION

ECOTOXICITY DATA : High basicity may pose potential hazard to plant and marine life.

XIII. DISPOSAL CONSIDERATIONS

Dispose of in accordance with all Government and Local regulations.

XIV. TRANSPORT INFORMATION

Transportation of Dangerous Goods
TDG Classification: Do not ship by air.
DOT Hazard Classification: Class 8 : Corrosive
DOT Shipping Name : Sodium Hydroxide ID: UN1824

SECTION 1: PRODUCT AND COMPANY IDENTIFICATION

Product Name:	**Hi-Cal Hydrate**	
Synonym/s:	**Hydrate, High Calcium Hydrated Lime, Type N Hydrated Lime, HL**	
Manufacturer:	**US Operations:** **Chemical Lime Co.** **3700 Hulen St.** **Fort Worth, TX 76107** **817-732-8164**	**Canadian Operations:** **Chemical Lime Co. of Canada Inc.** **20302-102B Ave.** **Langley, BC V1M 3H1** **604-888-4333**
Emergency Phone:	**Chemtrec 1-800-424-9300**	
Chemical Name: **Chemical Family:** **Chemical Formula:**	**Calcium Hydroxide** **Alkaline Earth Hydroxide** **$Ca(OH)_2$**	**WHMIS Classification:** **D2A, E**
Product Use/s:	**Water treatment, pH adjustment, FGT, Construction, Pulp/Paper**	
Prepared By:	**Chemical Lime Co.** **R&D/Technical Services, KSA**	

SECTION 2: COMPOSITION / INFORMATION ON INGREDIENTS

Ingredient	CAS	OSHA PEL, TWA 8/40h (mg/m3)	ACGIH TLV, TWA 8/40h (mg/m3)	NIOSH REL, TWA 8/40h (mg/m3)	NIOSH IDLH (mg/m3)	Conc. (%)
Calcium Hydroxide, $Ca(OH)_2$ (Hydrated Lime)	**1305-62-0**	**15** (total dust) **5** (respirable)	**5**	**5**	**N.A.**	**> 90**
Magnesium Hydroxide, $Mg(OH)_2$ (Brucite)	**1309-42-8**	**N.A.**	**N.A.**	**N.A.**	**N.A.**	**< 5**
Magnesium Oxide, MgO (Periclase)	**1309-48-4**	**10**	**10**	**N.A.**	**N.A.**	**< 5**
Calcium Carbonate, $CaCO_3$ (Limestone)	**1317-65-3 (471-34-1)**	**15** (total dust) **5** (respirable)	**10**	**10** (total dust) **5** (respirable)	**N.A.**	**< 3**
Crystalline Silica, SiO_2 (Quartz)	**14808-60-7**	**10/(SiO2% + 2)** (respirable)	**0.025** (respirable)	**0.05** (respirable)	**50**	**< 2**

OSHA Regulatory Status: This material is subject to 29 CFR 1910.1200 (Hazard Communication).

SECTION 3: HAZARDS IDENTIFICATION

Emergency Overview: Hydrate is an odorless white or grayish-white powder. Contact can cause irritation to eyes, skin, respiratory system, and gastrointestinal tract.

Potential Health Effects

Eyes: Contact can cause severe irritation or burning of eyes, including permanent damage.

Skin: Contact can cause irritation of skin.

Ingestion: This product can cause severe irritation of gastrointestinal tract if swallowed.

Inhalation: This product can cause severe irritation of the respiratory system. Long-term exposure may cause permanent damage. Hydrate is not listed by MSHA, OSHA, or IARC as a carcinogen However, this product may contain trace amounts of crystalline silica in the form of quartz or crystobalite, which has been classified by IARC as a Group I carcinogen to humans when inhaled. Inhalation of silica can also cause a chronic lung disorder, silicosis.

Medical Conditions Aggravated by Exposure: Contact may aggravate disorders of the eyes, skin, gastrointestinal tract, and respiratory system.

Potential Environmental Effects: This material is alkaline and if released into water or moist soil will cause an increase inpH.

SECTION 4: FIRST AID MEASURES

Eyes: Immediately flush eyes with generous amounts of water or eye wash solution if water is unavailable. Pull back eyelid while flushing to ensure that all lime dust has been washed out. Seek medical attention promptly if the initial flushing of the eyes does not remove the irritant. Do not rub eyes.

Skin: Brush off or remove as much dry lime as possible. Wash exposed area with large amounts of water. If irritation persists, seek medical attention promptly.

Inhalation: Move victim to fresh air. Seek medical attention. If breathing has stopped, give artificial respiration.

Ingestion: Do not induce vomiting. Seek medical attention immediately. Never give anything by mouth unless instructed to do so by medical personnel.

SECTION 5: FIRE FIGHTING MEASURES

Fire Hazards:	Hydrate is not combustible or flammable. However, hydrate reacts vigorously with acids, and may release heat sufficient to ignite combustible materials in specific instances. Hydrate is not considered to be an explosion hazard, although reaction with acids or other incompatible materials may rupture containers.
Hazardous Combustion Products:	None
Extinguishing Media:	Use dry chemical fire extinguisher. Do not use water or halogenated compounds, except that large amounts of water may be used to deluge small quantities of hydrate.
Fire Fighting Instructions:	Keep personnel away from and upwind of fire. Avoid skin contact or inhalation of dust. Wear full fire-fighting turn-out gear (full Bunker gear), and respiratory protection (SCBA).

SECTION 6: ACCIDENTAL RELEASE MEASURES

Spill / Leak Procedures:	**Do Not** use water on bulk material spills. Use proper protective equipment.
Small Spills:	Use dry methods to collect spilled materials. Avoid generating dust. Do not clean up with compressed air. Store collected materials in dry, sealed plastic or non-aluminum metal containers. Residue on surfaces may be water washed.
Large Spills:	Use dry methods to collect spilled materials. Evacuate area downwind of clean-up operations to minimize dust exposure. Store spilled materials in dry, sealed plastic or non-aluminum metal containers.
Containment:	Minimize dust generation and prevent bulk release to sewers or waterways.
Clean-up:	Residual amounts of material can be flushed with large amounts of water. Equipment can be washed with either a mild vinegar and water solution, or detergent and water.

SECTION 7: HANDLING AND STORAGE

Handling:	Keep in tightly closed plastic or non-aluminum metal containers. Protect containers from physical damage. Avoid direct skin contact with the material.
Storage:	Store in a cool, dry, and well-ventilated location. Do not store near acids or other incompatible materials. Keep away from moisture. Do not store or ship in aluminum containers.

SECTION 8: EXPOSURE CONTROLS / PERSONAL PROTECTION

Engineering Controls:	Provide ventilation adequate to maintain PELs.
Respiratory Protection:	Use NIOSH/MSHA approved respirators if airborne concentration exceeds PELs.
Skin Protection:	Use appropriate gloves and footwear to prevent skin contact. Clothing should fully cover arms and legs. Should lime get inside clothing or gloves, remove the clothing and the lime promptly.
Eye Protection:	Use safety glasses with side shields or safety goggles. Contact lenses should not be worn when working with lime products.
Other:	Eye wash fountain/stations and emergency showers should be available.

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

Appearance: White or grayish-white powder	**Odor:** Odorless	**Physical State:** Solid
Boiling Point (°C/°F): 2850 / 5162	**Melting Point (°C/°F):** dec 580 / 1076	**Specific Gravity** (Apparent) g/cc: 0.4 -0.55 (True) g/cc: 2.2 - 4
Vapor Pressure (mm Hg): N.A.	**Vapor Density:** N.A.	**Evaporation Rate:** N.A.
Solubility in Water Slightly soluble in water.	**pH (25°C/77°F):** 12.4	

SECTION 10: STABILITY AND REACTIVITY

Stability: Chemically stable, but slowly reacts with carbon dioxide to form calcium carbonate. See also Incompatibility below.

Incompatibility/ Conditions to Avoid: Hydrate should not be mixed or stored with the following materials, due to the potential for vigorous reaction and release of heat:

Acids (unless in a controlled process)	Organic Acid Anhydrides
Reactive Fluoridated Compounds	Nitro-Organic Compounds
Reactive Brominated Compounds	Reactive Phosphorous Compounds
Reactive Powdered Metals	Interhalogenated Compounds

Hazardous Decomposition Products: None

Hazardous Polymerization: None

Tenderer
TWAD, Vellore

Chief Engineer,

SECTION 11: TOXICOLOGICAL INFORMATION

ORL-RAT LD50: 7,340 MG/KG
ORL-MUS LD50: 7,300 MG/KG

Hydrated Lime is not listed by MSHA, OSHA, or IARC as a carcinogen, but this product may contain trace amounts of crystalline silica, which has been classified by IARC as carcinogenic to humans when inhaled in the form of quartz or crystobalite.

SECTION 12: ECOLOGICAL INFORMATION

Ecotoxicity: Because of the high pH of this product, it would be expected to produce significant ecotoxicity upon exposure to aquatic organisms and aquatic systems in high concentrations.

Environmental Fate: This material shows no bioaccumulation effect or food chain concentration toxicity.

SECTION 13: DISPOSAL CONSIDERATIONS

Dispose of in accordance with all applicable federal, state, and local environmental regulations. If this product as supplied, and unmixed, becomes a waste, it will not meet the criteria of a hazardous waste as defined under the U.S. Resource Conservation and Recovery Act (RCRA).

SECTION 14: TRANSPORTATION INFORMATION

Hydrate is not classified as a hazardous material by US DOT and is not regulated by the Transportation of Dangerous Goods (TDG) when shipped by any mode of transport.

SECTION 15: REGULATORY INFORMATION

EPA Regulations:

RCRA Hazardous Waste Number (40 CFR 261.33): not listed
RCRA Hazardous Waste Classification (40 CFR 261): not classified
CERCLA Hazardous Substance (40 CFR 302.4) unlisted specific per RCRA, Sec. 3001; CWA, Sec. 311(b)(4); CWA, Sec. 307(a), CAA, Sec. 112
CERCLA Reportable Quantity (RQ), not listed SARA 311/312 Codes: not listed
SARA Toxic Chemical (40 CFR 372.65): not listed
SARA EHS (Extremely Hazardous Substance) (40 CFR 355): not listed, Threshold Planning Quantity (TPQ): not listed
All chemical ingredients are listed on the USEPA TSCA Inventory List.

OSHA/MSHA Regulations:

Air Contaminant (29 CRF 1910.1000, Table Z-1, Z-1-A): 5mg/M^3TWA-8
MSHA: not listed
OSHA Specifically Regulated Substance (29 CFR 1910): not listed

State Regulations:

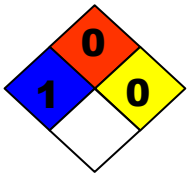
Consult state and local authorities for guidance. Components found in this product may contain trace amounts of inherent naturally occurring elements (such as, but not limited to arsenic and cadmium) that may be regulated.

Canada:

WHMIS Classification: "D2A" Materials Causing Other Toxic Effects
WHMIS Classification: "E" Corrosive Materials (listed due to corrosive effect on aluminum) Canada DSL: Listed

NFPA Hazard Class: Health: 1 Flammability: 0 Reactivity: 0

HMIS Hazard Class: Health: 1 Flammability: 0 Reactivity: 0 Personal Protection: E



SECTION 16: OTHER INFORMATION

Prepared By: **Chemical Lime Company, R&D/Technical Services, KSA**

Chemical Lime Company provides the information contained herein in good faith but makes no representation as to its comprehensiveness or accuracy. This document is intended only as a guide to the appropriate precautionary handling of the material by a properly trained person. Individuals receiving this information must consult their own technical and legal advisors and/ or exercise their own judgment in determining its appropriateness for a particular purpose. Chemical Lime Company makes no representations or warranties, either express or implied, including without limitation and warranties of merchantability or fitness for a particular purpose with respect to the information set forth herein or the product(s) to which the information refers. Accordingly, Chemical Lime Company will not be responsible or liable for any claims, losses or damages resulting from the use of or reliance upon or failure to use this information.

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TWAD, Vellore

Chief Engineer,

MATERIAL SAFETY DATA SHEET ISSUED: 10/23/97

CHLORINE REVISED: 11/01/99

SECTION I - PRODUCT IDENTIFICATION

Westlake CA&O
2468 Industrial Parkway
P O Box 527
Calvert City, KY 42029

Telephone No.: (270) 395-4151
Transportation Emergency No.:
CHEMTREC: (800) 424-9300
Medical Emergency No.:
POISON CENTER: (216) 379-8562

Chemical Family: Halogen
Chemical Name/Synonyms: Chlorine Trade
Mark: None
Formula: Cl_2; (Cl-Cl)
C.A.S. Registry No.: 7782-50-5
TSCA Inventory Status: All ingredients are listed on the USEPA's TSCA inventory Canadian Domestic Substances List Status: All ingredients have been nominated or are eligible for inclusion.
Workplace Hazardous Materials Information System (WHMIS) Classification: C,E Product
Use: Various Applications
SARA 313 Information: This product contains a toxic chemical or chemicals subject to the reporting requirements of section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR part 372.

SECTION II - HAZARDOUS INGREDIENTS

Hazard Summary Statement: WARNING! HIGHLY TOXIC. CORROSIVE. May be fatal if inhaled. Strong oxidizer. Most combustibles will burn in chlorine as they do in oxygen. Read entire Material Safety Data Sheet (MSDS).

Material [1,2,4,5,6]	C.A.S. Number	Amount in Product	ACGIH TLV-TWA	OSHA PEL-TWA
Chlorine	7782-50-5	> 99.5%	0.5 ppm 1 ppm short term exposure limit (STEL)	1 ppm - ceiling

N.A. - Not Applicable **N.E. - Not Established**

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Legislative Footnotes [1]Ingredient

listed on SARA Section 313 List of Toxic Chemicals. [2]Ingredient listed on

the *Pennsylvania Hazardous Substances List.*

[3]Ingredient listed on the California listing of *Chemicals Known to the State to Cause Cancer or Reproductive Toxicity*.

[4]Ingredient listed on the *Massachusetts Substance List.*

[5]*Workplace Hazardous Materials Information System* ingredient found on the Ingredient Disclosure List - Canada.

