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MIDWEST VANADIUM PTY LTD

WINDIMURRA VANADIUM PROJECT
AREA 19 - KILN OFF-GAS HANDLING CONTROL PHILOSOPHY

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1.0 PROCESS DESCRIPTION

(Reference P&ID: 6033-19-J-1002, 6033-19-J-1003)

1.1 Description

Off gas from the rotary kiln is used to evaporate pregnant solution and is cleaned before emission to the atmosphere. Kiln exhaust gas, at 450°C, is drawn from the kiln feed inlet chamber (19FH501) by a variable speed induced draft (ID) fan (19FAN501) and directed through a duct to four refractory lined cyclones (19CYC501A-D). The cyclones separate 90% of the dust from the gas stream. The cyclone underflow contains the dust that is returned to the kiln via rotary valves (19ROV501 A-D), kiln mixing screw (19MXR501) and kiln feed screw (19FDS502). The gas passes out the cyclone overflow and continues via a duct to the venturi scrubber (19SBR501).

Pregnant liquor, grading approximately 50 grams per litre of V_2O_5 equivalent, from the leaching section of the plant is pumped (25PPC505 A/B) to the suction of the scrubber circulation pumps (19PPC502 A/B) utilising the heat in the kiln exhaust gas to evaporate water and increase the concentration to approximately 100 grams per litre of V_2O_5 equivalent. The scrubber circulation pump (19PPC502 A/B) transfers the scrub solution to the pre-quencher section of the venturi scrubber (19SBR501) to saturate the gas stream with water vapour. The acceleration and then deceleration of the saturated gas stream across the venturi throat produces a pressure drop which causes the separation of solids from the gas stream. The solids and scrub solution exit the scrubbing tower (19SBR502) and gravitate into the scrubber circulation tank (19TNK501).

The saturated gas is drawn through the Scrubber Tower (19SBR501) to remove any remaining fine particulates and entrained V_2O_5 mist. The cleaned gas, depleted of all solids, mist and hazardous gases, passes through the kiln ID fan and exits to atmosphere via the main kiln stack (19STK501).

Excess scrub solution, namely the concentrated pregnant liquor, is pumped (19PPC501 A/B) to the dirty pregnant liquor tank (30TNK510), ahead of the desilication process.

Any spillage is handled by a sump pump (19PPS504). The resulting solution is pumped to the scrubber circulation tank and ultimately to the dirty preg tank.

1.2 Operational Considerations

Start-up of the rotary kiln (20KLN501) following commissioning or a prolonged shutdown requires the kiln to be heated to prevent thermal shock and failure of the refractory lining. The heating schedule for a cold kiln to reach operating temperature is approximately 4-6 days, and requires the kiln off-gas system to be operational. After a prolonged shutdown of the kiln, the heating requirement is half an hour of heating for every hour of downtime.

Extended operation of the kiln off-gas system, in particular the scrubbing circuit, increases the concentration of salts in the scrub solution. To prevent scaling of the scrubbing system, a bleed of scrub solution is required and raw water or alternatively if available, dilute pregnant solution added as makeup to balance the evaporative losses and the bleed.

2.0 CONTROL PHILOSOPHY

The kiln off-gas system must be operational before natural gas is burnt in the kiln to prevent damage to the scrubber internals due to high exhaust gas temperature. The order of operation is as follows:

- Scrubbing circuit
- Cyclones and Kiln ID fan
- Feed and transfer screws

2.1 Scrubbing Circuit

The scrubbing circuit is the first system to be started and the operation of the circuit is unconstrained by upstream and downstream equipment interlocks. However, should the scrubbing circuit report a FAULT, this will interlock upstream and downstream processes.

The scrubbing circuit consists of the Scrubber Circulation Tank (19TNK501) and Agitator (19AGT501), Venturi Scrubber (19SBR501), Scrubber Tower (19SBR502) and the Scrubber Circulation Pumps (19PPC501A/B).

2.1.1 Scrubber Circulation Tank (19TNK501)

The Scrubber Circulation Tank (19TNK501) provides storage of scrub solution. The tank is baffled and mechanically agitated (19AGT501) to ensure solids suspension. The tank is equipped with continuous level indication and a level controller (LIC195218) controls the addition of raw water to the scrubbing system via a flow control valve (FCV195206) to the scrubber wash pump (19PPC503) suction.

The scrubber circulation tank must be full before the circuit can be operated. Two different operating conditions are envisaged and each have a unique set of operating philosophies, namely:

- First fill
- Re-fill

A First fill condition exists at the initial start-up of the plant, or following a prolonged shutdown where dilute pregnant solution is not available.

A Re-fill condition exists when dilute pregnant solution is available to fill the Scrubber Circulation Tank.

2.1.1.1 First Fill

The level controller (LIC195218) maintains a constant level in the scrubber circulation tank. The level controller output is a flow rate set point at the raw water flow rate controller (FIC195206). The flow rate controller controls the operation of an actuated flow control valve (FCV195206) to achieve the desired flow rate.

The operation of the Scrubber Circulation Pumps is in accordance with the procedure described in Section 2.1.4.3

The Scrubber Circulation Tank is now full and the scrubbing circuit is ready for operation.

2.1.1.2 Re-Fill

The CCR operator opens the two actuated valves (HV195253, HV195256) situated on the suction side of the scrubber circulation pumps (19PPC502A/B). The duty pregnant liquor transfer pump (25PPC505A) is initiated as a group start. The group start opens the suction and discharge valves (HV255320, HV255322) simultaneously and then starts the pump provided the valve open status switches are energised. The suction and discharge valves are fail closed and fitted with proximity switches to indicate valve position. The proximity switches are interlocked to the operation of the respective pump.

The CCR operator inputs a flow rate set point to control (FIC255323) the speed of the pregnant liquor pump. Alternatively the operator may set the pump speed to 100% output. On detection of a high level alarm (LAH195218) in the scrubber circulation tank, the operator stops the pump. Failure to stop the pump will result in a High High Alarm (LAHH195218) and if the pump continues to operate, the tank will eventually overflow.

The Scrubber Circulation Tank is now full and the scrubbing circuit is ready for operation.

2.1.2 Venturi Scrubber (19BBR501)

The scrub solution to the Venturi Scrubber is distributed three ways, namely,

- Approximately 6% (30 m^3/h) of the circulating scrub solution is directed to two slurry spray nozzles located in the upper section of the Venturi Scrubber. A magnetic flow meter (FE195214) situated on the pipe line measures the scrub solution flow and a flow controller (FIC195214) controls the operation of a flow control valve (FCV195214) to maintain the flow set point ratio.

- Approximately 47% (225 m^3/h) of the circulating scrub solution is directed to four tangential inlet nozzles located above the venturi throat to irrigate the venturi walls. A magnetic flow meter (FE195215) situated on the pipe line measures the scrub solution flow and a flow controller (FIC195215) controls the operation of a flow control valve (FCV195215) to maintain the flow set point ratio.

