



MIDWEST VANADIUM PTY LTD

WINDIMURRA VANADIUM PROJECT

PROCESS DESIGN CRITERIA

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1.0 Introduction

The Design Criteria forms the basis for the design of the Windimurra Vanadium Project ore processing facilities and associated plant services.

Together with the Process Flow Diagrams, this data allows for the definition of the MetSim[®] model and generation of a mass balance for the design and specification of equipment. In addition it allows the development of schedules for operating requirements such as water, reagents and power.

Any recovery or similar data stated in the Design Criteria are used for design purposes and should not be construed as a statement of predicted plant performance.

Two production scenarios are presented in the Design Criteria and these only apply to Facility, 40, 41 and 45, namely:

- V2O5 Flake / FeV scenario assumes the production of flake and FeV
- FeV production assumes complete production of FeV

2.0 Reference List

The Process Design Criteria is based on data from a variety of sources. In order that the basis for the design criteria is fully understood, it is important that all data be referred to a source. The referencing of data within this document is as follows:

CODE	DESCRIPTION
1	Metallurgical testwork/simulation
2	Calculation
3	Engineer's experience/recommendation
4	Assumption
5	Normal practice
6	Vendor prediction
7	Client Data/Recommendation
8	Australian Bureau of Meteorology
9	Signet Value
10	Hatch Definitive Feasibility Study
11	Drytech
12	Vendor Supplied Information

3.0 Site Data

No	Item	Units	Value	Ref.	Rev.
3.01	<u>Location</u>				
	Country / State		80 km ESE of Mt Magnet	10	[A]
	Latitude		28°17'27.38"	8	[A]
	Longitude		118°32'03.89"	8	[A]
	Nearest town		Mt Magnet	10	[A]
	Site elevation	m	474	8	[A]
3.02	<u>Temperature</u>				
	Mean monthly maxima				
	July	C	18.70	10	[A]
	January	C	38.20	10	[A]
	Extreme	C	46.10	10	[A]
	Mean monthly minima				
	July	C	6.70	10	[A]
	January	C	22.20	10	[A]
	Extreme	C	-1.5	10	[A]
3.03	<u>Wet bulb temperature</u>				
	Maximum	C	20.90	8	[B]
	Minimum	C	9.10	8	[B]
3.04	<u>Dew point (3pm)</u>				
	July	C	5.10	8	[A]
	January	C	8.70	8	[A]
3.05	<u>Rainfall</u>				
	Annual mean rainfall	mm	238.8	10	[A]
	Wet days	d/a	46	10	[A]
	Wet period		Some light falls throughout the year	10	[A]
			Wettest months are May, June and July	10	[A]
	Highest recorded daily	mm	113	7	[A]
3.06	<u>Evaporation</u>				
	Annual mean	mm/a	2,590	10	[A]
3.07	<u>Relative Humidity</u>				
	January	9:00 am	% relative	35	8 [A]
		3:00 pm	% relative	21	8 [A]
	June	9:00 am	% relative	74	8 [A]
		3:00 pm	% relative	50	8 [A]
3.08	<u>Wind</u>				
	Direction		NE to SE	10	[A]
	Mean 9am wind speed	m/s	3.3	8	[A]
	Mean 3pm wind speed	m/s	3.3	8	[A]
	Regional wind speed limit for state design	m/s	43.4	3	[H]
	Maximum wind speed for serviceable design	m/s	37.0	3	[H]
3.09	<u>Dust Conditions</u>				
	Insoluble solids deposition	g/m ² /month	tba	-	-
3.10	<u>Site Seismic Conditions</u>				
	Design code		AS1170.4	3	[B]
	Importance level		2	3	[B]
	Annual probability of exceedance		1/500 years	3	[B]
	Acceleration coefficient		0.07	3	[B]
	Probability factor		1	3	[B]
	Site factor	structures founded on rock	0.67	3	[B]
		structures founded on fill	1.0	3	[B]
3.11	<u>Project Life</u>				
	Project life	Years	20	7	[A]
	Equipment design life	Years	20	7	[A]

4.0 Plant Availability and Throughput

No	Item	Units	Value	Ref.	Rev.
4.01	<u>Average Plant Availability and Throughput</u>				
	Annual magnetic ore treatment rate	t/a	1,034,900	7	[E]
	Operating days per year	days	365	3	[A]
	Operating hours per day	h	24	3	[A]
	Available operating hours per year	h/a	8,760	2	[A]
	Plant availability	%	90.2	7	[A]
	Available Hours	h	7,900	2	[A]
	Average magnetic ore treatment rate	t/h	131.00	2	[A]
4.02	<u>Unit Operation and Availability</u>				
		Operation	Availability		
	Facility 19 - Evaporation	Continuous	90.2	4	[A]
	Facility 20 - Roasting	Continuous	90.2	4	[A]
	Facility 25 - Leach	Batch	90.2	4	[A]
	Facility 30 - Desilication	Continuous	90.2	4	[A]
	Facility 35 - Ammonium Vanadate Production	Continuous	90.2	4	[A]
	Facility 36 - Flash Dryer	Continuous	90.2	11	[G]
	Facility 41 - V ₂ O ₃ Production	Continuous	90.2	11	[2]
	Facility 40 - V ₂ O ₅ Production future operating spli	% of available hours	13.25	7	[2]
	Facility 41 - V ₂ O ₃ Production future operating spli	% of available hours	86.75	7	[2]
	Facility 45 - Ferro Vanadium Plant Production	Batch	90.2	11	[G]
	Facility 45 - Ferro Vanadium Handling/Packaging	Batch	90.2	11	[G]
	Facility 50 - Plant Services	Continuous	90.2	4	[A]
	Facility 55 - Borefield	Continuous	90.2	4	[A]

5.0 V2O5 Department and Production

No	Item	Units	Production Scenarios		Ref.	Rev.
			V2O5/FeV	FeV		
5.01	<u>Ammonium Metavanadate Production</u>					
	Ammonium metavanadate production (dry basis)	t/a	14,023.18		2	[I]
		V t/a	6,106.82		2	[I]
		V ₂ O ₅ t/a	10,901.76		2	[I]
	Overall recovery for design for AMV	%	82.95		2	[I]
5.02	<u>V2O5 Flake Production</u>					
	V2O5 production (dry basis)	V ₂ O ₅ t/a	1,451.76	-	2	[I]
		V t/a	813.23	-	2	[I]
	Overall recovery for design for V2O5	%	11.05	-	2	[I]
5.03	<u>V2O3 Production</u>					
	V2O3 production (dry basis)	V ₂ O ₃ t/a	7,787.44	8983.79	2	[2]
		V t/a	5,293.59	6106.82	2	[I]
		V ₂ O ₅ t/a	9,450.00	10901.76	2	[I]
	Overall recovery for design for V2O5	%		71.90	2	[I]
5.04	<u>FeV Production</u>					
	V2O5 to Fe V conversion rate	%		96	7	[I]
	FeV Production equivalent	V ₂ O ₅ t/a	9,072.00	10,465.69	2	[I]
5.05	<u>Overall Production</u>					
	V2O5 Flake Product	V ₂ O ₅ t/a	1,451.76	-	2	[I]
	Ferrovanadium - FeV	V ₂ O ₅ t/a	9,072.00	10,465.69	2	[I]
	Overall	V ₂ O ₅ t/a	10,523.76	10,465.69	2	[I]
0.01	<u>Overall Recovery</u>					
	V2O5 Flake Product	%	11.05		2	[I]
	Ferrovanadium - FeV	%	69.02	79.63	2	[I]
	Overall	%	80.07	79.63	2	[I]

6.0 Feed Stock, Elemental and Mineralogical Composition

No	Item	Units	Value	Ref.	Rev.		
6.01	<u>Feed Stock</u>						
	Type		Magnetic minerals from beneficiation plant	7	[A]		
	Moisture content	%	9.0	7	[A]		
6.02	<u>Feed Stock (Solid) Elemental Composition</u>						
	H Hydrogen	%	0.00	2	[A]		
	C Carbon	%	0.21	2	[A]		
	O Oxygen	%	31.28	2	[A]		
	Na Sodium	%	0.05	2	[A]		
	Mg Magnesium	%	0.25	2	[A]		
	Al Aluminium	%	1.24	2	[A]		
	Si Silicon	%	1.17	2	[A]		
	P Phosphorous	%	0.00	2	[A]		
	S Sulfur	%	0.04	2	[A]		
	K Potassium	%	0.02	2	[A]		
	Ca Calcium	%	0.11	2	[A]		
	Ti Titanium	%	10.19	2	[A]		
	V Vanadium	%	0.71	2	[A]		
	Mn Manganese	%	0.22	2	[A]		
	Fe Iron	%	54.46	2	[A]		
	Zn Zinc	%	0.05	2	[A]		
6.03	<u>Feed Stock Mineralogical Composition</u>						
	SiO ₂ Gangue	%	2.50	2	[A]		
	Fe ₃ O ₄ Magnetite	%	74.72	2	[A]		
	Fe ₂ O ₃ Hematite	%	0.00	2	[A]		
	TiO ₂ Rutile	%	17.00	2	[A]		
	CaCO ₃ Calcite	%	0.27	2	[A]		
	MgCO ₃ Magnesite	%	0.86	2	[A]		
	FeV ₂ O ₄	%	1.55	2	[A]		
	V ₂ O ₅ Vanadium Pentoxide	% equivalent	1.27	2	[A]		
	Na ₂ SO ₄ Thenardite	%	0.17	2	[A]		
	Al ₂ O ₃ Corundum	%	2.35	2	[A]		
	ZnCO ₃ Smithsonite	%	0.10	2	[A]		
	MnCO ₃ Rhodochrosite	%	0.46	2	[A]		
6.05	<u>Feed Stock Particle Size Analysis</u>						
	Sizing (µm)						
	500	% Passing	100	7	[A]		
	75	% Passing	50	7	[A]		
	P ₈₀	µm	150	7	[A]		
6.04	<u>Mineral Specific Data</u>						
No	Item	Molecular Weight (g/mole)	Specific Gravity (t/m ³)			Ref.	Rev.
			Range	Average	Design		
	Fe ₃ O ₄ Magnetite	231.54	5.1 - 5.2	5.15	5.18	3	[A]
	Fe ₂ O ₃ Hematite	159.69	-	5.30	5.24	3	[A]
	TiO ₂ Rutile	79.88	-	4.25	4.26	3	[A]
	CaCO ₃ Calcite	100.09	-	-	2.71	3	[A]
	MgCO ₃ Magnesite	84.31	-	-	3.00	3	[A]
	V ₂ O ₅ Shcherbinaite	181.86	3.2-3.36	3.28	3.28	3	[A]
	Na ₂ SO ₄ Thenardite	142.04	2.67 - 2.7	2.68	2.68	3	[A]
	Al ₂ O ₃ Corundum	101.96	4.00 - 4.10	4.05	4.05	3	[A]
	ZnCO ₃ Smithsonite	125.4	4.40 - 4.50	4.45	4.45	3	[A]
	MnCO ₃ Rhodochrosite	114.95	-	3.69	3.69	3	[A]
6.06	<u>Feed Stock Density (dry basis)</u>						
	Calculated (Metsim®)	t/m ³		4.76		2	[A]
	Measured	t/m ³		4.60		7	[A]
6.07	<u>Feed Stock Bulk Densities (dry basis)</u>						
	Average loose bulk density	t/m ³		2.80		7	[A]