[6]Ingredient listed on the *New Jersey Right to Know Hazardous Substance List.*

Notes:

TLV-TWA - Threshold Limit Value - Time Weighted Average guideline for concentration of the chemical substance in the ambient workplace air. (The skin notation calls attention to the skin as an additional significant route of absorption of the listed chemical.) American Conference of Governmental Industrial Hygienists (ACGIH).

OSHA PEL - OSHA Permissible Exposure Limit, 8-hour TWA. 29 CFR 1910.1000, Transitional Limits column, Table Z-1-A, Table Z-2, and Table Z-3.

SECTION III - PHYSICAL DATA

Appearance: Greenish-yellow gas
amber liquid
Odor: Pungent, suffocating bleach like odor
Percent Volatiles: >99.5
Solubility in Water: Slight
Physical State: Gas (liquid under pressure)

Specific Gravity: Dry Gas (2.48 @ 0°C) or
Liquid (1.47 @ 0/4°C)
Melting Point: -101°C (-150°F)
Molecular Weight: 70.9
Vapor Pressure: 73 psia @ 50°F
Vapor Density: 2.5 (Air=1)

SECTION IV - FIRE & EXPLOSION HAZARD DATA

Flash Point: Test is not applicable to gases. Not combustible. Chlorine can support combustion and is a serious fire risk.

Flammable Limits in Air: Not Applicable

Note:

Flash Point: The lowest initial temperature of air passing around the specimen at which sufficient combustible gas is evolved to be ignited by a small external pilot flame.

Extinguishing Media: For small fires use dry chemical or carbon dioxide. For large fires use water spray, fog or foam.

Special Firefighting Procedures: Wear full face positive pressure self-contained breathing apparatus (SCBA). Wear full protective gear to prevent all body contact (moisture or water and chlorine can form hydrochloric and hypochlorous acids which are corrosive). Personnel not having suitable protection must leave the area to prevent exposure to toxic gases from the fire. Use water to keep fire-exposed containers cool (if containers are not leaking). Use water spray to direct escaping gas away from workers if it is necessary to stop the flow of gas. In enclosed or poorly ventilated areas, wear SCBA during cleanup immediately after a fire as well as during the attack phase of firefighting operations.

Unusual Fire and Explosion Hazards: Chlorine and water can be very corrosive. Corrosion of metal containers can make leaks worse. Although non-flammable, chlorine is a strong oxidizer and will support the burning of most combustible materials. Flammable gases and vapors can form explosive mixtures with chlorine. Chlorine can react violently when in contact with many materials and generate heat with possible flammable or explosive vapors. Chlorine gas is heavier than air and will collect in low-lying areas.

Explosive Characteristics: Containers heated by fire can explode.

SECTION V - Reactivity

Stability: Stable

Hazardous Polymerization: Will not occur.

Hazardous Decomposition Products: Hydrogen chloride may form from chlorine in the presence of water vapor.

CAUTION! Oxidizer. Extremely reactive.

Incompatibility (Materials to Avoid): Chlorine is extremely reactive. Liquid or gaseous chlorine can react violently with many combustible materials and other chemicals, including water. Metal halides, carbon, finely divided metals and sulfides can accelerate the rate of chlorine reactions. Hydrocarbon gases, e.g., methane, acetylene, ethylene or ethane, can react explosively if initiated by sunlight or a catalyst. Liquid or solid hydrocarbons, e.g., natural or synthetic rubbers, naphtha, turpentine, gasoline, fuel gas, lubricating oils, greases or waxes, can react violently. Metals, e.g., finely powdered aluminum, brass, copper, manganese, tin, steel and iron, can react vigorously or explosively with chlorine. Nitrogen compounds, e.g., ammonia and other nitrogen compounds, can react with chlorine to form highly explosive nitrogen trichloride.

Non-metals,

e.g., phosphorous, boron, activated carbon and silicon can ignite on contact with gaseous chlorine at room temperature. Certain concentrations of chlorine-hydrogen can explode by spark ignition. Chlorine is strongly corrosive to most metals in the presence of moisture. Copper may burn spontaneously. Chlorine reacts with most metals at high temperatures. Titanium will burn at ambient temperature in the presence of drychlorine.

SECTION VI - HEALTH HAZARD DATA

Threshold Limit Value: See Section II.

Primary Routes of Exposure: Inhalation, skin and eye contact. Effects

of Overexposure:

Acute: Low concentrations of chlorine can cause itching and burning of the eyes, nose, throat and respiratory tract. At high concentrations chlorine is a respiratory poison. Irritant effects become severe and may be accompanied by tearing of the eyes, headache, coughing,
choking, chest pain, shortness of breath, dizziness, nausea, vomiting, unconsciousness and death. Bronchitis and accumulation of fluid in the lungs (chemical pneumonia) may occur hours after exposure to high levels. Liquid as well as vapor contact can cause irritation, burns and blisters. Ingestion can cause nausea and severe burns of the mouth, esophagus and stomach.

Chronic: Prolonged or repeated overexposure may result in many or all of the effects reported for acute exposure (including pulmonary function effects).

Emergency and First Aid Procedures:

Inhalation (of process emissions): Take proper precautions to ensure rescuer safety before attempting rescue (wear appropriate protective equipment and utilize the "buddy system"). Remove source of chlorine or move victim to fresh air. If breathing has stopped, trained personnel should immediately begin artificial respiration or, if the heart has stopped, cardiopulmonary resuscitation (CPR). Avoid mouth-to-mouth contact. Oxygen may be beneficial if administered by a person trained in its use, preferably on a physician's advise. Obtain medical attention immediately.

Eye Contact: Immediately flush the contaminated eye(s) with lukewarm, gently flowing water for at least 20 minutes while the eyelid(s) are open. Take care not to rinse contaminated water into the non-affected eye. If irritation persists, obtain medical attentionimmediately.

Skin Contact: As quickly as possible, flush contaminated area with lukewarm, gently running water for at least 20 minutes. Under running water, remove contaminated clothing, shoes, and leather watchbands and belts. If irritation persists, obtain medical attention immediately. Completely decontaminate clothing, shoes and leather goods before re-use, or, discard.

Ingestion: Not an anticipated hazard.

SECTION VII - SPILL & LEAK PROCEDURE

Steps to be taken in case material is released or spilled: Restrict access to the area until completion of the cleanup. Issue a warning: POISON GAS. DO NOT TOUCH SPILLED LIQUID. Do no use water on a chlorine leak (corrosion of the container can occur, increasing the leak). Shut off leak if safe to do so. Wear NIOSH/MSHA-approved, self-contained, full- face, positive pressure respirator and full protective clothing capable of protection from both liquid and gas phases. Persons without suitable respiratory and body protection must leave the area.

The following evacuation guide was developed by the U.S. Department of Transportation (DOT): Spill or leak from a smaller container or small leak from a tank - isolate in all directions 250 feet. Large spill from a tank or from a number of containers - first, isolate 520 feet in all directions; secondly, evacuate in a downwind direction 1.3 miles wide and 2.0 miles long. Keep upwind from leak. Vapors are heavier than air and pockets of chlorine are likely to be trapped in low-lying areas. Use water spray on the chlorine vapor cloud to reduce vapors. Do not flush into public sewer or water systems. Chlorine can be neutralized with caustic soda or soda ash. Alkaline solutions for absorbing chlorine can be prepared as follows:

For 100 pound containers: 125 lbs. of caustic soda and 40 gallons of water
For 2,000 pound containers: 2,500 lbs. of caustic soda and 800 gallons of water For 100
pound containers: 300 lbs. of soda ash and 100 gallons of water
For 2,000 pound containers: 6,000 lbs. of soda ash and 2,000 gallons of water

CAUTION: Observe appropriate safety precautions for handling alkaline chemicals. Heat will be generated during the neutralization process.

Waste Disposal Method: Due to its inherent properties, hazardous conditions may result if the material is managed improperly. It is recommended that any containerized waste chlorine be managed as hazardous waste in accordance with all applicable federal, state, and local health and environmental laws and regulations.

SECTION VIII - SPECIAL PROTECTION INFORMATION

Ventilation: Effective exhaust ventilation should always be provided to draw fumes or vapors away from workers to prevent routine inhalation. Ventilation should be adequate to maintain the ambient workplace atmosphere below the legislated levels listed in Section II.

Respiratory Protection: Use NIOSH approved acid gas cartridge or canister respirator for routine work purposes when concentrations are above the permissible exposure limits. Use full facepiece respirators when concentrations are irritating to the eyes. A cartridge-type escape respirator should be carried at all times when handling chlorine for escape only in case of a spill or leak. Re-enter area only with NIOSH approved, self-contained breathing apparatus with full facepiece. The respiratory use limitations made by NIOSH or the manufacturer must be observed. Respiratory protection programs must be in accordance with 29 CFR 1910.134.

Eye/Face Protection: Non-ventilated chemical safety goggles or a full face shield.

Skin Protection: Wear impervious gloves, coveralls, boots and/or other resistance protective clothing. Safety shower/eyewash fountain should be readily available in the work area. Some operations may require the use of an impervious full-body encapsulating suit and respiratory protection.

Note: Neoprene, polyvinyl chloride (PVC), Viton, and chlorinated polyethylene show good resistance to chlorine.

Additional: Do not eat, drink or smoke in work areas. Maintain good housekeeping.

SECTION IX - SPECIAL PRECAUTIONS

Material Handling: Do not use near welding operations, flames or hot surfaces. Move cylinders by hand truck or cart designed for that purpose. Do not lift cylinders by their caps. Do not handle cylinders with oily hands. Secure cylinders in place in an upright position at all times. Do not drop cylinders or permit them to strike each other. Leave valve cap on cylinder until cylinder is secured and ready for use. Close all valves when not in actual use. Insure valves on gas cylinders are fully opened when gas is used. Open and shut valves at least once a day while cylinder is in use to avoid valve "freezing". Use smallest possible amounts in designated areas with adequate ventilation. Have emergency equipment for fires, spills and leaks readily available. Wash thoroughly after handling product. Provide a safety shower/eyewash station in handling area. An emergency contingency program should be developed for facilities handling chlorine.

Storage: Store in steel pressure cylinders in a cool, dry area outdoors or in well-ventilated, detached or segregated areas of noncombustible construction. Keep out of direct sunlight and away from heat and ignition sources. Cylinder temperatures should never exceed 51°C (125°F). Isolate from incompatible materials. Store cylinders upright on a level floor secured in position and protected from physical damage. Use corrosion resistant lighting and ventilation systems in the storage area. Keep cylinder valve cover on. Label empty cylinders. Store full cylinders separately from empty cylinders. Avoid storing cylinders for more than six months. Comply with applicable regulations for the storage and handling of compressed gases.

SECTION X - HAZARD CODES

NFPA (National Fire Protection Association)		HMIS (Hazardous Materials Identification System)	
Health:	4	Health:	3
Flammability:	0	Flammability:	0
Reactivity:	0	Reactivity:	0
Special:	OXY	Personal Protection:	X*

Key:
0 = Insignificant
Slight
2 = Moderate
3 = High
4 = Extreme

*See MSDS for specified protection 1 =

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Chief Engineer,

USER'S RESPONSIBILITY

This bulletin cannot cover all possible situations which the user may experience during processing. Each aspect of the user's operation should be examined to determine if, or where, additional precautions may be necessary. All health and safety information contained within this bulletin should be provided to the user's employees or customers. Westlake CA&O Corporation must rely upon the user to utilize this information to develop appropriate work practice guidelines and employee instructional programs for his or her operation.

DISCLAIMER OF LIABILITY

As the conditions or methods of use are beyond our control, we do not not assume any responsibility and expressly disclaim any liability for any use of this material. Information contained herein is believed to be true and accurate but all statements or suggestions are made without warranty, expressed or implied, regarding the accuracy of the information, the hazards connected with the use of the material or the results to be obtained from the use thereof. Compliance with all applicable federal, state and local laws and regulations remains the responsibility of the user.

SHIPPING INFORMATION

IDENTIFICATION - DOMESTIC TRANSPORTATION

Proper Shipping Name (172.101(c)): **Chlorine**
(Technical Name(s)) 172.203(k): **N/A**
Hazard Class 172.101(d): **2.3** UN/NA#
172.101(e): **UN 1017**
Haz. Substance 171.8: **RQ (Chlorine)**
Reportable Quantity (Appendix A to 172.101): **10 LB**
Inhalation Hazard 172.2a(b): **Zone B, Poison-Inhalation Hazard, Marine Pollutant**
Package Code 172.101(f): **N/A**
Placarded: **Poison Gas**

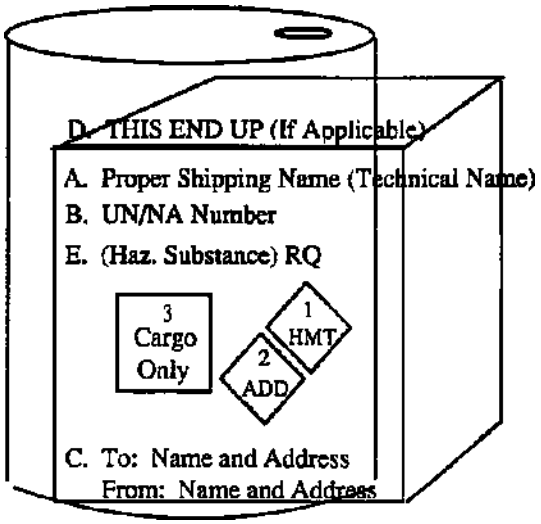
PACKAGING (Part 173)

- Packaging Section (172.101(i)) - Col. 8(a): None
  Col. 8(b): 173.304
  Col. 8(c): 173.314, 173.315

- General Packaging Section - General 173.24 Hazard Class: **POISON GAS**

MARKING

A. Proper Shipping Name (172.301(a)) (Technical Name) (172.301(b))
B. UN / NA Number (172.301(a))
C. Name & Address (172.301(d))
D. THIS END UP (172.312(a))
E. Hazardous Substance RQ (Name) (172.324)
ORM Designation (172.316(a))
Inhalation Hazard (172.313(a))



DOMESTIC LABELING
1. HMT LABELS (172.400)
2. Additional SubsidiaryHazard (172.402(a)):
8 (Corrosive)

DANGEROUS GOODS DETERMINATION (38th Edition) IATA

- Air Transport of This Material if Forbidden (Passenger and Cargo)

HANDLING

See the following standard operating procedures in the Book II:

- Aluminium sulphate dosing system.
- Chlorination.
- Remineralization.