- Approximately 47% (225 m^3/h) of the circulating scrub is directed to four tangential inlet nozzles located at the venturi throat. A magnetic flow meter (FE195247) situated on the pipe line measures the scrub solution flow and a flow controller (FIC195247) controls the operation of a flow control valve (FCV195247) to maintain the flow set point ratio.

The CCR operator inputs individual flow rate set points for each of the flow rate controllers (FIC195214, FIC195215, FIC195247). Alternatively the CCR operator may manually set the valve opening. During initial start-up of the scrubber circulation pump (19PPC502A), it is envisaged that the CCR operator will open the valves fully until the pump is operating and will automatically revert to flow ratio control.

The pressure drop through the venturi is a function of slurry irrigation rate and velocity through the throat of the venturi. The irrigation rate is fixed and therefore the pressure drop is controlled by varying the throat velocity, which is accomplished by adjusting the throat blade gap. Adjustment is via a pneumatic cylinder with position controlled by HIC195237. The pressure drop is measured by a differential pressure meter (PDT195209) positioned across the venturi.

2.1.3 Emergency Quench Water

In the event of a failure of the scrubber circulation pumps, the venturi outlet temperature will immediately rise and the high temperature alarm (TAH195217) will activate the emergency raw water valve (TV195202) to provide raw water and cool the gas stream. The temperature control valve is fail open and fitted with proximity switches to indicate valve position.

2.1.4 Scrubber Circulation System

The control philosophy for the scrubber circulation system is described for two operating conditions, namely:

- Kiln pre-heat
- Steady state operation

Pre-heating of the kiln (20KLN501) will require the Scrubber Circulation System to be operational to protect the scrubbing tower from thermal damage. Two different operating conditions are envisaged, namely First fill and Refill, and these conditions require different operating philosophies for the scrubber circulation system.

Steady state operation of the kiln off-gas system occurs when magnetite concentrate is fed to the kiln and dilute pregnant solution is available to operate the scrubbing system. This is the normal method of operation.

2.1.4.1 First Fill

It will be necessary to install a temporary pipeline between the Scrubber Discharge Pump (19PPC501A/B) and the magnetite handling spillage sump (19PPC501) to give a continuous bleed of scrub solution to prevent precipitation and fouling of the scrubbing system.

The CCR operator inputs a flow rate set point (FIC195227) to control the speed of the Scrubber Discharge Pump. The group start opens the suction and discharge valves (HV195257, HV195259) simultaneously and then starts the pump provided the valve open status switches are energised. The suction and discharge valves are fail closed and fitted with proximity switches to indicate valve position and are interlocked to the operation of the duty pump.

The level controller (LIC195218) maintains a constant level in the scrubber circulation tank. The level controller output is a flow rate set point at the raw water flow rate controller (FIC195206). The flow rate controller controls the operation of an actuated flow control valve (FCV195206) to achieve the desired flow rate.

The operation of the Scrubber Circulation Pumps is in accordance with the procedure described in Section 2.1.4.3.

2.1.4.2 Re-Fill

Dilute pregnant solution will be used to re-fill the scrubber circulating tank. The preferred mode of operation will be to control the addition of dilute pregnant solution and scrubber bleed to maintain a water balance. This control philosophy is shown in Section 2.1.5.

Should either the pregnant solution pump or the scrubber bleed pumps contain insufficient turn down to maintain the water balance, the minimum scrubber bleed ratio will be set and a lower V_2O_5 concentration will be tolerated.

The operation of the Scrubber Circulation Pumps is described in Section 2.1.4.3.

2.1.4.3 Steady State Operation

The scrubber circulation pump is fixed speed and circulates scrub solution through the venturi scrubber (19SBR501) and returns the slurry to the circulation tank via the scrubber tower (19SBR502). A nucleonic density gauge (DI195220) mounted to the pump discharge piping indicates slurry density. The density expected under normal operating conditions is 1.1 t/m³ and any significant increase in this value would indicate excessive dust carry over and possible cyclone blockage.

Activation of the duty scrubber circulation pump (19PPC502A/B) is a group start, opening the suction and discharge valves (HV195253, HV195252) simultaneously and then starts the pump provided the valve open position switches are energised. The suction and discharge valves are fail closed and fitted with proximity switches to indicate valve position and are interlocked to the operation of the duty pump.

Changing over from the duty pump to standby pump is initiated by the operator provided the duty suction and discharge valve position switches are energised CLOSED and no FAULTS are reported.

During steady state operation, dilute pregnant solution is fed to the suction piping of the Scrubber Circulation Pump to increase the V_2O_5 concentration from 50 to 100 g/L. Concentrated pregnant solution is bled from the scrubbing circuit via the scrubber discharge pump at a ratio of half the dilute pregnant solution feed flow rate.

The operation of the Dilute Pregnant Pump is described in Section 2.1.5

2.1.5 Dilute Pregnant Feed and Concentrate Pregnant Liquor Discharge

The pregnant liquor transfer pump (25PPC505A) is a group start through the OIS. The group start opens the suction and discharge valves (HV255320, HV255322) simultaneously and then starts the pump provided the valve open position switches are energised. The suction and discharge valves are fail closed and fitted with proximity switches to indicate valve position. The valve position switches are interlocked to the operation of the pump.

The pregnant liquor pump is variable speed (SC255318A). The speed of the pump is controlled (FIC255323) to an operator flow rate set point. Alternatively, the speed of the pump can be controlled (LIC255318) to maintain a constant level in the pregnant liquor storage tank (25TNK505).

The discharge flow rate of concentrated pregnant solution from the scrubber circulation tank is ratio controlled (FIC195227) to 50% of the dilute pregnant feed rate

to the scrubbing circuit. The flow rate ratio is an operator input at the OIS to control the speed of the scrubber discharge pump.

The scrubber discharge pump (19PPC501A) is a group start through the OIS. The group start opens the suction and discharge valves (HV195257, HV195259) simultaneously and then starts the pump provided the valve open position switches are energised. The suction and discharge valves are fail closed and fitted with proximity switches to indicate valve position. The valve position switches are interlocked to the operation of the pump.

2.1.6 Water Balance Control

Under normal operating conditions, the hot gas entering the scrubber will evaporate more water from the dilute pregnant liquor than is required to increase the V_2O_5 concentration from 50 to 100 g/L. This necessitates the addition of raw water to the scrubbing tower to make up for evaporative loss plus provide dilution to maintain a maximum V_2O_5 concentration of 100 g/L.

In the event of a reduction in V_2O_5 concentration in the dilute pregnant liquor, whilst the kiln off-gas conditions remain constant, the evaporation rate may be insufficient to achieve 100 g/L in the concentrated pregnant liquor. Under these conditions, a minimum raw water supply rate may need to be maintained to ensure a constant purge from the wash section of the scrubbing tower to maintain low solids and V_2O_5 concentration.

Raw water makeup will be into the wash section recirculation circuit via a flow control valve. The operator initiates the level control function (LIC195218) to maintain a constant level in the scrubber circulation tank. The level controller output is a flow rate set point at the raw water flow rate controller (FIC195206). The flow rate controller controls the operation of an actuated flow control valve (FCV195206) to achieve the desired flow rate.

