



Calculation Cover Sheet

Subject Harmonic Distortion Study
 Discipline Electrical

Project KARSTO
 Job No. 25474-000
 Calc. No. 25474-000-E0C-ES-00004
 Sheet 1 of 9

| | | | | | |
|---------------------------------------|-------------------------------------|--|--------------------------|--------------------------|--------------------------|
| Calculation Status Designation | Preliminary | Confirmed with Preliminary Information | Confirmed | Superseded | Voided |
| | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Computer Program/Type | SCP | Program Name. | Version/Release | Operating System | |
| | <input checked="" type="checkbox"/> | ETAP | 6.0.0 | Windows XP | |
| Nuclear Quality Classification | Safety-Related | Augmented Quality | Nonsafety-Related | | |
| | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | | |

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.

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| Rev. No. | Reason for Revision | Total No. of Sheets | Last Sheet No. | By | Checked | Approved/ Accepted | Date |
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Record of Revisions



CALCULATION SHEET

Project: Karsto

Subject: Harmonic Distortion Study

Job Number: 25474

Calculation No.: 25474-000-E0C-ES-00004

By: Victor Skavitine

Date: 11/21/08

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Harmonic Distortion Study

1.0 SCOPE

The scope of this Report includes a review and analysis of the electrical power system for the CO₂ 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 Harmonic Distortion (HD) Study is to:

- Ascertain the sources of harmonics in the system and their effects on the equipment.
- Determine the harmonics distortion levels on supply network.
- Determine HD spectrum per source of distortion.
- Calculate harmonic currents in main feeders.
- Calculate harmonic voltages at main switchgear.
- Calculate the require filter and determine the improvements due to filter installations.
- Determine the filter performance and loading if that filter required.

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



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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.

Power system harmonic analysis involves modeling the frequency characteristics of different components of power systems, computing harmonic indices at given buses and branches, identifying problems associated with the existing harmonics, and providing an environment to simulate and test any mitigation methods.

ETAP Harmonic Analysis module fully complies with the latest version of the IEEE Standards 519-1992, IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems

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

In Case 1 the Study is carried out to investigate the harmonic sources and existing levels. Harmonic filters are calculated and modeled on 22kV-SWGR bus-bars based on the Study results.

In Case 2 the Study is carried out to determine improvements due to filter installations in the Power System.

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 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 $I_b(\text{sym})=31.5\text{kA}$, $I_p=80\text{kA}$
- 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.



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- The estimated available short circuit currents at the primary side of 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 $\pm 7.5\%$
- Transformer sizing was checked by ETAP based on IEC standard, connected loads, operating load and ambient temperature 40° C.
- Symbols for two-winding VFD transformers (T1, T2, T3 on SLD) only for reference purpose and will be defined later by VFD Vendor.
- All 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 A/G trays is 40° C and for U/G Ducts is 20° C. Cables temperature range is from 20° C to 80° C.
- Power factor compensation capacitors adjusted 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.
- 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 library.
- Cable grouping was assumed as per Exhibit E5.7- Cabling and Cable Trays.



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- Cable sizing was verified by ETAP based on ICEA P-54-440 standard for above ground (A/G) tray installations and IEEE 399 standard for under ground (U/G) duct installations.
- Motor and Load data used in calculations are based on typical ETAP PowerStation library values for particular equipment.
- Equipment (VFD, UPS, and Charger) Harmonic models were created based on ETAP Library typical data for particular equipment. It is a preliminary calculation and is based on assumed (typical) data.

4.0 STUDY

4.1 CASE 1: HARMONICS DISTORTION SPECTRUM PER MAIN EQUIPMENT:

- System SC contribution at maximum available, supply voltage set to 1.0 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
- All loads are running on normal

4.2 CASE 2: HARMONICS MITIGATION DUE TO FILTER INSTALLATION:

- System SC contribution at maximum available, supply voltage set to 1.0p.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
- All loads are running on normal
- Harmonic filters HF 10 for 5-th harmonic is connected to the 22kV 22kV-SWGR



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4.3 RESULTS FOR EACH STUDY CASE ARE LISTED IN THE FOLLOWING TABLE:

Harmonic Distortion Study Results

| Bus Name | Bus Voltage | HS Study Case 1 | | HS Study Case 2 | |
|---------------|-------------|-----------------|------------------|-----------------|-----------------|
| | | Bus THD % | Bus IHD (5-th) % | Bus THD % | Bus IHD(5-th) % |
| 22kV-SWGR | 22 | 5.9 | 5.54 | 2.48 | 0.27 |
| 6.6kV-SWGR | 6.6 | 3.80 | 3.56 | 1.60 | 0.17 |
| 400V-LdCntr-1 | 0.4 | 5.73 | 5.44 | 2.34 | 0.26 |
| 400V-LdCntr-2 | 0.4 | 5.68 | 5.43 | 2.32 | 0.26 |
| 400V-MCC-1 | 0.4 | 5.73 | 5.43 | 2.34 | 0.26 |
| 400V-MCC-2 | 0.4 | 5.68 | 5.42 | 2.32 | 0.26 |
| 400V-EssMCC | 0.4 | 5.68 | 5.43 | 2.32 | 0.26 |

Allowed Harmonic Distortion Levels as per IEEE 519 (1992):

- Maximum voltage harmonic content of each harmonic =3% (IHD - Individual Harmonic Distortion).
- Maximum voltage harmonic content of all harmonics =5% (THD- Total Harmonic Distortion).

5.0 CONCLUSIONS

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

- Level of Harmonics in the Power System could be lowered by Harmonic filters
- Calculated Single-Tuned filters decreased the Harmonics level to the acceptable minimum as per IEEE 519 (1992) and will be provided with the compressor ASD.
- Harmonic level at the PCC (point of common coupling) which is the primary side of the 50 MVA transformer are 0.44% THD before the filters are implemented and only 0.18% THD after the filters are installed.



