Eskom	REPORT	Group Technology

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1. INTRODUCTION

As part of Eskom's drive to reduce emissions and meet more stringent legislative particulate emission limits by 2020, Eskom is looking into replacing the existing Electrostatic Precipitator (ESP) Plants, in various power stations, with Fabric Filter Plants (FFP). One of the power stations which this is envisaged for is Kriel Power Station. For this to be possible, a full feasibility study is required. One of the outcomes of the mechanical feasibility study was that the Dust Handling Plant (DHP) would also need to be upgraded as a result of the FFP retrofit. This report documents the load flow and fault study that was conducted to assess the feasibility and impact, of the proposed retrofits and upgrades, on the electrical reticulation network of the power station. The following are the main evaluations done as part of the study:

- Assessment of the size of the Unit Transformers with regards to loading, start-up capabilities and system voltages.
- Assessment of the size of the Station Transformer with regards to loading, start-up capabilities and system voltages.
- Assessment of all the new FFP and DHP compressors plants' impact on the upstream common plant electrical reticulation, with regard to the loading and system voltages.
- Assessment of the 11kV and 3.3kV fault levels on the major boards affected by the proposed retrofits and upgrades.
- Assessment of the loading on the affected electrical reticulation cables.
- Assessment of the impact that the proposed designs would have on the current operating philosophy of the auxiliary electrical reticulation, with reference to configuration and bus-section closing.
- The impact of adding the proposed Site 16 Ash Dam plant in additional to the FFP-DHP retrofit project.

Since not all design information is available at this stage, assumptions had to be made to complete this study. These are documented in this report.

Recommendations proposed in this document have been outlined with the technical capability and requirements of the electrical reticulation network in mind only. Other factors will have to be taken into account by the Electrical LDE and the project team.

2. SUPPORTING CLAUSES

2.1 SCOPE

2.1.1 Purpose

The main purpose of the study is to evaluate the feasibility and impact of the proposed FFP and DHP retrofit designs as conveyed in the *Kriel FFP Retrofit Concept Design Report (377-PRJ-1-BDDD-D00185-12)*, the *Kriel Dust Handling Plant Upgrade Electrical Concept Design Report (360-PRJ-1-DDDD-D00185-7)* and additional supporting Basic Design documents supplied (load lists, equipment lists, sizing documents, etc.).

An assessment of the integration of a new Ash Dam plant is also done in the study and presented in this document. This assessment was conducted using the information provided by the project LDE. See Appendix E for the load lists used.
This report should act as a supporting clause to the Basic Designs developed.

2.1.2 Applicability

This document is only applicable to the Kriel Power Station Fabric Filter Plant Retrofit, Dust Handling Plant Upgrade and the New Ash Dam Projects. This study did not include any other future project requirements.

2.2 NORMATIVE/INFORMATIVE REFERENCES

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

2.2.1 Normative

[1] 377-PRJ-1-BDDD-D00185-12 : Kriel FFP Retrofit Concept Design Report

[2] 360-PRJ-1-DDDD-D00185-7 : Kriel Dust Handling Plant Upgrade Electrical Concept Design Report

[3] 474-9389 : Kriel P/S Contractors' Yard Extension – Electrical Feasibility

[4] 377-PRJ-1-DDDDD00185-1 : Kriel ESP to FFP Retrofit Project – Power System Studies report

[5] 240-56227778 - Fault Current Calculations & Rating Switch-Gear Standard

[6] V. Mathebula, Eskom Group Technology, *Sizing Power Transformers to Achieve Acceptable Voltage Depression Levels Caused by Starting of Induction Motors*, November, 2015

2.2.2 Informative

[7] Aberdare Cables, *Cables Facts and Figures*

[8] CBi Electric Cables, *Cable Datasheets*

2.3 DEFINITIONS

None.

2.3.1 Classification

a. **Controlled disclosure:** controlled disclosure to external parties (either enforced by law, or discretionary).

2.4 ABBREVIATIONS

Abbreviation	Description
A	Ampere
AC	Alternating Current
C&I	Control and Instrumentation
CT	Current Transformer
DC	Direct Current
ESP	Electro Static Precipitator
FFP	Fabric Filter Plant
GTE	Group Technology Engineering
ID	Induced Draft
IED	Intelligent Electronic Device
LV	Low Voltage
MV	Medium Voltage
rms	Rout mean square
RTU	Remote Terminal Unit
SO3	Sulphur Trioxide
URS	User Requirement Specification
V	Voltage
VSD	Variable Speed Drive
DHP	Dust Handling Plant
FGD	Flue Gas Desulphurisation
LDE	Lead Discipline Engineer
EFP	Electric Feed Pump
EOD	Electrical Operating Desk
FGD	Flue Gas Desulphurization

2.5 ROLES AND RESPONSIBILITIES

Group Technology, Engineering (Electrical CoE), is required to conduct an electrical load flow and fault level study for the Electrical LDEs and the Kriel Power Station stakeholders to use to make an informed decision with respect to the way forward on the abovementioned project at Kriel Power Station. All the specifications and design decisions in the projects concerned should be done with the findings and recommendations from this report, in mind.

2.6 PROCESS FOR MONITORING

Group Technology Engineering, Electrical CoE, will be the custodian of this document.

2.7 RELATED/SUPPORTING DOCUMENTS

See appendices.

3. BACKGROUND

Multiple power system studies have been conducted for Kriel Power Station in the past decade. The latest one being the one, done July 2013, to assess the feasibility of the proposed Fabric Filter Plant (FFP) retrofit. The study presented in this document is a build up from this study and another one, conducted in 2012 to assess the feasibility of extending the contractor's yard at Kriel Power Station [3] [4].

The same Power Factory model used for the studies of [3] and [4] was used for this study. All changes made to the model used for the purposes of this case study are documented in Appendix A.

The case study was then used to assess the impact when the requirements of the Dust Handling Plant (DHP) upgrade are included. Upon request, the inclusion of a possible New Ash Dam Plant is assessed as a scenario.

4. ASSUMPTIONS

The following assumptions were used in order to complete the study:

a. The SO3 plant will be decommissioned after the FFP has been installed.

b. Assuming a power factor of 0.95 for the Units' 400V FFP Boards A & B.

c. Assuming 8000kW ID Fan motors, operating at a loading of 7031kW.

d. The new FFP transformers to be used to supply the FFP loads and ID fan auxiliaries will be 500kVA, 3.3/0.4kV, DYN11 transformers with an impedance of 4.51%.

e. The new 11/3.3kV, 10MVA Ash Handling Plant Compressor transformers 1 & 2, will be YNyn0 transformers with an impedance of 6.76%.

f. The new 11/0.4kV, 800kVA Ash Handling Plant Compressor transformers 1 & 2, will be DYN11 transformers with an impedance of 5%.

g. The new 11/0.4kV, 1.6MVA Ash Handling Plant Blower transformers 1 & 2, will be DYN11 transformers with an impedance of 6%.

h. The new 11/0.4kV, 1.25MVA Unit 1-3 Blower House transformer, will be DYN11 transformers with an impedance of 5.81%.

i. Assuming XLPE is used for all new MV cables.

j. A power factor of 0.923 for all FFP and DHP compressor motors

k. All compressor motors (FFP & DHP) are 90% loaded.

l. The EFPs and ID Fans are operating at full load.

m. The new cable from the new maintenance isolator to the loop supply maintenance isolator will be the same as the cables between the loop supply maintenance isolators. Length is estimated to be 50m.

n. The reactor cables from Station Boards 1 and 2 are 2 x 500mm^2 single core cables per phase.

o. All 3 new contractor's yard loads will be 60% loaded in all scenarios.

p. The assumed power factor for the New Ash Dam plant lumped loads was assumed to be 0.85.

5. INVESTIGATION METHODOLOGY

The loads (from electrical load lists) and equipment as described in the *Kriel ESP to FFP Retrofit Project – Power System Studies report (377-PRJ-1-DDDDD00185-1)* and the equipment sizing documents supplied by the DHP Electrical LDE (See Appendix B), forms the basis of the results obtained from the Power Factory Model developed. The results obtained from load flow and fault simulations of this model are presented and discussed in this report. All affected plants were scrutinised and each plant element has been evaluated against set criteria. For consistency, the same criteria are used as in the previously conducted studies on this power system (references [3] and [4]). These are reproduced below. All affected equipment was assessed under different operating scenarios of the electrical reticulation network.

5.1 SUPPLY TRANSFORMER REQUIREMENTS

The main supply transformers are the Unit Transformers A & B, on the units, and the FFP specific supply transformers A & B on the common plant. All transformers should not be loaded more than 90% of their capability when the load is regarded as "continuous". This criterion on the transformers should be adequately rated to handle the worst case motors start-up conditions.

Discussions with EOD operators at Kriel Power Station informed the bus section closing scenario investigated as the worst case. The impact of the proposed new plants on the upstream transformers during this scenario was investigated.

5.2 CABLES

This report focuses on the medium voltage cables only and some general rules have been set to which the installed cables had to comply with. These are:

a) Volt drop allowed under normal load conditions on MV = 3%.

b) Fault current withstand of 300ms as preference, with 200ms as an absolute minimum accompanied by a motivation.

c) Cables must be able to carry full load current.

d) Cables connected to transformers to be sized for transformer rating with de-rating factors were applicable.

e) Cables in the main cable tunnel in the power station need not be de-rated for temperature.

5.3 MV BOARDS

The continuous loading on all MV boards should be within the board current rating. The ratings of the main existing boards at Kriel are currently as shown in Table 1 and 2 below.

Table 1: Existing Switchgear Ratings at Kriel Power Station

Ratings	11kV Unit Board A and B	3.3kV Service Boards A and B	3.3kV Service Boards C and D	380V Unit Boards A and B	Loop Supply Maintenance Isolators
Busbar Rating	2000 A	2500 A	1250 A	2500 A	2000 A
Incomers	2000 A	2500 A	1250 A	2500 A	2000 A
Bus Section	2000 A	2500 A	1250 A	2500 A	2000 A
Feeders	1250 A	1250 A	630 A	Various	
Fault Rating	31.5kA for 3 sec	40kA for 3 sec	31.5kA for 3 sec	50kA for 1sec	31.5kA for 3 sec

Table 2: Existing Switchgear Ratings at Kriel Power Station

Ratings	11kV Station Boards 1 and 2	11kV Station Boards 3 and 4	11kV Station Boards 1&2 Maintenance Isolator	11kV Substation Boards 1, 2, 3 and 4
Busbar Rating	2500 A	1250 A	2500 A	1250 A
Incomers	2500 A	1250 A	2500 A	1250 A
Bus Section	N/A	1250 A	2500 A	1250 A
Feeders				
Fault Rating	31.5kA for 3 sec	25kA for 3 sec	31.5kA for 3 sec	25kA for 3 sec

Also, the fault rating of all the affected MV boards should be higher than the fault level simulated in the study. Only a fault level study for the recommended system (after transformer resizing) is presented in this document.

6. INTERPRETATION OF RESULTS

The DigSILENT Power Factory® analysis tool allows for graphical layout and result boxes or in tabular format. It is preferred to use the graphical representation as it indicates the results related to any element with the element.

The example in this paragraph is not related to Kriel but demonstrates the general rules applied in representing result in this report. In the graphical representation the legend of the result boxes are indicated in a legend block at the bottom left corner of the page. The tabular representation (not used in this report), causes some names to be truncated because of a "column width" restriction in Power Factory®. The graphical representation needs to be consulted then, to ensure that you are indeed at the point where you think you are, therefore only the graphical representation is used in this report.

For the load flow study, negative and positive values will appear in the result boxes. The convention used is that negative values indicate power/ current flow towards a node (terminal or bus bar) and a positive value indicates power / current flow away from a node. The percentage loading refers to the nominal current carrying capability of the various branch elements being it a cable or transformer.

The result boxes can represent different quantities. Different results can be shown for cables compared to transformers and therefore it is imperative that the legend be consulted.

Load Flow Balanced			
Nodes	Branches	External Grid	2-Winding Transformer
Ul Ul, Magnitude [kV]	P Active Power [MW]	P Active Power [MW]	S Apparent Power [MVA]
u u, Magnitude [p.u.]	I Current, Magnitude [kA]	Q Reactive Power [Mvar]	I Current, Magnitude [kA]
phiu U, Angle [deg]	loading Loading [%]	cosphi Power Factor [-]	loading Loading [%]

Figure 1: Results box contents for Load flow results

Once the legend is understood it can be applied to the result boxes in the graphical representation.

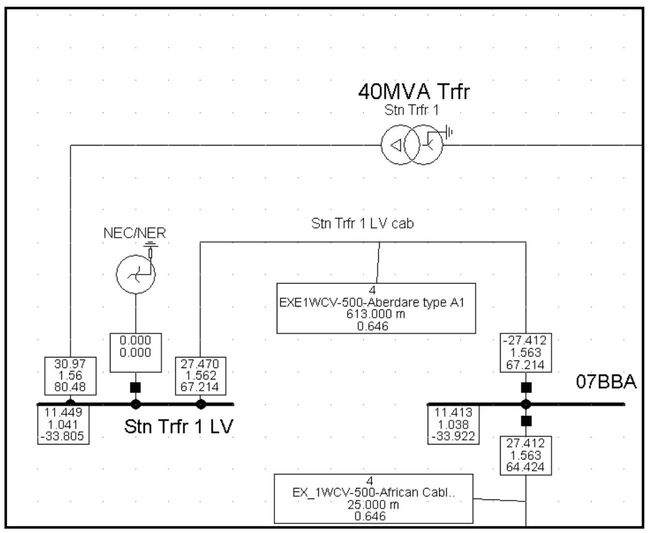


Figure 2: Interpretation of result boxes

Applying the legend to the results in the Figure 2 yields the following understanding:

a) At the node/busbar on the left named Stn trfr 1 LV, the result boxes list three values and there seem to be little correlation however, the left hand box is part of the transformer where as the right hand box at the same node is part of the cable or line as it is called in Power factory. Therefore applying the quantities listed under the 2-Winding Transformer from the legend the values in the left box mean:

- 30.97 - MVA
- 1.56 - kA
- 80.48 % of transformer rating

Similarly one can apply the quantities from the legend for branches and then the values in the right hand box are interpreted as:

- 27.470 - MW

- ➢ 1.562 - kA
- ➢ 67.27 % of cable rating

At station board 1 (07BBA) the result box either side of the node has similar values except for the signs. Negative value indicates power or current flowing towards the node and positive is power/current flow away from the node.

The fault study findings are presented by assessing the following short circuit current parameters at different boards and terminals:

- I_K – The steady state short circuit current
- I_{Kss} – The initial state short circuit current
- I_P – The peak state short circuit current

7. MODEL VERIFICATION

To ensure that reliable conclusions could be drawn from the simulation results, it was essential that it be verified how closely the model represents the behaviour of the current electrical reticulation at Kriel power station.

The first step was to develop a model that represents what is currently implemented on site. This was done by removing all the equipment/loads that had been added (on receipt of the model) to perform system studies for projects which have not been implemented yet. These are the Contractor's Yard Extension project and the FFP Retrofit project. The model was run to obtain the expected current loading conditions of the different equipment in the network. This simulation was done under full load conditions of the Unit and common plant. The results from this simulation are present in Figures 1 and 2 for the Units and Common plant respectively.

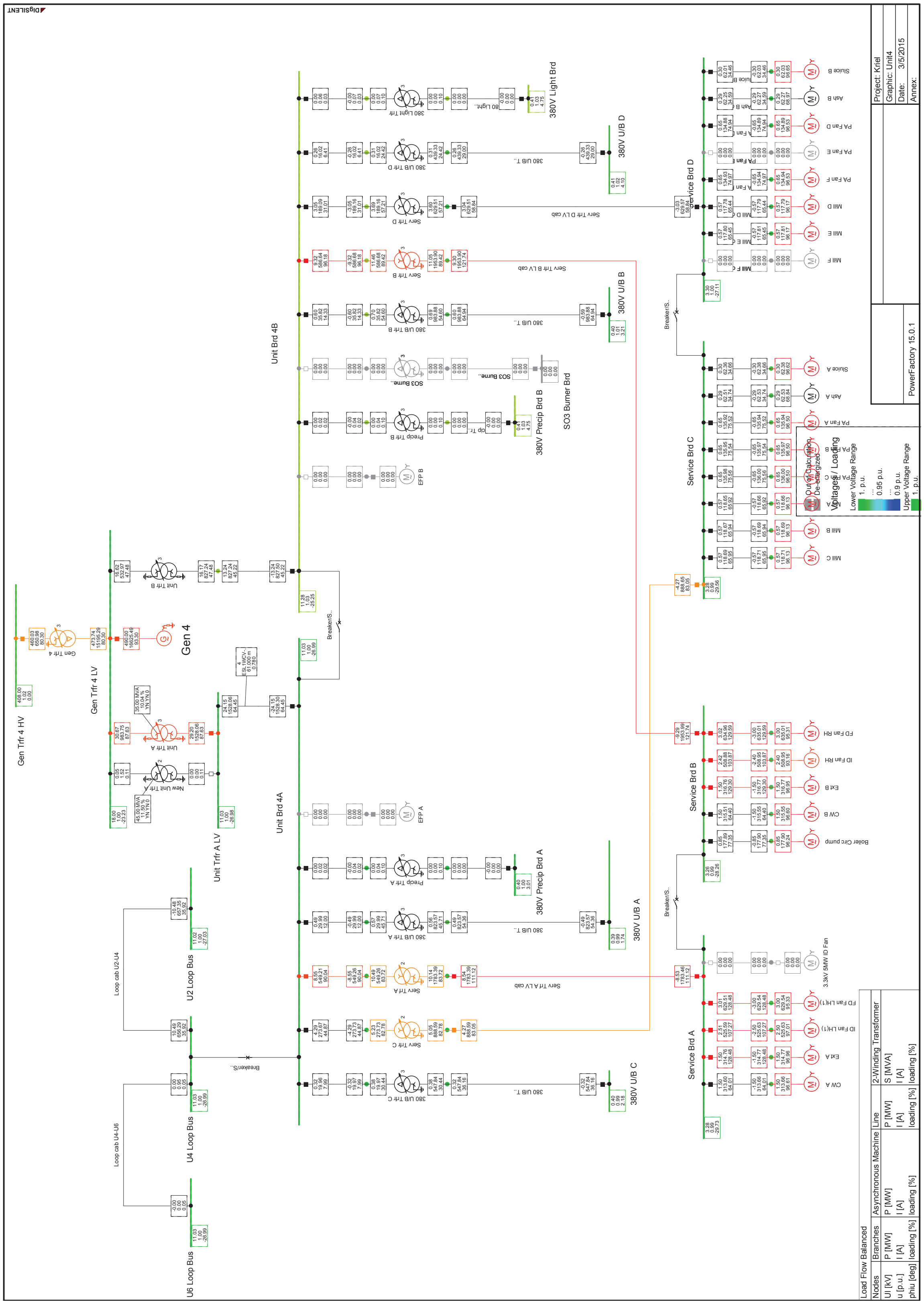


Figure 3: Simulation showing status of the current electrical network – Unit 4

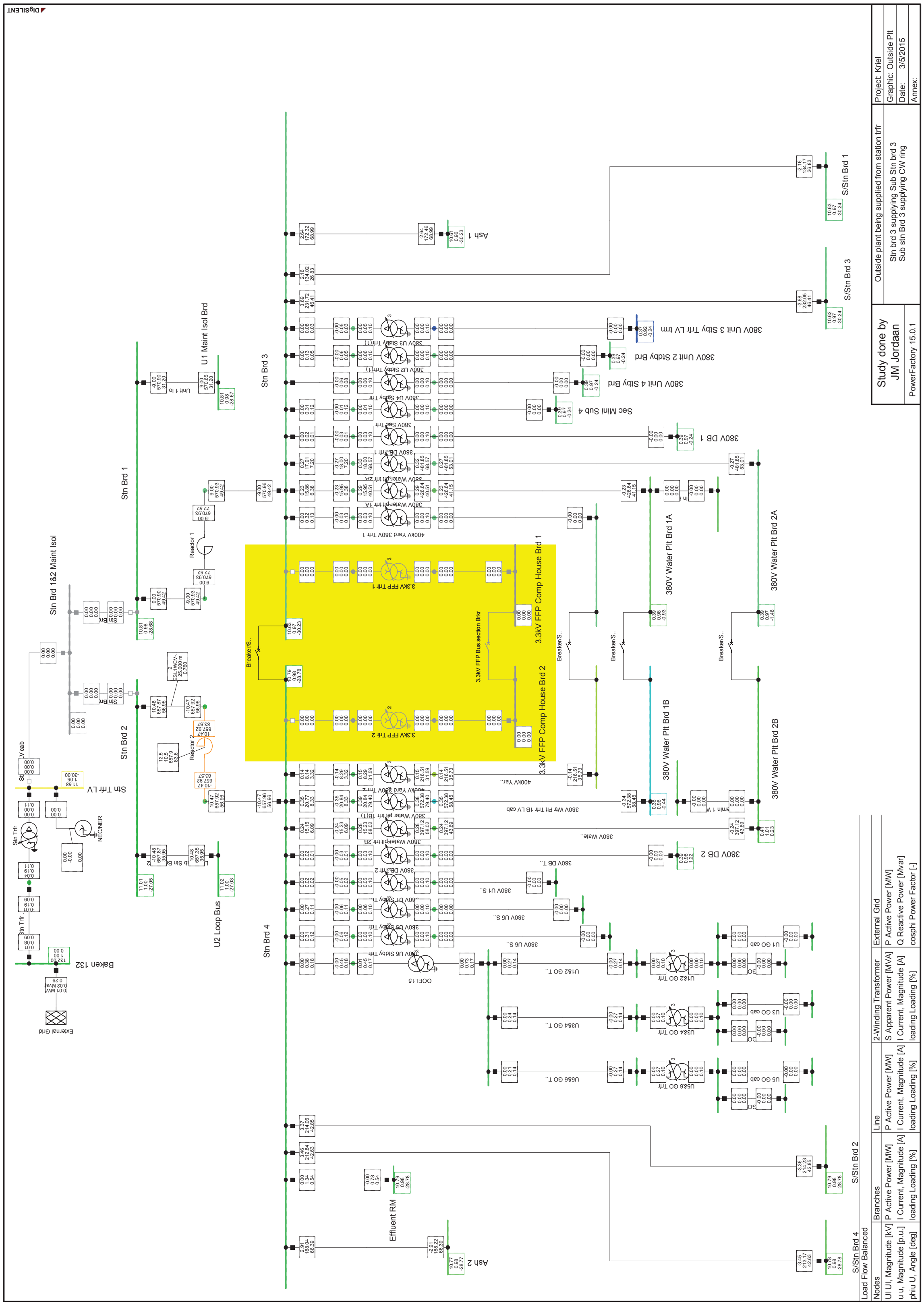


Figure 4: Simulation showing status of the current electrical network – Station Boards

The next step was to determine how accurately this represents the electrical network on site. As can be seen from the simulations no electrical equipment in the network is over loaded, as expected with a running plant. Where overloaded items were found in this model, they were verified on site (and latest site documents) and corrected in the model.

The last step was to correlate the loading from the simulation to actual loading at Kriel Power Station. From discussions with plant operators, operator trainers, simulator trainers and employees that work at the EOD, the following was established about Kriel Power Station:

- When a unit is generating at full capacity (550MW), the approximate unit auxiliary power consumption is 25MW.
- When a unit is generating at full capacity (550MW), the two Electric Feed Pumps (EFPs) are not used. From a generation capacity of approximately 300MW (operator dependant), the Boiler Steam Feed Pump is used and this does not use electric power. Therefore the 25MW auxiliary consumption is exclusive of the EFPs.
- When a unit is generating at full capacity (550MW), 5 mill groups (mill and PA fan) are required at any time.
- When a unit is generating at full capacity (550MW), the full capacity of the common plant is required, of course observing redundant equipment.

The above mentioned points form the basis of the model simulations in Figure 1 and 2 with regard to which plant components are switched off. From the abovementioned points, a comparison can already be made:

> From the simulation results in Figure 1, it can be calculated that the unit auxiliary load requirements at full generating capacity is:
>
> *(Unit 4A transformer loading – Common plant loading) + (Unit 4B transformer loading)*
>
> This gives *26.89MW.*

This is 7.56% higher than the know unit auxiliary power consumption. This can be justified by the fact that all plant equipment are electrically loaded between 95% and 100%, which is not the case on site. However, 15% is considered as an acceptable error margin for the study communicated in this document.

As a second check to confirm the validity of the well know 25MW unit auxiliary power consumption, the actual loading of the unit transformer for Unit 3 and 4, at different generating capacities was obtained from the plant's PI measurement system. The measurement data obtained was hourly readings from 12 August 2014 to 12 February 2015. From this data, the maximum instances were analysed. These revealed a unit auxiliary consumption of 39MW at a generation capacity of 505MW. The auxiliary consumption implies that the EFP pumps were running at this instance. Therefore subtracting their consumption and extrapolating the result for maximum generating capacity, this gives an auxiliary power consumption of 22.9MW. This is an acceptable 8.4% from the generalised maximum.

8. INVESTIGATED OPERATING SCENARIOS – DESCRIPTION AND FINDINGS

<u>Basis of Scenarios Presented</u>:

The Kriel Power Station electrical reticulation has a loop connecting Units 1, 3, 5 and 11kV Station Board 1 and another loop connecting Units 2, 4, 6 and 11kV Station Board 2. Under normal conditions Unit 1 (11kV Unit Board 1A) is supplying half of the common plant through the loop supply system connecting to Station Board 1; and Unit 2 (11kV Unit Board 2A) is supplying half of the common plant through the loop supply system connecting to Station Board 2.

Likewise, Station Board 1 can be supplied, through the loop supply, from the 11kV Unit Board 3A and 11kV Unit Board 5A. Also, it is possible to supply Station Board 2, through the loop supply, from the 11kV Unit Board 4A and 11kV Unit Board 6A.

Upon simulating the abovementioned normal condition, 11kV Station Board 2 was found to be loaded slightly more than 11kV Station Board 1. In order to check the impacts of the load additions on the different reticulation scenarios, 11kV Station Board 2, supplied by 11kV Unit 4A, was used as it represents a more severe case compared to 11kV Station Board 1.

For the above mentioned reason the left side of the common plant is used to assess all relevant impacts of load shifting due to bus-section closing. Therefore, Unit 4 is used to represent all the units and Station Board 2 represents Station board 1.

All operating scenarios, boards and transformers that were not affected by the additional loads of the FFP and DHP plant retrofits are not discussed in this study, as it is expected that the loading will be the same before and after the retrofits. The base case for all the scenarios presented is the addition of the FFP-DHP loads. Meaning that these loads are included in all the scenarios presented.

The B side equipment of the Units were only entertained for the normal operating scenario (Scenario 1) as these do not change with other operating scenarios investigated.

Findings that exist in multiple Scenarios are only mentioned in the first scenario in which they are noted. The study is done using the 55MVA Unit 4 A transformer as recommended in the previous revision of this study.

8.1 SCENARIO 1: NORMAL OPERATION – UNITS RUNNING AT FULL LOAD AND SUPPLYING HALF OF THE COMMON PLANT.

This is the base case and is used to monitor the contribution of each scenario and extrapolate as required with regard to recommendations.