2.2 Scrubbing Tower

The scrubbing tower is a vertical type scrubber with dual chevron demister pads and wash section. The scrubbing tower is designed to eliminate the carry over of fine particulates and V_2O_5 mist in the stack exhaust.

2.2.1 Chevron Wash Pads

An upper and lower Chevron demister pad is provided in the Scrubber Tower. The Chevron wash pads are provided with bottom wash manifolds to spray raw water intermittently onto the face of the pads. The lower chevron is also continuously wetted by separate fogging nozzles to help prevent build up from solids.

The upper and lower Chevron wash water supply is controlled by automatic valves (HV195203, HV195204). The upper Chevron spray water is sequenced to operate for 30 seconds per day whilst the lower Chevron spray water system is sequenced to operate for 30 seconds per shift. The CCR operator has the flexibility to adjust the wash timers for each spray system through the OIS.

The spray water flow valves are fail closed and fitted with proximity switches to indicate valve position. A flow element (FE195249, FE195250) fitted to each wash system alarms (FAL195249, FAL195250) for a low flow condition to indicate a lack of raw water supply or possibly blocked spray nozzles.

Raw water is supplied to the fogging nozzles. The CCR operator inputs a flow rate set point and the flow controller (FIC195205) controls the operation of the flow control valve (FCV195205) to maintain the required flow rate. If the flow control valve is fully open, and the actual flow is below the flow set point, this indicates that the fogging nozzles have become partially blocked and require cleaning.

2.2.2 Wash

A wash separator stage is located between the upper and lower Chevron pads to facilitate the separation of wash solution from the gas stream. Trays located at the bottom on the separator collect the wash solution and feed the scrubber wash pump (19PPC503).

A differential pressure transmitter (PDT195210) fitted across the inlet and outlet measures the pressure drop across the Scrubber Tower. Under normal operation the pressure drop across the Scrubber Tower is approximately 1.25 kPa. The differential pressure transmitted is alarmed for high differential pressure (PDAH195210). An increase in pressure drop will most likely be caused by a blockage of the lower Chevron or possibly solids build-up on the wash trays. In this event, the Chevron wash cycle must be increased.

2.3 Cyclones, Kiln ID Fan and Stack

2.3.1 Kiln Feed Hood

The kiln feed hood (19FH501)

2.3.2 Off-Gas Cyclones (19CYC501A/B/C/D)

The kiln off-gas duct (19DU501) connects the kiln feed hood (19FH501) with the off-gas cyclones (19CYC501A/B/C/D).

The off-gas cyclone installation consists of four refractory lined cyclones (19CYC501A/B/C/D) configured in parallel. Dust recovered in each cyclone separately gravitates to a collection vessel equipped with a rotary valve (19ROV501A/B/C/D). The rotary valves operate continuously, discharging the dust to the kiln mixing screw (19MXR501).

The cyclone dust collection vessels are equipped with level switches (LSH195305, LSH195307, LSH195309, LSH195311) to alarm at high level (LAH195305, LAH195307, 19LAH5309, LAH195311) to indicate either a blockage in the vessel or the rotary valve. The rotary valves are fitted with under speed switches (USS195304, USS195306, USS195308, USS195310) to alarm for shaft failure.

The cyclone gas exhaust duct is equipped with pressure indication (PI195302) and temperature indication (TI195303).

2.3.3 Kiln ID Fan (19FAN501)

The kiln ID fan (19FAN501) draws air from the kiln cooler tubes into the kiln, through the off-gas cyclones (19CYC501 A/B/C/D), scrubbing system and expels clean air to the atmosphere via the kiln scrubber stack (19STK501).

The kiln ID fan is variable speed (SC195232) and the speed of the fan is controlled (AAL205201) to maintain 5% oxygen content in the kiln exhaust gas. The fan is equipped with vibration monitoring (VT195263) and alarmed (VAH195263) to indicate if the fan blades become out of balance.

2.3.4 Kiln Exhaust Stack (19STK501)

The kiln exhaust stack is 50 m tall and is equipped with an opacity meter (AI195251) and temperature indication to give an instantaneous readout of emission level and gas exhaust temperature. A sample port has been provided for isokinetic sampling of the exhaust gas.

Condensation in the stack discharges to the kiln stack condensate seal pot (19WSP501).

2.4 Feed and Mixing Screws

Magnetite and soda ash are discharged from the magnetite conveyor and are combined with dust recovered from the off-gas cyclones in the kiln mixing screw (19MXR501). The fixed speed mixing screw mixes and transfers the material to the kiln feed screw (19FDS502).

The Kiln Feed Screw is also fixed speed and feeds the material into the kiln (20KLN501).

The magnetite feed conveyor (19CVR501) is interlocked to the operation of the Kiln Mixing Screw and Kiln Feed Screw. The failure of either screw will stop the operation of the magnetite conveyor.

3.0 EQUIPMENT

The following are the drives in this area:

Drive Name	Scrubber Circulation Tank Agitator
Equipment Number	19AGT501
Drive Type	DOL
P&ID Number	6033-19-J-1002
Modes	Auto or Manual
Alarms	Standard Drive
Trend	R, I, Slow
Process Interlocks	Nil

Drive Name	Kiln ID Fan
Equipment Number	19FAN501
Drive Type	VSD
P&ID Number	6033-19-J-1002
Modes	Auto or Manual
Alarms	Standard Variable Speed Drive
Trend	R, I, MO, Fast
Process Interlocks	Will trip 20BUR501 (BMS) & 19FDS502 when Stopped

Drive Name	Kiln Feed Screw
Equipment Number	19FDS502
Drive Type	DOL
P&ID Number	6033-19-J-1003
Modes	Auto or Manual
Alarms	Standard Drive
Trend	R, I, Slow
Process Interlocks	Will trip 19MXR501 when Stopped

Drive Name	Kiln Mixing Screw
Equipment Number	19MXR501
Drive Type	DOL
P&ID Number	6033-19-J-1003
Modes	Auto or Manual
Alarms	Standard Drive
Trend	R, I, Slow
Process Interlocks	Will trip 19CVR501 & 19ROV501A-D when Stopped

Drive Name	Scrubber Discharge Pump (*duty/standby pair*)
Equipment Number	19PPC501A/B
Drive Type	VSD
P&ID Number	6033-19-J-1002
Modes	Auto or Manual
Alarms	Standard Variable Speed Drive
Trend	R, I, MO, Fast
Process Interlocks	Nil

Drive Name	Scrubber Circulation Pump (*duty/standby pair*)
Equipment Number	19PPC502A/B
Drive Type	DOL
P&ID Number	6033-19-J-1002
Modes	Auto or Manual
Alarms	Standard Drive
Trend	R, I, Slow
Process Interlocks	Will trip 25PPC505A/B when Stopped

Drive Name	Scrubber Wash Pump
Equipment Number	19PPC503A
Drive Type	DOL
P&ID Number	6033-19-J-1002
Modes	Auto or Manual
Alarms	Standard Drive
Trend	R, I, Slow
Process Interlocks	Nil