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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, HS Case 1 -Results on SLD (THD), 1 page; Summary Report, 4 pages
- Attachment 3, HS Case 1 -Results on SLD (IHD, 5-th), 1 page
- Attachment 4, HS Case 1 - Harmonic Spectrum Plot for 22kV-SWGR, 1 page
- Attachment 5, HS Case 1 -Voltage Waveform for 22kV-SWGR, 1 page
- Attachment 6, HS Case 2 -Results on SLD (THD), 1 page; Summary Report, 2 pages
- Attachment 7, HS Case 2 -Results on SLD (IHD, 5-th), 1 page
- Attachment 8, HS Case 2 - Harmonic Spectrum Plot for 22kV-SWGR and PCC (Feeder A), 1 page
- Attachment 9, HS Case 2, -Voltage Waveform Plot for 22kV-SWGR and PCC (Feeder A), 1 page



CALCULATION SHEET

Project: Karsto

Subject: Harmonic Distortion Study

Job Number: 25474

Calculation No.: 25474-000-E0C-ES-00004

By: Victor Skavitine

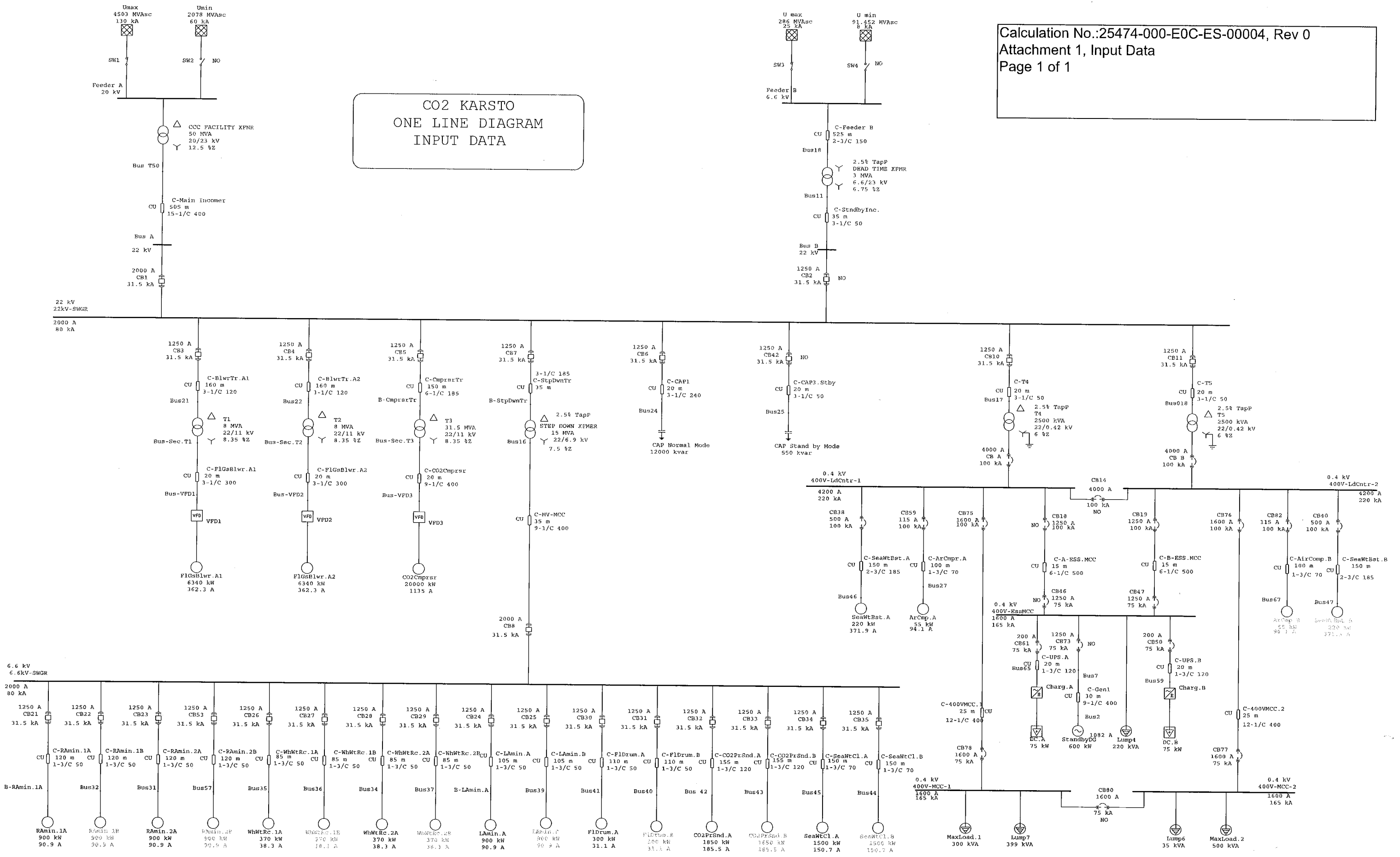
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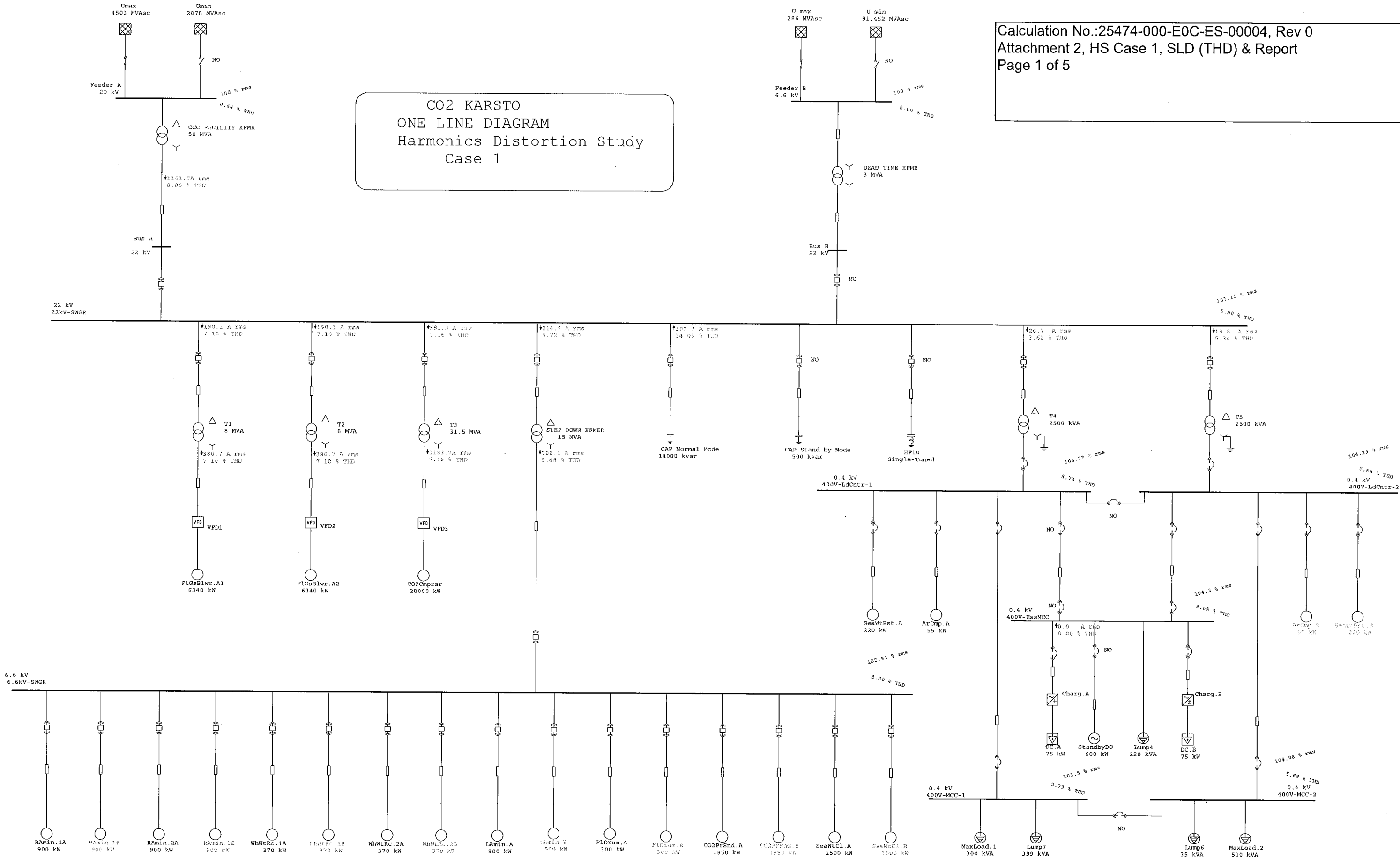
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ATTACHMENTS