8.1.1 Scenario Setup

- Unit 1 Generator is at full load supplying its own auxiliaries via Unit Transformer 1A & 1B.
- Unit 4 Generator is at full load supplying its own auxiliaries via Unit Transformer 4A & 4B.
- 11kV Station Board 2 is supplied from 11kV Unit Board 4A via the loop supply.
- 11kV Station Board 1 is supplied from 11kV Unit Board 1A via the loop supply.
- 11kV Maintenance Isolator Board Feeder Breaker from 11kV Unit Board 2A, 4A & 6A are open.
- 11kV Maintenance Isolator Board Feeder Breaker from 11kV Unit Board 1A, 3A & 5A are open.
- The Unit Loop Supply will be from the proposed unit maintenance isolator board.
- No bus sections are closed.
- The Station Transformer incomer breakers on Station Boards 1 and 2 are open.
- Feeder breakers to all FGD loads (on Station Boards and on Service Boards) are left open.
- All new Ash Dam loads (on Station Boards 3 and 4) are left open.

Note: All Common Plant and Unit Boards are fully loaded and no bus sections are closed.

8.1.2 Findings

The following areas of concern are highlighted as findings (see corresponding Power Factory simulation drawings in Appendix C):

Table 3: Loading results with proposed new 55MVA unit transformer with loads

Equipment	Size	Loading (MW/MVA)	Current drawn (A)	Board voltage (pu)	% of rating of element
Unit trfr 4A	55MVA	47.13MVA	2560	0.97	85.69%
Unit trfr 4B	35MVA	31.49MVA	1688	0.98	89.97%
Reactor 2	15MVA	12.99MVA	832.5	0.94	105.7%
3.3kV Service Brd B	2500A		1516	0.95	60.64%
3.3kV Service Brd C	1250A		924.3	0.95	73.94%
3.3kV Service Brd D	1250A		660.2	0.95	52.82%
3.3kV FFP Comp Hse Brd 2			341.8	0.93	

8.2 SCENARIO 2: ABNORMAL CONDITION – UNITS RUNNING AT FULL LOAD AND SUPPLYING THE COMMON PLANT, WITH THE 11KV SUBSTATION BOARDS 3 & 4 CONNECTED.

8.2.1 Scenario Setup

This scenario is identical to Scenario 1 above, except for the following conditions:

- The 11kV Substation Boards 3 & 4 bus-section is closed.
- Incomer circuit breaker on 11kV Substation Board 3 is open.

8.2.2 Findings

This scenario represents the worst case abnormal load condition (for the Unit A Transformers) of the electrical network, with the units fully loaded and operating at the Maximum Continuous Rating (MCR). The following areas of concern are highlighted as findings (see corresponding Power Factory simulation drawings in Appendix C):

Table 4: Loading results with proposed new 55MVA unit transformer with loads

Equipment	Size	Loading (MW/MVA)	Current drawn (A)	Board voltage (kV)	% rating of element
Unit trfr 4A	55MVA	53.98MVA	2965	0.96	98.15%
Proposed 11kV	2500A	53.98MVA	2965	0.96	118.6%

Unit A Brd Maint Isolator					
3.3kV Service Brd A	2500A		1322	0.95	52.88%
3.3kV Service Brd C	1250A		936.0	0.94	74.88%
Reactor 2	15MVA	18.81MW	1219	0.92	154.8%
Reactor 2 Cables	6 x 500mm^2 single cores	18.81MW	1219	0.92	105.5%
S/Stn Brd 4 Incmr Cable	6 x 150mm^2 single cores	9.57MW	609.8	0.91	122.0%

For extrapolation purposes, it is worth noting that this scenario introduces an additional 6.85MVA loading on the Unit A Transformer compared to the normal operation scenario.

It should be noted from the first 2 scenarios presented that if under-voltage problems exist on the upstream boards. As a result, the downstream boards also inherit this under-voltage. This effect will not be shown for downstream for the subsequent scenario findings as rectifying the under-voltage of the upstream boards will also rectify the under-voltage problems of the downstream boards.

8.3 SCENARIO 3: SEPARATE SUPPLIES – STATION TRANSFORMER USED TO SUPPLY ALL THE COMMON PLANT LOADS AND THE UNIT TRANSFORMERS SUPPLY UNIT AUXILIARIES.

8.3.1 Scenario Setup

This scenario is identical to Scenario 1 above, except for the following conditions:

- The feeder breaker to the units loop supply, on 11kV Station Boards 1 and 2 are open.
- The Station Transformer incomer breakers on Station Boards 1 and 2 are closed.

8.3.2 Findings

This scenario represents the worst case load condition (for the Station Transformers) of the electrical network at Kriel Power Station. Areas of concern are not as severe as findings in previously presented scenarios. See Appendix C for scenario simulation results details.

8.4 SCENARIO 4A: NEW ASH DAM 1 – UNITS RUNNING AT FULL LOAD AND SUPPLYING HALF OF THE COMMON PLANT. THE NEW ASH DAM 1 (DRY CONCEPT) LOADS ARE ADDED.

This scenario is investigated to determine the impact of the new Ash Dam, dry ash concept, on the Unit A transformer.

8.4.1 Scenario Setup

This scenario is identical to Scenario 1 above, except for the following conditions:

- The feeder breakers to the new Ash Dam (Dry Concept) plant loads, on 11kV Station Boards 3 and 4 are closed.
- The currently running Slurry Plant 11kV Boards are switched off.
- The currently running Ash Water Return (AWR) Plant 11kV Boards are switched off.

8.4.2 Findings

The following areas of concern are highlighted as findings (see corresponding Power Factory simulation drawings in Appendix C):

Table 5: Loading results with proposed new 55MVA unit transformer with loads

Equipment	Size	Loading (MW/MVA)	Current drawn (A)	Board voltage (kV)	% of rating of element
Unit trfr 4A	55MVA	48.10MVA	2616	0.96	87.45%
Proposed 11kV Unit Brd 4A Maint Isoltr	2500A	48.10MVA	2616	0.96	**104.6%**
Reactor 2	15MVA	13.81MW	886.7A	0.94	**112.6%**
11kV Stn Board 4	1250A	13.81MW	886.7A	0.94	70.94%

8.5 SCENARIO 4B: NEW ASH DAM 2 – UNITS RUNNING AT FULL LOAD AND SUPPLYING HALF OF THE COMMON PLANT. THE NEW ASH DAM 2 (WET CONCEPT) LOADS ARE ADDED.

This scenario is investigated to determine the impact of the new Ash Dam, wet ash concept, on the Unit A transformer.

8.5.1 Scenario Setup

This scenario is identical to Scenario 1 above, except for the following conditions:

- The feeder breakers to the new Ash Dam (Wet Concept) plant loads, on 11kV Station Boards 3 and 4 are closed.
- The currently running Slurry Plant 11kV Boards are switched off.
- The currently running Ash Water Return (AWR) Plant 11kV Boards are switched off.

8.5.2 Findings

The following areas of concern are highlighted as findings (see corresponding Power Factory simulation drawings in Appendix C):

Table 6: Loading results with proposed new 55MVA unit transformer with loads

Equipment	Size	Loading (MW/MVA)	Current drawn (A)	Board voltage (kV)	% of rating of element
Unit trfr 4A	55MVA	56.10MVA	3100	0.95	**102.0%**
Proposed 11kV Unit Brd 4A Maint Isoltr	2500A	56.10MVA	3100	0.95	**124.0%**
Reactor 2	15MVA	20.14MW	1345A	0.91	**170.9%**
Reactor 2 incoming cable	6 x 500mm^2 single core	20.14MW	1345A	0.95	**116.5%**
Reactor 2 outgoing cables	6 x 500mm^2 single core	20.14MW	1345A	0.91	**116.5%**
11kV Station Brd 4	1250A	20.14MW	1345A	0.91	**107.6%**

For extrapolation purposes, it is worth noting that this scenario introduces an additional 8MVA loading on the Unit A Transformer compared to the Dry Ash Dam Concept presented in Section 8.5. Also, if the worst case scenario of bus section closing is used (as described in Section 8.2), an additional 6.85MVA will be required from the Unit A Transformer.

8.6 SCENARIO 5A: ASH DAM 1 – STATION TRANSFORMER USED TO SUPPLY ALL THE COMMON PLANT LOADS AND THE UNIT TRANSFORMERS SUPPLY UNIT AUXILIARIES. ASH DAM 1 (DRY CONCEPT) LOADS CONNECTED.

This scenario is investigated to determine the impact of the new Ash Dam, dry ash concept, on the Station Transformer.

8.6.1 Scenario Setup

This scenario is identical to Scenario 3 above, except for the following conditions:

- The feeder breakers to the Ash Dam (Dry Concept) loads, on 11kV Station Boards 3 and 4 are closed.
- The currently running Slurry Plant 11kV Boards are switched off.
- The currently running Ash Water Return (AWR) Plant 11kV Boards are switched off.

8.6.2 Findings

Areas of concern are not as severe as findings in previously presented scenarios. See Appendix C for scenario simulation results details.

8.7 SCENARIO 5B: ASH DAM 2 – STATION TRANSFORMER USED TO SUPPLY ALL THE COMMON PLANT LOADS AND THE UNIT TRANSFORMERS SUPPLY UNIT AUXILIARIES. ASH DAM 2 (WET CONCEPT) LOADS CONNECTED.

This scenario is investigated to determine the impact of the new Ash Dam, wet ash concept, on the Station Transformer.

8.7.1 Scenario Setup

This scenario is identical to Scenario 3 above, except for the following conditions:

- The feeder breakers to the Ash Dam (Wet Concept) loads, on 11kV Station Boards 3 and 4 are closed.
- The currently running Slurry Plant 11kV Boards are switched off.
- The currently running Ash Water Return (AWR) Plant 11kV Boards are switched off.

8.7.2 Findings

The following areas of concern are highlighted as findings (see corresponding Power Factory simulation drawings in Appendix C):

Table 7: Loading results with the current 40MVA station transformer with loads

Equipment	Size	Loading (MW/MVA)	Current drawn (A)	Board voltage (kV)	% rating of element
Station Trfr	40MVA	48.26MVA	2586	0.98	**120.7%**
132kV OHL	205A	40.42MW	226.9	1.00	**110.7%**
Station Trfr LV Cable	9 x 500mm^2 single cores	40.36MW	2587	0.98	**141.3%**
Reactor 2	15MVA	20.28MW	1311	0.94	**166.5%**
Reactor 2 incoming cable	6 x 500mm^2 single core	20.28MW	1311	0.98	**113.5%**
Reactor 2 outgoing cables	6 x 500mm^2 single core	20.28MW	1311	0.94	**113.5%**
11kV Station Brd 4	1250A	20.28MW	1311	0.94	**104.9%**

9. DISCUSSION OF FINDINGS AND REMEDIAL ACTIONS

This section identifies the areas that are directly affected by the FFP and DHP load additions and identifies the necessary remedial interventions and also the impact of these on existing components in the Kriel electrical reticulation.

As can be seen from the simulation results information presented in Section 8, the currently proposed 55MVA Unit Transformers on the A-side of the units do not meet the set criterion when supplying the worst case load requirements of the common plant and unit after addition of the proposed FFP retrofit and DHP upgrade project. However, the worst case scenario does not constitute a "continuous operation" scenario. The scenarios that are used for prolonged periods of time are Scenarios 1 and 3, and as can be seen from the findings, the proposed transformers of concern are adequate, apart from the under-voltage issues experienced.

Only interventions required to accommodate the worst cases for each project are recommended here. To accommodate the less severe case, recommendations can be extrapolated from the worst case scenario since loading for all scenarios, and their relationship with the worst case is know from the simulated results in Section 8.

Other finding, for which remedial interventions are assessed is with regard to scenarios 4 and 9; i.e. the incorporation of the New Ash Dam plant. For this even bigger station and unit transformers are required. This is assessed separately as it is not part of the FFP-DHP project, which is the primary intent of this study.

9.1 ACCOMODATING SCENARIO 2

To alleviate the overloading issues experienced as presented in Section 8, the following transformer tap positions have to be maintained:

- All Unit A Transformers – tap position 1.
- All Unit B Transformers – tap position 1.
- All 12.5MVA and 6.3MVA Service Transformers – tap position 2.
- 3.3kV FFP Compressor House Transformers 1 and 2 – tap position 2.
- 3.3kV Ash Compressor House Transformers 1 and 2 – tap position 2.
- 3.3kV Ash Conveyor Transformers 1 and 2 – tap position 2.
- All other LV transformers in the common plant where the per unit voltage is between 0.95 and 0.97 – tap position 2 or 1 where multiple motors are supplied.

Items that need to be upgraded to overcome the overloading challenges presented in Section 8, for these scenarios, are as follows:

- All Unit's A transformers should be replaced with a 55MVA Unit A transformer.
- The 11kV Station Board 1 and 2 reactors should be replaced with 30MVA reactors.
- The current rating of the new proposed 11kV Unit A Board Maintenance Isolator needs to be changed to 3150A.
- The incoming and outgoing reactor cables to and from the respective station boards should be replaced with 3x500mm^2, 11kV, single core cables (per phase). Meaning that one more should be added to the existing two.
- The 11kV Substation Board 3 and 4 incomer cable should be changed to 3x150mm^2 cables (per phase). Meaning that one is to be added to the existing two.

All overloading challenge are overcome once all the above mentioned interventions are implemented in the Power Factory model and re-simulated. See Appendix D for the detailed simulation results. A summary is presented in Table 13 below:

Table 8: Loading results with recommended new 55MVA unit transformer with loads

Equipment	Size	Loading	Current	Board	% rating of

		(MW/MVA)	drawn (A)	voltage (pu)	element
Unit trfr 4A	55MVA	54.08MVA	2879	0.99	98.33%
New 11kV Unit A Brd Maint Isolator	3150A	52.14MVA	2879	0.99	91.40%
Reactor 2	30MVA	19.16MW	1185	0.97	75.25%
Reactor 2 Cables	9 x 500mm^2 single cores	19.16MW	1185	0.97	63.38%
S/Stn Brd 4 Incmr Cable	3 x 150mm^2 3-cores	9.71MW	591.3	0.96	87.60%

For the voltages to be within acceptable levels, the tap position of the Unit A transformer needs to be set at 1, assuming a negative polarity tap changer.

The 35MVA Unit B Transformers are also reasonably close to their maximum capacity. Therefore, for the units where these transformers are 30MVA, these will need to be replaced with 35MVA transformers.

9.2 ACCOMODATING SCENARIO 4B

Items that need to be upgraded, additional to those identified for accommodating Scenario 2, to overcome the overloading challenges presented in Section 8 are as follows:

- All Units' A transformers should be replaced with a 63MVA Unit A transformers. This will also account for the additional 6.85MVA additional load requirements during bus section closing on the substation boards.
- The 11kV Station Boards 3 and 4 should be upgraded to 2000A Boards.

All overloading challenges, are overcome once all the above mentioned interventions are implemented in the Power Factory model and re-simulated. See Appendix D for the detailed simulation results. See summary in Table 14 below:

Table 9: Loading results with recommended new 63MVA Unit Transformer with loads

Equipment	Size	Loading (MW/MVA)	Current drawn (A)	Board voltage (kV)	% of rating of element
Unit trfr 4A	63MVA	55.94MVA	3002	0.96	88.79%
11kV Station Brd 4	2000A	20.37MW	1296	0.98	64.85%

9.3 ACCOMODATING SCENARIO 5B

Items that need to be upgraded, additional to those identified for accommodating Scenario 2, to overcome the overloading challenges presented in Section 8 are as follows:

- Station Transformer should be replaced with a 55MVA transformer. This will also account for the additional 6.85MVA additional load requirements during bus section closing on the substation boards.
- The Station Transformer overhead line should be replaced with a 250A line.

- The Station Transformer LV side cable should be replaced with 4x1000mm^2, 11kV single core cables (per phase).
- The 11kV Station Boards 3 and 4 should be upgraded to 2000A Boards.
- To keep the voltages at acceptable levels, the tap position of the recommended Station Transformer would have to be at position 6.

All overloading challenges, are overcome once all the above mentioned interventions are implemented in the Power Factory model and re-simulated. See Appendix D for the detailed simulation results. See summary in Table 15 below:

Table 10: Loading results with the current 40MVA station transformer with loads

Equipment	Size	Loading (MW/MVA)	Current drawn (A)	Board voltage (kV)	% rating of element
Station Trfr	55MVA	48.02MVA	2465	1.02	88.30%
132kV OHL	250A	40.96MW	222.1	1.00	88.87%
Station Trfr LV Cable	12 x 1000mm^2 single cores	40.89MW	2465	1.02	94.98%
11kV Station Brd 4	2000A	20.57MW	1249	1.00	62.40%

It should be noted that even though the Station Transformer LV cable is close to capacity, overloading is not expected as

10. SYSTEM FAULT STUDIES: SWITCHGEAR

Now that the required resizing of the Unit and Station Transformers, to accommodate the new loads, has been implemented, the fault level studies can be carried out for the network switchgear. This is done separately for when the Station Transformer is used and for when the Unit A Transformer is used (normal condition). This assessment is done for the worst cases of transformer sizes for the implementation of the investigated projects.

Only boards downstream of the upgraded transformers are assessed. New equipment fault rating is not assessed. This is to be sized according to the respective fault level at the point of connection in the network as described below. Again, Unit 4 (and associated downstream boards) is used as a reference for the assessments.

The requirements and philosophies set in Eskom's *Fault Current Calculations & Rating Switch-Gear Standard* (240-56227778) were applied in the fault level studies and recommendations thereof.

10.1 ACCOMODATING SCENARIO 2 – RECOMMENDED 55MVA UNIT A TRANSFORMER

A pre-fault voltage factor of 1.05 was used since the Kriel system under this scenario generally has slight under-voltages.

Table 11: Fault levels and withstand capabilities of different boards

Equipment	Size (*Steady-State; Peak*)	Ik (kA)	Ikss (kA)	Ip (kA)	Recommended New Size
Unit Board 4A	31.5kA;	22.7	36.5	95.9	**40kA; 100kA**

	78.75kA				
Service Board A	40kA; 100kA	22.2	32.7	85.9	
Service Board C	31.5kA; 78.75kA	13.3	21.0	52.5	
Station Board 2	31.5kA; 78.75kA	21.5	33.9	85.6	**40kA; 100kA**
Station Board 4	25kA; 62.5kA	13.8	21.3	55.2	
Substation Board 2	25kA; 62.5kA	13.4	20.7	50.6	
Substation Board 4	25kA; 62.5kA	13.4	20.7	50.6	
3.3kV FFP Comp House Brd 2	TBD	15.6	18.7	44.9	
3.3kV Ash Comp Brd 2	TBD	16.5	23.3	59.0	

10.2 ACCOMODATING SCENARIO 4B – RECOMMENDED 63MVA UNIT A TRANSFORMER

A pre-fault voltage factor of 1.05 was used since the Kriel system under this scenario generally has slight under-voltages.

Table 12: Fault levels and withstand capabilities of different boards

Equipment	Size (*Steady-State; Peak*)	Ik (kA)	Ikss (kA)	Ip (kA)	Recommended New Size
Unit Board 4A	31.5kA; 78.75kA	22.2	34.6	91.3	**40kA; 100kA**
Service Board A	40kA; 100kA	22.1	32	85.1	
Service Board C	31.5kA; 78.75kA	13.3	20.9	52.3	
Station Board 2	31.5kA; 78.75kA	21.0	32.1	81.1	**40kA; 100kA**
Station Board 4	25kA; 62.5kA	13.6	19.5	50.8	
Substation Board 2	25kA; 62.5kA	13.2	19.2	47.6	
Substation Board 4	25kA; 62.5kA	13.2	18.9	46.4	

3.3kV FFP Comp House Brd 2	TBD	15.8	19.3	44.9	
3.3kV Ash Comp Brd 2	TBD	16.7	22.7	57.6	

It should be noted that a 63MVA transformer with an impedance of 15% was used in the fault level simulation, to keep the fault levels to at acceptable values. A simulation with lower impedance 63MVA transformer can be done upon request.

10.3 ACCOMODATING SCENARIO 5B – RECOMMENDED 55MVA STATION TRANSFORMER

A pre-fault voltage factor of 1.1 was used as the voltage levels are more stable in this scenario.

Table 13: Fault levels and withstand capabilities of different boards

Equipment	Size (*Steady-State; Peak*)	Ik (kA)	Ikss (kA)	Ip (kA)	Recommended New Size (kA)
Station Board 1&2 Maint Isolator	31.5kA; 78.75kA	21.6	27.0	72.1	
Station Board 2	31.5kA; 78.75kA	21.6	27.0	72.0	
Station Board 4	25kA; 62.5kA	14.1	18.1	48.4	
Substation Board 2	25kA; 62.5kA	13.1	17.0	44.1	
Substation Board 4	25kA; 62.5kA	13.7	17.6	43.6	
3.3kV FFP Comp House Brd 2	TBD	16.5	19.6	46.1	
3.3kV Ash Comp Brd 2	TBD	17.5	22.1	49.8	

As can be seen from the results presented, the peak short circuit level of 11kV Unit Board 4A and 11kV Station Board 2 are higher than the peak short circuit ratings of the respective boards. In this case, the current short circuit ratings would not be adequate. The short circuit current ratings of the rest of the highlighted boards are suitable in the case that the Unit A Transformers and the Station Transformers are replaced as recommended.

It should also be considered not to introduce the proposed new 11kV Maintenance Isolators between the Unit A Transformers and 11kV Unit A Boards, if the Unit A boards will be replaced in any case to accommodate the high fault level. The new Unit A Boards can be specified to accommodate the required new load requirements as well as new fault level.

11. SYSTEM FAULT STUDIES: CABLES

The high loading has already required quite big cables to be installed; hence the fault current with-stand rating of the upstream switchgear is quite high. It is appreciated that 300ms might sound short but all back-up type protection should clear a fault with-in this time and then no damage should occur on the entire length of any cable. The rating of cable(s) at risk was assessed based on this. The smallest cable that can withstand the biggest proposed transformer (63MVA) short circuit is calculated to be:

$$A = \frac{I_{SC}\sqrt{t}}{K} = \frac{(22.2kA)\sqrt{0.3}}{115} = 105mm^2$$

This is on the 11kV network. From a high level assessment, no cable is smaller that this on the 11kV network of the Unit Boards, Station Boards and Substation Boards. Cables at lower voltage levels generally have higher current ratings, implying bigger cross sectional areas and thus higher fault ratings, at reduced fault levels. Therefore is can be concluded that cables are adequate for the fault currents experienced under the assigned recommendations.

12. MOTOR START UP STUDY

Now that all recommendations have been made, it is necessary to assess whether the biggest motor on the Unit Boards is still able to start with the additional load, when supplied from the smallest recommended transformers. The method used to assess this is to check that the supply board voltage will not drop to a level that will reduce the motor toque below its breakaway toque. This assessment was done for the EFP Motors on the 11kV Boards 4A and 4B, which are to be supplied from a 55MVA and 35MVA transformer respectively. The following formulae were used:

$$\%\,Volt\ Drop\ During\ Starting = \frac{Motor\ Starting\ MVA}{Motor\ Starting\ MVA + Transformer\ Short\ Circuit\ MVA}$$ [6]

$$Expected\ Voltage\ \%\ During\ Startup = Board\ Voltage\ Under\ Normal\ Conditions - \%\,Volt\ Drop\ During\ Starting$$

The criterion set was that the expected per unit voltage during starting should not be less than 75%. This aligns with the requirements of the Eskom motor and under-voltage protection standards and also gives allowance for 5% cable voltage drop. Table 14 below shows the inputs used to calculate the expected voltage during the start-up of the EFP motors on 11kV Unit Boards 4A and 11kV Unit Boards 4B. the results obtained from the calculations are shown as well.

Table 14: Motor start-up voltage calculation

Kriel EFP Motor on Unit B Transformer			Kriel EFP Motor on Unit A Transformer	
Transformer MVA	3.50E+07		Transformer MVA	5.50E+07
Transformer %Z	10.04		Transformer %Z	12.6
Transformer SC MVA	3.49E+08		Transformer SC MVA	4.37E+08
Motor Power	1.00E+07		Motor Power	1.00E+07
Starting Factor	6		Starting Factor	6
Motor pf	0.933		Motor pf	0.933
Motor Start MVA	6.43E+07		Motor Start MVA	6.43E+07
% Volt Drop on Unit Brd	15.57		% Volt Drop on Unit Brd	12.84

System Voltage %	101		System Voltage %	99
Starting System Voltage %	**85.43**		**Starting System Voltage %**	**86.16**

As can be seen from Table 14 above, the system voltage drops to 86.16% on 11kV Unit Boards 4A and to 85.43% on 11kV Unit Boards 4B. These values are both within the set criterion, therefore it can be concluded that the EFP motors will still be able to start with the new proposed transformer size and additional loads.

13. OTHER SYSTEM STUDIES WORK TO BE CONDUCTED

In order to obtain a full and reliable assessment of the adequacy of the proposed electrical reticulation network changes with regard to load flow and fault studies investigation, the following is to be done prior to the finalisation of the basic design for the different projects:

- The transformer modelling needs to be relooked at. Currently, the models indicate losses which are in the range of 2MW and above. This will however, not affect the loading requirements of the new plants. What is reflected in the equipment loading is what the plants will be absorbing.
- The feasibility of the proposed cable sizes with regard to cable routing space and switchgear termination should be assessed by the different project LDEs.
- It should be ensured that the same simulations are run again once all actual plant information (ratings, impedances, etc.), for the new plant equipment proposed has been incorporated into the model.
- The feasibility of specifying high impedance Unit A Transformers in order to avoid high fault levels and hence avoiding the replacement/upgrade of the 11kV Unit A Boards and 11kV Station Boards 1 and 2. This would require a cost benefit analysis.

14. CONCLUSION

The load flow investigation has been carried out for 7 possible operating scenarios of the Kriel Power Station electrical reticulation. These scenarios encompass the FFP, DHP and New Ash Dam projects. From this load flow investigation, it has been determined that the currently proposed 55MVA Unit A Transformer will be adequate to support the new load requirements of the proposed FFP retrofit and DHP upgrade. If these plant modifications are to be accommodated, the Unit A Transformers will need to be replaced with 55MVA transformers and the Unit A Boards will also need to be replaced with or upgraded 2500A, 40kA switchgear. This will cater for the load and fault level requirements as presented in this document.

The higher fault levels introduced by recommended bigger Unit A Transformers make it necessary for the 11kV Station Boards 1 and 2 to be replaced as well. These higher fault levels also alleviate the need for the proposed new maintenance isolator on the units.

Other interventions which are required in order to accommodate these changes have been identified and highlighted in this document. i.e. replacement/upgrading of boards, cables, reactors, etc. these will be necessary to accommodate the new loading as presented in the different scenarios.

Four more scenarios are looked at to assess the impact of integrating a new Ash Dam plant into the Kriel Power Station electrical reticulation network, after the FFP and DHP have been implemented. These were selected to mainly assess the impact on the Station Transformer and the Unit Transformers. An assessment of any additional interventions required to be implement specifically was done.