6.0 Feed Stock, Elemental and Mineralogical Composition

No	Item	Units	Value	Ref.	Rev.
6.08	<u>Aqueous Composition</u>				
	Source		low salinity bore water	7	[A]
	Total dissolved solids	mg/L	tba	-	-
	pH		tba	-	-
	Elemental analysis				
			Assay	Calculated	
	Ca Calcium	mg/L	160	160	2 [A]
	Mg Magnesium	mg/L	120	120	2 [A]
	Na Sodium	mg/L	780	780	2 [A]
	K Potassium	mg/L	40	40	2 [A]
	Cl Chloride	mg/L	1,450	1450	2 [A]
	SO ₄ Sulphate	mg/L	400	400	2 [A]
	Component analysis				
	H ₂ O Water	%	-	99.69	2 [A]
	CaCO ₃ Calcium carbonate	%	-	0.02	2 [A]
	CaSO ₄ Calcium sulfate	%	-	0.03	2 [A]
	MgSO ₄ Magnesium sulfate	%	-	0.02	2 [A]
	Na ₂ SO ₄ Sodium sulfate	%	-	0.00	2 [A]
	K ₂ SO ₄ Potassium sulfate	%	-	0.00	2 [A]
	NaCl Sodium chloride	%	-	0.20	2 [A]
	KCl Potassium chloride	%	-	0.01	2 [A]
	MgCl ₂ Magnesium chloride	%	-	0.03	2 [A]
	CaCl ₂ Calcium chloride	%	-	0.00	2 [A]

7.0 Kiln Off-Gas System (Facility 19)

No	Item	Units	Value	Ref.	Rev.
Design Criteria					
7.01	<u>Operating Schedule</u>				
	Operating days per year	days	365	3	[A]
	Operating hours per day	h/d	24	3	[A]
	Availability	%	90.2	9	[A]
7.02	<u>Cyclones</u>				
	Status		new	4	[G]
	Duty				
	Description		high solids separation efficiency	4	[G]
	Solids separation efficiency	% of total feed	>90	4	[G]
	Temp	C	400	4	[G]
	No. Installed		4	6	[G]
7.03	<u>Pre-Quencher</u>				
	Status		new	4	[G]
	Quenching fluid		raw water, dilute pregnant solution & circulating slurry	4	[G]
	Duty				
	Description		high efficiency gas saturation	4	[G]
	Saturation efficiency	%	>99.9	4	[G]
	V ₂ O ₅ concentration	g/L	100	4	[G]
7.04	<u>Venturi Scrubber</u>				
	Status		new	4	[G]
	Package supplier		Process Plant Technology Pty Ltd	7	[G]
	Operation mode		continuous	7	[G]
	Duty				
	Description		high efficiency solids separation	4	[G]
	Efficiency	%	>99	4	[G]
7.05	<u>Gas/Liquid Separator</u>				
	Status		new	4	[G]
	Package supplier		Process Plant Technology Pty Ltd	7	[G]
	Operation mode		continuous	7	[G]
	Duty				
	Description		high efficiency demister	4	[G]
	Efficiency	%	>99	4	[G]
7.06	<u>Wash Zone</u>				
	Status		new	4	[G]
	Package supplier		Process Plant Technology Pty Ltd	7	[G]
	Operation mode		continuous	7	[G]
	Duty				
	Description		high efficiency wash	4	[G]
	Efficiency	%	>99	4	[G]

7.0 Kiln Off-Gas System (Facility 19)

No	Item	Units	Value	Ref.	Rev.
Basis for Design					
7.07	<u>Operating Schedule</u>				
	Operating hours per year	h/a	7,900	2	[G]
7.08	<u>Cyclones</u>				
	Feed				
	Solids	t/h	4.21	2	[G]
	Gas	Nm ³ /h	266,812	2	[G]
	Temperature	C	400	2	[G]
	Cyclone exhaust gas				
	Solids	t/h	0.42	2	[G]
	Gas	t/h	123.31	2	[G]
		Nm ³ /h	246,989	2	[G]
	Recovered Solids				
	Efficiency	%	90	2	[G]
	Solids	t/h	3.79	2	[G]
7.09	<u>Pre-Quencher/Venturi/Scrubber Tower</u>				
	Dilute preg solution				
	Flow rate	t/h	28.22	2	[G]
		m ³ /h	27.85	2	[G]
	Temperature	C	100.00	7	[G]
	Aqueous concentration	V ₂ O ₅ g/L	49.98	2	[G]
		V g/L	28.00	2	[G]
	Raw water makeup				
	Flow rate	t/h	5.52	2	[G]
		m ³ /h	5.52	2	[G]
	Temperature	C	20.00	7	[G]
	Evaporation rate (total)	t/h	37.50	2	[G]
	Off gas cooling	t/h	18.67	2	[2]
	Kiln feed moisture evap	t/h	18.83	2	[2]
	Discharge				
	Solids	t/h	0.42	2	[G]
	Solution	t/h	15.07	2	[G]
	Slurry	t/h	15.49	2	[G]
		m ³ /h	14.01	2	[G]
	Temperature	C	72.82	2	[G]
	Aqueous concentration	V ₂ O ₅ g/L	99.97	2	[G]
7.10	<u>Vent Gas</u>				
	Flow rate	Nm ³ /h	168,162	2	[G]
	Temperature	C	72.82	2	[G]
	Composition				
	H ₂ O	%	26.41	2	[G]
	Particulates	g/m ³	<30	7	[G]

8.0 Roasting (Facility 20)

No	Item	Units	Value	Ref.	Rev.
Design Criteria					
8.01	<u>Operating schedule</u>				
	Operating days per year	days	365	3	[A]
	Operating hours per day	h/d	24	7	[A]
	Availability	%	90.2	7	[A]
8.02	<u>Kiln</u>				
	Status		existing	7	[B]
	Operation mode		continuous	7	[A]
	Kiln parameters				
	Length	m	102	7	[A]
	Diameter	m	4.75	7	[A]
	Rotational speed	rpm	0.9	7	[A]
	Lining type		refractory castable, single layer	7	[A]
	Lining thickness	mm	150	7	[A]
	Kiln firing system		natural gas	7	[A]
	Kiln operation				
	Maximum design operating temperature	C	1,200	7	[A]
	Calcine discharge temperature	C	425	7	[A]
Reactions					
	H ₂ O(aq) --> H ₂ O (g)	Heat of Reaction kcal/kg mole	Extent %		
	CaCO ₃ (aq) --> CaCO ₃ (s)	10,520	100	4/7	[A]
	MgSO ₄ (aq) --> MgSO ₄ (a)	-150	100	4/7	[A]
	MgCl ₂ (aq) --> MgCl ₂ (s)	0	100	4/7	[A]
	NaCl (aq) --> NaCl (s)	-711	100	4/7	[A]
	KCl (aq) --> KCl (s)	0	100	4/7	[A]
	CaSO ₄ (aq) --> CaSO ₄ (a)	0	100	4/7	[A]
	Na ₂ CO ₃ (s) --> Na ₂ O (s) + CO ₂ (g)	-2120	100	4/7	[A]
	4Fe ₃ O ₄ (s) + O ₂ (g) --> 6Fe ₂ O ₃ (s)	-76,130	100	4/7	[A]
	V ₂ O ₅ (s) + Na ₂ O (s) --> 2NaVO ₃ (s)	-28,200	100	4/7	[A]
	Al ₂ O ₃ (s) + Na ₂ O (s) = Na ₂ O.Al ₂ O ₃ (s)	-78290	100	4/7	[A]
	2SiO ₂ (s) + Na ₂ O (s) --> Na ₂ Si ₂ O ₅ (s)	-41400	53	4/7	[B]
	MgCO ₃ (s) --> MgO (s) + CO ₂ (g)	-27,040	1.7	4/7	[A]
	CaCO ₃ (s) --> CaO (s) + CO ₂ (g)	27,886	100	4/7	[A]
	Na ₂ SO ₄ (s) --> Na ₂ O (s) + SO ₃ (g)	42,766	100	4/7	[A]
		137,416	100	4/7	[A]
8.03	<u>Kiln Discharge - Total</u>				
	Maximum instantaneous	% of kiln feed	200	7	[B]
Note: In then event of a ring collapse, the speed of the kiln will be reduced to limit the kiln discharge to a manageable level					
8.04	<u>Kiln Discharge Screen - Hot Screen</u>				
	Status		new	7	[D]
	Operation			3	[D]
	Mode		continuous	3	[D]
	Type		vibrating	3	[D]
	Aperture	mm	60	7	[D]
	Feed				
	Nominal at steady state	% of kiln discharge	136.14	7	[2]
	Maximum at instantaneous max	% of kiln discharge	272	7	[2]
	Feed Sizing (% passing)				
	250 mm	Nominal	Maximum	7	[D]
	100 mm	100	100	7	[D]
	75 mm	95	35	7	[D]
	60 mm	90	30	7	[D]
	50 mm	85	25	7	[D]
	20 mm	80	22	7	[D]
	3 mm	70	20	7	[D]
		60	18	7	[D]

8.0 Roasting (Facility 20)

No	Item	Units	Value	Ref.	Rev.	
8.04	<u>Kiln Discharge Screen - Hot Screen (continued)</u>					
	Screen Oversize - Calcine Lump					
	Production					
	Nominal at steady state	% of kiln discharge	10	7	[D]	
	Maximum at instantaneous max	% of kiln discharge	20	7	[D]	
	Physical properties					
	Temperature					
	Kiln discharge	C	425	7	[A]	
	P ₁₀₀	mm	250	7	[D]	
	Abrasion index	Average	0.0177	1	[E]	
		Maximum	0.0237	1	[E]	
	Crushing Wi	Average	2.9-3.5	1	[D]	
		Maximum	6.4	1	[D]	
	Screen Undersize - Calcine Fines					
	Production					
	Nominal at steady state	% of kiln discharge	90	7	[D]	
	Physical properties					
Temperature						
Kiln discharge	C	425	7	[D]		
Sizing (µm)						
P ₁₀₀	mm	60	7	[D]		
8.05	<u>Calcine Lump Crusher</u>					
	Status		new	7	[D]	
	Operation					
	Mode		continuous	3	[D]	
	Type		jaw crusher	3	[H]	
	Feed					
	Nominal at steady state	% of kiln discharge	10	7	[D]	
	Maximum at instantaneous max	% of kiln discharge	20	7	[D]	
	Physical properties					
	Temperature	Calcine lump	C	425	7	[D]
Product Sizing (µm)						
P ₁₀₀	mm	60	7	[D]		
8.06	<u>Cooling Water</u>					
	Source		potable water	7	[H]	
	Operation		forced air evaporative tower	7	[A]	
	Parameters					
	Cooling Capacity		kW	1,000	3	[H]
	Wet bulb temperature	maximum	C	20.90	8	[A]
		minimum	C	9.10	8	[A]
	Approach to wet bulb temperature		C	8.00	3	[A]
	Blowdown		% of feed	0.025	7	[A]
	Air addition		liquid/gas ratio	0.50	3	[A]