EMERGENCY PLAN

Chlorine

Incident management

Key Points

Fire

- Non combustible, but enhances combustion of other materials
- In the event of a fire involving chlorine, use fine water spray and liquid-tight protective clothing and breathing apparatus

Health

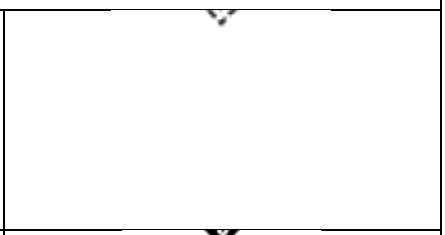
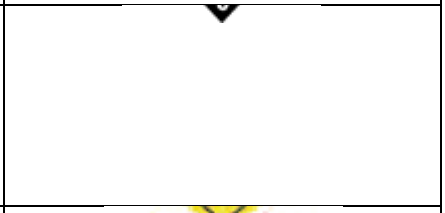
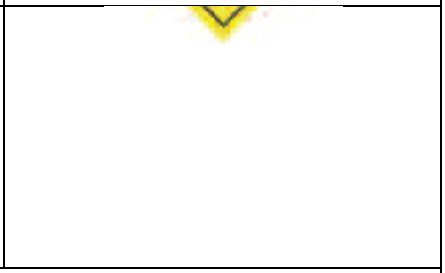
- Due to its gaseous nature inhalation and ocular exposure are most likely
- Toxic and irritant
- Contact with liquefied gas can cause frostbite
- Irritating to eyes, respiratory system and skin

Environment

- Dangerous for the environment
- Inform Environment Agency of substantial incidents

Hazard Identification

Standard (UK) Dangerous Goods Emergency Action Codes [(a)]

UN		**1017**	Chlorine	
EAC		**2XE**	Use fine water spray. Wear liquid-tight chemical protective clothing in combination with breathing apparatus*. Spillages and decontamination run-off should be prevented from entering drains and watercourses. There may be a public safety hazard outside the immediate area of the incident**.	
APP		**A(c)**	Liquefied gas with boiling point below -20 °C. Gas-tight chemical protective suit with breathing apparatus***.	
Hazards	**Class**	**2.3**	Toxic gas	
	Sub risks	**8**	Corrosive substance	
		5.1	Oxidising substance	
HIN		**268**	Toxic gas, corrosive	

UN – United Nations number; EAC – Emergency Action Code; APP – Additional Personal Protection; HIN - Hazard Identification Number

* Liquid-tight chemical protective clothing (BS 8428) in combination with self-contained open circuit positive pressure compressed air breathing apparatus (BS EN 137).
** People should stay indoors with windows and doors closed, ignition sources should be eliminated and ventilation stopped. Non-essential personnel should move at least 250 m away from the incident.
*** Gas-tight chemical protective clothing (BS EN 943) in combination with self-contained open circuit positive pressure compressed air breathing apparatus (BS EN 137).

[a] Dangerous Goods Emergency Action Code List, HM Fire Service Inspectorate, Publications Section, The Stationery Office, 2009.

***Chemical Hazard Information and Packaging for Supply Classification*[(a)]**

Classification	**T**	Toxic	
	Xi	Irritant	
	N	Dangerous for the environment	
Risk phrases	**R23**	Toxic by inhalation	
	R36/37/38	Irritating to eyes, respiratory system and skin	
	R50	Very toxic to aquatic organisms	
Safety phrases	**S1/2**	Keep locked up and out of the reach of children	
	S9	Keep container in a well-ventilated place	
	S45	In case of accident or if you feel unwell seek medical advice immediately (show the label where possible)This material and its container must be disposed of as hazardous waste	
	S61	Avoid release to the environment. Refer to special instructions / safety data sheet	

Specific concentration limits

Concentration	Classification
C ≥ 0.25 %	N; R50

[a] Annex VI to Regulation (EC) No 1272/2008 on Classification, Labelling and Packaging of Substances and Mixtures- Table 3.2.
http://esis.jrc.ec.europa.eu/index.php?PGM=cla (accessed 11/2011)

Globally Harmonised System of Classification and Labelling of Chemicals (GHS) [a]

Hazard Class and Category	Acute Tox. 3	Acute toxicity (inhalation), category 3	
	Eye Irrit. 2	Eye irritation, category 2A	
	STOT SE 3	Specific target organ toxicity following single exposure, category 3	
	Skin Irrit. 2	Skin irritation, category 2	
	Aquatic Acute 1	Acute hazards to the aquatic environment, category 1	
Hazard Statement	**H331**	Toxic if inhaled	
	H319	Causes serious eye irritation	
	H335	May cause respiratory irritation	
	H315	Causes skin irritation	
	H400	Very toxic to aquatic life	
Signal Words	DANGER		

Implemented in the EU on 20 January 2009.

[a] Annex VI to Regulation (EC) No 1272/2008 on Classification, Labelling and Packaging of Substances and Mixtures- Table 3.1.
http://esis.jrc.ec.europa.eu/index.php?PGM=cla (accessed 11/2011)

Physicochemical Properties

CAS number	7782-50-5
Atomic weight	35
Chemical symbol	Cl
Common synonyms	-
State at room temperature	Gas
Volatility	Vapour pressure = 4,800 mm Hg at 20^{o}C
Vapour density	2.5 at 21^{o}C (air = 1)
Flammability	Non combustible but enhances combustion of other substances
Lower explosive limit	Data not available
Upper explosive limit	Data not available
Water solubility	0.65 g 100 mL^{-1}
Reactivity	Reacts explosively with acetylene, ether, ammonia, fuel gas, hydrogen and finely divided metals
Reaction or degradation products	Reacts with hydrocarbons and Lewis acids to release HCl gas
Odour	Pungent odour of bleach

References[a,b,c]

[a] International Programme on Chemical Safety: International Chemical Safety Card Entry for Chlorine (00012623), 2001.
[b] The Dictionary of Substances and their Effects. Ed. S Gangolli. Second Edition, Volume 2, 1999.
[c] The Merck Index (14th Edition). Entry 2095: Chlorine, 2006.

Threshold Toxicity Values

EXPOSURE VIA INHALATION		
ppm	**mg m^{-3}**	**SIGNS AND SYMPTOMS**
0.2 – 3.5	**1 -10**	Odour detection
1 – 3	**3 – 9**	Mild mucous membrane irritation, tolerable for up to one hour
5	**14**	Severe irritation of the eyes and respiratory tract
14 – 21	**41 – 61**	Dangerous if exposed for 30 – 60 minutes
35 – 50	**101 – 145**	Fatal in 60 – 90 minutes
430	**1247**	Fatal over 30 minutes
1000	**2900**	Fatal within minutes

Reference[(a)]

[a] Chlorine (MEDITEXT® Medical Management). In: Klasco RK (Ed): TOMES® System. Thomson Micromedex, Greenwood Village, Colorado (accessed /2010).

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Chief Engineer, TWAD, Vellore

Published Emergency Response Guidelines

Emergency Response Planning Guideline (ERPG) Values **(a)**

	Listed value (ppm)	Calculated value (mg m^{-3})
ERPG-1*	1^	3
ERPG-2*	3	9
ERPG-3*	20	58

* Maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hr without experiencing other than mild transient adverse health effects or perceiving a clearly defined, objectionable odour.
** Maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hr without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action.
*** Maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hr without experiencing or developing life-threatening health effects.
^ Odour should be detectable near ERPG-1.

Acute Exposure Guideline Levels (AEGLs) **(b)**

	ppm				
	10 min	**30 min**	**60 min**	**4 hr**	**8 hr**
AEGL-1†	0.5	0.5	0.5	0.5	0.5
AEGL-2††	2.8	2.8	2.0	1.0	0.7
AEGL-3†††	50	28	20	10	7.1

† The level of the chemical in air at or above which the general population could experience notable discomfort.
†† The level of the chemical in air at or above which there may be irreversible or other serious long- lasting effects or impaired ability to escape.
††† The level of the chemical in air at or above which the general population could experience life-threatening health effects or death.

[a] American Industrial Hygiene Association (AIHA). 2010 Emergency Response Planning Guideline Values and Workplace Environmental Exposure Level Guides Handbook, Fairfax, VA (accessed 01/2011).
[b] U.S. Environmental Protection Agency. Acute Exposure Guideline Levels, http://www.epa.gov/oppt/aegl/pubs/chemlist.htm (accessed 01/2011).

Exposure Standards, Guidelines or Regulations

Occupational standards

WEL[(a)]	LTEL(8 hour reference period): No guideline value specified
	STEL(15 min reference period): 0.5 ppm ($1.5\ mg\ m^{-3}$)

Public health guidelines

DRINKING WATER QUALITY GUIDELINE[(b,c)]	$5\ mg\ L^{-1}$ $250\ mg\ L^{-1}$ chloride ions
AIR QUALITY GUIDELINE	No guideline value specified
SOIL GUIDELINE VALUE AND HEALTH CRITERIA VALUES	No guideline values specified

WEL – Workplace exposure limit; LTEL - Long-term exposure limit; STEL – Short-term exposure limit

[a] List of approved workplace exposure limits (as consolidated with amendments October 2007). http://www.hse.gov.uk/coshh/table1.pdf (An update to EH40/2005: Workplace Exposure Limits 2005. The Stationery Office, London) (accessed 01/2011).

[b] Guidelines for Drinking-Water Quality. 3rd Edition. Incorporating the 1st and 2nd Addenda, Volume 1. Recommendations. WHO. Geneva. 2008 (accessed 01/2011).

[c] The Water Supply (Water Quality) Regulations 2000 (England) and the Water Supply (Water Quality) Regulations 2001 (Wales)(accessed 01/2011).

Health Effects

***Major routes of exposure*[(a)]**

- Toxic via inhalation and ocular exposure. Dermal features usually occur only from exposure to concentrated chlorine gas or in the immediate vicinity of a release of pressurised liquid.

***Immediate Signs or Symptoms of Acute Exposure*[(a,b,c)]**

- Inhalation causes irritation of eyes and nose with sore throat, cough, chest tightness, headache, fever, wheeze, tachycardia and confusion. Chemical pneumonitis, tachypnoea, dyspnoea and stridor due to laryngeal oedema may follow. Pulmonary oedema with increasing breathlessness, wheeze, hypoxia and cyanosis may take up to 36h to develop. Optic neuropathy has been reported following acute inhalation.
- Symptoms usually occur immediately but, less commonly, may be delayed for several hours. Irritation to the mucous membranes in the nose and throat may occur after exposure to low concentrations (10 ppm) of chlorine. A feeling of suffocation, breathlessness, rhinorrhoea, coughing with white or bloodstained sputum, chest pain and tightness, abdominal pain, nausea, headache, dizziness and tachycardia may follow more substantial exposure (30 ppm) and worsen over several hours. Hoarseness and stridor may develop due to laryngeal oedema. Severe bronchoconstriction and non-cardiogenic pulmonary oedema occur in severe cases.
- Dermal exposure to concentrated chlorine may cause dermal burns and the pressurised liquid can cause frostbite.
- Ocular exposure causes immediate stinging and burning with lacrimation and blepharospasm. High concentrations will cause ocular burns.

TOXBASE - http://www.toxbase.org (accessed 01/2011)

[a] TOXBASE: Chlorine (E), 09/2002.

[b] TOXBASE: Corrosives – inhalation, 06/2010.

[c] TOXBASE: Chlorine – medical briefing, 03/2000.

Decontamination and First Aid

Important Notes

- Ambulance staff, paramedics and emergency department staff treating chemically- contaminated casualties should be equipped with Department of Health approved, gas-tight (Respirex) decontamination suits based on EN466:1995, EN12941:1998 and prEN943-1:2001, where appropriate.
- Decontamination should be performed using local protocols in designated areas such as a decontamination cubicle with adequate ventilation.
- Chlorine is a volatile gas and secondary contamination is unlikely, although chlorine gas can condense on the skin and contaminate others dermally, unless protected.

***Dermal exposure*[a,b]**

- Remove patient from exposure.
- The patient should remove all clothing and personal effects.
- Double-bag soiled clothing and place in a sealed container clearly labelled as a chemical hazard.
- Wash hair and all contaminated skin with copious amounts of water (preferably warm) and soap for at least 10-15 minutes. Decontaminate open wounds first and avoid contamination of unexposed skin.
- Pay special attention to skin folds, axillae, ears, fingernails, genital areas and feet.

***Ocular exposure*[b]**

- Remove patient from exposure.
- Remove contact lenses if necessary and immediately irrigate the affected eye thoroughly with water or 0.9% saline for at least 10-15 minutes.
- Patients with corneal damage or those whose symptoms do not resolve rapidly should be referred for urgent ophthalmological assessment.

***Inhalation*[c]**

- Remove patient from exposure.
- Ensure a clear airway and adequate ventilation.
- Give oxygen to patients with respiratory symptoms.
- Apply other supportive measures as indicated by the patient's clinical condition.
- Exposed individuals who have not developed symptoms should be told to seek medical advice if they develop respiratory problems.

Ingestion

- Not applicable

This document will be reviewed not later than 3 years or sooner if substantive evidence becomes available.

TOXBASE - http://www.toxbase.org (accessed 01/2011)
[a] TOXBASE: Chlorine, 09/2000.
[b] TOXBASE: Chlorine – medical briefing, 03/2000.
[c] TOXBASE: Corrosives – inhalation, 06/2010.

8. SAFETY

MAIN CONCEPTS AND ASPECTS

INDEX

1-Health & safety primary concepts

Health and Safety (HS): The objectives of HS are to advise and protect people against risks to health or safety arising out of work activities by ensuring risks in the changing workplace

are properly controlled, and their vision is to see Health and Safety as a cornerstone of a civilised society and, with that, to achieve a record of workplace health and safety that leads the world.

This is done through research, information and advice, promoting training, new or revised regulations and codes of practice, inspection, investigation and enforcement

Risk: The combination of the likelihood and the consequences of a specified hazardous event (incident). A risk, then always has two elements, the likelihood that a hazard may occur and the consequences (severity) of the hazardous event

1-Health & safety primary concepts

Risk Assessment: A process encompassing hazard identification, determination of risk, and the selection of appropriate risk control measures

Hazard: A situation that, if left un-addressed, may result in an injury or loss.