A fault study was conducted on the recommended transformer and cable changes to check the effect on boards and cables. This revealed that the fault rating of all Unit A Boards, Station Board 1 and Station Board 2 needs to be higher due to high peak fault currents existing in the recommended new reticulation system.

The motor start-up study that was conducted with the EFP motor on the 11kV Unit Boards revealed that the EFP motors (biggest) will be able to successfully start.

15. RECOMMENDATIONS

It is recommended that all the interventions identified for accommodating Scenario 2, be implemented if the FFP retrofit and DHP upgrade projects are to be catered for. Other interventions for accommodating the other projects discussed should be implemented once direction is given on the these project

The FFP and DHP electrical equipment loading is shown in the simulations presented in Appendix C. The FFP and DHP LDEs should use these to check the sizing of their equipment and confirm alignment of values used.

It is worth noting that in the scenario for separate supplies (Scenario 3), no upgrades or changes need to be done on the Units' electrical reticulation. It is understood that Kriel Power Station is not in favour of this for normal operation as it is more costly than then supplying the common plant from the Units; however this will alleviate the need to replace newly replaced equipment. Another standby Station Transformer would however be required in order to maintain the redundancy. It is recommended that the project LDEs consider presenting this option to the Station once the basic design has been completed and the cost thereof assigned.

Other system studies activities as highlighted in this document may be conducted to enhance the reliability and recommendations of the study presented in this document.

16. LIST OF APPLICABLE DRAWINGS

Drawing Number	Drawing Description
0.45/26	Kriel Power Station Layout Drawing
0.45/53930	Unit 1-6 Single Line Diagrams
0.45/198	Station Single Line Diagrams

17. AUTHORIZATION

This document has been seen and accepted by:

Name	Designation
Vonani Mathebula	GTE Chief Electrical Engineer
Busi Green	GTE Electrical LDE – New Ash Dam Project

Name	Designation
Lungile Malaza	GTE Electrical Design Application CoE Manager
Winston Seima	GTE Senior Electrical Technologist Engineer
Sanele Ndlovu	GTE Electrical LDE – Kriel FFP Retrofit Project
Ajay Nandakumar	GTE Electrical LDE – Kriel DHP Upgrade Project
Euveshen Govender	GTE Electrical Engineer – Kriel Power Station

18. REVISIONS

Date	Rev.	Compiler	Remarks
November 2014	0	SF Miya	First draft, for review
February 2015	0.1	SF Miya	Final report, after incorporation of review comments
August 2015	0.2	SF Miya	Final report, after addition of Ash Dam Project
September 2015	1	SF Miya	Final report for publishing
February 2016	1.1	SF Miya	Revised report after updated designs received.
February 2016	2	SF Miya	Revised report after incorporating comments from the review panel.

19. DEVELOPMENT TEAM

The following people were involved in the development of this document:

- Sicelo Miya

20. ACKNOWLEDGEMENTS

Much appreciation goes out to the following individuals for all their help in the investigation done:

- Winston Seima
- Euveshen Govender
- Sihle Mbatha
- Vonani Mathebula

- Johann Jordan

APPENDIX A – KRIEL POWER STATION POWERFACTORY MODEL REVISION RECORD

APPENDIX B – DUST HANDLING PLANT (DHP) EQUIPMENT SIZING INFORMATION

APPENDIX C – DIGSILENT POWER FACTORY SIMULATION RESULTS: FINDINGS

APPENDIX D – DIGSILENT POWER FACTORY SIMULATION RESULTS: RECOMMENDATIONS

APPENDIX E – NEW ASH DAM PLANT LOAD LISTS

REVISION RECORD SHEET

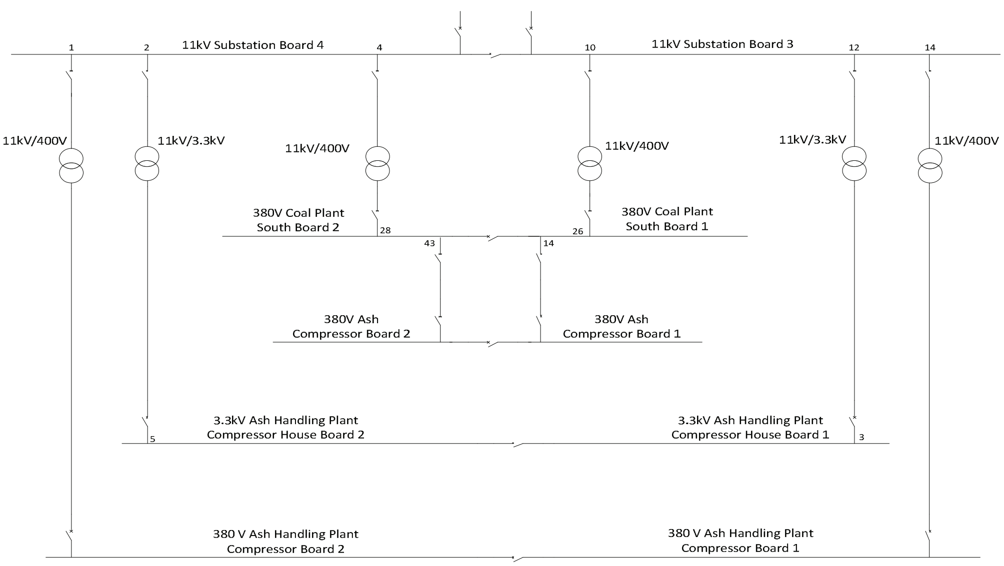
Rev	Date	File Name	Done / Revised By	Checked by PTM / GBE	Comments	Digsilent Version
0	2012/12/04	Kriel 2012_12_04.pfd	Okusha Engineering		First Issue	V14.1.4
0	2014/02/26	Kriel 2014-02-26 15h17	Johann Jordan & Paul Ruthenberg		Model that Paul Ruthenberg had been working on and updating. Not related/linked to the Okusha Engineering model reflected above.	V13.2
					1. Increased Unit Transformer A from 35MVA to 45MVA on unit 4 and unit 1.	
					2. Included Maintenance Isolator between Unit Transformer A and 11kV Unit Board A on unit 4 and unit 1.	
					3. Added an 500kVA 3.3/0.4kV FFP Transformer to service boards A and B on unit 4 and unit 1 (for study purposes).	
					4. Changed Unit Trfr 1B from a 30MVA to a 35MVA.	
					5. Changed Unit Trfr 2B from a 35MVA to a 30MVA.	
					6. Changed 3.3kV Ash Handling Compressor Trfrs 1&2 from a 5MVA to a 10MVA.	
					7. Changed 400V Ash Handling Compressor Trfrs 1&2 from a 315kVA to a 800kVA.	
					8. Added the 400V Ash Handling Plant Blower Trfrs 1&2 on s/s BD 4&3 respectively. 1.6MVA transformers used.	
					9. Increased length of all DHP plant cables by adding 10m.	

1		Kriel 2015-03-03 18h00_v15	Sicelo Miya		10. Changed all the cables of the DHP reticulation as sized in the load schedules supplied. 11. Old DHP compressors on the, 33KV ASH HANDLING PLANT COMPRESSOR HOUSE BOARDS, removed and 5 new ones added as per the load schedules supplied. These are modelled the same as the FFP compressors. 12. Made all the contactor's yard loadings be to 90%, as per the study done. 13. Added the new 11kV ID fans on the 11kV Unit Boards 1A and 1B 14. Added FGD Loads on the Service Boards and Station Boards 1 and 2 as per the design submitted. 15. Added a bus-coupler breaker between Substation Board 3 and 4. 16. Added a blower transformer (1.25MVA) and an LV board to accommodate the Unit 1-3 blower loads. Added on 11kV Substation BD 2. 17. Added DHP LV loads on the FFP common plant 400V FFP Compressor Boards 1 and 2, as proposed. 18. Added Lumped Loads for the New Ash Dam Concepts under diferent scenarios	V15.01
2		Kriel 2016-01-29 18h00_v15	Sicelo Miya		1. Changed the lumped loads on the 400V FFP Boards A and B to 68kW each as per the mechanical load supplied. 2. Changed the lumped FFP loads on the 400V FFP Compressor Boards A and B to 162kW each as per the mechanical load supplied. 3. Changed the ID fan motor size and characteristics to those of an 8MW, 11kV motor	V15.01

					4. Removed all FGD Loads	
					4. Updated the New Ash Dam lumped loads as per the revised load list and new operating and control philosophy.	
3		Kriel 2016-02-03 18h15_v15_Rec	Sicelo Miya		Refer to Kriel FFP-DHP System Studies Report 377-PRJ-1-DBBZ4-AS0000-1 (Revision 2) for all recommendations implemented on this model. Please note that these serve as recommendations to the project LDE only and is not indicative of proposed designs for implementation.	V15.01

APPENDIX B – DUST HANDLING PLANT EQUIPMENT SIZING INFORMATION

Existing:



New:

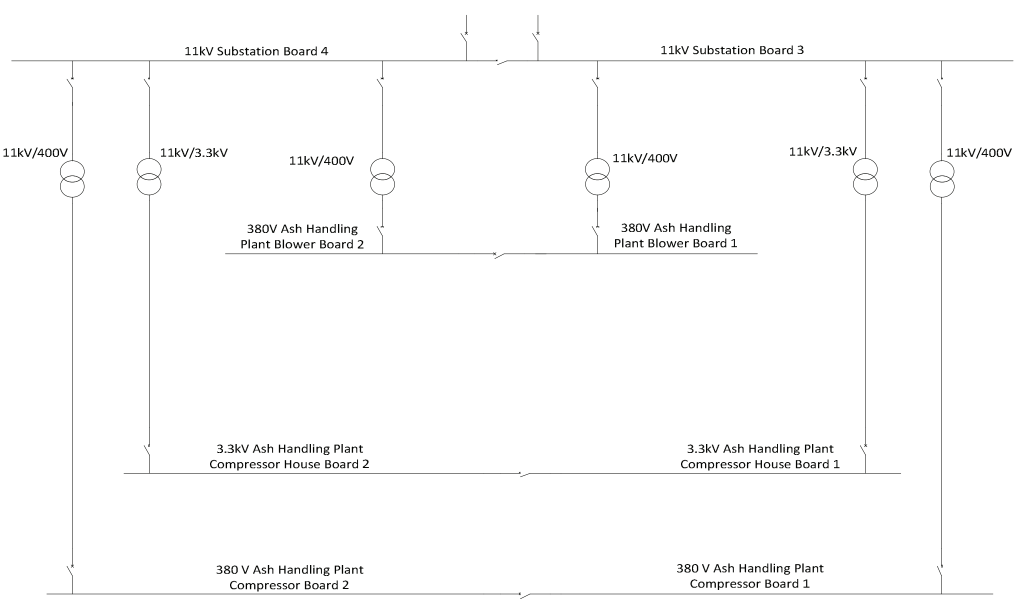


Table of Major Equipment Ratings

	Units	Existing	Existing Rated	New	New Rated
Loading on 11kV Substation Board 4	A	483.55 Worst Case	1250	840.6 Worst Case	1250
Loading on 11kV Substation Board 3	A	488.83 Worst Case	1250	845.9 Worst Case	1250
Fault Rating	kA	25	25	25	25
Loading on 3.3kV Ash Handling Plant Compressor House Board 2	A	New		544.1 Operating	2000
Loading on 3.3kV Ash Handling Plant Compressor House Board 1	A	New		608.9 Operating	2000
Bus Coupler Closed	A			1738.9 Worst Case While starting the largest motor	2000
Fault Rating	kA			20.28	25
Rating of TRFR feeding 3.3kV Ash Handling Plant Compressor House Board 2	kV kVA	New		11/3.3 10000	
Rating of TRFR feeding 3.3kV Ash Handling Plant Compressor House Board 1	kV kVA	New		11/3.3 10000	
Cable Size on Primary Side of TRFR	mm^2 Quantity	New		50 9	
Cable Size on Secondary Side of TRFR	mm^2 Quantity	New		400 9	
Loading on 380V Ash Handling Plant Compressor Board 2	A	New Board		304 Operating	1250
Loading on 380V Ash Handling Plant Compressor Board 1	A	New Board		385.4 Operating	1250
Bus Coupler Closed	A			952.4 Worst Case While starting the largest motor	1250
Fault Rating	kA			21.51	25
Rating of TRFR feeding 380V Ash Handling Plant Compressor Board 2	kV kVA	New		11/0.4 800	
Rating of TRFR feeding 380V Ash Handling Plant	kV kVA	New		11/0.4 800	

Compressor Board 1					
Cable Size on Primary Side of TRFR	mm^2 Quantity	New		150 1	
Cable Size on Secondary Side of TRFR	mm^2 Quantity	New		240 9	
Loading on 380V Ash Handling Plant Blower Board 2	A	New Board		815.1 Operating	2500
Loading on 380V Ash Handling Plant Blower Board 1	A			913.4 Operating	2500
Bus Coupler Closed	A			2191.1 Worst Case	2500
Fault Rating	kA			35.33	50
Rating of TRFR feeding 380V Ash Handling Plant Blower Board 2	kV kVA			11/0.4 1600	
Rating of TRFR feeding 380V Ash Handling Plant Blower Board 1	kV kVA			11/0.4 1600	
Cable Size on Primary Side of TRFR	mm^2 Quantity			150 1	
Cable Size on Secondary Side of TRFR	mm^2 Quantity			240 18	

Table 2 : Common Plant Electrical Requirements

Equipment	Motor Power (kW)	Quantity
Common DHP Compressor House		
Conveying Air Compressor	800 kW (to supply 675kW absorbed power)	8 (6 in service and 2 on standby)
Assumed Service Air Compressor	510	2 (1 new)
Conveying Air Compressor Cooling Pump	11	8 (6 in service and 1 on standby)
Conveying Air Compressor Cooling Tower Fan	25	3 (2 in service and 1 on standby)
Service Air Compressor Cooling Pump	7.5	2 (1 in service and 1 on standby)
Conveying Air Compressor Cooling Tower Pump	3	3 (2 n service and 1 on standby)

Comment [KN1]: 1 in service, 1 on standby

Air Driers	1	12 (11 new)
Pressurisation Fan	10	4
Pressurisation Fan Damper	4	1
Proposed raw water supply pump	55	2 (1 in service and 1 on standby)
Main Ash Silo		
Ash Bunker Vent Filter Fans	37	6
Units 1 to 3 and 4 to 6 Blower Rooms		
Hopper Aeration Air Blower Units 1 to 3	75	4 (1 per unit and 1 on standby)
Hopper Aeration Air Blower Units 1 to 3 Heaters	30	3 (1 per unit)
Hopper Aeration Air Blower Units 4 to 6	90	4(1 per unit and 1 on standby)
Hopper Aeration Air Blower Units 4 to 6 Heaters	45	3 (1per unit)
Pressurisation Fan	3	2
Pressurising fan damper	2	1
Main Silo Aeration Blowers		
Silo Aeration Air Blower	110	8 (6 in service and 2 on standby)
Pressurisation Fan	5	4
Pressurising fan damper	5	1
Instrument Air Compressor	200	2 (1 in service and 1 on standby)

Comment [KN2]: 8 in service, 4 on standby.

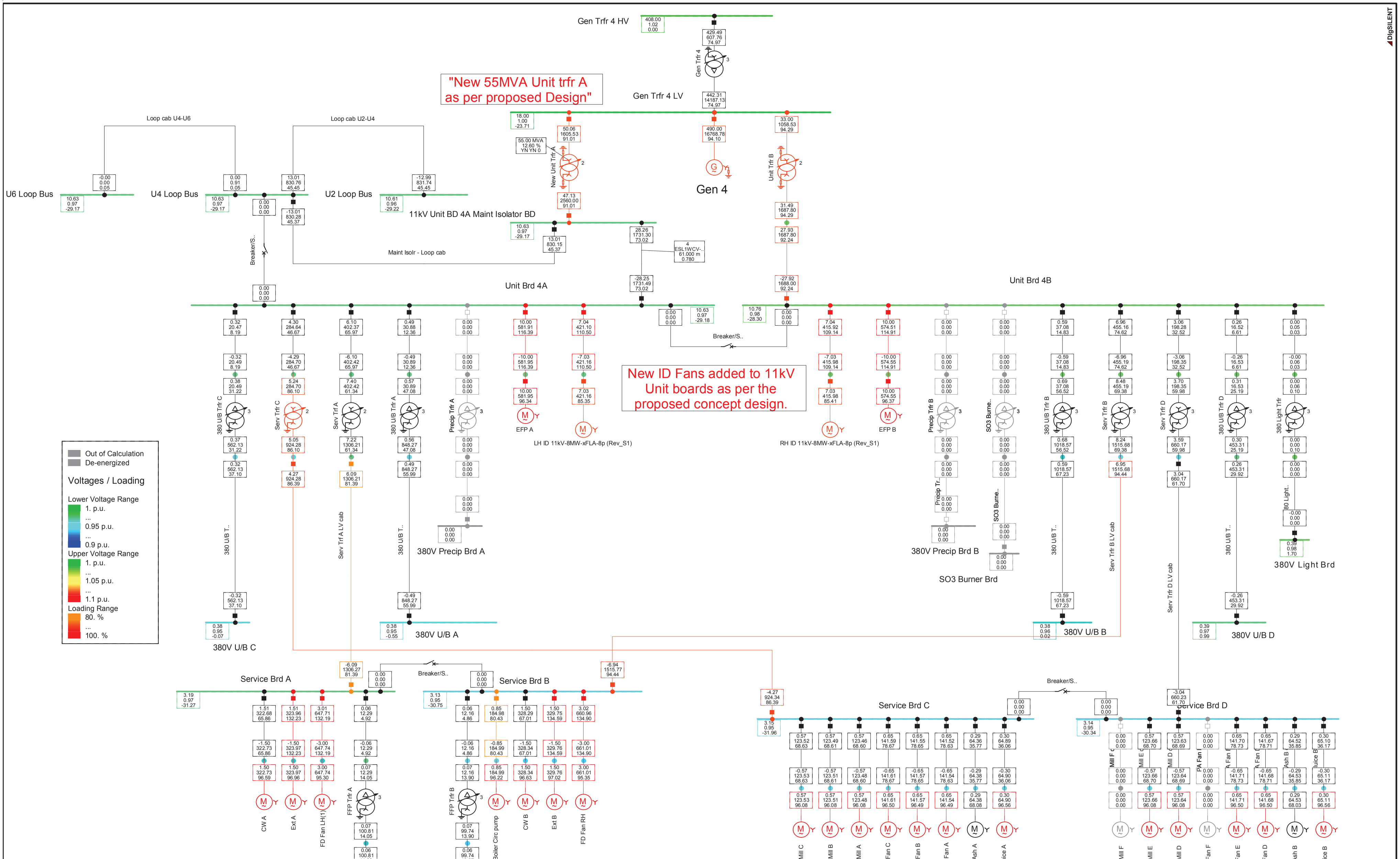
Comment [KN3]: Situated in the FFP compressor house

Comment [KN4]: Situated in the FFP compressor house

APPENDIX C – DIGSILENT SIMULATION RESULTS DRAWINGS: KRIEL POWER STATION SYSTEM STUDIES

This Appendix presents the simulation results for all the scenarios discussed in the main document. The main document is to be used in conjunction with this Appendix.

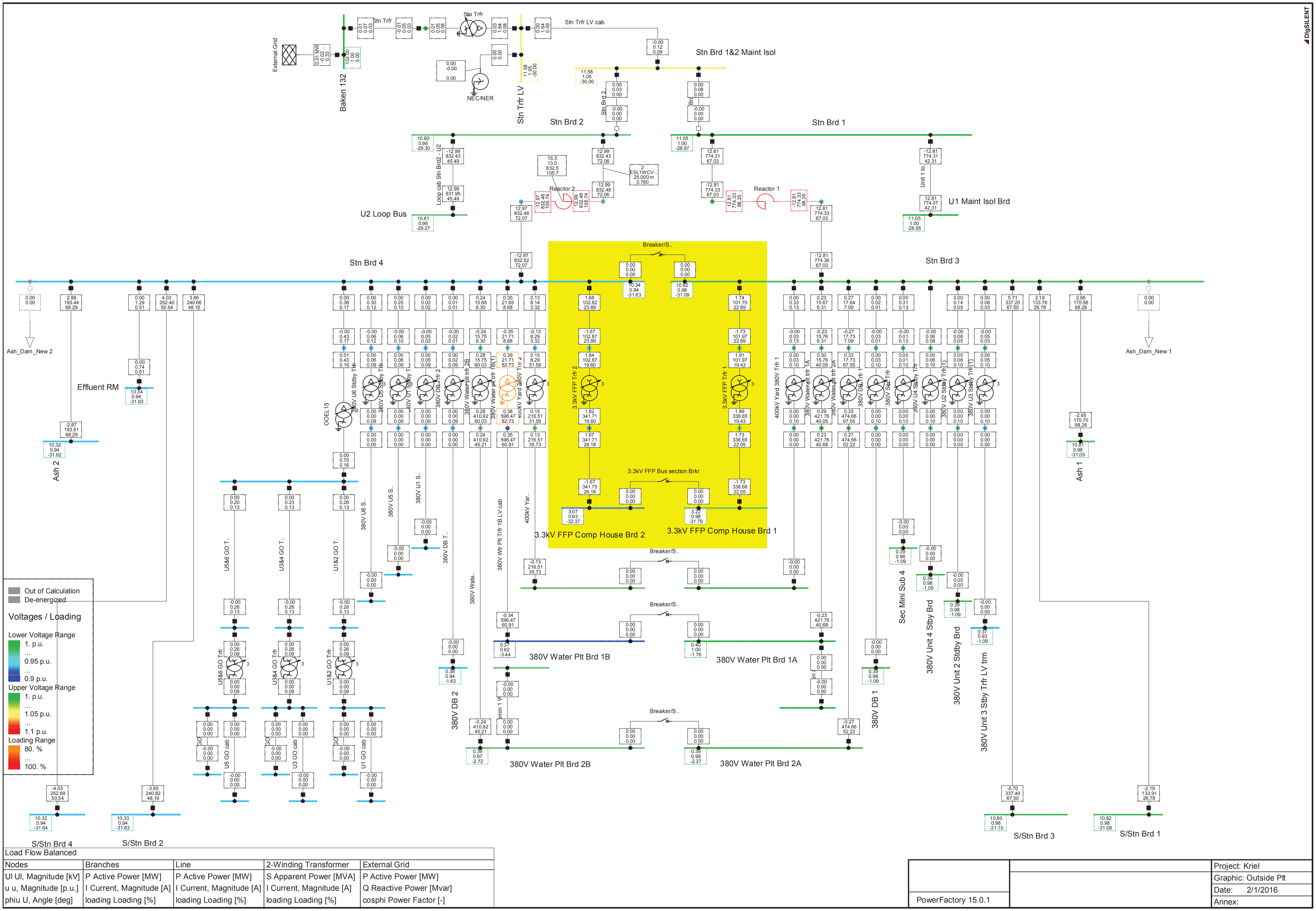
C1. SCENARIO 1: UNITS RUNNING AT FULL LOAD AND SUPPLYING HALF OF THE COMMON PLANT (UNIT 4).



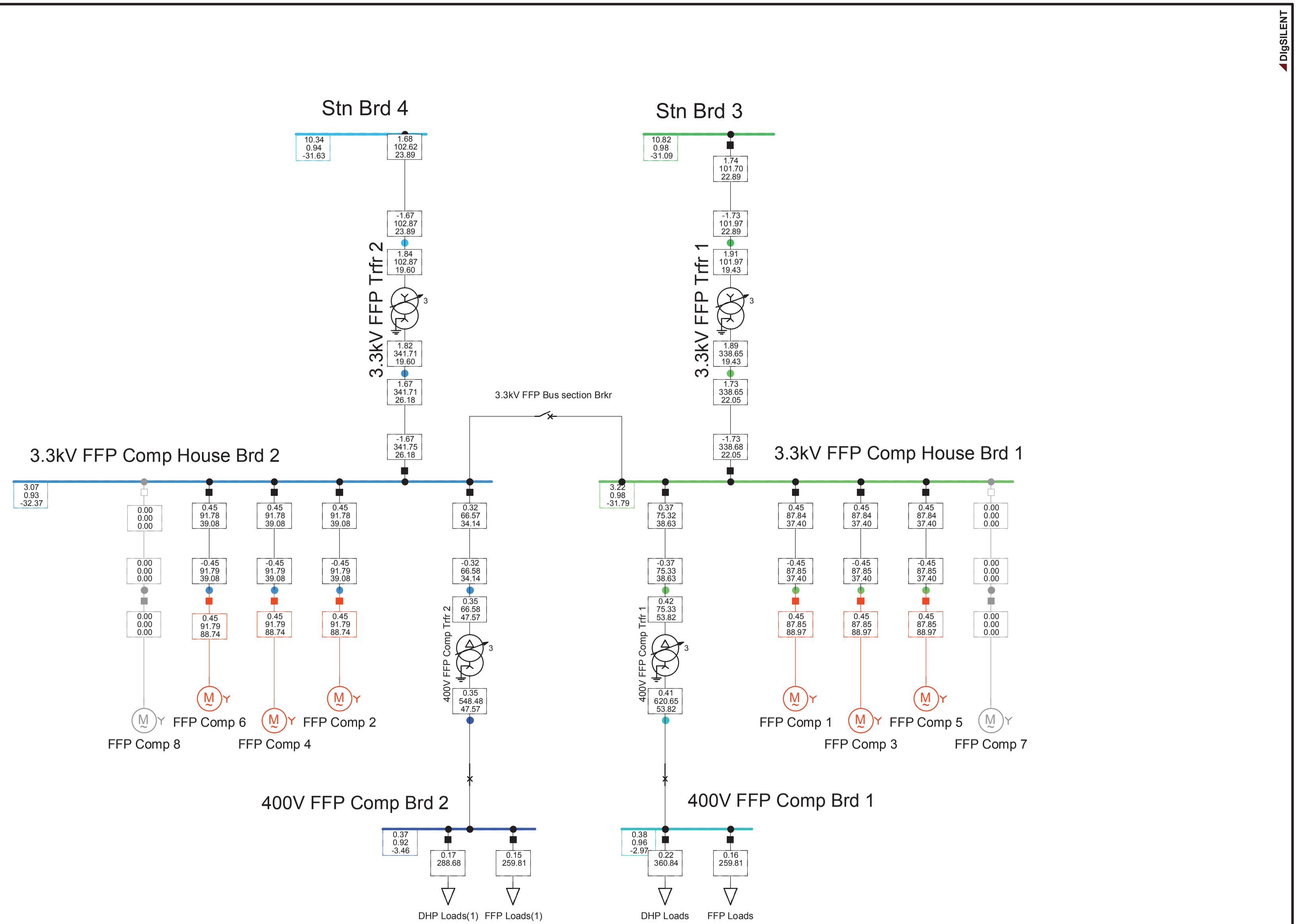
Load Flow Balanced					
Nodes	Branches	Asynchronous Machine	Line	General Load	2-Windi
Ul [kV]	P [MW]	P [MW]	P [MW]	P [MW]	S [MVA]
u [p.u.]	I [A]	I [A]	I [A]	Q [Mvar]	I [A]
phiu [deg]	loading [%]	loading [%]	loading [%]	[-]	loading
				I [A]	

		Project: Kriel
		Graphic: Unit4
		Date: 2/1/2016
PowerFactory 15.0.1		Annex:

C2. SCENARIO 1: UNITS RUNNING AT FULL LOAD AND SUPPLYING HALF OF THE COMMON PLANT (STATION BOARDS).



