Superconducting Fault Current Limiter

33kV SFCL

Balance of Plant Design Report

Milestone 6

CONFIDENTIALITY (Confidential or not confidential) :NOT **CONFIDENTIAL**
PROJECT OR PRODUCT : 33kV 800A normal current 1400A/15 mins over current design

UNIT APPROVAL	**Name**	**Date**
WRITTEN BY :	David Klaus	27.03.2012
CHECKED BY :	Adrian Wilson	28.03.2012
APPROVED BY :	Adrian Wilson	28.03.2012
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REVISION HISTORY RECORDS

Revision	**Date**	**Creation / Update summary**
Issue 1	28.03.2012	Customer Issue

TABLE OF CONTENTS

1. INTRODUCTION

This Report details the Balance of Plant design for the Jordanthorpe 33kV SFCL. The Balance of Plant design has been carried out with the assistance and agreement of Northern Powergrid and National Grid engineers and this work is summarised in Parts 2 and 3 of this Report <Part 2: 32386 FS SFCL Trial Jordanthorpe D1 1.doc> and < Part 3: Jordanthorpe DSC Spec D7.doc>

2. GENERAL ARRANGEMENT OF CONNECTION

The layout of the new plant associated with the SFCL connection is provided in the drawing <Part 4: 5108464-00.09-0100.pdf>

3. MAJOR PLANT USED

A Siemens 66kV Dead Tank Breaker will be used to bypass the SFCL and two Morris Line 66kv Disconnectors will be used for isolation.

4. CONCLUSION

This report details the 33kV SFCL Balance of Plant design for Jordanthorpe SGSP.

End of Report

FUNCTIONAL SPECIFICATION 2011

PROJECT NUMBER

32386

CFS Reference

A Functional Specification for a Superconducting Fault Current Limiter at Jordanthorpe Substation.

Version D1.1

Northern Powergrid

Revision Record

Version	Date	Revision Details	Author
D 1.0	20/05/2011	First draft	Joseph Helm
D1.1	11/11/2011	Revised draft following initial meetings with National Grid and agreement in principle for a busbar connection.	Joseph Helm

Contents

1. Purpose

The purpose of this functional specification is to outline the network configuration necessary to facilitate the deployment of a superconducting fault current limiter (SFCL) at Jordanthorpe 275/33kV substation at grid reference SK3608481626.

All work in this functional specification is non-contestable, since it is 90% funded under the Low Carbon Network Fund (LCNF) scheme.

This functional specification will enable Primary Engineering Projects (PEP) to prepare a firm price for the work required.

The firm price should identify and include the costs of any provisions necessary to meet operational and network security constraints during the construction phase and the particular methods of working and outage programme required.

2. Scope

This specification provides a description of the electrical network configuration and the works necessary to facilitate the deployment of a superconducting Fault Current Limiter at Jordanthorpe 275/33kV substation. It also describes the technical requirements and parameters of the plant and equipment to be installed. Sufficient technical information is provided to enable PEP to assess the feasibility and cost of the required investment.

The proposed busbar connection, which has been agreed in principle with National Grid, will place the SFCL on National Grid's network. It is assumed that National Grid will design and implement an appropriate protection scheme.

It is assumed that all switchgear specified will need to meet the appropriate Northern Powergrid/National Grid standards.

3. Introduction

Northern Powergrid, under the LCNF scheme, is undertaking an R&D project deploying a superconducting fault current limiter (SFCL) at Jordanthorpe 275/33kV Substation.

The project is a collaboration between Northern Powergrid and Applied Superconductor Limited (ASL) and was initiated under Ofgem's Low Carbon Network Fund (LCNF) to install a SFCL onto the 33kV network on a National Grid fed site in Sheffield with the purpose of demonstrating both the limitation of fault current imposed on the switchgear currently installed, and the creation of additional headroom which could be used to release capacity to facilitate the connection of new low carbon generation.

The SFCL design proposed for this site comprises a pre-saturated core in which the load current (copper) conductors are wound on an iron core, and the iron core itself is driven into saturation by a dc winding made of superconducting material. Under normal current operation the unit behaves to the network like an air cored reactor, however under fault conditions the fault current drives the iron core out of saturation and then behaves like an iron cored reactor to the faulted network, increasing its impedance and reducing the fault current by up to circa 40%.

The installation of the SFCL into one of the 33kV transformer tails at Jordanthorpe will limit the fault current contribution from this infeed and will facilitate the management of the fault level make issue at the site, which currently stands at 96.6% of the switchgear make rating. More significantly, the installation will increase the headroom with respect to fault level, allowing future connection of distributed generation (DG) to the network fed from Jordanthorpe.

