Calculation Cover Sheet

Subject	Load Flow Calculations	Project	KARSTO
Discipline	Electrical	Job No.	25474-000
		Calc. No.	25474-000-E0C-ES-00001
		Sheet	1 of 10

Calculation Status Designation	Preliminary	Confirmed with Preliminary Information	Confirmed	Superseded	Voided
	X				

Computer Program/Type	SCP	Program Name.	Version/Release	Operating System
	X	ETAP	6.0.0	Windows XP

Nuclear Quality Classification	Safety-Related	Augmented Quality	Nonsafety-Related

Use of these calculations by person, without access to pertinent factors and without proper regard for their purpose, could lead to erroneous conclusions.

Should it become necessary to use these calculations in your work in the future, it is suggested that the calculations be reviewed with authorized Bechtel personnel to ensure that the purposes, assumptions, judgments and limitations are thoroughly understood. Bechtel cannot assume responsibility for the use of these calculations not under our direct control.

Owner Document No. 10112936-PB-E-TDO-0001

Rev. No.	Reason for Revision	Total No. of Sheets	Last Sheet No.	By	Checked	Approved/ Accepted	Date
0	Issued for Comment	39	Attachment 6, Sheet 4 of 4	VS	WK	SMS	11/21/08

Record of Revisions

Contents

Load Flow Calculations

1.0 SCOPE

The scope of this Report includes a review and analysis of the electrical power system for the CO_2 Capture and Compression (CCC) facility adjacent to the gas-fired Combined Cycle Power Plant (CCPP) at Kårstø in the South-West of Norway. An electrical model was developed and various studies were conducted as a preliminary investigation of the power system performance to determine sizes and ratings of the major electrical equipment based on the system information available at this stage of the project. In order to complete these calculations some assumptions were made which are explained later in this report.

The 22kV Substation located in CCC facility is supplied with 20kV (Feeder A) and 6.6kV (Feeder B) in-feeds from the CCPP 20kV Generator Isophase Bus and 6.6kV Switchgear 10BBE through power transformers CCC FACILITY XFMR 1ESETP01 (50MVA, 20-23kV) located in CCPP facility and DEAD TIME XFMR 1ESETP02 (3MVA, 6.6-23Kv) located outdoor in the CCC facility. The 22kV Switchgear (1ESESI01) 22KV-SWGR is indoor switchgear with manual bus transfer arrangement. The voltage is further stepped down to 6.6kV and 400V distribution levels to feed various loads. Additionally, three large motors (compressor and blowers) are supplied from 22kV-switchgear (1ESESI01) via isolation transformers and controlled through adjustable speed drive systems (ASDS).

The purpose of Load Flow (LF) Calculations is to:

- Determine voltages at different parts of the system for different load conditions
- Determine Tap Changer settings of the transformers
- Verify load flow in each circuit to ensure that all equipment is properly rated
- Establish power ratings of major electrical equipment including transformers, switchgear and MCCs.
- Determine power factor (p.f.) compensation required to support overall p.f. =1.0 at the HV side of the 50MVA and 3 MVA Utility interfacing transformers.

Calculations reflect the most unfavorable operation and the pessimistic equipment parameter assumption.

2.0 METHODOLOGY

The electrical model was developed using ETAP PowerStation (Version 6.0.0) software based on Load List and Single Line Diagrams (SLD) as available at time of calculations and the system information provided by GASSNOVA as Owner and FICHTNER as Owner's Engineer.

Newton-Raphson method is used for calculations. ETAP provides three load flow calculation methods: Newton-Raphson, Fast-Decoupled, and Accelerated Gauss-Seidel. The Newton-Raphson method possesses a unique quadratic convergence characteristic and is recommended for use with any system as a first choice.

For worst case, all loads are based on peak demand loading and are considered as normal loading.

For all calculations, Normal system configuration is when Feeder A in-feed breaker is closed and Feeder B in-feed breaker is open and Low Voltage Switchgear 1ECEKL01/02 (400V-LdCntr) tie-breaker is open and in-feeds breakers closed. Alternate configurations are when Feeder A in-feed breaker is open and Feeder B in-feed breaker is closed (Stand by Mode) and for 400V-LdCntr in-feed breaker B is open and tie-breaker and in-feed breaker A are closed. For reference the SLDs are listed in Section 6.0.

Three cases of load flow were calculated, considering Full Production and Stand by operation conditions with power supply from Feeder A or Feeder B.
Comparing Voltage on both side of open in-feed Circuit Breakers for cases 2 and 3 we can investigate a pre-switching condition for 22KV-SWGR in case of manual switching from Feeder A to Feeder B and back. The voltage difference shall be within range of +/- 10% of nominal voltage.

One case of load flow was calculated for Essential Loads running from Generator connected to 400V-LdCntr 1.

Calculation cases comprise various scenarios to evaluate options and limitations pertaining to operation of the distribution system under different conditions.

3.0 ASSUMPTIONS AND SETTINGS

The following are detailed descriptions of connections, conditions and equipment assumed for the calculations. Single Line Diagrams using ETAP PowerStation are listed in Section 6.0 ATTACHMENTS.

- 50 MVA Power Transformer Data and 22KV-SWGR data was provided by FICHTNER as follows:
  - Power transformer connected to the external grid, 50 MVA , 20/23kV, 12.5% impedance, provided by others

- 22kV switchgear shall be designed for I_b(sym)=31.5kA, Ip=80kA

- The estimated available short circuit currents at CCPP switchgear 10BBE were provided by FICHTNER as follows:
  - Minimum available SC is 8kA
  - Maximum available SC is 25kA
- Assumed X/R ratio for Min/Max SC on CCPP switchgear 10BBE is 50.
- The estimated available short circuit currents at the primary side of the 50 MVA transformer were provided by FICHTNER as follows:
  - Minimum available SC is 60kA
  - Maximum available SC is 130kA
- Assumed X/R ratio for Min/Max SC on the primary side of the 50 MVA transformer is 95.
- Transformers sizes were considered as shown on the single line diagrams. Actual data was used for transformer impedances where known, otherwise typical data used where unknown.
- Transformer Impedance tolerance is considered in calculations as + 7.5%
- Transformer sizing was checked by ETAP based on IEC standard, connected loads, operating load and ambient temperature 40° C.
- Symbols for two-winding ASDS transformers (T1, T2, and T3 on SLD) only for reference purpose and will be defined later by ASDS Vendor.
- Voltage tolerance of the 20kV and 6.6kV upstream Owner provided utility systems is estimated as +/- 2%.
- All connected loads are based on Load List and Single Line Diagram.
- 50MVA CCC Facility transformer tap set to 0% and all other power transformers tap set to +2.5% on primary.
- Ambient temperature for above ground (A/G) trays is 40° C and for underground (U/G) ducts is 20° C. Cables temperature range is from 20° C to 80° C.
- Cable conductor resistances adjusted for temperature 80° C.
- Power factor compensation capacitors adjusted approximately to p.f. =1.0 at the HV side of the 50MVA and 3 MVA Utility interfacing transformers for all cases run.
- Basis for p.f.= 1 correction is 0.98 lag to 0.98 lead.

- Required rating for power factor compensation capacitors was calculated by ETAP for Normal Mode (Full Production, Power from feeder A) and Stand by Mode (Power from Feeder A or B).
- Cable Loading factors are from 1 to 1.35 for different loads according to IEC.
- Maximum Voltage Drops for Busses and Cables are as per Exhibit E5.7- Cabling and Cable Trays.
- Load category is "design" and assumed 100% of nameplate rating for pessimistic results.
- Cable Sizes are as shown on the SLD. Cable impedance values are typical as listed in the ETAP PowerStation cable library.
- Cable grouping was assumed as per Exhibit E5.7- Cabling and Cable Trays.
- Cable sizing was verified by ETAP based on ICEA P-54-440 standard for above ground tray installations and IEEE 399 standard for under ground duct installations.