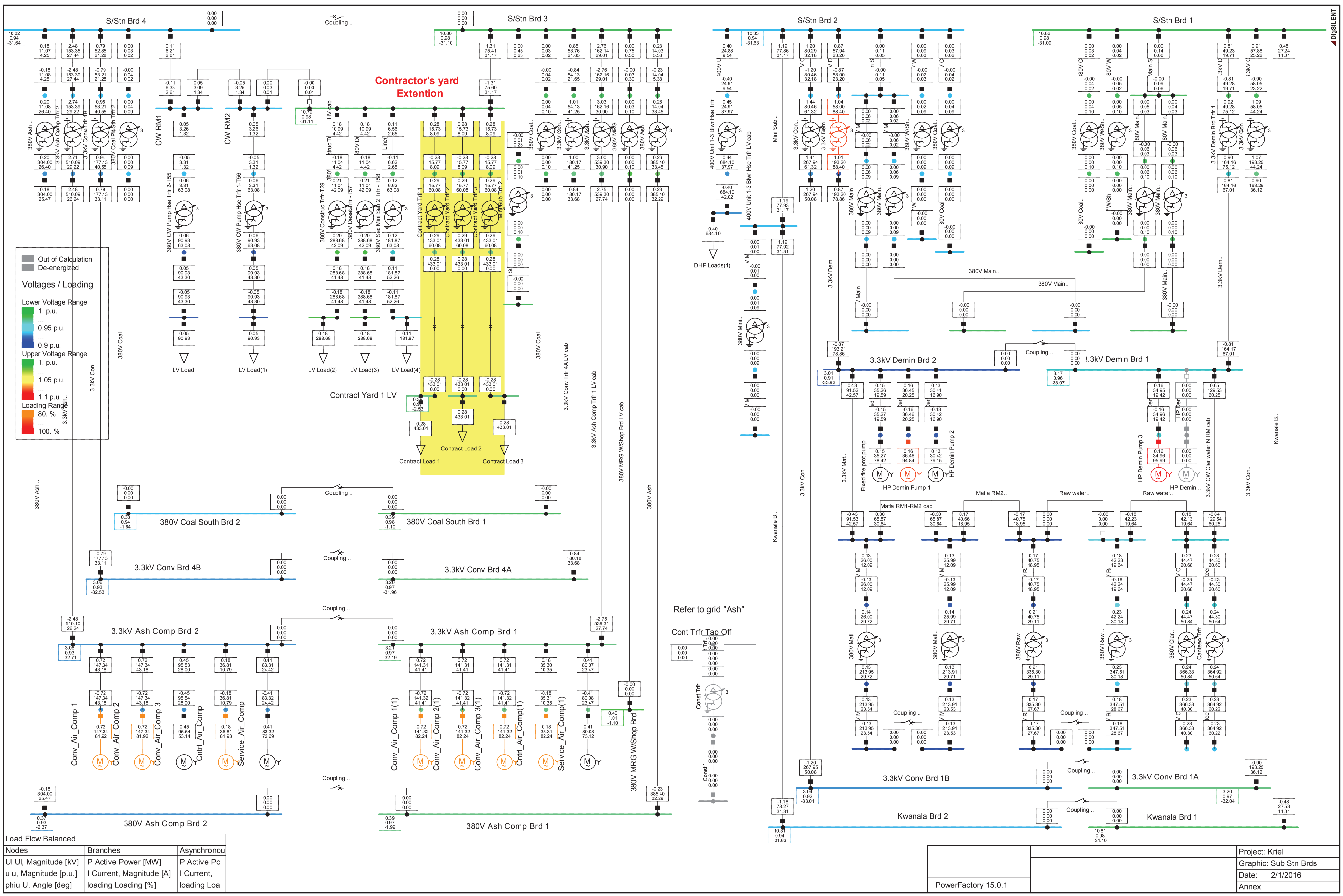
C3. SCENARIO 1: UNITS RUNNING AT FULL LOAD AND SUPPLYING HALF OF THE COMMON PLANT (FFP BOARDS).



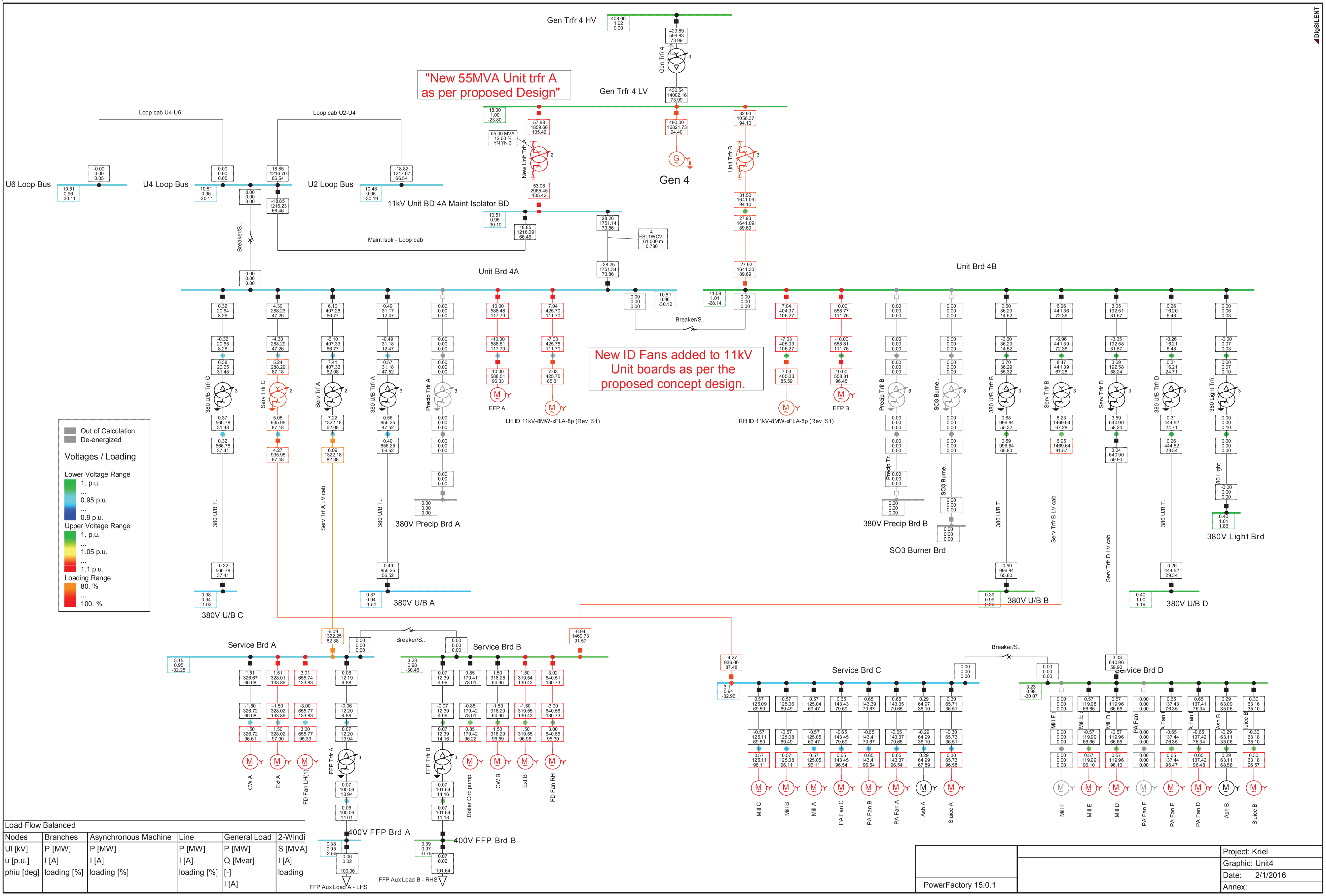
Load Flow Balanced				
Nodes	Branches	Asynchronous Machine	Line	2-Winding Transformer
Ul [kV]	P [MW]	P [MW]	P [MW]	S [MVA]
u [p.u.]	I [A]	I [A]	I [A]	I [A]
phiu [deg]	loading [%]	loading [%]	loading [%]	loading [%]

		Project: Kriel FFP
		Graphic: FFP Comp Plant
		Date: 2/1/2016
PowerFactory 15.0.1		Annex:

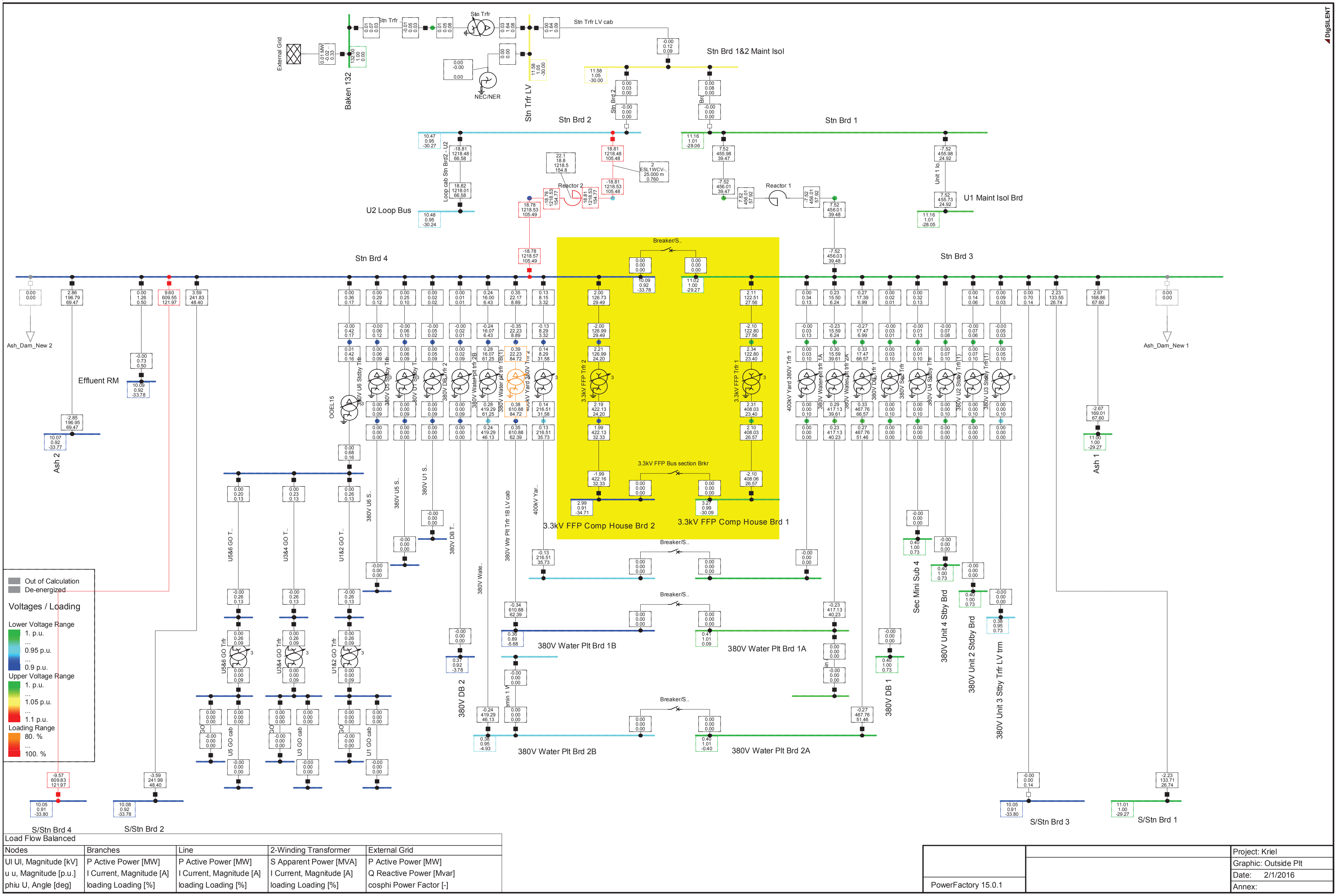
C4. SCENARIO 1: UNITS RUNNING AT FULL LOAD AND SUPPLYING HALF OF THE COMMON PLANT (DHP BOARDS).



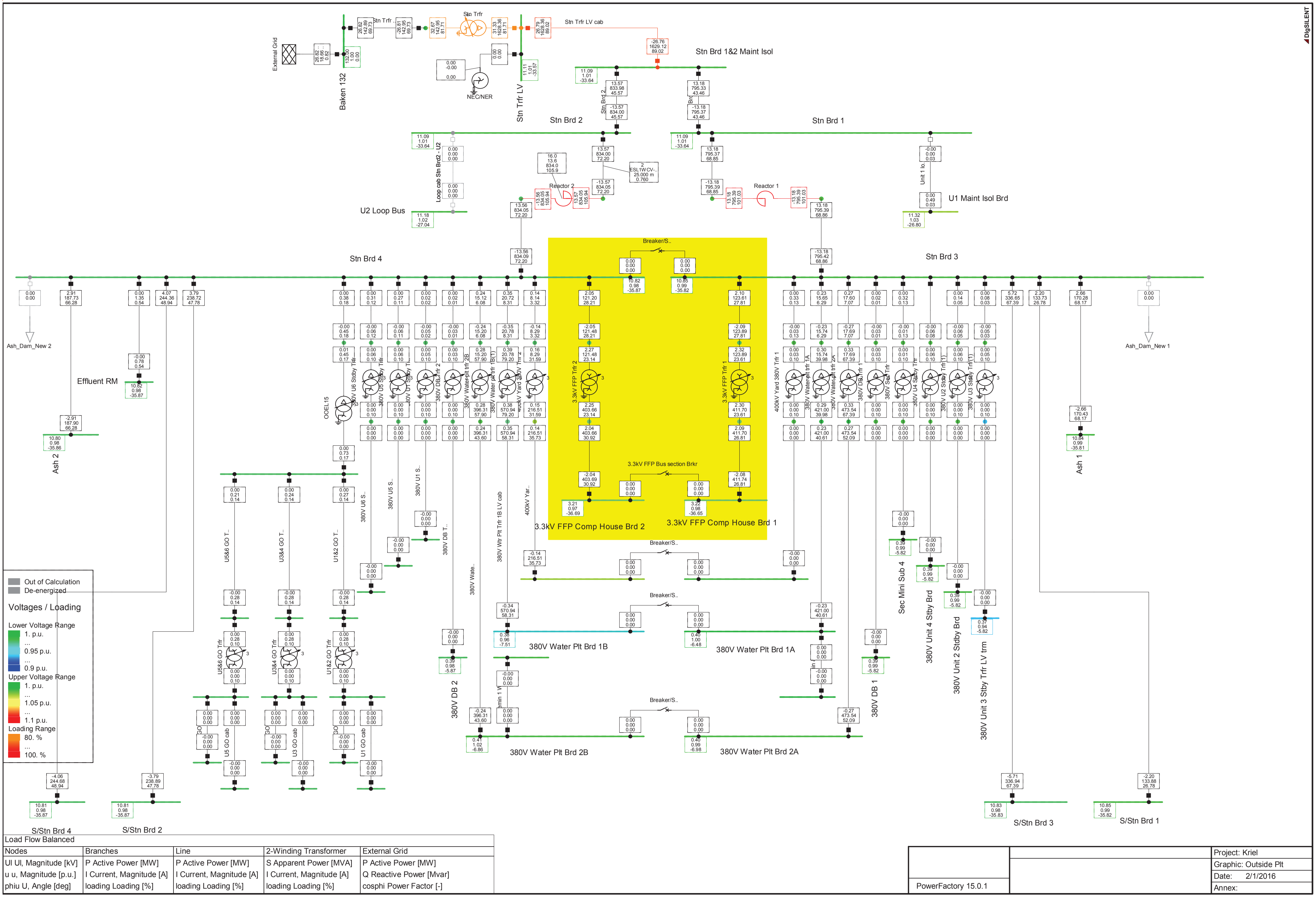
C5. SCENARIO 2: UNITS RUNNING AT FULL LOAD AND SUPPLYING THE COMMON PLANT, WITH THE 11KV SUBSTATION BOARDS 3 & 4 CONNECTED (UNIT 4).



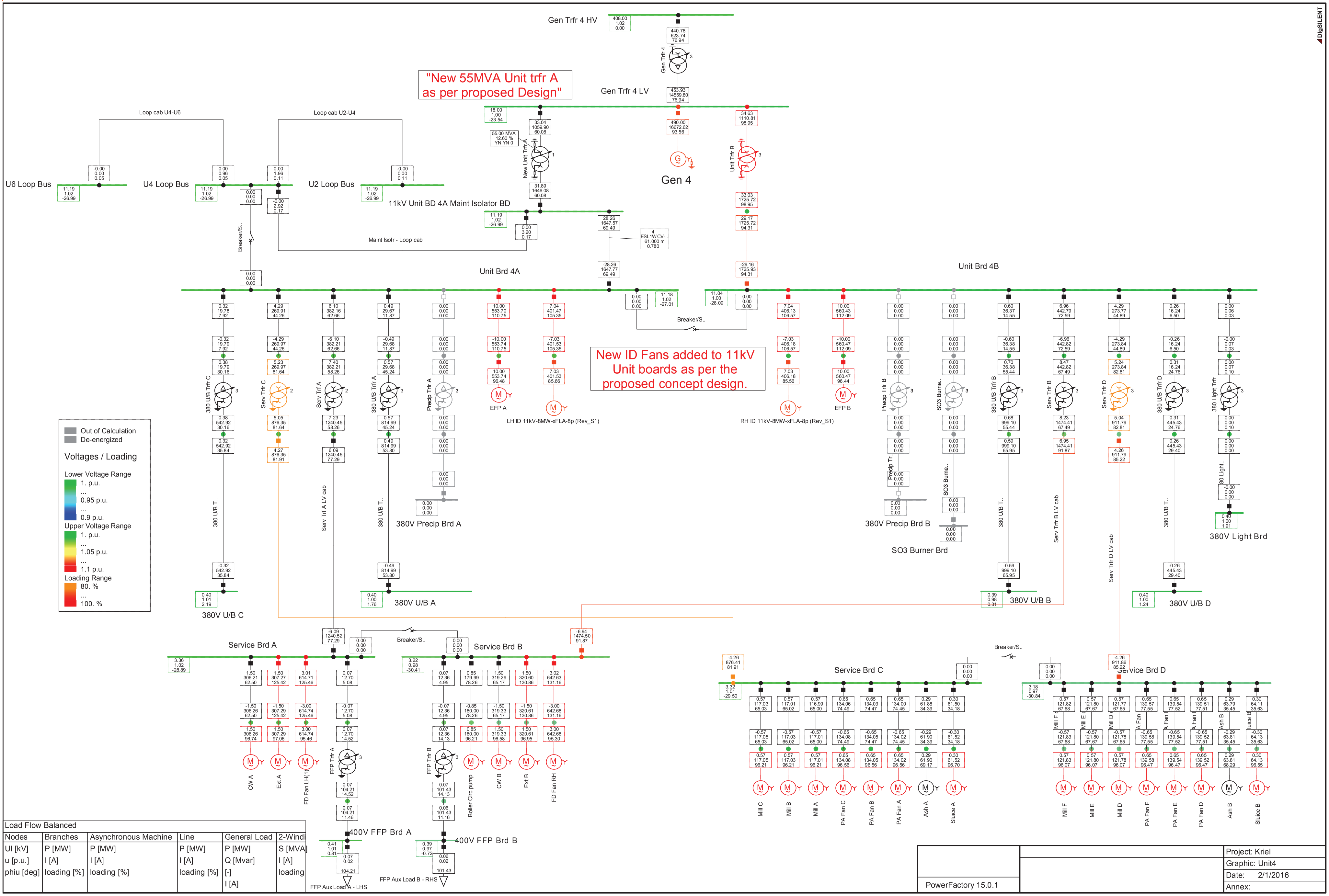
C1. SCENARIO 2: UNITS RUNNING AT FULL LOAD AND SUPPLYING THE COMMON PLANT, WITH THE 11KV SUBSTATION BOARDS 3 & 4 CONNECTED (STATION BOARDS).



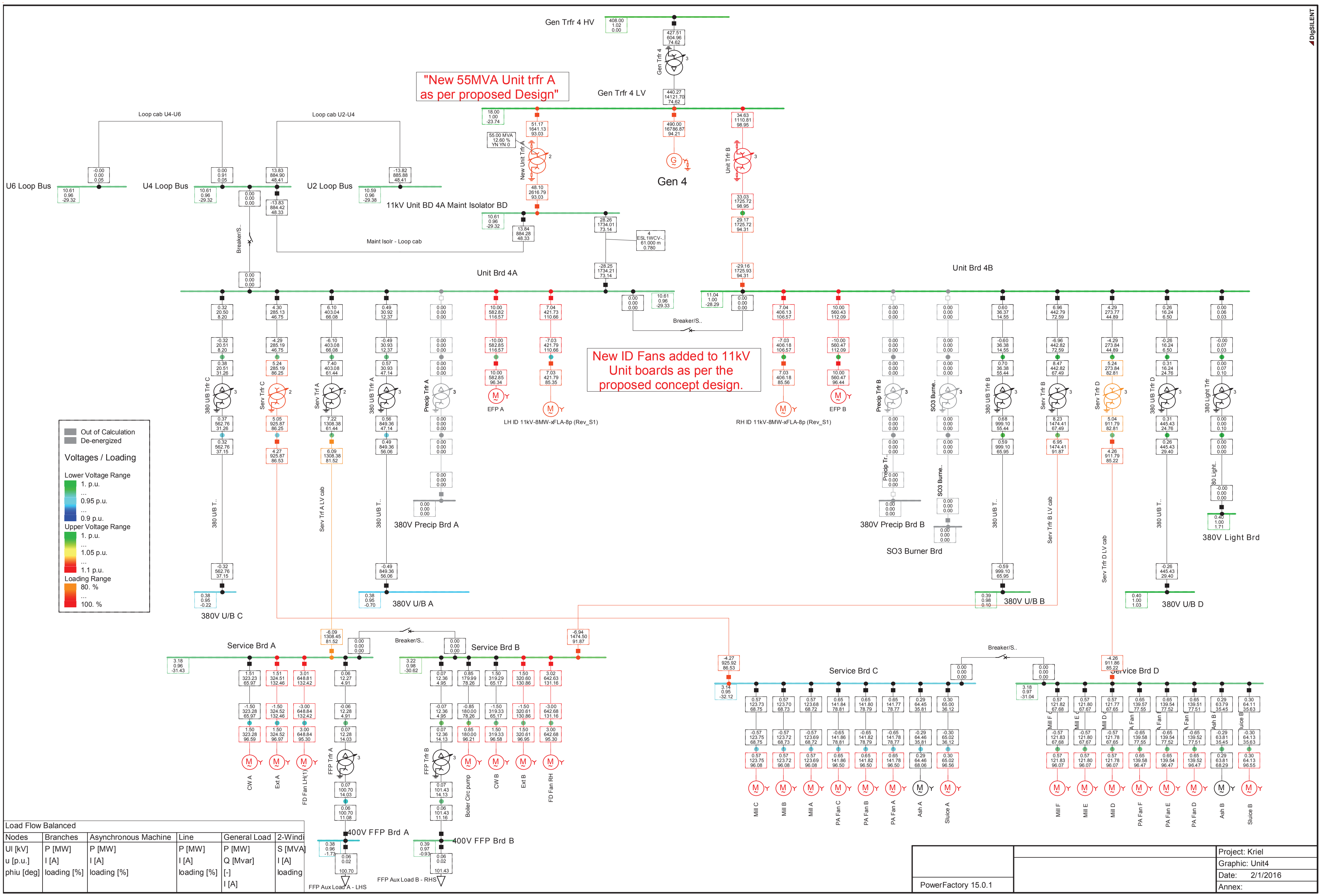
C2. SCENARIO 3: STATION TRANSFORMER USED TO SUPPLY ALL THE COMMON PLANT LOADS AND THE UNIT TRANSFORMERS SUPPLY UNIT AUXILIARIES (STATION BOARDS).



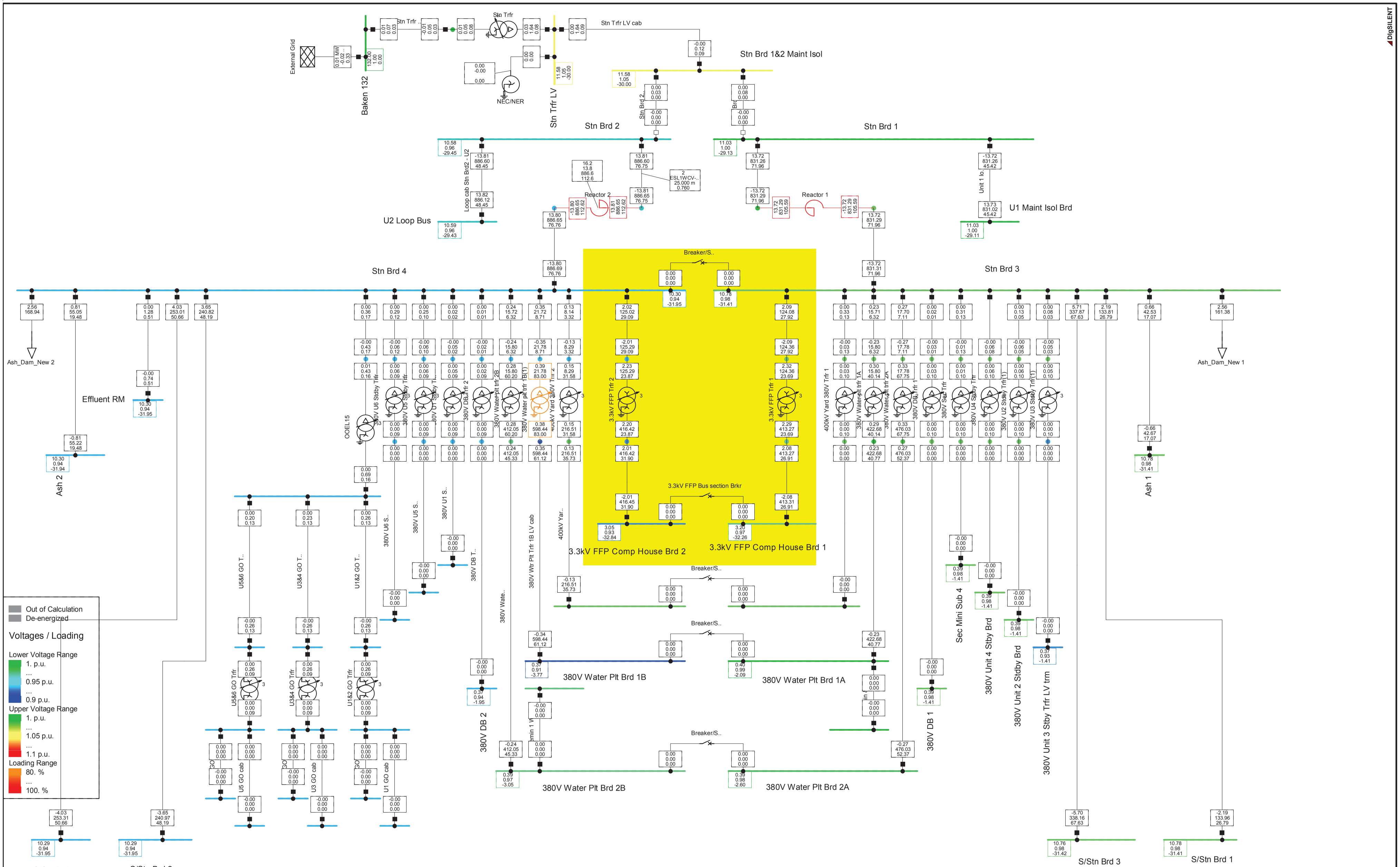
C3. SCENARIO 3: STATION TRANSFORMER USED TO SUPPLY ALL THE COMMON PLANT LOADS AND THE UNIT TRANSFORMERS SUPPLY UNIT AUXILIARIES (UNIT 4).



