


Electrical Equipment Sizes

CO₂ Capture Facility

Kårstø, Norway

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1.0 PURPOSE

The purpose of this document is to identify the sizing of the main electrical equipment for the Karsto CO₂ project. Sizes of equipment are based on estimated loads and will be reviewed during detailed design. The balance of equipment design data will be provided with equipment data sheets per document 10112936-FI-B-CON-0331. Note: Single line diagrams will be updated per the sizing outlined in this document.

2.0 CABLES

2.1 SIZING BASIS

The design of all power cables will be sized based on the following three criteria: Short circuit ampacity, the required full load ampacities, and to keep voltage drop to allowed levels.

2.2 CABLE SIZES

The below table shows estimated cable sizes for the main feeder cables only. This information is presented as reference only as document 10112936-FI-B-CON-0331 does not require cable schedules and sizing calculations.

From Equipment	To Equipment	Voltage Level (kV)	Voltage Rating (kV)	No. Per Phase	Size (mm ²)
CCC Facility XFMR	22kV SWGR	22	36	5	400
6.6kV Feeder B	Dead Time XFMR	6.6	12	2	150
Dead Time XFMR	22kV SWGR	22	36	1	50
22kV SWGR	ASD (Flue Gas Blower A)	22	36	1	120
ASD (Flue Gas Blower A)	Flue Gas Blower A	11	24	1	300
22kV SWGR	ASD (Flue Gas Blower B)	22	36	1	120
ASD (Flue Gas Blower B)	Flue Gas Blower B	11	24	1	300
22kV SWGR	ASD (CO ₂ Compressor)	22	36	2	185
ASD (CO ₂ Compressor)	CO ₂ Compressor	11	24	3	400
22kV SWGR	Step Down XFMR	22	36	1	185
22kV SWGR	Capacitor Bank	22	36	1	95
22kV SWGR	400V SWGR A	22	36	1	50
22kV SWGR	400V SWGR B	22	36	1	50
Step Down XFMR	6.6kV SWGR	6.6	12	3	400
6.6kV SWGR	CCW A	6.6	12	1	50
6.6kV SWGR	CCW B	6.6	12	1	50
6.6kV SWGR	Rich Amine Pump 1A	6.6	12	1	50

6.6kV SWGR	Rich Amine Pump 1B	6.6	12	1	50
6.6kV SWGR	Rich Amine Pump 2A	6.6	12	1	50
6.6kV SWGR	Rich Amine Pump 2B	6.6	12	1	50
6.6kV SWGR	Wash Water Recirc Pump 1A	6.6	12	1	50
6.6kV SWGR	Wash Water Recirc Pump 1B	6.6	12	1	50
6.6kV SWGR	Wash Water Recirc Pump 2A	6.6	12	1	50
6.6kV SWGR	Wash Water Recirc Pump 2B	6.6	12	1	50
6.6kV SWGR	Lean Amine Pump A	6.6	12	1	50
6.6kV SWGR	Lean Amine Pump B	6.6	12	1	50
6.6kV SWGR	Flash Drum Pump A	6.6	12	1	50
6.6kV SWGR	Flash Drum Pump B	6.6	12	1	50
6.6kV SWGR	CO ₂ Product Sendout Pump A	6.6	12	1	120
6.6kV SWGR	CO ₂ Product Sendout Pump B	6.6	12	1	120
6.6kV SWGR	Seawater Cooling Pump A	6.6	12	1	70
6.6kV SWGR	Seawater Cooling Pump B	6.6	12	1	70
400V SWGR A	400V MCC A	400	700	4	400
400V SWGR B	400V MCC B	400	700	4	400
Diesel Generator	400V SWGR A & B	400	700	3	300

3.0 UPS SIZING

3.1 SIZING BASIS

The UPS system is designed to feed all critical plant loads. The UPS system sizing is based on the identified loads in the electrical consumers list (Fichtner document number 10112936 – PB – E – PAL – 0001), and is sized based on the required voltage tolerances and back-up times given in Exhibits E5.1 and E5.5. The UPS system sizing has an intentional spare capacity of 20%.

3.2 SIZING

3.2.1 Inverters

The calculated connected load (including inverter efficiency) is 43 kW. A standard 60 kW inverter will be provided.