4.0 CALCULATIONS

4.1 CASE 1: NORMAL OPERATION WITH MAXIMUM SYSTEM LOAD. (THIS IS THE MINIMUM BUS VOLTAGE CASE):

- System SC contribution at maximum available, supply voltage set to 0.98 p.u.
- 22KV-SWGR Feeder A available and in-feed breaker is closed
- 22KV-SWGR Feeder B unavailable and in-feed breaker open
- 400V-LdCntr Tie-Breaker closed, "CB A" in-feed breaker closed and "CB B" in-feed breaker open
- All loads are running on normal plus the largest standby motor for CO2 Product Sendout Pump B is running

4.2 CASE 2: NORMAL OPERATION WITH MAINTANENCE OUTAGE. (THIS IS THE MAXIMUM BUS VOLTAGE CASE):

- System SC contribution at maximum available, supply voltage set to 1.02 p.u.
- 22KV-SWGR Feeder A available and in-feed breaker is closed
- 22KV-SWGR Feeder B unavailable and in-feed breaker open
- 400V-LdCntr Tie-Breaker open and both in-feed breakers closed
- Only Maintenance Loads are running on normal

4.3 CASE 3: STAND BY MODE. (THIS IS THE MINIMUM BUS VOLTAGE CASE):

- System SC contribution at maximum available, supply voltage set to 0.98 p.u.
- 22KV-SWGR Feeder A unavailable and in-feed breaker open
- 22KV-SWGR Feeder B available and in-feed breaker is closed
- 400V-LdCntr Tie-Breaker closed, "CB A" in-feed breaker closed and "CB B" in-feed breaker open
- Only Maintenance Loads are running on normal

4.4 CASE 4: STAND BY MODE. (THIS IS THE MAXIMUM BUS VOLTAGE CASE):

- System SC contribution at maximum available, supply voltage set to 1.02 p.u.
- 22KV-SWGR Feeder A unavailable and in-feed breaker open
- 22KV-SWGR Feeder B available and in-feed breaker is closed
- 400V-LdCntr Tie-Breaker open and both in-feed breakers closed
- Only Maintenance Loads are running on normal

4.5 CASE 5: ESSENTIAL LOADS:

- 22KV-SWGR Feeder A and Feeder B unavailable and in-feed breakers open
- 400V-LdCntr Tie-Breaker and in-feed breakers open
- Sea Water Boosting pump is off and its circuit breaker (CB38) is open
- Feeder to 400V-MCC-1 is off and feeder to 400V-EssMCC is on for 400V-LdCntr-1
- Stand by Diesel Generator StandbyDG in Swing bus mode and feeds 400V-EssMCC
- 400V-EssMCC feeder to 400V-LdCntr-1 is on and its CB is closed.
- Essential Loads are running on 400V-LdCntr-1 and 400V-EssMCC.

4.6 RESULTS OF THE CALCULATIONS:

- Reports and SLDs with Calculations Results are in the 6.0 Attachments.
- The Summary of results of each case is listed in the following table:

Load Flow Study Results

Bus Name	Bus Voltage	LF Case 1	LF Case 2	LF Case 3	LF Case 4	LF Case 5
	kV	BUS %V	BUS %V	BUS %V	BUS %V	BUS %V
Bus A	22	100.71	106.65	102.45	106.64	N/A
Bus B	22	99.96	104.04	99.7	103.78	N/A
22KV-SWGR	22	100.71	106.65	99.7	103.78	N/A
6.6kV-SWGR	6.6	99.91	N/A	N/A	N/A	N/A
400V-LdCntr-1	0.4	99.47	108.34	100.37	105.37	99.69
400V-LdCntr-2	0.4	99.47	108.51	100.37	105.55	N/A
400V-MCC-1	0.4	99.3	108.24	100.21	105.22	N/A
400V-MCC-2	0.4	99.34	108.5	100.36	105.54	N/A
400V-EssMCC	0.4	99.3	108.35	100.2	105.39	99.72

Transformer Tap selection criteria:

- Voltage drop under stationary conditions shall maximum be 4% of the nominal voltage
- Bus voltage should not exceed +/- 10% of the nominal under no-load conditions.

5.0 CONCLUSIONS

The calculations in this Report are based on assumed data and therefore it is considered as preliminary calculations only. At this stage, the results are adequate for equipment sizing. For the next phase of the project these calculations should be revisited when more information on equipment and the system is available.

- HV On-Load tap changers are not required on the 50 and 3MVA utility interfacing transformers. De-Energized tap changer can provide satisfactory performance when required. If the Utility interface voltage is greater than +/- 2% then HV OLTC's may be required on the utility interface transformers.
- Bus Voltages under stationary conditions are well above the minimum acceptable
- Voltage may have to be lowered for Case 2 and Case 4 by changing the tap settings on the 50MVA transformer if necessary during the Maintenance Outage.
- In pre-switching conditions (power switching from Feeder A to Feeder B and back) voltage difference on the incomer circuit breakers are within the required 10% limit. (Comparing Bus A, Bus B and 22kV-SWGR for Case 2 and Case 3).
- Compensating capacitors CAP Normal Mode shall be installed on the 22KV-SWGR bus for reactive power compensation during Normal Mode to support p.f.=1 as per

SLD. Part of these capacitors is used for other operation mode – CAP Stand by Mode. Two capacitor devices are modeled in ETAP to represent two settings in the Capacitor Bank and only one capacitor bank and MV CB feed is actually physically provided.

- Voltage drop on the power cables (as per SLD and Report results for the Case 1) are well below the maximum allowable by cable requirements as per the Exhibit E5.7

6.0 LIST OF ATTACHMENTS

6.1 INPUT DATA

- Attachment 1, Input Data, SLD, 1 page.