8.0 Roasting (Facility 20)

No	Item	Units	Value	Ref.	Rev.
Basis for Design					
8.07	<u>Operating Schedule</u>				
	Operating hours per year		7,900	2	[A]
8.08	<u>Kiln</u>				
	Feed				
	Magnetite Concentrate				
	Type		moist magnetic concentrate	7	[B]
	Solid mass flow	t/h	131.00	7	[B]
	Moisture content	%	11.39	7	[B]
	Composition				
	SiO ₂	%	2.50	2	[B]
	Fe ₃ O ₄	%	74.72	2	[B]
	Fe ₂ O ₃	%	0.00	2	[B]
	TiO ₂	%	17.00	2	[B]
	CaCO ₃	%	0.27	2	[B]
	MgCO ₃	%	0.86	2	[B]
	FeV ₂ O ₄	%	1.55	2	[B]
	V ₂ O ₅	% equivalent	1.27	2	[B]
	Na ₂ SO ₄	%	0.17	2	[B]
	Al ₂ O ₃	%	2.35	2	[B]
	ZnCO ₃	%	0.10	2	[B]
	MnCO ₃	%	0.46	2	[B]
	NaCl	%	0.00	2	[B]
	Sodium carbonate addition				
	Solid	t/h	5.11	2	[B]
	Addition rate equivalent	%	3.90	2	[B]
	Recovered dust				
	Solid	t/h	3.79	2	[H]
	Total solid mass feed rate	t/h	139.90	2	[H]
	Discharge				
	Solid mass flow	Nominal t/h	136.14	2	[B]
		Instantaneous maximum	272.28	2	[B]
	Solid mass gain	% of magnetite	3.92	2	[B]
	Calcine lump production	Nominal t/h	13.61	2	[B]
		Maximum	27.2	2	[D]
	Calcine fines production	Nominal t/h	122.53	2	[B]
	Calcine solids composition				
	SiO ₂	%	2.35	2	[B]
	Fe ₃ O ₄	%	0.00	2	[B]
	Fe ₂ O ₃	%	74.61	2	[B]
	TiO ₂	%	16.31	2	[B]
	CaCO ₃	%	0.00	2	[B]
	MgCO ₃	%	0.00	2	[B]
	K ₂ CO ₃	%	0.00	2	[B]
	FeV ₂ O ₅	% equivalent	0.22	2	[B]
	V ₂ O ₅ equivalent	%	1.22	2	[B]
	Na ₂ SO ₄	%	0.00	2	[B]
	Al ₂ O ₃	%	0.23	2	[B]
	ZnCO ₃	%	0.00	2	[B]
	MnCO ₃	%	0.00	2	[B]
	NaCl	%	0.02	2	[B]
	Sodium deportment				
	Soluble as NaVO ₃ , and/or Na ₂ O	%	45.00	2	[B]
	Insoluble as Na ₂ Al ₂ O ₄	%	55.00	2	[B]
	Vent				
	Oxygen content	% O ₂	5.00	2	[H]
	Temperature	C	400	2	[A]
8.09	<u>Kiln Discharge Screen - Hot Screen</u>				
	Feed				
	Solid mass flow	Nominal t/h	136.14	2	[2]
		Instantaneous max	272.28	2	[2]
	Override				
	Calcine lump production	Nominal t/h	20.42	2	[2]
		Maximum	40.84	2	[2]
	Undersize				
	Calcine fines production	Nominal t/h	115.72	2	[2]
		Maximum	231.4	2	[2]

8.0 Roasting (Facility 20)

No	Item	Units	Value	Ref.	Rev.
8.10	<u>Calcine Jaw Crusher</u>				
	Product				
	Solid mass flow	Nominal	t/h	20.42	2 [2]
		Instantaneous max	t/h	40.84	2 [2]
		Design	t/h	50.00	3 [D]
	Crusher Selection				
	Type		SHANBAO Jaw	11	[H]
	Model		PE 500 x 750 - 20 x 30"	11	[H]
	Number		1	11	[H]
	Installed power	kW	55	11	[H]
	Capacity	t/h	56	11	[H]
	Closed side setting	mm	40	11	[H]
	Open Side setting	mm	55	11	[H]
	Cooling water requirement	m ³ /h	35	11	[1]
8.11	<u>Natural Gas</u>				
	Kiln	Nm ³ /h	5,064	2	[B]
8.12	<u>Air addition to dryer and kiln</u>				
	Kiln	Nm ³ /h	317,792	2	[B]
8.13	<u>Cooling Water</u>				
	Consumption (instantaneous average)				
	Facility 20 - Kiln Bearings				
	Pier No 1	m ³ /h	0.90	6	[H]
	Pier No 2	m ³ /h	2.70	6	[H]
	Pier No 3	m ³ /h	1.50	6	[H]
	Pier No 4	m ³ /h	1.50	6	[H]
	Pier No 5	m ³ /h	0.90	6	[H]
	Total	m ³ /h	7.50	2	[H]
	Total (design)	m ³ /h	8.00	3	[H]
	Facility 20 - Crusher	m ³ /h	35	2/11	[H]
	Total	m ³ /h	43.00	3	[H]

9.0 Leach (Facility 25)

No	Item	Units	Value	Ref.	Rev.
Design Criteria					
9.01	<u>Operating Schedule</u>				
	Operating days per year	days	365	3	[A]
	Operating hours per day	h/d	24	3	[A]
	Availability	%	90.2	4	[B]
9.02	<u>Quench Tank</u>				
	Status		new	7	[B]
	Operation				
	Mode		continuous	7	[A]
	Type		static vessel	7	[A]
	Feed		calcine via pan conveyor	7	[A]
	Operating conditions				
	Temperature	C	100	7	[A]
	Pulp density	% w/w	50	3	[A]
	Density & temperature control				
	Startup		slug dose	7	[A]
	Ongoing		vat recycle solution	7	[A]
9.03	<u>Quench Scrubber</u>				
	Status		new	7	[B]
	Operation				
	Mode		continuous	3	[A]
	Type		wet venturi scrubber	3	[A]
	Operating conditions				
	Inlet temperature	C	100	7	[A]
	Saturation	% H ₂ O	100	3	[A]
9.04	<u>Leach Slurry Distribution Chute</u>				
	Status		new	7	[B]
	Operation mode		continuous	7	[A]
9.05	<u>Vats</u>				
	Status		existing	7	[B]
	Operation mode		batch	7	[A]
	Construction		concrete, steel lined	7	[A]
	Parameters				
	Number		3	7	[A]
	Length	m	25	7	[A]
	Width	m	10	7	[A]
	Depth (bottom of trays)	m	5.6	7	[A]
	Depth (bottom of live fill level)	m	4.7	7	[A]
	Volumetric capacity per vat	m ³	1,400	2	[A]
	Volumetric solution capacity per vat	m ³	1,200	7	[A]
	Calcine stacked bulk density	t/m ³	2.5	7	[A]
	Calcine mass capacity per vat	t	2,400	7	[A]
	Reactions				
	NaVO ₃ (s) --> NaVO ₃ (aq)	kcal/kg mole	4,565	7	[A]
	Na ₂ Si ₂ O ₅ (s) + H ₂ O (aq) --> SiO ₂ (aq) + NaOH (aq)	%	100	7	[A]
	Na ₂ O (s) + H ₂ O --> 2NaOH (aq)		337,515	7	[A]
	MgO (s) + H ₂ O (aq) --> Mg(OH) ₂ (aq)		-36,585	7	[H]
	CaO (s) + H ₂ O (aq) --> Ca(OH) ₂ (aq)		-9,475	7	[A]
			-19,605	7	[A]
9.06	<u>Cycle Parameters</u>				
	Pregnant liquor V ₂ O ₅ concentration	g/L	50	7	[A]
	Soluble loss	%	4	7	[A]
9.07	<u>Slug Dose Tank</u>				
	Status		existing	7	[B]
	Operation mode		batch	5	[A]
	Type		mechanically agitated	7	[A]
	Construction		carbon steel, internally painted	7	[A]
	Number of tanks existing		2	7	[B]
	Number of tanks new		1	7	[B]
	Tank dimensions				
	Diameter	m	13.4	7	[A]
	Height	m	9.6	7	[A]
	Tank capacity				
	Total	m ³	1,354	2	[A]
	Live	m ³	1,200	7	[A]

9.0 Leach (Facility 25)

No	Item	Units	Value	Ref.	Rev.
9.08	<u>Pregnant Liquor Storage Tanks</u>				
	Status		new	7	[B]
	Type		static	7	[A]
	Construction		carbon steel	7	[A]
	Operating temperature	C	95	7	[A]
	Number of tanks		1	7	[A]
	Residence time	h	>24	7	[B]
9.09	<u>Fresh Water Tank</u>				
	Status		new	7	[B]
	Type		static	7	[A]
	Construction		carbon steel, internally painted	7	[A]
	Operating temperature	C	ambient	3	[A]
	Number of tanks required		1	7	[A]
	Capacity required	m ³	1,200	7	[B]
9.10	<u>Calcine Tailings</u>				
	Moisture content		8.5	7	[A]
	Angle of repose		<70	7	[A]
	Basis for Design				
9.11	<u>Operating Schedule</u>				
	Operating hours per year		7,900	2	[A]
9.12	<u>Kiln Discharge</u>				
	Calcine fines	t/h	122.53	2	[B]
	Calcine lump	t/h	13.61	2	[B]
	Calcine total	t/h	136.14	2	[B]
9.13	<u>Quench Vessel</u>				
	Feed				
	Type		calcine	7	[B]
	Solid mass flow	t/h	136.14	2	[B]
	Temperature	C	420.00	2	[B]
	Quenched Slurry				
	Type		calcine slurry	7	[B]
	Solid mass flow	t/h	133.31	2	[B]
	Solution mass flow	t/h	344.54	2	[B]
	Solids density	% w/w	27.90	2	[B]
	Temperature	C	100.00	2	[B]
	Discharge Vent				
	Type		mixed flow - gas and entrained aqueous including scrubber air	7	[C]
	Gas mass flow	t/h	17.26	2	[C]
		Nm ³ /h	23,659	2	[C]
	Solution mass flow	t/h	3.48	2	[C]
	Solution Entrainment	% of solution	1.01	2	[C]
	Temperature	C	100.00	2	[C]
9.14	<u>Quench Scrubber</u>				
	Air				
	Gas mass flow	t/h	11.00	2	[C]
		Nm ³ /h	10,245	2	[C]
	Temperature	C	35.00	2	[C]
	Moisture content	%	1.00	2	[C]
	Scrub Solution				
	Type		recirculated solution	7	[C]
	Solution flow	t/h	5.00	2	[C]
		m ³ /h	4.93	2	[C]
	Temperature	C	100.00	2	[C]
	Vent				
	Gas mass flow	t/h	17.71	2	[C]
		Nm ³ /h	23,200	2	[C]
	Saturation	% H ₂ O	100	3	[C]
	Gas composition	% H ₂ O wt.	38.52	2	[C]
	Temperature	C	80.59	2	[C]

9.0 Leach (Facility 25)

No	Item	Units	Value	Ref.	Rev.
9.13	<u>V₂O₅ Deportment</u>				
	Outputs				
	Leached calcine			2	[C]
	Preg Solution			2	[C]
	Total			2	[C]
9.12	<u>Mass & Water Balance per Vat</u>				
	Inputs				
	Calcine			2	[C]
	Wash water			2	[C]
	Scrubber Air			2	[C]
	Total			2	[C]
	Outputs				
	Evaporative losses			2	[C]
	Leached calcine			2	[C]
	Preg Solution			2	[C]
	Total			2	[C]
9.13	<u>Cycle Times per Vat</u>				
	Fill	h	17.63	2	[A]
	Drain to preg/Wash/Drain to slug dose tank	h	25.3	2	[A]
	Empty	h	10.0	7	[A]
	Total	h	52.9	2	[A]
9.14	<u>Slug Dose Tank</u>				
	Aqueous composition	V ₂ O ₅ g/L	13.23	2	[B]
		V g/L	7.41	2	[B]
	Tank design				
	Existing				
	Number		2	7	[A]
	Capacity per tank	m ³	1,200	7	[A]
	Capacity total		2400	7	[H]
9.15	<u>Pregnant Liquor Storage Tanks</u>				
	Aqueous composition	V ₂ O ₅ g/L	49.98	2	[B]
		V g/L	28.00	2	[B]
	Storage capacity	m ³	800	2	[B]
		h	28.7	7	[B]
9.16	<u>Fresh Water Tank</u>				
	Residence time	h	26.99	2	[B]
	Tank design				
	Number		1	7	[B]
	Tank dimensions		Identical to existing tanks	7	[B]
	Diameter	m	13.4	7	[B]
	Height	m	9.6	7	[B]
	Tank capacity				
	Live	m ³	1,200	3	[B]
	Total	m ³	1,354	2	[B]

