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MIDWEST VANADIUM PTY LTD

WINDIMURRA VANADIUM PROJECT
AREA 41- V2O3 PRODUCTION CONTROL PHILOSOPHY

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1.0 PROCESS DESCRIPTION

Reference P&ID: (6033-41-J-1001, 6033-41-J-1002, 6033-41-J-1003)

1.1 Reduction Kilns

The dried AMV produced is transferred to the two V_2O_3 reactors (41KLN501, 502).

AMV is discharged from the air slide (36ASL502) outlet via the rotary valves (36ROV505, 506) to the reduction kilns buffer silos (41BIN501, 502) ahead of the reduction kilns (41KLN501, 502). The reduction kiln buffer silos are vented to the AMV silo. The AMV, from the buffer silos, is transferred to the kiln via screw feeders (41FDS501, 503), which double as an air seal to the kiln.

The reduction kilns are identical and each has a nameplate capacity of 14 t/d V_2O_3 giving an annual capacity of 10,465 tons V_2O_5 equivalent. The kilns consist of an externally gas fired rotating tube within a muffle furnace. The rotary tube is heated to 900 C from the outside by six natural gas burners. In the kiln, solid AMV disassociates into V_2O_5, nitrogen gas and hydrogen gas. The hydrogen gas reduces the V_2O_5 to V_2O_3. The V_2O_3 produced, in actual fact, has a chemical composition of approximately $V_2O_{3.6}$. The V_2O_3 discharges from the tube via gas tight water cooled screw (41FDS502, 504) and transferred to the V_2O_3 silo for storage and future ferrovanadium processing. The cooled water screw lowers the temperature of the V_2O_3 to prevent the oxidation to V_2O_5.

The venting system for the tube is co-current flow with the off-gas and any entrained dust leaving the system at the discharge end of the reduction kiln. Off gas from the two reactors are combined before cleaning in the scrubbing circuit. The kiln operates under a slight positive pressure (50 Pa) protected by specialized and proven dust/gas seals to prevent the ingress of air. This seal is one of the key fundamental designs of the plant which ensures the reduction process is controlled and that maximum conversion of AMV to V_2O_3 is achieved.

Maintaining a seal on the reduction kilns is of paramount importance due to the low melting temperature of V_2O_5. it is imperative that a reducing atmosphere is maintained within the reduction kilns. Introduction of air or other oxidising substances may lead to the production of V_2O_5 which will melt in the kiln and consequently 'cut' through the stainless steel shell.

The combusted natural gas, from each set of kiln burners, is vented to separate stacks (41STK501, 502).

V_2O_3 discharges the kiln via a cooling screw feeder (41FDS502, 41FDS504) and rotary valve (41ROV502, 504). Cooling of the V_2O_3 to below the 120 C prevents the oxidation of the V_2O_3 to V_2O_5. Cooling water is provided via a 5 MW evaporative cooling tower serving the entire vanadium processing plant.

Start up of the reactors requires nitrogen purging of the rotating tube to eliminate V_2O_3 reacting with oxygen and the steel alloy of the reactors until the process becomes self sustaining through generation of its own reducing atmosphere.

1.2 Reduction Kiln Off Gas Scrubbing

The Off gas Scrubbing system is designed to remove dust and ammonia vapours in the Reduction Furnace Offgas before it is released to atmosphere. An acidified barren liquor solution is used to scrub the gas, producing a barren stream fortified with ammonium sulphate which is recirculated through the Scrubber by the recirculation pumps.

The off gas from the reduction kilns is drawn through a bag filter (41DEX501) to remove entrained vanadium bearing solids from the gas stream ahead of the scrubbing tower (41SBR502). Recovered V_2O_3 from the bag filter is discharged to the slurry tank (41TNK501) to which barren solution is added in a semi batch process. This slurry is transferred back to first precipitation tank (35TNK502) to ensure all vanadium is recovered.

Off gas from the Reduction kilns enters the Off gas Scrubber, (41SBR502), and is quenched by a spray of recirculated barren liquor. This step both cools the gas and removes the bulk of the ammonia. The cooled gas then passes through two separate scrubbing stages, each fed by separate recirculating barren liquor streams. In the first scrubbing stage, liquor is recirculated through the lower half of the column, via the First Stage Recirculation Pumps, (41PPC505). The gas then passes into the second scrubbing stage, where liquor is recirculated through the top section of the column via the Second Stage Recirculation Pumps, (41PPC507). These two recirculating streams are separated within the Scrubber by chimneys allowing only gas to pass through.

The pH of both recirculating streams is measured via dedicated pH pots. The pH in the first stage recirculation is controlled to a pH of 6.8 by injecting concentrated sulphuric acid into the system, via an acid mixing tee, (41MXR501). The sulphuric acid is injected at the discharge of the Second Stage Recirculation Pumps, (41PPC507), thus the final scrubbing stage has the lowest pH and serves as a polishing stage, operating at 2-3 g/l free sulphuric acid.

To prevent the accumulation of ammonium sulphate in the system, a constant barren liquor purge stream is pumped by the Bleed Pump, (41PPC504). The purge is taken from the first stage recirculation at the base of the scrubber as this has the highest dissolved solids concentration and lowest free acid, i.e. a pH of approximately 6.8. This solution sent back to the precipitation circuit to maximise recovery.

The liquid level at base of the Scrubber is automatically controlled via the addition of fresh barren liquor into the system. The barren liquor is fed into the suction of the Second Stage Recirculation Pumps (41PPC507).

The top section of the Scrubber is fitted with a demister, which eliminates droplet entrainment into the outlet vapour. A wash manifold is provided to routinely wash the demister. Cleaned vapour discharges from the top of the Scrubber to the Scrubber ID Fans, (41FAN503), and to atmosphere via the stack.

A safety shower (41SHS501) is supplied with this area of the plant.

2.0 CONTROL PHILOSOPHY

2.1 Reduction Kilns

There are two reduction kilns in the V_2O_3 production area, for simplicity only kiln line 1 will be explained. Kiln line 2 is identical to kiln line 1 in all ways except pipe, valve, instrument and equipment numbering.

2.1.1 Kiln Feed

The reduction kiln buffer silo (41BIN501) is equipped with level (LE415101) indication and level switches alarmed at high (LAH415137), low (LAL415138) and low low (LALL415139) levels. The low level alarm initiates the transfer of AMV from the AMV silo via the air slide whist the high level alarm stops to transfer sequence. AMV from the flash drying is fed into the reduction kiln buffer silo (41BIN501) on a batch basis. The low low alarm interlocks the operation of the discharge screw to ensure the screw (41FDS501) is fully submerged to prevent the ingress of air into the reduction kiln.

The buffer silo is positioned on load cells to give an indication of weight in the bin and the mass flow of AMV withdrawn from the bin via the discharge screw feeder. The discharge screw is variable speed (SC415136) and the speed of the screw is controlled (HIC415102) to a mass flow set point. When the level in the silo falls to the low level (LAL415138), the speed of the screw is held constant to enable the silo refill sequence to be initiated. When the level in the bin reaches the high level (LAH415137), the level switch energises and this initiates the automatic control of the discharge screw to maintain the mass flow set point.

2.1.2 Kiln Purging

Approximately 40 Nm^3 of industrial grade nitrogen is injected into the feed screw at start-up or after long period of downtime, to purge the system of oxygen and prevent the generation of V_2O_5 upon start up of the reduction kiln. The nitrogen line is fitted with flow indication (FE505933), a normalised flow totalizer (FQ505933) and an actuated valve (FV505934). The plant will space provision for 3 nitrogen packs, each containing 227 Nm^3 of nitrogen providing enough capacity for approximately 16 purges of the reduction kiln, assuming no other nitrogen use.

2.1.3 Kiln Operation

The reduction kiln is fitted with 6 optical pyrometers (TE415103/105/107 and TE415131/133/135) each with back up thermocouples (TE415104/106/108 and TE415132/134). The kiln is divided into 3 sections to which temperatures are controlled. Section 1 (feed end) is controlled to 750°C, Section 2 (middle section) is controlled to 900°C and Section 3 (discharge end) is controlled to 920°C. The temperatures in each section of the kiln are controlled by varying fuel and air to the burners. This is managed by the burner management system.

The Kiln is operated at a slight positive pressure to prevent air leaking in. The pressure is maintained through the generation gases due to the reduction reactions. The pressure of the kilns is controlled (PIC415305) to a setpoint by a damper prior to the baghouse and wet scrubber. In the event of a low pressure the air dilution damper (41DA503) will fully open to prevent air being drawn through the reduction kiln seals.

2.1.4 Burner Management System

To be supplied by Thermal Systems

2.1.5 Kiln Product Handling

The kiln discharges into the discharge hood of the kiln which is fitted with a low and high level switches (LSH/LSL415110) and alarms. The discharge hood of the kiln choke feeds the reduction kiln discharge screw, which is fitted with an under speed switch (USS415116) to indicate any problems with the motor or shaft.

The kiln seal is fitted with a cooling water jacket, with the cooling water return temperature monitored (TE415111) and cooling water feed is fitted with and Hand valve (HV415114).

The screw discharges to a rotary valve which maintains a seal to the kiln. The rotary valve is also fitted with an under speed switch (USS415127). The screw is fitted with a cooling water system, with temperature indication (TI415140) and a low flow alarm on the cooling water return line to indicate loss of cooling water or potential problems in the line.

A temperature indicator is fitted between the cooling screw and rotary valve to indicate the performance of the cooling screw and will alarms before the product reaches temperatures that may damage the rotary valve.

The rotary valve discharges to the reduction kiln product bin which is fitted with level indication (LE415216) and load cells (WE415217A/B/C). Both reduction kilns discharge to a single product bin (41BIN504).

2.2 Reduction Kiln Off Gas Scrubbing

2.2.1 Dust Scrubbing

The off gas from the reduction kilns enters the scrubbing system via individual lines each fitted with dampers (41DA501, 41DA502). The dampers are used to maintain a slight positive pressure within each reduction kiln, despite a suction being applied via the exhaust fan.

The reduction kiln off gas streams are fitted with pressure indication (PIC415305, PIC415304 for reduction kilns 1 and 2 respectively). Each kiln off gas is fed to the baghouse (41DEX501) through separate ducts which are be operated by dampers (PCV415305, PCV415304). Both off gas streams are combined and the temperature of the gas entering the scrubber is fitted with temperature indication (TIC415301) which controls the addition of dilution air (TCV415301) to ensure no damage occurs to the baghouse.

The gas then enters the V_2O_3 baghouse (41DEX501) equipped with high temperature bags. The baghouse operates by reverse pulsing air through the filter bags to remove particulate on a continuous timed cycle. The baghouse is fitted with differential pressure indication (PDI415302) alarmed at a high differential pressure to indicate that the bags may be blocked. A level switch (LSH415303) mounted in the collection hopper is alarmed at a high level (LAH415303).

The solids that are collected in the hopper are discharged to the slurry tank (41TNK501) via a fixed speed rotary valve (41ROV505) fitted with an under speed switch (USS415311) to alarm for failure of the drive.

The slurry tank operates in a semi-batch process utilising barren solution to slurry the dust collected. The slurry tank is fitted with continuous level indication three inlet lines, an outlet line and a recirculation line. The slurry system works on a timed sequence cycling through purge and recirculation cycles. For the operating cycle of the slurry tank see Dust slurry system.

2.2.2 Dust Slurry System

The slurry from the baghouse is fed to the slurry tank via a rotary valve, where it is then slurried and discharged in semi batch cycle. The operation of the dust slurry system is as follows.