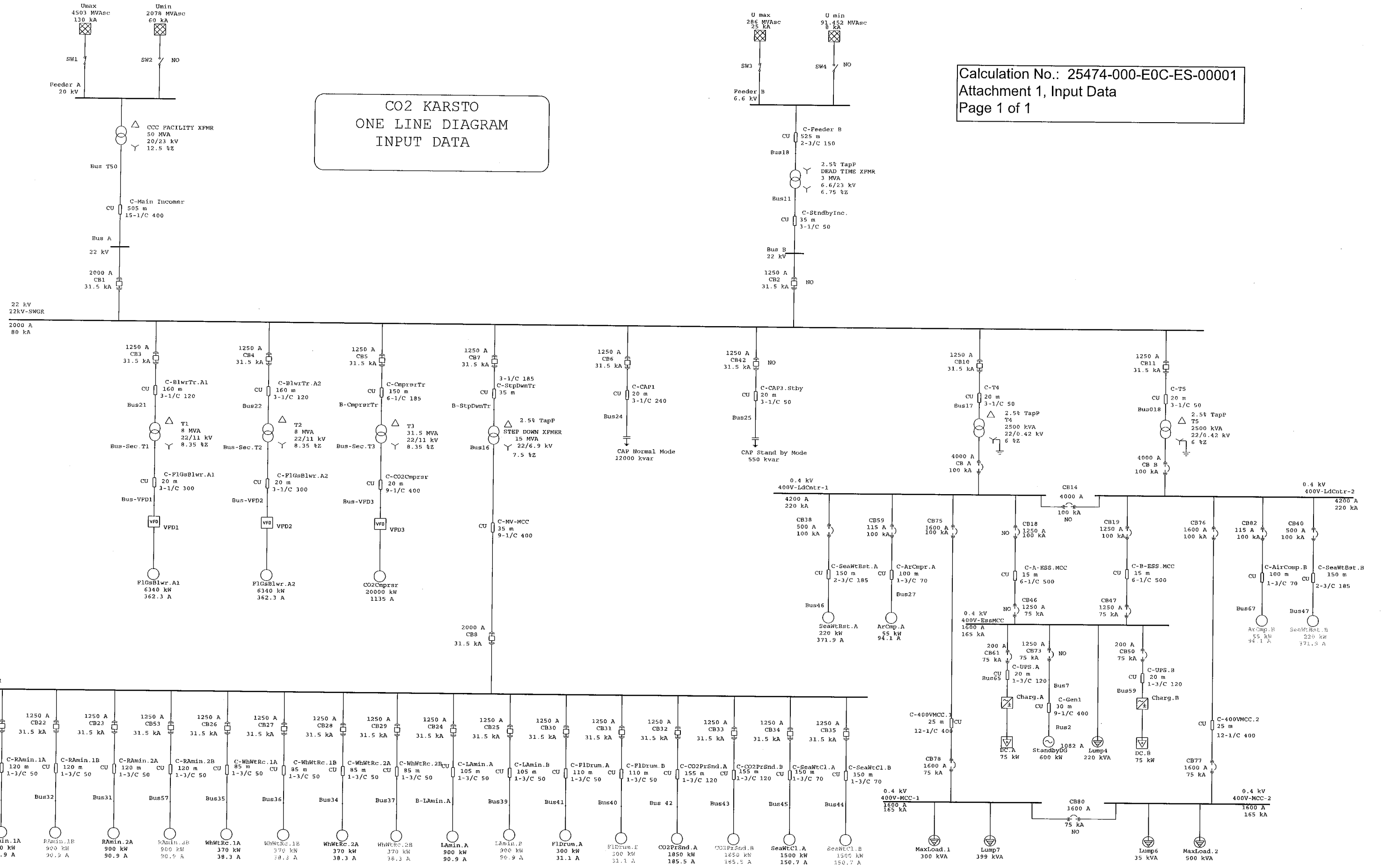
6.2 LOAD FLOW CALCULATIONS REPORTS AND SINGLE LINE DIAGRAMS

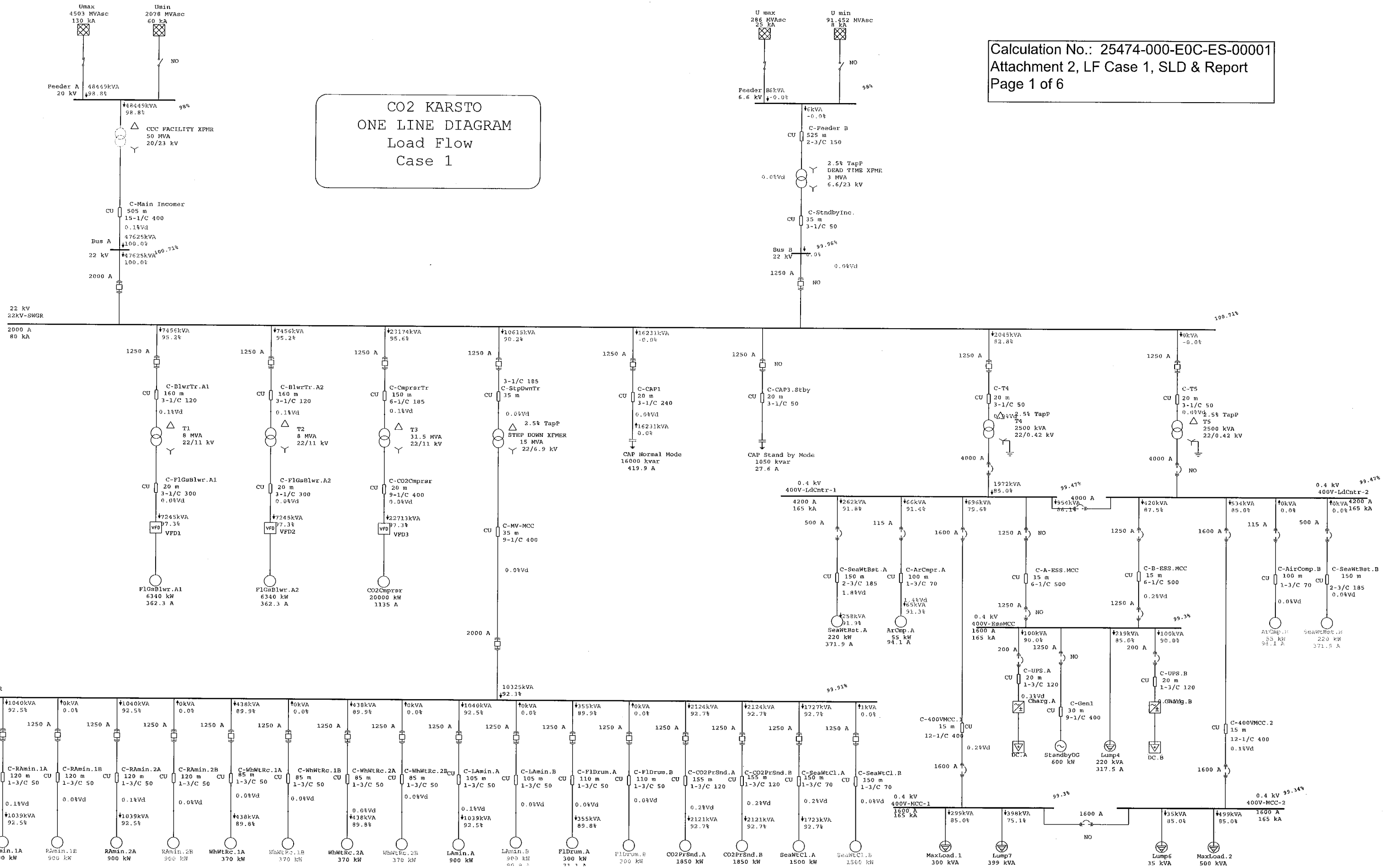
- Attachment 2, LF Case 1 – Results on SLD, 1 page; Summary Report, 5 pages.
- Attachment 3, LF Case 2 – Results on SLD, 1 page; Summary Report, 5 pages.
- Attachment 4, LF Case 3 – Results on SLD, 1 page; Summary Report, 4 pages.
- Attachment 5, LF Case 4 – Results on SLD, 1 page; Summary Report, 5 pages.
- Attachment 6, LF Case 5 – Results on SLD, 1 page; Summary Report, 4 pages.

ATTACHMENTS

CO2 KARSTO
ONE LINE DIAGRAM
INPUT DATA

Calculation No.: 25474-000-E0C-ES-00001
Attachment 1, Input Data
Page 1 of 1





Calculation No.: 25474-000-E0C-ES-00001
Attachment 2, LF Case 1, SLD & Report
Page 1 of 6

Project:	CO2 Karsto	ETAP		Page:	1
Location:	Karsto, South-West of Norway	6.0.0C		Date:	19-11-2008
Contract:	Bechtel 25474			SN:	BANTRELENG
Engineer:	Victor Skavitine	Study Case: LF Case1RevA		Revision:	Base
Filename:	KARSTO			Config.:	UmaxLmaxV98%

Preliminary Design

Branch Loading Summary Report

CKT / Branch		Cable & Reactor			Transformer				
		Ampacity	Loading		Capability	Loading (input)		Loading (output)	
ID	Type	(Amp)	Amp	%	(MVA)	MVA	%	MVA	%
CCC FACILITY XFMR	Transformer				50.000	48.449	96.9	47.655	95.3
DEAD TIME XFMR	Transformer				3.000	0.001	0.0	0.001	0.0
STEP DOWN XFMER	Transformer				15.000	10.614	70.8	10.328	68.9
T1	Transformer				8.000	7.453	93.2	7.246	90.6
T2	Transformer				8.000	7.453	93.2	7.246	90.6
T3	Transformer				31.500	23.164	73.5	22.715	72.1
T4	Transformer				2.500	2.045	81.8	1.972	78.9

* Indicates a branch with operating load exceeding the branch capability.

Project:	CO2 Karsto	ETAP		Page:	2
Location:	Karsto, South-West of Norway	6.0.0C		Date:	19-11-2008
Contract:	Bechtel 25474			SN:	BANTRELENG
Engineer:	Victor Skavitine	Study Case: LF Case1RevA		Revision:	Base
Filename:	KARSTO			Config.:	UmaxLmaxV98%