CO2 KARSTO
 ONE LINE DIAGRAM
 INPUT DATA



CO2 KARSTO
 ONE LINE DIAGRAM
 Harmonics Distortion Study
 Case 1



Project: CO2 Karsto
 Location: Karsto, South-West of Norway
 Contract: Bechtel 25474
 Engineer: Victor Skavitine
 Filename: KARSTO

ETAP
 6.0.0C

Study Case: HS Case1RevA

Page: 1
 Date: 20-11-2008
 SN: BANTRELENG
 Revision: Base
 Config.: UmaxLnrmV100

Preliminary Design

VIHD (Individual Harmonic Distortion) Report

| Bus | ID | kV | Voltage Distortion | | Order |
|---------------|----|--------|--------------------|--------|-------|
| | | | Fund. % | VIHD % | |
| 6.6kV-SWGR | | 6.600 | 102.87 | 3.17 | 5 |
| 22kV-SWGR | | 22.000 | 102.97 | 5.14 | 5 |
| 400V-EssMCC | | 0.400 | 104.03 | 4.75 | 5 |
| 400V-LdCntr-1 | | 0.400 | 103.60 | 4.78 | 5 |
| 400V-LdCntr-2 | | 0.400 | 104.12 | 4.75 | 5 |
| 400V-MCC-1 | | 0.400 | 103.33 | 4.79 | 5 |
| 400V-MCC-2 | | 0.400 | 103.92 | 4.75 | 5 |
| B-CmprsrTr | | 22.000 | 102.91 | 5.15 | 5 |
| B-LAmin.A | | 6.600 | 102.75 | 3.16 | 5 |
| B-RAmin.1A | | 6.600 | 102.73 | 3.16 | 5 |
| B-StpDwnTr | | 22.000 | 102.96 | 5.14 | 5 |
| Bus16 | | 6.600 | 102.89 | 3.17 | 5 |
| Bus17 | | 22.000 | 102.97 | 5.14 | 5 |
| Bus018 | | 22.000 | 102.97 | 5.14 | 5 |
| Bus21 | | 22.000 | 102.91 | 5.15 | 5 |
| Bus22 | | 22.000 | 102.91 | 5.15 | 5 |
| Bus24 | | 22.000 | 102.98 | 5.15 | 5 |
| Bus27 | | 0.400 | 102.28 | 4.78 | 5 |
| Bus31 | | 6.600 | 102.73 | 3.16 | 5 |
| Bus32 | | 6.600 | 102.87 | 3.16 | 5 |
| Bus34 | | 6.600 | 102.83 | 3.17 | 5 |
| Bus35 | | 6.600 | 102.83 | 3.17 | 5 |
| Bus36 | | 6.600 | 102.87 | 3.16 | 5 |
| Bus37 | | 6.600 | 102.87 | 3.16 | 5 |
| Bus39 | | 6.600 | 102.87 | 3.16 | 5 |
| Bus40 | | 6.600 | 102.87 | 3.16 | 5 |
| Bus41 | | 6.600 | 102.83 | 3.17 | 5 |
| Bus 42 | | 6.600 | 102.71 | 3.15 | 5 |
| Bus43 | | 6.600 | 102.87 | 3.15 | 5 |
| Bus44 | | 6.600 | 102.87 | 3.15 | 5 |
| Bus45 | | 6.600 | 102.66 | 3.16 | 5 |
| Bus46 | | 0.400 | 101.91 | 4.67 | 5 |
| Bus47 | | 0.400 | 104.12 | 4.56 | 5 |
| Bus57 | | 6.600 | 102.87 | 3.16 | 5 |
| Bus59 | | 0.400 | 104.03 | 4.75 | 5 |
| Bus65 | | 0.400 | 104.03 | 4.75 | 5 |
| Bus67 | | 0.400 | 104.12 | 4.68 | 5 |
| Bus A | | 22.000 | 102.97 | 5.14 | 5 |
| Bus-Sec.T1 | | 11.000 | 100.20 | 6.06 | 5 |
| Bus-Sec.T2 | | 11.000 | 100.20 | 6.06 | 5 |

Project: CO2 Karsto
 Location: Karsto, South-West of Norway
 Contract: Bechtel 25474
 Engineer: Victor Skavitine
 Filename: KARSTO

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 Revision: Base
 Config.: UmaxLnmV100

Preliminary Design

| Bus | | Voltage Distortion | | |
|------------|--------|--------------------|--------|-------|
| ID | kV | Fund. % | VIHD % | Order |
| Bus-Sec.T3 | 11.000 | 101.02 | 5.84 | 5 |
| Bus T50 | 22.000 | 103.03 | 5.10 | 5 |
| Bus-VFD1 | 11.000 | 100.18 | 6.06 | 5 |
| Bus-VFD2 | 11.000 | 100.18 | 6.06 | 5 |
| Bus-VFD3 | 11.000 | 101.01 | 5.84 | 5 |
| Bus-Sec.T1 | 11.000 | 100.20 | 3.07 | 11 |
| Bus-Sec.T2 | 11.000 | 100.20 | 3.07 | 11 |
| Bus-VFD1 | 11.000 | 100.18 | 3.07 | 11 |
| Bus-VFD2 | 11.000 | 100.18 | 3.07 | 11 |

Indicates buses with IHD (Individual Harmonic Distortion) exceeding the limit

Project: CO2 Karsto
 Location: Karsto, South-West of Norway
 Contract: Bechtel 25474
 Engineer: Victor Skavitine
 Filename: KARSTO