1. The slurry tank is filled for a time period or until LAH415306 is activated.
2. Tank is put into recirculation for a set time period
3. Slurry is discharged for a set time or until LAL415306 is activated
4. Tank begins filling again after a time period or when LAL415306 is activated.

The sequencing of the slurry system is available in the section _____.

2.2.3 Gas Scrubbing

This information is an interpretation of vendor data and is provided as information only. The Vendor Document *C50-102 PROCESS OPERATING MANUAL* and *C50-145 FUNCTIONAL SPECIFICATION* should be used as the official reference documentation for the gas scrubber in area 41.

The gas that exits the V_2O_3 baghouse feeds directly into the scrubbing tower. The scrubbing tower is a vertical type scrubber equipped with a single demister pad, two stages of solution recirculation and pH control. The scrubbing tower is designed to recover ammonia from the gas stream by contacting the gas stream with acidic scrub solution to produce ammonium sulphate.

The demister wash water supply is controlled on a timed basis (KS415310) and operates on a on/off cycle. The CCR operator has the flexibility to adjust the wash timers for each spray system through the OIS. A flow meter (FE415312) fitted to the spray system alarms (FAL415312) for a low flow condition to indicate a lack of raw water supply or possibly blocked spray nozzles.

The scrubbing tower is equipped with level control (LIC415309) to regulate the makeup of barren solution to the scrubber via a level control valve (LCV415309).

The scrubbing tower incorporates two separate stages of solution recirculation.

The first stage recirculation pump (41PPC505) transfers scrub solution from bottom of the scrubbing tower to the middle of the tower. The pump discharge is equipped with a flow element (FE415316) to give an instantaneous readout of

volumetric flow. A portion of the circulating scrub solution flow is directed to a separate vessel fitted with pH (AE415315) measured. The pH element (AE415315) measures the acidity of the scrub solution and the pH controller (AIC415315) controls the operation of the acid dosing valve (ACV415320) to maintain the operator input pH set point. Concentrated sulphuric acid is dosed directly into the second stage recirculation scrub solution via an acid mixing tee (41MXR501).

The second stage recirculation pump (41PPC506) transfers scrub solution from the middle of the scrubbing tower to the top of the tower. A portion of the scrub solution is directed to a separate vessel fitted with a pH element (AE415314) to give an indication (AI415314) of acidity in the middle section of the scrubber.

Scrub solution is bled from the tower via the scrubber bleed pump (41PPC504) to maintain an ammonium sulphate concentration of approximately 300 g/L. The scrubber bleed pump is fixed speed and the flow rate of the scrubber bleed is controlled (FIC415318) to an operator input set point for flow rate by a control valve (FCV415318).

The gas from the scrubbing tower exits out the V_2O_3 scrubber stack which is fitted with an opacity monitor (AE415322).

3.0 EQUIPMENT

The following are the drives in this area:

Drive Name	Reduction Kiln 1 Gas Burner
Equipment Number	41BUR501
Drive Type	Feeder
P&ID Number	6033-41-J-1001
Modes	Auto or Manual
Alarms	Standard Drive
Trend	R, Fast
Process Interlocks	Will trip 41FDS501when stopped

Drive Name	Reduction Kiln 2 Gas Burner
Equipment Number	41BUR502
Drive Type	Feeder
P&ID Number	6033-41-J-1002
Modes	Auto or Manual
Alarms	Standard Drive
Trend	R, Fast
Process Interlocks	Will trip 41FDS503 when stopped

Drive Name	Extraction Fan
Equipment Number	41FAN503
Drive Type	DOL
P&ID Number	6033-41-J-1003
Modes	Auto or Manual
Alarms	Standard Drive
Trend	R, I, MO, Fast
Process Interlocks	Will trip 41BUR501 and 41BUR502 when stopped

Drive Name	Reduction Kiln 1 Buffer Silo Discharge Screw
Equipment Number	41FDS501
Drive Type	VSD
P&ID Number	6033-41-J-1001
Modes	Auto or Manual
Alarms	Standard Drive
Trend	R, I, MO, Fast
Process Interlocks	Will trip 41FDS502 when stopped

Drive Name	Reduction Kiln 1 Discharge Screw
Equipment Number	41FDS502
Drive Type	VSD
P&ID Number	6033-41-J-1001
Modes	Auto or Manual
Alarms	Standard Drive
Trend	R, I, MO, Fast

Process Interlocks	HOLD

Drive Name	Reduction Kiln 2 Buffer Silo Discharge Screw
Equipment Number	41FDS503
Drive Type	VSD
P&ID Number	6033-41-J-1002
Modes	Auto or Manual
Alarms	Standard Drive
Trend	R, I, MO, Fast
Process Interlocks	HOLD

Drive Name	Reduction Kiln 2 Discharge Screw
Equipment Number	41FDS504
Drive Type	VSD
P&ID Number	6033-41-J-1002
Modes	Auto or Manual
Alarms	Standard Drive
Trend	R, I, MO, Fast
Process Interlocks	HOLD

Drive Name	Reduction Kiln 1 Main / Standby Drive
Equipment Number	41KLN501A / B
Drive Type	DOL
P&ID Number	6033-41-J-1001
Modes	Auto or Manual
Alarms	Standard Drive
Trend	R, I, Slow
Process Interlocks	HOLD

Drive Name	Reduction Kiln 2 Main / Standby Drive
Equipment Number	41KLN502A / B
Drive Type	DOL
P&ID Number	6033-41-J-1002
Modes	Auto or Manual
Alarms	Standard Drive
Trend	R, I, Slow
Process Interlocks	HOLD

Drive Name	Slurry Pump
Equipment Number	41PPC502
Drive Type	DOL
P&ID Number	6033-41-J-1003
Modes	Auto or Manual
Alarms	Standard Drive
Trend	R, I, Slow
Process Interlocks	HOLD

Drive Name	Scrubber Bleed Pump
Equipment Number	41PPC504
Drive Type	DOL
P&ID Number	6033-41-J-1003
Modes	Auto or Manual
Alarms	Standard Drive
Trend	R, I, Slow
Process Interlocks	Nil

Drive Name	1st Stage Recirculation Pump
Equipment Number	41PPC505
Drive Type	DOL
P&ID Number	6033-41-J-1003
Modes	Auto or Manual
Alarms	Standard Drive
Trend	R, I, Slow
Process Interlocks	Will set AIC415315 to Manual at 0 when stopped and will trip 41PPC504

Drive Name	2nd Stage Recirculation Pump
Equipment Number	41PPC506
Drive Type	DOL
P&ID Number	6033-41-J-1003
Modes	Auto or Manual
Alarms	Standard Drive
Trend	R, I, Slow
Process Interlocks	Will set AIC415315 to Manual at 0 when stopped and will trip 41PPC504

Drive Name	Reduction Kiln 1 Discharge Rotary Valve
Equipment Number	41ROV502
Drive Type	DOL
P&ID Number	6033-41-J-1001
Modes	Auto or Manual
Alarms	Standard Drive
Trend	R, Slow
Process Interlocks	HOLD

Drive Name	Reduction Kiln 2 Discharge Rotary Valve
Equipment Number	41ROV504
Drive Type	DOL
P&ID Number	6033-41-J-1002
Modes	Auto or Manual
Alarms	Standard Drive
Trend	R, Slow
Process Interlocks	HOLD

Drive Name	V2O3 Scrubber Filter Rotary Valve
Equipment Number	41ROV505
Drive Type	DOL
P&ID Number	6033-41-J-1003
Modes	Auto or Manual
Alarms	Standard Drive
Trend	R, Slow
Process Interlocks	HOLD

Drive Name	Reduction Kiln Product Bin Rotary Valve
Equipment Number	41ROV508
Drive Type	VSD
P&ID Number	6033-41-J-1002
Modes	Auto or Manual
Alarms	Standard Drive
Trend	R, I, MO, Fast
Process Interlocks	Nil

Drive Name	Reduction Kiln 1 Buffer Silo
Equipment Number	41BIN501
Drive Type	N/A
Alarms	LAL/LAH415101, WAL/WAH415102
Start/Stop	DCS
Process Interlocks (soft)	

Drive Name	Reduction Kiln 1 Buffer Silo Discharge Screw
Equipment Number	41FDS501
Drive Type	Variable Speed (SC415136)
Alarms	TBA
Start/Stop	DCS
Process Interlocks (soft)	LAL415101
	WAL415102

Drive Name	AMV Reduction Kiln 1
Equipment Number	41KLN501
Drive Type	N/A
Alarms	PAL/PAH415109, LAH415110, TAL/TAH415111
Start/Stop	DCS
Process Interlocks (soft)	

Drive Name	Reduction Kiln 1 Gas Burners
Equipment Number	41BUR501A
Drive Type	

Drive Name	Reduction Kiln 1 Gas Burners
Equipment Number	41BUR501A
Alarms	TAL/TAH415103
Start/Stop	DCS
Process Interlocks (soft)	

Drive Name	Reduction Kiln 1 Gas Burners
Equipment Number	41BUR501B
Drive Type	
Alarms	TAL/TAH415104, TAL/TAH415131
Start/Stop	DCS
Process Interlocks (soft)	

Drive Name	Reduction Kiln 1 Gas Burners
Equipment Number	41BUR501C
Drive Type	
Alarms	TAL/TAH415105, TAL/TAH415132
Start/Stop	DCS
Process Interlocks (soft)	

Drive Name	Reduction Kiln 1 Gas Burners
Equipment Number	41BUR501D
Drive Type	
Alarms	TAL/TAH415106, TAL/TAH415133
Start/Stop	DCS
Process Interlocks (soft)	

Drive Name	Reduction Kiln 1 Gas Burners
Equipment Number	41BUR501E
Drive Type	
Alarms	TAL/TAH415107, TAL/TAH415134
Start/Stop	DCS
Process Interlocks (soft)	

Drive Name	Reduction Kiln 1 Gas Burners
Equipment Number	41BUR501F
Drive Type	
Alarms	TAL/TAH415108, TAL/TAH415135
Start/Stop	DCS
Process Interlocks (soft)	

Drive Name	Reduction Kiln 1 Main Drive
Equipment Number	41KLN501A
Drive Type	Variable Speed
Alarms	TBA

Drive Name	Reduction Kiln 1 Main Drive
Equipment Number	41KLN501A
Start/Stop	DCS
Process Interlocks (soft)	

Drive Name	Reduction Kiln 1 Stand by Drive
Equipment Number	41KLN501B
Drive Type	Variable Speed
Alarms	TBA
Start/Stop	DCS
Process Interlocks (soft)	

Drive Name	Reduction Kiln 1 Discharge Rotary Valve
Equipment Number	41ROV502
Drive Type	Variable Speed
Alarms	USA415127
Start/Stop	DCS
Process Interlocks (soft)	41FDS502

Drive Name	Reduction Kiln1 Discharge Screw
Equipment Number	41FDS502
Drive Type	Variable Speed
Alarms	USA415116, TAL/TAH415140
Start/Stop	DCS
Process Interlocks (soft)	41KLN501A
	41KLN501B

Drive Name	Reduction Kiln 2 Buffer Silo
Equipment Number	41BIN502
Drive Type	N/A
Alarms	LAL/LAH415201, WAL/WAH415202
Start/Stop	DCS
Process Interlocks (soft)	

Drive Name	Reduction Kiln 2 Buffer Silo Discharge Screw
Equipment Number	41FDS503
Drive Type	Variable Speed (SC455221)
Alarms	TBA
Start/Stop	DCS
Process Interlocks (soft)	LAL415201
	WAL415202

