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MIDWEST VANADIUM PTY LTD

WINDIMURRA VANADIUM PROJECT
AREA 20 - ROASTING CONTROL PHILOSOPHY

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1.0 PROCESS DESCRIPTION

Reference P&ID: (6033-20-J-1002, 6033-20-J-1003, 6033-20-J-1004, 6033-20-J-1005, 6033-20-J-1006)

1.1 Rotary Kiln

The mixed magnetite concentrate, soda ash and recovered dust enters the 4.75 metre diameter by 102 metre long, refractory lined, rotary kiln via a kiln feed screw feeder (19FDS502). Natural gas and air (20FAN501) are introduced at the discharge end of the kiln to the kiln gas burner (20BUR501) which is burnt to generate a maximum temperature of approximately 1200°C in the hottest part of the kiln. The design residence time of the material is 5.5 hours, which includes a period of over an hour where the temperature reaches approximately 1200°C. The vanadium in the magnetite concentrate reacts with the sodium in the soda ash to produce a water soluble sodium vanadate. Kiln gases are drawn through the kiln, along with secondary air, by the kiln ID fan.

The calcine produced in the kiln passes through a set of parallel planetary coolers, which consists of nine cooler tubes, each 2.1 metres in diameter and 15 metres long, through which secondary kiln air is drawn. The heat transfer between the cold air and hot calcine material results in the calcine exiting at approximately 450 °C. The incoming air is heated to over 600°C. Any spillage around the kiln area is pumped away by the roasting spillage sump pump (20PPS502).

The rotary kiln is supplied with two variable speed main drives and can reach a maximum speed of 1 rpm. A barring drive is installed to ensure kiln rotation can continue in the event of a failure of the main drives, albeit at a much lower rotational speed.

A 1 megawatt cooling tower (20CTR501) provides cooling water to cool the kiln support roller bearings and to also cool the jaw crusher bearings. Cooling water is pumped (20PPC502 A/B) from the cooling tower to the kiln support roller bearings and the jaw crusher and the resulting hot water is returned to the cooling tower. Potable water is supplied to the cooling tower and a water treatment unit (20WTP501) doses biocide and antiscalant to the water.

The cooling water circuit possesses a sump pump (20PPD507) to handle all spillage that may occur.

1.2 Calcine Handling

The calcine produced from the kiln is passed over a hot vibrating screen (20SN501) to separate the calcine lump from the fine material. The fine material passes through a discharge chute (20CHU502) to the drag chain conveyor (20CVR501). The oversize calcine lumps are transferred to the calcine jaw crusher to reduce lump size to a size more amenable to leaching (initially set to -60mm). An emergency oversize bunker can be used when experiencing problems with the jaw crusher. The emergency stockpile can be reclaimed by a bobcat.

The crusher product passes through a discharge chute (20CHU506) onto the drag chain conveyor. The crushed and fine material is conveyed to a bucket elevator,

which in turn feeds the quench vessel (25VSL501) for quenching prior to transport to the leaching vats.

Transfer points from the kiln to the hot screen are under a slight negative pressure from the kiln ID fan. The drag chain conveyor, jaw crusher and bucket elevator transfer points are also under a slight negative pressure also, but from the quench scrubber fan.

2.0 CONTROL PHILOSOPHY

The control philosophy for the Roasting Area is described in the following Sections:

- Cooling water system
- Calcine handling.
- Rotary kiln operation
- Burner management system

2.1 Rotary Kiln Operation

2.1.1 Rotary Kiln Operation

The two main kiln drives are variable speed (SC205220, SC205221) and are capable of rotating the kiln at a maximum speed of 1 rpm. The speed of the kiln is set by the operator through the OIS and will impact maximum throughput. The kiln speed set point will be optimised during commissioning. The main kiln drives are equipped with current measurement which can help to determine kiln speed and is used during kiln start-up/ramp-up.

The kiln barring drive (20KLN501C1, C2) is provided to rotate the kiln in the event of the loss of the main kiln drives. A standby diesel generator has been provided to operate the barring drive in the event of a power failure. The emergency generator starts automatically when power is lost.

The kiln is positioned on five piers each containing four separate oil lubricated and water cooled bearings. Each bearing station is equipped with a temperature indicator and cooling water line with a sight glass, gate valve and ball valve to regulate flow. The kiln bearing temperature is monitored from the CCR and can be controlled by the manual adjustment of the ball valve located on the respective bearing's cooling water line. The sight glass is situated on the cooling water line.

The kiln is inclined at a two degree angle to facilitate the movement of calcine to the discharge end of the kiln. As the kiln rotates, the kiln floats and moves upwards and downwards along the bearing station. When the kiln hits the lower position switch (ZS205224), the kiln thrust hydraulic pump (25KLN501J) operates and activates a hydraulic cylinder to drive the kiln upwards by approximately 250mm. When the upper limit switch (ZS205223) is activated, the hydraulic pump stops. If the upper limit switch is faulty and does not activate a higher limit switch (ZS205222) will be activated as a back-up to prevent the kiln from been pushed from its rollers. Over a period of several hours the kiln floats to the lower limit switch where the thrust system repositions the kiln. All switches are alarmed and monitored in the CCR.

The kiln feed hood is equipped with temperature indication (TI195316) and pressure indication (PI195317). An emergency water spray system is activated on the detection of a high temperature alarm to protect the cyclones and connecting duct work from thermal damage. The pressure controller controls the speed of the kiln ID fan (19FAN501) to maintain a -0.5kPag operating pressure in the kiln and a 5% oxygen concentration in the off-gas.