10.0 Desilication (Facility 30)

No	Item	Units	Value	Ref.	Rev.
Design Criteria					
10.01	<u>Operating Schedule</u>				
	Operating days per year	days	365	3	[A]
	Operating hours per day	h/d	24	3	[A]
	Required availability	%	90.2	9	[A]
10.02	<u>Dirty Preg Tank</u>				
	Status		existing	7	[B]
	Type		open, mechanically agitated	7	[H]
	Construction		carbon steel, internally painted	7	[A]
	Number of tanks		1	7	[A]
	Tank dimensions				
	Diameter	m	8.5	7	[B]
	Height	m	6.3	7	[B]
	Tank capacity				
	Total	m ³	357	2	[B]
	Live	m ³	320	7	[B]
	Operating parameters				
	Mode		continuous	7	[A]
	Temperature	C	90	7	[A]
10.03	<u>Liquor Cooling</u>				
	Status		new	7	[G]
	Duty		cooling	3	[G]
	Hot Side (cooled side)				
	Fluid				
	Type		dirty pregnant aqueous	3	[G]
	Outlet temperature at desilication discharge	C	75	3	[G]
	Efficiency of heat transfer (including fouling allowance)		90%	3	[G]
	Cold Side (cooling side)				
	Fluid				
	Type		cooling water	3	[G]
	Temperature	C	30.0	6	[2]
	Approach temperature	C	7	6	[2]
	Outlet temperature	C	57	6	[2]
10.03	<u>Desilication</u>				
	Status		existing	7	[B]
	Operation mode		continuous	7	[A]
	Tank				
	Number installed		3	7	[A]
	Type		covered, mechanically agitated	7	[A]
	Construction		carbon steel, butyl rubber lined	7	[A]
	Dimensions				
	Diameter	m	5.0	7	[A]
	Height	m	5.0	7	[A]
	Capacity				
	Live	m ³	90.0	7	[A]
	Operating parameters				
	Residence time	h	4.0	7	[A]
	Temperature	C	85.0	7	[A]
	pH		8.3	7	[A]
	pH control		H ₂ SO ₄ addition	7	[A]
	Reagent Addition				
	Sulphuric acid	t H ₂ SO ₄ : t V ₂ O ₅	0.53	7	[G]
	Aluminium sulfate		133% of stoichiometric requirement	7	[B]
	Reactions				
	2SiO ₂ + Al ₂ (SO ₄) ₃ + 8NaOH -->	Heat of Reaction kcal/kg mole	Extent %		
	Al ₂ (SO ₄) ₃ + 6 NaOH --> 2 Al(OH) ₃ + 3 Na ₂ SO ₄	288,140	100	7	[A]
	2NaOH + H ₂ SO ₄ --> Na ₂ SO ₄ + 2H ₂ O	175,860	100	7	[A]
		-35,169	100	7	[A]
10.04	<u>Desilication Filter Feed Tank</u>				
	Status		new	7	[A]
	Feed tank residence time	h	4.8	4	[B]

10.0 Desilication (Facility 30)

No	Item	Units	Value	Ref.	Rev.
10.05	<u>Precoat Tank</u>				
	Status		future	7	[A]
10.06	<u>Desilication Filter</u>				
	Status		new	7	[B]
	Filter type		plate and frame, membrane	4	[A]
	Number of filters		1	4	[A]
	Filtration rate	t/m ² h	0.010	4	[A]
	Intermediate cake moisture content	% w/w	40	7	[A]
	Wash efficiency per displacement	%	0.7	7	[A]
	Number of washing stages		1	4	[A]
	Wash water				
	Source		raw water	4	[A]
	Quality		low saline water	4	[A]
	V ₂ O ₅ loss	% soluble	0.50	7	[A]
	Overall Wash efficiency	Design	%	4	[A]
	Final moisture content		% w/w	7	[A]
	Maximum design temperature		C	4	[A]
	Filtrate clarity		ppm solid	4	[A]
	Cycles per day		5	7	[H]
10.07	<u>Clean Pregnant Solution Tank</u>				
	Status		existing	7	[B]
	Type		covered and static	7	[A]
	Construction		carbon steel, internally painted	7	[A]
	Number of tanks		1	7	[A]
	Tank dimensions				
	Diameter	m	8.50	7	[A]
	Height	m	6.30	7	[A]
	Tank capacity				
	Total	m ³	357	2	[A]
	Live	m ³	320	7	[A]
10.08	<u>Wash Tank</u>				
	Status		new	7	[B]
	Residence time	h	12	3	[A]
	Number of tanks		1	3	[A]

10.0 Desilication (Facility 30)

No	Item	Units	Value	Ref.	Rev.
Basis for Design					
10.09	<u>Operating Schedule</u>				
	Operating hours per year	h/a	7,900	2	[A]
10.10	<u>Dirty Preg Tank</u>				
	Feed				
	Aqueous feed rate	t/h	15.07	2	[B]
	Temperature	m ³ /h	13.92	2	[B]
	Residence time (actual)	C	72.82	2	[B]
		h	22.98	2	[B]
10.11	<u>Liquor Cooling</u>				
	Feed				
	Total flow rate	m ³ /h	14.01	2	[G]
	Inlet temperature	C	73	2	[G]
	Outlet temperature	C	56	2	[G]
	Cooling water				
	Aqueous flow rate	m ³ /h	28.69	2	[B]
	Supply temperature	C	28.7	2	[B]
	Outlet temperature		45.0	2	[B]
	Heat exchanger				
	Type		spiral	3	[G]
	Installed		1	3	[2]
	Operating		1	3	[G]
	Standby		0	3	[2]
10.11	<u>Desilication</u>				
	Feed				
	Aqueous flow rate	m ³ /h	14.68	2	[B]
	Aqueous SG	t/m ³	1.09	2	[B]
	Aqueous Composition				
	SiO ₂	g/L	4.04	2	[B]
	V ₂ O ₅ g/L	g/L	100.9	2	[B]
	V g/L	g/L	56.5	2	[B]
	Temperature	C	56.09	2	[B]
	Reagent Consumption				
	Sulphuric acid	t/h	0.76	2	[B]
		m ³ /h	0.40	2	[B]
	Aluminium sulfate	t/h	16.74	2	[B]
		m ³ /h	14.90	2	[B]
	Discharge				
	Solids flow rate	t/h	0.79	2	[B]
	Aqueous flow rate	t/h	15.94	2	[B]
	Slurry density	% w/w	4.73	2	[B]
	Slurry flow rate	t/h	16.74	2	[B]
		m ³ /h	14.90	2	[B]
	Temperature	C	75.00	2	[G]
	Aqueous composition				
	SiO ₂	g/L	0.00	2	[B]
	V ₂ O ₅ g/L	g/L	94.8	2	[B]
	V g/L	g/L	53.1	2	[B]
	Temperature	C	75.00	2	[B]
	Required residence time	h	4.00	7	[B]
	Actual residence time	h	18.12	2	[B]
10.12	<u>Desilication Filter Feed Tank</u>				
	Feed				
	Solids				
	Flow rate	t/h	0.79	2	[B]
	Density	% w/w	4.73	2	[B]
	Aqueous				
	Flow rate	t/h	15.94	2	[B]
		m ³ /h	14.68	2	[B]
	Slurry				
	Flow rate	t/h	16.74	2	[B]
		m ³ /h	14.90	2	[B]
	Temperature	C	75.00	3	[B]

10.0 Desilication (Facility 30)

No	Item	Units	Value	Ref.	Rev.
10.12	<u>Desilication Filter Feed Tank - continued</u>				
	Tank				
	Type		mechanically agitated	3	[B]
	Construction		carbon steel, butyl rubber lined	3	[B]
	Total capacity required (live)	m ³	71.50	2	[B]
	Number of tanks		1	3	[B]
10.13	<u>Precoat Tank (Future)</u>				
	Tank				
	Type		mechanically agitated	3	[B]
	Construction		carbon steel, butyl rubber lined	3	[B]
	Number of tanks		1	3	[B]
	Dimensions				
	Diameter	m	2	3	[B]
	Height	m	2.6	3	[B]
	Capacity	m ³	8.17	3	[B]
10.14	<u>Desilication Filter</u>				
	Feed				
	Solids flow rate	Nominal t/h	0.79	2	[B]
		Design t/h	0.95	7	[B]
	Aqueous flow rate	m ³ /h	14.68	2	[B]
	Slurry	t/h	16.74	2	[B]
	Temperature	C	75.00	2	[B]
	Filter availability	%	91	3	[B]
	Number of filters selected		1	10	[B]
	Selected filtration area	m ²	603	6	[H]
	Primary filtrate (at nominal feed rate)				
	Aqueous flow rate	m ³ /h	14.19	2	[B]
	Aqueous grade	V ₂ O ₅ g/L	94.83	2	[B]
		V g/L	53.12	2	[B]
	Wash water (at nominal feed rate)				
	Addition	Nominal m ³ /h	0.82	2	[B]
		Design m ³ /h	2.00	7	[B]
	Ratio	Nominal m ³ /t	1.04	2	[B]
		Design m ³ /t	0.48	7	[B]
	Number of wash displacements		1.6	2	[B]
	Efficiency per displacement	%	70	2	[B]
	Overall wash efficiency	%	99.5	2	[B]
	Secondary filtrate (at nominal feed rate)				
	Aqueous flow rate	m ³ /h	0.78	2	[B]
	Aqueous grade	V ₂ O ₅ g/L	50.02	2	[B]
		V g/L	28.02	2	
	Cake (at nominal feed rate)				
	Solid flow rate	t/h	0.79	2	[B]
	Moisture content	%	40.00	2	[B]
	Aqueous grade	V ₂ O ₅ mg/L	13,562	2	[B]
		V mg/L	7,597	2	[B]
10.15	<u>Clean Pregnant Solution Tank</u>				
	Residence time required	h	6.00	2	[B]
	Residence time (actual)	h	21.38	2	[B]
10.16	<u>Wash Tank</u>				
	Withdrawal rate	m ³ /h	0.82	2	[B]
	Tank				
	Type		open, static	7	[B]
	Construction		carbon steel, internally painted	7	[B]
	Total capacity required (live)	m ³	9.84	2	[B]
	Number of tanks		1	3	[B]

11.0 Ammonium Metavanadate Production (Facility 35)

No	Item	Units	Value	Ref.	Rev.
Design Criteria					
11.01	<u>Operating Schedule</u>				
	Operating days per year	days	365	3	[A]
	Operating hours per day	h/d	24	3	[A]
	Availability	%	90.2	9	[A]
11.02	<u>Pregnant Liquor Cooling</u>				
	Status		new	7	[B]
	Duty		cooling	3	[A]
	Hot Side (cooled side)				
	Fluid				
	Type		clean pregnant Aqueous	3	[A]
	Temperature	C	75	6	[2]
	Outlet temperature	C	35	7	[A]
	Efficiency of heat transfer (including fouling allowance)		90%	3	[A]
	Cold Side (cooling side)				
	Fluid				
	Type		cooling water	3	[A]
	Temperature	C	30	6	[2]
	Approach temperature	C	10	6	[2]
	Outlet temperature	C	45	6	[2]
11.03	<u>Ammonium Sulfate Mixing System</u>				
	Status		see reagents	3	[F]
11.03	<u>AMV Precipitation</u>				
	Status		new	7	[B]
	Operation mode		continuous	7	[A]
	Operating parameters				
	Residence time required	h	4	7	[B]
	Residence time selected (3 tank system)	h	12	3	[B]
	Temperature	C	35	7	[A]
	pH		natural, 7.8	7	[A]
	Reagent Addition				
	Precipitant		ammonium sulfate	7	[A]
	pH Control		N/A	7	[2]
	Reactions and Extents				
	$2\text{NaVO}_3 + (\text{NH}_4)_2\text{SO}_4 \rightarrow 2\text{NH}_4\text{VO}_3 + \text{Na}_2\text{SO}_4$			7	[A]
		Heat of Reaction kcal/kg mole	Extent %		
		-2,176	99.4		
11.04	<u>AMV Product Thickener</u>				
	Status		new	7	[B]
	Thickener type		high rate	3	[A]
	Settling rate	t/h.m ²	0.09	10	[A]
	Rise velocity	m/h	0.7	10	[A]
	Overflow clarity	ppm solids	tba	-	-
11.05	<u>AMV Filter</u>				
	Status		new	7	[B]
	Filter type		belt filter	7	[A]
	Number of filters		1	7	[A]
	Filtration rate	t/m ² .h	0.10	10	[A]
	Intermediate cake moisture content	% w/w	20.00	4	[A]
	Wash efficiency per displacement	%	0.7	4	[A]
	Number of washing stages		3	4	[H]
	Wash water				
	Source		potable water	7	[A]
	Overall Wash efficiency	%	>99	4	[A]
	Final moisture content	% w/w	20.00	10	[A]
	Filter operating water requirements				
	Source		barren solution from thickener overflow	6	[G]
	Consumption				
	Cloth and belt wash	m ³ /h	6.8	6	[G]
	Seal strip and drum wash	m ³ /h	0.4	6	[G]
	Total		7.2	6	[G]
	Filter vacuum pump water requirements				
	Source		potable water	6	[G]
	Consumption	L/min	57	6	[2]