Drive Name	Scrubber Wash Pump - FUTURE
Equipment Number	19PPC503B
Drive Type	DOL
P&ID Number	6033-19-J-1002
Modes	Auto or Manual
Alarms	Standard Drive
Trend	Nil
Process Interlocks	Nil

Drive Name	Scrubbing Area Spillage Pump
Equipment Number	19PPS504
Drive Type	DOL
P&ID Number	6033-19-J-1002
Modes	Auto or Manual
Alarms	Standard Drive
Trend	R, Slow
Process Interlocks	Nil

Drive Name	CYCLONE U/F Rotary Valve A
Equipment Number	19ROV501A
Drive Type	DOL
P&ID Number	6033-19-J-1003
Modes	Auto or Manual
Alarms	Standard Drive
Trend	R, Slow
Process Interlocks	Nil

Drive Name	CYCLONE U/F Rotary Valve B
Equipment Number	19ROV501B
Drive Type	DOL
P&ID Number	6033-19-J-1003
Modes	Auto or Manual
Alarms	Standard Drive
Trend	R, Slow
Process Interlocks	Nil

Drive Name	CYCLONE U/F Rotary Valve C
Equipment Number	19ROV501C
Drive Type	DOL
P&ID Number	6033-19-J-1003
Modes	Auto or Manual
Alarms	Standard Drive
Trend	R, Slow
Process Interlocks	Nil

Drive Name	CYCLONE U/F Rotary Valve D
Equipment Number	19ROV501D
Drive Type	DOL
P&ID Number	6033-19-J-1003
Modes	Auto or Manual
Alarms	Standard Drive
Trend	R, Slow
Process Interlocks	Nil

Drive Name	Magnetite Handling Spillage Pump
Equipment Number	19PPS501
Drive Type	DOL
P&ID Number	6033-19-J-1002
Modes	Auto or Manual
Alarms	Standard Drive
Trend	R, Slow
Process Interlocks	Nil

NOTE: for trends letters indicate the following trends

R = Running status
I = Amps
MO = Motor output (for VSD and reversible drives)

4.0 INSTRUMENTS

4.1 Analogue Indicators

The following are the analogue indicators in this area:

Indicator Name	19STK501 Opacity Indicator			
Indicator Number	AI-19-5251			
P&ID Number	6033-19-J-1002			
Indicator Type	Field Indicator			
Range	0 - 50 g/m^3			
Normal	30			
Alarms	HH	H	L	LL
Values	45	40		
Priorities	Urgent	Control		
Process Interlocks	Nil			
Trend	Slow			
Extras	Nil			
Cascaded Loop	Nil			

Indicator Name	19PPC502 Discharge Density Indicator			
Indicator Number	DI-19-5220			
P&ID Number	6033-19-J-1002			
Indicator Type	Field Indicator			
Range	1000 - 1170 kg/m^3			
Normal	1120			
Alarms	HH	H	L	LL
Values	1160	1140		
Priorities	Urgent	Control		
Process Interlocks	Nil			
Trend	Slow			
Extras	Nil			
Cascaded Loop	Nil			

Indicator Name	Scrubber Raw Water Addition Flow			
Indicator Number	FI-19-5201			
P&ID Number	6033-19-J-1002			
Indicator Type	Field Indicator			
Range	0 - 70 m^3/hr			
Normal	8			
Alarms	HH	H	L	LL
Values	65	55	5	2
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Nil			
Trend	Slow			
Extras	Phase - Liquid / SG - 1.05			
Cascaded Loop	Nil			

Indicator Name	19PPC501A Gland Seal Flow			
Indicator Number	FI-19-5221			
P&ID Number	6033-19-J-1002			
Indicator Type	Field Indicator			
Range	0 – 1.5 m^3/hr			
Normal	1			
Alarms	HH	H	L	LL
Values	1.3	1.1	0.4	0.2
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Will trip 19PPC501A at FAL			
Trend	Slow			
Extras	Nil			
Cascaded Loop	Nil			

Indicator Name	19PPC501B Gland Seal Flow			
Indicator Number	FI-19-5222			
P&ID Number	6033-19-J-1002			
Indicator Type	Field Indicator			
Range	0 – 1.5 m^3/hr			
Normal	1			
Alarms	HH	H	L	LL
Values	1.3	1.1	0.4	0.2
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Will trip 19PPC501B at FAL			
Trend	Slow			
Extras	Nil			
Cascaded Loop	Nil			

Indicator Name	Venturi Quench Spray Flow			
Indicator Number	FI-19-5248			
P&ID Number	6033-19-J-1002			
Indicator Type	Field Indicator			
Range	0 - 60 m^3/hr			
Normal	40			
Alarms	HH	H	L	LL
Values	55	50	10	5
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Nil			
Trend	Fast			
Extras	Phase - Liquid / SG - 1.05			
Cascaded Loop	Nil			

Indicator Name	Top Demister Pad Sprays Flow			
Indicator Number	FI-19-5249			
P&ID Number	6033-19-J-1002			
Indicator Type	Field Indicator			
Range	0 - 60 m^3/hr			
Normal	40			
Alarms	HH	H	L	LL
Values	55	50	10	5
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Nil			
Trend	Fast			
Extras	Phase - Liquid / SG - 1.05			
Cascaded Loop	Nil			

Indicator Name	Bottom Demister Pad Sprays Flow			
Indicator Number	FI-19-5250			
P&ID Number	6033-19-J-1002			
Indicator Type	Field Indicator			
Range	0 - 60 m^3/hr			
Normal	40			
Alarms	HH	H	L	LL
Values	55	50	10	5
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Nil			
Trend	Fast			
Extras	Phase - Liquid / SG - 1.05			
Cascaded Loop	Nil			

Indicator Name	19FAN501 Gas Flow			
Indicator Number	FI-19-5273			
P&ID Number	6033-19-J-1002			
Indicator Type	Field Indicator			
Range	0 - 200000 Nm^3/hr			
Normal	152000			
Alarms	HH	H	L	LL
Values	185000	170000	75000	40000
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	FALL for >2mins will trip BMS			
Trend	Fast			
Extras	Nil			
Cascaded Loop	Nil			

Indicator Name	19FAN501 Motor Current Indicator			
Indicator Number	II-19-5233			
P&ID Number	6033-19-J-1002			
Indicator Type	Field Indicator			
Range	0 – 2000 Amps			
Normal	1245			
Alarms	HH	H	L	LL
Values	1700	1500	800	500
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Will trip 19FAN501 at IAHH			
Trend	Slow			
Extras	Nil			
Cascaded Loop	Nil			

Indicator Name	19AGT501 Motor Current Indicator			
Indicator Number	II-19-5274			
P&ID Number	6033-19-J-1002			
Indicator Type	Field Indicator			
Range	0 – 8 Amps			
Normal	4.4			
Alarms	HH	H	L	LL
Values	7	6	2	1
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Will trip 19AGT501 at IAHH			
Trend	Slow			
Extras	Nil			
Cascaded Loop	Nil			