C4. SCENARIO 4A: UNITS RUNNING AT FULL LOAD AND SUPPLYING HALF OF THE COMMON PLANT. THE NEW ASH DAM 1 (DRY CONCEPT) LOADS ARE ADDED (UNIT 4).



C5. SCENARIO 4A: UNITS RUNNING AT FULL LOAD AND SUPPLYING HALF OF THE COMMON PLANT. THE NEW ASH DAM 1 (DRY CONCEPT) LOADS ARE ADDED (STATION BOARDS).



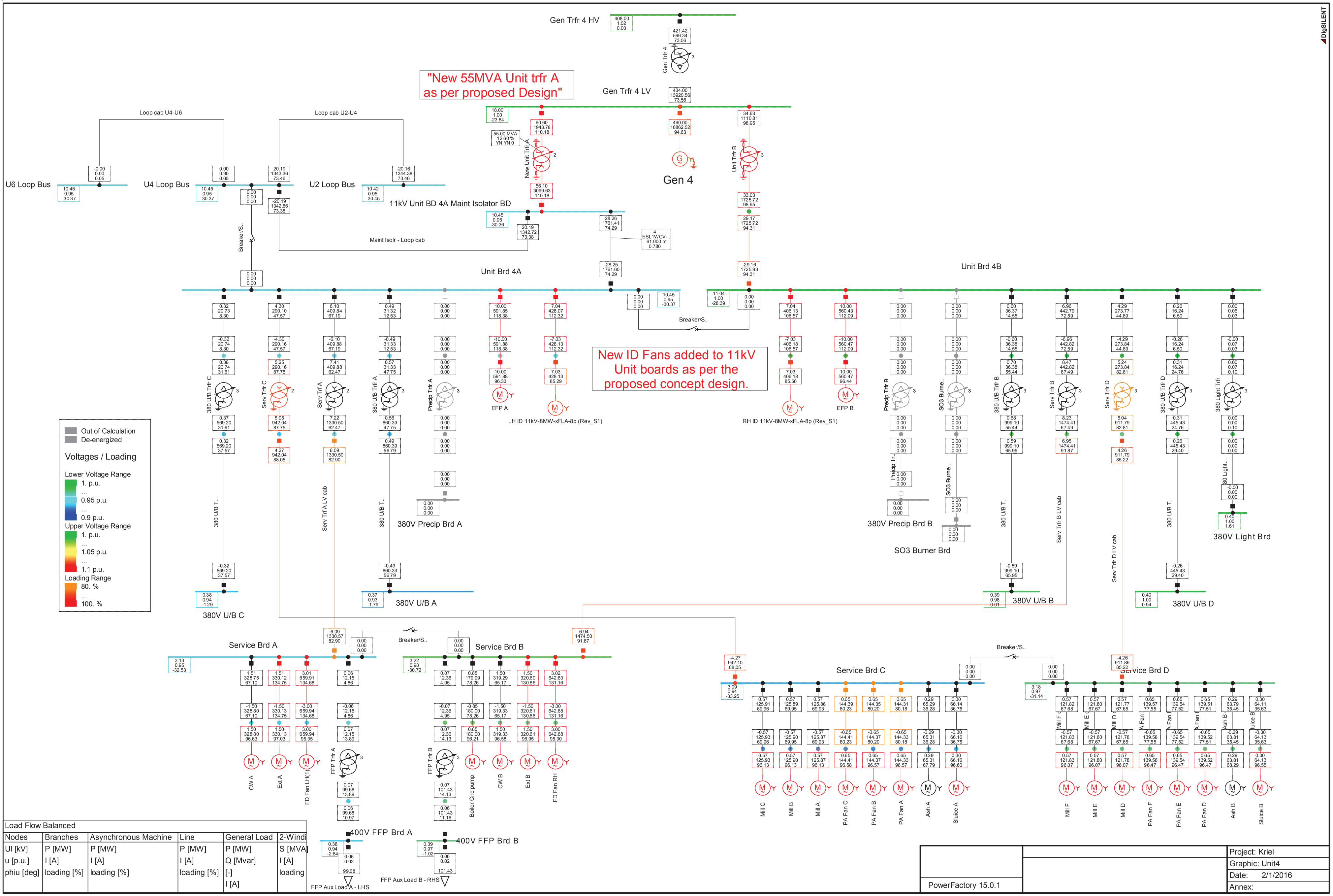
Load Flow Balanced

Nodes	Branches	Line	2-Winding Transformer	External Grid
Ul Ul, Magnitude [kV]	P Active Power [MW]	P Active Power [MW]	S Apparent Power [MVA]	P Active Power [MW]
u u, Magnitude [p.u.]	I Current, Magnitude [A]	I Current, Magnitude [A]	I Current, Magnitude [A]	Q Reactive Power [Mvar]
phiu U, Angle [deg]	loading Loading [%]	loading Loading [%]	loading Loading [%]	cosphi Power Factor [-]

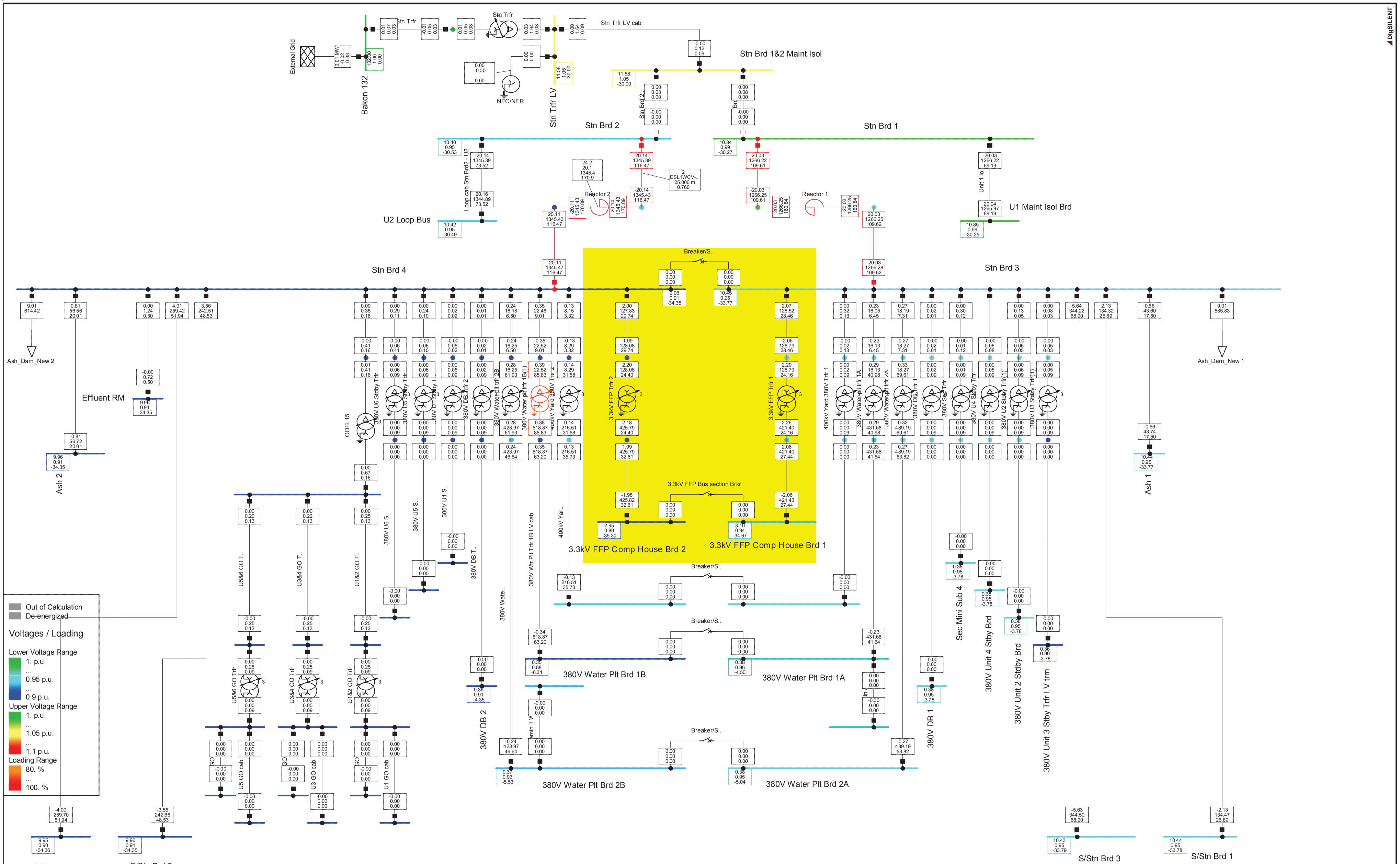
PowerFactory 15.0.1

Project: Kriel
Graphic: Outside Plt
Date: 2/1/2016
Annex:

C6. SCENARIO 4B: UNITS RUNNING AT FULL LOAD AND SUPPLYING HALF OF THE COMMON PLANT. THE NEW ASH DAM 2 (WET CONCEPT) LOADS ARE ADDED (UNIT 4).



C7. SCENARIO 4B: UNITS RUNNING AT FULL LOAD AND SUPPLYING HALF OF THE COMMON PLANT. THE NEW ASH DAM 2 (WET CONCEPT) LOADS ARE ADDED (STATION BOARDS).

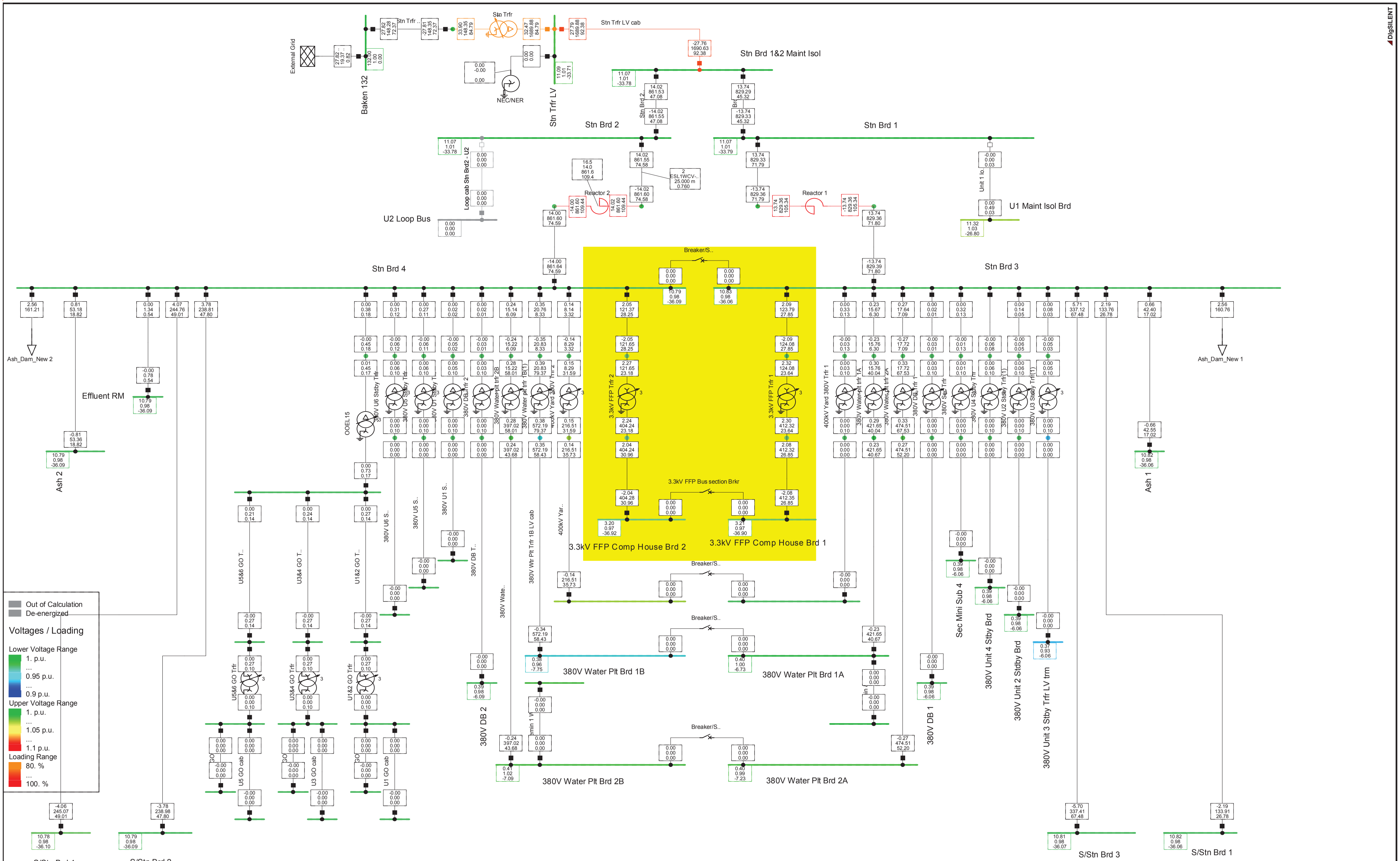


Load Flow Balanced				
Nodes	Branches	Line	2-Winding Transformer	External Grid
Ul Ul, Magnitude [kV]	P Active Power [MW]	P Active Power [MW]	S Apparent Power [MVA]	P Active Power [MW]
u u, Magnitude [p.u.]	I Current, Magnitude [A]	I Current, Magnitude [A]	I Current, Magnitude [A]	Q Reactive Power [Mvar]
phiu U, Angle [deg]	loading Loading [%]	loading Loading [%]	loading Loading [%]	cosphi Power Factor [-]

PowerFactory 15.0.1

Project: Kriel
Graphic: Outside Plt
Date: 2/1/2016
Annex:

C8. SCENARIO 5A: STATION TRANSFORMER USED TO SUPPLY ALL THE COMMON PLANT LOADS AND THE UNIT TRANSFORMERS SUPPLY UNIT AUXILIARIES. ASH DAM 1 (DRY CONCEPT) LOADS CONNECTED (STATION BOARDS).



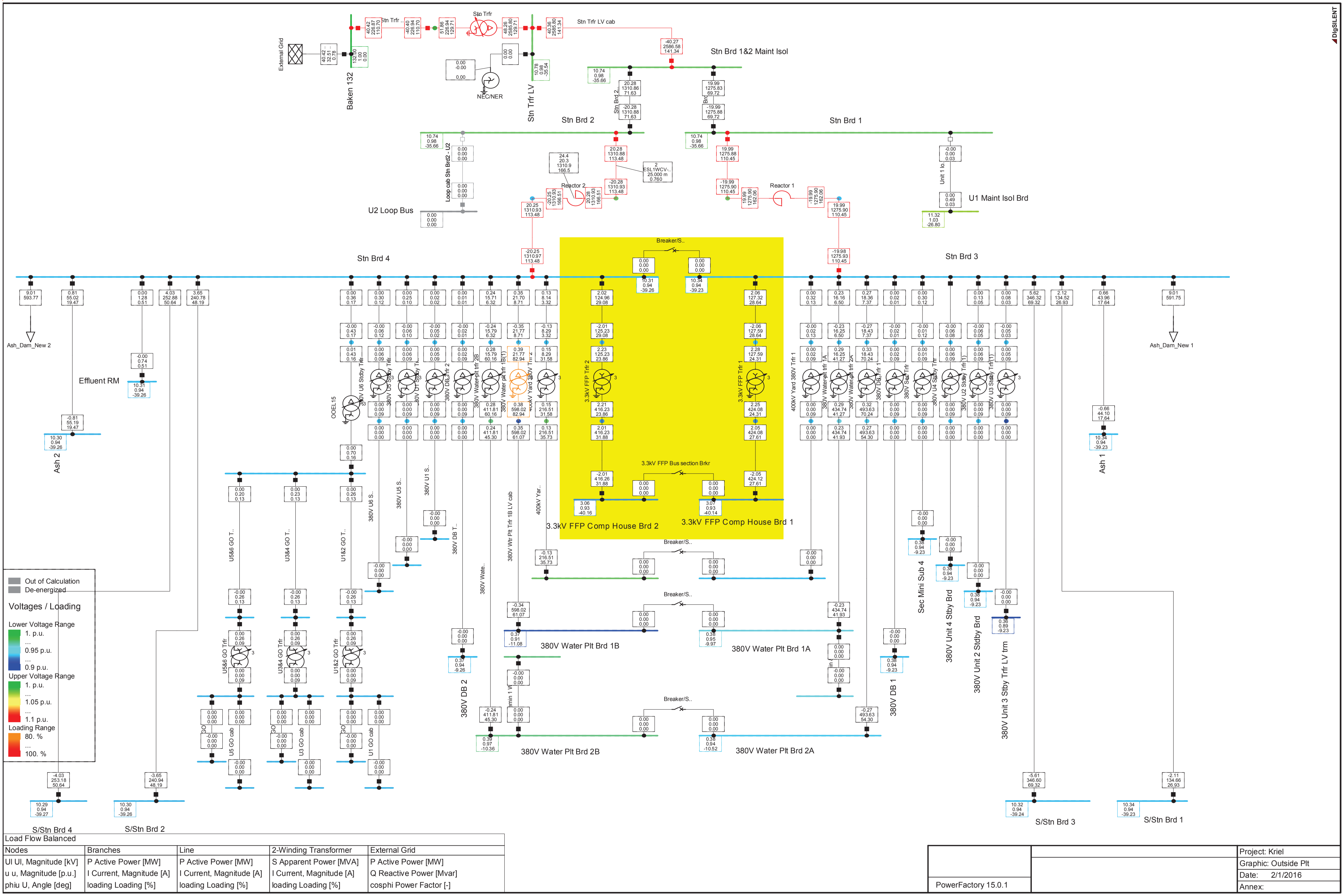
Load Flow Balanced

Nodes	Branches	Line	2-Winding Transformer	External Grid
Ul Ul, Magnitude [kV]	P Active Power [MW]	P Active Power [MW]	S Apparent Power [MVA]	P Active Power [MW]
u u, Magnitude [p.u.]	I Current, Magnitude [A]	I Current, Magnitude [A]	I Current, Magnitude [A]	Q Reactive Power [Mvar]
phiu U, Angle [deg]	loading Loading [%]	loading Loading [%]	loading Loading [%]	cosphi Power Factor [-]

PowerFactory 15.0.1

Project: Kriel
Graphic: Outside Plt
Date: 2/1/2016
Annex:

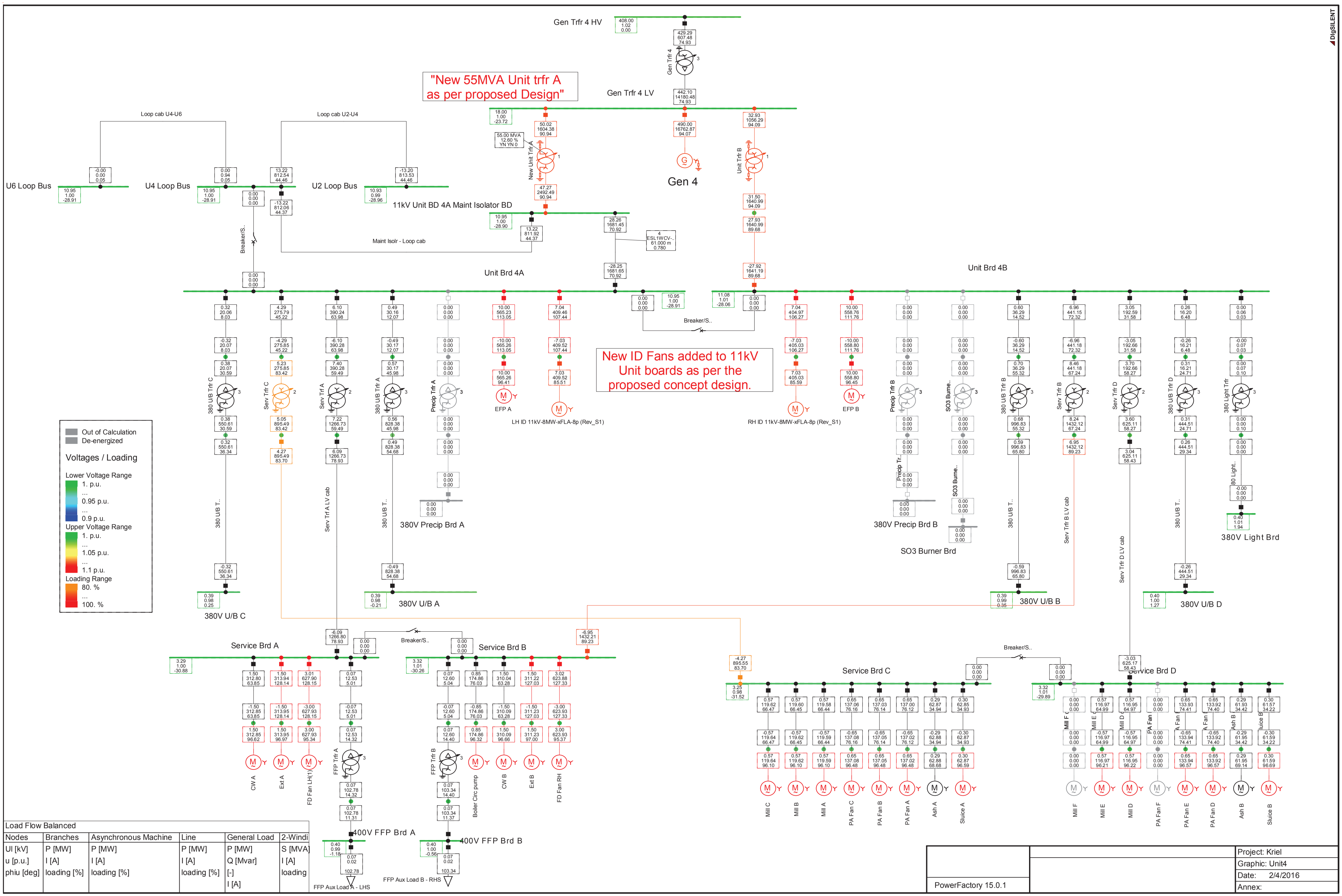
C9. SCENARIO 5B: STATION TRANSFORMER USED TO SUPPLY ALL THE COMMON PLANT LOADS AND THE UNIT TRANSFORMERS SUPPLY UNIT AUXILIARIES. ASH DAM 1 (WET CONCEPT) LOADS CONNECTED (STATION BOARDS).



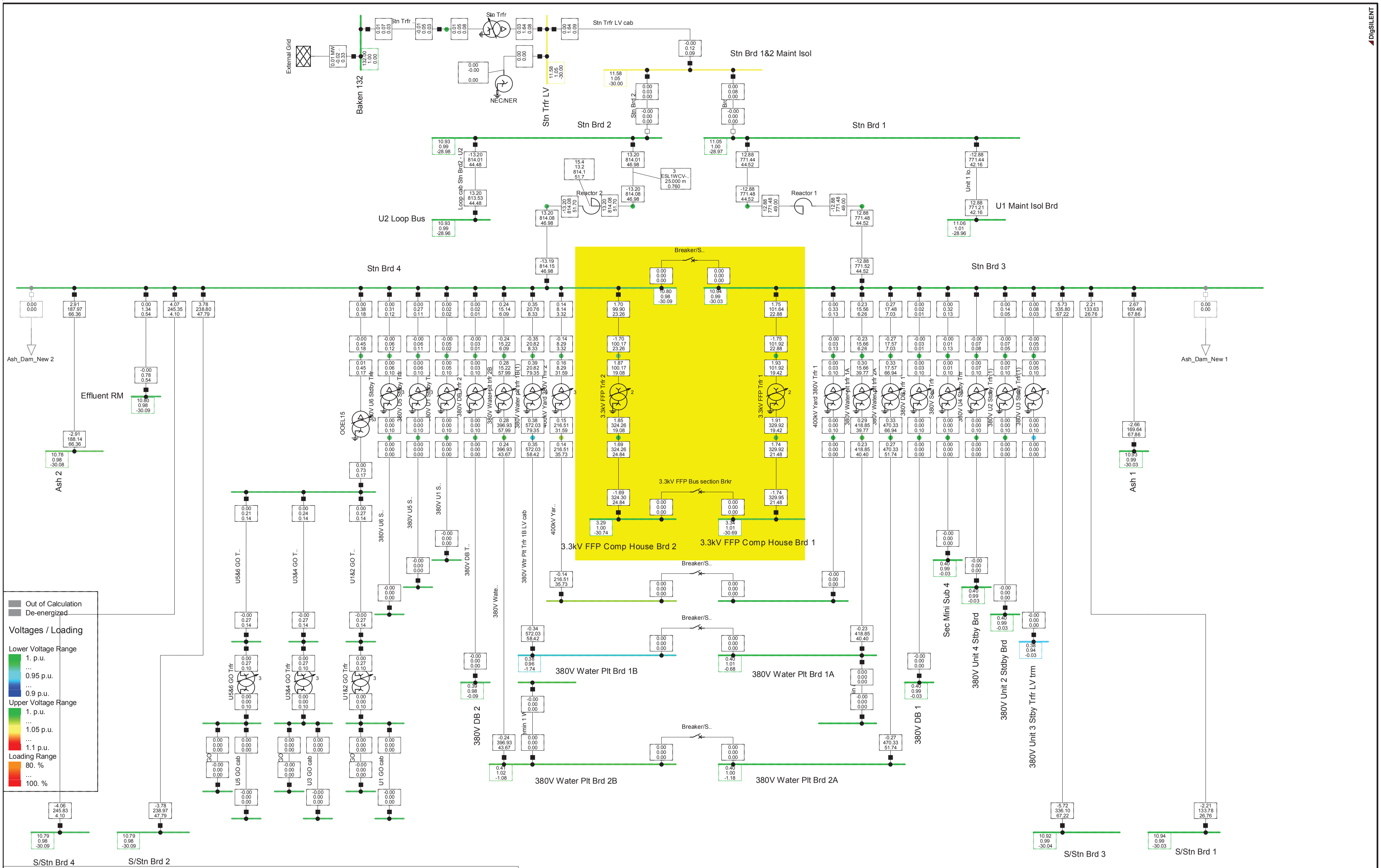
APPENDIX D – DIGSILENT SIMULATION RESULTS DRAWINGS: KRIEL POWER STATION SYSTEM STUDIES

This Appendix presents the simulation results for all the scenarios discussed in the main document. This is for the instances where the recommended changes to the proposed designs are implemented. The main document is to be used in conjunction with this Appendix.