The unit, Manufactured by Zenergy Power, is supplied to Northern Powergrid by Applied Superconductor Limited and builds on an IFI collaborative project to implement a SFCL operating at 11kV on the Northern Powergrid distribution network at Station Road Scunthorpe.

The work to be carried out to facilitate this project is as follows:

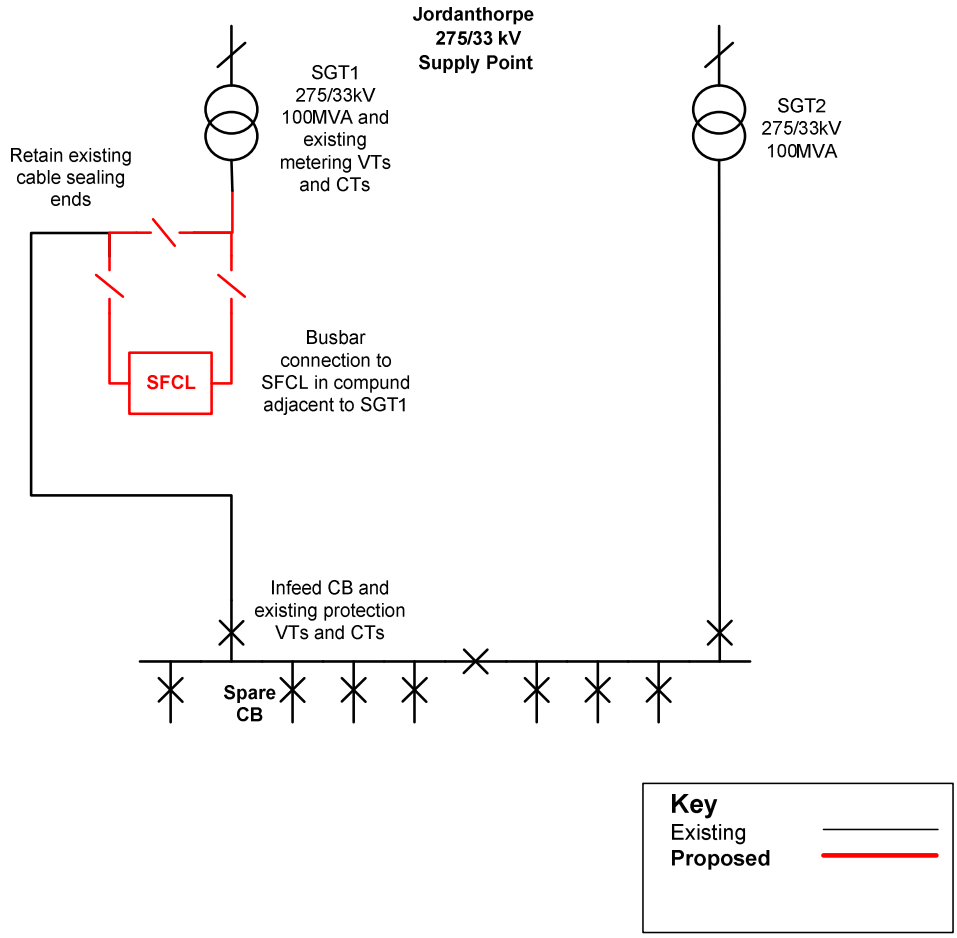
- Agree access arrangements to the identified spare SGT compound (within the perimeter of the 275/33kV compound) and agree the personnel authorisation required with National Grid
- Test the integrity of the existing bund and carry out remedial work if required or install an omnibund or similar.
- Confirm the suitability of the existing plinth to site the SFCL
- Design and construct foundations and supporting structures for busbars and pole mounted isolators and bypass switchgear
- Divert existing 415V cable between SGT1 auxiliary transformer and the auxiliary distribution board if required to facilitate civil works.
- Relocate lamp post
- Provide 100kVA auxiliary 3 phase & neutral supply at 415V to the SFCL. The preferred arrangement is to provide the supply from the National Grid auxiliary board subject to confirmation of available capacity.
- Provide a suitable tripping 110V battery supply or connection to National Grid's 110V supply.
- Make suitable provisions for connection to the substation earth point. (The existing plinths have connections to the substation earth system.)