Indicator Name	19SBR501 Pressure Differential			
Indicator Number	PDI-19-5209			
P&ID Number	6033-19-J-1002			
Indicator Type	Field Indicator			
Range	0 – 12 kPag			
Normal	5			
Alarms	HH	H	L	LL
Values	12	10	2	0
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Nil			
Trend	Slow			
Extras	Phase - Gas			
Cascaded Loop	Nil			

Indicator Name	19SBR502 Pressure Differential			
Indicator Number	PDI-19-5210			
P&ID Number	6033-19-J-1002			
Indicator Type	Field Indicator			
Range	0 – 15 kPag			
Normal	7			
Alarms	HH	H	L	LL
Values	15	13	2	0
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Nil			
Trend	Slow			
Extras	Phase - Gas			
Cascaded Loop	Nil			

Indicator Name	19DU504 Duct Pressure			
Indicator Number	PI-19-5212			
P&ID Number	6033-19-J-1002			
Indicator Type	Field Indicator			
Range	-15 - 0 kPag			
Normal	-10			
Alarms	HH	H	L	LL
Values	0	-3	-12	-15
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Nil			
Trend	Slow			
Extras	Phase - Gas			
Cascaded Loop	Nil			

Indicator Name	19DU503 Duct Pressure			
Indicator Number	PI-19-5262			
P&ID Number	6033-19-J-1002			
Indicator Type	Field Indicator			
Range	-12 - 0 kPag			
Normal	-9			
Alarms	HH	H	L	LL
Values	-1	-3	-10	-11
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Nil			
Trend	Slow			
Extras	Phase - Gas			
Cascaded Loop	Nil			

Indicator Name	19DU502 Duct Pressure			
Indicator Number	PI-19-5302			
P&ID Number	6033-19-J-1003			
Indicator Type	Field Indicator			
Range	-10 - 0 kPag			
Normal	-7			
Alarms	HH	H	L	LL
Values	-1	-2	-8	-9
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Nil			
Trend	Slow			
Extras	Phase - Gas			
Cascaded Loop	Nil			

Indicator Name	19FH501 Pressure			
Indicator Number	PI-19-5317			
P&ID Number	6033-19-J-1003			
Indicator Type	Field Indicator			
Range	-10 - 0 kPag			
Normal	-5			
Alarms	HH	H	L	LL
Values	0	-1	-8	-9
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Nil			
Trend	Moderate			
Extras	Phase - Gas			
Cascaded Loop	Nil			

Indicator Name	19DU504 Gas Temperature			
Indicator Number	TI-19-5208			
P&ID Number	6033-19-J-1002			
Indicator Type	Field Indicator			
Range	0 - 100°C			
Normal	75			
Alarms	HH	H	L	LL
Values	95	85	20	10
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Nil			
Trend	Slow			
Extras	Phase - Gas			
Cascaded Loop	Nil			

Indicator Name	19STK501 Gas Temperature			
Indicator Number	TI-19-5213			
P&ID Number	6033-19-J-1002			
Indicator Type	Field Indicator			
Range	0 - 100°C			
Normal	75			
Alarms	HH	H	L	LL
Values	95	85	20	10
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Nil			
Trend	Slow			
Extras	Phase - Gas			
Cascaded Loop	Nil			

Indicator Name	19DU503 Gas Temperature			
Indicator Number	TI-19-5217			
P&ID Number	6033-19-J-1002			
Indicator Type	Field Indicator			
Range	0 - 110°C			
Normal	85			
Alarms	HH	H	L	LL
Values	105	95	20	10
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	At TAH will Open TV195202 and trip 19FAN501			
Trend	Slow			
Extras	Phase - Gas			
Cascaded Loop	Nil			

Indicator Name	19FAN501 Bearing Temperature			
Indicator Number	TI-19-5264			
P&ID Number	6033-19-J-1002			
Indicator Type	Field Indicator			
Range	0 - 80°C			
Normal	60			
Alarms	HH	H	L	LL
Values	75	70	15	5
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	TAHH will trip 19FAN501			
Trend	Moderate			
Extras	Bearing monitoring			
Cascaded Loop	Nil			

Indicator Name	19FAN501 Bearing Temperature			
Indicator Number	TI-19-5265			
P&ID Number	6033-19-J-1002			
Indicator Type	Field Indicator			
Range	0 - 80°C			
Normal	60			
Alarms	HH	H	L	LL
Values	75	70	15	5
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	TAHH will trip 19FAN501			
Trend	Moderate			
Extras	Bearing monitoring			
Cascaded Loop	Nil			

Indicator Name	19FAN501 Motor Winding Temperature			
Indicator Number	TI-19-5281			
P&ID Number	6033-19-J-1002			
Indicator Type	Field Indicator			
Range	0 - 80°C			
Normal	60			
Alarms	HH	H	L	LL
Values	75	70	15	5
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	TAHH will trip 19FAN501			
Trend	Slow			
Extras	Nil			
Cascaded Loop	Nil			

Note: The above data relates to all of the following tags; TI-19-5281 to TI-19-5288

Indicator Name	19DU502 Gas Temperature			
Indicator Number	TI-19-5303			
P&ID Number	6033-19-J-1003			
Indicator Type	Field Indicator			
Range	0 - 500°C			
Normal	400			
Alarms	HH	H	L	LL
Values	480	450	100	50
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Nil			
Trend	Slow			
Extras	Phase - Gas			
Cascaded Loop	Nil			

Indicator Name	19FH501 Gas Temperature			
Indicator Number	TI-19-5316			
P&ID Number	6033-19-J-1003			
Indicator Type	Field Indicator			
Range	0 - 600°C			
Normal	450			
Alarms	HH	H	L	LL
Values	550	500	100	50
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	At TAH will Open TV195316			
Trend	Moderate			
Extras	Phase - Gas			
Cascaded Loop	Nil			

4.2 Status Indicators

The following are the status indicators in this area:

Status Name	Scrubber Discharge Pump Selection
Status Number	HS-19-5227
P&ID Number	6033-19-J-1002
States	1 = 19PPC501B, 0 = 19PPC501A
Indication	HS-19-5227 and selection to be visible on DCS
Process Interlocks	Will send Start/Stop signal and controller outputs to selected pump
Extras	Nil

Status Name	19CYC501A U/F Hopper Level
Status Number	LSH-19-5305
P&ID Number	6033-19-J-1003
States	1 = Healthy, 0 = LAH
Indication	LAH-19-5305
Process Interlocks	Nil
Extras	Nil

Status Name	19CYC501B U/F Hopper Level
Status Number	LSH-19-5307
P&ID Number	6033-19-J-1003
States	1 = Healthy, 0 = LAH
Indication	LAH-19-5307
Process Interlocks	Nil
Extras	Nil

Status Name	19CYC501C U/F Hopper Level
Status Number	LSH-19-5309
P&ID Number	6033-19-J-1003
States	1 = Healthy, 0 = LAH
Indication	LAH-19-5309
Process Interlocks	Nil
Extras	Nil