Drive Name	Reduction Kiln 2
Equipment Number	41KLN502
Drive Type	N/A
Alarms	PAL/PAH415209, LAH415228, TAL/TAH415210
Start/Stop	DCS
Process Interlocks (soft)	

Drive Name	Reduction Kiln 2 Gas Burner
Equipment Number	41BUR502A
Drive Type	
Alarms	TAL/TAH415203
Start/Stop	DCS
Process Interlocks (soft)	

Drive Name	Reduction Kiln 2 Gas Burner
Equipment Number	41BUR502B
Drive Type	
Alarms	TAL/TAH415204, TAL/TAH415223
Start/Stop	DCS
Process Interlocks (soft)	

Drive Name	Reduction Kiln 2 Gas Burner
Equipment Number	41BUR502C
Drive Type	
Alarms	TAL/TAH415205, TAL/TAH415224
Start/Stop	DCS
Process Interlocks (soft)	

Drive Name	Reduction Kiln 2 Gas Burner
Equipment Number	41BUR502D
Drive Type	
Alarms	TAL/TAH415206, TAL/TAH415225
Start/Stop	DCS
Process Interlocks (soft)	

Drive Name	Reduction Kiln 2 Gas Burner
Equipment Number	41BUR502E
Drive Type	
Alarms	TAL/TAH415207, TAL/TAH415226
Start/Stop	DCS
Process Interlocks (soft)	

Drive Name	Reduction Kiln 2 Gas Burner
Equipment Number	41BUR502F
Drive Type	
Alarms	TAL/TAH415208, TAL/TAH415227
Start/Stop	DCS
Process Interlocks (soft)	

Drive Name	Reduction Kiln 2 Main Drive
Equipment Number	41KLN502A
Drive Type	Variable Speed
Alarms	TBA
Start/Stop	DCS
Process Interlocks (soft)	

Drive Name	Reduction Kiln 2 Stand By Drive
Equipment Number	41KLN502B
Drive Type	Variable Speed
Alarms	TBA
Start/Stop	DCS
Process Interlocks (soft)	

Drive Name	Reduction Kiln 2 Discharge Rotary Valve
Equipment Number	41ROV504
Drive Type	Variable Speed
Alarms	USA415231
Start/Stop	DCS
Process Interlocks (soft)	41FDS504

Drive Name	Reduction Kiln 2 Discharge Screw
Equipment Number	41FDS504
Drive Type	Variable Speed
Alarms	USA415234, TAL/TAH415242
Start/Stop	DCS
Process Interlocks (soft)	41KLN502A
	41KLN502B

Drive Name	Reduction Kiln Product Dust Filter
Equipment Number	41DEX504
Drive Type	Fixed Speed (On/Off)
Alarms	PDAH415235
Start/Stop	DCS
Process Interlocks (soft)	PDAH415235

Drive Name	Reduction Kiln Product Bin
Equipment Number	41BIN504
Drive Type	N/A
Alarms	LAL/LAH415216, WAL/WAH415217, LAL415236
Start/Stop	N/A
Process Interlocks (soft)	

Drive Name	Reduction Kiln Product Bin Rotary Valve
Equipment Number	41ROV508
Drive Type	Variable Speed (SC415220)
Alarms	USA415232
Start/Stop	DCS
Process Interlocks (soft)	LAL415236

Drive Name	V_2O_3 Scrubber Baghouse
Equipment Number	41DEX501
Drive Type	N/A
Alarms	PDAH415302, TAH415301, LAH415303
Start/Stop	DCS
Process Interlocks (soft)	PDAH415302

Drive Name	V_2O_3 Scrubber Filter Rotary Valve
Equipment Number	41ROV505
Drive Type	Variable Speed (SC415323)
Alarms	USA415311
Start/Stop	DCS
Process Interlocks (soft)	LAH415306

Drive Name	Slurry Tank Agitator
Equipment Number	41AGT501
Drive Type	Fixed Speed
Alarms	TBA
Start/Stop	DCS
Process Interlocks (soft)	

Drive Name	Slurry Tank
Equipment Number	41TNK501
Drive Type	N/A
Alarms	LAL/LAH415306
Start/Stop	N/A
Process Interlocks (soft)	

Drive Name	Slurry Pump
Equipment Number	41PPC502
Drive Type	Variable Speed (SC415308)
Alarms	TBA
Start/Stop	DCS
Process Interlocks (soft)	LIC415306
	LAL415306

Drive Name	Scrubber Bleed Pump
Equipment Number	41PPC504
Drive Type	Variable Speed (SC415317)
Alarms	TBA
Start/Stop	DCS
Process Interlocks (soft)	LIC415309

Drive Name	Scrubbing Tower
Equipment Number	41SBR502
Drive Type	N/A
Alarms	FAL415312, AAL/AAH415315
Start/Stop	N/A
Process Interlocks (soft)	

Drive Name	1st Stage Recirculation Pump
Equipment Number	41PPC505
Drive Type	Fixed speed
Alarms	TBA
Start/Stop	DCS
Process Interlocks (soft)	LIC415309

Drive Name	2nd Stage Recirculation Pump
Equipment Number	41PPC506
Drive Type	Fixed speed
Alarms	TBA
Start/Stop	DCS
Process Interlocks (soft)	

Drive Name	Extraction Fan
Equipment Number	41FAN503
Drive Type	
Alarms	TBA
Start/Stop	DCS
Process Interlocks (soft)	

Drive Name	V_2O_3 Scrubber Stack
Equipment Number	41STK503
Drive Type	N/A
Alarms	AAH415322
Start/Stop	N/A
Process Interlocks (soft)	

4.0 INSTRUMENTS

The following are the analogue indicators (instruments) in this area:

Indicator Name	41-VSL-503 Analysis Indicator			
Indicator Number	AI-41-5314			
P&ID Number	6033-41-J-1003			
Indicator Type	HOLD - AWAITING INFORMATION			
Range	-			
Normal				
Alarms	HH	H	L	LL
Values				
Priorities	Urgent	Control	Control	Urgent
Process Interlocks				
Trend	Slow			
Extras				
Cascaded Loop				

Indicator Name	41-STK-503 Analysis Indicator			
Indicator Number	AI-41-5322			
P&ID Number	6033-41-J-1003			
Indicator Type				
Range	-			
Normal				
Alarms	HH	H	L	LL
Values				
Priorities	Urgent	Control	Control	Urgent
Process Interlocks				
Trend	Slow			
Extras				
Cascaded Loop				

Indicator Name	Cooling screw water outlet			
Indicator Number	FI-41-5144			
P&ID Number	6033-41-J-1001			
Indicator Type	Cooling screw cooling water return			
Range	0 - 20 m3/hr			
Normal	15			
Alarms	HH	H	L	LL
Values	18	16	4	2
Priorities	Urgent	Control	Control	Urgent
Process Interlocks				
Trend	Slow			
Extras	Phase - liquid / SG - 1			
Cascaded Loop				

Indicator Name	Cooling screw water outlet
Indicator Number	FI-41-5245

P&ID Number	6033-41-J-1002			
Indicator Type	Cooling screw cooling water return			
Range	0 - 20 m3/hr			
Normal	15			
Alarms	HH	H	L	LL
Values	18	16	4	2
Priorities	Urgent	Control	Control	Urgent
Process Interlocks				
Trend	Slow			
Extras	Phase - liquid / SG - 1			
Cascaded Loop				

Indicator Name	Demister sprays			
Indicator Number	FI-41-5312			
P&ID Number	6033-41-J-1003			
Indicator Type	Demister spray water			
Range	0 - 1.5 m3/hr			
Normal	1			
Alarms	HH	H	L	LL
Values	1.35	1.2	0.3	0.15
Priorities	Urgent	Control	Control	Urgent
Process Interlocks				
Trend	Slow			
Extras	Phase - Liquid / SG - 1.1			
Cascaded Loop				

Indicator Name	1st stage recirculation line			
Indicator Number	FI-41-5316			
P&ID Number	6033-41-J-1003			
Indicator Type	Scrubber tower recirculation			
Range	10 - 25 m3/hr			
Normal	22			
Alarms	HH	H	L	LL
Values	23.5	22	13	11.5
Priorities	Urgent	Control	Control	Urgent
Process Interlocks				
Trend	Slow			
Extras	Phase - Liquid / SG - 1.25			
Cascaded Loop				

Indicator Name	2nd stage recirculation line			
Indicator Number	FI-41-5319			
P&ID Number	6033-41-J-1003			
Indicator Type	Scrubber tower recirculation			
Range	0.1 - 4 m3/hr			
Normal	3.5			
Alarms	HH	H	L	LL
Values	3.61	3.22	0.88	0.49
Priorities	Urgent	Control	Control	Urgent

Process Interlocks	
Trend	Slow
Extras	Phase - Liquid / SG - 1.25
Cascaded Loop	

Indicator Name	Reduction Kiln Product Bin			
Indicator Number	LI-41-5216			
P&ID Number	6033-41-J-1002			
Indicator Type	Radar			
Range	0 - 100 %			
Normal	60			
Alarms	HH	H	L	LL
Values	90	80	20	10
Priorities	Urgent	Control	Control	Urgent
Process Interlocks				
Trend	Slow			
Extras	Phase - Solids / SG - 2.77			
Cascaded Loop				

Indicator Name	V2O3 Scrubber Slurry Tank			
Indicator Number	LI-41-5306			
P&ID Number	6033-41-J-1003			
Indicator Type				
Range	0 - 100 %			
Normal	60			
Alarms	HH	H	L	LL
Values	90	80	20	10
Priorities	Urgent	Control	Control	Urgent
Process Interlocks				
Trend	Slow			
Extras	Phase - Slurry / SG - 1.2			
Cascaded Loop				

Indicator Name	Reduction kiln product dust filter LP			
Indicator Number	PDI-41-5235			
P&ID Number	6033-41-J-1002			
Indicator Type				
Range	-6 - 0 kPag			
Normal	-4.5			
Alarms	HH	H	L	LL
Values				
Priorities				
Process Interlocks				
Trend	Slow			
Extras	Phase - Air / Solid			
Cascaded Loop				

Indicator Name	V2O3 Scrubber Baghouse HP

Indicator Number	PDI-41-5302			
P&ID Number	6033-41-J-1003			
Indicator Type				
Range	-3.5 - 0 kPag			
Normal	-0.5			
Alarms	HH	H	L	LL
Values				
Priorities				
Process Interlocks				
Trend	Slow			
Extras	Phase - Air			
Cascaded Loop				

Indicator Name	Reduction kiln 1 Exhaust stack			
Indicator Number	PI-41-5109			
P&ID Number	6033-41-J-1001			
Indicator Type				
Range	0 - 2 kPag			
Normal	1			
Alarms	HH	H	L	LL
Values	1.8	1.6	0.4	0.2
Priorities	Urgent	Control	Control	Urgent
Process Interlocks				
Trend	Slow			
Extras	Phase - Air			
Cascaded Loop				

Indicator Name	Reduction kiln 2 Exhaust stack			
Indicator Number	PI-41-5209			
P&ID Number	6033-41-J-1002			
Indicator Type				
Range	0 - 2 kPag			
Normal	1			
Alarms	HH	H	L	LL
Values	1.8	1.6	0.4	0.2
Priorities	Urgent	Control	Control	Urgent
Process Interlocks				
Trend	Slow			
Extras	Phase - Air / Solid			
Cascaded Loop				