The kiln primary air fan (20FAN501) provides air required for the transportation of the natural gas to the burner. The fan is variable speed and the speed of the fan is controlled (SC205209) as part of the burner management system (described in section 2.2).

The kiln main ID fan (19FAN501) draws in secondary air from the cooler tubes to cool the hot calcine to 450 C before discharge to the calcine handling system.

The burner tunnel cooling fans (20FAN503A/B) circulate air through the burner tunnel to prevent it reaching excessive temperatures.

The kiln interior CCTV (CAM205228) provides a visual inspection of the charge in the kiln. The position of the charge up the inside wall of the kiln is a good indication of optimum roasting conditions. A high position at approximately 2 o'clock indicates optimum recovery in similar vanadium kiln operations. A low position is a possible indication of insufficient flux or a low material temperature. The CCTV is air cooled and automatically retracts on the loss of plant air or power to protect the camera from thermal damage.

The kiln is equipped with an optical pyrometer (TE205227) to measure the temperature in the hot zone of the kiln. The pyrometer is air cooled using plant air and will automatically retract on the loss of plant air or power to protect the instrumentation from thermal damage.

A kiln gun is provided to attempt to cut slots in the build-up on the inside of the kiln walls in order to dislodge this build-up. The kiln gun is mounted on a tripod.

2.1.2 Rotary Kiln Cause and Effect

Indication

Kiln exhaust gas temp = 450 C

Pyrometer = 1200 C

CCTV visual inspection

Checks

Correct feed rate

Correct soda ash addition rate

Correct kiln speed

Correct O2 concentration – correct air flow

Check for build-up of a ring

Main drive current

Variables – corrective actions

Gas rate

Change O2 exhaust set point

Burner position – adjustment

Flame length - ?

2.2 Burner Management System

The burner management system (or BMS) is a regulatory control for the safe operation of the kiln burners (main and pilot) and incorporates the valve train for the natural gas inlet to the burners.

There are 4 outputs required from the PCS to operate the BMS, these are;

- System run – signal to start the BMS and purge the kiln.
- Pilot run – signal to start the pilot flame.
- Main burner run – signal to start the main burner.
- System reset – signal to clear all alarms and prepare the BMS for a restart.

Upon receiving each of the above signals the BMS will attempt the requested action and will send a signal back to the PCS of any errors occurring during operation or when the operation is complete. All alarms that occur within in the BMS are sent to the PCS so the CCR operator is aware of any problems with the system.

The kiln primary air fan is started from the PCS; however the control of the variable speed drive is from the BMS, which controls to achieve a calculated mixture of natural gas and air.

Kiln off-gas temperature (TI195316) is controlled by manipulating the burner flame intensity. This is achieved by sending a signal to the BMS to change the flame intensity, which will then alter the natural gas flow.

Air flow through the planetary coolers and kiln is dependent on the pressure drop across the kiln and as such a set negative pressure in the feed hood needs to be maintained. This set pressure (PI195317) is controlled by changing the speed of the kiln ID fan (19FAN501). Oxygen content (AI205201) in the kiln off-gas is also monitored (via the BMS) and controlled by manipulating the kiln ID fan speed.

2.2.1 Flame Control

2.3 Cooling Water System

Cooling water return from the kiln bearings gravitate to the cooling water return tank (20TNK506). The cooling water tank is equipped with level control (LIC205609) to control the speed (SC205610) of the cooling water return pump (20PPC504) to maintain a constant level in the tank. The tank level is an operator set point through the OIS. The cooling water transfer pump transfers the cooling water to the kiln cooling tower (20CTR501).

Cooling water from the crusher is returned directly to the kiln cooling water tower inlet manifold.

The cooling water enters the evaporative cooling tower and cascades down the tower packing. The tower is fitted with a fan to draw in air through vents. Water evaporates, saturating the air and thus cools the cascading water. The cooled water is collected in the reservoir to which corrosion inhibitor and biocide are added to prevent corrosion due to the low mineral water and bacterial growth that may otherwise block pipe lines and the cooling tower itself. To compensate for the evaporation loss, potable water is added to the reservoir via a float valve.

The continual evaporation of water from the cooling water circuit results in the concentration of salts. Should the concentration of salts increase above the solubility limit, precipitation will occur. To avoid precipitation, a portion of the cooling water is bled from the system.

Cooling water is pumped from the kiln cooling tower reservoir via the duty pump (20PPC502A) or the standby pump (20PPC502B). The pump discharge is equipped with temperature indication (TI205301) and a flowmeter to alarm (FAL205302) for low flow.

2.4 Calcine Handling

Calcine from the kiln cooler tubes discharges to the hot screen (20SN501) via the hot screen feed chute (20CHU503). The hot screen feed chute is equipped with temperature indication (TI205401) and a blocked chute switch to alarm for a blocked chute (BCA205402) condition.

The hot screen is a fixed frequency, single deck vibrating screen type. The screen deck is 60mm aperture punched bisalloy plate. Minus 60 mm calcine passes through the screen and is directed to the drag chain conveyor via hot screen fines discharge chute (20CHU502). The hot screen fines discharge chute is equipped with a blocked chute switch to alarm for a blocked chute (BCA205404) condition.