Status Name	19CYC501D U/F Hopper Level
Status Number	LSH-19-5311
P&ID Number	6033-19-J-1003
States	1 = Healthy, 0 = LAH
Indication	LAH-19-5311
Process Interlocks	Nil
Extras	Nil

Status Name	19FH501 Level
Status Number	LSH-19-5318
P&ID Number	6033-19-J-1003
States	1 = Healthy, 0 = LAH
Indication	LAH-19-5318
Process Interlocks	Nil
Extras	Nil

Status Name	19FAN501 Speed
Status Number	HC-19-5232
P&ID Number	6033-19-J-1002
States	Range 0 - 100%
Indication	Input speed to be shown on DCS
Process Interlocks	Nil
Extras	Operator input to control fan speed

Status Name	19SBR501 Throat Position
Status Number	ZC-19-5269
P&ID Number	6033-19-J-1002
States	Range 0 - 100%
Indication	Input position to be shown on DCS
Process Interlocks	Nil
Extras	Operator input to control venturi throat position

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5.0 AUTOMATIC VALVES

5.1 ON/OFF Service

The following are the automatic (ON/OFF service) valves in this area:

Valve Name	19SBR501 Quench Spray Water Valve
Valve Number	TV-195202
Valve Modes	Auto or Manual
P&ID Number	6033-19-J-1002
Process Interlocks	Nil
Fail Position	Open
Indication	Open, Closed
Extras	Will open at TAH195217

Valve Name	Top Chevron Pad Spray Water Valve
Valve Number	HV-195203
Valve Modes	Auto or Manual
P&ID Number	6033-19-J-1002
Process Interlocks	Nil
Fail Position	Closed
Indication	Open, Closed
Extras	Timed operation ~ open 30sec every 12hrs

Valve Name	Bottom Chevron Pad Spray Water Valve
Valve Number	HV-195204
Valve Modes	Auto or Manual
P&ID Number	6033-19-J-1002
Process Interlocks	Nil
Fail Position	Closed
Indication	Open, Closed
Extras	Timed operation ~ open 30sec every 6hrs

Valve Name	19PPC502A Discharge Valve
Valve Number	HV-195252
Valve Modes	Auto or Manual
P&ID Number	6033-19-J-1002
Process Interlocks	Will trip 19PPC502A when Closed
Fail Position	Closed
Indication	Open, Closed
Extras	Nil

Valve Name	19PPC502A Suction Valve
Valve Number	HV-195253
Valve Modes	Auto or Manual
P&ID Number	6033-19-J-1002
Process Interlocks	Will trip 19PPC502A when Closed
Fail Position	Closed
Indication	Open, Closed
Extras	Nil

Valve Name	19PPC502B Discharge Valve
Valve Number	HV-195254
Valve Modes	Auto or Manual
P&ID Number	6033-19-J-1002
Process Interlocks	Will trip 19PPC502B when Closed
Fail Position	Closed
Indication	Open, Closed
Extras	Nil

Valve Name	19PPC502A Pregnant Liquor Suction Valve
Valve Number	HV-195255
Valve Modes	Auto or Manual
P&ID Number	6033-19-J-1002
Process Interlocks	Nil
Fail Position	Closed
Indication	Open, Closed
Extras	Will only open if HV195253 is Open

Valve Name	19PPC502B Suction Valve
Valve Number	HV-195256
Valve Modes	Auto or Manual
P&ID Number	6033-19-J-1002
Process Interlocks	Will trip 19PPC502B when Closed
Fail Position	Closed
Indication	Open, Closed
Extras	Nil

Valve Name	19PPC501A Suction Valve
Valve Number	HV-195257
Valve Modes	Auto or Manual
P&ID Number	6033-19-J-1002
Process Interlocks	Will trip 19PPC501A when Closed
Fail Position	Closed
Indication	Open, Closed
Extras	Nil

Valve Name	19PPC501B Suction Valve
Valve Number	HV-195258
Valve Modes	Auto or Manual
P&ID Number	6033-19-J-1002
Process Interlocks	Will trip 19PPC501B when Closed
Fail Position	Closed
Indication	Open, Closed
Extras	Nil

Valve Name	19PPC501A Discharge Valve
Valve Number	HV-195259
Valve Modes	Auto or Manual
P&ID Number	6033-19-J-1002
Process Interlocks	Will trip 19PPC501A when Closed
Fail Position	Closed
Indication	Open, Closed
Extras	Nil

Valve Name	19PPC501B Discharge Valve
Valve Number	HV-195260
Valve Modes	Auto or Manual
P&ID Number	6033-19-J-1002
Process Interlocks	Will trip 19PPC501B when Closed
Fail Position	Closed
Indication	Open, Closed
Extras	Nil

Valve Name	19PPC502B Pregnant Liquor Suction Valve
Valve Number	HV-195268
Valve Modes	Auto or Manual
P&ID Number	6033-19-J-1002
Process Interlocks	Nil
Fail Position	Closed
Indication	Open, Closed
Extras	Will only open if HV195256 is Open

Valve Name	19DU501 Gas Cooling Sprays
Valve Number	TV-195316
Valve Modes	Auto or Manual
P&ID Number	6033-19-J-1003
Process Interlocks	Nil
Fail Position	Open
Indication	Open, Closed
Extras	Will open at TAH195316

6.0 CONTROL LOOPS

The following are the Control Loops in this area:

Loop Name	19-SBR-502 Spray Water Flow			
Loop Input	FI-19-5205			
P&ID Number	6033-19-J-1002			
Loop Type	STD PID Loop			
Modes	Auto & Manual			
Range	0 - 40 m3/hr			
Normal	5			
Alarms	HH	H	L	LL
Values	36	32	3	1
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Nil			
Trend	PV, SP & OP, Fast			
Loop Output	0 - 100 %	FCV-19-5205		
Action	Reverse			
Loop Tuning	Fast			
Extras	Nil			
Cascaded Loop	Nil			

Loop Name	19-SBR-502 Raw Water Make-up			
Loop Input	FI-19-5206			
P&ID Number	6033-19-J-1002			
Loop Type	STD PID Loop			
Modes	Auto, Manual & Cascade			
Range	0 - 30 m3/hr			
Normal	3			
Alarms	HH	H	L	LL
Values	27	24	2	1
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Nil			
Trend	PV, SP & OP, Fast			
Loop Output	0 - 100 %	FCV-19-5206		
Action	Reverse			
Loop Tuning	Fast (Inner Loop)			
Extras	Nil			
Cascaded Loop	LIC-19-5218			

Loop Name	19-SBR-501 Upper Sprays Flow			
Loop Input	FI-19-5214			
P&ID Number	6033-19-J-1002			
Loop Type	STD PID Loop			
Modes	Auto & Manual			
Range	0 - 50 m3/hr			
Normal	30			
Alarms	HH	H	L	LL
Values	45	40	10	5
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Nil			
Trend	PV, SP & OP, Fast			
Loop Output	0 - 100 %	FCV-19-5214		
Action	Reverse			
Loop Tuning	Fast			
Extras	Totaliser required (FQ195214)			
Cascaded Loop	Nil			