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 Study Case: HS Case1RevA

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 SN: BANTRELENG
 Revision: Base
 Config.: UmaxLnmV100

Preliminary Design

VTHD (Total Harmonic Distortion) Report

| Bus ID | Voltage Distortion kV | Voltage Distortion | |
|---------------|-----------------------------|-----------------------|-----------|
| | | Fund. % | VTHD % |
| 6.6kV-SWGR | 6.600 | 102.87 | 3.80 |
| 22kV-SWGR | 22.000 | 102.97 | 5.90 |
| 400V-EssMCC | 0.400 | 104.03 | 5.68 |
| 400V-LdCntr-1 | 0.400 | 103.60 | 5.73 |
| 400V-LdCntr-2 | 0.400 | 104.12 | 5.68 |
| 400V-MCC-1 | 0.400 | 103.33 | 5.73 |
| 400V-MCC-2 | 0.400 | 103.92 | 5.68 |
| B-CmprsrTr | 22.000 | 102.91 | 5.89 |
| B-LAmin.A | 6.600 | 102.75 | 3.79 |
| B-RAmin.1A | 6.600 | 102.73 | 3.79 |
| B-StpDwnTr | 22.000 | 102.96 | 5.89 |
| Bus16 | 6.600 | 102.89 | 3.81 |
| Bus17 | 22.000 | 102.97 | 5.90 |
| Bus018 | 22.000 | 102.97 | 5.90 |
| Bus21 | 22.000 | 102.91 | 5.89 |
| Bus22 | 22.000 | 102.91 | 5.89 |
| Bus24 | 22.000 | 102.98 | 5.91 |
| Bus27 | 0.400 | 102.28 | 5.72 |
| Bus31 | 6.600 | 102.73 | 3.79 |
| Bus32 | 6.600 | 102.87 | 3.79 |
| Bus34 | 6.600 | 102.83 | 3.80 |
| Bus35 | 6.600 | 102.83 | 3.80 |
| Bus36 | 6.600 | 102.87 | 3.79 |
| Bus37 | 6.600 | 102.87 | 3.79 |
| Bus39 | 6.600 | 102.87 | 3.79 |
| Bus40 | 6.600 | 102.87 | 3.79 |
| Bus41 | 6.600 | 102.83 | 3.80 |
| Bus 42 | 6.600 | 102.71 | 3.78 |
| Bus43 | 6.600 | 102.87 | 3.78 |
| Bus44 | 6.600 | 102.87 | 3.78 |
| Bus45 | 6.600 | 102.66 | 3.79 |
| Bus46 | 0.400 | 101.91 | 5.59 |
| Bus47 | 0.400 | 104.12 | 5.46 |
| Bus57 | 6.600 | 102.87 | 3.79 |
| Bus59 | 0.400 | 104.03 | 5.68 |
| Bus65 | 0.400 | 104.03 | 5.68 |
| Bus67 | 0.400 | 104.12 | 5.60 |
| Bus A | 22.000 | 102.97 | 5.90 |
| Bus-Sec.T1 | 11.000 | 100.20 | 8.25 |
| Bus-Sec.T2 | 11.000 | 100.20 | 8.25 |

Project: CO2 Karsto
 Location: Karsto, South-West of Norway
 Contract: Bechtel 25474
 Engineer: Victor Skavitine
 Filename: KARSTO

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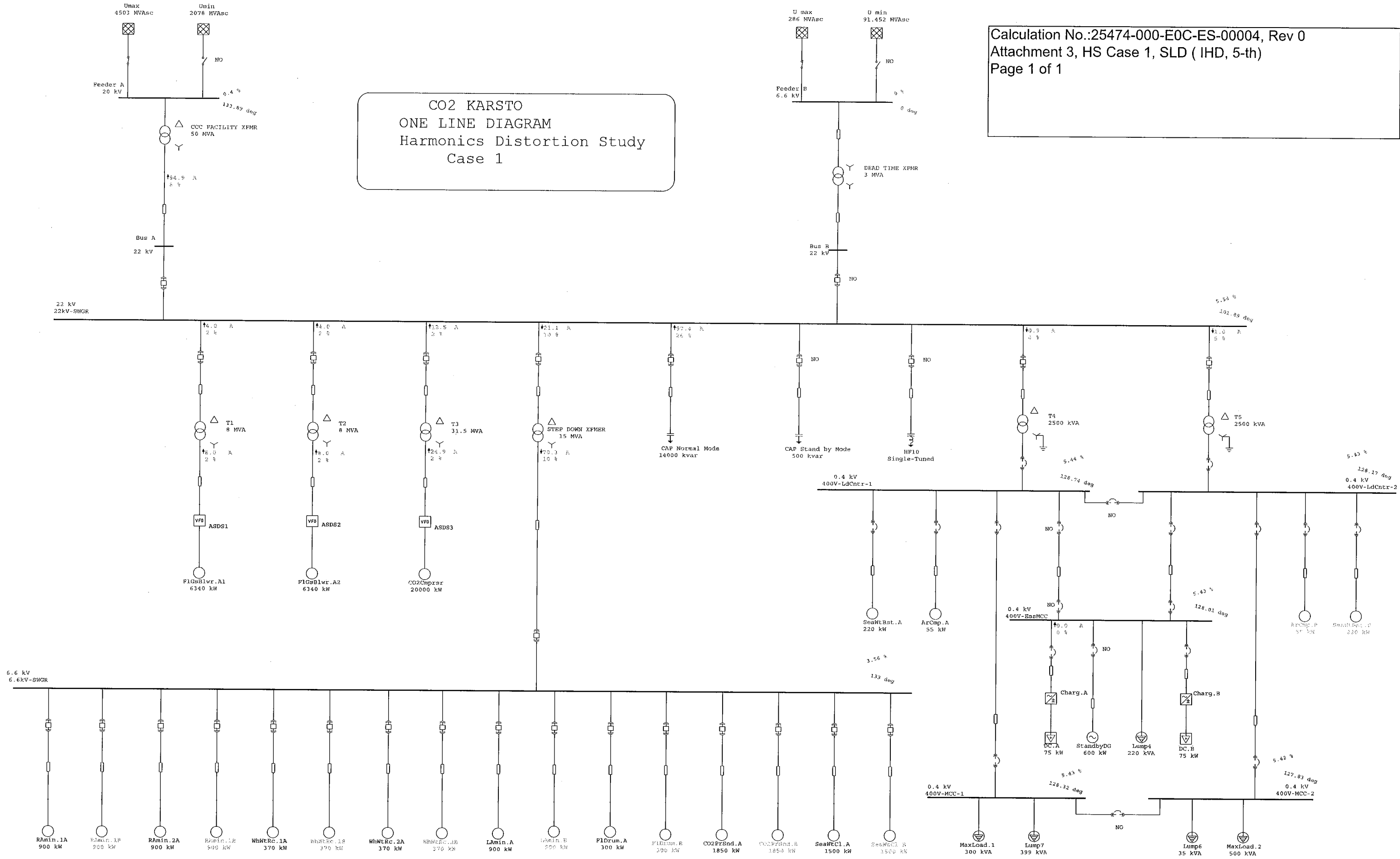
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 Revision: Base
 Config.: UmaxLnrmV100