Oversize from the hot screen is discharged to either the hot screen oversize chute (20CHU504) or the emergency kiln oversize chute (20CHU505), depending on the position of the diverter gate (SV205414). Both chutes are fitted with blocked chute switches to alarm for a blocked chute condition (BCA205415, BCA205416). Under normal operation, oversize will report to the hot screen oversize discharge chute and then onto the calcine jaw crusher (20CRJ501).

The diverter gate can be changed to direct product to the emergency kiln oversize chute by manual selection, or if a fault is registered with the crusher or other downstream equipment in the calcine handling area.

The crusher is single toggle water cooled jaw crusher. The crusher installation includes an oil circulation and cooling system. The Jaw crusher oil heat exchanger is controlled (TIC205408) by measuring the oil exit temperature (TE205408) and adjusting the cooling water flow (TCV205409). The cooling water return, from the Jaw crusher oil heat exchanger, is fitted with a flow element (FE205410) which will alarm for a low flow condition and interlock the operation of the crusher.

Crushed calcine is discharged to the drag chain conveyor (20CVR501) via the jaw crusher discharge chute (20CHU506). The chute is fitted with a blocked chute switch to alarm (BCA205406) for a blocked chute condition.

The drag chain conveyor discharges calcine to the bucket elevator (20BE501) and the bucket elevator transfers the calcine to the quench vessel (25VSL 501). The drag chain conveyor and bucket elevator are fixed speed and equipped with under speed switches (USS205405, USS205412) to alarm for the failure of the drive shaft. The drag chain conveyor transfer point and bucket elevator are ducted to the quench scrubber (25SBR501) to provide a slight negative pressure and thus ensure the extraction of dust. All chutes are equipped with blocked chute switches to alarm for a blocked chute condition and interlock the operation of the upstream equipment.

3.0 EQUIPMENT

The following are the drives in this area:

Drive Name	Quench Vessel Bucket Elevator
Equipment Number	20BE501
Drive Type	DOL
P&ID Number	6033-20-J-1004
Modes	Auto or Manual
Alarms	Standard Drive
Trend	R, I, Slow
Process Interlocks	Will trip 20CVR501 when Stopped

Drive Name	Kiln Burner Trolley Drive
Equipment Number	20BUR501A
Drive Type	DOL Reversing
P&ID Number	6033-20-J-1002
Modes	Auto or Manual
Alarms	Standard Reversing Drive
Trend	R, MO, Slow
Process Interlocks	Nil

Drive Name	Calcine Jaw Crusher
Equipment Number	20CRJ501
Drive Type	DOL
P&ID Number	6033-20-J-1004
Modes	Auto or Manual
Alarms	Standard Drive
Trend	Slow
Process Interlocks	Will activate change-over to emergency chute when Stopped

Drive Name	Kiln Cooling Tower
Equipment Number	20CTR501
Drive Type	DOL
P&ID Number	6033-20-J-1003
Modes	Auto or Manual
Alarms	Standard Drive
Trend	R, I, Slow
Process Interlocks	Nil

Drive Name	Drag Chain Conveyor
Equipment Number	20CVR501
Drive Type	Conveyor
P&ID Number	6033-20-J-1004
Modes	Auto or Manual
Alarms	Standard Conveyor
Trend	R, I, Slow
Process Interlocks	Will trip 20SN501 & 20CRJ501 when Stopped

Drive Name	Kiln Primary Air Fan
Equipment Number	20FAN501
Drive Type	VSD
P&ID Number	6033-20-J-1002
Modes	Auto or Manual
Alarms	Standard Variable Speed Drive
Trend	R, I, MO, Moderate
Process Interlocks	Will trip 20BUR501A (BMS) & 19FDS502 when Stopped

Drive Name	Burner Tunnel Cooling Fan
Equipment Number	20FAN503A
Drive Type	DOL
P&ID Number	6033-20-J-1002
Modes	Auto or Manual
Alarms	Standard Drive
Trend	R, I, Slow
Process Interlocks	Nil

Drive Name	Burner Tunnel Cooling Fan
Equipment Number	20FAN503B
Drive Type	DOL
P&ID Number	6033-20-J-1002
Modes	Auto or Manual
Alarms	Standard Drive
Trend	R, I, Slow
Process Interlocks	Nil

Drive Name	Kiln Main Drive
Equipment Number	20KLN501A
Drive Type	VSD
P&ID Number	6033-20-J-1002
Modes	Auto or Manual
Alarms	Standard Variable Speed Drive
Trend	R, I, MO, Moderate
Process Interlocks	Will trip 20KLN501B & 19FDS502 when Stopped

Drive Name	Kiln Main Drive
Equipment Number	20KLN501B
Drive Type	VSD
P&ID Number	6033-20-J-1002
Modes	Auto or Manual
Alarms	Standard Variable Speed Drive
Trend	R, I, MO, Moderate
Process Interlocks	Will trip 20KLN501A & 19FDS502 when Stopped

Drive Name	Kiln Barring Drive
Equipment Number	20KLN501C1
Drive Type	DOL
P&ID Number	6033-20-J-1002
Modes	Auto or Manual
Alarms	Standard Drive
Trend	R, I, Slow
Process Interlocks	Will trip 20KLN501C2 when Stopped

Drive Name	Kiln Barring Drive
Equipment Number	20KLN501C2
Drive Type	DOL
P&ID Number	6033-20-J-1002
Modes	Auto or Manual
Alarms	Standard Drive
Trend	R, I, Slow
Process Interlocks	Will trip 20KLN501C1 when Stopped