Preliminary Design

Branch Losses Summary Report

CKT / Branch	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop
ID	MW	Mvar	MW	Mvar	kW	kvar	From	To	in Vmag
C-CO2PrSnd.A	1.970	0.795	-1.967	-0.793	3.1	1.1	99.9	99.7	0.17
C-CO2PrSnd.B	1.970	0.795	-1.967	-0.793	3.1	1.1	99.9	99.7	0.17
C-FlDrum.A	0.319	0.156	-0.319	-0.156	0.2	-0.3	99.9	99.9	0.04
C-FlDrum.B	0.000	0.000			0.0	-0.4	99.9	99.9	0.00
C-LAmin.A	0.962	0.396	-0.961	-0.396	1.3	0.0	99.9	99.8	0.12
C-LAmin.B	0.000	0.000			0.0	-0.4	99.9	99.9	0.00
C-MV-MCC	-9.534	-3.963	9.536	3.966	1.8	2.1	99.9	99.9	0.03
C-RAmin.1A	0.962	0.396	-0.961	-0.396	1.4	0.0	99.9	99.8	0.14
C-RAmin.1B	0.000	0.000			0.0	-0.4	99.9	99.9	0.00
C-RAmin.2A	0.962	0.396	-0.961	-0.396	1.4	0.0	99.9	99.8	0.14
C-RAmin.2B	0.000	0.000			0.0	-0.4	99.9	99.9	0.00
C-SeaWtCl.A	1.600	0.649	-1.597	-0.648	3.4	0.7	99.9	99.7	0.21
C-SeaWtCl.B	0.000	-0.001			0.0	-0.6	99.9	99.9	0.00
C-WhWtRc.1A	0.394	0.192	-0.394	-0.192	0.2	-0.2	99.9	99.9	0.04
C-WhWtRc.1B	0.000	0.000			0.0	-0.3	99.9	99.9	0.00
C-WhWtRc.2A	0.394	0.192	-0.394	-0.192	0.2	-0.2	99.9	99.9	0.04
C-WhWtRc.2B	0.000	0.000			0.0	-0.3	99.9	99.9	0.00
C-BlwrTr.A1	7.095	2.290	-7.092	-2.292	3.4	-2.0	100.7	100.7	0.05
C-BlwrTr.A2	7.095	2.290	-7.092	-2.292	3.4	-2.0	100.7	100.7	0.05
C-CAP1	0.001	-16.231	0.000	16.231	1.0	0.6	100.7	100.7	0.01
C-CmprsrTr	22.163	6.772	-22.153	-6.771	10.2	1.0	100.7	100.7	0.06
C-StpDwnTr	9.571	4.592	-9.570	-4.592	1.0	-0.1	100.7	100.7	0.01
C-T4	1.692	1.148	-1.692	-1.148	0.1	-0.4	100.7	100.7	0.00
C-T5	0.000	0.000			0.0	-0.4	100.7	100.7	0.00
C-B-ESS.MCC	-0.367	-0.203	0.367	0.204	0.4	0.7	99.3	99.5	0.17
C-UPS.A	0.090	0.044	-0.090	-0.044	0.2	0.1	99.3	99.0	0.26
C-UPS.B	0.090	0.044	-0.090	-0.044	0.2	0.1	99.3	99.0	0.26
C-400VMCC.1	0.554	0.421	-0.553	-0.420	0.7	1.0	99.5	99.3	0.17
C-ArCmpr.A	0.060	0.027	-0.060	-0.027	0.9	0.2	99.5	98.1	1.38
C-SeaWtBst.A	0.241	0.104	-0.237	-0.102	4.0	2.4	99.5	97.7	1.77
T4	-1.677	-1.038	1.692	1.148	15.6	110.7	99.5	100.7	6.28
C-400VMCC.2	0.454	0.282	-0.454	-0.281	0.4	0.6	99.5	99.3	0.13
C-AirComp.B	0.000	0.000			0.0	0.0	99.5	99.5	0.00
C-SeaWtBst.B	0.000	0.000			0.0	0.0	99.5	99.5	0.00
T3	22.153	6.771	-22.097	-5.262	55.2	1508.2	100.7	98.7	1.95

Project:	CO2 Karsto	ETAP		Page:	3
Location:	Karsto, South-West of Norway	6.0.0C		Date:	19-11-2008
Contract:	Bechtel 25474			SN:	BANTRELENG
Engineer:	Victor Skavitine	Study Case: LF Case1RevA		Revision:	Base
Filename:	KARSTO			Config.:	UmaxLmaxV98%

Preliminary Design

CKT / Branch	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop
ID	MW	Mvar	MW	Mvar	kW	kvar	From	To	in Vmag
STEP DOWN XFMER	9.570	4.592	-9.536	-3.966	33.7	626.5	100.7	99.9	5.11
C-StndbyInc.	0.000	-0.001			0.0	-0.7	100.0	100.0	0.00
DEAD TIME XFMR	0.000	0.001	0.000	-0.001	0.0	0.0	100.0	98.0	2.50
C-Feeder B	0.000	0.001	0.000	-0.006	0.0	-5.4	98.0	98.0	0.00
T1	7.092	2.292	-7.049	-1.679	43.1	613.6	100.7	97.9	2.80
T2	7.092	2.292	-7.049	-1.679	43.1	613.6	100.7	97.9	2.80
C-Main Incomer	-47.617	-0.861	47.646	0.912	28.9	50.9	100.7	100.8	0.06
C-FlGsBlwr.A1	7.049	1.679	-7.048	-1.678	0.7	0.6	97.9	97.8	0.01
C-FlGsBlwr.A2	7.049	1.679	-7.048	-1.678	0.7	0.6	97.9	97.8	0.01
C-CO2Cmprsr	22.097	5.262	-22.096	-5.261	1.8	1.7	98.7	98.7	0.01
CCC FACILITY XFMR	-47.646	-0.912	47.869	7.476	222.5	6564.7	100.8	98.0	1.68
					487.5	10088.0			

Project:	CO2 Karsto	ETAP		Page:	4
Location:	Karsto, South-West of Norway	6.0.0C		Date:	19-11-2008
Contract:	Bechtel 25474			SN:	BANTRELENG
Engineer:	Victor Skavitine			Revision:	Base
Filename:	KARSTO	Study Case: LF Case1RevA		Config.:	UmaxLmaxV98%

Preliminary Design

Alert Summary Report

% Alert Settings

	Critical	Marginal
Loading		
Bus	100.0	95.0
Cable	100.0	95.0
Reactor	100.0	95.0
Line	100.0	95.0
Transformer	100.0	95.0
Panel	100.0	95.0
Protective Device	100.0	95.0
Generator	100.0	95.0
Bus Voltage		
OverVoltage	105.0	102.0
UnderVoltage	96.0	98.0
Generator Excitation		
OverExcited (Q Max.)	100.0	95.0
UnderExcited (Q Min.)	100.0	

Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type

Marginal Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus46	Bus	Under Voltage	0.400	kV	0.391	97.7	3-Phase
Bus-Sec.T1	Bus	Under Voltage	11.000	kV	10.764	97.9	3-Phase
Bus-Sec.T2	Bus	Under Voltage	11.000	kV	10.764	97.9	3-Phase
Bus-VFD1	Bus	Under Voltage	11.000	kV	10.763	97.8	3-Phase
Bus-VFD2	Bus	Under Voltage	11.000	kV	10.763	97.8	3-Phase
CCC FACILITY XFMR	Transformer	Overload	50.000	MVA	48.449	96.9	3-Phase

Project:	CO2 Karsto	ETAP		Page:	5
Location:	Karsto, South-West of Norway	6.0.0C		Date:	19-11-2008
Contract:	Bechtel 25474			SN:	BANTRELENG
Engineer:	Victor Skavitine		Study Case: LF Case1RevA	Revision:	Base
Filename:	KARSTO			Config.:	UmaxLmaxV98%