Indicator Name	Reduction kiln 1 muffle furnace			
Indicator Number	TI-41-5103			
P&ID Number	6033-41-J-1001			
Indicator Type	Pyrometer			
Range	0 - 1000 deg C			
Normal	750			
Alarms	HH	H	L	LL
Values	900	800	700	650

Priorities	Urgent	Control	Control	Urgent
Process Interlocks				
Trend	Fast			
Extras	Phase -			
Cascaded Loop				

Indicator Name	Reduction kiln 1 muffle furnace			
Indicator Number	TI-41-5104			
P&ID Number	6033-41-J-1001			
Indicator Type	Thermocouple			
Range	0 - 1000 deg C			
Normal	750			
Alarms	HH	H	L	LL
Values	900	800	700	650
Priorities	Urgent	Control	Control	Urgent
Process Interlocks				
Trend	Fast			
Extras	Phase -			
Cascaded Loop				

Indicator Name	Reduction kiln 1 muffle furnace			
Indicator Number	TI-41-5105			
P&ID Number	6033-41-J-1001			
Indicator Type	Pyrometer			
Range	0 - 1000 deg C			
Normal	900			
Alarms	HH	H	L	LL
Values	950	920	800	750
Priorities	Urgent	Control	Control	Urgent
Process Interlocks				
Trend	Fast			
Extras	Phase -			
Cascaded Loop				

Indicator Name	Reduction kiln 1 muffle furnace			
Indicator Number	TI-41-5106			
P&ID Number	6033-41-J-1001			
Indicator Type	Thermocouple			
Range	0 - 1000 deg C			
Normal	900			
Alarms	HH	H	L	LL
Values	950	920	800	750
Priorities	Urgent	Control	Control	Urgent
Process Interlocks				
Trend	Fast			
Extras	Phase -			
Cascaded Loop				

Indicator Name	Reduction kiln 1 muffle furnace			
Indicator Number	TI-41-5107			
P&ID Number	6033-41-J-1001			
Indicator Type	Pyrometer			
Range	0 - 1000 deg C			
Normal	920			
Alarms	HH	H	L	LL
Values	950	940	800	750
Priorities	Urgent	Control	Control	Urgent
Process Interlocks				
Trend	Fast			
Extras	Phase -			
Cascaded Loop				

Indicator Name	Reduction kiln 1 muffle furnace			
Indicator Number	TI-41-5108			
P&ID Number	6033-41-J-1001			
Indicator Type	Thermocouple			
Range	0 - 1000 deg C			
Normal	920			
Alarms	HH	H	L	LL
Values	950	940	800	750
Priorities	Urgent	Control	Control	Urgent
Process Interlocks				
Trend	Fast			
Extras	Phase -			
Cascaded Loop				

Indicator Name	Kiln 1 Discharge Cooling Water Return			
Indicator Number	TI-41-5111			
P&ID Number	6033-41-J-1001			
Indicator Type				
Range	0 - 100 deg C			
Normal	50			
Alarms	HH	H	L	LL
Values	90	70	20	10
Priorities	Urgent	Control	Control	Urgent
Process Interlocks				
Trend	Slow			
Extras	Phase - liquid / SG - 1			
Cascaded Loop	Nil			

Indicator Name	Cooling Water Supply			
Indicator Number	TI-41-5112			
P&ID Number	6033-41-J-1001			
Indicator Type	RTD			
Range	0 - 75 deg C			
Normal	35			
Alarms	HH	H	L	LL

Values	60	45	20	15
Priorities	Urgent	Control	Control	Urgent
Process Interlocks				
Trend	Slow			
Extras	Phase - liquid / SG - 1			
Cascaded Loop	Nil			

Indicator Name	Reduction kiln 1 muffle furnace			
Indicator Number	TI-41-5131			
P&ID Number	6033-41-J-1001			
Indicator Type	Pyrometer			
Range	0 - 1000 deg C			
Normal	750			
Alarms	HH	H	L	LL
Values	900	800	700	650
Priorities	Urgent	Control	Control	Urgent
Process Interlocks				
Trend	Fast			
Extras	Phase -			
Cascaded Loop				

Indicator Name	Reduction kiln 1 muffle furnace			
Indicator Number	TI-41-5132			
P&ID Number	6033-41-J-1001			
Indicator Type	Thermocouple			
Range	0 - 1000 deg C			
Normal	900			
Alarms	HH	H	L	LL
Values	950	920	800	750
Priorities	Urgent	Control	Control	Urgent
Process Interlocks				
Trend	Fast			
Extras	Phase -			
Cascaded Loop				

Indicator Name	Reduction kiln 1 muffle furnace			
Indicator Number	TI-41-5133			
P&ID Number	6033-41-J-1001			
Indicator Type	Pyrometer			
Range	0 - 1000 deg C			
Normal	900			
Alarms	HH	H	L	LL
Values	950	920	800	750
Priorities	Urgent	Control	Control	Urgent
Process Interlocks				
Trend	Fast			
Extras	Phase -			
Cascaded Loop				

Indicator Name	Reduction kiln 1 muffle furnace			
Indicator Number	TI-41-5134			
P&ID Number	6033-41-J-1001			
Indicator Type	Thermocouple			
Range	0 - 1000 deg C			
Normal	920			
Alarms	HH	H	L	LL
Values	950	940	800	750
Priorities	Urgent	Control	Control	Urgent
Process Interlocks				
Trend	Fast			
Extras	Phase -			
Cascaded Loop				

Indicator Name	Reduction kiln 1 muffle furnace			
Indicator Number	TI-41-5135			
P&ID Number	6033-41-J-1001			
Indicator Type	Pyrometer			
Range	0 - 1000 deg C			
Normal	920			
Alarms	HH	H	L	LL
Values	950	940	800	750
Priorities	Urgent	Control	Control	Urgent
Process Interlocks				
Trend	Fast			
Extras	Phase -			
Cascaded Loop				

Indicator Name	Kiln 1 Discharge Screw Cooling Water Return			
Indicator Number	TI-41-5140			
P&ID Number	6033-41-J-1001			
Indicator Type	RTD			
Range	0 - 100 deg C			
Normal	40			
Alarms	HH	H	L	LL
Values	90	70	20	10
Priorities	Urgent	Control	Control	Urgent
Process Interlocks				
Trend	Slow			
Extras	Phase - liquid / SG - 1			
Cascaded Loop	Nil			

Indicator Name	Kiln 1 Discharge Screw Product
Indicator Number	TI-41-5141
P&ID Number	6033-41-J-1001
Indicator Type	
Range	0 - 200 deg C
Normal	70

Alarms	HH	H	L	LL
Values	120	100	35	25
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	TAHH will trip 41FDS when activated			
Trend	Slow			
Extras	Phase - Air / Solid			
Cascaded Loop	Nil			

Indicator Name	Reduction kiln 2 muffle furnace			
Indicator Number	TI-41-5203			
P&ID Number	6033-41-J-1002			
Indicator Type	Pyrometer			
Range	0 - 1000 deg C			
Normal	750			
Alarms	HH	H	L	LL
Values	900	800	700	650
Priorities	Urgent	Control	Control	Urgent
Process Interlocks				
Trend	Fast			
Extras	Phase -			
Cascaded Loop				

Indicator Name	Reduction kiln 2 muffle furnace			
Indicator Number	TI-41-5204			
P&ID Number	6033-41-J-1002			
Indicator Type	Thermocouple			
Range	0 - 1000 deg C			
Normal	750			
Alarms	HH	H	L	LL
Values	900	800	700	650
Priorities	Urgent	Control	Control	Urgent
Process Interlocks				
Trend	Fast			
Extras	Phase -			
Cascaded Loop				

Indicator Name	Reduction kiln 2 muffle furnace			
Indicator Number	TI-41-5205			
P&ID Number	6033-41-J-1002			
Indicator Type	Pyrometer			
Range	0 - 1000 deg C			
Normal	900			
Alarms	HH	H	L	LL
Values	950	920	800	750
Priorities	Urgent	Control	Control	Urgent
Process Interlocks				
Trend	Fast			
Extras	Phase -			
Cascaded Loop				

Indicator Name	Reduction kiln 2 muffle furnace			
Indicator Number	TI-41-5206			
P&ID Number	6033-41-J-1002			
Indicator Type	Thermocouple			
Range	0 - 1000 deg C			
Normal	900			
Alarms	HH	H	L	LL
Values	950	920	800	750
Priorities	Urgent	Control	Control	Urgent
Process Interlocks				
Trend	Fast			
Extras	Phase -			
Cascaded Loop				

Indicator Name	Reduction kiln 2 muffle furnace			
Indicator Number	TI-41-5207			
P&ID Number	6033-41-J-1002			
Indicator Type	Pyrometer			
Range	0 - 1000 deg C			
Normal	920			
Alarms	HH	H	L	LL
Values	950	940	800	750
Priorities	Urgent	Control	Control	Urgent
Process Interlocks				
Trend	Fast			
Extras	Phase -			
Cascaded Loop				

Indicator Name	Reduction kiln 2 muffle furnace			
Indicator Number	TI-41-5208			
P&ID Number	6033-41-J-1002			
Indicator Type	Thermocouple			
Range	0 - 1000 deg C			
Normal	920			
Alarms	HH	H	L	LL
Values	950	940	800	750
Priorities	Urgent	Control	Control	Urgent
Process Interlocks				
Trend	Fast			
Extras	Phase -			
Cascaded Loop				

Indicator Name	Kiln 2 Discharge Cooling Water Return
Indicator Number	TI-41-5210
P&ID Number	6033-41-J-1002
Indicator Type	
Range	0 - 100 deg C

Normal	50			
Alarms	HH	H	L	LL
Values	90	70	20	10
Priorities	Urgent	Control	Control	Urgent
Process Interlocks				
Trend	Slow			
Extras	Phase - liquid / SG - 1			
Cascaded Loop	Nil			

Indicator Name	Cooling Water Supply			
Indicator Number	TI-41-5212			
P&ID Number	6033-41-J-1002			
Indicator Type	RTD			
Range	0 - 75 deg C			
Normal	35			
Alarms	HH	H	L	LL
Values	60	45	20	15
Priorities	Urgent	Control	Control	Urgent
Process Interlocks				
Trend	Slow			
Extras	Phase - liquid / SG - 1			
Cascaded Loop	Nil			

Indicator Name	Reduction kiln 2 muffle furnace			
Indicator Number	TI-41-5223			
P&ID Number	6033-41-J-1002			
Indicator Type	Pyrometer			
Range	0 - 1000 deg C			
Normal	750			
Alarms	HH	H	L	LL
Values	900	800	700	650
Priorities	Urgent	Control	Control	Urgent
Process Interlocks				
Trend	Fast			
Extras	Phase -			
Cascaded Loop				

Indicator Name	Reduction kiln 2 muffle furnace			
Indicator Number	TI-41-5224			
P&ID Number	6033-41-J-1002			
Indicator Type	Thermocouple			
Range	0 - 1000 deg C			
Normal	900			
Alarms	HH	H	L	LL
Values	950	920	800	750
Priorities	Urgent	Control	Control	Urgent
Process Interlocks				
Trend	Fast			
Extras	Phase -			

Cascaded Loop	

Indicator Name	Reduction kiln 2 muffle furnace			
Indicator Number	TI-41-5225			
P&ID Number	6033-41-J-1002			
Indicator Type	Pyrometer			
Range	0 - 1000 deg C			
Normal	900			
Alarms	HH	H	L	LL
Values	950	920	800	750
Priorities	Urgent	Control	Control	Urgent
Process Interlocks				
Trend	Fast			
Extras	Phase -			
Cascaded Loop				