11.0 Ammonium Metavanadate Production (Facility 35)

No	Item	Units	Value	Ref.	Rev.
11.06	<u>Seal and Gland Water Tank</u>				
	Status		new	7	[B]
	Feed tank residence time	h	3	2	[2]
11.07	<u>Barren Aqueous Tank</u>				
	Status		existing	7	[B]
	Type		open	7	[B]
	Construction		carbon steel, internally painted	7	[B]
	Number of tanks		1	3	[B]
	Tank dimensions				
	Diameter	m	6.90	7	[B]
	Height	m	4.50	7	[B]
	Tank capacity				
	Total	m ³	168	2	[B]
	Live	m ³	150	7	[B]
	Basis for Design				
11.08	<u>Operating Schedule</u>				
	Operating hours per year	h/a	7,900	2	[A]
11.09	<u>Pregnant Liquor Cooling</u>				
	Feed				
	Aqueous flow rate	m ³ /h	14.97	2	[B]
	Inlet temperature	C	73	2	[B]
	Outlet temperature	C	35	2	[B]
	Cooling water				
	Aqueous flow rate	m ³ /h	28.69	2	[B]
	Supply temperature	C	28.7	2	[B]
	Outlet temperature		40.0	2	[B]
	Heat exchanger				
	Type		plate	3	[B]
	Heat transfer coefficient	KJ/m ² C	tba	-	-
	Installed		2	3	[B]
	Operating		1	3	[B]
	Standby		1	3	[B]
11.10	<u>Ammonium Sulfate Mixing System</u>				
	Status		see reagents	3	[F]
11.11	<u>AMV Precipitation</u>				
	Feed				
	Aqueous flow rate (total)	m ³ /h	21.02	2	[B]
	Discharge				
	Solids				
	Flow rate	t/h	1.87	2	[B]
	V ₂ O ₅ equivalent grade	%	77.74	2	[B]
	Density	% w/w	5.88	2	[B]
	Aqueous				
	Flow rate	m ³ /h	24.92	2	[B]
	V ₂ O ₅ equivalent grade	g/L	0.33	2	[B]
	Slurry				
	Flow rate	t/h	31.80	2	[B]
	Density	t/m ³	1.24	2	[B]
		m ³ /h	25.73	2	[B]
	Tank				
	Type		mechanically agitated and covered	7	[A]
	Construction		carbon steel, internally painted or polyurethane lined	7	[A]
	Total capacity required (live)	m ³	252.27	2	[B]
	Number of tanks required		3	3	[B]
	Capacity per tank (live)	m ³	84.09	2	[B]

11.0 Ammonium Metavanadate Production (Facility 35)

No	Item	Units	Value	Ref.	Rev.
11.12	<u>AMV Product Thickener</u>				
	Feed				
	Solids flow rate	t/h	1.87	2	[B]
	Slurry density	% solids	5.88	2	[B]
	Underflow				
	Solids flow rate	t/h	1.87	2	[B]
	Slurry density	% solids	35.00	2	[B]
	Overflow				
	Solids flow rate	t/h	0.00	2	[B]
	Aqueous flow rate	m ³ /h	30.70	2	[B]
	Suspended solids	ppm	tba	-	-
	Required thickener area	m ²	20.8	2	[B]
	Required thickener diameter	m	5.1	2	[B]
	Selected thickener diameter	m	5.0	3	[B]
11.13	<u>AMV Filter</u>				
	Feed				
	Solids flow rate	Nominal t/h	1.87	2	[B]
		Design t/h	2.00	4	[B]
	Aqueous flow rate	Nominal m ³ /h	2.91	2	[B]
	Filter availability	%	91	2	[B]
	Filter area required at availability	Nominal m ²	19	2	[B]
		Design m ²	20	2	[B]
	Number of filters selected		1	4	[B]
	Selected filtration area	m ²	20	4	[B]
	Primary filtrate (at nominal feed rate)				
	Aqueous flow rate	m ³ /h	2.92	2	[B]
	Aqueous grade	V ₂ O ₅ g/L	0.32	2	[B]
		V g/L	0.18	2	[B]
	Wash water (at nominal feed rate)				
	Addition	m ³ /h	2.00	2	[B]
	Ratio	m ³ /t	1.07	2	[B]
	Concentration	g/L (NH ₄) ₂ SO ₄	0.00	2	[B]
	Number of wash displacements		1.5	2	[B]
	Wash efficiency per displacement	%	62.00	2	[B]
	Overall wash efficiency	%	99.9	2	[B]
	Secondary filtrate (at nominal feed rate)				
	Aqueous flow rate	m ³ /h	1.04	2	[B]
	Aqueous grade	V ₂ O ₅ g/L	0.06	2	[B]
		V g/L	0.04	2	[B]
	Cake (at nominal feed rate)				
	Solid flow rate	t/h	1.87	2	[B]
	Moisture content	%	20.00	2	[B]
	Aqueous grade	V ₂ O ₅ mg/L	2.0	2	[B]
		V mg/L	1.1	2	[B]
11.14	<u>Seal and Gland Water Tank</u>				
	Withdrawal rate	m ³ /h	3.62	6	[2]
	Number of tanks		1	4	[B]
	Tank				
	Type		closed	4	[A]
	Construction		carbon steel, internally painted	4	[A]
	Total capacity required (live)	m ³	10.86	2	[2]
	Number of tanks		1	3	[B]
11.15	<u>Barren Aqueous Tank</u>				
	Feed rate	m ³ /h	5.13	2	[B]
	Residence time (actual)	h	29.25	2	[B]

12.0 Flash Dryer (Facility 36)

No	Item	Units	Value	Ref.	Rev.
Design Criteria					
12.01	<u>Operating Schedule</u>				
	Operating days per year	days	365	3	[H]
	Operating hours per day	h/d	24	3	[H]
	Availability	%	90.2	11	[H]
12.02	<u>Plant Specification (Flash Dryer)</u>				
	Status		Drytech package	11	[H]
	Feed product		AMV	11	[H]
			Maximum Nominal Minimum		
	Wet capacity	t/h	3.72 2.8 2.17	11	[H]
	Dry capacity	t/h	2.98 2.1 1.52	11	[H]
	Initial feed moisture	t/h	30 25 20	11	[H]
	Discharge moisture Total)	% H ₂ O	<0.5	11	[H]
	Discharge feed rate	t/h	2	11	[H]
	Specific heat solids	KJ/kg K	1.105	11	[H]
	Product inlet temperature	C	20	11	[H]
	Product discharge temperature	C	<100	11	[H]
	Process temperature	C	400 - 475	11	[H]
	Heating requirements	GJ/h	2.6	11	[H]
	Heating medium		Natural gas	11	[H]
	Exhaust Stack emission levels				
	Particulates	mg/Nm ³	<30	11	[H]
	Ammonia	mg/Nm ³	<100	11	[H]
12.03	<u>Primary Cyclone</u>				
	Status		Drytech package	11	[H]
	Type		tba	11	[H]
	No. Installed		1	11	[H]
	Duty				
	Description		high solids separation efficiency	11	[H]
	Solids separation efficiency		85.00	11	[H]
	Gas temperature		Maximum Nominal Minimum	11	[H]
		C	180 150 130	11	[H]
	Gas flow (air and H ₂ O vapour)		Maximum Nominal Minimum	11	[H]
		Nm ³ /h	7750 6046 5276	11	[H]
12.04	<u>Secondary Cyclone</u>				
	Status		Drytech package	11	[H]
	No. Installed		2	11	[H]
	Duty				
	Description		high solids separation efficiency	11	[H]
	Solids separation efficiency	% of feed	60.00	11	[H]
	Gas temperature		Maximum Nominal Minimum	11	[H]
		C	150 130 120	11	[H]
	Gas flow (air and H ₂ O vapour)		Maximum Nominal Minimum	11	[H]
		Nm ³ /h	7750 6046 5276	11	[H]
12.05	<u>AMV Dryer Baghouse</u>				
	Status		Drytech package	11	[H]
	Type		reverse pulsed	11	[H]
	Duty				
	Description		high solids separation efficiency	11	[H]
	Solids separation efficiency	% of total feed	99.90	11	[H]
	Temp (maximum)	C	120	11	[H]
	Gas temperature		Maximum Nominal Minimum	11	[H]
		C	130 120 110	11	[H]
	Gas flow (air and H ₂ O vapour)		Maximum Nominal Minimum	11	[H]
		Nm ³ /h	7750 6046 5276	11	[H]
	Baghouse pulsing system				
	Air type		instrument	11	[H]
	Air flow	FAD m ³ /h	48.4	11	[H]
	Air pressure	kPag	620	11	[H]

12.0 Flash Dryer (Facility 36)

No	Item	Units	Value	Ref.	Rev.
12.06	<u>AMV Silo Air Slide and Aeration Pad</u>				
	Status		Drytech package	11	[H]
	Air type		blower air	11	[H]
	Air flow	Nm³/h	349	11	[H]
	Air pressure	kPag	35	11	[H]
	Basis for Design				
12.06	<u>Operating Schedule</u>				
	Operating hours per year	h/a	7,900	2	[A]
12.07	<u>Flash Dryer</u>				
	Feed				
	Solids flow rate	t/h	1.87	2	[H]
	Aqueous flow rate	t/h	0.47	2	[H]
	Moisture content	%	20.00	2	[H]
	Total flow rate	t/h	2.34	2	[H]
	Product				
	Solids flow rate	t/h	1.87	2	[H]
	Aqueous flow rate	t/h	0.00	2	[H]
	Moisture content	%	0.00	2	[H]
	Total flow rate	t/h	1.87	2	[H]
12.08	<u>Primary Cyclone</u>				
	Recovered product				
	Solids flow rate	t/h	1.59	2	[H]
	Product loss to overflow				
	Solids flow rate	t/h	0.28	2	[H]
12.09	<u>Secondary Cyclone</u>				
	Recovered product				
	Solids flow rate	t/h	0.17	2	[H]
	Product loss to overflow				
	Solids flow rate	t/h	0.11	2	[H]
12.10	<u>AMV Dryer Baghouse</u>				
	Recovered product				
	Solids flow rate	t/h	0.11	2	[H]
	Product loss to overflow				
	Solids flow rate	g/h	112.11	2	[H]