Preliminary Design

| Bus ID | kV | Voltage Distortion | |
|------------|--------|--------------------|--------|
| | | Fund. % | VTHD % |
| Bus-Sec.T3 | 11.000 | 101.02 | 7.11 |
| Bus T50 | 22.000 | 103.03 | 5.85 |
| Bus-VFD1 | 11.000 | 100.18 | 8.26 |
| Bus-VFD2 | 11.000 | 100.18 | 8.26 |
| Bus-VFD3 | 11.000 | 101.01 | 7.12 |

Indicates buses with THD (Total Harmonic Distortion) exceeding the limit

CO2 KARSTO
 ONE LINE DIAGRAM
 Harmonics Distortion Study
 Case 1



Project: CO2 Karsto
Location: Karsto, South-West of Norway
Contract: Bechtel 25474
Engineer: Victor Skavtine

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6.0.0C
Study Case: HS Case1RevA

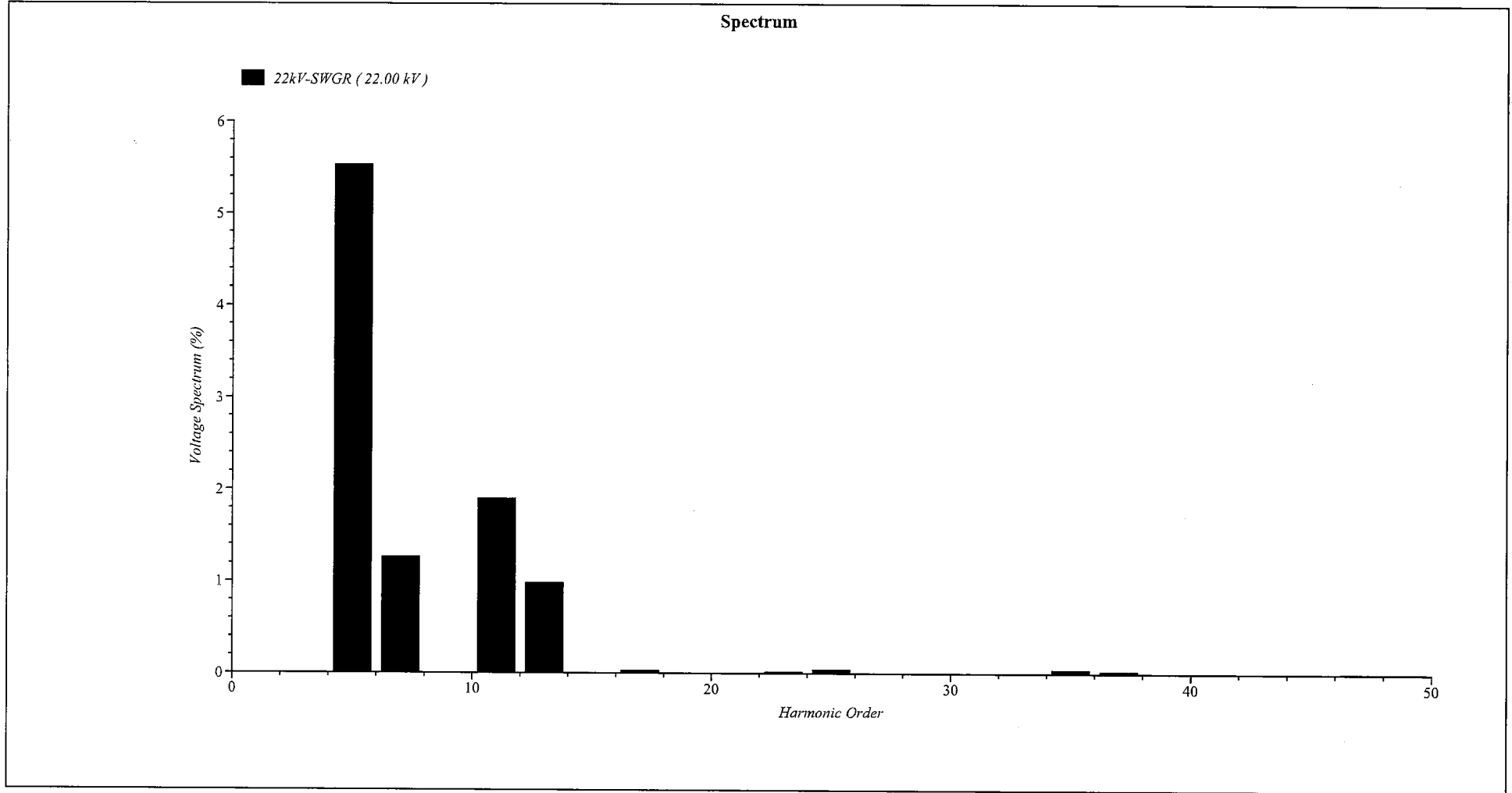
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SN: SANTRELENG
Revision: Base
Config.: UmaxIngreV100

Preliminary Design

Project File: N:\1047\08.0 Engineering\08.7 Electrical\08.7.42 ETAP\KARSTO
Output Report: HS Case1

HARMONIC LOAD FLOW ANALYSIS



Project: 002 Karsto
Location: Karsto, South-West of Norway
Contract: Bechtel 25474
Engineer: Victor Skavicine