Biological Hazard :This term is used to describe a variety of infectious agents that may enter the body. This includes HIV, Hepatitis A, B, C and others such as leptospirosis (Weil's disease).

Personal Protective Equipment: All equipment (including clothing affording protection against the weather) which is intended to be worn or held by a person at work and which protects him against one or more risks to his health or safety', e.g. safety helmets, gloves, eye protection, high-visibility clothing, safety footwear and safety harnesses.

1-Health & safety primary concepts

Emergency: The occurrence of an unplanned or uncontrolled event, which requires immediate attention. Circumstances which cannot be anticipated and which threaten serious disruption to the service, e.g.severe weather conditions such as fog, flooding or heavy snow, breakdowns,incidents or sudden illness to a key member of staff.

Confined Space: Any place including any chamber, tank, pit, trench, culvert, tunnel, inspection pit, pipe, sewer, well, or other similar places,in which, by virtue of its enclosed nature, there arises a reasonably foreseeable specified risk, due to oxygen deficiency,toxic fumes or any other hazard.

Incident: Incident: work-related event(s) in which an injury or ill health (regardless of severity) or fatality occurred, or could have occurred

Near Miss: A situation whereby an injury or loss was only avoided by either the intervention of emergency action or just good luck.

Corrective Action: actions carried out to remove the causes of non-conformities, incidents, to prevent them from reoccurring.

Preventive Action: actions carried out to remove the causes of possible non- conformities, incidents, to prevent them from occurring.

Non-conformity: deviations from the requirements specified in Ferrovial Agroman/Cadagua Safety Management System

Severity:The outcome (consequences) of an incident to a person, an item of equipment, the infrastructure or the environment. SitePhysical location where the work is to be undertaken.

2.1- Our work affects our health & our health affects our work.

On average, people adults spend nearly half of their waking hours at work. Where we work influences our health, not only by exposing us to physical conditions that have health effects, but also by providing a setting where healthy activities and behaviors can be promoted. In addition to features of worksites, the nature of the work we do and how it is organized also can affect our physical and mental health. Work can provide a sense of identity, social status and purpose in life, as well as social support. For most of the people, employment is the primary source of income, giving them the means to live in homes and neighborhoods that promote health and to pursue health-promoting behaviors. Not only does work affect health; health also affects work.

Good health is often needed for employment, particularly for low- skilled workers. Lack of employment among those who are unable to work because of ill health can lead to further economic and social disadvantage and fewer resources and opportunities to improve health, perpetuating a vicious cycle.

2-2 Employment-related health problems have significant human and economic costs for individuals and for society overall.

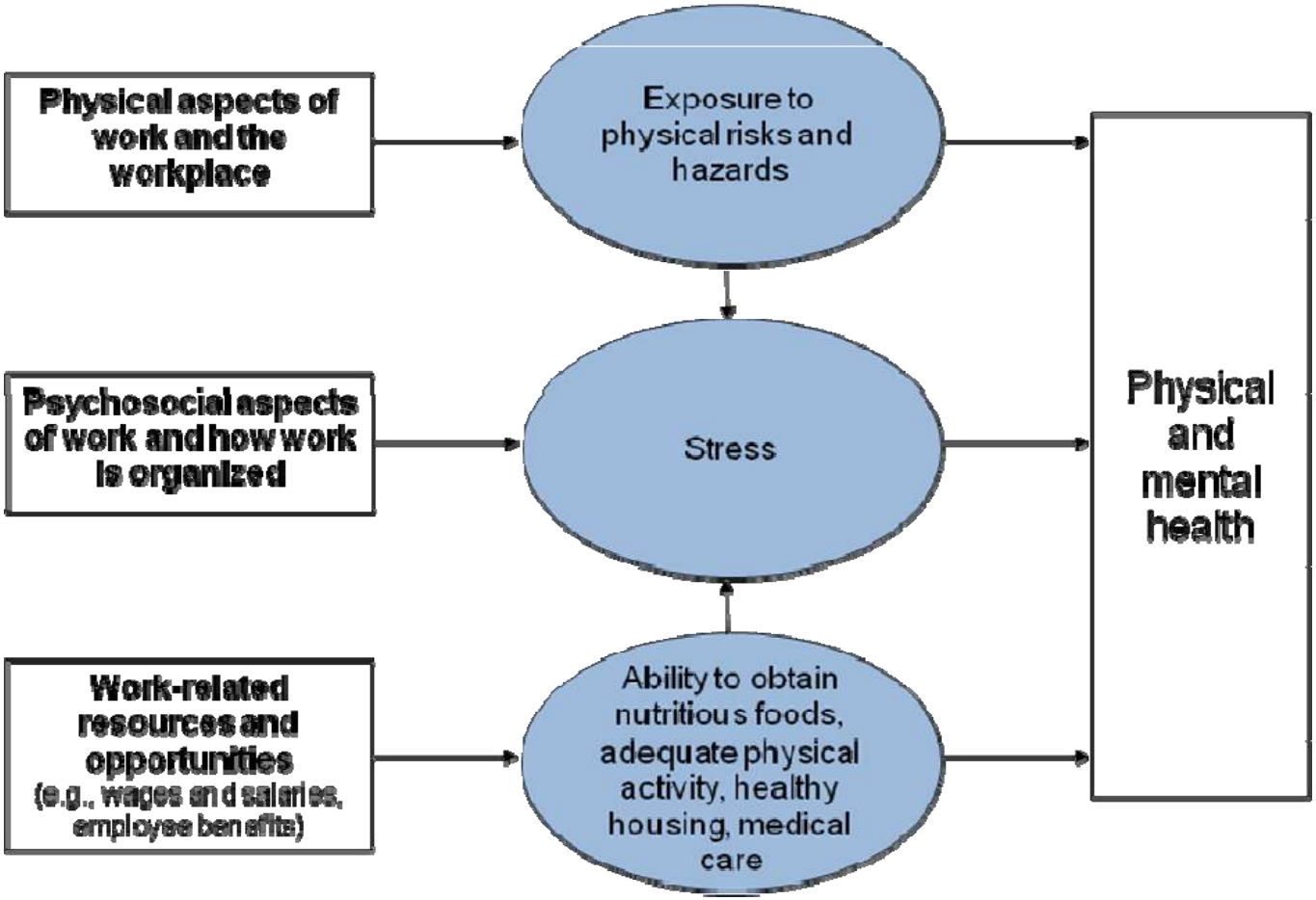
1- Eg. In America in 2007, over 5,000 fatal and 4 million nonfatal work-related injuries and illnesses were reported in private industry workplaces; about half of the non-fatal injuries resulted in time away from work due to recuperation, job transfer or job restriction.

2-Some reports have found that the total economic costs to the nation of occupational illness and injury match those of cancer and nearly those of heart disease.

3-Healthy workers and their families are likely to incur lower medical costs and be more productive, while those with chronic health conditions generate higher costs in terms of health care use, absenteeism, disability and overall reduced productivity.

4-Workplace injuries and work-related illnesses have a major financial impact on both large and small employers. In 2006, the cost to employers for workers' compensation totaled $87.6 billion.

Figure 1. **How work shapes health for workers and their families**



3.1 Occupational Health Hazards

Hazard Type	Examples
CHEMICAL Flammability Toxicity	Gases, Vapors, Dusts, Fumes, Mists, Fibers etc. (Crude, H2S, SO2, NH3, TCE, HC,, Welding fumes etc.)
PHYSICAL	Noise, Heat stress, Ionizing and Non-ionizing Radiation, Vibration
BIOLOGICAL	Insects, Mold, Yeast, Fungi, Bacteria, Viruses
ERGONOMICS	Repetitive Motion, Improper Lifting / Reaching, Poor Visual Conditions

Occupational Health Risk

Risk Type	Examples
Falling from height	Ladders, Stairs, Scaffolding, Tanks, vehicles, etc
Falling to the same level	Poor housekeeping, objects, spills and water on the floor,
Crash car	Driving, while walking near cars
Objects falling	Using cranes, forklift, storaging….

Occupational Health Risk

Risk	Examples
Electrical	Working with electrical box, electrical hand tools, powerlines, transformer…..
Entrapment	During operation and maintenance or machinary, equipment….

Hazard minimization_Using

vehicles

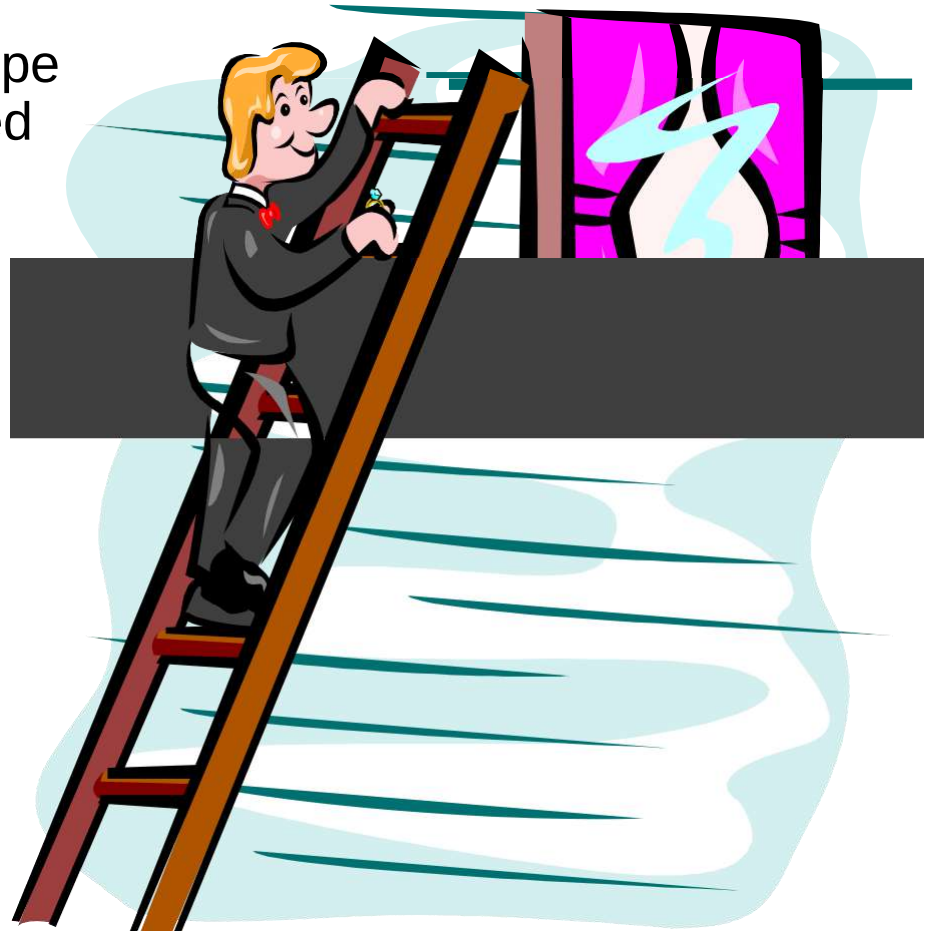
- Should be installed with spark arrestor
- Shut off the motor, and hand brakes must on before leaving any vehicle.
- Never leave a vehicle running unattended.

- Do not remove the key from the ignition switch.
- Respect the traffic rules
- On the site 20 km

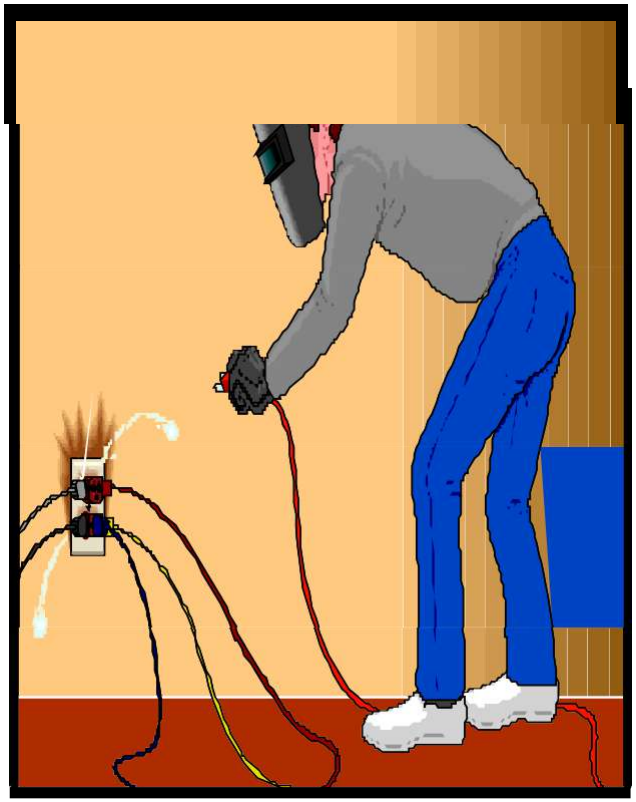
- All Scaffolding must be approved by Safety Dept. before any work commence on them.
- Scaffolding must be erecting and dismanteling and used by trained personnel.
- Use harness

- All ladders must be held by another person or tied off with rope when used by an unaccompanied worker

- Wooden ladders not allowed.