3.2.2 Batteries

The calculated total load on the batteries is 64 kW including the 43 kW from the inverters. Allowing for 20% spare capacity the batteries will be sized to feed 77 kW.

The battery amp-hour is calculated using backup time as defined by Exhibit E5.5. Using the above loads on the battery and the specified time durations, a total of 1144 amp-hours are required. The selected amp-hour rating for battery is 1200Ah.

3.2.3 Battery Charger

The battery charger will be designed to fully charge the connected battery within 24 hours while simultaneously supplying full loads. The battery charger will also be designed to fully charge (Boost Charge) the connected battery within 10 hours while

disconnected from loads. Given the above requirements, 800A battery chargers are selected.

4.0 TRANSFORMERS

4.1 LOAD CENTER TRANSFORMERS

4.1.1 Sizing Basis

The load center transformers are sized to supply the required power to the 400V system. Each load center transformer is sized to supply all 400 volt loads which the coupled load centers and their respective sub-switchgears feed during worst case operating conditions. All load center transformers are sized with at least 20 percent spare capacity.

4.1.2 Sizing

Refer to Appendix 1 for sizing.

4.2 STEP-DOWN TRANSFORMER

4.2.1 Sizing Basis

The step-down transformer is sized to supply the required power to the 6.6 kV system and is sized with 20 percent spare capacity.

4.2.2 Sizing

Refer to Appendix 2 for sizing.

4.3 CCC FACILITY TRANSFORMER

4.3.1 Sizing Basis

The CCC facility transformer is sized to supply all required power for the CCC facility from the existing power plant. This transformer is supplied by others; therefore the sizing basis is the contractor's required power with contractor's design allowance.

4.3.2 Sizing

Refer to Appendix 3 for sizing.

4.4 DEAD-TIME TRANSFORMER

4.4.1 Sizing Basis

The dead time transformer is sized to supply power to the maintenance loads required for the CCC facility. Note: Although a 2 MVA transformer is sufficient, due to availability and ease of manufacturing, a 3 MVA transformer is selected.

4.4.2 Sizing

Refer to Appendix 4 for sizing.

5.0 LOW VOLTAGE LOAD CENTERS AND MCCS

5.1 SIZING BASIS

The 400 volt load centers and motor control centers (MCCs) are sized to supply their loads (when coupler is closed) during the worst case operating base, and will be sized as not to limit the power from their connected infeed transformers.

5.2 SIZING

Tag No	Description	Maximum Load At Incoming Breakers (Includes spare capacity)	Size
1ECEKLO1	400V Load Center 1	3523 Amps	4000 Amps
1ECEKLO2	400V Load Center 2	3523 Amps	4000 Amps
1ECECM01	400V MCC 1	1251 Amps	1600 Amps
1ECECM02	400V MCC 2	1251 Amps	1600 Amps
1ECECM03	Essential MCC	923 Amps	1250 Amps

6.0 MEDIUM VOLTAGE SWITCHGEARS

6.1 SIZING BASIS

The 6.6 kV and 22 kV switchgear is sized to supply its connected loads during the maximum operating load plus design margin, and will be sized as not to limit power from their connected infeed transformers.

6.2 SIZING

Tag No	Description	Maximum Load At Incoming Breakers (including spare capacity)	Size
1EESIO1	22kV SWGR	1310 Amps	2000 Amps
1EESIO2	6.6kV SWGR	1313 Amps	2000 Amps

7.0 STAND-BY EMERGENCY DIESEL GENERATOR

7.1 SIZING BASIS

The emergency diesel generator is sized to supply essential facility loads. Refer to document 25474-000-3BD-E12G-00002 (10112936-PB-E-TED-0004), for full design basis.

7.2 SIZING

The calculated load to be supplied is 441 kW. A standard 750 kW (600 kWe) diesel generator will be selected.

8.0 POWER FACTOR CORRECTION CAPACITORS

8.1 SIZING BASIS

The power factor correction capacitors are sized to correct the facilities power factor to nominal 1.0 at the battery limit.

8.2 SIZING

Per the contractor's load flow calculation a 14800 kVAr capacitor bank is required. For the purposes of the FEED study, the contractor selected a 4 stage 20 kVAr capacitor bank.