- Connection of the FCL will be achieved as follows:
    - Remove the existing busbar between SGT1 CTs and the corresponding cable sealing ends
    - Construct a high level busbar between the CTs and a pole mounted isolator connected by a further busbar to the FCL bushings
    - Construct a low level return busbar between the SFCL and a second pole mounted isolator to the cable sealing ends.
    - Provide by-pass functionality of the SFCL using an appropriately rated air break disconnector or circuit breaker connected between the high level and low level busbars.
- It is assumed that National Grid will design the protection scheme. To facilitate unit protection of the SFCL CTs will be specified and connected either side of the SFCL.
- Provide appropriate pilot cables to National Grid.
- National Grid to modify their SCADA to incorporate the new network configuration to accept new alarms from, and issue commands to the SFCL.
- The addition of the SFCL impedence and the additional reactive current flowing will need to be accommodated by the National Grid Voltage Control system.
- Provide the following to the SFCL
    - Volt free communication signals to/from the SFCL device
    - 4-20mA signals representing the voltages either side of the SFCL device
    - 4-20mA signals representing the current flowing through the unit
    - Earth
- Agree operational procedures for access, operation and maintenance of the SFCL device.

4. Existing & Proposed Network Configuration

Jordanthorpe Grid Supply Point (GSP) is a 33kV substation fed from two 100MVA transformers connected to the 275kV network.

The proposed network configuration is shown below. The existing cable sealing ends are retained and the SFCL is connected by two sets of busbars and a pairs of isolators. By-pass functionality is provided by an appropriately rated air break disconnector or circuit breaker.



Proposed SFCL location

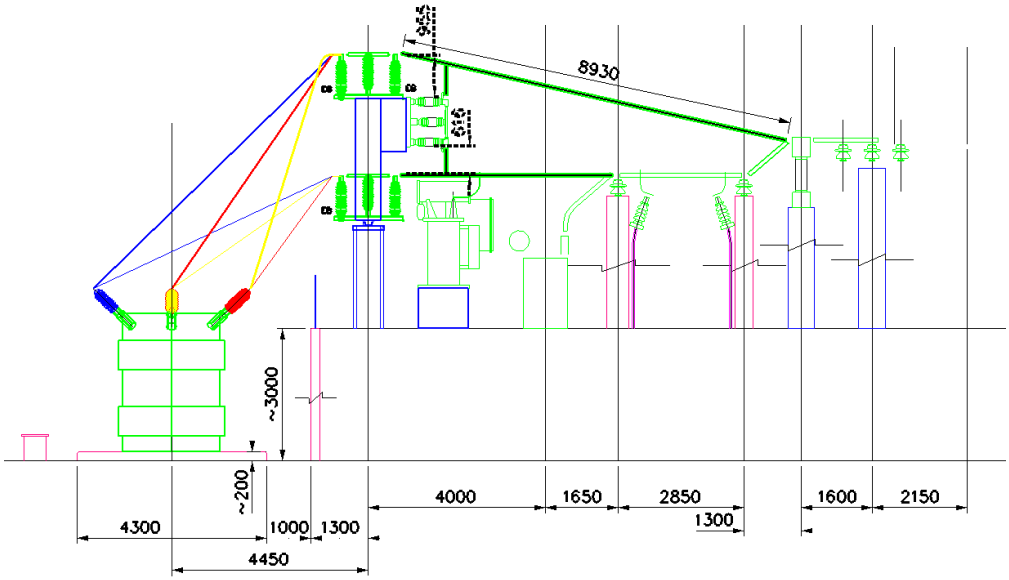
The photograph below is an aerial view of the Jordanthorpe site. The boundary of an enclosed compound adjacent to SGT1 is identified in red. This spare SGT compound is currently unused and it is proposed that this compound is acquired from National Grid on a temporary basis for the duration of the demonstration project.

Aerial photograph of the Jordanthorpe site

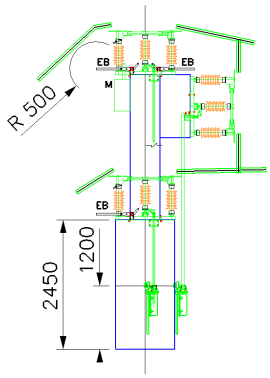
Northern Powergrid proposes to interrupt the bus bar between the SGT1 CTs and the 33kV cable sealing ends which feed the Northern Powergrid 33kV substation situated at the top right of the photograph. The SFCL connection will therefore need isolators and a bypass circuit breaker or rated air break disconnector.

The main benefits of this approach opposed to a cable connection are the lack of disruption to underground cables, the ease of returning the site back to normal operation after the demonstration and making best use of the existing infrastructure to minimise civil costs.

A feasibility study drawing showing the proposed busbar connection arrangement is included below.



Drawing to show the proposed busbar connection arrangement of the SFCL to the SGT1 33kV feeder and detail showing proposed isolator arrangement.



Drawing to show the proposed isolator and bypass arrangement. This design is subject to a rated air break switch disconnector being approved by CE and NG.