13.0 V2O5 Production (Facility 40) - FUTURE

No	Item	Units	Production Scenarios	Ref.	Rev.
			V2O5/FeV		
Design Criteria					
13.01	Operating Schedule				
	Operating days per year	days	365	3	[A]
	Operating hours per day	h/d	24	3	[A]
	Availability	%	90.2	9	[A]
	V ₂ O ₅ Availability	%	13.2	9	[G]
13.02	Deammoniator				
	Status		Drytech package	11	[G]
	Number of kilns		1	11	[G]
	Kiln dimensions				
	Diameter	m	1.1	11	[G]
	Heated Length	m	9	11	[G]
	Total Length	m	11.3	11	[G]
	Materials of construction		321 SS	11	[G]
	Wall thickness	mm	10	11	[G]
	Kiln capacity (total)	t/d V ₂ O ₅	15.7	11	[G]
	Kiln Feed				
	AMV feed	t/h	0.93	11	[G]
	Temperature	C	<90	11	[G]
	Kiln operating conditions				
	Process	C	>400	11	[G]
	Tube Wall				
	Zone 1	C	600	11	[G]
	Zone 2	C	650	11	[G]
	Zone 3	C	680	11	[G]
	Residence time at process temperature	min	30	11	[G]
	Degree of filling	%	8-15	11	[G]
	Reactions				
	2NH ₄ VO ₃ (s) --> V ₂ O ₅ (s) + 2NH ₃ (g) + H ₂ O (aq)			7	[G]
	2NH ₃ (g) --> N ₂ (g) + 3H ₂ (g)			7	[G]
13.03	Scrubber Cyclone				
	Status		Drytech package	11	[G]
	No. Installed		1	11	[G]
	Duty				
	Description		high solids separation efficiency	11	[G]
	Solids separation efficiency	% of total feed	>90	11	[G]
	Temperature	C	400	11	[G]
13.04	Scrubber Bag House				
	Status		Drytech package	11	[G]
	No. Installed		1	11	[G]
	Duty				
	Description		high solids separation efficiency	11	[G]
	Solids separation efficiency	% of total feed	>99.9	11	[G]
13.05	Ammonia Scrubber				
	Status		Drytech package	7	[C]
	Ammonium sulfate concentration in product	%	30	7	[C]
	Reactions				
	2NH ₃ (g) + H ₂ SO ₄ (aq) --> (NH ₄) ₂ SO ₄ (aq)			7	[C]
	Exhaust Stack emission levels				
	Particulates	mg/Nm ³	<30	11	[G]
	Ammonia	mg/Nm ³	<100	11	[G]

13.0 V2O5 Production (Facility 40) - FUTURE

No	Item	Units	Production Scenarios	Ref.	Rev.
			V2O5/FeV		
	Basis for Design				
13.06	<u>Operating Schedule</u>				
	Operating hours per year	h/a	7,900	2	[G]
	V ₂ O ₅ facility	h/a	1,047	2	[G]
13.07	<u>Deammoniator</u>				
	Feed				
	Solids flow rate	t/h	0.25	7	[G]
	Slurry flow rate	t/h	0.25	7	[G]
		m ³ /h	0.97	7	[G]
	Density	%	100.00	7	[G]
	Solids concentration	V ₂ O ₅ wt. %	77.74	7	[G]
		V wt. %	43.55	7	[G]
	Discharge				
	Slurry flow rate	t/h	0.20	7	[G]
		m ³ /h	0.55	7	[G]
	Moisture	% H ₂ O	0.00	7	[G]
	Solids concentration	V ₂ O ₅ wt. %	98.59	7	[G]
		V wt. %	55.23	7	[G]
	Gas Flow Rate	t/h	0.05	7	[G]
		Nm ³ /h	890.17	7	[G]
	V ₂ O ₅ product rate	t/h	0.18	7	[G]
		t/a	192.33	2	[G]
13.08	<u>Scrubber Cyclone / Bag House</u>				
	Recovered dust				
	Solids flow rate	kg/h	12.44	7	[G]
13.09	<u>Ammonia Scrubber</u>				
	Feed				
	Gas flow rate	t/h	0.05	7	[G]
		Nm ³ /h	890.17	7	[G]
	Sulphuric acid addition	m ³ /h	0.39	7	[G]
	Discharge				
	Aqueous flow rate	t/h	0.11	7	[G]
		m ³ /h	2.03	7	[G]
	Gas flow rate to atmosphere	t/h	0.03	7	[G]
		Nm ³ /h	1168.97	7	[G]
13.10	<u>Total Purge Solution</u>				
	Slurry flow rate	t/h	0.51	7	[C]
		m ³ /h	3.97	7	[C]
	Density	%	15	7	[C]
	Aqueous concentration	(NH ₄) ₂ SO ₄ g/L	312.25	7	[C]
		% (NH ₄) ₂ SO ₄	30	7	[C]
	Solids concentration	V ₂ O ₅ wt. %	77.74	7	[C]
		V wt. %	43.55	7	[C]

14.0 V2O3 Production (Facility 41)

No	Item	Units	Value	Ref.	Rev.
Design Criteria					
14.01	<u>Operating Schedule</u>				
	Operating days per year	days	365	3	[A]
	Operating hours per day	h/d	24	3	[A]
	Availability	%	90.2	9	[A]
	V ₂ O ₃ Availability	%	86.8	9	[C]
14.02	<u>V₂O₅ Reactor</u>				
	Status		Drytech package	7	[C]
	Number of kilns		2	11	[G]
	Kiln dimensions (tube)				
	Diameter	m	1.1	11	[G]
	Heated Length	m	9	11	[G]
	Total Length	m	11.3	11	[G]
	Materials of construction		310 SS	11	[G]
	Wall thickness	mm	10	11	[G]
	Kiln capacity (total)				
	Per kiln	t/d V ₂ O ₅ equiv	14	11	[G]
	Total	t/d V ₂ O ₅ equiv	28	11	[G]
	Kiln Feed				
	AMV feed	kg/h	830	11	[G]
	Temperature	C	<90	11	[G]
	Kiln operating conditions				
	Process	C	>800	11	[G]
	Tube Wall				
	Zone 1	C	750	11	[G]
	Zone 2	C	900	11	[G]
	Zone 3	C	920	11	[G]
	Residence time at process temperature	min	30	11	[G]
	Degree of filling	%	8-15	11	[G]
	Reactions				
	2NH ₄ VO ₃ (s) --> V ₂ O ₅ (s) + 2NH ₃ (g) + H ₂ O (aq)	Heat of Reaction kcal/kg mole	Extent %	7	[C]
	2NH ₃ (g) --> N ₂ (g) + 3H ₂ (g)	26,456	95	7	[C]
	V ₂ O ₅ (s) + 2H ₂ (g) --> V ₂ O ₃ (s) + 2H ₂ O (g)	11,020	85	7	[C]
		19305	100	7	[C]
14.03	<u>Bag House</u>				
	Status		Drytech package	11	[G]
	No. Installed		1	11	[G]
	Duty				
	Description		high solids separation efficiency	11	[G]
	Solids separation efficiency	% of total feed	>99.9	11	[G]
	Maximum gas inlet temperature	C	150	11	[G]
14.04	<u>Ammonia Scrubber</u>				
	Status		Drytech package	11	[H]
	Scrub solution		barren solution	11	[H]
	pH control		H ₂ SO ₄	11	[H]
	Reactions				
	2NH ₃ (g) + H ₂ SO ₄ (aq) --> (NH ₄) ₂ SO ₄ (aq)	Heat of Reaction kcal/kg mole	Extent %	7	[H]
		-32051	95		
	Exhaust stack emission levels				
	Particulates	mg/Nm ³	<30	11	[H]
	Ammonia	mg/Nm ³	<100	11	[H]

14.0 V2O3 Production (Facility 41)

No	Item	Units	Production Scenarios		Ref.	Rev.
			V2O5/FeV	FeV		
Basis for Design						
14.04	<u>Operating Schedule</u>					
	Operating hours per year	h/a	7,900		2	[I]
	V ₂ O ₃ facility	h/a	6,853		2	[I]
14.05	<u>V₂O₃ Reactor</u>					
	Feed (Total for all reactors)					
	Solids flow rate	t/h	1.62	1.87	7	[I]
	Slurry flow rate	t/h	1.62	1.87	7	[I]
		m ³ /h	0.78	0.80	7	[I]
	Density	%	100.00	100.00	7	[I]
	Solids concentration	V ₂ O ₅ wt.%	77.74		7	[I]
		V wt.%	43.55		7	[I]
	Discharge (Total for all reactors)					
	Solids flow rate	t/h	0.99	1.14	7	[2]
		m ³ /h	0.23	0.26	7	[2]
	Density	%		100.00	7	[2]
	Solids concentration	V ₂ O ₅ wt.%	121.35		7	[2]
		V wt.%	67.98		7	[2]
	Gas Flow Rate	t/h	0.32	0.36	7	[I]
		Nm ³ /h	646.11	745.37	7	[I]
	V ₂ O ₃ product rate	t/h	0.99	1.14	7	[I]
		t/a	7787.44	8983.79	2	[2]
14.06	<u>Scrubber Bag House</u>					
	Recovered dust					
	Solids flow rate	kg/h	200.00	230.73	11	[2]
14.07	<u>Ammonia Scrubber</u>					
	Feed					
	Gas flow rate	t/h	0.62	0.72	7	[I]
		Nm ³ /h	3,831.82	4420.48	7	[I]
	Sulphuric acid addition	m ³ /h	0.05	0.05	7	[I]
	Discharge					
	Aqueous flow rate	t/h	0.11	0.12	7	[I]
		m ³ /h	0.25	0.28	7	[I]
	Gas flow rate to atmosphere	t/h	0.60	0.69	7	[I]
		Nm ³ /h	3,564.69	4112.32	7	[I]
14.08	<u>V₂O₃ Slurry System</u>					
	Operating mode		Batch		11	[2]
	Assumed solids flow	kg/h	200		11	[2]
	Liquid volume	m ³	0.64		11	[2]
	Recirculation time	min	50		11	[2]
	Discharge flowrate	m ³ /h	5.50		11	[2]
	Discharge time	min	10		11	[2]

15.0 FeV Production - DC Arc Furnace (Facility 45)

No	Item	Units	Value	Ref.	Rev.
Design Criteria					
15.01	<u>Operating Schedule</u>				
	Operating days per year	days	365	3	[H]
	Operating hours per day	h/d	24	3	[H]
	Availability	%	90.2	9	[H]
15.02	<u>FeV Furnace</u>				
	Design concept		allow sufficient layout in FeV building to accommodate the maximum capacity of the furnace	7	[H]
	No. of furnace taps				
	Actual	taps / day	8	7	[H]
	Design	taps / day	10	7	[H]
	No. of tapping pots required (design)				
	In tilting position		8	7	[H]
	Pre-heat station		1 (optional)	7	[H]
	Spare		2 (housed in furnace maintenance building)	7	[H]
	Total		10	7	[H]
	Furnace batch cycle time				
	Actual	h	3	7	[H]
	Design	h	2.4	7	[H]
	Operating temperature	C	2,000	7	[H]
	Required pot standing time required immediately after a tap before movement to tipping station	min	15	7	[H]
	Pot temperature after tipping and return to furnace	C	400	7	[H]
	Tapping pot cooling before tipping				
	Time	h	16	7	[H]
	Estimated pot temperature after this time	C	400	7	[H]
15.03	<u>Tapping Pot Pre-heat</u>				
	Heat up time from cold	h	12	7	[H]
	Pre-heat temperature	C	800	7	[H]
	Specific heat of refractory		not known	7	[H]
15.04	<u>Tapping Pot</u>				
	Free-board	m	0.75	7	[H]
	FeV volume	m ³	0.404	7	[H]
	Slag volume	m ³	1.121	7	[H]
	Required FeV button thickness				
	Design	mm	150	7	[H]
	Maximum	mm	175	7	[H]
15.05	<u>Furnace Charge Makeup</u>				
	V ₂ O ₃	kg	3,205.96	7	[H]
	Aluminum	kg	1,300.00	7	[H]
	Iron	kg	439.45	7	[H]
	Lime	kg	568.70	7	[H]
	Fines	kg	100.00	7	[H]
	Remelts	kg	50.00	7	[H]
	Total		5,664.11	7	[H]
15.06	<u>FeV Furnace Production - per batch</u>				
	Slag SG				
	SG	t/m ³	3.10	7	[H]
	Weight	t	3.42	7	[H]
	Volume	m ³	1.12	7	[H]
	Composition				
	Al ₂ O ₃	%	69.67	7	[H]
	CaO	%	16.63	7	[H]
	V ₂ O ₅	%	4.35	7	[H]
	Other	%	8.00	7	[H]
	FeV				
	SG	t/m ³	6.00	7	[H]
	Weight	t	2.585	7	[H]
	Volume	m ³	0.43	7	[H]
	Total FeV + Slag				
	Weight	t	6.00	7	[H]
	Volume	m ³	1.55	7	[H]
	FeV Produced per annum	t	6,420	7	[H]
	No batches per day		6.80	7	[H]