Load Center Transformers

Item No.	Tag No.	Item Description	Type of Operation	Voltage (Input Rating)	Rated Power (Note 1) kW	Required Power (Note 1) kW	FLA (Note 1) A	Sizing Current A	
1	IBAMA103	Seal Air Fans A	Standby	400	4	3.7	7.6	0	
2	IBAMA104	Seal Air Fans B	Standby	400	4	3.7	7.6	0	
3	IBAMA105	Seal Air Fans C	Standby	400	4	3.7	7.6	0	
4	IPAMC101A	Instrument/Service Air Compressor A	Continuous	400	55	45	95	95	
5	IPAMC101B	Instrument/Service Air Compressor B	Standby	400	55	45	95	0	
6	IQGMC103	Air Cooler for Air Compressor A	Continuous	400	7.5	5.6	14	14	
7	IQGMC103	Air Cooler for Air Compressor B	Standby	400	7.5	5.6	14	0	
8	ICYMEI18	Fresh Amine Storage Tank Heaters	Continuous	400	11	10	17	17	
9	ICYMEI19	Lean Amine Solvent Storage Tank Heater	Continuous	400	150	150	220	220	
10	IWPMEI23	Process Water Tank Heater	Continuous	400	11	10	17	17	
11	IWRMEI22	Softened Water Tank Heater	Continuous	400	5.5	5	9	9	
12	ICNMP107A	Reflux Pump A	Continuous	400	45	22	80	80	
13	ICNMP107B	Reflux Pump B	Standby	400	45	22	80	0	
14	IBAMP109A	Flue Gas Fogger Water Supply Pump A	Continuous	400	37	30	65	65	
15	IBAMP109B	Flue Gas Fogger Water Supply Pump B	Standby	400	37	30	65	0	
16	IBAMP109C	Flue Gas Fogger Water Supply Pump C	Continuous	400	37	30	65	65	
17	IBAMP109D	Flue Gas Fogger Water Supply Pump D	Standby	400	37	30	65	0	
18	ICYMP110A	Fresh Amine Metering Pump A	Continuous	400	1.1	0.5	2.4	2.4	
19	ICYMP110B	Fresh Amine Metering Pump B	Standby	400	1.1	0.5	2.4	0	
20	ICYMP111A	Lean Amine Solvent Fill Pump A	Continuous	400	45	29	80	80	
21	ICYMP111B	Lean Amine Solvent Fill Pump B	Standby	400	45	29	80	0	
22	IXWMT103A	Amine Waste Sump Pump A	Continuous	400	11	8.17	20.5	20.5	
23	IXWMT103B	Amine Waste Sump Pump B	Standby	400	11	8.17	20.5	0	
24	IXWMP113A	Wastewater Forwarding Pump A	Continuous	400	7.5	7.5	14	14	
25	IXWMP113B	Wastewater Forwarding Pump B	Standby	400	7.5	7.5	14	0	
26	ISCMP114A	LP Condensate Return Pump A	Continuous	400	75	56	127	127	
27	ISCMP114B	LP Condensate Return Pump B	Standby	400	75	56	127	0	
28	ICYMP116A	Chemical Additive Metering Pump A	Continuous	400	2.2	2	4.37	4.37	
29	ICYMP116B	Chemical Additive Metering Pump B	Standby	400	2.2	2	4.37	0	
30	ICYMP117A	Caustic Metering Pump A	Continuous	400	1.1	0.1	2.4	2.4	
31	ICYMP117B	Caustic Metering Pump B	Standby	400	1.1	0.1	2.4	0	
32	IWPMP119A	Absorber make-up water Pump A	Continuous	400	7.5	5.6	14	14	