D1. SCENARIO 1: UNITS RUNNING AT FULL LOAD AND SUPPLYING HALF OF THE COMMON PLANT (UNIT 4).



D2. SCENARIO 1: UNITS RUNNING AT FULL LOAD AND SUPPLYING HALF OF THE COMMON PLANT (STATION BOARDS).

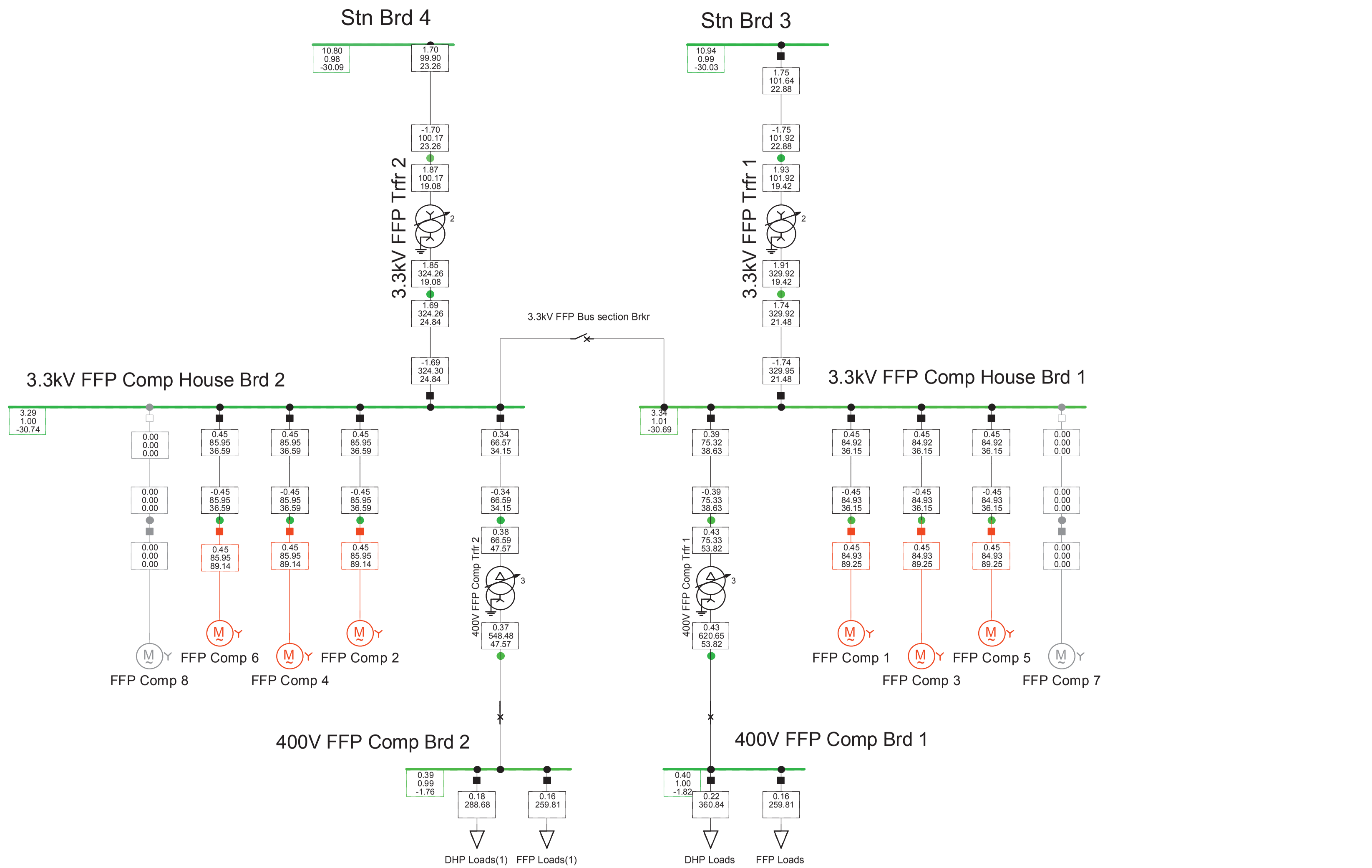


Load Flow Balanced				
Nodes	Branches	Line	2-Winding Transformer	External Grid
Ul Ul, Magnitude [kV]	P Active Power [MW]	P Active Power [MW]	S Apparent Power [MVA]	P Active Power [MW]
u u, Magnitude [p.u.]	I Current, Magnitude [A]	I Current, Magnitude [A]	I Current, Magnitude [A]	Q Reactive Power [Mvar]
phiu U, Angle [deg]	loading Loading [%]	loading Loading [%]	loading Loading [%]	cosphi Power Factor [-]

PowerFactory 15.0.1

Project:	Kriel
Graphic:	Outside Plt
Date:	2/4/2016
Annex:	

D1. SCENARIO 1: UNITS RUNNING AT FULL LOAD AND SUPPLYING HALF OF THE COMMON PLANT (FFP BOARDS).

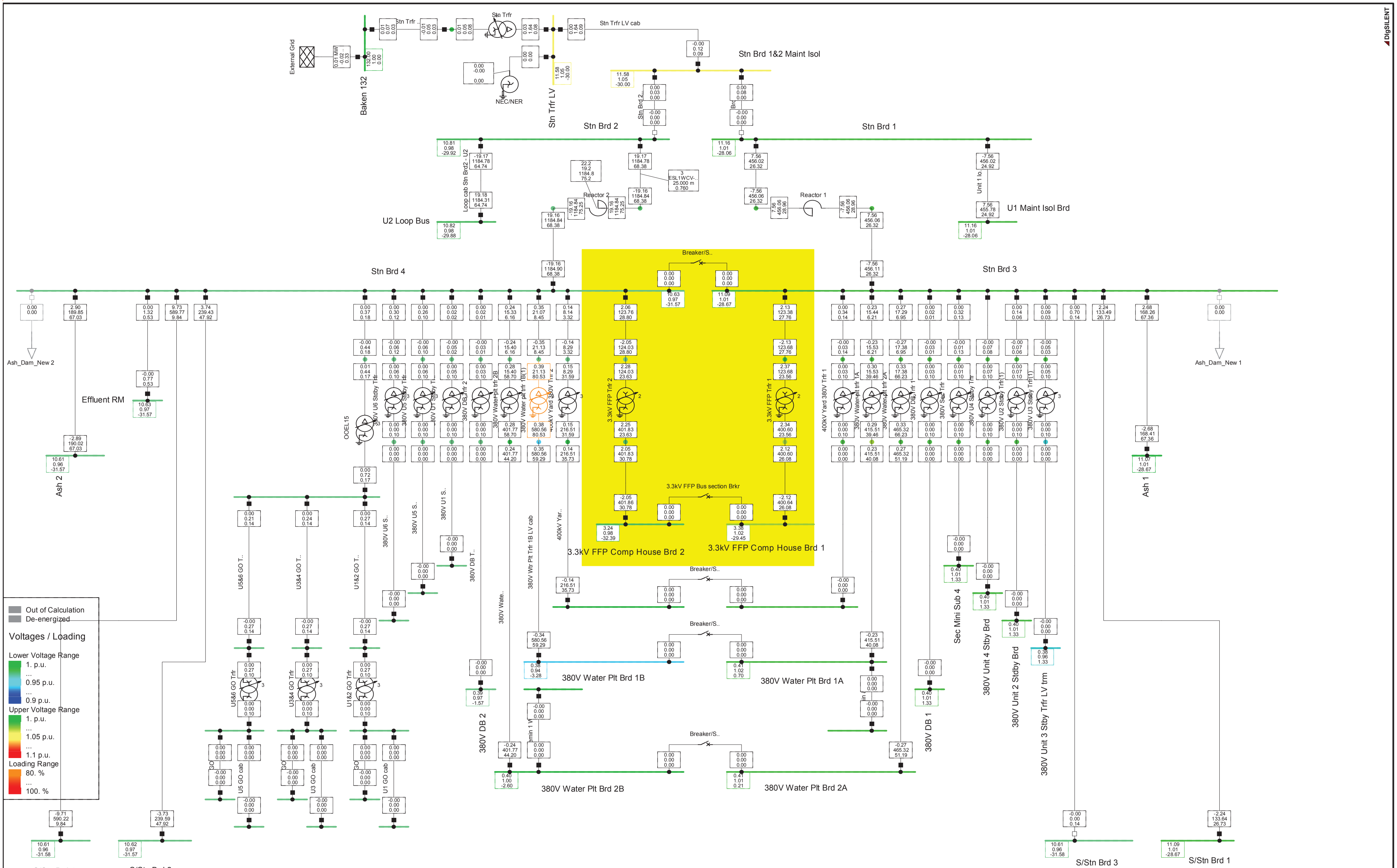


Load Flow Balanced				
Nodes	Branches	Asynchronous Machine	Line	2-Winding Transformer
Ul [kV]	P [MW]	P [MW]	P [MW]	S [MVA]
u [p.u.]	I [A]	I [A]	I [A]	I [A]
phiu [deg]	loading [%]	loading [%]	loading [%]	loading [%]

PowerFactory 15.0.1

Project: Kriel FFP
Graphic: FFP Comp Plant
Date: 2/4/2016
Annex:

D2. SCENARIO 2: UNITS RUNNING AT FULL LOAD AND SUPPLYING THE COMMON PLANT, WITH THE 11KV SUBSTATION BOARDS 3 & 4 CONNECTED. (STATION BOARDS).

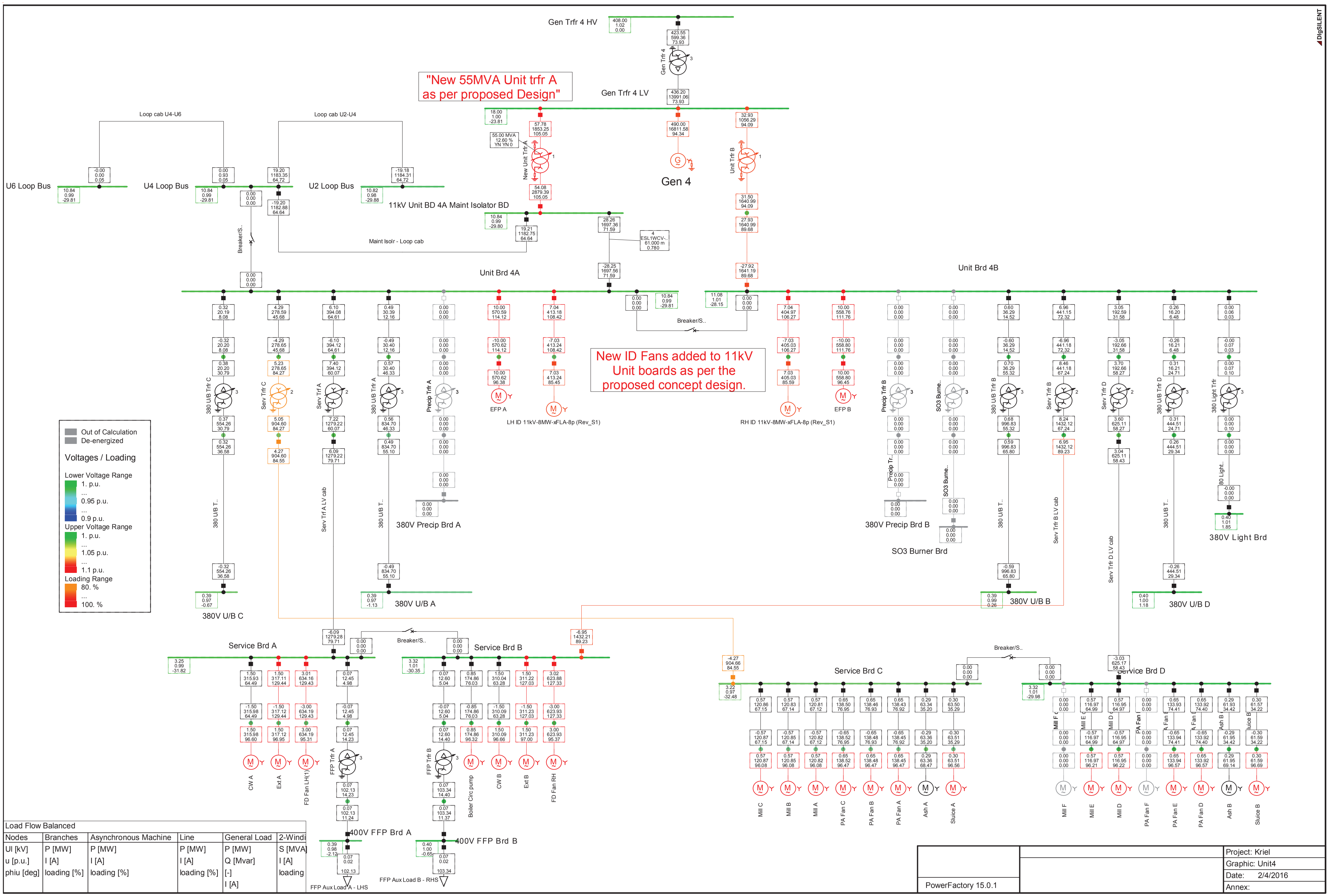


Load Flow Balanced				
Nodes	Branches	Line	2-Winding Transformer	External Grid
Ul Ul, Magnitude [kV]	P Active Power [MW]	P Active Power [MW]	S Apparent Power [MVA]	P Active Power [MW]
u u, Magnitude [p.u.]	I Current, Magnitude [A]	I Current, Magnitude [A]	I Current, Magnitude [A]	Q Reactive Power [Mvar]
phiu U, Angle [deg]	loading Loading [%]	loading Loading [%]	loading Loading [%]	cosphi Power Factor [-]

PowerFactory 15.0.1

Project:	Kriel
Graphic:	Outside Plt
Date:	2/4/2016
Annex:	

D3. SCENARIO 2: UNITS RUNNING AT FULL LOAD AND SUPPLYING THE COMMON PLANT, WITH THE 11KV SUBSTATION BOARDS 3 & 4 CONNECTED (UNIT 4).

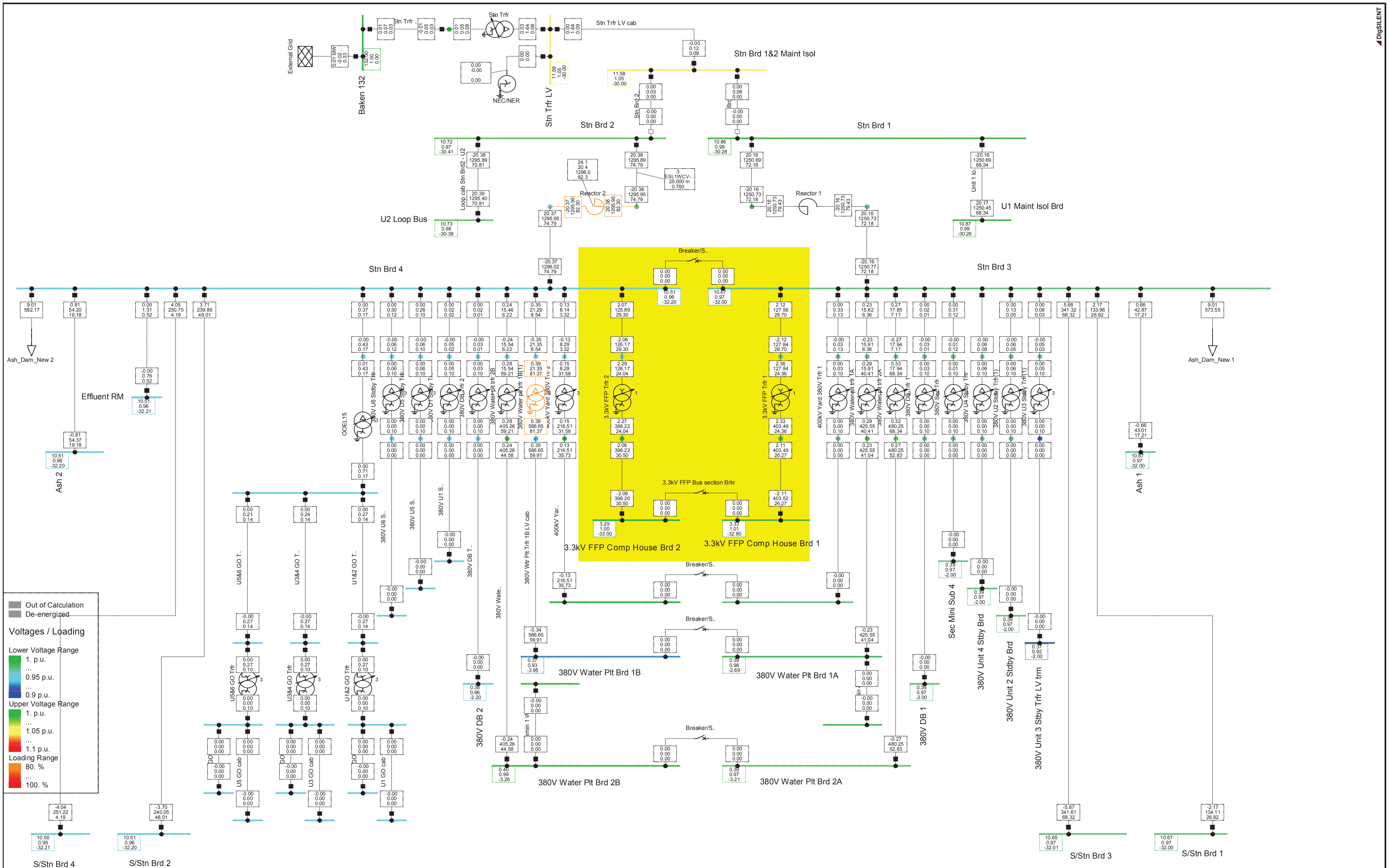


Load Flow Balanced					
Nodes	Branches	Asynchronous Machine	Line	General Load	2-Windi
Ul [kV]	P [MW]	P [MW]	P [MW]	P [MW]	S [MVA]
u [p.u.]	I [A]	I [A]	I [A]	Q [Mvar]	I [A]
phiu [deg]	loading [%]	loading [%]	loading [%]	[-]	loading
				I [A]	

PowerFactory 15.0.1

Project: Kriel
Graphic: Unit4
Date: 2/4/2016
Annex:

D4. SCENARIO 4B: UNITS RUNNING AT FULL LOAD AND SUPPLYING HALF OF THE COMMON PLANT. THE NEW ASH DAM 2 (WET CONCEPT) LOADS ARE ADDED. (STATION BOARDS).

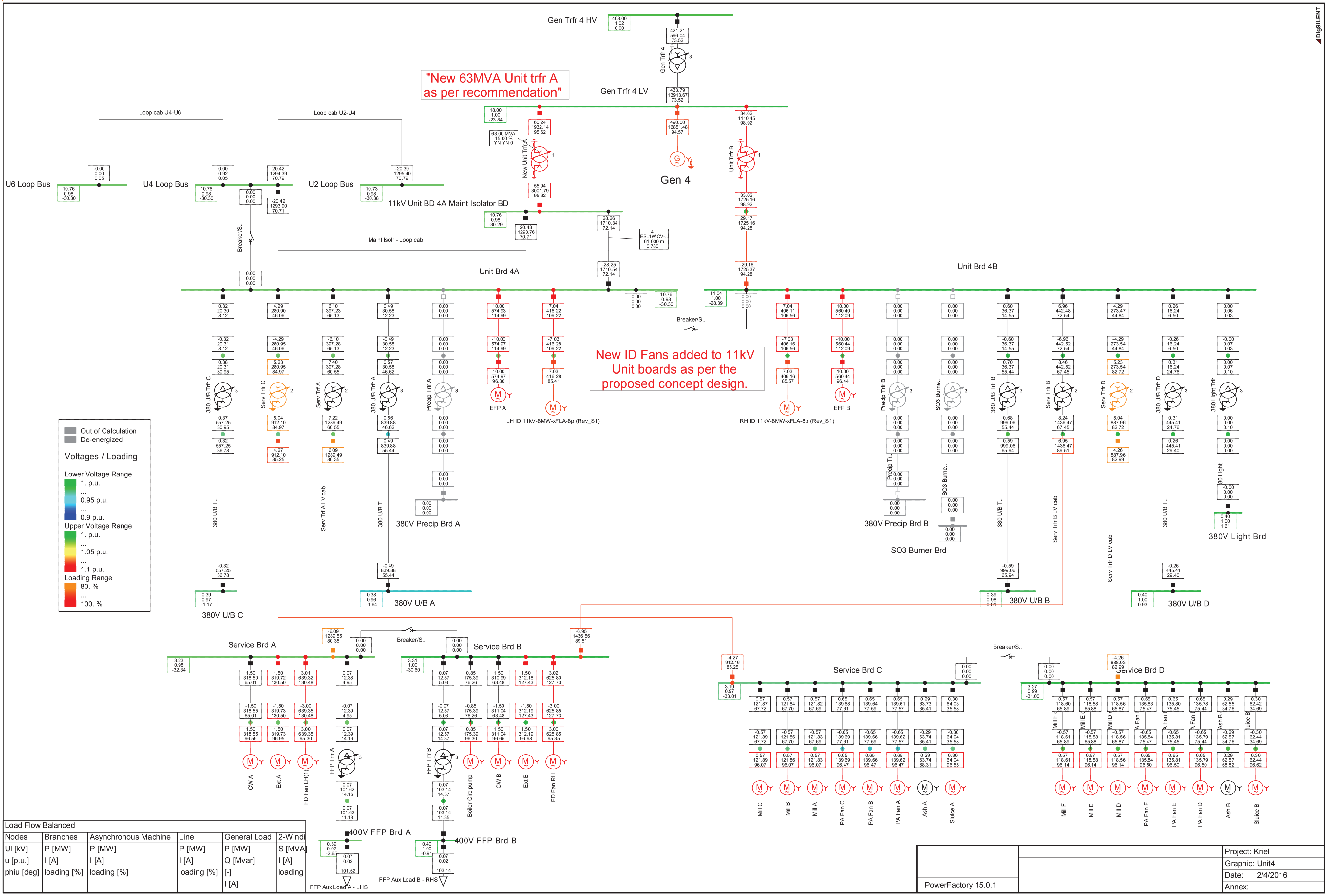


Load Flow Balanced				
Nodes	Branches	Line	2-Winding Transformer	External Grid
Ul Ul, Magnitude [kV]	P Active Power [MW]	P Active Power [MW]	S Apparent Power [MVA]	P Active Power [MW]
u u, Magnitude [p.u.]	I Current, Magnitude [A]	I Current, Magnitude [A]	I Current, Magnitude [A]	Q Reactive Power [Mvar]
phiu U, Angle [deg]	loading Loading [%]	loading Loading [%]	loading Loading [%]	cosphi Power Factor [-]

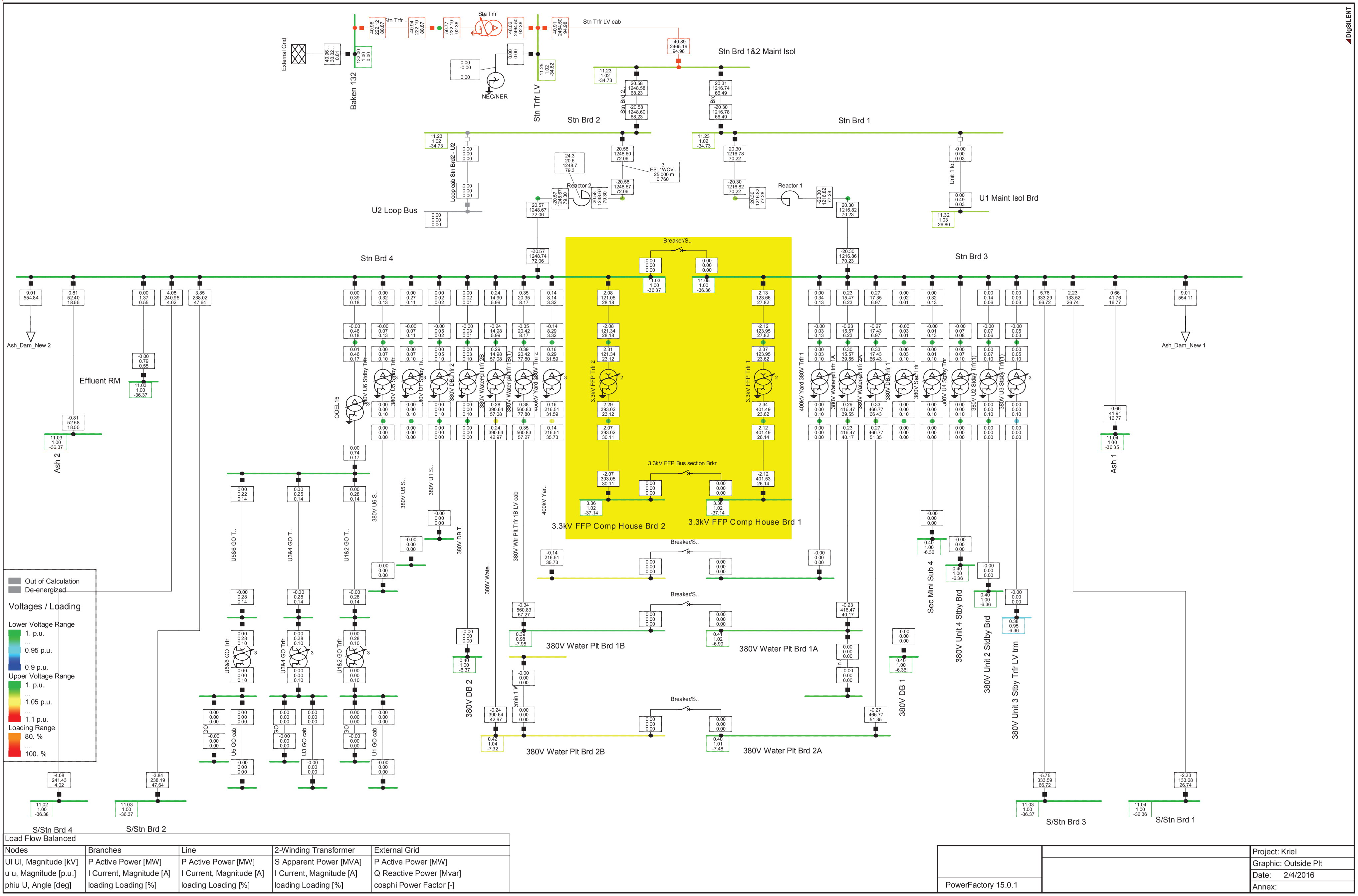
PowerFactory 15.0.1

Project: Kriel
Graphic: Outside Plt
Date: 2/4/2016
Annex:

D5. SCENARIO 4B: UNITS RUNNING AT FULL LOAD AND SUPPLYING HALF OF THE COMMON PLANT. THE NEW ASH DAM 2 (WET CONCEPT) LOADS ARE ADDED. (UNIT 4).