16.0 FeV Production - Handling/Packaging (Facility 45)

No	Item	Units	Value	Ref.	Rev.
Basis for Design / Design Criteria					
16.01	<u>Operating Schedule</u>				
	Sequence		crush 1 day, package 1 day, day spare	11	[H]
	Operation Mode		batch	11	[H]
16.02	<u>Grizzly Screen</u>				
	Status		new	11	[H]
	Type		static horizontal	11	[H]
	Aperture	mm	375	11	[H]
16.03	<u>Primary Jaw Crusher</u>				
	Status		new	11	[H]
	Type		single toggle jaw crusher	11	[H]
	Product Sizing	P ₁₀₀ mm	50	11	[H]
16.04	<u>Secondary Conveyor Discharge Screen</u>				
	Status				
	Type		inclined vibrating single deck	11	[H]
	Aperture	mm	100	11	[H]
16.05	<u>Secondary Jaw Crusher</u>				
	Status		new	11	[H]
	Type		single toggle jaw crusher	11	[H]
	Product Sizing	P ₁₀₀ mm	30	11	[H]
16.06	<u>Triple Deck Screen</u>				
	Status		new	11	[H]
	Type		inclined vibrating triple deck	11	[H]
	Aperture				
	Deck 1	mm	25	11	[H]
	Deck 2	mm	10	11	[H]
	Deck 3	mm	6	11	[H]
16.07	<u>Double Deck Screen</u>				
	Status		new	11	[H]
	Type		inclined vibrating double deck	11	[H]
	Aperture				
	Deck 1	mm	3	11	[H]
	Deck 2	mm	1	11	[H]
16.08	<u>Product Silos</u>				
	Status		new	11	[H]
	Material of construction		carbon steel	11	[H]
	Number of silos		5	11	[H]
	Silo capacity				
	50-25	m ³	15	11	[H]
	25-10	m ³	15	11	[H]
	10-6	m ³	10	11	[H]
	6-3	m ³	10	11	[H]
	3-2	m ³	10	11	[H]
16.09	<u>Fine FeV Storage Bin</u>				
	Status		new	11	[H]
	Material of construction		carbon steel	11	[H]
	Number of bins		1	11	[H]
	Bin capacity	m ³	2	11	[H]

17.0 Reagents (Facility - various)

No	Item	Units	Value	Ref.	Rev.
Design Criteria					
17.01	<u>Ammonium Sulfate</u>				
	Supply				
	Form		white crystalline solid	7	[A]
	Chemical formula		(NH ₄) ₂ SO ₄	7	[A]
	Chemical analysis				
	(NH ₄) ₂ SO ₄	%	100	7	[A]
	Generic name		amsul	7	[A]
	Concentration	% (NH ₄) ₂ SO ₄ wt.	100	7	[A]
	Delivery size	t	75	7	[A]
	Physical properties				
	Boiling point	C	not applicable	6	[A]
	Melting point	C	350	6	[A]
	Vapour pressure (@ 20C)	mm Hg	Negligible	6	[A]
	Flash point		not applicable	6	[A]
	Solubility in water	g/L @ 0 C	706	6	[A]
		g/L @ 20 C	760	6	[A]
		g/L @ 100 C	1,038	6	[A]
	pH (@ 20% aq. solution)		4.2 - 7	6	[A]
	Specific gravity		1.77	6	[A]
	Bulk reagent storage				
	Bulk reagent density	t/m ³	1.1	6	[A]
	Storage method		bunkers	7	[F]
	Bunker storage capacity				
		m ³	200	10	[F]
		t	220	2	[F]
		days	4.37	7	[F]
	Mixing system				
	Mixing method		batch	7	[G]
	Number of mixing tanks		2.0	3	[G]
	Residence time per mixing tank	h	12.0	3	[G]
	Mixing tank batch				
	Barren solution	m ³	61.55	2	[G]
	Scrubber effluent (V2O3/V2O5)	m ³	85.42	2	[G]
	Ammonium sulphate	t	25.16	2	[G]
	Total	m ³	75.95	2	[G]
	Mixing tank capacity				
	Live	m ³	100.00	3	[G]
	Addition (@100% Active Ingredient)				
	AMV precipitation	t/h	2.10	3	[F]
		t/t V ₂ O ₅ in Feed	2.70	2	[F]
		t/a	16,562	2	[F]
17.02	<u>Sulfuric Acid</u>				
	Supply				
	Form		liquid	6	[A]
	Chemical formula		H ₂ SO ₄	6	[A]
	Chemical analysis				
	H ₂ SO ₄	%	>98	6	[A]
	H ₂ O	%	<2	6	[A]
	Generic name		sulfuric acid	6	[A]
	Concentration	% H ₂ SO ₄	98	6	[A]
	Delivery size	t	99	6	[A]
	Bulk Storage		bullet, insulated and fitted with an internal heater	6	[A]
	Hazardous Information				
	Dangerous Goods Class		8	6	[A]
	HAZCHEM Code		2P	6	[A]
	Packing Group		II	6	[A]
	Poisons Schedule Number		6	6	[A]
	Physical Properties				
	Appearance		viscous clear to brownish liquid	6	[A]
	Boiling Point @ 101.3 kPa	C	330	6	[A]
	Freezing Point	C	12.2	6	[A]
	Vapour Pressure		not applicable	6	[A]
	Solution SG @ 20 C	t/m ³	1.834	6	[A]
	Viscosity @14 C	Cp	52	6	[A]
	Flash Point		does not give off flammable vapors	6	[A]
	Flammability Limits		not flammable	6	[A]
	Bulk reagent density	t/m ³	1.834	6	[A]
	Bulk storage capacity	days	8.7	6	[A]
	Storage tanks		1	7	[B]

17.0 Reagents (Facility - various)

No	Item	Units	Value	Ref.	Rev.
17.02	<u>Sulfuric Acid (continued)</u>				
	Tank dimensions				
	Diameter	m	6.20	7	[B]
	Height	m	3.00	7	[B]
	Capacity				
	Total	m ³	91	2	[B]
	Live	m ³	83	7	[B]
		days	8.66	2	[B]
	Consumption				
	Desilication		0.755	2	[C]
	V ₂ O ₅ production		0.081	2	[C]
	V ₂ O ₃ production		0.079	2	[C]
	Total		0.915	2	[C]
17.03	<u>Aluminium Sulfate</u>				
	Supply				
	Form		aqueous	6	[A]
	Chemical formula		Al ₂ (SO ₄) ₃	6	[A]
	Generic name		Alum	6	[A]
	Concentration	% Al ₂ (SO ₄) ₃ wt.	50	6	[A]
	Specific gravity	t/m ³	1.56	6	[A]
	Delivery size		bulk aqueous	6	[A]
	Physical properties				
	Boiling point	C	107	6	[A]
	Melting point	C	not relevant	6	[A]
	Vapour pressure (@ 20C)	mm Hg	not available	6	[A]
	Flash point		not relevant	6	[A]
	pH		1-3	6	[A]
	Bulk reagent storage capacity				
	Storage tanks		1	7	[B]
	Tank dimensions				
	Diameter	m	5.10	7	[B]
	Height	m	3.00	7	[B]
	Capacity per tank				
	Total	m ³	61	2	[B]
	Live	m ³	56	7	[B]
		days	7.41	2	[B]
	Consumption (aqueous solution)				
	Desilication	t/h	0.49	2	[B]
		t/a	3,884	2	[B]
17.04	<u>Sodium Carbonate</u>				
	Supply				
	Form		white crystalline solid	6	[F]
	Chemical formula		Na ₂ CO ₃	6	[F]
	Chemical analysis				
	Na ₂ CO ₃	%	100	6	[F]
	Generic name		soda ash	6	[F]
	Hazardous Information				
	UN Number		none allocated	6	[F]
	Dangerous Goods Class		none allocated	6	[F]
	HAZCHEM Code		none allocated	6	[F]
	Packing Group		none allocated	6	[F]
	Poisons Schedule Number		5	6	[F]
	Physical properties				
	Boiling point	C	decomposes	6	[F]
	Melting point	C	851	6	[F]
	Vapour pressure (@ 20C)	mm Hg	not pertinent	6	[F]
	Flash point	C	none	6	[F]
	pH		11.6	6	[F]
	Specific gravity	t/m ³	2.53	6	[F]
	Storage silo				
	Bulk reagent density	t/m ³	1	6	[F]
	Number of silos		1	7	[F]
	Silo capacity	m ³	500	10	[F]
		t	500	2	[F]
		days	4.08	7	[F]
	Consumption				
	Roasting	t/h	5.11	2	[F]
		t/a	40,349	2	[F]
	% w/w dry magnetite concentrate		3.90	2	[F]

17.0 Reagents (Facility - various)

No	Item	Units	Value	Ref.	Rev.
17.05	<u>Lime (burnt)</u>				
	Supply				
	Form		4 - 20mm lump	12	[2]
	Chemical formula		CaO	7	[G]
	Chemical analysis				
	CaO	%	>92	12	[2]
	Generic name		burnt lime	7	[G]
	Hazardous Information				
	UN Number		tba	-	[G]
	Dangerous Goods Class		tba	-	[G]
	HAZCHEM Code		tba	-	[G]
	Packing Group		tba	-	[G]
	Poisons Schedule Number		tba	-	[G]
	Physical properties				
	Boiling point	C	tba	-	[G]
	Melting point	C	tba	-	[G]
	Vapour pressure (@ 20C)	mm Hg	tba	-	[G]
	Flash point	C	tba	-	[G]
	pH		tba	-	[G]
	Specific gravity	t/m ³	-	-	[G]
	Storage silo				
	Bulk reagent density	t/m ³	1.052	12	[2]
	Number of silos		1	7	[G]
	Silo capacity	m ³	tba	-	[G]
		t	tba	-	[G]
		days	tba	-	[G]
	Consumption				
	FeV Production	t/a	1,100	7	[G]
17.06	<u>Aluminium</u>				
	Supply				
	Form		1 - 3mm prills	7	[G]
	Chemical formula		Al	7	[G]
	Chemical analysis				
	Al	%	100	7	[G]
	Generic name		Aluminium	7	[G]
	Hazardous Information				
	UN Number		tba	-	[G]
	Dangerous Goods Class		tba	-	[G]
	HAZCHEM Code		tba	-	[G]
	Packing Group		tba	-	[G]
	Poisons Schedule Number		tba	-	[G]
	Physical properties				
	Boiling point	C	tba	-	[G]
	Melting point	C	tba	-	[G]
	Vapour pressure (@ 20C)	mm Hg	tba	-	[G]
	Flash point	C	tba	-	[G]
	pH		tba	-	[G]
	Specific gravity	t/m ³	-	-	[G]
	Storage silo				
	Bulk reagent density	t/m ³	2.56 - 2.60	7	[G]
	Number of silos		1	7	[G]
	Silo capacity	m ³	tba	-	[G]
		t	tba	-	[G]
		days	tba	-	[G]
	Consumption				
	FeV Production	t/a	3,500	7	[G]

17.0 Reagents (Facility - various)

No	Item	Units	Value	Ref.	Rev.
17.07	<u>Mild Steel</u>				
	Supply				
	Form		0.5 - 1 kg pieces	7	[G]
	Chemical formula		Fe	7	[G]
	Chemical analysis				
	C	%	0.05 - 0.29	7	[G]
	N	%	<0.05	7	[G]
	Generic name		mild steel	7	[G]
	Hazardous Information				
	UN Number		-	-	[G]
	Dangerous Goods Class		-	-	[G]
	HAZCHEM Code		-	-	[G]
	Packing Group		-	-	[G]
	Poisons Schedule Number		-	-	[G]
	Physical properties				
	Boiling point	C	tba	-	[G]
	Melting point	C	tba	-	[G]
	Vapour pressure (@ 20C)	mm Hg	-	-	[G]
	Flash point	C	tba	-	[G]
	pH		-	-	[G]
	Specific gravity	t/m ³	7.9	-	[G]
	Storage				
	Method		covered area	4	[G]
	Bulk reagent density	t/m ³	tba	-	[G]
	Capacity	t	tba	-	[G]
		days	tba	-	[G]
	Consumption				
	FeV Production	t/a	1,200	7	[G]