Drive Name	Kiln Drive Gear Lube Pump
Equipment Number	20KLN501D
Drive Type	Feeder
P&ID Number	6033-20-J-1002
Modes	Manual
Alarms	Standard Feeder
Trend	Nil
Process Interlocks	Will trip 20KLN501A/B if both 20KLN501D&E are Stopped for >15mins

Drive Name	Kiln Drive Gear Lube Pump
Equipment Number	20KLN501E
Drive Type	Feeder
P&ID Number	6033-20-J-1002
Modes	Manual
Alarms	Standard Feeder
Trend	Nil
Process Interlocks	Will trip 20KLN501A/B if both 20KLN501D&E are Stopped for >15mins

Drive Name	Kiln Drive A Lube and Cooling Unit
Equipment Number	20KLN501G
Drive Type	DOL
P&ID Number	6033-20-J-1002
Modes	Auto or Manual
Alarms	Standard Drive
Trend	R, Slow
Process Interlocks	Will trip 20KLN501A when Stopped

Drive Name	Kiln Drive B Lube and Cooling Unit
Equipment Number	20KLN501H
Drive Type	DOL
P&ID Number	6033-20-J-1002
Modes	Auto or Manual
Alarms	Standard Drive
Trend	R, Slow
Process Interlocks	Will trip 20KLN501B when Stopped

Drive Name	Kiln Thrust Device Hydraulic Pump
Equipment Number	20KLN501J
Drive Type	DOL
P&ID Number	6033-20-J-1002
Modes	Auto or Manual
Alarms	Standard Drive
Trend	R, Slow
Process Interlocks	Nil

Drive Name	Kiln Shoebrake Thruster No.1
Equipment Number	20KLN501K1
Drive Type	DOL
P&ID Number	6033-20-J-1002
Modes	Auto or Manual
Alarms	Standard Drive
Trend	R, Slow
Process Interlocks	Nil

Drive Name	Kiln Shoebrake Thruster No.2
Equipment Number	20KLN501K2
Drive Type	DOL
P&ID Number	6033-20-J-1002
Modes	Auto or Manual
Alarms	Standard Drive
Trend	R, Slow
Process Interlocks	Nil

Drive Name	Kiln Drive A Motor Cooling Fan
Equipment Number	20KLN501M
Drive Type	DOL
P&ID Number	6033-20-J-1002
Modes	Auto or Manual
Alarms	Standard Drive
Trend	R, Slow
Process Interlocks	Nil

Drive Name	Kiln Drive B Motor Cooling Fan
Equipment Number	20KLN501N
Drive Type	DOL
P&ID Number	6033-20-J-1002
Modes	Auto or Manual
Alarms	Standard Drive
Trend	R, Slow
Process Interlocks	Nil

Drive Name	Cooling Water Pump Duty
Equipment Number	20PPC502A
Drive Type	Soft Starter
P&ID Number	6033-20-J-1003
Modes	Auto or Manual
Alarms	Standard Drive with soft starter
Trend	R, I, Slow
Process Interlocks	Nil

Drive Name	Cooling Water Pump Standby
Equipment Number	20PPC502B
Drive Type	Soft Starter
P&ID Number	6033-20-J-1003
Modes	Auto or Manual
Alarms	Standard Drive with soft starter
Trend	R, I, Slow
Process Interlocks	Nil

Drive Name	Cooling Water Return Pump
Equipment Number	20PPC504
Drive Type	VSD
P&ID Number	6033-20-J-1006
Modes	Auto or Manual
Alarms	Standard Variable Speed Drive
Trend	R, I, MO, Moderate
Process Interlocks	Nil

Drive Name	Roasting Spillage Pump
Equipment Number	20PPS502
Drive Type	DOL
P&ID Number	6033-20-J-1002
Modes	Auto or Manual
Alarms	Standard Drive
Trend	R, Slow
Process Interlocks	Nil

Drive Name	Hot Screen
Equipment Number	20SN501
Drive Type	DOL
P&ID Number	6033-20-J-1004
Modes	Auto or Manual
Alarms	Standard Drive
Trend	R, I, Slow
Process Interlocks	Will trip 19FDS502 when Stopped

Drive Name	Water Cooling Treatment Unit
Equipment Number	20WTP501
Drive Type	Feeder
P&ID Number	6033-20-J-1003
Modes	Manual
Alarms	Standard Feeder
Trend	Nil
Process Interlocks	Nil

Drive Name	20CRJ501 Oil Circulation Pump
Equipment Number	20PPC505
Drive Type	DOL
P&ID Number	6033-20-J-1004
Modes	Auto or Manual
Alarms	Standard Drive
Trend	R, Slow
Process Interlocks	Will trip 20CRJ501 when Stopped

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	20-KLN-501 Off Gas Analysis Indicator			
Indicator Number	AI-20-5201			
P&ID Number	6033-20-J-1002			
Indicator Type	Field Indicator			
Range	0 – 30 % O_2			
Normal	5			
Alarms			L	LL
Values			3	1
Priorities			Control	Urgent
Process Interlocks	AALL will trip 20BUR501 (BMS) and 19FDS502			
Trend	Moderate			
Extras	Also measures CH_4, CO, CO_2, NO_2 and NO – hardwired to BMS			
Cascaded Loop	Nil			

Indicator Name	20CTR501 Discharge Flow			
Indicator Number	FI-20-5302			
P&ID Number	6033-20-J-1003			
Indicator Type	Field Indicator			
Range	0 - 65 m3/hr			
Normal	50			
Alarms	HH	H	L	LL
Values	62	57	12	5
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Nil			
Trend	Moderate			
Extras	Phase - Liquid / SG - 1			
Cascaded Loop	Nil			