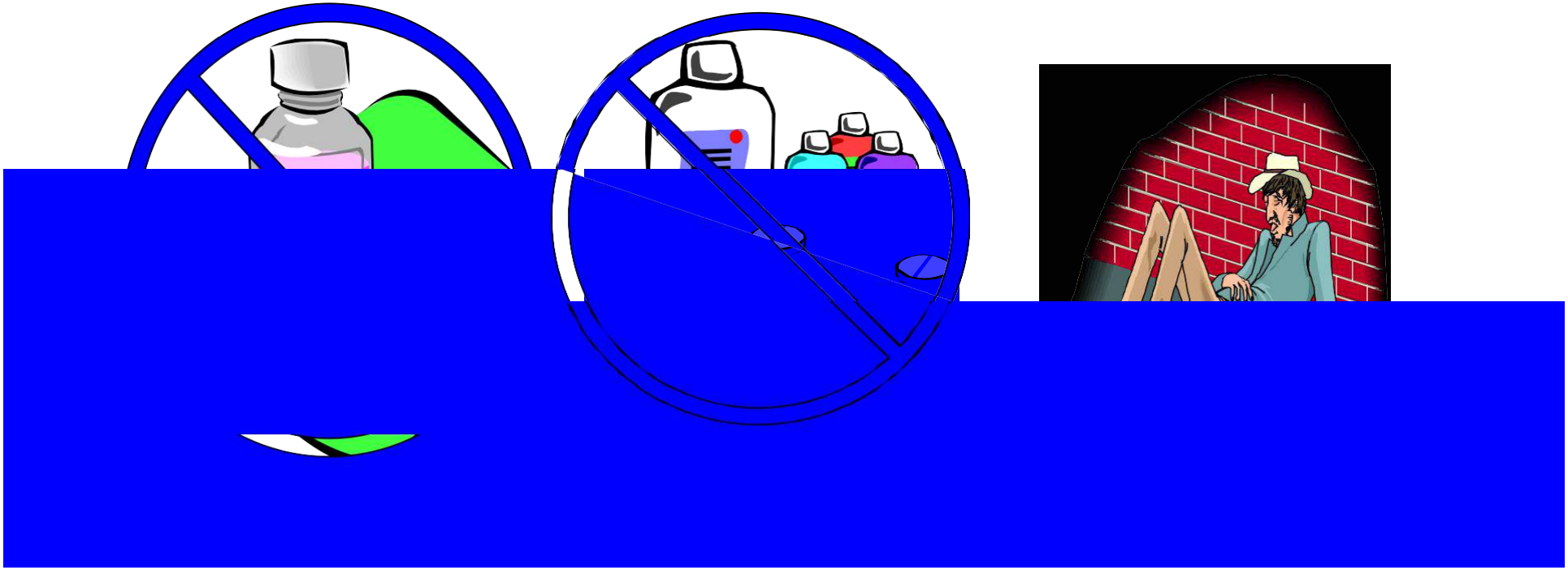


- All Electrical Equipment must be inspected and certified by Electrical Dept.
- Only qualified personnel

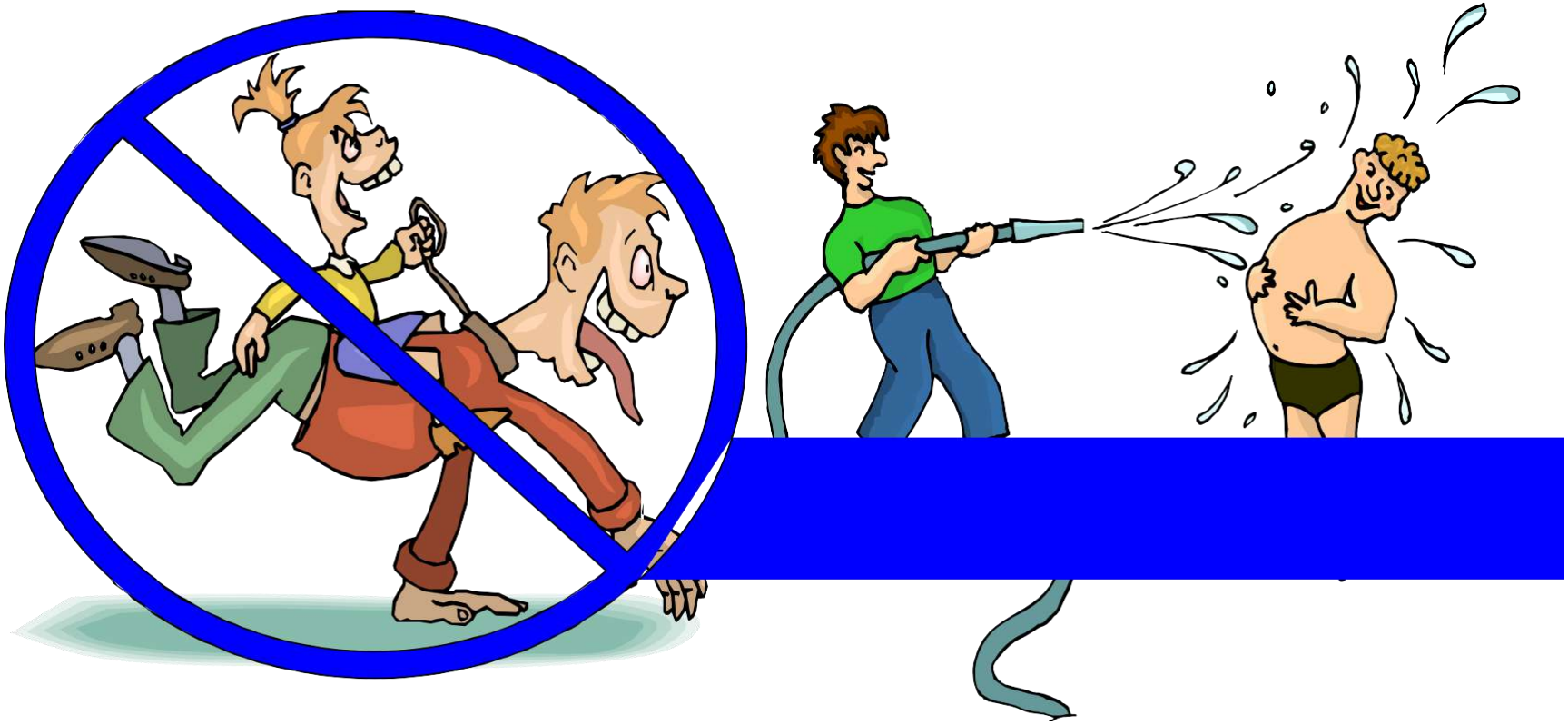


Use of any:

- Drugs or Alcoholic Beverages on the job



- Horse play or Fighting



Conduct prohibited

Where is smoking permitted?

- Only in designated areas

3.3 Hazard minimization

What other safety precautions should be followed ?

- All Trash, Waste and Scrap must be placed in proper containers.
- Disposal of materials at the job site, on the ground, in ditches or process sewers is prohibited.

3.3 Treatment

<u>If you exposed to chemicals on your eyes</u>

- Eyewash station
- Flush for15 minutes.
- Medical attention.

Treatment

If you exposed to chemicals on your eyes

YOU MUST

- head to the shower
- wash (15 to 20mts)to remove chemicals
- Remove clothes if necessary
- Report to Clinic for Medical Treatment

4.1- What is P.P.E.:

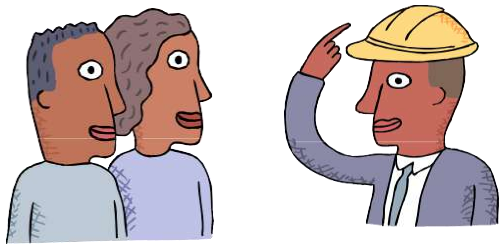
Protective clothing, helmets, goggles, or other garment or equipment designed to protect the wearer's body from injury and it´s purpose is to reduce employee exposure to hazards when engineering and administrative controls are not feasible or effective to reduce these risks to acceptable levels. PPE is needed when there are hazards present.

4.2-Type of P.P.E:

- Eye and face protection
- Head protection
- Hand protection
- Ear protection
- Foot protection

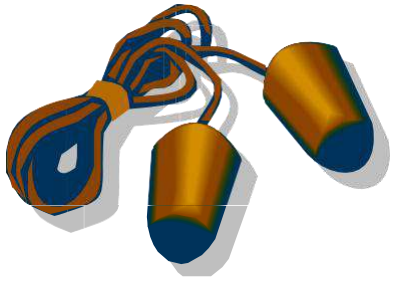
Hard Hat

- Hard Hats play an important role in head protection.
- Anyone who has worked on Site will tell you that hard hats work
- Hard hats shall all comply with international standards
- It is important to remember that hard hats should *never* be modified!
- Use only fittings and accessories that are designed to work with that particular model



Hearing Protection

- Hearing protection is mandatory in areas where an employee may experience high noise levels (85dba) or required by signage



- High noise level areas include:
  - ✓ tanks/pumps (mud, water
  - ✓ Electrical handtool
  - ✓ Working around mobil equipment (crane, forklifts etc..)
- Exposure to high level noise <u>will</u> damage your hearing!
- Hearing protection is supplied... *USE IT!*

4.5 Safety Glasses

- You should always use the correct eye protection if you work with:liquid chemicals, molten metals, hazardous gases,flying particle etc.
- All Safety glasses shall comply with international standards
- Safety Glasses must be worn at the Rig site

- Always clean your Safety Glasses
- ***REMEMBER:*** *Safety Glasses should be worn over your eyes! Not on the top of your head or in your pocket!*

4-Personal Protective Equipment

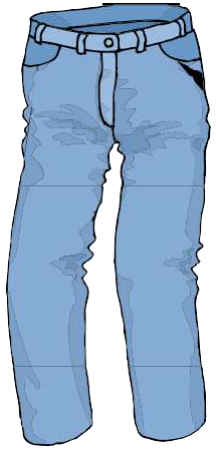
4.6 Face Shield

- ***Face Shields are required whenever operating a grinder***
- Wear Safety glasses and a Face Shield for maximum protection
- Signs are in place to remind you!

4-Personal Protective Equipment

4.7 Clothes

- Appropriate clothing can help protect you from nicks, cuts, and scratches
- Clothing also helps to protect you from UV exposure
- Reflective/bright clothing helps to make you more visible around the work site

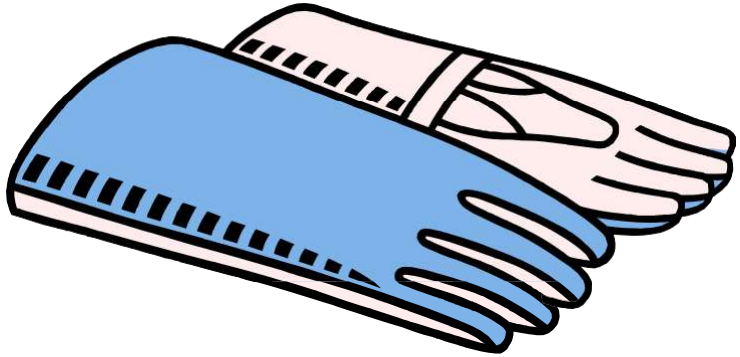


Safety boots

- Safety boots provide adequate foot protection on the work site
- Boots should be well fitting and in good repair
- Damaged boots could increase your risk of injury

Gloves

- Gloves are an important piece of PPE, they protect the hands during general work activities
- It is important to remember that gloves may not be suitable for all tasks. Examples are driving vehicles/plant and doing small technical tasks



4.10 In summary

- PPE is not a ‘force field’ which will protect you from all harm! However; PPE *will* assist in minimising injury
- Correctly using PPE is everyone’s responsibility!
- Damaged PPE must be replaced as soon as possible
- PPE that is worn out is to be returned to the HSE Advisor and if a replacement is required, this will be issued

5- Emergency procedure

5.1 Know emergency evacuation procedure

Emergency Order

Incase of noticing fire / emergency / injury:

1. Raise alarm by shouting, e.g. –Fire-Fire-Fire etc. to get attention of others.

2. Inform to Site Manager call point or over telephone or by radio over operation group.

3. Report in person, if unable to communicate by other means.

4. Try to extinguish by first available fire fighting equipment.

5. Guide the fire / emergency vehicle to the scene of emergency if deemed necessary and walk to the designated area.

5- Emergency procedure

5.1 Know emergency evacuation procedure

<u>On Hearing Fire Alarm:</u>

6. Leave your work area safe.

7. Don't run in panic; do not take undue risk, park vehicles on nearest safe parking (leaving keys inside the ignition switch) and walk safely to the designated area.
8. For Essential employees (On duty Fire crew, back up fire crew, operations shift fire crew, SFF & P staff, ERP members, Fire wardens and Operations personnel shall proceed to their defined areas and discharge their duties as per the directives

9. All other employees except the one's defined above shall report to their respective assembly points.
10. Assist if requested accordingly.

11. Do not return to work area until all clear alarm has been sounded .

<u>You should:</u>

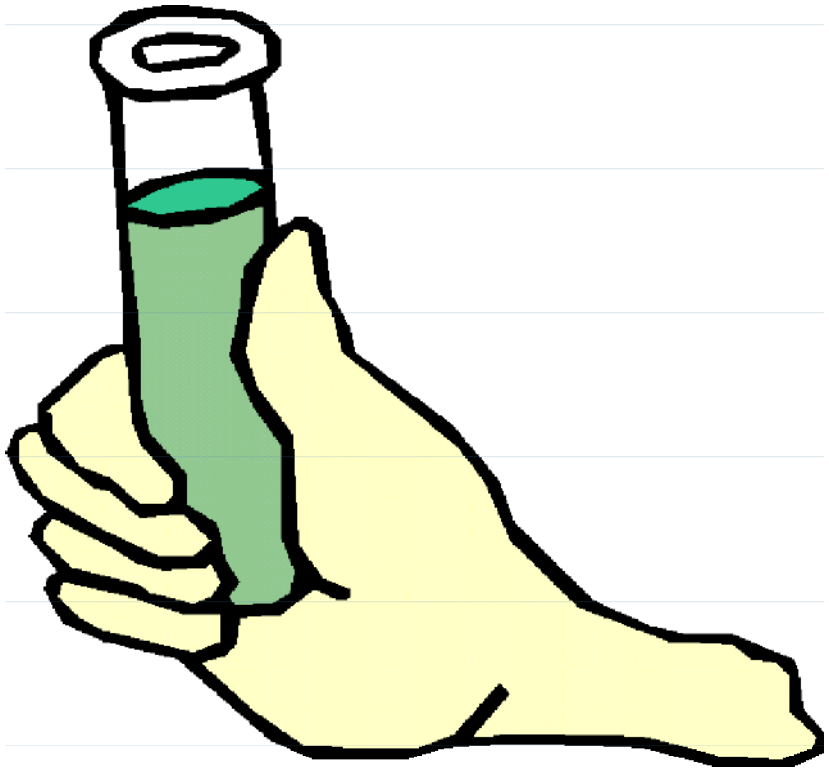
- Shut off the engine
- Switch off electricity
- Pull off the road
- Never leave running

<u>How to notify?</u>

- Fire alarm
- Calling phone
- Any company Employee
- The Contract Co-ordinator
- Your Supervisor or Foreman

REMAIN AT THE ASSEMBLY POINT UNTIL You receive official Instruction (all clear siren)

7-Chemical Handling

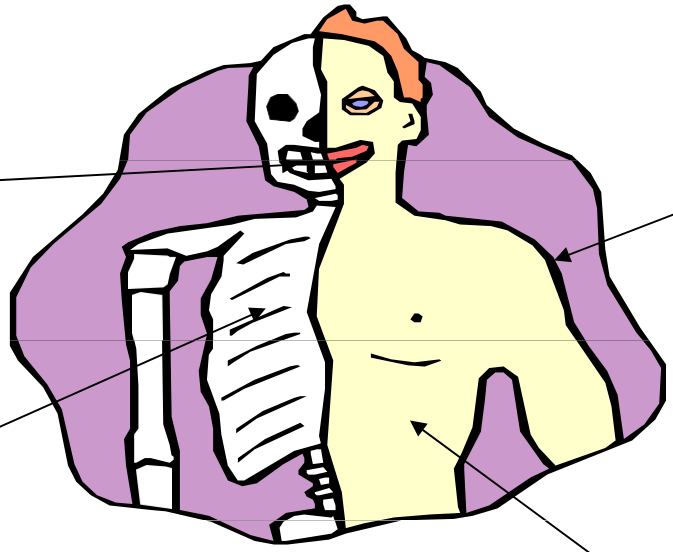


Chemical Handling-what?