D6. SCENARIO 5B: STATION TRANSFORMER USED TO SUPPLY ALL THE COMMON PLANT LOADS AND THE UNIT TRANSFORMERS SUPPLY UNIT AUXILIARIES. ASH DAM 2 (WET CONCEPT) LOADS CONNECTED (STATION BOARDS).



Inputs & Outputs List - Option 1 - Dry System

1. Actuators

No.	KKS code	Plant Area	Description	Type	P & ID ref.	Valve size [NB]	Voltage [V]	Power [kW]
1	N/A	RSSC system	RSSC dewatering pump suction isolation	Open & close	0.45/BMH/ASH/1132	500	380	3
2	N/A	RSSC system	RSSC dewatering pump suction isolation	Open & close	0.45/BMH/ASH/1132	500	380	3
3	N/A	RSSC system	RSSC dewatering pump suction isolation	Open & close	0.45/BMH/ASH/1132	500	380	3
4	N/A	RSSC system	RSSC dewatering pump suction isolation	Open & close	0.45/BMH/ASH/1132	500	380	3
5	N/A	RSSC system	RSSC dewatering pump suction isolation	Open & close	0.45/BMH/ASH/1132	500	380	3
6	N/A	RSSC system	RSSC dewatering pump suction isolation	Open & close	0.45/BMH/ASH/1132	500	380	3
7	N/A	RSSC system	RSSC dewatering pump discharge isolation	Open & close	0.45/BMH/ASH/1132	500	380	3
8	N/A	RSSC system	RSSC dewatering pump discharge isolation	Open & close	0.45/BMH/ASH/1132	500	380	3
9	N/A	RSSC system	RSSC dewatering pump discharge isolation	Open & close	0.45/BMH/ASH/1132	500	380	3
10	N/A	RSSC system	RSSC dewatering pump discharge isolation	Open & close	0.45/BMH/ASH/1132	500	380	3
11	N/A	RSSC system	RSSC dewatering pump discharge isolation	Open & close	0.45/BMH/ASH/1132	500	380	3
12	N/A	RSSC system	RSSC dewatering pump discharge isolation	Open & close	0.45/BMH/ASH/1132	500	380	3
13	N/A	RSSC system	RSSC dewatering bilge pump suction isolation	Open & close	0.45/BMH/ASH/1132	100	380	1
14	N/A	RSSC system	RSSC dewatering bilge pump discharge isolation	Open & close	0.45/BMH/ASH/1132	100	380	1
15	N/A	Crawl mounted stackers	Link conveyor 1 - take-up pump	Open & close	0.45/BMH/ASH1135 Sht 2	80	380	0.75
16	N/A	Crawl mounted stackers	Link conveyor 2 - take-up pump	Open & close	0.45/BMH/ASH1135 Sht 2	80	380	0.75
17	N/A	Crawl mounted stackers	Boom 1 - take-up pump	Open & close	0.45/BMH/ASH1135 Sht 1	80	380	0.75
18	N/A	Crawl mounted stackers	Boom 2 - take-up pump	Open & close	0.45/BMH/ASH1135 Sht 1	80	380	0.75
No new actuators for the boilers BBA plant.								

27.5

2. Drives

No.	KKS code	Plant Area	Description	Type	P & ID ref.	New Installation [Y/N]	Voltage [V]	Power [kW]
1	N/A	RSSC system	RSSC units - hydraulic drive	VSD	0.45/BMH/ASH/1131	Y	380	22
2	N/A	RSSC system	RSSC units - hydraulic drive	VSD	0.45/BMH/ASH/1131	Y	380	22
3	N/A	RSSC system	RSSC units - hydraulic drive	VSD	0.45/BMH/ASH/1131	Y	380	22
4	N/A	RSSC system	RSSC units - hydraulic drive	VSD	0.45/BMH/ASH/1131	Y	380	22
5	N/A	RSSC system	RSSC units - oil blast cooler motor	Fixed speed	0.45/BMH/ASH/1131	Y	380	3
6	N/A	RSSC system	RSSC units - oil blast cooler motor	Fixed speed	0.45/BMH/ASH/1131	Y	380	3
7	N/A	RSSC system	RSSC units - oil blast cooler motor	Fixed speed	0.45/BMH/ASH/1131	Y	380	3
8	N/A	RSSC system	RSSC units - oil blast cooler motor	Fixed speed	0.45/BMH/ASH/1131	Y	380	3
9	N/A	RSSC system	RSSC units - oil tank motor	Fixed speed	0.45/BMH/ASH/1131	Y	380	1.1
10	N/A	RSSC system	RSSC units - oil tank motor	Fixed speed	0.45/BMH/ASH/1131	Y	380	1.1
11	N/A	RSSC system	RSSC units - oil tank motor	Fixed speed	0.45/BMH/ASH/1131	Y	380	1.1
12	N/A	RSSC system	RSSC units - oil tank motor	Fixed speed	0.45/BMH/ASH/1131	Y	380	1.1
13	N/A	RSSC system	RSSC dewatering pump motor	Fixed speed	0.45/BMH/ASH/1132	Y	380	160
14	N/A	RSSC system	RSSC dewatering pump motor	Fixed speed	0.45/BMH/ASH/1132	Y	380	160
15	N/A	RSSC system	RSSC dewatering pump motor	Fixed speed	0.45/BMH/ASH/1132	Y	380	160
16	N/A	RSSC system	RSSC dewatering pump motor	Fixed speed	0.45/BMH/ASH/1132	Y	380	160
17	N/A	RSSC system	RSSC dewatering pump motor	Fixed speed	0.45/BMH/ASH/1132	Y	380	160
18	N/A	RSSC system	RSSC dewatering pump motor	Fixed speed	0.45/BMH/ASH/1132	Y	380	160
19	N/A	RSSC system	RSSC dewatering bilge pump motor	Fixed speed	0.45/BMH/ASH/1132	Y	380	7.5
20	N/A	BBA conveyors	Drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	55
21	N/A	BBA conveyors	Drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	55
22	N/A	BBA conveyors	Take-up winch motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	3
23	N/A	BBA conveyors	Take-up winch motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	3
24	N/A	BBA conveyors	Moveable head winch motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	7.5
25	N/A	BBA conveyors	Moveable head winch motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	7.5
26	N/A	PFA conveyors	Drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	110
27	N/A	PFA conveyors	Drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	110
28	N/A	PFA conveyors	Take-up winch motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	3
29	N/A	PFA conveyors	Take-up winch motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	3
30	N/A	PFA conveyors	Moveable head winch motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	7.5
31	N/A	PFA conveyors	Moveable head winch motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	7.5
32	N/A	Overland conveyors	Overland 1 - drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	160
33	N/A	Overland conveyors	Overland 1 - drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	160
34	N/A	Overland conveyors	Overland 1 - drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	160
35	N/A	Overland conveyors	Overland 1 - drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	160

36	N/A	Overland conveyors	Overland 1 - take-up winch motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	5.5
37	N/A	Overland conveyors	Overland 1 - take-up winch motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	5.5
38	N/A	Overland conveyors	Overland 1 - moveable head winch motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	7.5
39	N/A	Overland conveyors	Overland 1 - moveable head winch motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	7.5
40	N/A	Overland conveyors	Overland 2 - drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	3 300	300
41	N/A	Overland conveyors	Overland 2 - drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	3 300	300
42	N/A	Overland conveyors	Overland 2 - drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	3 300	300
43	N/A	Overland conveyors	Overland 2 - drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	3 300	300
44	N/A	Overland conveyors	Overland 2 - take-up winch motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	7.5
45	N/A	Overland conveyors	Overland 2 - take-up winch motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	7.5
46	N/A	Overland conveyors	Overland 2 - moveable head winch motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	7.5
47	N/A	Overland conveyors	Overland 2 - moveable head winch motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	7.5
48	N/A	Overland conveyors	Overland 3 - drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	3 300	560
49	N/A	Overland conveyors	Overland 3 - drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	3 300	560
50	N/A	Overland conveyors	Overland 3 - drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	3 300	560
51	N/A	Overland conveyors	Overland 3 - drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	3 300	560
52	N/A	Overland conveyors	Overland 3 - take-up winch motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	15
53	N/A	Overland conveyors	Overland 3 - take-up winch motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	15
54	N/A	Overland conveyors	Overland 3 - moveable head winch motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	15
55	N/A	Overland conveyors	Overland 3 - moveable head winch motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	15
56	N/A	Overland conveyors	Overland 4 - drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	3 300	400
57	N/A	Overland conveyors	Overland 4 - drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	3 300	400
58	N/A	Overland conveyors	Overland 4 - drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	3 300	400
59	N/A	Overland conveyors	Overland 4 - drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	3 300	400
60	N/A	Overland conveyors	Overland 4 - take-up winch motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	11
61	N/A	Overland conveyors	Overland 4 - take-up winch motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	11
62	N/A	Overland conveyors	Overland 4 - moveable head winch motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	15
63	N/A	Overland conveyors	Overland 4 - moveable head winch motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	15
64	N/A	Extendible conveyors	Extendible 1 - drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	185
65	N/A	Extendible conveyors	Extendible 1 - drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	185
66	N/A	Extendible conveyors	Extendible 1 - take-up winch motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	7.5
67	N/A	Extendible conveyors	Extendible 2 - drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	3 300	250
68	N/A	Extendible conveyors	Extendible 2 - drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	3 300	250
69	N/A	Extendible conveyors	Extendible 2 - take-up winch motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	11
70	N/A	Shiftable conveyors	Shiftable 1 - drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	132
71	N/A	Shiftable conveyors	Shiftable 1 - drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	132
72	N/A	Shiftable conveyors	Shiftable 1 - take-up winch motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	4
73	N/A	Shiftable conveyors	Shiftable 2 - drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	185
74	N/A	Shiftable conveyors	Shiftable 2 - drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	185
75	N/A	Shiftable conveyors	Shiftable 2 - take-up winch motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	4
76	N/A	Crawl mounted stackers	Tripper car drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	3
77	N/A	Crawl mounted stackers	Tripper car drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	3
78	N/A	Crawl mounted stackers	Tripper car drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	3
79	N/A	Crawl mounted stackers	Tripper car drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	3
80	N/A	Crawl mounted stackers	Tripper car drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	3
81	N/A	Crawl mounted stackers	Tripper car drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	3
82	N/A	Crawl mounted stackers	Tripper car drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	3
83	N/A	Crawl mounted stackers	Tripper car drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	3
84	N/A	Crawl mounted stackers	Tripper car drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	3
85	N/A	Crawl mounted stackers	Tripper car drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	3
86	N/A	Crawl mounted stackers	Tripper car drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	3
87	N/A	Crawl mounted stackers	Tripper car drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	3
88	N/A	Crawl mounted stackers	Tripper car drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	3
89	N/A	Crawl mounted stackers	Tripper car drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	3
90	N/A	Crawl mounted stackers	Tripper car drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	3
91	N/A	Crawl mounted stackers	Tripper car drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	3
92	N/A	Crawl mounted stackers	Tripper car drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	3
93	N/A	Crawl mounted stackers	Tripper car drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	3
94	N/A	Crawl mounted stackers	Tripper car drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	3

95	N/A	Crawl mounted stackers	Tripper car drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	3	
96	N/A	Crawl mounted stackers	Link conveyor 1 - drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	90	
97	N/A	Crawl mounted stackers	Link conveyor 2 - drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	90	
98	N/A	Crawl mounted stackers	Boom 1 - drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	132	
99	N/A	Crawl mounted stackers	Boom 2 - drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	132	
100	N/A	Crawl mounted stackers	Crawler drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	75	
101	N/A	Crawl mounted stackers	Crawler drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	75	
102	N/A	Crawl mounted stackers	Crawler drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	75	
103	N/A	Crawl mounted stackers	Crawler drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	75	
No new drives for the boilers BBA plant.									5096.7
All lighting and plug points and other LV connections were not included.									

5124.2

3. Flow meters

No.	KKS code	Plant Area	Description	Type	P & ID ref.	Valve size [NB]
1	N/A	RSSC system	Dewatering pump discharge pipeline		0.45/BMH/ASH/1132	500
2	N/A	RSSC system	Dewatering pump discharge pipeline		0.45/BMH/ASH/1132	500
3	N/A	RSSC system	Dewatering pump discharge pipeline		0.45/BMH/ASH/1132	500
4	N/A	RSSC system	Dewatering pump discharge pipeline		0.45/BMH/ASH/1132	500

4. Level Indicator Transmittors (LIT)

No.	KKS code	Plant Area	Description	Type	P & ID ref.
1	N/A	RSSC system	Lever Indicator Transmitter (LIT) 1 - dewatering sump		0.45/BMH/ASH/1132
2	N/A	RSSC system	Lever Indicator Transmitter (LIT) 2 - dewatering sump		0.45/BMH/ASH/1132
3	N/A	RSSC system	Lever Indicator Transmitter (LIT) 3 - dewatering sump		0.45/BMH/ASH/1132

5. Pressure Indicator Transmittors (PIT)

No.	KKS code	Plant Area	Description	Type	P & ID ref.
1	N/A	RSSC system	RSSC dewatering pump 1 suction		0.45/BMH/ASH/1132
2	N/A	RSSC system	RSSC dewatering pump 1 discharge		0.45/BMH/ASH/1132
3	N/A	RSSC system	RSSC dewatering pump 2 suction		0.45/BMH/ASH/1132
4	N/A	RSSC system	RSSC dewatering pump 2 discharge		0.45/BMH/ASH/1132
5	N/A	RSSC system	RSSC dewatering pump 3 suction		0.45/BMH/ASH/1132
6	N/A	RSSC system	RSSC dewatering pump 3 discharge		0.45/BMH/ASH/1132
7	N/A	RSSC system	RSSC dewatering pump 4 suction		0.45/BMH/ASH/1132
8	N/A	RSSC system	RSSC dewatering pump 4 discharge		0.45/BMH/ASH/1132
9	N/A	RSSC system	RSSC dewatering pump 5 suction		0.45/BMH/ASH/1132
10	N/A	RSSC system	RSSC dewatering pump 5 discharge		0.45/BMH/ASH/1132
11	N/A	RSSC system	RSSC dewatering pump 6 suction		0.45/BMH/ASH/1132
12	N/A	RSSC system	RSSC dewatering pump 6 discharge		0.45/BMH/ASH/1132

6. Generic conveyor instrumentation (for RSSCs & ash conveyors)

No.	KKS code	Plant Area	Description	Type	P & ID ref.
1	N/A	Throughout entire conveyor	Pullwire Trip Switch		0.45/BMH/ASH/1133-4
2	N/A	Throughout entire conveyor	Conveyor NDE Emergency Stop		0.45/BMH/ASH/1133-4
3	N/A	Throughout entire conveyor	Belt Alignment Switch		0.45/BMH/ASH/1133-4
4	N/A	Throughout entire conveyor	Conveyor NDE Emergency Stop		0.45/BMH/ASH/1133-4
5	N/A	Throughout entire conveyor	Conveyor DE Emergency Stop		0.45/BMH/ASH/1133-4
6	N/A	Throughout entire conveyor	Conveyor Drive Emergency Stop		0.45/BMH/ASH/1133-4
7	N/A	Head end of conveyor	Belt Tear Switch		0.45/BMH/ASH/1133-4
8	N/A	Head end of conveyor	Head Speed Switch Lo Lo		0.45/BMH/ASH/1133-4
9	N/A	Head end of conveyor	Conveyor Drive Speed Control		0.45/BMH/ASH/1133-4
10	N/A	Head and tail end	Belt Rip Switch		0.45/BMH/ASH/1133-4
11	N/A	Tail end of conveyor	Tail Speed Switch Lo Lo		0.45/BMH/ASH/1133-4
12	N/A	Drive section of conveyor	Conveyor Drive Thermistor		0.45/BMH/ASH/1133-4
13	N/A	Drive end of conveyor	Speed Switch		0.45/BMH/ASH/1133-4
14	N/A	Each Loading point	Blocked Chute Detector		0.45/BMH/ASH/1133-4
15	N/A	Gravity Take up section	Take Up Horizontal High Level		0.45/BMH/ASH/1133-4
16	N/A	Gravity Take up section	Take Up Vertical High Level		0.45/BMH/ASH/1133-4
17	N/A	Gravity Take up section	Take Up Horizontal Low Level		0.45/BMH/ASH/1133-4
18	N/A	Gravity Take up section	Take Up Vertical Low level		0.45/BMH/ASH/1133-4
19	N/A	Gravity Take up section	Take Up Over Travel Limit		0.45/BMH/ASH/1133-4
20	N/A	Gravity Take up section	Take Up Under Travel Limit		0.45/BMH/ASH/1133-4

21	N/A	Gravity Take up section	Take Up Winch Ultimate Limit		0.45/BMH/ASH/1133-4
22	N/A	Dump pile	Dump Pile Level Switch		0.45/BMH/ASH/1133-4
23	N/A	Conveyor configuration dependant	Position Switch A		0.45/BMH/ASH/1133-4
24	N/A	Conveyor configuration dependant	Position Switch B		0.45/BMH/ASH/1133-4
25	N/A	Conveyor configuration dependant	Ultimate Limit Reverse		0.45/BMH/ASH/1133-4
26	N/A	Conveyor configuration dependant	Ultimate Limit Forward		0.45/BMH/ASH/1133-4
27	N/A	Conveyor configuration dependant	Thruster Brake Open Limit		0.45/BMH/ASH/1133-4
28	N/A	Conveyor configuration dependant	Moisture Analyser		0.45/BMH/ASH/1133-4
29	N/A	Conveyor configuration dependant	Belt Scale		0.45/BMH/ASH/1133-4
30	N/A	Conveyor configuration dependant	Flow Switch Low		0.45/BMH/ASH/1133-4
31	N/A	Conveyor configuration dependant	Hydraulic Oil Level Switch		0.45/BMH/ASH/1133-4
32	N/A	Conveyor configuration dependant	Filter Pressure Differential Switch Hi		0.45/BMH/ASH/1133-4
33	N/A	Conveyor configuration dependant	Hydraulic Pressure Indicator		0.45/BMH/ASH/1133-4
34	N/A	Conveyor configuration dependant	Hydraulic Pressure Switch Hi Hi		0.45/BMH/ASH/1133-4
35	N/A	Conveyor configuration dependant	Spile Bar Actuator Closed		0.45/BMH/ASH/1133-4
36	N/A	Conveyor configuration dependant	Spile Bar Actuator Open		0.45/BMH/ASH/1133-4
37	N/A	Conveyor configuration dependant	Flow Switch Low		0.45/BMH/ASH/1133-4
38	N/A	Conveyor configuration dependant	Belt Condition Monitor		0.45/BMH/ASH/1133-4
39	N/A	Conveyor configuration dependant	Embedded Loop Monitor		0.45/BMH/ASH/1133-4
40	N/A	Conveyor configuration dependant	Level Switch		0.45/BMH/ASH/1133-4
41	N/A	Conveyor configuration dependant	Limit Switch		0.45/BMH/ASH/1133-4
42	N/A	Conveyor configuration dependant	Temp Sensor		0.45/BMH/ASH/1133-4
43	N/A	Conveyor configuration dependant	Oil Level Transmitter		0.45/BMH/ASH/1133-4
44	N/A	Conveyor configuration dependant	Start Warning Siren		0.45/BMH/ASH/1133-4
45	N/A	Auto Hydraulic Take-up section	Control Station Emergency Stop		0.45/BMH/ASH1135 Sht 1 & 2
46	N/A	Auto Hydraulic Take-up section	Take-up Limit In		0.45/BMH/ASH1135 Sht 1 & 2
47	N/A	Auto Hydraulic Take-up section	Take-up Limit Out		0.45/BMH/ASH1135 Sht 1 & 2

Inputs & Outputs List - Option 2 - Wet System

1. Actuators

No.	KKS code	Plant Area	Description	Type	P & ID ref.	Valve size [NB]	Voltage [V]	Power [kW]
1	N/A	BBA plant	BBA slurry pump suction isolation	Open & close	0.45/BMH/ASH/1231	500	380	3
2	N/A	BBA plant	BBA slurry pump suction isolation	Open & close	0.45/BMH/ASH/1231	500	380	3
3	N/A	BBA plant	BBA slurry pump discharge isolation	Open & close	0.45/BMH/ASH/1231	500	380	3
4	N/A	BBA plant	BBA slurry pump discharge isolation	Open & close	0.45/BMH/ASH/1231	500	380	3
5	N/A	BBA plant	BBA slurry pump cross over	Open & close	0.45/BMH/ASH/1231	500	380	3
6	N/A	BBA plant	BBA slurry pump cross over	Open & close	0.45/BMH/ASH/1231	500	380	3
7	N/A	BBA plant	BBA slurry pump cross over	Open & close	0.45/BMH/ASH/1231	500	380	3
8	N/A	BBA plant	BBA slurry pump cross over	Open & close	0.45/BMH/ASH/1231	500	380	3
9	N/A	BBA plant	BBA sump make-up	Control valve	0.45/BMH/ASH/1231	300	380	2
10	N/A	BBA plant	BBA sump make-up	Control valve	0.45/BMH/ASH/1231	300	380	2
11	N/A	BBA plant	Back flush to BBA slurry pump suction pipeline	Open & close	0.45/BMH/ASH/1231	300	380	2
12	N/A	BBA plant	Back flush to BBA slurry pump suction pipeline	Open & close	0.45/BMH/ASH/1231	300	380	2
13	N/A	BBA plant	BBA sluice way lifting liner	Open & close	0.45/BMH/ASH/1231	N/A	380	3
14	N/A	BBA plant	BBA sluice way lifting liner	Open & close	0.45/BMH/ASH/1231	N/A	380	3
15	N/A	BBA plant	BBA bilge pump suction isolation	Open & close	0.45/BMH/ASH/1231	100	380	1
16	N/A	BBA plant	BBA bilge pump discharge isolation	Open & close	0.45/BMH/ASH/1231	100	380	1
17	N/A	BBA plant	BBA agitation pump suction isolation	Open & close	0.45/BMH/ASH/1231	600	380	3
18	N/A	BBA plant	BBA agitation pump suction isolation	Open & close	0.45/BMH/ASH/1231	600	380	3
19	N/A	BBA plant	BBA agitation pump discharge isolation	Open & close	0.45/BMH/ASH/1231	250	380	2
20	N/A	BBA plant	BBA agitation pump discharge isolation	Open & close	0.45/BMH/ASH/1231	250	380	2
21	N/A	PFA plant	PFA slurry pump suction isolation	Open & close	0.45/BMH/ASH/1232	500	380	3
22	N/A	PFA plant	PFA slurry pump suction isolation	Open & close	0.45/BMH/ASH/1232	500	380	3
23	N/A	PFA plant	PFA slurry pump suction isolation	Open & close	0.45/BMH/ASH/1232	500	380	3
24	N/A	PFA plant	PFA slurry pump suction isolation	Open & close	0.45/BMH/ASH/1232	500	380	3
25	N/A	PFA plant	PFA slurry pump suction isolation	Open & close	0.45/BMH/ASH/1232	500	380	3
26	N/A	PFA plant	PFA slurry pump suction isolation	Open & close	0.45/BMH/ASH/1232	500	380	3
27	N/A	PFA plant	PFA slurry pump discharge isolation	Open & close	0.45/BMH/ASH/1232	500	380	3
28	N/A	PFA plant	PFA slurry pump discharge isolation	Open & close	0.45/BMH/ASH/1232	500	380	3
29	N/A	PFA plant	PFA slurry pump discharge isolation	Open & close	0.45/BMH/ASH/1232	500	380	3
30	N/A	PFA plant	PFA slurry pump discharge isolation	Open & close	0.45/BMH/ASH/1232	500	380	3
31	N/A	PFA plant	PFA slurry pump discharge isolation	Open & close	0.45/BMH/ASH/1232	500	380	3
32	N/A	PFA plant	PFA slurry pump discharge isolation	Open & close	0.45/BMH/ASH/1232	500	380	3
33	N/A	PFA plant	PFA slurry pump cross over	Open & close	0.45/BMH/ASH/1232	500	380	3
34	N/A	PFA plant	PFA slurry pump cross over	Open & close	0.45/BMH/ASH/1232	500	380	3
35	N/A	PFA plant	PFA slurry pump cross over	Open & close	0.45/BMH/ASH/1232	500	380	3
36	N/A	PFA plant	PFA slurry pump cross over	Open & close	0.45/BMH/ASH/1232	500	380	3
37	N/A	PFA plant	PFA slurry pump cross over	Open & close	0.45/BMH/ASH/1232	500	380	3
38	N/A	PFA plant	PFA slurry pump cross over	Open & close	0.45/BMH/ASH/1232	500	380	3
39	N/A	PFA plant	PFA slurry pump cross over	Open & close	0.45/BMH/ASH/1232	500	380	3
40	N/A	PFA plant	PFA slurry pump cross over	Open & close	0.45/BMH/ASH/1232	500	380	3
41	N/A	PFA plant	PFA slurry pump cross over	Open & close	0.45/BMH/ASH/1232	500	380	3
42	N/A	PFA plant	PFA slurry pump cross over	Open & close	0.45/BMH/ASH/1232	500	380	3
43	N/A	PFA plant	PFA slurry pump cross over	Open & close	0.45/BMH/ASH/1232	500	380	3
44	N/A	PFA plant	PFA slurry pump cross over	Open & close	0.45/BMH/ASH/1232	500	380	3
45	N/A	PFA plant	PFA slurry pump cross over	Open & close	0.45/BMH/ASH/1232	500	380	3
46	N/A	PFA plant	PFA slurry pump cross over	Open & close	0.45/BMH/ASH/1232	500	380	3
47	N/A	PFA plant	PFA slurry pump cross over	Open & close	0.45/BMH/ASH/1232	500	380	3
48	N/A	PFA plant	PFA slurry pump cross over	Open & close	0.45/BMH/ASH/1232	500	380	3
49	N/A	PFA plant	PFA slurry pump cross over	Open & close	0.45/BMH/ASH/1232	500	380	3
50	N/A	PFA plant	PFA slurry pump cross over	Open & close	0.45/BMH/ASH/1232	500	380	3
51	N/A	PFA plant	PFA slurry pump cross over	Open & close	0.45/BMH/ASH/1232	500	380	3
52	N/A	PFA plant	PFA slurry pump cross over	Open & close	0.45/BMH/ASH/1232	500	380	3
53	N/A	PFA plant	PFA slurry pump cross over	Open & close	0.45/BMH/ASH/1232	500	380	3
54	N/A	PFA plant	PFA slurry pump cross over	Open & close	0.45/BMH/ASH/1232	500	380	3
55	N/A	PFA plant	PFA slurry pump cross over	Open & close	0.45/BMH/ASH/1232	500	380	3
56	N/A	PFA plant	PFA slurry pump cross over	Open & close	0.45/BMH/ASH/1232	500	380	3
57	N/A	PFA plant	PFA sump make-up	Control valve	0.45/BMH/ASH/1232	600	380	3
58	N/A	PFA plant	PFA sump make-up	Control valve	0.45/BMH/ASH/1232	600	380	3
59	N/A	PFA plant	Back flush to PFA slurry pump suction pipeline	Open & close	0.45/BMH/ASH/1232	300	380	2
60	N/A	PFA plant	Back flush to PFA slurry pump suction pipeline	Open & close	0.45/BMH/ASH/1232	300	380	2
61	N/A	PFA plant	PFA bilge pump suction isolation	Open & close	0.45/BMH/ASH/1232	100	380	1
62	N/A	PFA plant	PFA bilge pump discharge isolation	Open & close	0.45/BMH/ASH/1232	100	380	1
63	N/A	PFA plant	PFA agitation pump suction isolation	Open & close	0.45/BMH/ASH/1233	900	380	4
64	N/A	PFA plant	PFA agitation pump suction isolation	Open & close	0.45/BMH/ASH/1233	900	380	4
65	N/A	PFA plant	PFA agitation pump suction isolation	Open & close	0.45/BMH/ASH/1233	900	380	4
66	N/A	PFA plant	PFA agitation pump suction isolation	Open & close	0.45/BMH/ASH/1233	900	380	4
67	N/A	PFA plant	PFA agitation pump suction isolation	Open & close	0.45/BMH/ASH/1233	900	380	4