ETAP
6.0.0c

Study Case: HS Case1RevA

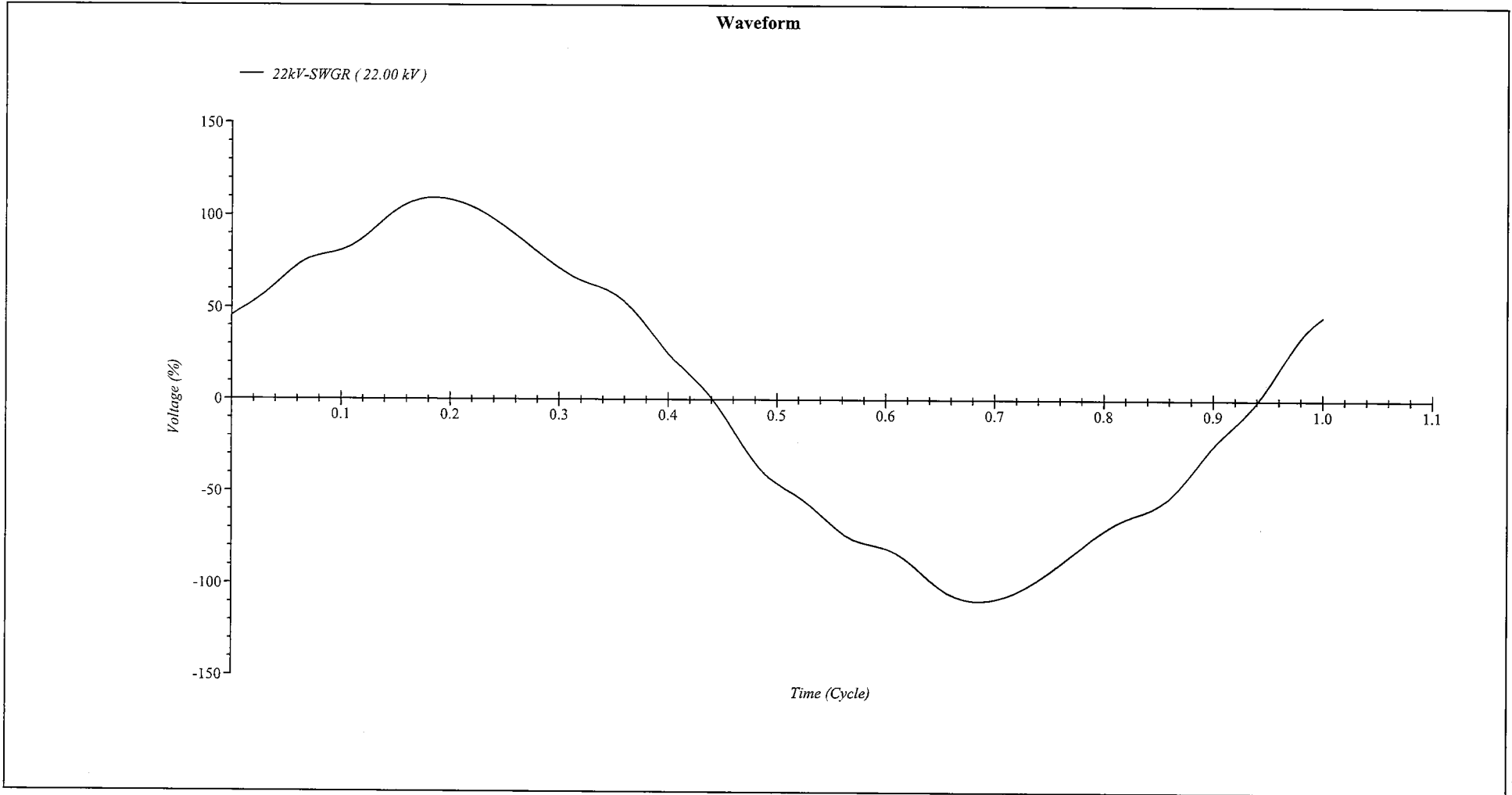
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Config.: UnaxInrwV100

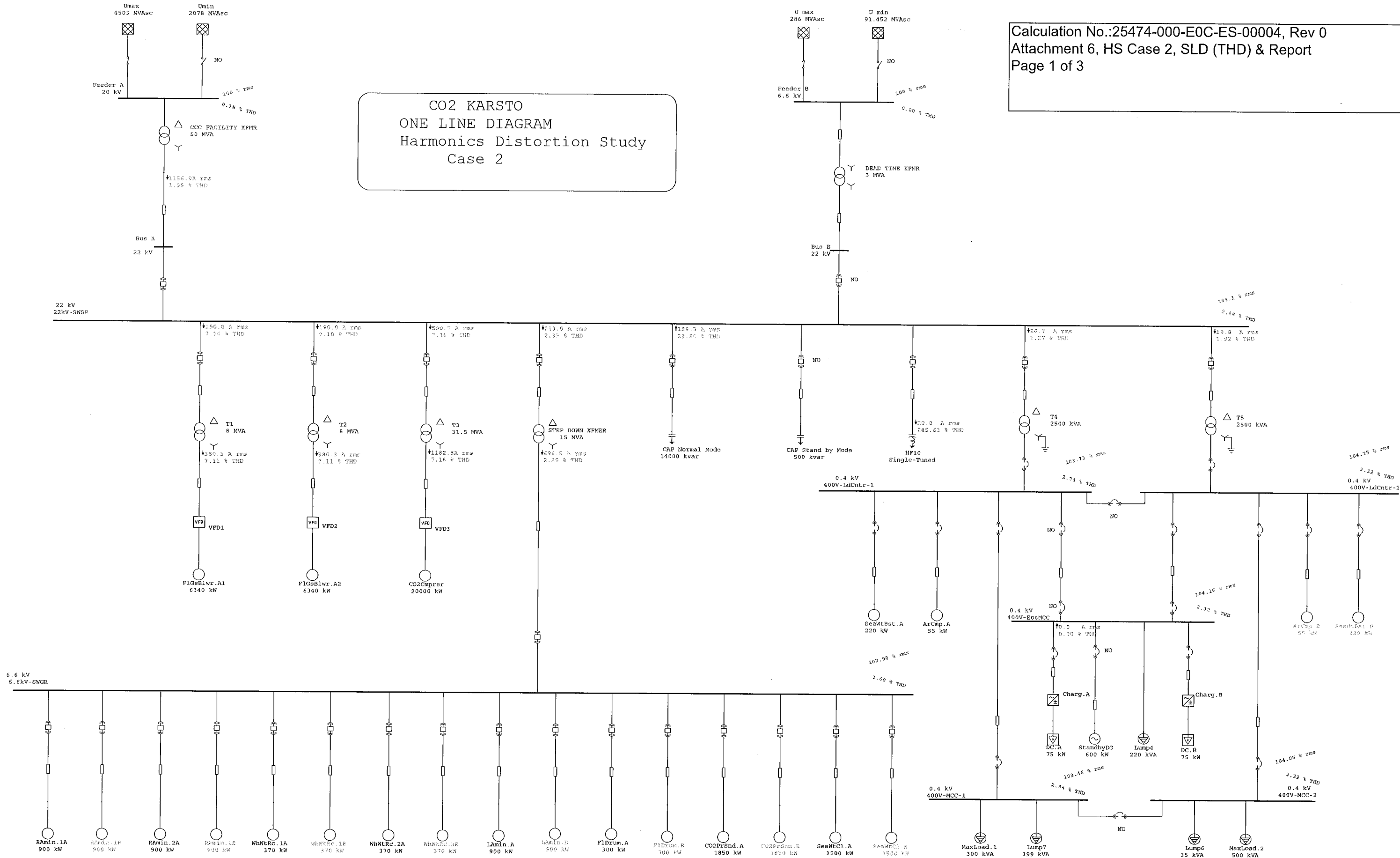
Preliminary Design

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Output Report: HS Case1

HARMONIC LOAD FLOW ANALYSIS



CO2 KARSTO
 ONE LINE DIAGRAM
 Harmonics Distortion Study
 Case 2



Project: CO2 Karsto
 Location: Karsto, South-West of Norway
 Contract: Bechtel 25474
 Engineer: Victor Skavitine
 Filename: KARSTOHS