Indicator Name	20HEX502 Cooling Water Return Flow			
Indicator Number	FI-20-5410			
P&ID Number	6033-20-J-1004			
Indicator Type	Field Indicator			
Range	0 - 60 m3/hr			
Normal	45			
Alarms	HH	H	L	LL
Values	55	50	10	5
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Nil			
Trend	Moderate			
Extras	Phase - Liquid / SG - 1			
Cascaded Loop	Nil			

Indicator Name	20KLN501B Current Indicator			
Indicator Number	II-20-5231			
P&ID Number	6033-20-J-1002			
Indicator Type	Field Indicator			
Range	0 – 1500			
Normal	730			
Alarms	HH	H	L	LL
Values	1300	1100	400	200
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	IAHH will trip 20KLN501B			
Trend	Slow			
Extras	Nil			
Cascaded Loop	Nil			

Indicator Name	20KLN501A Current Indicator			
Indicator Number	II-20-5233			
P&ID Number	6033-20-J-1002			
Indicator Type	Field Indicator			
Range	0 – 1500			
Normal	730			
Alarms	HH	H	L	LL
Values	1300	1100	400	200
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	IAHH will trip 20KLN501A			
Trend	Slow			
Extras	Nil			
Cascaded Loop	Nil			

Indicator Name	20FAN501A Current Indicator			
Indicator Number	II-20-5234			
P&ID Number	6033-20-J-1002			
Indicator Type	Field Indicator			
Range	0 – 100			
Normal	40			
Alarms	HH	H	L	LL
Values	80	65	20	10
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	IAHH will trip 20FAN501A			
Trend	Slow			
Extras	Nil			
Cascaded Loop	Nil			

Indicator Name	20PPC505 Speed Indicator			
Indicator Number	SI-20-5403			
P&ID Number	6033-20-J-1004			
Indicator Type	Field Indicator			
Range	0 – 100 %			
Normal	80			
Alarms	HH	H	L	LL
Values	95	90	20	10
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Nil			
Trend	Slow			
Extras	Nil			
Cascaded Loop	Nil			

Indicator Name	20FAN501A Bearing Temperature			
Indicator Number	TI-20-5208			
P&ID Number	6033-20-J-1002			
Indicator Type	Field Indicator			
Range	0 - 80°C			
Normal	60			
Alarms	HH	H	L	LL
Values	72	64	16	8
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	At TAHH will trip 20FAN501A			
Trend	Slow			
Extras	Nil			
Cascaded Loop	Nil			

Indicator Name	20KLN501 Temperature			
Indicator Number	TI-20-5227			
P&ID Number	6033-20-J-1002			
Indicator Type	Field Indicator			
Range	0 - 1300°C			
Normal	1100			
Alarms	HH	H	L	LL
Values	1250	1200	300	150
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Nil			
Trend	Moderate			
Extras	Pyrometer			
Cascaded Loop	Nil			

Indicator Name	20KLN501A Motor Winding Temperature			
Indicator Number	TI-20-5251			
P&ID Number	6033-20-J-1002			
Indicator Type	Field Indicator			
Range	0 - 80°C			
Normal	60			
Alarms	HH	H	L	LL
Values	75	70	15	10
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	TAHH will trip 20KLN501A			
Trend	Slow			
Extras	Nil			
Cascaded Loop	Nil			

Note: The above data relates to the following tags; TI-20-5251 to TI-20-5253

Indicator Name	20KLN501B Motor Winding Temperature			
Indicator Number	TI-20-5254			
P&ID Number	6033-20-J-1002			
Indicator Type	Field Indicator			
Range	0 - 80°C			
Normal	60			
Alarms	HH	H	L	LL
Values	75	70	15	10
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	TAHH will trip 20KLN501B			
Trend	Slow			
Extras	Nil			
Cascaded Loop	Nil			

Note: The above data relates to the following tags; TI-20-5254 to TI-20-5256

Indicator Name	20CTR501 Discharge Temperature			
Indicator Number	TI-20-5301			
P&ID Number	6033-20-J-1003			
Indicator Type	Field Indicator			
Range	0 - 45°C			
Normal	30			
Alarms	HH	H		
Values	40	35		
Priorities	Urgent	Control		
Process Interlocks	Nil			
Trend	Moderate			
Extras	Phase - Liquid / SG - 1			
Cascaded Loop	Nil			

Indicator Name	20KLN501 Discharge Temperature			
Indicator Number	TI-20-5401			
P&ID Number	6033-20-J-1004			
Indicator Type	Field Indicator			
Range	0 - 550°C			
Normal	400			
Alarms	HH	H	L	LL
Values	520	470	250	150
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Nil			
Trend	Slow			
Extras	Phase - Liquid / SG - 1			
Cascaded Loop	Nil			

Indicator Name	20-HEX-502 Cooling Water Temperature			
Indicator Number	TI-20-5409			
P&ID Number	6033-20-J-1004			
Indicator Type	Field Indicator			
Range	0 - 60°C			
Normal	45			
Alarms	HH	H	L	LL
Values	55	50	15	5
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Nil			
Trend	Slow			
Extras	Nil			
Cascaded Loop	Nil			