18.0 Water Supply and Storage (Facility 50)

No	Item	Units	Value	Ref.	Rev.
Design Criteria					
18.01	<u>High Saline Bore Water</u>				
	Source		high salinity bore water	7	[A]
	Delivery		pipeline from borefield, hypersaline water from RO plant - Infrastructure SOW	7	[A]
	Total dissolved solids	mg/L	17,400	7	[A]
	pH	mg/L	7.0	7	[A]
	Conductivity @ 25 C	mS/m	28,600	7	[A]
	Elemental analysis				
			Assay	Calculated	
	Ca Calcium	mg/L	440	440	7 [A]
	Mg Magnesium	mg/L	590	590	7 [A]
	Na Sodium	mg/L	4,700	4700	7 [A]
	K Potassium	mg/L	76	76	7 [A]
	Cl Chloride	mg/L	7,400	7561	7 [A]
	SO ₄ Sulphate	mg/L	2,000	2000	7 [A]
	Component analysis				
	H ₂ O Water	%	-	98.40	2 [A]
	CaCO ₃ Calcium carbonate	%	-	0.11	2 [A]
	CaSO ₄ Calcium sulfate	%	-	0.00	2 [A]
	MgSO ₄ Magnesium sulfate	%	-	0.25	2 [A]
	Na ₂ SO ₄ Sodium sulfate	%	-	0.00	2 [A]
	K ₂ SO ₄ Potassium sulfate	%	-	0.00	2 [A]
	NaCl Sodium chloride	%	-	1.19	2 [A]
	KCl Potassium chloride	%	-	0.01	2 [A]
	MgCl ₂ Magnesium chloride	%	-	0.03	2 [A]
	CaCl ₂ Calcium chloride	%	-	0.00	2 [A]
	Process Consumption (instantaneous average)				
	Facility 15 - Beneficiation	m ³ /h	257.08	1	[A]
	Facility 20 - Roasting	m ³ /h	-	-	-
	Facility 25 - Leach	m ³ /h	-	-	-
	Facility 28 - Evaporation	m ³ /h	-	-	-
	Facility 30 - Desilication	m ³ /h	-	-	-
	Facility 35 - AMV Production	m ³ /h	-	-	-
	Facility 40 - 0 V2O3 / V2O3	m ³ /h	-	-	-
	Reagents	m ³ /h	-	-	-
	Water Supply and Storage	m ³ /h	-	-	-
	Total	m ³ /h	257.08	2	[A]
18.02	<u>Raw Water</u>				
	Source		low salinity bore pipe line - Infrastructure SOW	7	[A]
	Delivery		pipeline from borefield into raw water tank	7	[A]
	Total dissolved solids	mg/L	tba	-	-
	pH	mS/m	tba	-	-
	Conductivity @ 25 C				
	Ca Calcium	mg/L	160	160	7 [A]
	Mg Magnesium	mg/L	120	120	7 [A]
	Na Sodium	mg/L	780	780	7 [A]
	K Potassium	mg/L	40	40	7 [A]
	Cl Chloride	mg/L	1,450	1450	7 [A]
	SO ₄ Sulphate	mg/L	400	400	7 [A]
	Component analysis				
	H ₂ O Water	%	-	99.69	2 [A]
	CaCO ₃ Calcium carbonate	%	-	0.02	2 [A]
	CaSO ₄ Calcium sulfate	%	-	0.03	2 [A]
	MgSO ₄ Magnesium sulfate	%	-	0.02	2 [A]
	Na ₂ SO ₄ Sodium sulfate	%	-	0.00	2 [A]
	K ₂ SO ₄ Potassium sulfate	%	-	0.00	2 [A]
	NaCl Sodium chloride	%	-	0.20	2 [A]
	KCl Potassium chloride	%	-	0.01	2 [A]
	MgCl ₂ Magnesium chloride	%	-	0.03	2 [A]
	CaCl ₂ Calcium chloride	%	-	0.00	2 [A]

18.0 Water Supply and Storage (Facility 50)

No	Item	Units	Value	Ref.	Rev.	
18.03	<u>Raw Water (continued)</u>					
	Process Consumption (instantaneous average)					
	Facility 15 - Beneficiation	m ³ /h	20.00	2	[G]	
	Facility 20 - Roasting	m ³ /h	5.52	2	[G]	
	Facility 25 - Leach	m ³ /h	44.42	2	[G]	
	Facility 30 - Desilication	m ³ /h	0.82	2	[G]	
	Facility 35 - AMV Production	m ³ /h	0.00	2	[G]	
	Facility 40 - V ₂ O ₅	m ³ /h	0.00	2	[G]	
	Facility 41 & 45 - V ₂ O ₃ / FeV	m ³ /h	10.41	2	[G]	
	Total (required from Raw Water Tank)	m ³ /h	81.16	2	[G]	
	Infrastructure Consumption (instantaneous average)					
	RO Plant	m ³ /h	37.50	2	[G]	
	Total Project Consumption (instantaneous average)	m ³ /h	118.66	2	[I]	
18.03	<u>Potable Water System</u>					
	Source	Low salinity bore water - Infrastructure SOW		7	[A]	
	Treatment method	reverse osmosis		7	[A]	
	Treatment rate	m ³ /h	37.5	7	[A]	
	Potable water production rate	m ³ /h	25.0	7	[A]	
	Brine production	m ³ /h	12.5	7	[A]	
	Process Consumption (instantaneous average)					
	Facility 35 - AMV Production	m ³ /h	2.0	2	[G]	
	Facility 50 - Cooling Towers	m ³ /h	11.7	2	[G]	
	Total	m ³ /h	13.7	2	[G]	
	Storage capacity	m ³	100	7	[G]	
	At average consumption	h	7.32	7	[G]	
	Water quality specification					
	Electrical conductivity	µS/cm	tba	-	-	
	Total dissolved solids	mg/L	<500	7	[A]	
	Suspended solids	mg/L	tba	-	-	
	Colour (True)	PCU	<15	7	[A]	
	pH		6.5 - 8.5	7	[A]	
	Turbidity	NTU	5	7	[A]	
	Total hardness	mg/L	<200	7	[A]	
	Total alkalinity	mg/L	tba	-	-	
	Sulphate	mg/L	<250	7	[A]	
	Chloride	mg/L	<250	7	[A]	
	Calcium	mg/L	tba	-	-	
	Magnesium	mg/L	<0.1	7	[A]	
	Sodium	mg/L	<180	7	[A]	
	Potassium	mg/L	tba	-	-	
	Arsenic	mg/L	<0.007	7	[A]	
	Antimony	mg/L	<0.003	7	[A]	
	Cadmium	mg/L	<0.002	7	[A]	
	Chromium	mg/L	<0.05	7	[A]	
	Copper	mg/L	<2	7	[A]	
	Lead	mg/L	<0.01	7	[A]	
18.04	<u>Cooling Water - Kiln</u>					
	Source	Low salinity bore water		7	[A]	
	Operation	forced air evaporative tower		7	[A]	
	Parameters					
	Cooling Capacity	kW	1,000	3	[A]	
	Wet bulb temperature	maximum	C	20.90	8	[A]
		minimum	C	9.10	8	[A]
	Approach to wet bulb temperature	C	8.00	3	[A]	
	Blowdown	% of feed	0.025	7	[A]	
	Air addition	liquid/gas ratio	0.50	3	[A]	
	Drift	m ³ /h	0.01	3	[G]	
	Evaporation	m ³ /h	1.32	3	[G]	
	Blowdown	m ³ /h	0.04	3	[G]	
	Makeup	m ³ /h	1.37	3	[G]	
	Consumption (instantaneous average)					
	Bearings	m ³ /h	7.50	2	[G]	
	Impact crusher	m ³ /h	35.00	2/11	[G]	
	Total	m ³ /h	42.50	3	[G]	

18.0 Water Supply and Storage (Facility 50)

No	Item	Units	Value	Ref.	Rev.
18.05	<u>Cooling Water - Plant</u>				
	Source		potable water	7	[A]
	Operation		forced air evaporative tower	7	[A]
	Parameters				
	Cooling Capacity	kW	5,000	3	[A]
	Wet bulb temperature	maximum	0.67	8	[A]
		minimum	1.00	8	[A]
	Approach to wet bulb temperature	C	8.00	3	[A]
	Blowdown	% of feed	0.025	7	[A]
	Air addition	liquid/gas ratio	0.50	3	[A]
	Feed rate	m ³ /h	280.66	2	[G]
	Drift	m ³ /h	0.03	3	[G]
	Evaporation	m ³ /h	6.62	3	[G]
	Blowdown	m ³ /h	0.19	3	[G]
	Makeup	m ³ /h	6.83	3	[G]
	Cooling water production	m ³ /h	267.0	3	[G]
	Consumption (instantaneous average)				
	Facility 30 - Desilication	m ³ /h	40.32	2	[G]
	Facility 35 - AMV Production	m ³ /h	11.47	2	[G]
	Facility 40, 41	m ³ /h	tba	3	[G]
	Facility 45 - V ₂ O ₄	m ³ /h	100.00	3	[G]
	Total	m ³ /h	151.79	2	[G]

19.0 Services (Facility 50)

No	Item	Units	Value	Ref.	Rev.
Design Criteria					
19.01	<u>Plant Air</u>				
	Capacity	FAD m ³ /h	360	4	[H]
	Air receiver capacity	m ³	3	3	[H]
	Pressure	kPag	750	3	[H]
	Air quality specification				
	Moisture @ oil aerosol	mg/m ³	1	3	[H]
	Particulates	mg/m ³	5	3	[H]
19.02	<u>Instrument Air</u>				
	Capacity	FAD m ³ /h	933	4	[H]
	Air receiver capacity	m ³	3	3	[H]
	Pressure	kPag	750	3	[H]
	Dryer				
	Type		refrigerate	3	[H]
	Drier temperature	C	3	3	[H]
	Dryer Pre-filter				
	Moisture @ oil aerosol	mg/m ³	0.1	3	[H]
	Particulates	mg/m ³	1	3	[H]
	Dryer Post-filter				
	Moisture @ oil aerosol	mg/m ³	0.1	3	[H]
	Particulates	mg/m ³	1	3	[H]
19.03	<u>Natural Gas</u>				
	Supplier		Alinta	7	[A]
	Pressure	kPag	750	7	[H]
	Chemical analysis				
	Nitrogen	% mole	2.31	10	[A]
	Methane	% mole	84.3	10	[A]
	Carbon dioxide	% mole	2.34	10	[A]
	Ethane	% mole	6.21	10	[A]
	Propane	% mole	3.35	10	[A]
	Iso-butane	% mole	0.47	10	[A]
	n-butane	% mole	0.72	10	[A]
	Iso-pentane	% mole	0.04	10	[A]
	n-pentane	% mole	0.03	10	[A]
	Hexanes	% mole	0.01	10	[A]
	Heptanes	% mole	0.002	10	[A]
	Gas density	kg/m ³	0.751	2	[A]
	Net calorific value	MJ/Nm ³	38.9	2	[A]
19.04	<u>Nitrogen</u>				
	Supplier		BOC	3	[I]
	Supply				
	Form		gas	6	[I]
	Purity	% N ₂	99.99	6	[I]
	Type		KAY Pack - 15 bottles per pack	6	[I]
	Volume	m ³	227	6	[I]
	Pressure	kPa	25,000	6	[I]
	No Packs required		3	6	[I]
19.05	<u>Oxygen</u>				
	Supplier		BOC	3	[I]
	Supply				
	Form		gas	-	[I]
	Purity	% O ₂	99.9	-	[I]
	Type		tba	-	[I]
	Volume	m ³	tba	-	[I]
	Pressure	kPa	tba	-	[I]
	No Packs required		tba	-	[I]