ETAP
 6.0.0C
 Study Case: HS Case2Rev0

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 Revision: Base
 Config.: UminLnrmV98%

Preliminary Design

Filter Overloading

| Filter | | | Capacitor C1 | | | Inductor L1 | | | Capacitor C2 | | | Inductor L2 | | |
|--------|------|------------|--------------|------------|---------------|-------------|-------------|---------------|--------------|------------|---------------|-------------|-------------|---------------|
| ID | Type | Connection | Max. kV | Opr. kV | % OverVolt | Max. Amp | Opr. Amp | % Overload | Max. kV | Opr. kV | % OverVolt | Max. Amp | Opr. Amp | % Overload |
| | | | | | | | | | | | | | | |

Filter Types: 0 = By-Pass, 1 = High-Pass (Damped), 2 = High-Pass (Undamped), 3 = Single Tuned, 4 = 3rd Order Damped, 5 = 3rd Order C-Type

Project: CO2 Karsto
 Location: Karsto, South-West of Norway
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 Engineer: Victor Skavitine
 Filename: KARSTOHS

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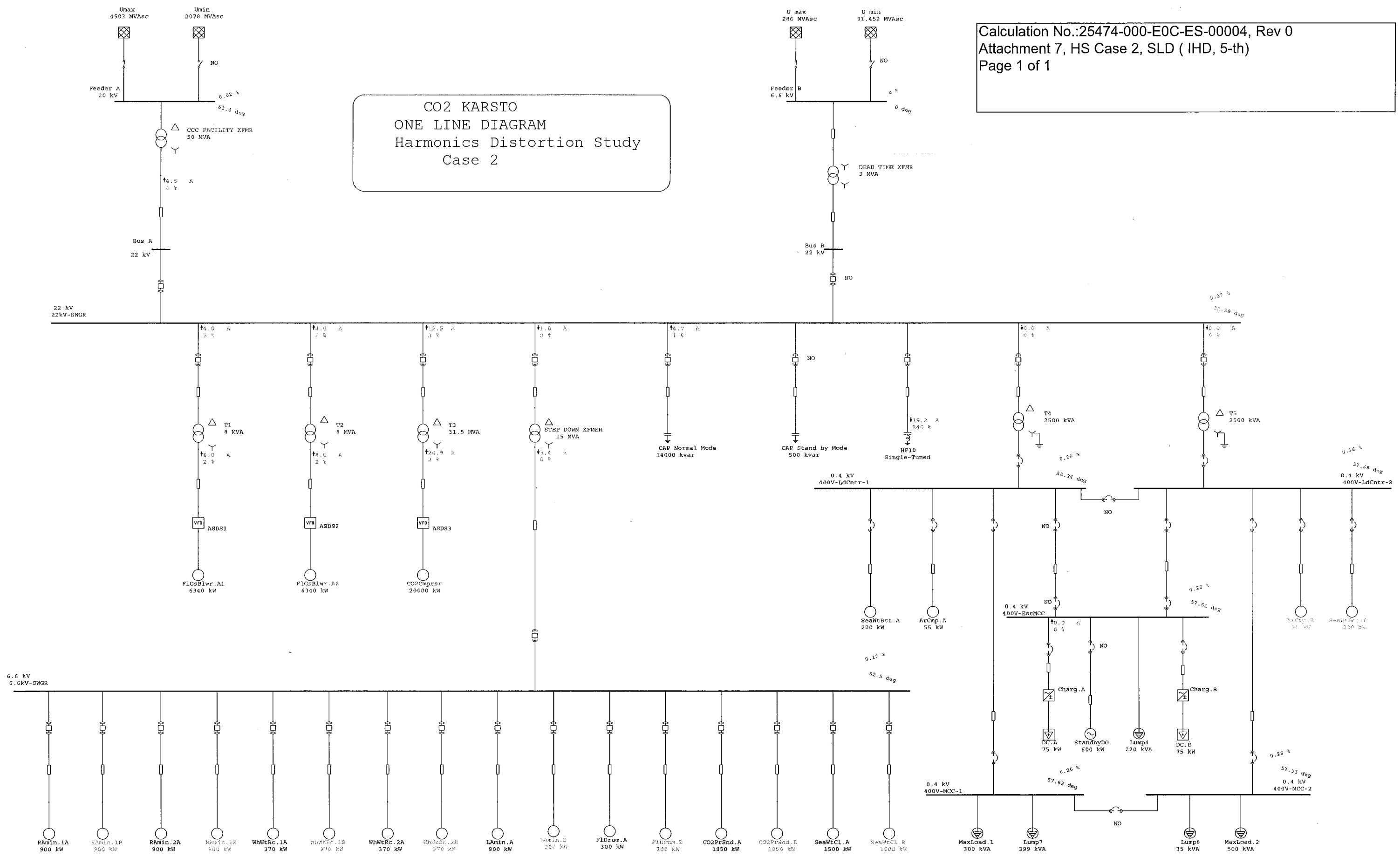
Preliminary Design