Indicator Name	Reduction kiln 2 muffle furnace			
Indicator Number	TI-41-5226			
P&ID Number	6033-41-J-1002			
Indicator Type	Thermocouple			
Range	0 - 1000 deg C			
Normal	920			
Alarms	HH	H	L	LL
Values	950	940	800	750
Priorities	Urgent	Control	Control	Urgent
Process Interlocks				
Trend	Fast			
Extras	Phase -			
Cascaded Loop				

Indicator Name	Reduction kiln 2 muffle furnace			
Indicator Number	TI-41-5227			
P&ID Number	6033-41-J-1002			
Indicator Type	Pyrometer			
Range	0 - 1000 deg C			
Normal	920			
Alarms	HH	H	L	LL
Values	950	940	800	750
Priorities	Urgent	Control	Control	Urgent
Process Interlocks				
Trend	Fast			
Extras	Phase -			
Cascaded Loop				

Indicator Name	Kiln 2 Discharge Screw Product
Indicator Number	TI-41-5233
P&ID Number	6033-41-J-1002
Indicator Type	

Range	0 - 200 deg C			
Normal	70			
Alarms	HH	H	L	LL
Values	120	100	35	25
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	TAHH will trip 41FDS when activated			
Trend	Slow			
Extras	Phase - Air / Solid			
Cascaded Loop	Nil			

Indicator Name	Kiln 2 Discharge Screw Cooling Water Return			
Indicator Number	TI-41-5242			
P&ID Number	6033-41-J-1002			
Indicator Type	RTD			
Range	0 - 100 deg C			
Normal	40			
Alarms	HH	H	L	LL
Values	90	70	20	10
Priorities	Urgent	Control	Control	Urgent
Process Interlocks				
Trend	Slow			
Extras	Phase - liquid / SG - 1			
Cascaded Loop	Nil			

Indicator Name	41-BIN-501 Weight Indicator			
Indicator Number	WI-41-5102			
P&ID Number	6033-41-J-1001			
Indicator Type				
Range	0 - 2500 kg			
Normal				
Alarms	HH	H	L	LL
Values	1750	1400	500	250
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	WALL will trip 41FDS501 when activated WAHH will trip 36ROV505 when activated			
Trend	Slow			
Extras				
Cascaded Loop	Nil			

Indicator Name	41-BIN-502 Weight Indicator			
Indicator Number	WI-41-5202			
P&ID Number	6033-41-J-1002			
Indicator Type				
Range	0 - 2500 kg			
Normal				
Alarms	HH	H	L	LL
Values	1750	1400	250	100
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	WALL will trip 41FDS503 when activated			

	WAHH will trip 36ROV506 when activated
Trend	Slow
Extras	
Cascaded Loop	Nil

Indicator Name	41-BIN-504 Weight Indicator			
Indicator Number	WI-41-5217			
P&ID Number	6033-41-J-1002			
Indicator Type				
Range	0 - 15000 kg			
Normal				
Alarms	HH	H	L	LL
Values	13500	12000	1000	500
Priorities	Urgent	Control	Control	Urgent
Process Interlocks				
Trend	Slow			
Extras				
Cascaded Loop				

Tag Number	Description
LE415101	Reduction Kiln 1 Buffer Silo Level
WE415102A/B/C	Reduction Kiln 1 Buffer Silo Weight
TE415103	AMV Reduction Kiln 1 Temperature Sensor
TE415104	AMV Reduction Kiln 1 Temperature Sensor
TE415105	AMV Reduction Kiln 1 Temperature Sensor
TE415106	AMV Reduction Kiln 1 Temperature Sensor
TE415107	AMV Reduction Kiln 1 Temperature Sensor
TE415108	AMV Reduction Kiln 1 Temperature Sensor
TE415130	AMV Reduction Kiln 1 Temperature Sensor
TE415131	AMV Reduction Kiln 1 Temperature Sensor
TE415132	AMV Reduction Kiln 1 Temperature Sensor
TE415133	AMV Reduction Kiln 1 Temperature Sensor
TE415134	AMV Reduction Kiln 1 Temperature Sensor
TE415135	AMV Reduction Kiln 1 Temperature Sensor
PT415109	Reduction Kiln 1 Exhaust Gas Pressure
LSH415110	Reduction Kiln 1 Discharge High Level Switch
USS415127	Reduction Kiln 1 Discharge Rotary Valve Underspeed Switch
USS415116	Reduction Kiln 1Discharge Screw Underspeed Switch
TE415141	Reduction Kiln 1 Discharge Chute Temperature Sensor
TE415111	Cooling Water Return Temperature Sensor
TE415112	Cooling Water Temperature Sensor
TE415140	Cooling Water Return Temperature Sensor
FSH415126	V_2O_3 Safety Shower High Flow Switch
LE415201	Reduction Kiln 2 Buffer Silo Level
WE415202A/B/C	Reduction Kiln 2 Buffer Silo Weight
TE415203	Reduction Kiln 2 Temperature Sensor
TE415204	Reduction Kiln 2 Temperature Sensor
TE415205	Reduction Kiln 2 Temperature Sensor

Tag Number	Description
TE415206	Reduction Kiln 2 Temperature Sensor
TE415207	Reduction Kiln 2 Temperature Sensor
TE415208	Reduction Kiln 2 Temperature Sensor
TE415222	Reduction Kiln 2 Temperature Sensor
TE415223	Reduction Kiln 2 Temperature Sensor
TE415224	Reduction Kiln 2 Temperature Sensor
TE415225	Reduction Kiln 2 Temperature Sensor
TE415226	Reduction Kiln 2 Temperature Sensor
TE415227	Reduction Kiln 2 Temperature Sensor
PT415209	Reduction Kiln 2 Exhaust Gas Pressure
LSH415228	Reduction Kiln 2 Discharge High Level Switch
USS415231	Reduction Kiln 2 Discharge Rotary Valve Underspeed Switch
USS415234	Reduction Kiln 2Discharge Screw Underspeed Switch
TE415233	Reduction Kiln 2 Discharge Chute Temperature Sensor
LE415216	Reduction Kiln Product Bin Level
PDT415235	Reduction Kiln Product Dust Filter Pressure Differential
WE415217A/B/C	Reduction Kiln Product Bin Weight
LSL415236	Reduction Kiln Product Bin Low Level Switch
USS415232	Reduction Kiln Product Bin Rotary Valve Underspeed Switch
TE415210	Cooling Water Return Temperature Sensor
TE415242	Cooling Water Return Temperature Sensor
TE415212	Cooling Water Temperature Sensor
PT415304	Reduction Kiln 2 Off Gas Pressure
PT415305	Reduction Kiln 1 Off Gas Pressure
TE415301	Kiln Off Gas Temperature
PDT415302	V_2O_3 Scrubber Filter Pressure Differential
LSH415303	V_2O_3 Scrubber Filter Low Level Switch
USS415311	V_2O_3 Scrubber Filter Rotary Valve Underspeed Switch
LE415306	Slurry Tank Level
FSL415312	Raw Water Low Flow Switch
LT415309	Scrubbing Tower Level
PI415323	Scrubbing Tower Pressure
PI415321	Scrubbing Tower Pressure
PDTXXXXXX	Scrubbing Tower Pressure Differential
FT415318	Scrubber Bleed Flow Sensor
FE415316	1st Stage Recirculation Flow Sensor
AE415315	1st Stage Recirculation pH Sensor
FE415319	2nd Stage Recirculation Flow Sensor
AE415314	2nd Stage Recirculation pH Sensor
AE415322	V_2O_3 Scrubber Exhaust Opacity

The following are the indicators (instruments) in this area:

Tag Number	Description
LI415101	Reduction Kiln 1 Buffer Silo Level
WI415102	Reduction Kiln 1 Buffer Silo Weight
TI415103	AMV Reduction Kiln 1 Temperature Sensor
TI415104	AMV Reduction Kiln 1 Temperature Sensor
TI415105	AMV Reduction Kiln 1 Temperature Sensor
TI415106	AMV Reduction Kiln 1 Temperature Sensor

Tag Number	Description
TI415107	AMV Reduction Kiln 1 Temperature Sensor
TI415108	AMV Reduction Kiln 1 Temperature Sensor
TI415130	AMV Reduction Kiln 1 Temperature Sensor
TI415131	AMV Reduction Kiln 1 Temperature Sensor
TI415132	AMV Reduction Kiln 1 Temperature Sensor
TI415133	AMV Reduction Kiln 1 Temperature Sensor
TI415134	AMV Reduction Kiln 1 Temperature Sensor
TI415135	AMV Reduction Kiln 1 Temperature Sensor
PI415109	Reduction Kiln 1 Exhaust Gas Pressure
TI415111	Cooling Water Return Temperature Sensor
TI415112	Cooling Water Temperature Sensor
TI415127	Cooling Water Return Temperature Sensor
LI415201	Reduction Kiln 2 Buffer Silo Level
WI415202	Reduction Kiln 2 Buffer Silo Weight
TI415203	Reduction Kiln 2 Temperature Sensor
TI415204	Reduction Kiln 2 Temperature Sensor
TI415205	Reduction Kiln 2 Temperature Sensor
TI415206	Reduction Kiln 2 Temperature Sensor
TI415207	Reduction Kiln 2 Temperature Sensor
TI415208	Reduction Kiln 2 Temperature Sensor
TI415222	Reduction Kiln 2 Temperature Sensor
TI415223	Reduction Kiln 2 Temperature Sensor
TI415224	Reduction Kiln 2 Temperature Sensor
TI415225	Reduction Kiln 2 Temperature Sensor
TI415226	Reduction Kiln 2 Temperature Sensor
TI415227	Reduction Kiln 2 Temperature Sensor
PI415209	Reduction Kiln 2 Exhaust Gas Pressure
TI415233	Reduction Kiln 2 Discharge Chute Temperature Sensor
LI415216	Reduction Kiln Product Bin Level
PDI415235	Reduction Kiln Product Dust Filter Pressure Differential
WI415217	Reduction Kiln Product Bin Weight
TI415210	Cooling Water Return Temperature Sensor
TI415211	Cooling Water Return Temperature Sensor
TI415212	Cooling Water Temperature Sensor
PI415304	Reduction Kiln 2 Off Gas Pressure
PI415305	Reduction Kiln 1 Off Gas Pressure
TIC415301	Kiln Off Gas Temperature
PDI415302	V_2O_3 Scrubber Filter Pressure Differential
LIC415306	Slurry Tank Level
LIC415309	Scrubbing Tower Level
PI415323	Scrubbing Tower Pressure
PDIXXXXXX	Scrubbing Tower Pressure Differential
FI415318	Scrubber Bleed Flow Sensor
FI415316	1st Stage Recirculation Flow Sensor
AIC415315	1st Stage Recirculation pH Sensor
FI415319	2nd Stage Recirculation Flow Sensor
AI415314	2nd Stage Recirculation pH Sensor
AI415322	V_2O_3 Scrubber Exhaust Opacity

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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	Reduction 1 kiln seal cooling water line - Provision of cooling water to reduction kiln 1 seal
Valve Number	HV-415114
Valve Modes	Auto or Manual
P&ID Number	6033-41-J-1001
Process Interlocks	HOLD
Fail Position	Open
Indication	Open, Closed
Extras	Nil

Valve Name	Reduction Kiln 1 cooling screw cooling water line - Provision of cooling water to cooling screw
Valve Number	HV-415115
Valve Modes	Auto or Manual
P&ID Number	6033-41-J-1001
Process Interlocks	HOLD
Fail Position	Open
Indication	Open, Closed
Extras	Nil