4.1. Point of Connection

Under this proposal the SFCL will be installed on the 33kV SGT1 transformer tails. The SGT, 33kV transformer tail and 33kV transformer circuit breaker up to the point of the clamp onto the 33kV busbars are owned by National Grid. The installation of the SFCL, an auxiliary transformer and 33kV isolators would all be connected to National Grid assets.

It is proposed that as the SFCL is connected to National Grid assets, National Grid will take control of the device through their SCADA system; however CE will retain ownership of the device and will be responsible for its recovery at the end of the demonstration period.

Subject to confirmation of available capacity, auxiliary supplies will be provided from the National Grid auxiliary board. If there is insufficient available capacity, auxiliary supplies will be made available by connection of a new 33kV/415V transformer on site or alternatively by connection to the LV network.

4.2. Characteristics of the Point of Connection

The existing Northern Powergrid network is designed to be compliant with Electricity Safety Quality and Continuity Regulations (ESQCR) and other relevant Engineering Recommendations issued by the Energy Networks Association. The following information is also relevant:

4.2.1. System Voltage

The nominal system voltage is 33,000V.

4.2.2. Short circuit contribution from the Northern Powergrid 33kV system

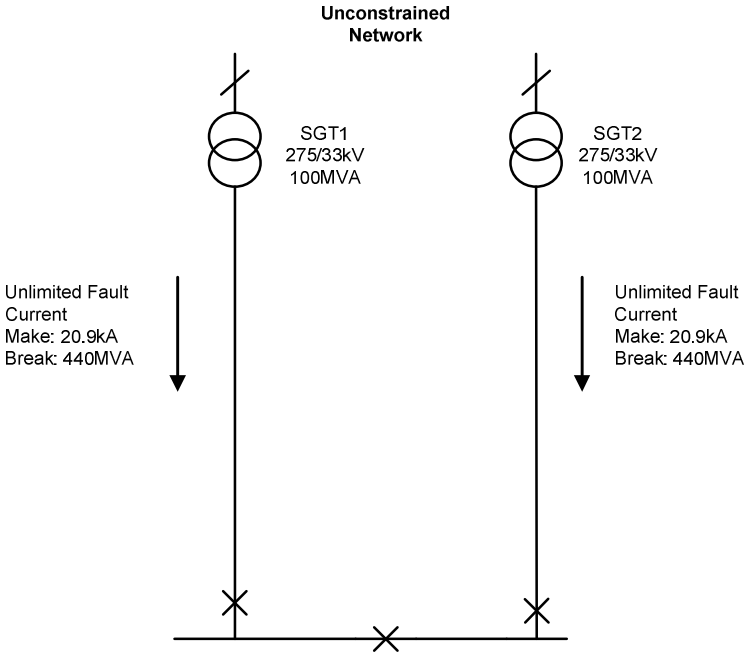
	Time ms	Maximum		Minimum
		kA	Network X/R ratio	kA
3 phase symmetrical rms	0	14.79	28.02	7.74
1 phase rms	0	3.34	0.24	1.65

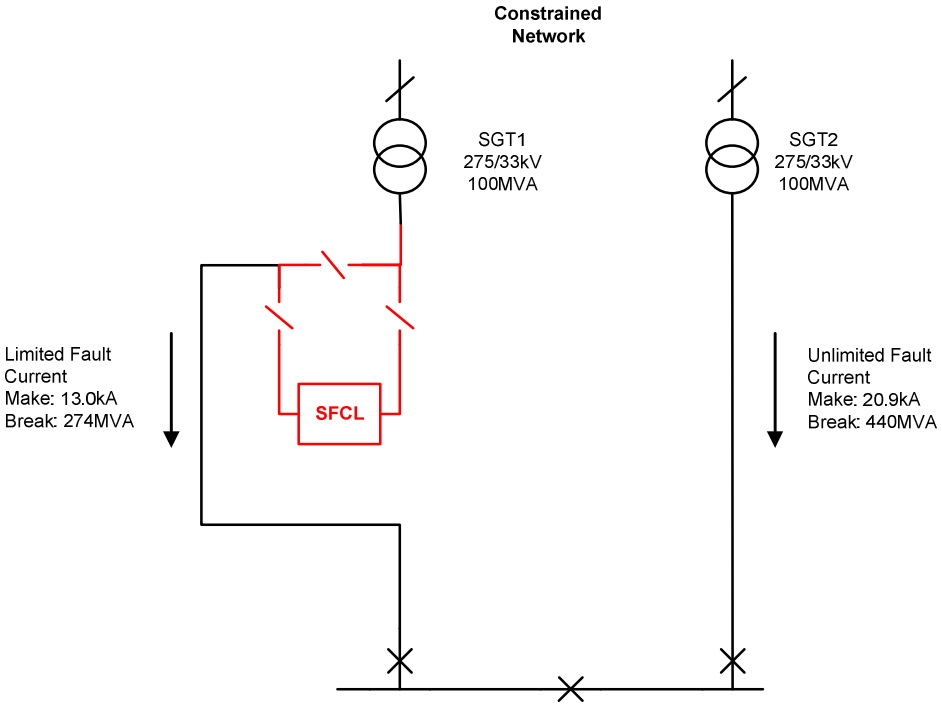
The above values may change in the future as Northern Powergrid operates a dynamic system and should be confirmed prior to being used to calculate protection settings.