Various substances used for a variety of operations usually in concentrated form:

- Granules- can give off dust, vapours, gases
- Powders-as granules, dusts more likely
- Liquids-vapours and gases
- Gases-gas may be heavy or light
- Solids- dust and gases

Routes of entry



INGESTION OR EATEN/DRUNK- DUSTS AND LIQUIDS

INJECTION INTO THE BLOOD- LIQUIDS AND GASES

INHALATION OR BREATHED IN-DUSTS VAPOURS AND GASES

ABSORBTION OR THROUGH THE SKIN- LIQUIDS AND VAPOURS

Common Routes of entry

- Vapours/ gases/dusts breathed in
- Spills on skin or eyes
- Contamination of food/ drink and cigarettes
- Accidental ingestion- drinking incorrectly labelled products
- High pressure contact through skin (injection)

7.4 Hazardous effects and their warning labels

Flammable- burns easily

These labels mean that fire is a problem so no ignition sources close and fire fighting equipment should be nearby!

Oxidizing -assists burning

More dangerous-take extreme care!!

Toxic- kills
Very toxic kills quickly and more often!

Corrosive- burns skin, blinds eyes, dissolves metals/ plastics etc

10.4 Hazardous effects and their warning labels

Can explode easily spreading danger

Irritates skin, eyes throat

Dangerous to the environment- extra carefully

Material safety data sheets (msds)

TOTAL SAFETY	MATERIAL SAFETY DATA SHEET	DATE OF ISSUE:
		MSDS#

PRODUCT NAME: KASARIN

MANUFACTURER: GRIMREAPER CHEMICAL COMPANY

HAZARDS

EXPLOSIVE
FLAMMABLE
VERY TOXIC

FIRE FIGHTING

USE FOAM ONLY

FIRST AID

IF SWALLOWED USE ANTIDOTE DIMOROL, SEEK MEDICAL HELP

SPILLAGE

SWEEP UP CAREFULLY AVOIDING IGNITION
EVACUATE AREA

PERSONAL PROTECTION

FULL BA SET, FULL CHEMICAL SUIT

SPECIAL PRECAUTIONS

EXTEREMLY HAZARDOUS, MEDICAL HELP SHOULD BE NEARBY

- The chemical supplier must provide a sheet giving certain information about the chemical
- The MSDS sheet will tell you exactly what PPE you must wear for preparation and application and it's effects

7.4 Transport and handling

- Handle with care- know the msds data
- Wear appropriate ppe
- If the container breaks or leaks put all the required ppe on and follow the msds guidelines
- Report to hse
- Check your health

First Aid

- Know the msds actions for first aid and how to use safety showers/ eyewash equipment before you need it. If you feel unwell after using chemicals- see the doctor!!

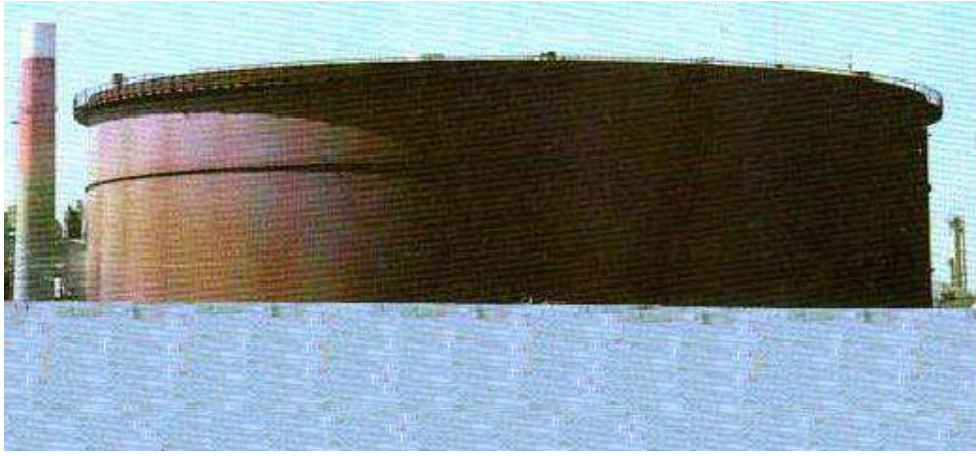
8-Confined Spaces

Definition

Permit-Required Confined Space

- Is large enough and so configured that an employee can bodily enter and perform assigned work.
- Has limited or restricted means for entry or exit.
- Is not designed for continuous employee occupancy.

Examples of permit-required confined spaces:

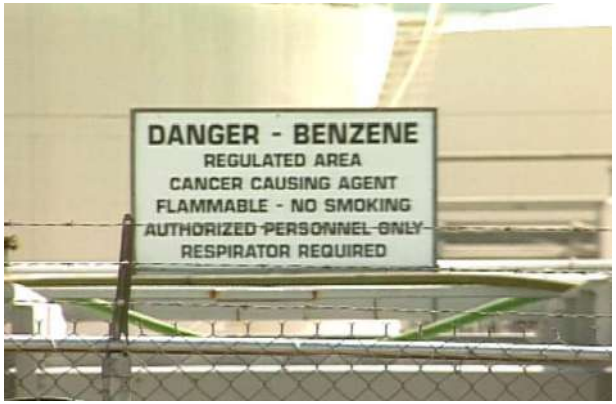


Examples of permit-required confined spaces:

Vessel

Inlet basin

Confined Spaces Hazards



<u>Hazardous atmosphere</u>

- Unsafe amounts of a flammable GAS, VAPOR, MIST, OR DUST
- Harmful levels of a HAZARDOUS SUBSTANCE

<u>Engulfment by materials</u>

<u>Serious S&H Hazards</u> examples:

- Electricity

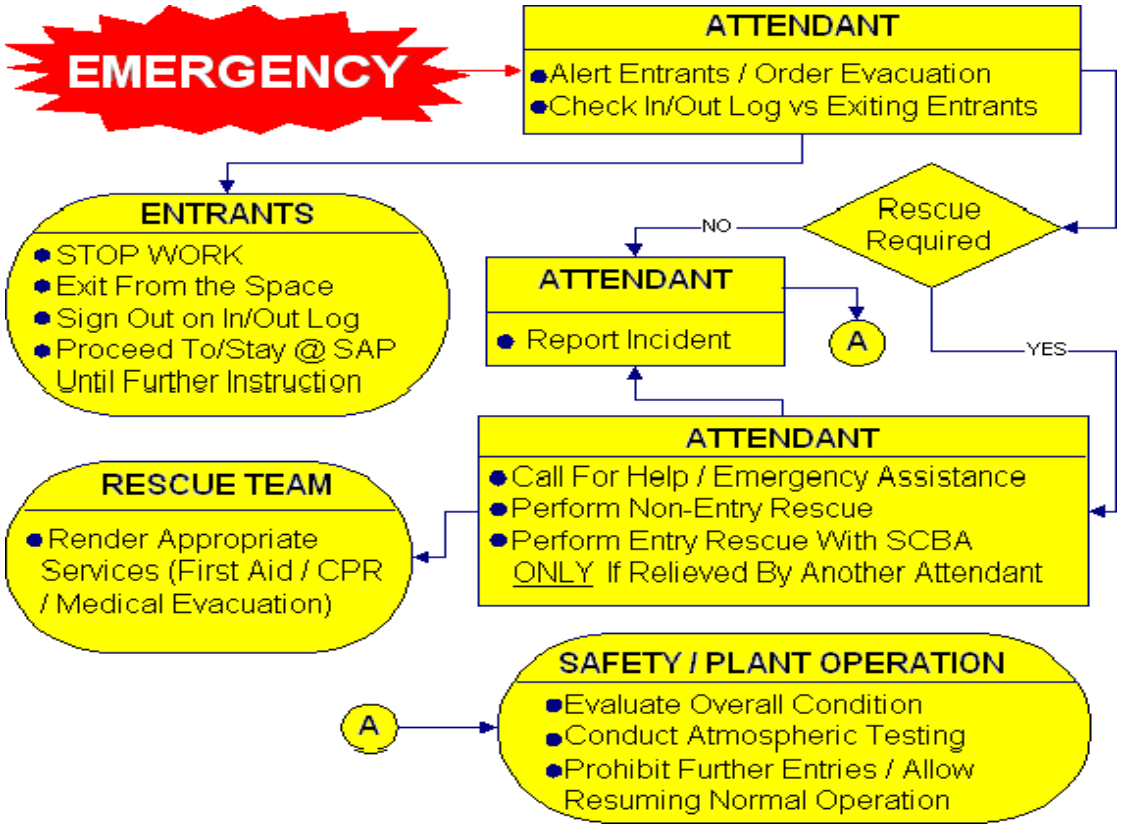
Possible dangers

- Oxygen Deficiency
- Combustible/flammable/ explosive atmospheres
- Toxic gases or vapors
- Physical hazards
- Corrosive chemicals
- Unknowns

Basic Rules of Confined Space Entry

- Planning sessions by qualified persons
- Testing of atmosphere
- Ventilation
- Training the personnel
- Lockout/tagout
- Standby people/communication
- Tools and equipment
- Entry permit
- Continuous monitoring of atmosphere
- Recordkeeping
- Attendant[s] should be outside of confined space, monitoring and controlling at all time.
- Adequate PPE must be used
- Isolation

Basic Rules of Confined Space Entry



- attendant[s] shall ensure awareness of emergency procedure

Conclusion

- Never Take Chances
- Learn by training and safe practices …not by mistake
- Know confined space procedure and strictly comply with it.

What is First Aid?

, ,
professional medical assistance.

- What is your obligation to provide first aid?

Principles of first aid

- **LOOK AFTER NUMBER ONE - YOU**

- Consider the danger to you, others and the casualty.

- Wear protective equipment such as gloves, masks etc.

- Be careful not to get an injury helping, such as cuts and abrasions if accessing a damaged vehicle, a back injury whilst lifting or a lumbar problem.

- Promote a safe environment at an accident scene, at work and at home.

Principles of first aid

- **D**anger
- **R**esponse
- **A**irway
- **B**reathing
- **C**ompression
- **D**efibrillation

First aid Protocol

- Assess the scene…
- Assess the casualty…
- Assess what to do next…

Triple A Protocol

Identify the hazard

9.3.1 Asses the scene

- Protect yourself and others
- Protect the casualty
- Phone the Ambulance nº…. (112 Mobile phones)

9.3.1 Asses the scene

- Traffic
- Unstable environment
- Fire or explosion
- Burns
- Chemical fumes
- Electrocution
- Needle stick injury
- Back injuries
- Equipment failure
- Biological
- Aggressive behaviour
- Body fluids especially blood
- Aggressive animals?

INFECTION CONTROL

In every first aid situation, you must assume that the injured casualty has a disease.

- **Before First Aid:**
- Wash your hands
- Use Gloves
- Use a Resuscitation Mask

- **During First Aid:**
- Ensure gloves are worn and not torn
- Consider double gloving
- If you come in contact with body fluids, wash immediately and seek medical advice

RISK ASSESSMENT, METHOD STATEMENT, CONSTRUCTION PHASE HEALTH AND SAFETY PLAN

CONTENTS

EDITION Nº.	1.4
Date:	02.01.2013
WRITTEN BY	Health, Safety, Quality & Environmental Director Robert Hackett
REVIEWED BY	Health and Safety Manager (Group) José Carlos Rodrigo
APPROVED BY	Managing Director Ignacio Clopes

PREVIOUS EDITIONS	
Number	Date
1.0	04.02.2008
1.1	01.09.2009
1.2	13.01.2010
1.3	06.04.2011

1. PURPOSE

Following the procedure's framework established in Ferrovial Agroman Group, this procedure has been adapted to the legal requirements, best practices and existing customs within the UK & Republic of Ireland.

To identify the arrangements for;

- Systematic identification of reasonably foreseeable significant Hazards and to assess reasonably foreseeable Risks associated with those Hazards.
- Documentation of the controls developed to mitigate risks in written Method Statements.
- Where the works fall within the remit of the Construction (Design and Management) Regulations, 2007, prepare a suitable and sufficient Construction Phase Health and Safety Plan (UK).
- Where the works fall within the remit of Safety, Health and Welfare at Work (Construction) Regulations 2006, further develop, as necessary, before the commencement of the construction work, the safety and health plan for the construction site (ROI)

2. SCOPE

Applies to all operational areas and projects wherever they are in the UK and those of the Republic of Ireland, under Ferrovial Agroman UK & Ireland, Ferrovial Agroman UK Ltd, Ferrovial Agroman Ireland Ltd and Ferrovial Agroman Airports Ltd.

3. REFERENCE

S UK

Legislation
- The Health and Safety at Work etc Act, 1974
- The Construction (Design and Management) Regulations, 2007
- The Management of Health and Safety at Work Regulations, 1999.