Valve Name	Reduction kiln 2 seal cooling water line - Provision of cooling water to reduction kiln 2 seal
Valve Number	HV-415214
Valve Modes	Auto or Manual
P&ID Number	6033-41-J-1002
Process Interlocks	HOLD
Fail Position	Open
Indication	Open, Closed
Extras	Nil

Valve Name	Reduction Kiln 2 cooling screw cooling water line - Provision of cooling water to cooling screw
Valve Number	HV-415215
Valve Modes	Auto or Manual
P&ID Number	6033-41-J-1002
Process Interlocks	HOLD
Fail Position	Open
Indication	Open, Closed
Extras	Nil

Valve Name	Slurry Tank Discharge line - Discharging slurry tank

Valve Number	LV-415306A
Valve Modes	Auto or Manual
P&ID Number	6033-41-J-1003
Process Interlocks	HOLD
Fail Position	Open
Indication	Open, Closed
Extras	Nil

Valve Name	Slurry tank recirculation line - Recirculating slurry
Valve Number	LV-415306B
Valve Modes	Auto or Manual
P&ID Number	6033-41-J-1003
Process Interlocks	HOLD
Fail Position	Closed
Indication	Open, Closed
Extras	Nil

Valve Name	Area 41 scrubber demister spray - On / Off Demister Spray
Valve Number	HV-415310
Valve Modes	Auto or Manual
P&ID Number	6033-41-J-1003
Process Interlocks	Nil
Fail Position	Closed
Indication	Open, Closed
Extras	Nil

Valve Name	Slurry tank barren liquor line - Barren liquor make-up
Valve Number	LV-415325
Valve Modes	Auto or Manual
P&ID Number	6033-41-J-1003
Process Interlocks	
Fail Position	Open
Indication	Open, Closed
Extras	Nil

Tag Number	Associated Equipment

5.2 Modulating Service

The following are the automatic valves (modulating service) in this area:

Tag Number	Associated Equipment
PCV415305	Reduction Kiln 1 Product duct damper
PCV415304	Reduction Kiln 2 Product duct damper
TCV415301	Reduction Kiln Off Gas to Scrubber
HV415310	Raw Water To Scrubbing Tower
LCV415309	Barren Solution to 2nd Stage Recirculation Pump
ACV415320	Sulphuric Acid To Scrubbing Tower

The following are the control loops in this area:

Loop Name	Ammonia Tower pH control			
Loop Input	AI-41-5315			
P&ID Number	6033-41-J-1003			
Loop Type	STD PID Loop			
Modes	Auto & Manual			
Range	0 - 10 pH			
Normal	6.8			
Alarms	HH	H	L	LL
Values	9	8	5	2
Priorities	Urgent	Control	Control	Urgent
Process Interlocks	Set to manual & Output to 0% when either recirculation pumps stop			
Trend	PV, SP & OP, Slow			
Loop Output	0 - 100 %	ACV-41-5315		
Action	Reverse			
Loop Tuning	Slow (Process Lag)			
Extras				
Cascaded Loop	Nil			

Loop Name	41-PPC-504 Discharge Flow Indicating Controller - Scrubber Bleed Line			
Loop Input	FI-41-5318			
P&ID Number	6033-41-J-1003			
Loop Type	STD PID Loop			
Modes	Auto & Manual			
Range	0 - 5 m3/hr			
Normal	3			
Alarms	HH	H	L	LL
Values	4.5	4	0.5	0.1
Priorities	Urgent	Control	Control	Urgent
Process Interlocks				
Trend	PV, SP & OP, Slow			
Loop Output	0 - 100 %	FCV-41-5318		
Action	Direct			

Loop Tuning	Slow
Extras	If LAH415309 is activated Loop will be overidden and valve opned to 100% until LAH is no longer active
Cascaded Loop	Nil

Loop Name	41-SBR-502 Level Indicating Controller - V2O3 Scrubbing Tower			
Loop Input	LI-41-5309			
P&ID Number	6033-41-J-1003			
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				
Trend	PV, SP & OP, Slow			
Loop Output	0 - 100 %	41-LIC-5309		
Action	Direct			
Loop Tuning	Slow			
Extras				
Cascaded Loop	Nil			

Loop Name	41-DEX-501 Feed From Reduction Kiln 2 Pressure Indicating Controller - Reduction kiln 1			
Loop Input	PI-41-5304			
P&ID Number	6033-41-J-1003			
Loop Type	STD PID Loop			
Modes	Auto & Manual			
Range	-0.5 - 2 kPag			
Normal	0.5			
Alarms	HH	H	L	LL
Values	1.75	1.5	0	-0.25
Priorities	Urgent	Control	Control	Urgent
Process Interlocks				
Trend	PV, SP & OP, Slow			
Loop Output	0 - 100 %	41-PIC-5304		
Action	Reverse			
Loop Tuning	Slow			
Extras				
Cascaded Loop	Nil			

Loop Name	41-DEX-501 Feed From Reduction Kiln 1 Pressure Indicating Controller - Reduction kiln 2
Loop Input	PI-41-5305
P&ID Number	6033-41-J-1003
Loop Type	STD PID Loop
Modes	Auto & Manual

Range	-0.5 - 2 kPag			
Normal	0.5			
Alarms	HH	H	L	LL
Values	1.75	1.5	0	-0.25
Priorities	Urgent	Control	Control	Urgent
Process Interlocks				
Trend	PV, SP & OP, Slow			
Loop Output	0 - 100 %	41-PIC-5305		
Action	Reverse			
Loop Tuning	Slow			
Extras				
Cascaded Loop	Nil			

Loop Name	41-DEX-501 Temperature Indicator Controller - Reduction Kiln Off Gas			
Loop Input	TI-41-5301			
P&ID Number	6033-41-J-1003			
Loop Type	STD PID Loop			
Modes	Auto & Manual			
Range	100 - 300 deg C			
Normal	150			
Alarms	HH	H	L	LL
Values	280	260	140	120
Priorities	Urgent	Control	Control	Urgent
Process Interlocks				
Trend	PV, SP & OP, Moderate			
Loop Output	0 - 100 %	41-TIC-5301		
Action	Reverse			
Loop Tuning	Moderate			
Extras				
Cascaded Loop	Nil			

6.0 FUNCTIONAL PREREQUISITES

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

Area	System	Associated Drawing	Associated Control Philosophy
35	AMV Precipitation	6033-35-1001	6033-G-00-F-010
35	AMV Thickening	6033-35-1002	6033-G-00-F-010
36	AMV Flash Drier	6033-36-1001	6033-G-00-F-011

7.0 STARTUP SEQUENCE

Due to the release of particulates and gases form the reduction kilns, the off gas scrubber is always shut down after the kilns. For this reason the start up sequence is divided into two distinct sections:

- Ammonia Scrubbing System
- V_2O_3 Baghouse
- Reduction Kiln Pre-heat Sequence
- Reduction Kiln Purge
- Reduction Kiln Operation
- Burner Management System

7.1 Ammonia Scrubbing System

This information is an interpretation of vendor data and is provided as information only. The Vendor Document *C50-102 PROCESS OPERATING MANUAL* and *C50-145 FUNCTIONAL SPECIFICATION* should be used as the official reference documentation for the gas scrubber in area 41.

Due to the nature of the gases and particulates released from the reduction kilns the ammonia scrubbing system should be started prior to the baghouse and the reduction kilns.

Prerequisites

No.	TAG No.	Equip. No.	Description	Status
1			Plant Air	AVAILABLE
			Raw Water	AVAILABLE
2	LI355201		Barren solution tank level	SUFFICIENT LEVEL
4		30PPC505 A/B	Sulphuric acid feed pump	RUNNING

Start Sequence

Prerequisite	Step No.	Description
	1	SET Scrubber bleed flow control (FIC415318) to MANUAL at 0 output
	2	SET Scrubber Level Control (LIC415309) to MANUAL at 10% output
Steps 1 - 2	3	START Barren Solution Purge pump (35PPC507) in AUTO
Step 3	4	SET Scrubber Level Control (LIC415309) to AUTO with a Setpoint of 60%
Step 4 + 60 s	5	START 2nd Stage recirculation Pump (41PPC506) in AUTO
	6	Ensure flow FI416319 = approx 20 m^3/h
Steps 5 – 6 + Scrubber Level = 60%	7	START 1st Stage Recirculation Pump (41PPC505) in AUTO
Step 7	8	START Scrubber Tower pH Control (AIC415315) to AUTO with a setpoint of pH 3.5
Step 8	9	SET Scrubber Air Bleed Temp control (TIC415301)to MANUAL with an output of 10%
Step 9	10	START Scrubber Bleed Pump (41PPC504) in AUTO
Step 10	11	SET Scrubber Bleed flow control to AUTO with an setpoint of 3 m^3/h
Step 11	12	START Dust Slurry System (See 7.2 below)
Step 12	13	START Baghouse System (See 7.3 below)
Step 13	14	OPEN V_2O_3 Scrubber Fan Damper (41DA504) to 10%
Step 14	15	START Extraction Fan (41FAN503) in AUTO
Step 15 + 30 s		Adjust 41DA504 until PI415324 reads -1.5 kPag (Damper adjustment and pressure reading must both be performed manually).
Step 16		Start Demister spray sequence

Demister Spray Sequence

Prerequisite	Step No.	Description
	1	SET HV415310 and KS415310 to AUTO
Step 1	2	OPEN HV415310
Step 2 + 30 s	3	CLOSE HV415310
Step 3 + 120 s	4	Repeat sequence from Step 2

7.2 Dust Slurry System

This information is an interpretation of vendor data and is provided as information only. The Vendor Document *C50-XXX XXXX XXXX* should be used as the official reference documentation for the Area 41 Reduction kilns and associated equipment.

Prerequisites

No.	TAG No.	Equip. No.	Description	Status
1		Various	Plant Services	HEALTHY
2			Ammonia scrubbing system	RUNNING

Start Sequence

Prerequisite	Step No.	Description
	1	Ensure LV415325/306A/306B are CLOSED
	2	SET Level system (Lx415306) to AUTO
Steps 1 and 2	3	OPEN barren solution inlet valve (HV415325)
Step 3	4	Fill Tank until LAH415306 is ACTIVATED
Step 4	5	CLOSE barren solution inlet valve (HV415325)
Step 5	6	OPEN Recirculation valve (HV415306B)
Step 6	7	START Slurry Pump (41PPC502) in AUTO
Step 7	8	SET valves LV415325/306A/306B to AUTO
Step 8	9	SET Operating mode (HIC415306) to AUTO or TIMED
Step 9	10	START Dust Slurry Operating Sequence (see below)

Operating Sequence (AUTO)

Prerequisite	Step No.	Description
	1	Ensure HV415325 and HV415306A are CLOSED and HV415306B is OPEN and Slurry Pump (41PPC502) is RUNNING
Step 1 + 60 min	2	OPEN HV415306A
	3	CLOSE HV415306B
Steps 2-3 + LAL415306 is activated	4	OPEN HV415325
	5	OPEN HV415306B
	6	CLOSE HV415306A
Steps 5-6 + LAH415306 is activated	7	CLOSE HV415325
Step 7	8	Repeat Sequence from Step 2

Operating Sequence (TIMED)

Prerequisite	Step No.	Description
	1	Ensure HV415325 and HV415306A are CLOSED and HV415306B is OPEN and Slurry Pump (41PPC502) is RUNNING
Step 1 + 55 min	2	OPEN HV415306A
	3	CLOSE HV415306B
Steps 2-4 + 5 min (or LAL415306 is activated)	4	OPEN HV415325
	5	OPEN HV415306B
	6	CLOSE HV415306A
Steps 5-6 + LAH415306 is activated	7	CLOSE HV415325
Step 7	8	Repeat Sequence from Step 2

7.3 Baghouse System

This information is an interpretation of vendor data and is provided as information only. The Vendor Document *C50-XXX XXXX XXXX* should be used as the official reference documentation for the Area 41 Reduction kilns and associated equipment.