Jordanthorpe substation was previously subject to switching restrictions in order to manage fault make duty. The 2011 fault level survey assessed the make duty to have reduced by approximately 5% since the 2007 study to just within the rating of the switchgear. Based on the 2011 Fault Level Survey the fault levels for the 33kV system are 846MVA break and 42.2kA make. The installed switchgear has a 3-phase break rating of 1000MVA, and a make rating of 43.7kA.

It is anticipated that the SFCL will limit the fault level to 714MVA break and 33.9kA make by restricting the fault contribution from one transformer.

The Network contribution from both transformers together is 880MVA break and 41.8kA make. A single transformer provides 440MVA break and 20.9kA make. To achieve a break rating of 714MVA and make rating of 33.9kA one transformer needs to be limited to 274MVA break and 13.0kA make as follows:


Unconstrained
Network
SGT1
275/33kV
100MVA
SGT2
275/33kV
100MVA
Unlimited Fault
Current
Make: 20.9kA
Break: 440MVA
Unlimited Fault
Current
Make: 20.9kA
Break: 440MVA


Constrained
Network
SGT1
275/33kV
100MVA
SGT2
275/33kV
100MVA
Limited Fault
Current
Make: 13.0kA
Break: 274MVA
SFCL
Unlimited Fault
Current
Make: 20.9kA
Break: 440MVA

5. Technical Data

All works shall be carried out to comply with the relevant British Standards, Energy Networks Association Technical Standards, IEC Standards, Engineering Recommendations, Northern Powergrid Design and Construction Specifications for Contestable Works associated with 33/66 and 132kV connections and to good industry and engineering practices. All plant, mains and other equipment shall be approved by Northern Powergrid.

5.1. Overhead Lines

No new overhead lines are required for this work.

5.2. Underground Cables

No new overhead lines are required for this work.

5.3. Switchgear

The following new switchgear is required:

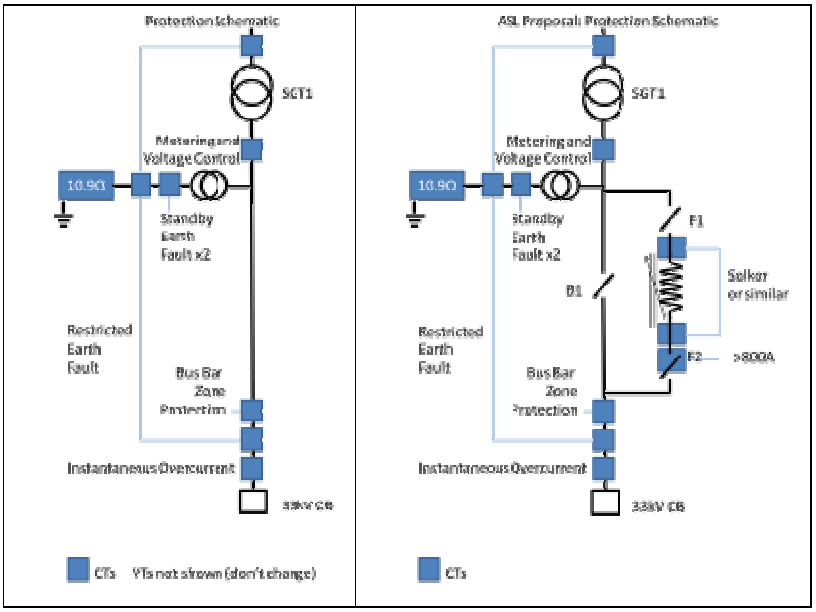
Switchgear type	ABSD	Disconnector/earth switch
Quantity	1	2
Class	Outdoor	Outdoor
Number of poles	3	3
Voltage /kV	33	33
Rated normal current /A	2000	2000
Rated short time current /kA	25	25
Duration of short circuit /s	3	3
Rated peak withstand current /kA	78.75	78.75
Rated peak short-circuit making current /kAp	78.75	-
Rated supply voltage of closing and opening devices /V	110	110
Rated bus transfer switching	-	80% normal rated current @ 100V bus transfer voltage

N.B. The switchgear data above were used for the network study and form the basis upon which the agreed technical option has been authorised. A decision to change any of these parameters should be referred to Asset Management for agreement prior to any equipment being ordered or any work being carried out on site.