Loop Name	19-SBR-501 Middle Sprays Flow			
Loop Input	FI-19-5215			
P&ID Number	6033-19-J-1002			
Loop Type	STD PID Loop			
Modes	Auto & Manual			
Range	0 - 230 m3/hr			
Normal	200			
Alarms	HH	H	L	LL
Values	230	215	45	20
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Nil			
Trend	PV, SP & OP, Fast			
Loop Output	0 - 100 %	FCV-19-5215		
Action	Reverse			
Loop Tuning	Fast			
Extras	Totaliser required (FQ195215)			
Cascaded Loop	Nil			

Loop Name	Dirty Preg Bleed Flow			
Loop Input	FI-19-5227			
P&ID Number	6033-19-J-1002			
Loop Type	STD PID Loop			
Modes	Auto, Manual & Cascade			
Range	0 - 25 m3/hr			
Normal	15			
Alarms	HH	H	L	LL
Values	23	20	5	3
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Nil			
Trend	PV, SP & OP, Fast			
Loop Output	0 - 100 %	SC-19-5227A/B		
Action	Reverse			
Loop Tuning	Fast			
Extras	Ratioed to be ~50% of FI255323			
Cascaded Loop	FIC255323			

Loop Name	19-SBR-501 Lower Sprays Flow			
Loop Input	FI-19-5247			
P&ID Number	6033-19-J-1002			
Loop Type	STD PID Loop			
Modes	Auto & Manual			
Range	0 - 230 m3/hr			
Normal	200			
Alarms	HH	H	L	LL
Values	230	215	45	20
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Nil			
Trend	PV, SP & OP, Fast			
Loop Output	0 - 100 %	FCV-19-5247		
Action	Reverse			
Loop Tuning	Fast			
Extras	Totaliser required (FQ195247)			
Cascaded Loop	Nil			

Loop Name	19-TNK-501 Level			
Loop Input	LI-19-5218			
P&ID Number	6033-19-J-1002			
Loop Type	STD PID Loop			
Modes	Auto & Manual			
Range	0 - 100 %			
Normal	60			
Alarms	HH	H	L	LL
Values	90	80	20	10
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	LALL will trip 19PPC501A/B, 19PPC502A/B and 19AGT501 LAL will start 19AGT501			
Trend	PV, SP & OP, Fast			
Loop Output	0 - 30 m^3/h	FIC-19-2506		
Action	Reverse			
Loop Tuning	Slow (Outer Loop)			
Extras	Nil			
Cascaded Loop	FIC-19-5206			

7.0 CALCULATION BLOCKS

The following are the calculations required in this area:

Calculation Name	Scrubber Dirty Preg Bleed Flow
Calculation Number	TBA
Inputs	• Pregnant Liquor Transfer Flow (***P***) = FIC-25-5323 (m^3/hr) • Bleed Off Ratio (***R***) = Operator Input (default 50) (%)
Outputs	Dirty Preg Bleed Flow Rate (***D***) = Setpoint for FIC-19-5227 (m^3/hr)
Calculation	(D) = (P)*(R)/100
Range	0 - 25 m^3/hr
Mode	Active when FIC-19-5227 is in CASCADE
Extras	Nil

8.0 FUNCTIONAL PREREQUISITES

The operation of this Area requires the following plant functional areas to be operational:

Area	System	Associated Drawing	Associated Control Philosophy

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9.0 STARTUP

The start-up sequence for this area, for the integrated operation of the Vanadium recovery plant is shown below

9.1 Scrubber Circulation System

9.1.1 First Fill

Prerequisites

No.	TAG No.	Equip. No.	Description	Status
1			Plant services available	HEALTHY
2			All drives in start sequence	HEALTHY.
3			Drain valve 100V1122	CLOSED

Start Sequence

Prerequisite	Step No.	Description
	1	Ensure the following valves are Closed (check ZSC is Energised): HV195253, HV195256, HV195257, HV195258, HV195252, HV195254
Step 1	2	Select scrubber circulation tank level (LIC195218) control loop
Step 2	3	Set flow control (FIC195206) to CASCADE
Step 3	4	Set level control (LIC195218) to AUTO and input set point of 100%
Step 4	5	Wait until level is 50%
Step 5	6	Set scrubber circulation tank agitator (19AGT501) to AUTO and Start

9.1.2 Refill

Prerequisites

No.	TAG No.	Equip. No.	Description	Status
1			Plant services available	HEALTHY
2			All drives in start sequence	HEALTHY
3			Drain valve 100V1122	CLOSED

Start/Stop Sequence

Prerequisite	Step No.	Description
	1	Ensure the following valves are Closed (check ZSC is Energised): HV195253, HV195256, HV195257, HV195258, HV195252, HV195254, HV255319, HV255320, HV255321, HV255322
Step 1	2	Open Scrubber circulation pump suction valves (HV195253 and HV195256)
Step 1	3	Open pregnant liquor transfer valves (HV195255, HV195268)
	4	Set Flow control loop (FIC255323) to AUTO and input flow set point
Step 2-3	5	Group Start duty pregnant liquor transfer pump (25PPC505A/B) – Open suction and discharge valves and Start pump in AUTO
Step 5	6	Wait until Scrubber circulation tank level is %50
Step 6	7	Set Scrubber circulation tank agitator to AUTO and Start
Step 7	8	Wait until LAH195218 is reached
Step 8	9	Group Stop duty pregnant liquor transfer pump (25PPC505A/B) – Stop pump and Close suction and discharge valves
Step 9	10	Close pregnant liquor transfer valves (HV195255, HV195268)
Step 9	11	Close Scrubber circulation pump suction valves (HV195253 and HV195256)

9.1.3 Circuit Operation – First fill

Prerequisites

No.	TAG No.	Equip. No.	Description	Status
1			Plant services available	HEALTHY
2			All drives in start sequence	HEALTHY
3			Temporary pipe line installed	
4	LAH195218	19TNK201	Scrubber circulation tank level	ENERGISED
5			First fill sequence	COMPLETE

Start Sequence

Prerequisite	Step No.	Description
	1	Set FCV195214 to Manual @ 100%
	2	Set FCV195215 to Manual @ 100%
	3	Set FCV195247 to Manual @ 100%
	4	Ensure the following valves are closed (ZSC energised); HV195253, HV195256, HV195257, HV195258, HV195252, HV195254
Step 1-4	5	Group Start duty scrubber circulation pump (19PPC502A/B) – Open suction and discharge valves, set pump to AUTO and Start
Step 5	6	Set flow control FIC195214 to AUTO and input set point
Step 5	7	Set flow control FIC195215 to AUTO and input set point
Step 5	8	Set flow control FIC195247 to AUTO and input set point
	9	Set flow control FIC195227 to AUTO and input set point
	10	Set level control LIC195218 to AUTO
Step 5	11	Set Scrubber Wash Pump (19PPC503) to AUTO and Start
Step 9	12	Group Start duty scrubber discharge pump (19PPC501A/B) – Open suction and discharge valves, set pump to AUTO and Start