Indicator Name	20KLN501S53 Bearing Temperature			
Indicator Number	TI-20-5502			
P&ID Number	6033-20-J-1005			
Indicator Type	Field Indicator			
Range	0 - 80°C			
Normal	60			
Alarms	HH	H	L	LL
Values	72	64	16	8
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Nil			
Trend	Slow			
Extras	Nil			
Cascaded Loop	Nil			

Indicator Name	20KLN501S52 Bearing Temperature			
Indicator Number	TI-20-5504			
P&ID Number	6033-20-J-1005			
Indicator Type	Field Indicator			
Range	0 - 80°C			
Normal	60			
Alarms	HH	H	L	LL
Values	72	64	16	8
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Nil			
Trend	Slow			
Extras	Nil			
Cascaded Loop	Nil			

Indicator Name	20KLN501S54 Bearing Temperature			
Indicator Number	TI-20-5506			
P&ID Number	6033-20-J-1005			
Indicator Type	Field Indicator			
Range	0 - 80°C			
Normal	60			
Alarms	HH	H	L	LL
Values	72	64	16	8
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Nil			
Trend	Slow			
Extras	Nil			
Cascaded Loop	Nil			

Indicator Name	20KLN501S51 Bearing Temperature			
Indicator Number	TI-20-5508			
P&ID Number	6033-20-J-1005			
Indicator Type	Field Indicator			
Range	0 - 80°C			
Normal	60			
Alarms	HH	H	L	LL
Values	72	64	16	8
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Nil			
Trend	Slow			
Extras	Nil			
Cascaded Loop	Nil			

Indicator Name	20KLN501S43 Bearing Temperature			
Indicator Number	TI-20-5510			
P&ID Number	6033-20-J-1005			
Indicator Type	Field Indicator			
Range	0 - 80°C			
Normal	60			
Alarms	HH	H	L	LL
Values	72	64	16	8
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Nil			
Trend	Slow			
Extras	Nil			
Cascaded Loop	Nil			

Indicator Name	20KLN501S42 Bearing Temperature			
Indicator Number	TI-20-5512			
P&ID Number	6033-20-J-1005			
Indicator Type	Field Indicator			
Range	0 - 80°C			
Normal	60			
Alarms	HH	H	L	LL
Values	72	64	16	8
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Nil			
Trend	Slow			
Extras	Nil			
Cascaded Loop	Nil			

Indicator Name	20KLN501S44 Bearing Temperature			
Indicator Number	TI-20-5514			
P&ID Number	6033-20-J-1005			
Indicator Type	Field Indicator			
Range	0 - 80°C			
Normal	60			
Alarms	HH	H	L	LL
Values	72	64	16	8
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Nil			
Trend	Slow			
Extras	Nil			
Cascaded Loop	Nil			

Indicator Name	20KLN501S41 Bearing Temperature			
Indicator Number	TI-20-5516			
P&ID Number	6033-20-J-1005			
Indicator Type	Field Indicator			
Range	0 - 80°C			
Normal	60			
Alarms	HH	H	L	LL
Values	72	64	16	8
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Nil			
Trend	Slow			
Extras	Nil			
Cascaded Loop	Nil			

Indicator Name	20KLN501S33 Bearing Temperature			
Indicator Number	TI-20-5518			
P&ID Number	6033-20-J-1005			
Indicator Type	Field Indicator			
Range	0 - 80°C			
Normal	60			
Alarms	HH	H	L	LL
Values	72	64	16	8
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Nil			
Trend	Slow			
Extras	Nil			
Cascaded Loop	Nil			

Indicator Name	20KLN501S32 Bearing Temperature			
Indicator Number	TI-20-5520			
P&ID Number	6033-20-J-1005			
Indicator Type	Field Indicator			
Range	0 - 80°C			
Normal	60			
Alarms	HH	H	L	LL
Values	72	64	16	8
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Nil			
Trend	Slow			
Extras	Nil			
Cascaded Loop	Nil			

Indicator Name	20KLN501S34 Bearing Temperature			
Indicator Number	TI-20-5522			
P&ID Number	6033-20-J-1005			
Indicator Type	Field Indicator			
Range	0 - 80°C			
Normal	60			
Alarms	HH	H	L	LL
Values	72	64	16	8
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Nil			
Trend	Slow			
Extras	Nil			
Cascaded Loop	Nil			

Indicator Name	20KLN501S31 Bearing Temperature			
Indicator Number	TI-20-5524			
P&ID Number	6033-20-J-1005			
Indicator Type	Field Indicator			
Range	0 - 80°C			
Normal	60			
Alarms	HH	H	L	LL
Values	72	64	16	8
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Nil			
Trend	Slow			
Extras	Nil			
Cascaded Loop	Nil			

Indicator Name	20KLN501S23 Bearing Temperature			
Indicator Number	TI-20-5526			
P&ID Number	6033-20-J-1005			
Indicator Type	Field Indicator			
Range	0 - 80°C			
Normal	60			
Alarms	HH	H	L	LL
Values	72	64	16	8
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Nil			
Trend	Slow			
Extras	Nil			
Cascaded Loop	Nil			

Indicator Name	20KLN501S22 Bearing Temperature			
Indicator Number	TI-20-5528			
P&ID Number	6033-20-J-1005			
Indicator Type	Field Indicator			
Range	0 - 80°C			
Normal	60			
Alarms	HH	H	L	LL
Values	72	64	16	8
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Nil			
Trend	Slow			
Extras	Nil			
Cascaded Loop	Nil			