5.4. Protection

The Jordanthorpe SGT1 transformer and feeder is protected by a Restricted Earth Fault (REF) system and a Standby Earth fault (SEF) system. Putting the SFCL into this protected zone would also protect the network from it; however it would not be evident if the fault was in the SFCL or the transformer. A fast acting Solkor protection fitted each side the SFCL would indicate if the fault is within the SFCL in which the device could be by-passed and the feeder re-energised. Unit protection of the SFCL would need ingoing and outgoing CTs at the SFCL. It is proposed to mount the CTs within the SFCL unit. The existing and proposed protection schematic is shown in the diagram below.

An overcurrent (>800A) relay will also need to be added to the design to trigger the by-passing of the FCL.



Existing and proposed protection schematic.

The following protection is required:

Site	Work Class*	Voltage kV	Circuit No	Circuit Name	Protection & Metering Requirements
Jordanthorpe	NC	33		SGT1	Include the SFCL in the existing SGT1 Restricted Earth Fault (REF) and Standby Earth fault (SEF) protection. Provide discrimination through Solkor unit protection around the SFCL. Buckholtz signal from the FCL to initiate trip. A trip signal triggers the opening of SGT1 CB, S10 and the Brinsworth CB.
				SFCL	An overcurrent relay will initiate closing of the by-pass ABSD in the event that the current through the SFCL exceeds 800A. A time delay will allow for the auto-reclose sequence of SGT2 before by-passing the SFCL. By-pass may also be initiated by a non-fault failure of the SFCL.

Operating Procedures

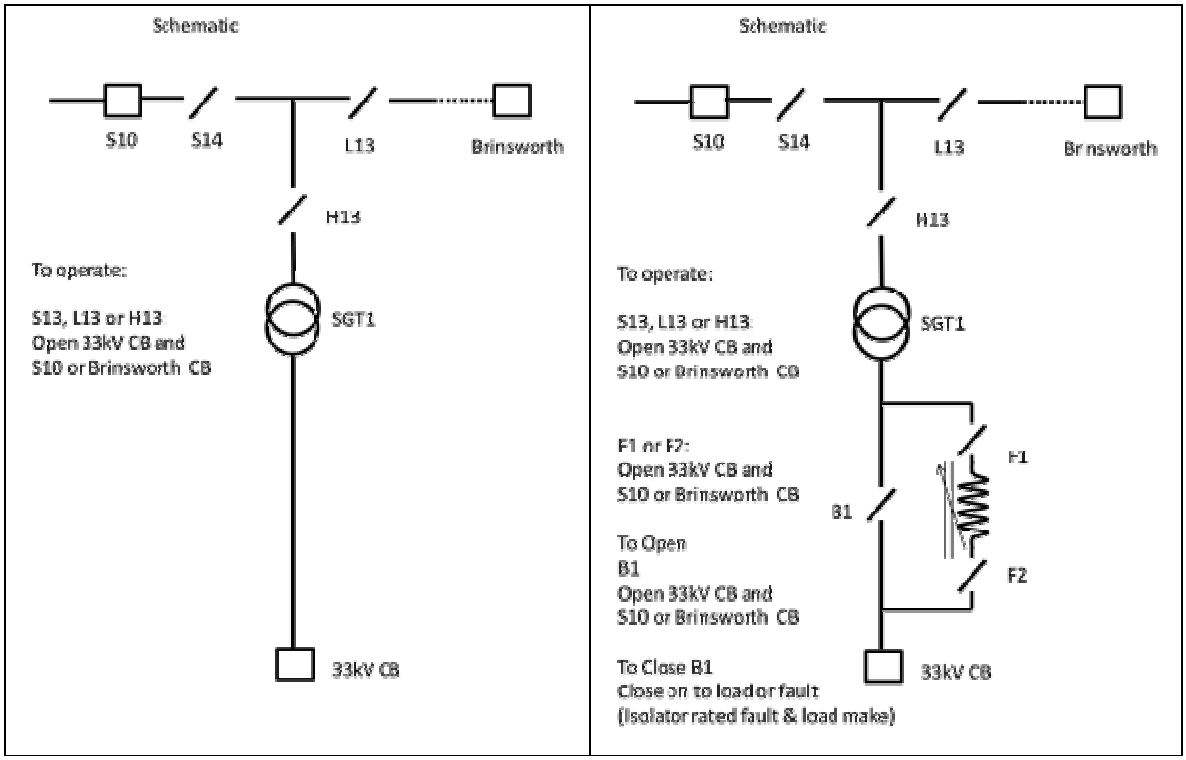
The new isolators will need to be included in the substation control scheme. Included below is a schematic as to their locations:

Operating procedures and appropriate interlocks shall be required for the following operations:

To Switch in the SFCL

To Switch out the SFCL

To emergency bypass the SFCL in the event of an overcurrent signal or non-fault event



5.4.1. Protection Settings

Tech Services is responsible for confirming that the Northern Powergrid elements of the protection scheme proposed are correct and can be implemented, having made the necessary assessment and calculation of the required protection settings. Tech Services Engineers require access to the DINIS or IPSA network study file. The following is the network study model reference for the proposed scheme.

DINIS or IPSA File Reference
Insert the Full File Reference Including the Engineers Username

5.4.2. Generation Loss/Earth of Mains scheme

No 'loss of mains/earth' scheme is required for this work.

5.4.3. Export Management Equipment

An export management scheme is not required.

5.4.4. Power Quality Monitoring

The proposed substation shall be fitted with a Fault Recorder, either a separate unit or by configuring the protection relays with this functionality. The data must be down-loadable post fault.

5.4.5. Communications Channels

The following protection related communication channels are required:

Route	Requirement	Function	Work Class
		Intertripping	NC

The table should indicate the sites between which communications routes are required. This information is presented here rather than in the protection section to avoid being too prescriptive as to which protection relay panels the channel should terminate in.

5.5. Metering Equipment

No metering equipment is required for this work.

5.6. Load Management Equipment

No load management scheme is required for this work.

5.7. Transformers

No new power transformers are required.

5.8. Neutral Earthing

No new neutral earthing is required for this work.

5.9. Ancillary Equipment

The following ancillary equipment is required to be provided or replaced to complete this work:

Site	Description	YES/NO	Work Class*
Jordanthorpe	LVAC Board	Yes	NC
	Main Battery (110V) –unless direct from NG	Yes	NC
	Telecoms Battery	Yes	NC
	Disturbance Recorder	Yes	NC
	Telecontrol Facilities	Yes	NC
	Heating & Lighting	No	NC

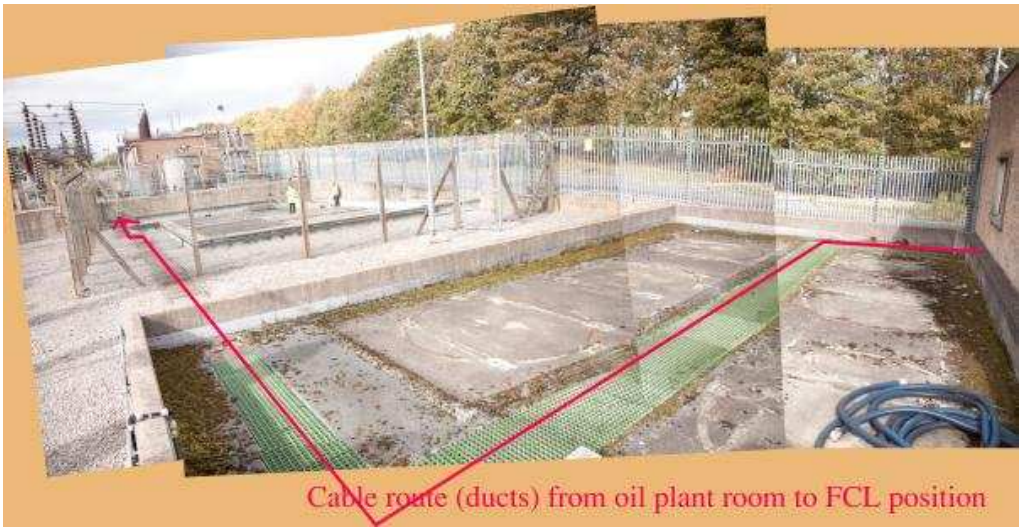
* All work is non-contestable

The LVAC board / main battery / telecom battery / telecontrol facilities may all be extended from the existing substation to the new board, depending upon final design.

5.10. Site Auxiliary Supplies

A 100kVA three phase supply is required to the SFCL and auxiliaries. Subject to confirmation of available capacity, auxiliary supplies will be provided from the National Grid auxiliary board. If there is insufficient available capacity, auxiliary supplies will be made available by connection of a new 33kV/415V transformer on site or alternatively by connection to the LV network.

Subject to confirmation of available capacity, a supply may be taken from a spare 160A switch in the disused oil plant room and ducted to the SFCL as illustrated below.