9.1.4 Circuit Operation – Steady State Operation

Prerequisites

No.	TAG No.	Equip. No.	Description	Status
1			Plant services available	HEALTHY
2			All drives in start sequence	HEALTHY
3			Refill sequence complete	COMPLETE
4	LAH195218	19TNK201	Scrubber circulation tank level	ENERGISED

Start Sequence

Prerequisite	Step No.	Description
	1	Set FCV195214 to MANUAL @ 100%
	2	Set FCV195215 to MANUAL @ 100%
	3	Set FCV195247 to MANUAL @ 100%
	4	Ensure the following valves are closed (ZSC energised): HV195253, HV195256, HV195257, HV195258, HV195252, HV195254
Step 1-4	5	Group start duty scrubber circulation pump (19PPC502A/B) – Open suction and discharge valves, set pump to AUTO and Start
Step 5	6	Set flow control FIC195214 to AUTO and input set point
Step 5	7	Set flow control FIC195215 to AUTO and input set point
Step 5	8	Set flow control FIC195247 to AUTO and input set point
	9	Set flow control FIC195227 to AUTO and input set point
	10	Set level control LIC195218 to AUTO
Step 5	11	Set Scrubber Wash Pump (19PPC503) to AUTO and Start
	12	Set flow control FIC255323 to AUTO and input set point
Step 9	13	Group Start duty scrubber discharge pump (19PPC501A/B) – Open suction and discharge valves, set pump to AUTO and Start
Step 13	14	Open duty scrubber circulation pump pregnant liquor suction valve (HV195255/68)
Step 14	15	Group Start duty pregnant liquor transfer pump (25PPC505A/B) – Open suction and discharge valves, set pump to AUTO and Start

9.2 Scrubber Tower Operation

Prerequisites

No.	TAG No.	Equip. No.	Description	Status
1			Plant services available	HEALTHY
2			All drives in start sequence	HEALTHY
3			Refill sequence complete	COMPLETE
4			Scrubbing circuit operational	HEALTHY

Start Sequence

Prerequisite	Step No.	Description
	1	Set HV195203 to AUTO
	2	Set HV195204 to AUTO
	3	Set FIC195205 to AUTO and input set point
	4	Set FIC195206 to AUTO and input set point

9.3 Kiln ID Fan

Prerequisites

No.	TAG No.	Equip. No.	Description	Status
1			Scrubbing circuit operational	HEALTHY
2		19CYC501 A-D	Off-gas cyclones operating	HEALTHY

Start Sequence

Prerequisite	Step No.	Description
	1	Set Kiln ID Fan (19FAN501) to AUTO and Start

9.4 Kiln Feed

Prerequisites

No.	TAG No.	Equip. No.	Description	Status
1			Plant services available	HEALTHY
2			All drives in start sequence	HEALTHY
3	LAH195318	19FH501	Kiln feed hood and dust hopper	HEALTHY

Start Sequence

Prerequisite	Step No.	Description
	1	Kiln Feed Screw 19FDS502
Step 1	2	Kiln Mixing Screw 19MXR501
Step 2	3	Set Cyclone 1 U/F (19ROV501A) rotary valve to AUTO and Start
Step 2	4	Set Cyclone 2 U/F (19ROV501B) rotary valve to AUTO and Start
Step 2	5	Set Cyclone 3 U/F (19ROV501C) rotary valve to AUTO and Start
Step 2	6	Set Cyclone 4 U/F (19ROV501D) rotary valve to AUTO and Start
Step 2	7	Start Magnetite Handling Sequence

10.0 SHUTDOWN

There are two scenarios in which this system may be shutdown, namely:

- Crash Stop
- Controlled Stop

A crash stop represents a temporary interruption to plant production as a result of a downstream equipment interlock or a deliberate stop of the kiln mixing screw or the kiln feed screw by the CCR operator. Due to the immediate stoppage, the kiln mixing and kiln feed screws remain loaded with material. The kiln main ID fan continues to operate. The cyclone underflow rotary valves are stopped whilst the scrubber circulation system and scrubbing tower continue to operate. The addition of dilute pregnant to the scrubber circulation pumps is stopped along with the scrubber discharge pumps. No sequence is provided for a crash stop; rather all equipment is stopped instantaneously based on the interlock hierarchy.

A controlled stop is a sequenced shutdown of the area to accommodate a planned shutdown to facilitate maintenance of equipment. When a controlled stop is initiated, the stop sequence ensures the kiln mixing screw and kiln feed screw are run empty. To enable a controlled shutdown, local interlocks are overridden.

10.1 Crash Stop Sequence

The following is the Crash Stop shutdown sequences in this area:

Prerequisites

No.	TAG No.	Equip. No.	Description	Status

Stop Sequence

Prerequisite	Step No.	Description
	1	STOP Kiln Feed Screw (19FDS502)
	2	STOP Kiln Mixing Screw (19MXR501)
	3	STOP Off-gas Cyclone 1 U/F Rotary Valve (19CYC501A)
	4	STOP Off-gas Cyclone 2 U/F Rotary Valve (19CYC501B)
	5	STOP Off-gas Cyclone 3 U/F Rotary Valve (19CYC501C)
	6	STOP Off-gas Cyclone 4 U/F Rotary Valve (19CYC501D)
	7	Group Stop 25PPC505A/B – Stop pump and close suction and discharge valves
	8	Group Stop 19PPC501A/B – Stop pump and close suction and discharge valves

10.2 Controlled Stop Sequence

The following are the controlled shutdown sequences in this area:

Prerequisites

No.	TAG No.	Equip. No.	Description	Status
1			Magnetite Handling Area	STOPPED

Stop Sequence

Prerequisite	Step No.	Description
	1	Stop Off-gas Cyclone 1 U/F Rotary Valve (19CYC501A)
	2	Stop Off-gas Cyclone 2 U/F Rotary Valve (19CYC501B)
	3	Stop Off-gas Cyclone 3 U/F Rotary Valve (19CYC501C)
	4	Stop Off-gas Cyclone 4 U/F Rotary Valve (19CYC501D)
Step 1-4 + time delay	5	Stop Kiln Mixing Screw (19MXR501)
Step 5 + time delay	6	Stop Kiln Feed Screw (19FDS502)
Step 6 + time delay	7	Stop Kiln (20KLN501)
Step 7 + time delay	8	Stop Kiln ID Fan (19FAN501)
	9	Input flow rate set point for FIC195227
Step 8 + time delay	10	Group Stop 25PPC505A/B – Stop duty pump and close associated suction and discharge valves
Step 10 + time delay	11	Group Stop 19PPC502A/B – Stop duty pump and close associated suction and discharge valves
	12	Set HV195203 and HV195204 to MANUAL and Close
	13	Set FCV195205 to MANUAL and Close
	14	Set FCV195206 to MANUAL and Close
	15	Stop Scrubber Wash Pump (19PPC503A)
LALL195218 is activated	16	Group Stop 19PPC501A/B – Stop duty pump and close associated suction and discharge valves

Note: Time delays to be determined – facility will be required to adjust these times during operation.