33	IWPMP119B	Absorber make-up water Pump B	Standby	400	7.5	5.6	14	0	
34	IWLMP121A	Sea Water Booster Pump A	Continuous	400	224	200	422	422	
35	IWLMP121B	Sea Water Booster Pump B	Standby	400	224	200	422	422	
36	IQGMC103	CO2 Compressor Lube Oil Pumps A	Continuous	400	7.5	7.5	14	14	
37	IQGMC103	CO2 Compressor Lube Oil Pumps B	Continuous	400	7.5	7.5	14	14	
38	IBAMA101	Flue Gas Blower Lube Oil Pumps A	Continuous	400	4	3.75	7.6	7.6	
39	IBAMA101	Flue Gas Blower Lube Oil Pumps B	Continuous	400	4	3.75	7.6	7.6	
40	IBAMA102	Flue Gas Blower Lube Oil Pumps C	Continuous	400	4	3.75	7.6	7.6	
41	IBAMA102	Flue Gas Blower Lube Oil Pumps D	Continuous	400	4	3.75	7.6	7.6	
42	ISCMP120A	HP Condensate Return Pump A	Continuous	400	7.5	7.5	14	14	
43	ISCMP120B	HP Condensate Return Pump B	Standby	400	7.5	7.5	14	0	
44	IPAMS105A	Instrument Air Dryer A	Continuous	400	11	10	17	17	
45	IPAMS105B	Instrument Air Dryer B	Standby	400	11	10	17	0	
46	ICYMS103	Reclaimer Chemical Feed Package	Continuous	400	5.5	5	10.8	11	
47	IQGMS104	CO2 Drying Package	Continuous	400	11	10	17	17	
48	IBAMD008A	Common Flue Gas Duct Isolation Dampers A	Standby	400	4	0	7.6	0	
49	IBAMD008B	Common Flue Gas Duct Isolation Dampers B	Standby	400	4	0	7.6	0	
50	IBAMD034A	Flue Gas Duct Isolation Damper (Absorber 1) A	Standby	400	4	0	7.6	0	
51	IBAMD034B	Flue Gas Duct Isolation Damper (Absorber 1) B	Standby	400	4	0	7.6	0	
52	IBAMD060A	Flue Gas Duct Isolation Damper (Absorber 2) A	Standby	400	4	0	7.6	0	
53	IBAMD060B	Flue Gas Duct Isolation Damper (Absorber 2) B	Standby	400	4	0	7.6	0	
54	1ANMG001	Emergency Diesel Gen Heater	Continuous	400	9	9	13	13	
55	Later	Control Bldg HVAC Units A	Continuous	400	110	77	158	158	
56	Later	Control Bldg HVAC Units B	Standby	400	110	77	158	0	
57	Later	Electric Building HV Units	Continuous	400	80	56	115	115	
58	Later	Vent Fans (Compressor Building)	Continuous	400	100	70	144	144	
59	Later	Vent Fans (Blower Buildings)	Continuous	400	64	45	92	92	
60	Later	Stores/Workshop HV Units	Continuous	400	82	57	118	118	
61	Later	Electrical Heat Tracing	Continuous	400/230	250	200	360	252	
62	Later	Lighting	Continuous	400/230	160	158	230	230	
63	Later	Brine Solution Skid	Continuous	400	3	2	5	5	
64	IWRMP122A	Softened Water Supply Pumps A	Continuous	400	1	0.5	2	2	
65	IWRMP122B	Softened Water Supply Pumps B	Standby	400	1	0.5	2	0	
					80	64	110	0	
								Current	2937
								KVA	2032
								Spare Capacity (20%)	2439
								Selected Size (KVA)	2500