Indicator Name	20KLN501S24 Bearing Temperature			
Indicator Number	TI-20-5530			
P&ID Number	6033-20-J-1005			
Indicator Type	Field Indicator			
Range	0 - 80°C			
Normal	60			
Alarms	HH	H	L	LL
Values	72	64	16	8
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Nil			
Trend	Slow			
Extras	Nil			
Cascaded Loop	Nil			

Indicator Name	20KLN501S21 Bearing Temperature			
Indicator Number	TI-20-5532			
P&ID Number	6033-20-J-1005			
Indicator Type	Field Indicator			
Range	0 - 80°C			
Normal	60			
Alarms	HH	H	L	LL
Values	72	64	16	8
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Nil			
Trend	Slow			
Extras	Nil			
Cascaded Loop	Nil			

Indicator Name	20KLN501S13 Bearing Temperature			
Indicator Number	TI-20-5602			
P&ID Number	6033-20-J-1006			
Indicator Type	Field Indicator			
Range	0 - 80°C			
Normal	60			
Alarms	HH	H	L	LL
Values	72	64	16	8
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Nil			
Trend	Slow			
Extras	Nil			
Cascaded Loop	Nil			

Indicator Name	20KLN501S12 Bearing Temperature			
Indicator Number	TI-20-5604			
P&ID Number	6033-20-J-1006			
Indicator Type	Field Indicator			
Range	0 - 80°C			
Normal	60			
Alarms	HH	H	L	LL
Values	72	64	16	8
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Nil			
Trend	Slow			
Extras	Nil			
Cascaded Loop	Nil			

Indicator Name	20KLN501S14 Bearing Temperature			
Indicator Number	TI-20-5606			
P&ID Number	6033-20-J-1006			
Indicator Type	Field Indicator			
Range	0 - 80°C			
Normal	60			
Alarms	HH	H	L	LL
Values	72	64	16	8
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Nil			
Trend	Slow			
Extras	Nil			
Cascaded Loop	Nil			

Indicator Name	20KLN501S11 Bearing Temperature			
Indicator Number	TI-20-5608			
P&ID Number	6033-20-J-1006			
Indicator Type	Field Indicator			
Range	0 - 80°C			
Normal	60			
Alarms	HH	H	L	LL
Values	72	64	16	8
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Nil			
Trend	Slow			
Extras	Nil			
Cascaded Loop	Nil			

Indicator Name	20KLN501 Axial Position			
Indicator Number	ZI-20-5222			
P&ID Number	6033-20-J-1002			
Indicator Type	Field Indicator			
Range	0 – 100%			
Normal	50			
Alarms	HH	H	L	LL
Values	90	80	20	10
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	ZAL will start 20KLN501J, ZAH will stop 20KLN501J			
Trend	Slow			
Extras	ZSH205223 and ZSL250224 are protection if ZT205222 fails			
Cascaded Loop	Nil			

4.2 Status Indicators

The following are the status indicators in this area:

Status Name	Cooling Water Pump Selection
Status Number	HS-20-5303
P&ID Number	6033-20-J-1003
States	1 = 20PPC502B, 0 = 20PPC502A
Indication	HS-20-5303 and selection to be visible on DCS
Process Interlocks	Will send Start/Stop signal and controller outputs to selected pump
Extras	Nil

Status Name	20HEX502 Oil Flow
Status Number	FSL-20-5418
P&ID Number	6033-20-J-1004
States	1 = Healthy, 0 = FAL
Indication	FAL-20-5418
Process Interlocks	Will trip 20PPC505 if active for >2mins
Extras	Nil

5.0 AUTOMATIC VALVES

5.1 ON/OFF Service

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

Valve Name	20CHU504 Diverter Gate
Valve Number	FV-205414
Valve Modes	Auto or Manual
P&ID Number	6033-19-J-1004
Process Interlocks	Nil
Fail Position	Last
Indication	Open, Closed
Extras	Pneumatic ram - Open position directs calcine to 20CRJ501

6.0 CONTROL LOOPS

The following are the control loops for the area:

Loop Name	20-TNK-506 Level			
Loop Input	LT-20-5609			
P&ID Number	6033-20-J-1006			
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 20PPC504			
Trend	PV, SP & OP, Fast			
Loop Output	0 - 100 %	SC-20-5610		
Action	Direct			
Loop Tuning	Slow			
Extras	Nil			
Cascaded Loop	Nil			

Loop Name	20CRJ501 Oil Temperature			
Loop Input	TT-20-5408			
P&ID Number	6033-20-J-1004			
Loop Type	STD PID Loop			
Modes	Auto & Manual			
Range	0 - 80 deg C			
Normal	60			
Alarms	HH	H	L	LL
Values	72	64	16	8
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	TAHH will trip 20CRJ501			
Trend	PV, SP & OP, Fast			
Loop Output	0 - 100 %	TCV-20-5409		
Action	Direct			
Loop Tuning	Slow			
Extras	Nil			
Cascaded Loop	Nil			

Loop Name	20BUR501 Flame Control			
Loop Input	TT-20-5			
P&ID Number	6033-20-J-1002			
Loop Type	STD PID Loop			
Modes	Auto & Manual			
Range	0 - 500 deg C			
Normal	400			
Alarms	HH	H	L	LL
Values	480	450	150	100
Priorities	Urgent	Control	Control	Urgent
Process Interlocks				
Trend	PV, SP & OP, Slow			
Loop Output	0 - 100 %			
Action	Reverse			
Loop Tuning	Slow			
Extras	Nil			
Cascaded Loop	Nil			

7.0 CALCULATION BLOCKS

There are no calculation blocks in this area.