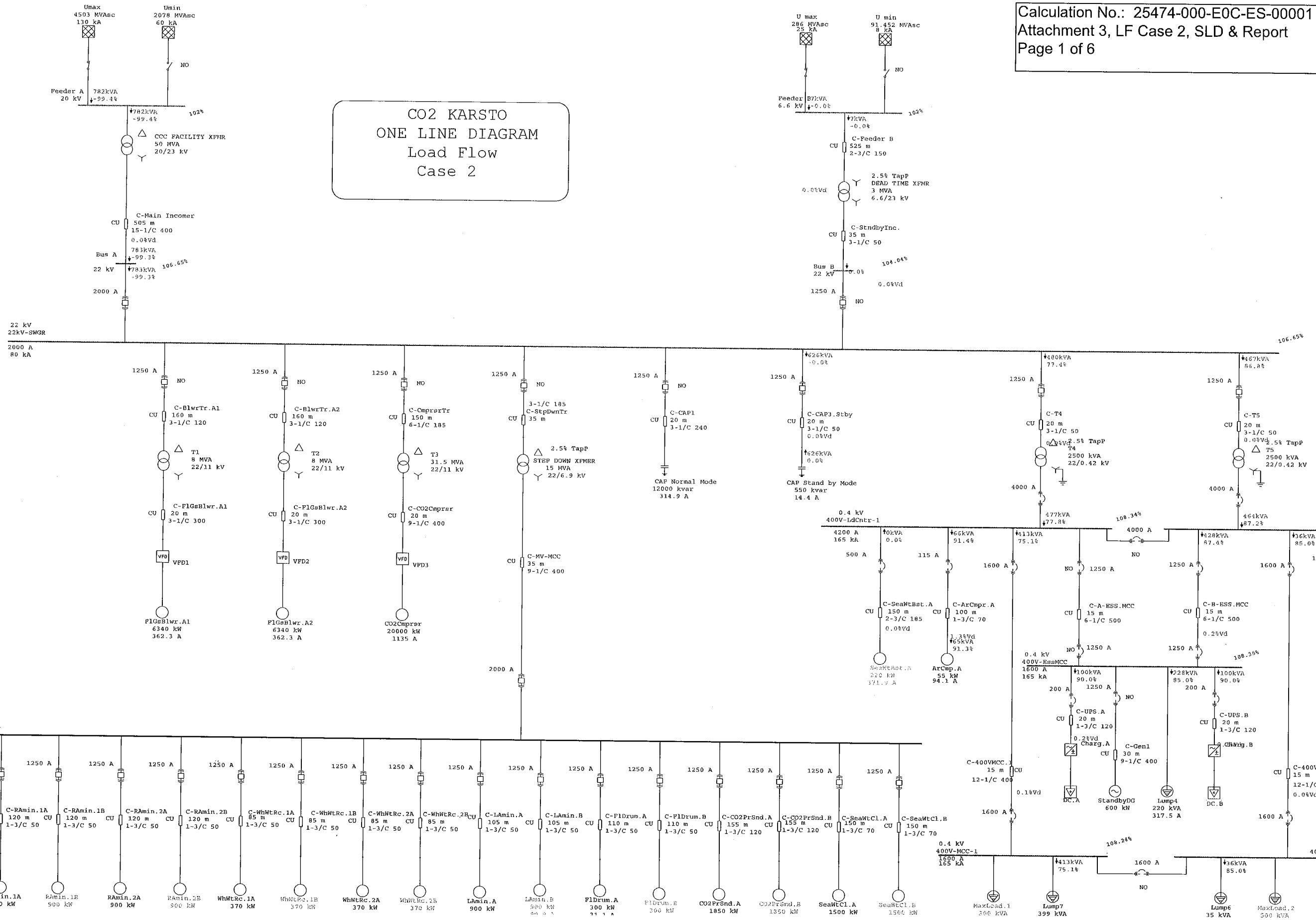
Preliminary Design

SUMMARY OF TOTAL GENERATION, LOADING & DEMAND

	MW	Mvar	MVA	% PF
Source (Swing Buses):	47.869	7.470	48.448	98.80 Lagging
Source (Non-Swing Buses):	0.000	0.000	0.000	
Total Demand:	47.869	7.470	48.448	98.80 Lagging
Total Motor Load:	47.145	13.452	49.027	96.16 Lagging
Total Static Load:	0.236	-16.070	16.071	1.47 Leading
Total Constant I Load:	0.000	0.000	0.000	
Total Generic Load:	0.000	0.000	0.000	
Apparent Losses:	0.488	10.088		
System Mismatch:	0.000	0.000		

Number of Iterations: 4

CO2 KARSTO
ONE LINE DIAGRAM
Load Flow
Case 2



Project:	CO2 Karsto	ETAP		Page:	1
Location:	Karsto, South-West of Norway	6.0.0C		Date:	19-11-2008
Contract:	Bechtel 25474			SN:	BANTRELENG
Engineer:	Victor Skavitine	Study Case: LF Case2RevA		Revision:	Base
Filename:	KARSTO			Config.:	UmaxLmtAV102

Preliminary Design

Branch Loading Summary Report

CKT / Branch		Cable & Reactor			Transformer				
		Ampacity	Loading		Capability	Loading (input)		Loading (output)	
ID	Type	(Amp)	Amp	%	(MVA)	MVA	%	MVA	%
CCC FACILITY XFMR	Transformer				50.000	0.783	1.6	0.782	1.6
DEAD TIME XFMR	Transformer				3.000	0.001	0.0	0.001	0.0
T4	Transformer				2.500	0.481	19.2	0.477	19.1
T5	Transformer				2.500	0.468	18.7	0.464	18.6

* Indicates a branch with operating load exceeding the branch capability.

Project:	CO2 Karsto	ETAP		Page:	2
Location:	Karsto, South-West of Norway	6.0.0C		Date:	19-11-2008
Contract:	Bechtel 25474			SN:	BANTRELENG
Engineer:	Victor Skavitine		Study Case: LF Case2RevA	Revision:	Base
Filename:	KARSTO			Config.:	UmaxLmtAV102

Preliminary Design

Branch Losses Summary Report

CKT / Branch	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop
ID	MW	Mvar	MW	Mvar	kW	kvar	From	To	in Vmag
C-CAP3.Stby	0.000	-0.626	0.000	0.626	0.0	0.0	106.7	106.7	0.00
C-T4	0.372	0.304	-0.372	-0.305	0.0	-0.5	106.7	106.7	0.00
C-T5	0.406	0.232	-0.406	-0.232	0.0	-0.5	106.7	106.7	0.00
C-B-ESS.MCC	-0.374	-0.207	0.374	0.208	0.4	0.6	108.4	108.5	0.16
C-UPS.A	0.090	0.044	-0.090	-0.044	0.2	0.1	108.4	108.1	0.23
C-UPS.B	0.090	0.044	-0.090	-0.044	0.2	0.1	108.4	108.1	0.23
C-400VMCC.1	0.311	0.273	-0.310	-0.272	0.2	0.3	108.3	108.2	0.09
C-ArCmpr.A	0.060	0.027	-0.060	-0.027	0.8	0.2	108.3	107.1	1.27
C-SeaWtBst.A	0.000	0.000			0.0	0.0	108.3	108.3	0.00
T4	-0.371	-0.299	0.372	0.305	0.8	5.5	108.3	106.7	3.65
C-400VMCC.2	0.031	0.019	-0.031	-0.019	0.0	0.0	108.5	108.5	0.01
C-AirComp.B	0.000	0.000			0.0	0.0	108.5	108.5	0.00
C-SeaWtBst.B	0.000	0.000			0.0	0.0	108.5	108.5	0.00
T5	-0.405	-0.227	0.406	0.232	0.7	5.2	108.5	106.7	3.47
C-StndbyInc.	0.000	-0.001			0.0	-0.8	104.0	104.0	0.00
DEAD TIME XFMR	0.000	0.001	0.000	-0.001	0.0	0.0	104.0	102.0	2.60
C-Feeder B	0.000	0.001	0.000	-0.007	0.0	-5.9	102.0	102.0	0.00
C-Main Incomer	-0.777	0.090	0.777	-0.089	0.0	0.0	106.7	106.7	0.00
CCC FACILITY XFMR	-0.777	0.089	0.777	-0.088	0.1	1.6	106.7	102.0	0.02
					3.3	5.8			

Project:	CO2 Karsto	ETAP		Page:	3
Location:	Karsto, South-West of Norway	6.0.0C		Date:	19-11-2008
Contract:	Bechtel 25474			SN:	BANTRELENG
Engineer:	Victor Skavitine	Study Case:	LF Case2RevA	Revision:	Base
Filename:	KARSTO			Config.:	UmaxLmtAV102

Preliminary Design

Alert Summary Report

% Alert Settings

	Critical	Marginal
Loading		
Bus	100.0	95.0
Cable	100.0	95.0
Reactor	100.0	95.0
Line	100.0	95.0
Transformer	100.0	95.0
Panel	100.0	95.0
Protective Device	100.0	95.0
Generator	100.0	95.0
Bus Voltage		
OverVoltage	105.0	102.0
UnderVoltage	96.0	98.0
Generator Excitation		
OverExcited (Q Max.)	100.0	95.0
UnderExcited (Q Min.)	100.0	

Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
22kV-SWGR	Bus	Over Voltage	22.000	kV	23.464	106.7	3-Phase
400V-EssMCC	Bus	Over Voltage	0.400	kV	0.433	108.4	3-Phase
400V-LdCntr-1	Bus	Over Voltage	0.400	kV	0.433	108.3	3-Phase
400V-LdCntr-2	Bus	Over Voltage	0.400	kV	0.434	108.5	3-Phase
400V-MCC-1	Bus	Over Voltage	0.400	kV	0.433	108.2	3-Phase
400V-MCC-2	Bus	Over Voltage	0.400	kV	0.434	108.5	3-Phase
Bus A	Bus	Over Voltage	22.000	kV	23.464	106.7	3-Phase
Bus T50	Bus	Over Voltage	22.000	kV	23.464	106.7	3-Phase
Bus018	Bus	Over Voltage	22.000	kV	23.463	106.7	3-Phase
Bus17	Bus	Over Voltage	22.000	kV	23.463	106.7	3-Phase
Bus25	Bus	Over Voltage	22.000	kV	23.464	106.7	3-Phase
Bus27	Bus	Over Voltage	0.400	kV	0.428	107.1	3-Phase
Bus46	Bus	Over Voltage	0.400	kV	0.433	108.3	3-Phase
Bus47	Bus	Over Voltage	0.400	kV	0.434	108.5	3-Phase
Bus59	Bus	Over Voltage	0.400	kV	0.432	108.1	3-Phase
Bus65	Bus	Over Voltage	0.400	kV	0.432	108.1	3-Phase
Bus67	Bus	Over Voltage	0.400	kV	0.434	108.5	3-Phase

Marginal Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus B	Bus	Over Voltage	22.000	kV	22.888	104.0	3-Phase
Bus11	Bus	Over Voltage	22.000	kV	22.888	104.0	3-Phase
Bus18	Bus	Over Voltage	6.600	kV	6.732	102.0	3-Phase
Feeder A	Bus	Over Voltage	20.000	kV	20.400	102.0	3-Phase
Feeder B	Bus	Over Voltage	6.600	kV	6.732	102.0	3-Phase

Project:	CO2 Karsto	ETAP		Page:	5
Location:	Karsto, South-West of Norway	6.0.0C		Date:	19-11-2008
Contract:	Bechtel 25474			SN:	BANTRELENG
Engineer:	Victor Skavitine		Study Case: LF Case2RevA	Revision:	Base
Filename:	KARSTO			Config.:	UmaxLmtAV102

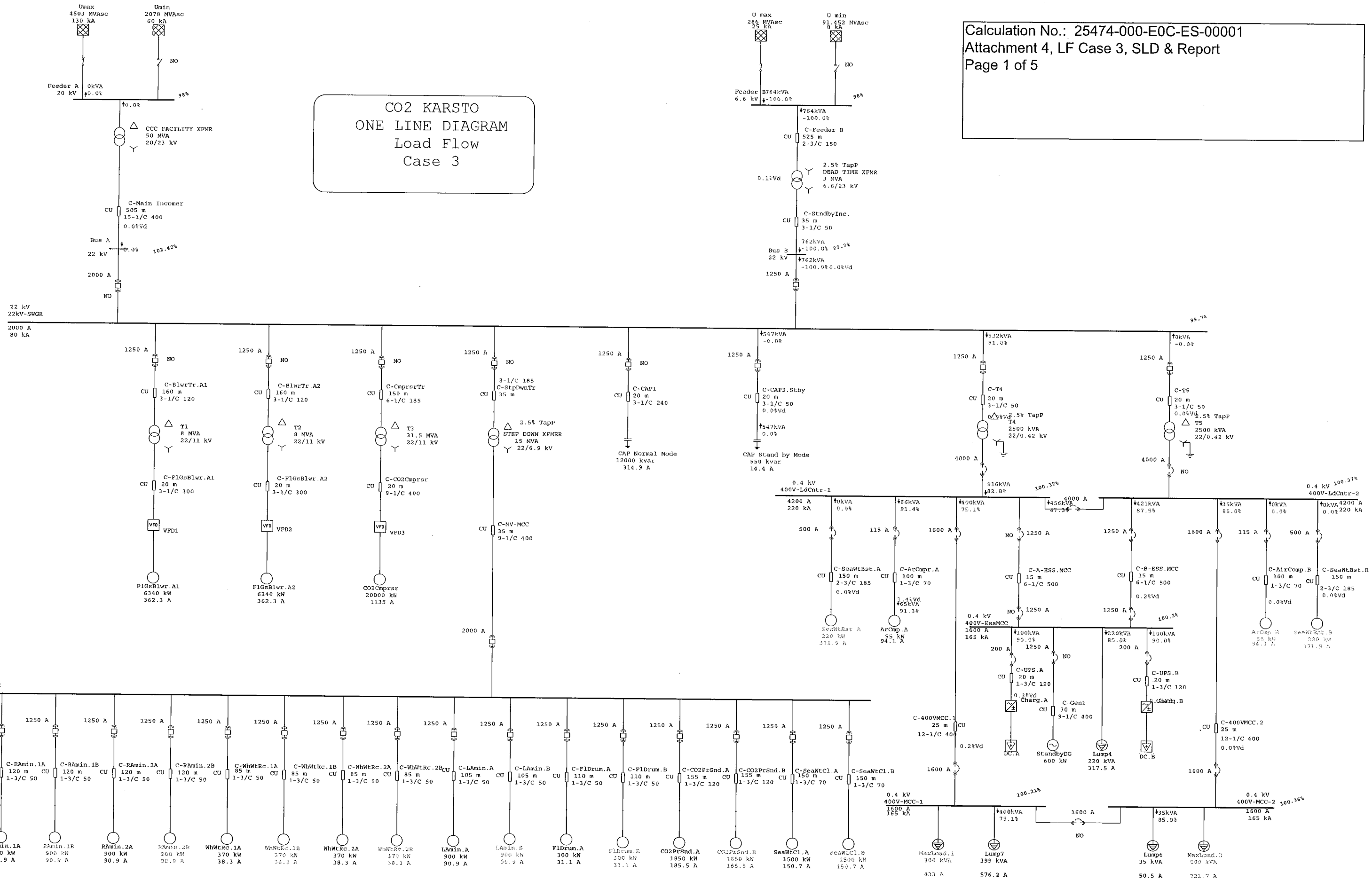
Preliminary Design

SUMMARY OF TOTAL GENERATION, LOADING & DEMAND

	MW	Mvar	MVA	% PF
Source (Swing Buses):	0.777	-0.095	0.783	99.27 Leading
Source (Non-Swing Buses):	0.000	0.000	0.000	
Total Demand:	0.777	-0.095	0.783	99.27 Leading
Total Motor Load:	0.653	0.432	0.783	83.40 Lagging
Total Static Load:	0.121	-0.532	0.546	22.20 Leading
Total Constant I Load:	0.000	0.000	0.000	
Total Generic Load:	0.000	0.000	0.000	
Apparent Losses:	0.003	0.006		
System Mismatch:	0.000	0.000		

Number of Iterations: 4

CO2 KARSTO
ONE LINE DIAGRAM
Load Flow
Case 3



Project:	CO2 Karsto	ETAP		Page:	1
Location:	Karsto, South-West of Norway	6.0.0C		Date:	19-11-2008
Contract:	Bechtel 25474			SN:	BANTRELENG
Engineer:	Victor Skavitine	Study Case: LF Case3RevA		Revision:	Base
Filename:	KARSTO			Config.:	UmaxLmtBV98%

Preliminary Design

Branch Loading Summary Report

CKT / Branch		Cable & Reactor			Transformer				
		Ampacity	Loading		Capability	Loading (input)		Loading (output)	
ID	Type	(Amp)	Amp	%	(MVA)	MVA	%	MVA	%
CCC FACILITY XFMR	Transformer				50.000				
DEAD TIME XFMR	Transformer				3.000	0.764	25.5	0.762	25.4
T4	Transformer				2.500	0.932	37.3	0.916	36.7

* Indicates a branch with operating load exceeding the branch capability.