NOTES

1. FLA (full load amps) of the motors are based on typical industrial motors and take into account the motor efficiency and power factor.



Step-Down Transformer

Item No.	Tag No.	Item Description	Type of Operation	Voltage (Input Rating)	Rated Power (Note 1) kW	Required Power kW	FLA A	SIZING CURRENT A
15	1CNMP101A	Rich Amine Pumps (Absorber 1) A	Continuous	6.6kv	900	789	90	90
16	1CNMP101B	Rich Amine Pumps (Absorber 1) B	Standby	6.6kv	900	789	90	0
17	1CNMP124A	Rich Amine Pumps (Absorber 2) A	Continuous	6.6kv	900	789	90	90
18	1CNMP124B	Rich Amine Pumps (Absorber 2) B	Standby	6.6kv	900	789	90	0
19	1CNMP102A	Wash Water Recirculation Pump (Absorber 1) A	Continuous	6.6kv	373	319	37	37
20	1CNMP102B	Wash Water Recirculation Pump (Absorber 1) B	Standby	6.6kv	373	319	37	0
21	1CNMP104A	Wash Water Recirculation Pump (Absorber 2) A	Continuous	6.6kv	373	319	37	37
22	1CNMP104B	Wash Water Recirculation Pump (Absorber 2) B	Standby	6.6kv	373	319	37	0
23	1CNMP105A	Lean Amine Pump A	Continuous	6.6kv	900	802	90	90
24	1CNMP105B	Lean Amine Pump B	Standby	6.6kv	900	802	90	0
25	1CNMP106A	Flash Drum Pump A	Continuous	6.6kv	300	102	32	32
26	1CNMP106B	Flash Drum Pump B	Standby	6.6kv	300	102	32	0
29	1QGMP108A	CO2 Product Sendout Pump A	Continuous	6.6kv	1865	911	185	185
30	1QGMP108B	CO2 Product Sendout Pump B	Standby	6.6kv	1865	911	185	185
45	1WLMP115A	Sea Water Cooling Pump A	Continuous	6.6kv	1500	1500	150	150
46	1WLMP115B	Sea Water Cooling Pump B	Standby	6.6kv	1500	1500	150	0
Current								896
KVA								10231
Spare Capacity (20%)								12277
Selected Size (kVA)								15000

NOTES

1. FLA (full load amps) of the motors are based on typical industrial motors and take into account the motor efficiency and power factor.



Item No.	Tag No.	Item Description	Voltage (Input Rating)	Rated Power (Note 1) kW	Required Power kW	FLA	SIZING Current
1	IBAMA101	Flue gas blower (Absorber 1)	22kv	6340	5072	183	183
2	IBAMA102	Flue gas blower (Absorber 2)	22kv	6340	5072	183	183
3	IQGMC103	CO2 Compressor	22kv	20000	18000	575	575
Current (A)							941
KVA (22 kV Base)							35814
Design Margin (5%)							37605
From Load Center Transformer (kVA)							2032
From Step-Down Transformer (kVA)							10231
Total							49868
REQUIRED SIZE							50000

NOTES

1. FLA (full load amps) of the motors are based on typical industrial motors and take into account the motor efficiency and power factor.



Item No.	Tag No.	Item Description	Voltage (Input Rating)	Rated Power (Note 1) kW	Required Power kW	FLA A
1	IPAMC101A	Instrument/Service Air Compressor A	400	55	45	95
2	IQGMC103	Air Cooler for Air Compressor A	400	7.5	5.6	14
3	1CYME118	Fresh Amine Storage Tank Heaters	400	11	10	17
4	1CYME119	Lean Amine Solvent Storage Tank Heater	400	150	150	220
5	1WPME123	Process Water Tank Heater	400	11	10	17
6	1WRME122	Softened Water Tank Heater	400	5.5	5	9
7	1CYMP116A	Chemical Additive Metering Pump A	400	2.2	2	4.37
8	1CYMP117A	Caustic Metering Pump A	400	1.1	0.1	2.4
9	IQGMC103	CO2 Compressor Lube Oil Pumps A	400	7.5	7.5	14
10	IQGMC103	CO2 Compressor Lube Oil Pumps B	400	7.5	7.5	14
11	1BAMA101	Flue Gas Blower Lube Oil Pumps A	400	4	3.75	7.6
12	1BAMA101	Flue Gas Blower Lube Oil Pumps B	400	4	3.75	7.6
13	1BAMA102	Flue Gas Blower Lube Oil Pumps C	400	4	3.75	7.6
14	1BAMA102	Flue Gas Blower Lube Oil Pumps D	400	4	3.75	7.6
15	1PAMS105A	Instrument Air Dryer A	400	11	10	17
16		Control Bldg HVAC Units A	400	110	77	158
17		Control Bldg HVAC Units B	400	110	77	158
18		Electric Building HV Units	400	80	56	115
19		Vent Fans (Compressor Building)	400	100	70	144
20		Vent Fans (Blower Buildings)	400	64	45	92
21		Stores/Workshop HV Units	400	82	57	118
22		Electrical Heat Tracing	400	250	200	360
23		UPS	400	80	77	110
24		Lighting	400	160	158	230
					Amps	1939
					KVA	1342
					Spare Capacity (20%)	1610
					Selected Size (kVA)	3000

NOTES

1. FLA (full load amps) of the motors are based on typical industrial motors and take into account the motor efficiency and power factor.