Republic of Ireland Legislation
- Safety, Health and Welfare at Work Act 2005
- Safety, Health and Welfare at Work (Construction) Regulations 2006
- Safety, Health and Welfare at Work (General Application) Regulations 2007

Other
- Data Protection Acts 1988 and 2003 (Data Controllers & Data Processors)
- Standard OHSAS 18001:2007.
- H&S-P/12: Control of Records.
- H&S-P/12-01: Site Safety Filing.

4. DEFINITIONS

Hazard: A substance, material or activity with the potential to cause harm or loss.

Risk: A combination of the Likelihood and the Severity derived from a Hazard materializing.

Residual Risk: The Risk that is left taking account of the Safety Control Measure(s) in place and should include latent risk factors.

Risk Assessment: A managed process to evaluate the magnitude of those Risks that are reasonably foreseeable and cannot be eliminated.

Likelihood & Frequency: The possibility of a Risk materializing or how often it

occurs. Severity: The consequence in terms of seriousness when a risk materializes.

Safety Control Measure: An action or series of actions designed to reduce the risk associated with an activity to As Low As Reasonably Practicable (ALARP).

Method Statement: A formally written safe system of work.

The Author: The person or group given the task of preparing Method Statements for a given activity.

Competent Person: Shall have practical and theoretical knowledge as well as sufficient experience of the equipment, process or procedure involved to enable him to undertake the operation without undue risk to himself or those affected by his activities.

As Low As Reasonably Practicable (ALARP): A statutory duty which has to be carried out so far as is reasonably practicable, allowing for the balancing of costs and Risks.

5. RESPONSIBILITIES

Health and Safety Competent Person e.g. Health and Safety Advisor (UK & ROI):

- Jointly with the Competent Person(s) support the development, communication and recording of; Risk Assessments, Method Statements and the Construction Phase Health and Safety Plan (UK) referred to as 'The Plan' throughout this document.
- Manage change in connection with said documents.
- Perform periodic reviews of working conditions at sites in his area and advise, support and monitor compliance.

Health and Safety Competent Person - Project Supervisor for the Construction stage, Safety Advisor (ROI Only)

- Further develop, as necessary, before the commencement of construction work, the Safety and Health Plan Construction Stage (ROI) referred to as 'The Plan' throughout this document, for the construction site
- Make adjustments to The Plan where required to take account of the progress of the work and any changes which occur
- Ensure that The Plan and any rules contained in it are in writing and that they are brought to the attention of all contractors and other relevant persons who may be affected by them
- Advise the project management team and exercise a general supervision of the observance of The Plan requirements and the promotion of the safe conduct of work generally

Competent Person (e.g. Engineer, Planner, the Project Managers designated representative):

- Jointly with the Health and Safety Competent Person(s) support the development, communication and recording of; Risk Assessments, Method Statements and The Plan.
- Manage change in connection with said documents.
- Perform periodic reviews of working conditions at job sites in his area.

Project Manager: Provide adequate information and resources to support the Health and Safety Competent Person and Competent Person in order that they can expedite their responsibilities. Notify the Health and Safety Competent Person of any planned or actual changes in the working conditions that occur at the site.

Site Manager(s): Ensure that the operational controls developed from Risk Assessments, Method Statements and The Plan are effectively implemented and maintained.

6. OPERATION MODE

Part 1 – Risk Assessment

The process for assessment and quantification of Risk shall be common throughout all Ferrovial Agroman UK & Ireland work locations wherever practicable, and whenever they are directly responsible for undertaking the work activities. It is recognized and accepted that subcontractors risk assessments and method statements will be submitted via their own processes and templates, however they shall, as part of the review process, be checked to ensure they are fit for purpose and accepted prior to commencement of any work activities.

The output of Risk Assessment is Safety Control Measures. These shall ensure that the Residual Risk is reduced to a level that is ALARP.

A five step strategy to Risk Assessment shall be adopted which will be as follows:

Risk Assessment, a 5 Step Strategy

A suitable and sufficient assessment of the risks (Risk Assessment) that are present at all sites managed and controlled by Ferrovial Agroman shall be undertaken.

All Risk Assessment activity must be recorded using document H&S-F/01-01 Risk Assessment and Calculation Template, or equivalent.

The 5 sequential phases to be followed for Risk Assessment and planning of the preventive actions are:

Step 1 - Hazard Identification

Identify all significant Hazards that might result in harm or loss, identified from review of the works information, site surveys, documentation, contract and design information designers hazard / risk identification). This might include but is not limited to:

- Slipping/tripping hazards (e.g. poorly maintained floors or Stairs).
- Fire (e.g. from flammable materials).
- Chemicals (e.g. concrete).
- Moving parts of machinery (e.g. blades).
- Working at height (e.g. ladders/scaffold towers).
- Confined spaces (e.g. excavations).
- Ejection of materials (e.g. from circular saws).
- Pressure systems (e.g. boilers).
- Vehicles (e.g. excavators).
- Electricity (e.g. substandard wiring).
- Dust (e.g. dry ground conditions).
- Fumes (e.g. from welding).
- Manual Handling.
- Noise.
- Vibration.
- Poor lighting.
- Inclement weather conditions.
- Human Behaviours

Step 2 – Identify Affected Persons

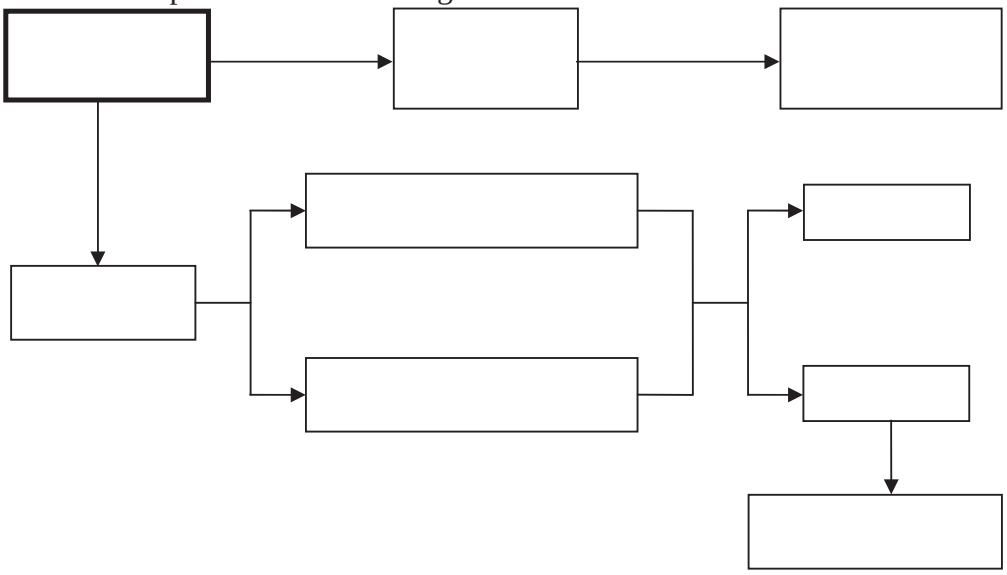
Persons affected by the Hazards identified should be identified. This should not be by individuals but by grouping together those who undertake similar work activities. This might include but is not limited to:

- Office based employees.
- Site based employees.
- Contractors.
- Cleaners.
- Persons sharing the work place.
- Members of the public.

Particular attention must be given to those who represent a more significant Risk when exposed to the Hazards identified. This might include but is not limited to:

- Persons with disabilities.
- Visitors.
- Young persons.
- Inexperienced workers.
- Lone workers.
- Trespassers.
- Pregnant workers.

On identification a member of the SHE Team must be immediately informed of the circumstances including, activity and the significant risks. The SHE Team shall then implement the following:



Step 3 – Assess theRisk

Initially the Risk will be assessed taking account of the normal Safety Control Measures in operation. Following this, an evaluation of the Residual Risk will be made to establish if this is adequate to reduce to a level that is ALARP.

Evaluate the Risk

The Risk associated with the Hazard must be evaluated using H&S-F/01-01 Risk Assessment and Calculation Template, or equivalent.

For example:

Risks resulting from adverse effects

Risk Quantification (Likelihood X Severity)		No injury, damage or environmental impact	Minor injury, damage or environmental impact	Major injury, damage or environmental impact	Fatality, building loss, catastrophic environmental impact
		SEVERITY			
LIKELIHOOD		0	1	2	3
Almost no likelihood	0	L(0)	L(0)	L(0)	L(0)
A small likelihood	1	L(0)	L(1)	M(2)	H(3)
A high likelihood	2	L(0)	M(2)	H(4)	H(6)
Almost certain	3	L(0)	H(3)	H(6)	H(9)

Low Residual Risk	Medium Residual Risk	High Residual Risk
TOLERABLE	ALARP	INTOLERABLE

Notes:

1. Low Residual Risk = Risk is TOLERABLE. No further preventative action required, consider cost effective solutions or improvements that impose no additional cost.

2. Medium Residual Risk = Work may only start if the risk has been reduced to As Low as Reasonably Practicable (ALARP). Consider additional control measures that reduce the risk without significantly increasing cost.

3. High Residual Risk = Risk is INTOLERABLE. Do not start work or continue until risk level is reduced using suitable control measures to a reasonably practicable level.

4. Control measures are to ensure that residual risks are reduced to as low as reasonably practicable. Where controls fail to reduce to a TOLERABLE or ALARP level the assessment must be referred to your Line Manager.

5. If the operations are likely to affect the public or the safe operation of a public transport system, the control measures must reduce the likelihood of significant harm to the level that existed before work is commenced.

Evaluate the adequacy of Safety Control Measures

For most activities there will be a level of Safety Control Measures embedded in that activity. This might include but is not limited to:

- Adequate information, instruction, training and supervision.
- Adequate systems and procedures including exclusion/prohibition of non-essential personnel.
- Adequate Personal Protective Equipment.

An evaluation of whether the Safety Control Measures, are suitable and sufficient shall be made. It shall determine whether the Residual Risk has been reduced to a level that is

ALARP. In undertaking this evaluation consideration should be given to establish if the Safety Control Measures:

- Meet the standards set out by legal requirements.
- Meet the standards set out in the contract
- Meet the standards set out in the Ferrovial Agroman Safety Management System.
- Comply with recognized industry best practice.

When it is determined that the Residual Risk has not been reduced to a level that is ALARP, additional Safety Control Measures must be developed until an ALARP condition prevails.

Step 4 - Record the Risk Assessment Findings

All Risk Assessments shall be recorded on document H&S-F/01-01 Risk Assessment and Calculation Template, or equivalent.

A record of all Risk Assessments must be maintained in accordance with the Operational Procedure H&S-P/12-01 Site Safety Filing.

Risk Assessment Communication.

At all sites, Risk Assessments shall be communicated by an appointed representative of the local Line Management team or a Subcontractors Supervisor. Recipients of the briefing will sign a declaration to confirm that they have participated, understood the information provided, and will co-operate with the Safety Control Measures identified. At this time recipients will also have an opportunity to make comment on any H&S matters appertaining to the Risk Assessment. The appointed representative or Subcontractors Supervisor will take notes of any comments made and forward these to the Risk Assessor(s) who will in turn respond to the employee making the observations. Records of all such communication will be maintained with the relevant Risk Assessment and filed in accordance with Operational Procedure H&S-P/12-01 Site Safety Filing.

Step 5 – Periodic Review of Risk Assessments.

All Risk Assessments shall be subject to periodic review by a Competent Person(s) and H&S Competent Person. The review period must be determined on the basis of the Residual Risk. However as general guidance for all generic risk assessments, this should not exceed a period of 12 months. A record of the review shall be maintained along with any changes made to the original documents.

In certain circumstances the period at which a Risk Assessment is reviewed may be less than 12 months. These circumstances include but are not limited to:

- After a significant incident, disease or dangerous occurrence.
- After a significant change to the work process or activity.
- After changes to the work force or work place.
- After changes to legislation, guidance or industrial best practice.

After agreed consultation with the Ferrovial Agroman Group Health and Safety Team.

Part 2 – Method Statement

General Principle

The Method Statement shall be clearly written, in plain English. It shall be easily communicable, to any person, who is required to work for Ferrovial Agroman.

Task Analysis

The job specification shall be broken down into key elements so that the most effective use of Method Statements can be decided. This activity is termed a Task Analysis. A record of the Task Analysis shall be kept and shall include (though not necessarily be limited to) details of:

- Component elements of job/task/activity/location
- Options for carrying out the work (those that can be considered as reasonably available)
- Time required to carry out job/task/activity, both planned and actual available
- Sequence of work
- Skills/competencies needed for the job/task/activity

Site Survey

Site surveying prior to the main task(s) occurring is an essential element in gathering site specific condition information prior to carrying out detailed Hazard and Risk Assessment. The site survey shall include (though not be limited to) gathering information on site hazards related to:

- Safe working at the site
- Access, egress and walking routes
- Availability of welfare
- Activities of neighbors or other contractors
- Surface and buried services
- Anything else that the surveyor considers relevant, e.g. contaminated land, presence of activists.

Risk Assessment

Before preparing a Method Statement, all Risk Assessment applicable to the works should be reviewed. Where a Risk Assessment for a particular activity is not available, one should be prepared in accordance with the earlier documented arrangements.

Method Statement Writing

When preparing Method Statements the Author shall document all information to enable the person(s) undertaking the work to do so safely, to the quality standards required and without harming the environment.

Emphasis is to be placed on the clear and positive communication of actions required for the safe and efficient completion of the work. For guidance, when preparing Method Statements, the Author shall ensure that the following information is clearly set:

- Description of Work
  - Summary of work to be undertaken including key targets
  - Date and duration of work
  - Significant Hazards

- Key Roles and Contact Information
  - Roles - e.g. Supervisor, First Aid persons, Tradesmen, specific plant competencies, etc.
  - Contact Information - Telephone number(s), only ones useful during job
  - Client and sub-contractor company information
  - Emergencies: Procedure, assembly area, hospitals, fire services, environmental support, etc.
  - Incident reporting and recording

- Site Safety
  - Safe Systems of Work
  - Site Register and Signage
  - Sub-contractors and other parties who may perform part of the work or impact upon the work
  - PPE Checklist (including enough detail to ensure correct type/grade of PPE is used including task specific PPE) e.g.:
    - ◊ Safety Footwear – boots with steel mid-sole
    - ◊ Hard Hat(s)
    - ◊ Gloves
    - ◊ Glasses to BS EN 166 – 349B (only quote numbers marked on the appropriate item)
    - ◊ High visibility clothing
  - Site Security (prevention of public access and vandalism)
  - Documentation to be available on site

- Method of Work
  - Detailed description of work
  - Logical and ordered flow of statements
  - Set out in short, clear and positive statements
  - Maximum of facts, minimum of non-relevant data
  - Cross references to other documents where appropriate
  - Health & Safety Controls
  - Welfare Arrangements

- Appendices

- Diagrams are worth a 1000 words!
- Risk Assessments (attach all associated)

The Author shall concentrate on including detail of items that do not form part of the core competency of persons engaged on the work.