Prerequisites

No.	TAG No.	Equip. No.	Description	Status
1		Various	Plant Services	HEALTHY
2			Ammonia scrubbing system	RUNNING
3			Dust Slurry system	RUNNING

Start Sequence

Prerequisite	Step No.	Description
	1	START Baghouse rotary valve (41ROV505) in AUTO
Step 1	2	START Baghouse house reverse pulse system in AUTO
Step 2	3	SET Bleed Air Damper (41DA503) to AUTO
Step 3	4	SET Baghouse Temperature control loop (TIC415301) to MANUAL at 100% output (damper fully open)
Step 4	5	START Opacity monitor (AE415322) in AUTO

7.4 Reduction Kilns

Note that following equipment and tag numbers refer to the start up of reduction kiln 1, the start up of reduction kiln will follow the same description however the equipment and tag numbers will differ.

7.4.1 Reduction kiln pre-heat (from cold)

This information is an interpretation of vendor data and is provided as information only. The Vendor Document *C50-XXX XXXX XXXX* should be used as the official reference documentation for the Area 41 Reduction kilns and associated equipment.

Prerequisites

No.	TAG No.	Equip. No.	Description	Status
1		Various	Plant Air	AVAILABLE
2		Various	Cooling Water	AVAILABLE
3			Ammonia scrubbing system	RUNNING
4			Baghouse system	RUNNING
5		41BIN501	AMV in bin	SUFFICIENT CAPACITY
6		41BIN504	Reduction Kiln Product Bin	SUFFICIENT CAPACITY
7	PI505933		Nitrogen	AVAILABLE

Start Sequence

Prerequisite	Step No.	Description
	1	OPEN Cooling water valves (HV415114/115)
Step 1	2	START Reduction Kiln 1 main drive (41KLN501A) in AUTO
Step 2	3	Input Temperature setpoint of 600 C for each burner zone
Step 3	4	Set Temperature ramp up schedule
	5	START Burner Management System in AUTO
Steps 4-5	6	START Burners in AUTO
Step 6 + All burner zones at 600 C	7	Set Feed ramp up schedule
Step 7	8	Set Kiln Pressure control (PIC415305) to AUTO with a Setpoint of 0.5 kPag
Step 8	9	Perform Nitrogen Purge (See 7.4.2 Below)
Step 9	10	Begin kiln operating sequence (see 7.4.3 Below)

Step #	Equip. No.	Step Description	Status
1		Start – Cooling water services to kiln	ENERGISED
1(a)	HV415114	ZSO415114 ENERGISED	OPEN

1(b)	HV415115	ZSO415115 ENERGISED	OPEN
2		Start – Reduction Kiln 1	
2(a)		Reduction kiln 1 main drive	AUTO
2(b)		START Reduction kiln 1 main drive	RUNNING
3		Input Temperature Controller Set Points	
3(a)	TI415103	Zone 1 Burner 1 Pyrometer Temperature	SET POINT
3(b)	TI415131	Zone 1 Burner 2 Pyrometer Temperature	SET POINT
3(c)	TI415105	Zone 2 Burner 1 Pyrometer Temperature	SET POINT
3(d)	TI415133	Zone 2 Burner 2 Pyrometer Temperature	SET POINT
3(e)	TI415107	Zone 3 Burner 1 Pyrometer Temperature	SET POINT
3(f)	TI415135	Zone 3 Burner 2 Pyrometer Temperature	SET POINT
3(g)	TI415104	Zone 1 Burner 1 Thermo Temperature	SET POINT
3(h)	TI415132	Zone 2 Burner 1 Thermo Temperature	SET POINT
3(i)	TI415106	Zone 2 Burner 2 Thermo Temperature	SET POINT
3(j)	TI415134	Zone 3 Burner 1 Thermo Temperature	SET POINT
3(k)	TI415108	Zone 3 Burner 2 Thermo Temperature	SET POINT
4		Group start - Burner Management System (BMS)	
4(a)		Burner Management System (BMS)	AUTO
4(b)		START Burner Management System (BMS)	RUNNING
5		Kiln Temperatures	
5(a)	TI415103	Zone 1 Burner 1 Pyrometer Temperature	PV=SP
5(b)	TI415131	Zone 1 Burner 2 Pyrometer Temperature	PV=SP
5(c)	TI415105	Zone 2 Burner 1 Pyrometer Temperature	PV=SP
5(d)	TI415133	Zone 2 Burner 2 Pyrometer Temperature	PV=SP
5(e)	TI415107	Zone 3 Burner 1 Pyrometer Temperature	PV=SP
5(f)	TI415135	Zone 3 Burner 2 Pyrometer Temperature	PV=SP
5(g)	TI415104	Zone 1 Burner 1 Thermo Temperature	PV=SP
5(h)	TI415132	Zone 2 Burner 1 Thermo Temperature	PV=SP
5(i)	TI415106	Zone 2 Burner 2 Thermo Temperature	PV=SP
5(j)	TI415134	Zone 3 Burner 1 Thermo Temperature	PV=SP
5(k)	TI415108	Zone 3 Burner 2 Thermo Temperature	PV=SP
6		Group start – Kiln feed	
6(a)		Start feed system according to heat up schedule	
7		Baghouse Air Bleed System	
7(a)	TIC415301	Baghouse air bleed temperature controller	SET POINT
7(a)	TCV415301	Baghouse air bleed damper (41DA503)	AUTO

7.4.2 Reduction kiln purge

This information is an interpretation of vendor data and is provided as information only. The Vendor Document *C50-XXX XXXX XXXX* should be used as the official reference documentation for the Area 41 Reduction kilns and associated equipment.

The reduction kiln purge is required for the following conditions:

- Start-up from cold
- Restart after more than 2 hours downtime

Prerequisites

No.	TAG No.	Equip. No.	Description	Status
1		Various	Plant Air	AVAILABLE
2		Various	Cooling Water	AVAILABLE
3			Ammonia scrubbing system	RUNNING
4			Baghouse system	RUNNING
5	PI505933		Nitrogen	AVAILABLE
6			Kiln preheated 600C	COMPLETE

Start Sequence

Prerequisite	Step No.	Description
	1	Ensure Reduction Kiln 1 Pressure Control (PIC415305) is operating in AUTO
	2	Ensure valves FV505934 and FV505935 are CLOSED
Steps 1-2	3	OPEN FV505934
Step 3	4	Allow ~ 40 Nm^3 of nitrogen through the Reduction kiln (as determined from FQ505933)
Step 4	5	CLOSE FV505934

Step #	Equip. No.	Step Description	Status
1		Reduction Kiln 1 Pressure Control	
1(a)	PIC415305	Reduction kiln I pressure controller	AUTO
1(b)	PCV415305	Reduction kiln I pressure valve	AUTO
2		Nitrogen Purge Sequence	
2(a)		ZSC50934 ENERGISED	CLOSED
2(b)		ZSC50935 ENERGISED	CLOSED
2(c)	FQI505933	Input nitrogen flow	SET POINT
2(d)	HS50933	Kiln selection hand switch	SELECT
2(e)		ZSO50934 ENERGISED	OPEN
2(f)	FQI50933	Nitrogen flow totaliser	PV = SP
2(g)		ZSC50934 ENERGISED	CLOSED

7.4.3 Reduction Kiln Operation

This information is an interpretation of vendor data and is provided as information only. The Vendor Document *C50-XXX XXXX XXXX* should be used as the official reference documentation for the Area 41 Reduction kilns and associated equipment.

Local Prerequisites

No.	TAG No.	Equip. No.	Description	Status
1		Various	Plant Air	AVAILABLE
2		Various	Cooling Water	AVAILABLE
3			Ammonia scrubbing system	RUNNING
4			Baghouse system	RUNNING
5		41BIN501	AMV bin	SUFFICIENT CAPACITY
6		41BIN504	Reduction Kiln Product Bin	SUFFICIENT CAPACITY
7		Various	Kiln preheated to 600 C	COMPLETE

Start Sequence

Prerequisite	Step No.	Description
	1	Ensure Cooling water services are being supplied to Reduction Kiln
	2	Ensure Kiln Main Drive is RUNNING in AUTO
Steps 1-2	3	Set Kiln temperature ramp up schedule
Step 3	4	Set Burner zones' Operating-Temperature setpoints
Step 4	5	OPEN 41GA501
Step 5	6	Set Loss of weight - mass flow controller (HIC415136) to AUTO with setpoint determined from ramp up schedule
Step 6	7	START 41FDS501 in AUTO
Step 7 + XX min (or LAH415110 is Activated)	8	START 41FDS502 in AUTO
Step 8	9	START 41ROV502 in AUTO

Step #	Equip. No.	Step Description	Status
1		Start – Cooling water services to kiln	ENERGISED
1(a)	HV415114	ZSO415114 ENERGISED	OPEN
1(b)	HV415115	ZSO415115 ENERGISED	OPEN
2		Group start - Kiln Main Drive	
2(a)	41KLN501	Kiln Main Drive	AUTO
2(b)	41KLN501	START Kiln Main Drive	RUNNING
3		Kiln Temperature	
3(a)		Review temperature across kiln	

Step #	Equip. No.	Step Description	Status
3(b)		Set ramp up schedule	
4		Input Temperature Controller Set Points	
4(a)	TI415103	Zone 1 Burner 1 Pyrometer Temperature	SET POINT
4(b)	TI415131	Zone 1 Burner 2 Pyrometer Temperature	SET POINT
4(c)	TI415105	Zone 2 Burner 1 Pyrometer Temperature	SET POINT
4(d)	TI415133	Zone 2 Burner 2 Pyrometer Temperature	SET POINT
4(e)	TI415107	Zone 3 Burner 1 Pyrometer Temperature	SET POINT
4(f)	TI415135	Zone 3 Burner 2 Pyrometer Temperature	SET POINT
4(g)	TI415104	Zone 1 Burner 1 Thermo Temperature	SET POINT
4(h)	TI415132	Zone 2 Burner 1 Thermo Temperature	SET POINT
4(i)	TI415106	Zone 2 Burner 2 Thermo Temperature	SET POINT
4(j)	TI415134	Zone 3 Burner 1 Thermo Temperature	SET POINT
4(k)	TI415108	Zone 3 Burner 2 Thermo Temperature	SET POINT
5		Input Temperature Controllers	
5(a)	TI415103	Zone 1 Burner 1 Pyrometer Temperature	AUTO
5(b)	TI415131	Zone 1 Burner 2 Pyrometer Temperature	AUTO
5(c)	TI415105	Zone 2 Burner 1 Pyrometer Temperature	AUTO
5(d)	TI415133	Zone 2 Burner 2 Pyrometer Temperature	AUTO
5(e)	TI415107	Zone 3 Burner 1 Pyrometer Temperature	AUTO
5(f)	TI415135	Zone 3 Burner 2 Pyrometer Temperature	AUTO
5(g)	TI415104	Zone 1 Burner 1 Thermo Temperature	AUTO
5(h)	TI415132	Zone 2 Burner 1 Thermo Temperature	AUTO
5(i)	TI415106	Zone 2 Burner 2 Thermo Temperature	AUTO
5(j)	TI415134	Zone 3 Burner 1 Thermo Temperature	AUTO
5(k)	TI415108	Zone 3 Burner 2 Thermo Temperature	AUTO
6		Group start – Kiln feed system	
6(a)	41GA501	OPEN Kiln buffer feed silo gate	OPEN
6(b)	WIC415102	Reduction kiln 1 buffer silo weight controller Note set point according to ramp up schedule	SET POINT
6(c)	41FDS501	Reduction kiln 1 buffer silo discharge screw	AUTO
6(d)	41FDS501	START Reduction kiln 1 buffer silo discharge screw	RUNNING
7		Group Start – Reduction Kiln Discharge	
7(a)	41FDS502	Reduction kiln 1 discharge screw	AUTO
7(b)	41FDS502	START Reduction kiln 1 discharge screw	RUNNING
7(c)	41ROV502	Reduction kiln 1 discharge rotary valve	AUTO
7(d)	41ROV502	START Reduction kiln 1 discharge rotary valve	RUNNING
8		End Sequence	