68	N/A	PFA plant	PFA agitation pump suction isolation	Open & close	0.45/BMH/ASH/1233	900	380	4
69	N/A	PFA plant	PFA agitation pump discharge isolation	Open & close	0.45/BMH/ASH/1233	400	380	3
70	N/A	PFA plant	PFA agitation pump discharge isolation	Open & close	0.45/BMH/ASH/1233	400	380	3
71	N/A	PFA plant	PFA agitation pump discharge isolation	Open & close	0.45/BMH/ASH/1233	400	380	3
72	N/A	PFA plant	PFA agitation pump discharge isolation	Open & close	0.45/BMH/ASH/1233	400	380	3
73	N/A	PFA plant	PFA agitation pump discharge isolation	Open & close	0.45/BMH/ASH/1233	400	380	3
74	N/A	PFA plant	PFA agitation pump discharge isolation	Open & close	0.45/BMH/ASH/1233	400	380	3
75	N/A	PFA plant	PFA agitation pump discharge bleed off	Control valve	0.45/BMH/ASH/1233	400	380	3
76	N/A	PFA plant	PFA agitation pump discharge bleed off	Control valve	0.45/BMH/ASH/1233	400	380	3
77	N/A	PFA plant	PFA agitation pump discharge bleed off	Control valve	0.45/BMH/ASH/1233	400	380	3
78	N/A	PFA plant	PFA agitation pump discharge bleed off	Control valve	0.45/BMH/ASH/1233	400	380	3
79	N/A	PFA plant	PFA agitation pump discharge bleed off	Control valve	0.45/BMH/ASH/1233	400	380	3
80	N/A	PFA plant	PFA agitation pump discharge bleed off	Control valve	0.45/BMH/ASH/1233	400	380	3
81	N/A	New Ash Dam 16 N	BBA pipeline isolation	Open & close	0.45/BMH/ASH/1234	500	380	3
82	N/A	New Ash Dam 16 N	BBA pipeline isolation	Open & close	0.45/BMH/ASH/1234	500	380	3
83	N/A	New Ash Dam 16 N	PFA pipeline isolation	Open & close	0.45/BMH/ASH/1234	500	380	3
84	N/A	New Ash Dam 16 N	PFA pipeline isolation	Open & close	0.45/BMH/ASH/1234	500	380	3
85	N/A	New Ash Dam 16 N	PFA pipeline isolation	Open & close	0.45/BMH/ASH/1234	500	380	3
86	N/A	New Ash Dam 16 N	PFA pipeline isolation	Open & close	0.45/BMH/ASH/1234	500	380	3
87	N/A	New Ash Dam 16 N	PFA pipeline isolation	Open & close	0.45/BMH/ASH/1234	500	380	3
88	N/A	New Ash Dam 16 N	PFA pipeline isolation	Open & close	0.45/BMH/ASH/1234	500	380	3
89	N/A	AWR system	Low Level Reservoirs pump suction isolation	Open & close	0.45/BMH/ASH/1235	600	380	3
90	N/A	AWR system	Low Level Reservoirs pump suction isolation	Open & close	0.45/BMH/ASH/1235	600	380	3
91	N/A	AWR system	Low Level Reservoirs pump suction isolation	Open & close	0.45/BMH/ASH/1235	600	380	3
92	N/A	AWR system	Low Level Reservoirs pump suction isolation	Open & close	0.45/BMH/ASH/1235	600	380	3
93	N/A	AWR system	Low Level Reservoirs pump suction isolation	Open & close	0.45/BMH/ASH/1235	600	380	3
94	N/A	AWR system	Low Level Reservoirs pump suction isolation	Open & close	0.45/BMH/ASH/1235	600	380	3
95	N/A	AWR system	Low Level Reservoirs pump discharge isolation	Open & close	0.45/BMH/ASH/1235	600	380	3
96	N/A	AWR system	Low Level Reservoirs pump discharge isolation	Open & close	0.45/BMH/ASH/1235	600	380	3
97	N/A	AWR system	Low Level Reservoirs pump discharge isolation	Open & close	0.45/BMH/ASH/1235	600	380	3
98	N/A	AWR system	Low Level Reservoirs pump discharge isolation	Open & close	0.45/BMH/ASH/1235	600	380	3
99	N/A	AWR system	Low Level Reservoirs pump discharge isolation	Open & close	0.45/BMH/ASH/1235	600	380	3
100	N/A	AWR system	Low Level Reservoirs pump discharge isolation	Open & close	0.45/BMH/ASH/1235	600	380	3

2. Drives

No.	KKS code	Plant Area	Description	Type	P & ID ref.	New Installation [Y/N]	Voltage [V]	Power [kW]
1	N/A	BBA plant	BBA slurry pump motor - 1st stage	VSD	0.45/BMH/ASH/1231	Y	3 300	1 040
2	N/A	BBA plant	BBA slurry pump motor - 2nd stage	Fixed speed	0.45/BMH/ASH/1231	Y	3 300	1 040
3	N/A	BBA plant	BBA slurry pump motor - 3rd stage	Fixed speed	0.45/BMH/ASH/1231	Y	3 300	1 040
4	N/A	BBA plant	BBA slurry pump motor - 1st stage	VSD	0.45/BMH/ASH/1231	Y	3 300	1 040
5	N/A	BBA plant	BBA slurry pump motor - 2nd stage	Fixed speed	0.45/BMH/ASH/1231	Y	3 300	1 040
6	N/A	BBA plant	BBA slurry pump motor - 3rd stage	Fixed speed	0.45/BMH/ASH/1231	Y	3 300	1 040
7	N/A	BBA plant	BBA bilge pump motor	Fixed speed	0.45/BMH/ASH/1231	Y	380	7.5
8	N/A	BBA plant	BBA agitation pump motor	Fixed speed	0.45/BMH/ASH/1231	Y	3 300	300
9	N/A	BBA plant	BBA agitation pump motor	Fixed speed	0.45/BMH/ASH/1231	Y	3 300	300
10	N/A	PFA conveyors	Drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	110
11	N/A	PFA conveyors	Drive motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	110
12	N/A	PFA conveyors	Take-up winch motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	3
13	N/A	PFA conveyors	Take-up winch motor	Fixed speed	0.45/BMH/ASH/1133-4	Y	380	3
14	N/A	PFA conveyors	Moveable head winch motor	Fixed speed	0.45/BMH/ASH/1232	Y	380	7.5
15	N/A	PFA conveyors	Moveable head winch motor	Fixed speed	0.45/BMH/ASH/1232	Y	380	7.5
16	N/A	PFA plant	PFA slurry pump motor - 1st stage	VSD	0.45/BMH/ASH/1232	Y	3 300	800
17	N/A	PFA plant	PFA slurry pump motor - 2nd stage	Fixed speed	0.45/BMH/ASH/1232	Y	3 300	800
18	N/A	PFA plant	PFA slurry pump motor - 3rd stage	Fixed speed	0.45/BMH/ASH/1232	Y	3 300	800
19	N/A	PFA plant	PFA slurry pump motor - 1st stage	VSD	0.45/BMH/ASH/1232	Y	3 300	800
20	N/A	PFA plant	PFA slurry pump motor - 2nd stage	Fixed speed	0.45/BMH/ASH/1232	Y	3 300	800
21	N/A	PFA plant	PFA slurry pump motor - 3rd stage	Fixed speed	0.45/BMH/ASH/1232	Y	3 300	800
22	N/A	PFA plant	PFA slurry pump motor - 1st stage	VSD	0.45/BMH/ASH/1232	Y	3 300	800
23	N/A	PFA plant	PFA slurry pump motor - 2nd stage	Fixed speed	0.45/BMH/ASH/1232	Y	3 300	800
24	N/A	PFA plant	PFA slurry pump motor - 3rd stage	Fixed speed	0.45/BMH/ASH/1232	Y	3 300	800
25	N/A	PFA plant	PFA slurry pump motor - 1st stage	VSD	0.45/BMH/ASH/1232	Y	3 300	800
26	N/A	PFA plant	PFA slurry pump motor - 2nd stage	Fixed speed	0.45/BMH/ASH/1232	Y	3 300	800
27	N/A	PFA plant	PFA slurry pump motor - 3rd stage	Fixed speed	0.45/BMH/ASH/1232	Y	3 300	800
28	N/A	PFA plant	PFA slurry pump motor - 1st stage	VSD	0.45/BMH/ASH/1232	Y	3 300	800
29	N/A	PFA plant	PFA slurry pump motor - 2nd stage	Fixed speed	0.45/BMH/ASH/1232	Y	3 300	800
30	N/A	PFA plant	PFA slurry pump motor - 3rd stage	Fixed speed	0.45/BMH/ASH/1232	Y	3 300	800
31	N/A	PFA plant	PFA slurry pump motor - 1st stage	VSD	0.45/BMH/ASH/1232	Y	3 300	800
32	N/A	PFA plant	PFA slurry pump motor - 2nd stage	Fixed speed	0.45/BMH/ASH/1232	Y	3 300	800
33	N/A	PFA plant	PFA slurry pump motor - 3rd stage	Fixed speed	0.45/BMH/ASH/1232	Y	3 300	800
34	N/A	PFA plant	PFA bilge pump motor	Fixed speed	0.45/BMH/ASH/1232	Y	380	7.5
35	N/A	PFA plant	PFA agitation pump motor	Fixed speed	0.45/BMH/ASH/1233	Y	3 300	490
36	N/A	PFA plant	PFA agitation pump motor	Fixed speed	0.45/BMH/ASH/1233	Y	3 300	490

37	N/A	PFA plant	PFA agitation pump motor	Fixed speed	0.45/BMH/ASH/1233	Y	3 300	490
38	N/A	PFA plant	PFA agitation pump motor	Fixed speed	0.45/BMH/ASH/1233	Y	3 300	490
39	N/A	PFA plant	PFA agitation pump motor	Fixed speed	0.45/BMH/ASH/1233	Y	3 300	490
40	N/A	PFA plant	PFA agitation pump motor	Fixed speed	0.45/BMH/ASH/1233	Y	3 300	490
41	N/A	PFA plant	PFA agitation pump motor	Fixed speed	0.45/BMH/ASH/1233	Y	3 300	490
42	N/A	PFA plant	PFA agitation pump motor	Fixed speed	0.45/BMH/ASH/1233	Y	3 300	490
43	N/A	PFA plant	PFA agitation pump motor	Fixed speed	0.45/BMH/ASH/1233	Y	3 300	490
44	N/A	PFA plant	PFA agitation pump motor	Fixed speed	0.45/BMH/ASH/1233	Y	3 300	490
45	N/A	PFA plant	PFA agitation pump motor	Fixed speed	0.45/BMH/ASH/1233	Y	3 300	490
46	N/A	PFA plant	PFA agitation pump motor	Fixed speed	0.45/BMH/ASH/1233	Y	3 300	490
47	N/A	PFA plant	PFA agitation pump motor	Fixed speed	0.45/BMH/ASH/1233	Y	3 300	490
48	N/A	PFA plant	PFA agitation pump motor	Fixed speed	0.45/BMH/ASH/1233	Y	3 300	490
49	N/A	PFA plant	PFA agitation pump motor	Fixed speed	0.45/BMH/ASH/1233	Y	3 300	490
50	N/A	PFA plant	PFA agitation pump motor	Fixed speed	0.45/BMH/ASH/1233	Y	3 300	490
51	N/A	PFA plant	PFA agitation pump motor	Fixed speed	0.45/BMH/ASH/1233	Y	3 300	490
52	N/A	PFA plant	PFA agitation pump motor	Fixed speed	0.45/BMH/ASH/1233	Y	3 300	490
53	N/A	AWR system	Low Level Reservoir pump motor	Fixed speed	0.45/BMH/ASH/1235	Y	3 300	300
54	N/A	AWR system	Low Level Reservoir pump motor	Fixed speed	0.45/BMH/ASH/1235	Y	3 300	300
55	N/A	AWR system	Low Level Reservoir pump motor	Fixed speed	0.45/BMH/ASH/1235	Y	3 300	300
56	N/A	AWR system	Low Level Reservoir pump motor	Fixed speed	0.45/BMH/ASH/1235	Y	3 300	300
57	N/A	AWR system	Low Level Reservoir pump motor	Fixed speed	0.45/BMH/ASH/1235	Y	3 300	300
58	N/A	AWR system	Low Level Reservoir pump motor	Fixed speed	0.45/BMH/ASH/1235	Y	3 300	300
59	N/A	AWR system	Low Level Reservoir pump motor	Fixed speed	0.45/BMH/ASH/1235	Y	3 300	300
60	N/A	AWR system	Low Level Reservoir pump motor	Fixed speed	0.45/BMH/ASH/1235	Y	3 300	300
61	N/A	AWR system	Low Level Reservoir pump motor	Fixed speed	0.45/BMH/ASH/1235	Y	3 300	300
62	N/A	AWR system	Low Level Reservoir pump motor	Fixed speed	0.45/BMH/ASH/1235	Y	3 300	300
63	N/A	AWR system	Low Level Reservoir pump motor	Fixed speed	0.45/BMH/ASH/1235	Y	3 300	300
64	N/A	AWR system	Low Level Reservoir pump motor	Fixed speed	0.45/BMH/ASH/1235	Y	3 300	300
65	N/A	AWR system	Low Level Reservoir pump motor	Fixed speed	0.45/BMH/ASH/1235	Y	3 300	300
66	N/A	AWR system	Low Level Reservoir pump motor	Fixed speed	0.45/BMH/ASH/1235	Y	3 300	300
67	N/A	AWR system	Low Level Reservoir pump motor	Fixed speed	0.45/BMH/ASH/1235	Y	3 300	300
68	N/A	AWR system	Low Level Reservoir pump motor	Fixed speed	0.45/BMH/ASH/1235	Y	3 300	300
69	N/A	AWR system	Low Level Reservoir pump motor	Fixed speed	0.45/BMH/ASH/1235	Y	3 300	300
70	N/A	AWR system	Low Level Reservoir pump motor	Fixed speed	0.45/BMH/ASH/1235	Y	3 300	300

18 023

3. Flow meters

No.	KKS code	Plant Area	Description	Type	P & ID ref.	Valve size [NB]
1	N/A	BBA plant	BBA agitation pump discharge pipeline		0.45/BMH/ASH/1231	250
2	N/A	BBA plant	BBA slurry pump discharge pipeline		0.45/BMH/ASH/1231	500
3	N/A	BBA plant	BBA slurry pump discharge pipeline		0.45/BMH/ASH/1231	500
4	N/A	PFA plant	PFA slurry pump discharge pipeline		0.45/BMH/ASH/1232	500
5	N/A	PFA plant	PFA slurry pump discharge pipeline		0.45/BMH/ASH/1232	500
6	N/A	PFA plant	PFA slurry pump discharge pipeline		0.45/BMH/ASH/1232	500
7	N/A	PFA plant	PFA slurry pump discharge pipeline		0.45/BMH/ASH/1232	500
8	N/A	PFA plant	PFA slurry pump discharge pipeline		0.45/BMH/ASH/1232	500
9	N/A	PFA plant	PFA slurry pump discharge pipeline		0.45/BMH/ASH/1232	500
10	N/A	PFA plant	PFA agitation pump discharge pipeline		0.45/BMH/ASH/1233	400
11	N/A	PFA plant	PFA agitation pump discharge pipeline		0.45/BMH/ASH/1233	400
12	N/A	PFA plant	PFA agitation pump discharge pipeline		0.45/BMH/ASH/1233	400
13	N/A	PFA plant	PFA agitation pump discharge pipeline		0.45/BMH/ASH/1233	400
14	N/A	PFA plant	PFA agitation pump discharge pipeline		0.45/BMH/ASH/1233	400
15	N/A	PFA plant	PFA agitation pump discharge pipeline		0.45/BMH/ASH/1233	400
16	N/A	AWR system	Low Level Reservoir pump discharge pipeline		0.45/BMH/ASH/1235	600
17	N/A	AWR system	Low Level Reservoir pump discharge pipeline		0.45/BMH/ASH/1235	600
18	N/A	AWR system	Low Level Reservoir pump discharge pipeline		0.45/BMH/ASH/1235	600
19	N/A	AWR system	Low Level Reservoir pump discharge pipeline		0.45/BMH/ASH/1235	600

4. Level Indicator Transmittors (LIT)

No.	KKS code	Plant Area	Description	Type	P & ID ref.
1	N/A	BBA plant	Lever Indicator Transmitter (LIT) 1 - sump 1		0.45/BMH/ASH/1231
2	N/A	BBA plant	Lever Indicator Transmitter (LIT) 2 - sump 1		0.45/BMH/ASH/1231
3	N/A	BBA plant	Lever Indicator Transmitter (LIT) 3 - sump 1		0.45/BMH/ASH/1231
4	N/A	BBA plant	Lever Indicator Transmitter (LIT) 1 - sump 2		0.45/BMH/ASH/1231
5	N/A	BBA plant	Lever Indicator Transmitter (LIT) 2 - sump 2		0.45/BMH/ASH/1231
6	N/A	BBA plant	Lever Indicator Transmitter (LIT) 3 - sump 2		0.45/BMH/ASH/1231
7	N/A	PFA plant	Lever Indicator Transmitter (LIT) 1 - sump 1		0.45/BMH/ASH/1232
8	N/A	PFA plant	Lever Indicator Transmitter (LIT) 2 - sump 1		0.45/BMH/ASH/1232
9	N/A	PFA plant	Lever Indicator Transmitter (LIT) 3 - sump 1		0.45/BMH/ASH/1232
10	N/A	PFA plant	Lever Indicator Transmitter (LIT) 1 - sump 2		0.45/BMH/ASH/1232
11	N/A	PFA plant	Lever Indicator Transmitter (LIT) 2 - sump 2		0.45/BMH/ASH/1232
12	N/A	PFA plant	Lever Indicator Transmitter (LIT) 3 - sump 2		0.45/BMH/ASH/1232
13	N/A	AWR system	Lever Indicator Transmitter (LIT) 1 - low level dam 1		0.45/BMH/ASH/1235

14	N/A	AWR system	Lever Indicator Transmitter (LIT) 2 - low level dam 1		0.45/BMH/ASH/1235
15	N/A	AWR system	Lever Indicator Transmitter (LIT) 3 - low level dam 1		0.45/BMH/ASH/1235
16	N/A	AWR system	Lever Indicator Transmitter (LIT) 1 - low level dam 2		0.45/BMH/ASH/1235
17	N/A	AWR system	Lever Indicator Transmitter (LIT) 2 - low level dam 2		0.45/BMH/ASH/1235
18	N/A	AWR system	Lever Indicator Transmitter (LIT) 3 - low level dam 2		0.45/BMH/ASH/1235

5. Pressure Indicator Transmittors (PIT)

No.	KKS code	Plant Area	Description	Type	P & ID ref.
1	N/A	BBA plant	BBA slurry pump suction pipeline		0.45/BMH/ASH/1231
2	N/A	BBA plant	BBA slurry pump suction pipeline		0.45/BMH/ASH/1231
3	N/A	BBA plant	BBA slurry pump discharge pipeline		0.45/BMH/ASH/1231
4	N/A	BBA plant	BBA slurry pump discharge pipeline		0.45/BMH/ASH/1231
5	N/A	BBA plant	BBA agitation pump suction pipeline		0.45/BMH/ASH/1231
6	N/A	BBA plant	BBA agitation pump suction pipeline		0.45/BMH/ASH/1231
7	N/A	BBA plant	BBA agitation pump discharge pipeline		0.45/BMH/ASH/1231
8	N/A	BBA plant	BBA agitation pump discharge pipeline		0.45/BMH/ASH/1231
9	N/A	PFA plant	PFA slurry pump suction pipeline		0.45/BMH/ASH/1232
10	N/A	PFA plant	PFA slurry pump suction pipeline		0.45/BMH/ASH/1232
11	N/A	PFA plant	PFA slurry pump suction pipeline		0.45/BMH/ASH/1232
12	N/A	PFA plant	PFA slurry pump suction pipeline		0.45/BMH/ASH/1232
13	N/A	PFA plant	PFA slurry pump suction pipeline		0.45/BMH/ASH/1232
14	N/A	PFA plant	PFA slurry pump suction pipeline		0.45/BMH/ASH/1232
15	N/A	PFA plant	PFA slurry pump discharge pipeline		0.45/BMH/ASH/1232
16	N/A	PFA plant	PFA slurry pump discharge pipeline		0.45/BMH/ASH/1232
17	N/A	PFA plant	PFA slurry pump discharge pipeline		0.45/BMH/ASH/1232
18	N/A	PFA plant	PFA slurry pump discharge pipeline		0.45/BMH/ASH/1232
19	N/A	PFA plant	PFA slurry pump discharge pipeline		0.45/BMH/ASH/1232
20	N/A	PFA plant	PFA slurry pump discharge pipeline		0.45/BMH/ASH/1232
21	N/A	PFA plant	PFA agitation pump suction pipeline		0.45/BMH/ASH/1233
22	N/A	PFA plant	PFA agitation pump suction pipeline		0.45/BMH/ASH/1233
23	N/A	PFA plant	PFA agitation pump suction pipeline		0.45/BMH/ASH/1233
24	N/A	PFA plant	PFA agitation pump suction pipeline		0.45/BMH/ASH/1233
25	N/A	PFA plant	PFA agitation pump suction pipeline		0.45/BMH/ASH/1233
26	N/A	PFA plant	PFA agitation pump suction pipeline		0.45/BMH/ASH/1233
27	N/A	PFA plant	PFA agitation pump discharge pipeline		0.45/BMH/ASH/1233
28	N/A	PFA plant	PFA agitation pump discharge pipeline		0.45/BMH/ASH/1233
29	N/A	PFA plant	PFA agitation pump discharge pipeline		0.45/BMH/ASH/1233
30	N/A	PFA plant	PFA agitation pump discharge pipeline		0.45/BMH/ASH/1233
31	N/A	PFA plant	PFA agitation pump discharge pipeline		0.45/BMH/ASH/1233
32	N/A	PFA plant	PFA agitation pump discharge pipeline		0.45/BMH/ASH/1233
33	N/A	AWR system	Low Level Reservoirs pump suction pipeline		0.45/BMH/ASH/1235
34	N/A	AWR system	Low Level Reservoirs pump suction pipeline		0.45/BMH/ASH/1235
35	N/A	AWR system	Low Level Reservoirs pump suction pipeline		0.45/BMH/ASH/1235
36	N/A	AWR system	Low Level Reservoirs pump suction pipeline		0.45/BMH/ASH/1235
37	N/A	AWR system	Low Level Reservoirs pump suction pipeline		0.45/BMH/ASH/1235
38	N/A	AWR system	Low Level Reservoirs pump suction pipeline		0.45/BMH/ASH/1235
39	N/A	AWR system	Low Level Reservoirs pump discharge pipeline		0.45/BMH/ASH/1235
40	N/A	AWR system	Low Level Reservoirs pump discharge pipeline		0.45/BMH/ASH/1235
41	N/A	AWR system	Low Level Reservoirs pump discharge pipeline		0.45/BMH/ASH/1235
42	N/A	AWR system	Low Level Reservoirs pump discharge pipeline		0.45/BMH/ASH/1235
43	N/A	AWR system	Low Level Reservoirs pump discharge pipeline		0.45/BMH/ASH/1235
44	N/A	AWR system	Low Level Reservoirs pump discharge pipeline		0.45/BMH/ASH/1235

7. Subsystems

No.	KKS code	Plant Area	Description	Type	P & ID ref.
1	N/A	BBA plant	BBA slurry pump sealing water system - 1st stage		0.45/BMH/ASH/1236
2	N/A	BBA plant	BBA slurry pump sealing water system - 2nd stage		0.45/BMH/ASH/1237
3	N/A	BBA plant	BBA slurry pump sealing water system - 3rd stage		0.45/BMH/ASH/1238
4	N/A	BBA plant	BBA agitation pump sealing water system - 1st stage		0.45/BMH/ASH/1236
5	N/A	BBA plant	BBA agitation pump sealing water system - 2nd stage		0.45/BMH/ASH/1237
6	N/A	PFA plant	PFA slurry pump sealing water system - 1st stage		0.45/BMH/ASH/1236
7	N/A	PFA plant	PFA slurry pump sealing water system - 1st stage		0.45/BMH/ASH/1236
8	N/A	PFA plant	PFA slurry pump sealing water system - 2nd stage		0.45/BMH/ASH/1237
9	N/A	PFA plant	PFA slurry pump sealing water system - 2nd stage		0.45/BMH/ASH/1237
10	N/A	PFA plant	PFA slurry pump sealing water system - 3rd stage		0.45/BMH/ASH/1238
11	N/A	PFA plant	PFA slurry pump sealing water system - 3rd stage		0.45/BMH/ASH/1238
12	N/A	PFA plant	PFA agitation pump sealing water system - 1st stage		0.45/BMH/ASH/1236
13	N/A	PFA plant	PFA agitation pump sealing water system - 1st stage		0.45/BMH/ASH/1236
14	N/A	PFA plant	PFA agitation pump sealing water system - 2nd stage		0.45/BMH/ASH/1237
15	N/A	PFA plant	PFA agitation pump sealing water system - 2nd stage		0.45/BMH/ASH/1237
16	N/A	PFA plant	PFA agitation pump sealing water system - 3rd stage		0.45/BMH/ASH/1238
17	N/A	PFA plant	PFA agitation pump sealing water system - 3rd stage		0.45/BMH/ASH/1238

18	N/A	AWR system	Low Level Reservoirs pump sealing water system - 1st stage		0.45/BMH/ASH/1236
19	N/A	AWR system	Low Level Reservoirs pump sealing water system - 1st stage		0.45/BMH/ASH/1236
20	N/A	AWR system	Low Level Reservoirs pump sealing water system - 2nd stage		0.45/BMH/ASH/1237
21	N/A	AWR system	Low Level Reservoirs pump sealing water system - 2nd stage		0.45/BMH/ASH/1237
22	N/A	AWR system	Low Level Reservoirs pump sealing water system - 3rd stage		0.45/BMH/ASH/1238
23	N/A	AWR system	Low Level Reservoirs pump sealing water system - 3rd stage		0.45/BMH/ASH/1238