VTHD (Total Harmonic Distortion) Report

| Bus ID | Voltage kV | Distortion | |
|------------|---------------|------------|-----------|
| | | Fund. % | VTHD % |
| B-CmprsrTr | 22.000 | 100.64 | 3.60 |
| B-StpDwnTr | 22.000 | 100.68 | 3.60 |
| Bus7 | 0.400 | 101.59 | 3.31 |
| Bus9 | 0.400 | 100.23 | 3.26 |
| Bus17 | 22.000 | 100.69 | 3.61 |
| Bus018 | 22.000 | 100.69 | 3.61 |
| Bus21 | 22.000 | 100.64 | 3.60 |
| Bus22 | 22.000 | 100.64 | 3.60 |
| Bus24 | 22.000 | 100.69 | 3.62 |
| Bus27 | 0.400 | 100.44 | 3.29 |
| Bus46 | 0.400 | 100.04 | 3.23 |
| Bus47 | 0.400 | 102.03 | 3.16 |
| Bus58 | 0.400 | 101.39 | 3.28 |
| Bus59 | 0.400 | 101.84 | 3.25 |
| Bus62 | 22.000 | 100.69 | 3.61 |
| Bus63 | 22.000 | 100.69 | 3.61 |
| Bus64 | 22.000 | 100.69 | 3.60 |
| Bus A | 22.000 | 100.69 | 3.61 |
| Bus-Sec.T1 | 11.000 | 98.79 | 4.13 |
| Bus-Sec.T2 | 11.000 | 98.79 | 4.13 |
| Bus-Sec.T3 | 11.000 | 98.74 | 4.51 |
| Bus T50 | 23.000 | 96.37 | 3.58 |
| Bus-VFD1 | 11.000 | 98.78 | 4.13 |
| Bus-VFD2 | 11.000 | 98.78 | 4.13 |
| Bus-VFD3 | 11.000 | 98.73 | 4.52 |
| LV MCC A | 0.400 | 101.52 | 3.30 |
| LV MCC B | 0.400 | 101.97 | 3.28 |
| LV SWGR A | 0.400 | 101.59 | 3.31 |
| LV SWGR B | 0.400 | 102.03 | 3.29 |
| MV SWGR | 22.000 | 100.69 | 3.61 |

Indicates buses with THD (Total Harmonic Distortion) exceeding the limit

CO2 KARSTO
 ONE LINE DIAGRAM
 Harmonics Distortion Study
 Case 2



Project: C02 Karsto
Location: Karsto, South-West of Norway
Contract: Bechtel 25474
Engineer: Victor Skavtine

ETAP
6.0.0c

Study Case: HS Case2RevA

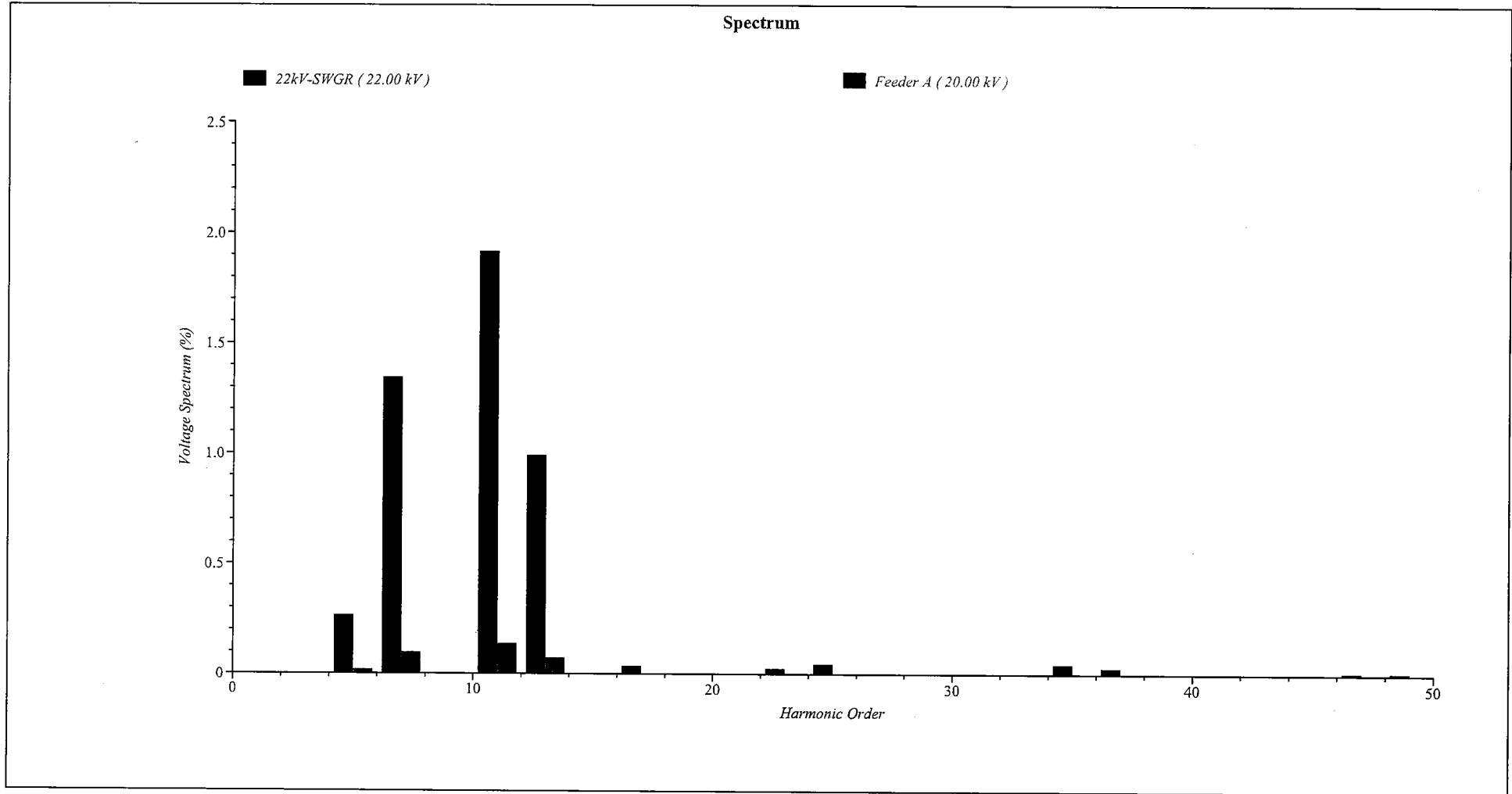
Calculation No.:25474-000-E0C-ES-00004, Rev 0
Attachment 8, HS Case 2
Page 1 of 1

Date: 11-20-2008
SN: SANTALENG
Revision: Base
Config.: UmaxLnmV100

Preliminary Design

Project File: M:\1047\08.0 Engineering\08.1 Electrical\08.1.42 ETAP\KARSTO
Output Report: HS Case2

HARMONIC LOAD FLOW ANALYSIS



Project: 002 Karsto
Location: Karsto, South-West of Norway
Contract: Bechtel 25474
Engineer: Victor Skavtine

BTAP
6.0.0C
Study Case: HS Case2RevA

Calculation No.:25474-000-E0C-ES-00004, Rev 0
Attachment 9, HS Case 2
Page 1 of 1

Date: 11-20-2008
SN: BANTELENG
Revision: Base
Config.: UmaxIntrv100

Preliminary Design

Project File: W:\1047\08.0 Engineering\08.7 Electrical\08 7.42 ETAP\KARSTO
Output Report: HS Case2

HARMONIC LOAD FLOW ANALYSIS