7.5 Burner Management System

Thermal systems to provide

8.0 SHUTDOWN

Due to the release of particulates and gases form the reduction kilns, the off gas scrubber is always shut down after the kilns. For this reason the shut down sequence is divided into to distinct sections:

- Reduction Kilns
- Off Gas Scrubber

8.1 Shutdown Sequence

The following are the controlled shutdown sequences in this area:

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 equipment initiated by the CCR operator. Due to the immediate stoppage, kilns, scrubbing system and associated equipment are burdened with material. Start-up after a crash stop is initiated by the CCR operator via a group start sequence at the DCS. No sequence is provided for a crash stop; rather all equipment is stopped instantaneously.

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 that the kilns, scrubbing system and associated equipment are run empty. To enable a controlled shutdown, local interlocks are overridden.

8.1.1 Reduction Kilns

Two scenarios will be discussed for the reduction kiln shit down procedures, the controlled shut, and a crash stop due to power outage.

8.1.1.1 Stop due to Power Outage

This information is an interpretation of vendor data and is provided as information only. The Vendor Document *C50-XXX XXXX XXXX* should be used as the official reference documentation for the Area 41 Reduction kilns and associated equipment.

Stop Sequence

Prerequisite	Step No.	Description
	1	Ensure Cooling water services are being supplied to Reduction Kiln
Step 1	2	Switch Reduction Main Kiln Drive to Emergency Power
Step 2	3	START Main Drive from Emergency power in AUTO
Step 3	4	Allow all burner zones to cool below 600 C

Step #	Equip. No.	Step Description	Status
1		Group Start essential services in Emergency Power	
1(a)	41KLN501A/B	Switch Kiln Drive to Emergency Power	ACHIEVED
1(b)	50PPC508A/B	Switch Cooling Water Pump to Emergency Power	ACHIEVED
2		Cool Kiln To Safe Temperature	
2(a)	TI415103	Zone 1 Burner 1 Pyrometer Temperature =< 600 C	ACHIEVED
2(b)	TI415131	Zone 1 Burner 2 Pyrometer Temperature =< 600 C	ACHIEVED
2(c)	TI415105	Zone 2 Burner 1 Pyrometer Temperature =< 600 C	ACHIEVED
2(d)	TI415133	Zone 2 Burner 2 Pyrometer Temperature =< 600 C	ACHIEVED
2(e)	TI415107	Zone 3 Burner 1 Pyrometer Temperature =< 600 C	ACHIEVED
2(f)	TI415135	Zone 3 Burner 2 Pyrometer Temperature =< 600 C	ACHIEVED
2(g)	TI415104	Zone 1 Burner 1 Thermo Temperature =< 600 C	ACHIEVED
2(h)	TI415132	Zone 2 Burner 1 Thermo Temperature =< 600 C	ACHIEVED
2(i)	TI415106	Zone 2 Burner 2 Thermo Temperature =< 600 C	ACHIEVED
2(j)	TI415134	Zone 3 Burner 1 Thermo Temperature =< 600 C	ACHIEVED
2(k)	TI415108	Zone 3 Burner 2 Thermo Temperature =< 600 C	ACHIEVED

8.1.1.2 Controlled Stop

This information is an interpretation of vendor data and is provided as information only. The Vendor Document *C50-XXX XXXX XXXX* should be used as the official reference documentation for the Area 41 Reduction kilns and associated equipment.

Stop Sequence

Prerequisite	Step No.	Description
	1	Set TIC415301 to MANUAL with Damper 100% OPEN
Step 1	2	STOP 41FDS501
Step 2	3	Set all burner zone temp set points =< 600 C
Step 3	4	STOP 41FDS502
Step 4	5	STOP 41ROV502
Step 5 (If for prolonged stop)	6	STOP Burners

Step #	Equip. No.	Step Description	Status
1	41FDS501	Stop Kiln Feed	STOPPED
2		Cool Kiln To Safe Temperature	
2(a)	TI415103	Zone 1 Burner 1 Pyrometer Temperature =< 600 C	ACHIEVED
2(b)	TI415131	Zone 1 Burner 2 Pyrometer Temperature =< 600 C	ACHIEVED
2(c)	TI415105	Zone 2 Burner 1 Pyrometer Temperature =< 600 C	ACHIEVED
2(d)	TI415133	Zone 2 Burner 2 Pyrometer Temperature =< 600 C	ACHIEVED
2(e)	TI415107	Zone 3 Burner 1 Pyrometer Temperature =< 600 C	ACHIEVED
2(f)	TI415135	Zone 3 Burner 2 Pyrometer Temperature =< 600 C	ACHIEVED
2(g)	TI415104	Zone 1 Burner 1 Thermo Temperature =< 600 C	ACHIEVED
2(h)	TI415132	Zone 2 Burner 1 Thermo Temperature =< 600 C	ACHIEVED
2(i)	TI415106	Zone 2 Burner 2 Thermo Temperature =< 600 C	ACHIEVED
2(j)	TI415134	Zone 3 Burner 1 Thermo Temperature =< 600 C	ACHIEVED
2(k)	TI415108	Zone 3 Burner 2 Thermo Temperature =< 600 C	ACHIEVED
3		Group Stop Kiln Discharge Equipment	
3(a)	41FDS502	Stop Reduction Kiln Discharge Screw	STOPPED
3(b)	41ROV502	Stop Reduction Kiln Discharge Rotary Valve	STOPPED
4		Turn off Burners	DEACTIVATED

8.1.2 Reduction Kiln Off Gas Scrubbing

This information is an interpretation of vendor data and is provided as information only. The Vendor Document *C50-102 PROCESS OPERATING MANUAL* and *C50-145 FUNCTIONAL SPECIFICATION* should be used as the official reference documentation for the gas scrubber in area 41.

Prerequisites

No.	TAG No.	Equip. No.	Description	Status
1		Various	Reduction Kiln Area	Shut Down

Stop Sequence

Prerequisite	Step No.	Description
	1	STOP 41FAN503
	2	SET AIC415315 to MANUAL at 0 output
Steps 1-2 + 30s	3	STOP 41PPC506
Step 3	4	SET HV415310to MANUAL and CLOSED
Step 4	5	STOP 41PPC505
Step 5	6	STOP 41PPC504
Step 6	7	SET LIC415309 to MANUAL at 0 output

Step #	Equip. No.	Step Description	Status
1		Open V_2O_3 Bag house air bleed damper	
1(a)	TIC415301	Set Temperature Control to MANUAL	MANUAL
1(b)	TCV415301	OPEN air bleed damper to 100%	OPEN
2	HV415310	CLOSE Raw Water valve (ZSC415310)	ENERGISED
3		Stop Acid addition	
3(a)	AIC415315	Turn pH control to MANUAL	MANUAL
3(b)	ACV415315	CLOSE acid addition valve	CLOSED
4	41PPC506	Turn OFF 2nd stage recirculation pump	STOPPED
5		Stop Scrubber Bleed	
5(a)	41PPC504	Turn OFF Scrubber bleed pump	STOPPED
5(b)	SV4153XX	CLOSE scrubber bleed valve (ZSC4153XX)	ENERGISED
6		Turn off Scrubber Tower Level Control	
6(a)	LIC415309	Set Scrubbing Tower Level control to MANUAL	MANUAL
6(b)	LCV415309	CLOSE Barren Liquor addition valve	CLOSED
7	41PPC505	Turn OFF 1st stage recirculation pump	STOPPED
8	41FAN503	Turn OFF Extraction Fan	STOPPED
9	AE415322	Turn OFF Opacity monitor	STOPPED

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9.0 INTERLOCKS

9.1 Equipment Interlocks

The following equipment interlocks apply in this area:

- All actuated valves are equipped with proximity switches to indicate (ZSO) valve open and closed (ZSC) position. Where the actuated valves are associated with the isolation of a pump, the failure of the valve will interlock the operation of the pump.

- Pumps fed from tanks or hoppers equipped with continuous level measurement (LI) are interlocked at Low Level (LAL) to prevent damage to the pump due to cavitation.

- Streams split into multiple directions using actuated valves are interlocked such that only one valve can be open at a time. The failure of any valve will interlock the operation of the supply pump.

9.2 Process Interlocks

The following process interlocks apply in this area:

Equipment	Interlocks
41FDS501	Reduction Kiln 1 Buffer Silo (41BIN501) LAL415101
	Reduction Kiln 1 Buffer Silo (41BIN501) WAL415102
	Reduction Kiln 1 Drop Box (41KLN501) LAH415110
	Reduction Kiln 1 Discharge Screw (41FDS502) FAILURE
	Reduction Kiln 1 Discharge Rotary Valve (41ROV502) FAILURE
41FDS502	Reduction Kiln 1 Discharge Rotary Valve (41ROV502) FAILURE
	Reduction Kiln Product Bin (41BIN504) LAH415216
	Reduction Kiln Product Bin (41BIN504) WAH415217
41ROV502	Reduction Kiln Product Bin (41BIN504) LAH415216
	Reduction Kiln Product Bin (41BIN504) WAH415217
41FDS503	Reduction Kiln 2 Buffer Silo (41BIN502) LAL415201
	Reduction Kiln 2 Buffer Silo (41BIN502) WAL415202
	Reduction Kiln 2 Drop Box (41KLN502) LAH415228
	Reduction Kiln 2 Discharge Screw (41FDS504) FAILURE
	Reduction Kiln 2 Discharge Rotary Valve (41ROV504) FAILURE
41FDS504	Reduction Kiln 2 Discharge Rotary Valve (41ROV504) FAILURE
	Reduction Kiln Product Bin (41BIN504) LAH415216
	Reduction Kiln Product Bin (41BIN504) WAH415217
41ROV502	Reduction Kiln Product Bin (41BIN504) LAH415216
	Reduction Kiln Product Bin (41BIN504) WAH415217
ACV415320	2nd stage recirculation pump (41PPC506) FAILURE

Aside from the interlocks given above, several interlocks will be present in the kiln off gas system that will cause a shut of critical equipment in the area.

The failure of the extraction fan (41FAN503) at the scrubber discharge will result in the shut down of both reduction kiln feed screws (41FDS501, 41FDS503).

The Failure of the 1st and / or 2nd recirculation pumps (41PPC505 and 41PPC506 respectively) will also result in the shut down of the reduction kiln feed screws.