Project:	CO2 Karsto	ETAP		Page:	2
Location:	Karsto, South-West of Norway	6.0.0C		Date:	19-11-2008
Contract:	Bechtel 25474			SN:	BANTRELENG
Engineer:	Victor Skavitine	Study Case: LF Case3RevA		Revision:	Base
Filename:	KARSTO			Config.:	UmaxLmtBV98%

Preliminary Design

Branch Losses Summary Report

CKT / Branch	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop
ID	MW	Mvar	MW	Mvar	kW	kvar	From	To	in Vmag
C-CAP3.Stby	0.000	-0.547	0.000	0.547	0.0	0.0	99.7	99.7	0.00
C-T4	0.762	0.537	-0.762	-0.537	0.0	-0.4	99.7	99.7	0.00
C-T5	0.000	0.000			0.0	-0.4	99.7	99.7	0.00
C-B-ESS.MCC	-0.368	-0.203	0.368	0.204	0.4	0.7	100.2	100.4	0.17
C-UPS.A	0.090	0.044	-0.090	-0.044	0.2	0.1	100.2	99.9	0.25
C-UPS.B	0.090	0.044	-0.090	-0.044	0.2	0.1	100.2	99.9	0.25
C-400VMCC.1	0.301	0.264	-0.300	-0.264	0.4	0.5	100.4	100.2	0.16
C-ArCmpr.A	0.060	0.027	-0.060	-0.027	0.9	0.2	100.4	99.0	1.37
C-SeaWtBst.A	0.000	0.000			0.0	0.0	100.4	100.4	0.00
T4	-0.759	-0.513	0.762	0.537	3.3	23.5	100.4	99.7	4.31
C-400VMCC.2	0.030	0.018	-0.030	-0.018	0.0	0.0	100.4	100.4	0.01
C-AirComp.B	0.000	0.000			0.0	0.0	100.4	100.4	0.00
C-SeaWtBst.B	0.000	0.000			0.0	0.0	100.4	100.4	0.00
C-StndbyInc.	0.762	-0.011	-0.762	0.011	0.0	-0.7	99.7	99.7	0.00
DEAD TIME XFMR	-0.762	0.011	0.764	0.004	1.4	15.4	99.7	97.9	2.68
C-Feeder B	-0.764	-0.004	0.764	-0.001	0.6	-5.0	97.9	98.0	0.07
C-Main Incomer							102.5	102.5	0.00
CCC FACILITY XFMR							102.5	98.0	0.00
					7.5	34.0			

Project:	CO2 Karsto	ETAP		Page:	3
Location:	Karsto, South-West of Norway	6.0.0C		Date:	19-11-2008
Contract:	Bechtel 25474			SN:	BANTRELENG
Engineer:	Victor Skavitine		Study Case: LF Case3RevA	Revision:	Base
Filename:	KARSTO			Config.:	UmaxLmtBV98%

Preliminary Design

Alert Summary Report

% Alert Settings

	Critical	Marginal
Loading		
Bus	100.0	95.0
Cable	100.0	95.0
Reactor	100.0	95.0
Line	100.0	95.0
Transformer	100.0	95.0
Panel	100.0	95.0
Protective Device	100.0	95.0
Generator	100.0	95.0
Bus Voltage		
OverVoltage	105.0	102.0
UnderVoltage	96.0	98.0
Generator Excitation		
OverExcited (Q Max.)	100.0	95.0
UnderExcited (Q Min.)	100.0	

Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type

Marginal Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
Bus A	Bus	Over Voltage	22.000	kV	22.540	102.5	3-Phase
Bus T50	Bus	Over Voltage	22.000	kV	22.540	102.5	3-Phase
Bus18	Bus	Under Voltage	6.600	kV	6.463	97.9	3-Phase

Project:	CO2 Karsto	ETAP		Page:	4
Location:	Karsto, South-West of Norway	6.0.0C		Date:	19-11-2008
Contract:	Bechtel 25474			SN:	BANTRELENG
Engineer:	Victor Skavitine		Study Case: LF Case3RevA	Revision:	Base
Filename:	KARSTO			Config.:	UmaxLmtBV98%

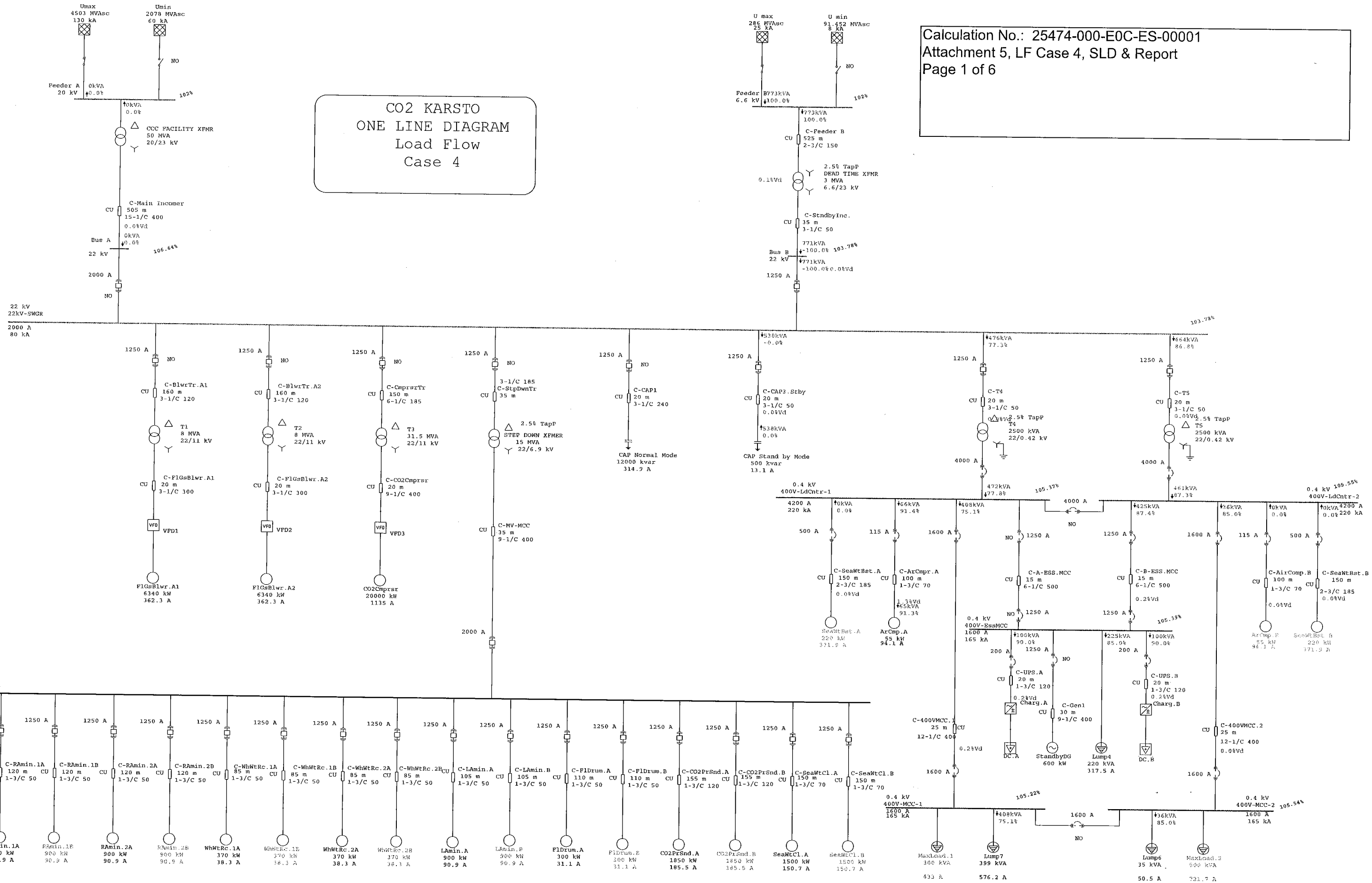
Preliminary Design

SUMMARY OF TOTAL GENERATION, LOADING & DEMAND

	MW	Mvar	MVA	% PF
Source (Swing Buses):	0.764	-0.001	0.764	100.00 Leading
Source (Non-Swing Buses):	0.000	0.000	0.000	
Total Demand:	0.764	-0.001	0.764	100.00 Leading
Total Motor Load:	0.653	0.432	0.783	83.40 Lagging
Total Static Load:	0.104	-0.467	0.478	21.70 Leading
Total Constant I Load:	0.000	0.000	0.000	
Total Generic Load:	0.000	0.000	0.000	
Apparent Losses:	0.008	0.034		
System Mismatch:	0.000	0.000		

Number of Iterations: 3

CO2 KARSTO
ONE LINE DIAGRAM
Load Flow
Case 4



Project:	CO2 Karsto	**ETAP**	Page: 1
Location:	Karsto, South-West of Norway	6.0.0C	Date: 19-11-2008
Contract:	Bechtel 25474		SN: BANTRELENG
Engineer:	Victor Skavitine	Study Case: LF Case4RevA	Revision: Base
Filename:	KARSTO		Config.: UmaxLmtBV102

Preliminary Design

Branch Loading Summary Report

CKT / Branch		Cable & Reactor			Transformer				
		Ampacity	Loading		Capability	Loading (input)		Loading (output)	
ID	Type	(Amp)	Amp	%	(MVA)	MVA	%	MVA	%
CCC FACILITY XFMR	Transformer				50.000	0.000	0.0	0.000	0.0
DEAD TIME XFMR	Transformer				3.000	0.772	25.7	0.771	25.7
T4	Transformer				2.500	0.476	19.0	0.472	18.9
T5	Transformer				2.500	0.464	18.6	0.461	18.4

* Indicates a branch with operating load exceeding the branch capability.