8.0 FUNCTIONAL PREREQUISITES

The operation of the Area requires the following upstream/downstream areas of the plant to be operational:

Area	System	Associated Drawing	Associated Control Philosophy
19	Kiln Off Gas	6033-19-J-1002	6033-G-00-F-006
25	Leach Vats	6033-25-J-1002	6033-G-00-F-008

9.0 STARTUP/SHUTDOWN

9.1 Cooling water system

Local Prerequisites

No.	TAG No.	Equip. No.	Description	Status
1			Plant services available	HEALTHY
2			All drives in start sequence available	HEALTHY
3			Drain valve 25V1301	CLOSED
4		20PPC502A	Duty pump suction/discharge valves	OPEN
5			Set pump bleed valve (100V1721)	OPEN/SET
6			Cooling water valves to bearing stations	OPEN

Start Sequence

Prerequisite	Step No.	Description
LAL205609 Not Energised	1	Set cooling water return pump (20PPC504) to AUTO and Start
Step 1	2	Set cooling tower (20CTR501) to AUTO and Start
	3	Start 20WTP501
Step 2	4	Set duty cooling water pump (20PPC502A/B) to AUTO and Start

Stop Sequence

Prerequisite	Step No.	Description
	1	Stop duty cooling water pump (20PPC502A/B)
	2	Stop kiln cooling tower (20CTR501)
	3	Stop cooling water return pump (20PPC504)
	4	Stop 20WTP501

Note - Cooling water return pump will interlock when the cooling water return tank reaches a Low Level (LAL205609).

9.2 Calcine handling system

Local Prerequisites

No.	TAG No.	Equip. No.	Description	Status
1			Plant services available	HEALTHY
2			All drives in start sequence available	HEALTHY
3		20PPC502A/B	Cooling water pump	RUNNING
4			Hot screen diverter gate	HEALTHY
5		25PPC513A/B	Leach Vat Recycle Pump	RUNNING

Start Sequence

Prerequisite	Step No.	Description
	1	Set bucket elevator (20BE501) to AUTO and Start
Step 1	2	Set drag chain conveyor (20CVR501) to AUTO and Start
	3	Set jaw crusher oil circulation pump (20PPC505) to AUTO and Start
Step 2	4	Set jaw crusher (20CRJ501) to AUTO and Start
	5	Position diverter gate to direct calcine to crusher (ZSO energised)
Step 4	6	Set hot calcine screen (20SN501) to AUTO and Start

Note – never stop oil pump.

Stop Sequence

Prerequisite	Step No.	Description
	1	Stop hot calcine screen (20SN501)
Step 1	2	Change diverter gate position over (ZSC Energised)
Step 2	3	Stop jaw crusher (20CRJ501)
Step 3	4	Stop drag chain conveyor (20CVR501)
Step 4	5	Stop bucket elevator (20BE501)

9.3 Kiln

Local Prerequisites

No.	TAG No.	Equip. No.	Description	Status
1			Plant services available	HEALTHY
2			All drives in start sequence available	HEALTHY
3			Cooling water system	OPERATING
4			Calcine handling Area	OPERATING
5		20KLN501 C1/C2	Barring gear	NOT ENGAGED

Start Sequence

Prerequisite	Step No.	Description
	1	Set kiln drive gear lube pumps (20KLN501D/E) to AUTO and Start
	2	Set kiln main girth cooling/lube (20KLN501R) to AUTO and Start
	3	Set kiln drive lube and cooling units (20KLN501G/H) to AUTO and Start
	4	Set kiln drive motor cooling fans (20KLN501M/N) to AUTO and Start
	5	Set burner tunnel cooling fans (20FAN503A/B) to AUTO and Start
	6	Stop barring drive (20KLN501C1/C2)
	7	Set kiln main drives (20KLN501A/B) to AUTO @ 0.8rpm speed set point and Start
	8	Ensure Kiln ID fan (19FAN501) is running
	9	Set kiln primary air fan (20FAN501) to AUTO and Start
	10	Start Burner Management System (see 9.3.1)
	11	Start kiln feed sequence

Note: This sequence is only relevant for a hot restart of the kiln. If the kiln has been shut down for a long period of time the operator will need to perform a manual restart which will allow for ramp up in temperature over a set time period.

Stop Sequence

Prerequisite	Step No.	Description
	1	Stop kiln feed
	2	Stop burner
Step 2	3	Stop pilot burner
Step 3	4	Stop kiln main drives (20KLN501A/B)
Step 4	5	Start kiln barring drive (20KLN501C1/C2)
Step 4	6	Stop kiln drive motor cooling fans (20KLN501M/N)
Step 4	7	Stop kiln drive lube and cooling units (20KLN501G/H)
Step 4	8	Stop kiln drive gear lube pumps
Step 4 + time delay	9	Stop burner tunnel cooling fans (20FAN503A/B)
Step 4 + time delay	10	Stop kiln primary air fan (20FAN501)

9.3.1 Burner Management System (20KLN501P/Q)

Start Sequence

Prerequisite	Step No.	Description
	1	Reset all BMS alarms (HS205738)
Step 1	2	Start kiln purge (HS205732)
Step 2	3	Signal received from BMS that purge is complete (YI205733)
Step 3	4	Start pilot burner (HS205734)
Step 4	5	Signal received from BMS that pilot burner is on (YI205735)
Step 5	6	Start main burner (HS205736)
Step 6	7	Signal received from BMS that main burner is on (YI205737)