Templates – No one template will suit all of our Clients. However a Template is attached which may be modified in line with specific contract requirements. For guidance on its specific application, contact the Local Health and Safety Manager or Safety Advisor attached to the contract/project. Refer to H&S-F/01-02 Method Statement Template.

Completed Method Statements shall be retained in accordance with Operational Procedure H&S-P/12-01 Site Safety Filing.

Conformance Check

Prior to seeking 'Acceptance' of the Method Statement from the Project, the Author shall check the Method Statement against the contract requirements applicable to the specific contract.

A conformance checklist is provided in document H&S-F/01-03 Method Statement Conformance Checklist. This checklist should be completed for all Method Statements prepared by Ferrovial Agroman and those submitted by Subcontractors.

Briefing and Communication

When 'accepted' by the Project or Site Manager, the Method Statement(s) shall be briefed to the persons carrying out the work. A record of the briefing shall be prepared using H&S-F/04-01 Record of Training, or equivalent, attached to the associated Method Statement and Risk Assessment and filed in accordance with H&S-P/12-01 Site Safety Filing.

Method Statements are only of any value if they are read, understood, used and followed accurately. In other words, effectively implemented. Briefing and communication forms an essential step in this process. To this end, the Author shall ensure that the Method Statement is written in a form that can be readily briefed and communicated to the persons carrying out the work.

During the briefing of the Method Statement, the briefer shall gauge understanding of the workgroup by asking a series of questions on details included in the Method Statement being briefed out. The briefer shall include each person within the workgroup in the question and answer process, only stopping when they are satisfied that sufficient understanding of the Method Statements is in place.

Part 3 – Construction Phase Health and Safety Plan (UK)

All works that are undertaken at Sites and that are controlled by the Construction (Design and Management) Regulations, 2007 Ferrovial Agroman must prepare a

Construction Phase Health and Safety Plan and issue this prior to the commencement of works. The Plan will define how health and safety is to be managed for a specific contract.

The required scope of the Plan shall, as a minimum, address the items listed below:

- How the Project Manager shall comply with the Ferrovial Agroman /Client's Health and Safety Policy Statement(s)
- How the Project Manager shall comply with relevant legislation, regulation and contract specific standards
- How all significant health and safety hazards and risks are to be controlled. This section shall demonstrate how the hazard/risk information supplied by the Client/CDM Coordinator has been included
- An organization chart identifying the management structure for delivery of the plan. This shall include individuals' names and their position in the management structure for the Contract, interfaces with the Client and other organizations, the lines of communication, key CDM roles (Client, CDM Coordinator, Principal Contractor, Designer, Contractors etc)
- How incidents are to be prevented and any health and safety emergencies dealt with
- How the Project Manager is to achieve the Client's health and safety requirements and a level of health and safety performance that is acceptable to the Client
- How the various roles and responsibilities needed to meet the health and safety requirements shall be organized within the Project Director/Manager's management structure and how internal communications between them shall be managed
- How relevant personnel are to be made aware of their health and safety responsibilities
- How non compliance and corrective actions shall be addressed
- How any health and safety information that affects the operational maintenance or subsequent contracting works is to be included in the Health and Safety file

A Construction Phase Health and Safety Plan template is provided in document H&S- F/01-04 Construction Phase Health and Safety Plan Template (UK).

Part 4 – Safety and Health Plan Construction Stage (ROI)

All works that are undertaken at Sites and that are controlled by the Safety, Health and Welfare at Work (Construction) Regulations 2006, the Project Supervisor Construction Stage (PSCS) must develop the Safety and Health Plan for the Construction Site and issue prior to commencement of the works.

The Plan for the Construction Site will define how health and safety is to be managed for a specific contract. The required scope of the Plan shall, as a minimum, address the items listed below:

- Description of the project including appointments, extent and location of existing records and any restrictions that may affect the works
- Communication and management of work including:
  - management structure and responsibilities
  - general statement of principles and project objectives
  - arrangements for monitoring health and safety performance
  - liaison between stakeholders
  - arrangements for ensuring cooperation between contractors
  - consultation with the workforce
  - exchange and handling of design information between all stakeholders
  - selection and control of subcontractors
  - security arrangements
  - induction and other training
  - site rules
  - welfare facilities and first aid
  - reporting, recording and investigating accidents and dangerous occurrences
  - emergency procedures
  - material procedures
  - plant procurement and control
- Arrangements for controlling significant site risks
- Project Review and Safety File

A Safety and Health Plan Construction Stage template is provided in document H&S- F/01-05 Safety and Health Plan Construction Stage Template (ROI).

7. RECORD AND FILE

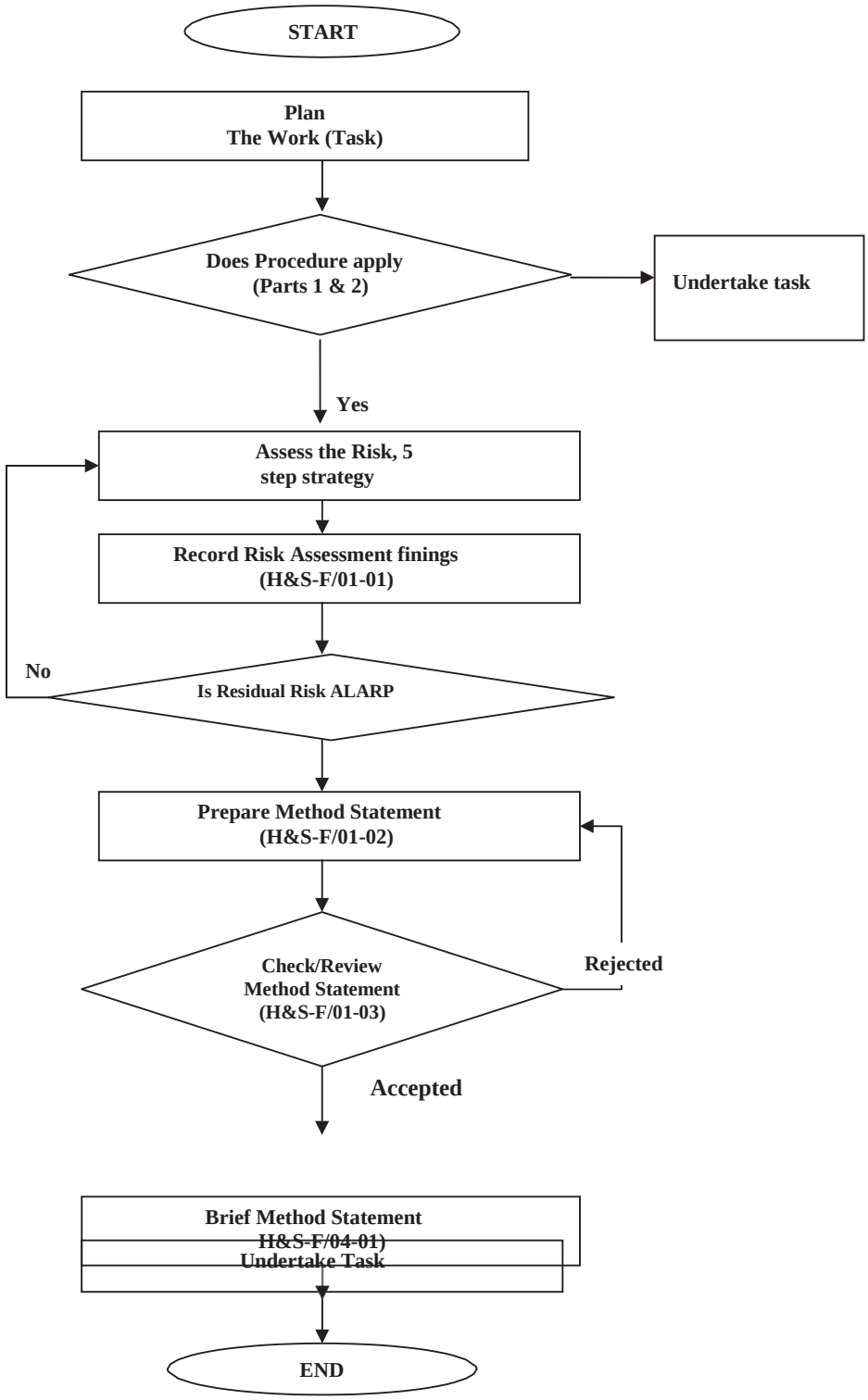
The signed original of this procedure shall be filed with the Health, Safety, Quality & Environmental Director.

The records and other documents generated by the implementation of this procedure are filed pursuant to the provisions in H&S-P/12 Control of Records.

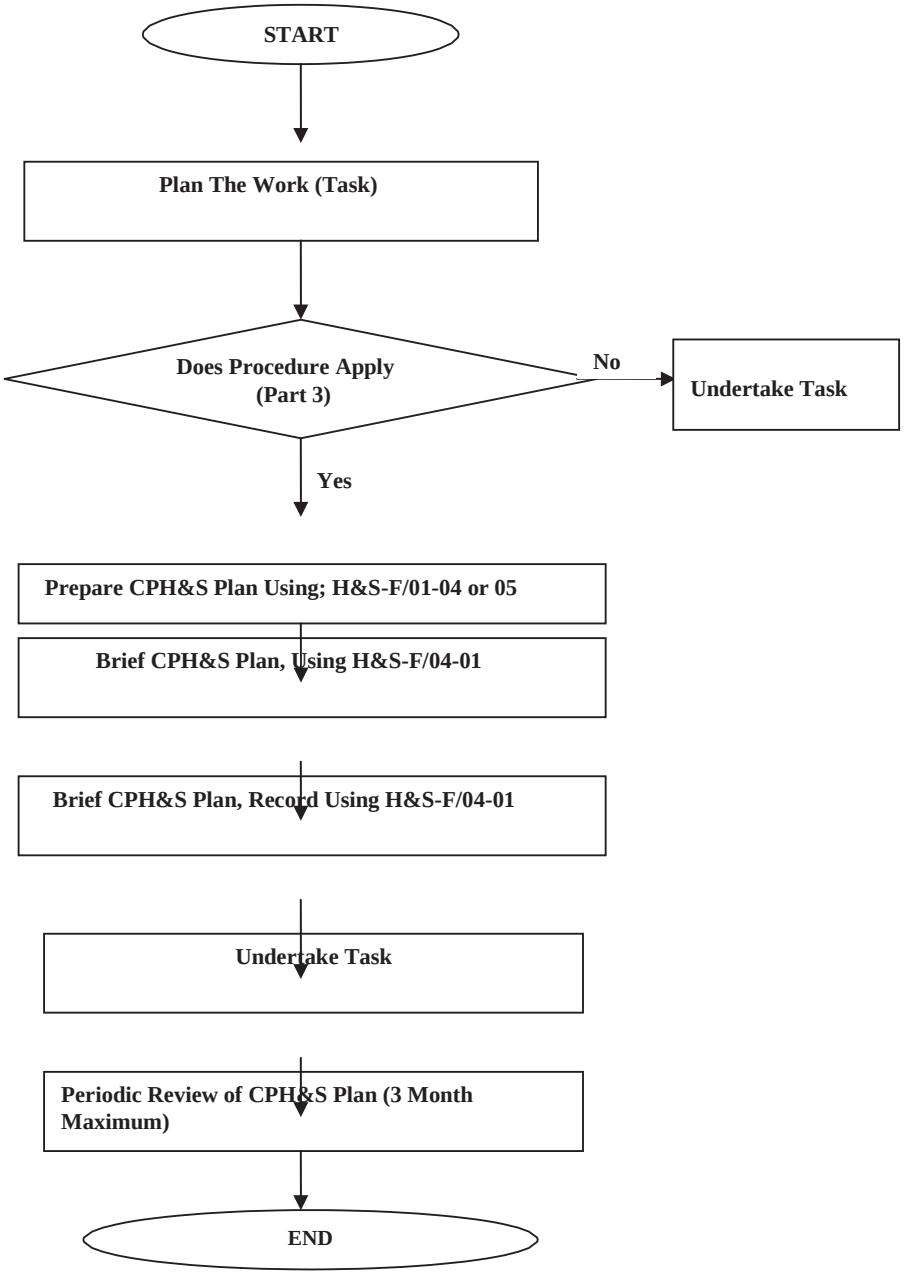
8. APPENDICES

H&S-F/01-01 Risk Assessment and Calculation Template.
H&S-F/01-02 Method Statement Template
H&S-F/01-03 Method Statement Conformance Checklist
H&S-F/01-04ConstructionPhaseHealthandSafetyPlanTemplate(UK)
H&S-F/01-05 Safety and Health Plan Construction Stage Template (ROI)
Appendix A – FlowChart
AppendixB–FlowChart

Appendix A


START
Plan
The Work (Task)
Does Procedure apply
(Parts 1 & 2)
Undertake task
Yes
Assess the Risk, 5
step strategy
Record Risk Assessment finings
(H&S-F/01-01)
No
Is Residual Risk ALARP
Prepare Method Statement
(H&S-F/01-02)
Check/Review
Method Statement
(H&S-F/01-03)
Rejected
Accepted
Brief Method Statement
H&S-F/04-01)
Undertake Task
END

Appendix B


START
Plan The Work (Task)
Does Procedure Apply (Part 3)
No
Undertake Task
Yes
Prepare CPH&S Plan Using; H&S-F/01-04 or 05
Brief CPH&S Plan, Using H&S-F/04-01
Brief CPH&S Plan, Record Using H&S-F/04-01
Undertake Task
Periodic Review of CPH&S Plan (3 Month Maximum)
END