Project:	CO2 Karsto	ETAP		Page:	2
Location:	Karsto, South-West of Norway	6.0.0C		Date:	19-11-2008
Contract:	Bechtel 25474			SN:	BANTRELENG
Engineer:	Victor Skavitine	Study Case: LF Case4RevA		Revision:	Base
Filename:	KARSTO			Config.:	UmaxLmtBV102

Preliminary Design

Branch Losses Summary Report

CKT / Branch	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop
ID	MW	Mvar	MW	Mvar	kW	kvar	From	To	in Vmag
C-CAP3.Stby	0.000	-0.538	0.000	0.539	0.0	0.0	103.8	103.8	0.00
C-T4	0.368	0.301	-0.368	-0.302	0.0	-0.5	103.8	103.8	0.00
C-T5	0.403	0.230	-0.403	-0.231	0.0	-0.5	103.8	103.8	0.00
C-B-ESS.MCC	-0.372	-0.206	0.372	0.206	0.4	0.7	105.4	105.6	0.16
C-UPS.A	0.090	0.044	-0.090	-0.044	0.2	0.1	105.4	105.1	0.24
C-UPS.B	0.090	0.044	-0.090	-0.044	0.2	0.1	105.4	105.1	0.24
C-400VMCC.1	0.307	0.270	-0.306	-0.269	0.4	0.5	105.4	105.2	0.16
C-ArCmpr.A	0.060	0.027	-0.060	-0.027	0.8	0.2	105.4	104.1	1.30
C-SeaWtBst.A	0.000	0.000			0.0	0.0	105.4	105.4	0.00
T4	-0.367	-0.296	0.368	0.302	0.8	5.6	105.4	103.8	3.59
C-400VMCC.2	0.030	0.019	-0.030	-0.019	0.0	0.0	105.6	105.5	0.01
C-AirComp.B	0.000	0.000			0.0	0.0	105.6	105.6	0.00
C-SeaWtBst.B	0.000	0.000			0.0	0.0	105.6	105.6	0.00
T5	-0.402	-0.225	0.403	0.231	0.8	5.4	105.6	103.8	3.41
C-StndbyInc.	0.771	-0.008	-0.771	0.007	0.0	-0.8	103.8	103.8	0.00
DEAD TIME XFMR	-0.771	0.008	0.772	0.007	1.4	14.5	103.8	101.9	2.78
C-Feeder B	-0.772	-0.007	0.773	0.002	0.5	-5.5	101.9	102.0	0.07
C-Main Incomer	0.000	0.000	0.000	0.000	0.0	0.0	106.6	106.6	0.00
CCC FACILITY XFMR	0.000	0.000	0.000	0.000	0.0	0.0	106.6	102.0	0.00
					5.5	19.9			

Project:	CO2 Karsto	ETAP		Page:	3
Location:	Karsto, South-West of Norway	6.0.0C		Date:	19-11-2008
Contract:	Bechtel 25474			SN:	BANTRELENG
Engineer:	Victor Skavitine	Study Case: LF Case4RevA		Revision:	Base
Filename:	KARSTO			Config.:	UmaxLmtBV102

Preliminary Design

Alert Summary Report

% Alert Settings

	Critical	Marginal
Loading		
Bus	100.0	95.0
Cable	100.0	95.0
Reactor	100.0	95.0
Line	100.0	95.0
Transformer	100.0	95.0
Panel	100.0	95.0
Protective Device	100.0	95.0
Generator	100.0	95.0
Bus Voltage		
OverVoltage	105.0	102.0
UnderVoltage	96.0	98.0
Generator Excitation		
OverExcited (Q Max.)	100.0	95.0
UnderExcited (Q Min.)	100.0	

Critical Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
400V-EssMCC	Bus	Over Voltage	0.400	kV	0.422	105.4	3-Phase
400V-LdCntr-1	Bus	Over Voltage	0.400	kV	0.421	105.4	3-Phase
400V-LdCntr-2	Bus	Over Voltage	0.400	kV	0.422	105.6	3-Phase
400V-MCC-1	Bus	Over Voltage	0.400	kV	0.421	105.2	3-Phase
400V-MCC-2	Bus	Over Voltage	0.400	kV	0.422	105.5	3-Phase
Bus A	Bus	Over Voltage	22.000	kV	23.460	106.6	3-Phase
Bus T50	Bus	Over Voltage	22.000	kV	23.460	106.6	3-Phase
Bus46	Bus	Over Voltage	0.400	kV	0.421	105.4	3-Phase
Bus47	Bus	Over Voltage	0.400	kV	0.422	105.6	3-Phase
Bus59	Bus	Over Voltage	0.400	kV	0.421	105.1	3-Phase
Bus65	Bus	Over Voltage	0.400	kV	0.421	105.1	3-Phase
Bus67	Bus	Over Voltage	0.400	kV	0.422	105.6	3-Phase

Project:	CO2 Karsto	ETAP		Page:	4
Location:	Karsto, South-West of Norway	6.0.0C		Date:	19-11-2008
Contract:	Bechtel 25474			SN:	BANTRELENG
Engineer:	Victor Skavitine		Study Case: LF Case4RevA	Revision:	Base
Filename:	KARSTO			Config.:	UmaxLmtBV102

Preliminary Design

Marginal Report

Device ID	Type	Condition	Rating/Limit	Unit	Operating	% Operating	Phase Type
22kV-SWGR	Bus	Over Voltage	22.000	kV	22.831	103.8	3-Phase
Bus B	Bus	Over Voltage	22.000	kV	22.831	103.8	3-Phase
Bus018	Bus	Over Voltage	22.000	kV	22.831	103.8	3-Phase
Bus11	Bus	Over Voltage	22.000	kV	22.832	103.8	3-Phase
Bus17	Bus	Over Voltage	22.000	kV	22.831	103.8	3-Phase
Bus25	Bus	Over Voltage	22.000	kV	22.831	103.8	3-Phase
Bus27	Bus	Over Voltage	0.400	kV	0.416	104.1	3-Phase
Feeder A	Bus	Over Voltage	20.000	kV	20.400	102.0	3-Phase
Feeder B	Bus	Over Voltage	6.600	kV	6.732	102.0	3-Phase

Project:	CO2 Karsto	ETAP		Page:	5
Location:	Karsto, South-West of Norway	6.0.0C		Date:	19-11-2008
Contract:	Bechtel 25474			SN:	BANTRELENG
Engineer:	Victor Skavitine		Study Case: LF Case4RevA	Revision:	Base
Filename:	KARSTO			Config.:	UmaxLmtBV102

Preliminary Design

SUMMARY OF TOTAL GENERATION, LOADING & DEMAND

	MW	Mvar	MVA	% PF
Source (Swing Buses):	0.773	0.002	0.773	100.00 Lagging
Source (Non-Swing Buses):	0.000	0.000	0.000	
Total Demand:	0.773	0.002	0.773	100.00 Lagging
Total Motor Load:	0.653	0.432	0.783	83.40 Lagging
Total Static Load:	0.115	-0.450	0.465	24.66 Leading
Total Constant I Load:	0.000	0.000	0.000	
Total Generic Load:	0.000	0.000	0.000	
Apparent Losses:	0.005	0.020		
System Mismatch:	0.000	0.000		

Number of Iterations: 3