5.11. Civil Engineering

A significant structure is required to support busbars to and from the SFCL and to support the ABSD and two disconnector/earth switches. Foundations for the supporting structure will require the relocation of a lamp post and possibly the diversion of the cable between the auxiliary transformer and the LV board.

The requirement of a plinth suitable for mounting the SFCL of mass 20 tonnes and a bund capable of containing 4000 litres of oil can be easily met by the current design which utilises the spare supergrid transformer bay. The spare bay has a large bund and two plinths as can be seen in the photograph below.

Dimensions of the SFCL are approximately 6m (inc cooling fins) x 5m x 5m (tall). In addition the auxiliary housing for the cryogenic compressors and DC supply is 4m x 2.4m x 2.4m high.

DC cables and helium pipes connect between the SFCL and the auxiliary housing which need to be no more than 1.5m apart from the SFCL including any height differential.

Water chillers are to be housed outside the auxiliary housing. The chillers weigh 471kg each (when full) and are 0.76m x 1.45m x 1.86 high.

Spare supergrid transformer bay. The SFCL is to be mounted on the far plinth.

The following civil works are required to complete this work:

Site	Description		Work Class*
Jordanthorpe	Move lamp post adjacent to SGT1 aux transformer to alternative location. Divert aux cable to LV board if required.		NC
	Test the integrity of the existing bund and operation of the bund pumps.		
	Construct foundations between SGT1 aux transformer and the retaining wall for the busbar/ABSD/disconnector supporting structure		
	Erect busbar/ABSD/disconnector supporting structure		
	Adapt existing plinth below retaining wall (if necessary) to accommodate: 1. FCL approx 20 tonnes 6m x 4m 2. Auxiliary enclosure approx 1tonne 2.1m x 4.2m 3. 2 x water chillers approx 0.4T 1m x 2m,		
	Does the substation lie within a flood plain?	NO	
	Are flood mitigation measures required to be incorporated at the site	NO	
	Is there any additional bunding required at the site to protect newly installed equipment	NO	

* All work is non-contestable

N.B. Any switchroom should also be large enough to cater for necessary protection / control equipment detailed in section 5.3 and ancillary equipment detailed in 5.9.

No equipment will be recovered in the course of this work.

5.12. Technical Data Requirement

The earthing system associated with the works to be carried out at Jordanthorpe should be suitable to cater for EHV (33 kV) earth fault currents of 15 kA.

Earthing is currently in place on each of the existing plinths. It will be necessary to test the integrity of the existing earthing.

5.13. Land Rights

It will be necessary to lease the spare supergrid compound from NG for the duration of the demonstration project, anticipated to be up to three years.

5.14. 11kV Outlet Schemes

No 11 kV outlet scheme is required for this work.

5.15. Other Relevant Information

5.15.1. Network Product Specifications

The following specifications can be made available on request:

NPS No.	Title
NPS/002/001	Technical Specification for Earthing Materials
	Plant and Switchgear
NPS/003/010	Technical Specification for 415V Distribution Fuse Boards for Use in 132/11kV, 66/11kV and 33/11kV Substations
NPS/003/016	Technical Specification for 110V Batteries and Chargers
NPS/003/022	Technical Specification for 33kV Disconnectors, Switch Disconnectors & Earth Switches

6. Comments on Proposal

6.1. Comments - Technical Services

I have the following comments on the proposed scheme:

(Please add any comments about issues that you wish to raise about the scheme and confirm whether or not it is technically acceptable to Technical Services)

I confirm that the protection scheme associated with this proposal is acceptable.

SIGNED **DATE**

Andrew Scott

Technical Services Engineer

6.2. Comments – Network Management

I have the following comments on the proposed scheme:

(Please add any comments about issues that you wish to raise about the scheme and confirm whether or not it is operationally acceptable to Network Management)

I confirm that this proposal is operationally acceptable.

SIGNED **DATE**

Mark Elliott

Northern Powergrid Control Planning Manager

6.3. Comments – Primary Engineering Projects

I have the following comments on the proposed scheme:

(Please add any comments about issues that you wish to raise about the scheme and confirm whether or not it is acceptable for construction by Primary Engineering Projects)

I confirm that this proposal is technically acceptable for construction.

SIGNED **DATE**

Name

Primary Engineering Projects Engineer

7. Authorisation

The following signatures are provided, outside the formal delegations of authority, in order to approve the use of this draft functional specification ahead of the preparation of a technically authorised investment appraisal.

Project Owner	I sign to confirm that I have completed and checked this proposal and I am satisfied with its content.	
	Signature	Date Joseph Helm Asset Management Engineer

Functional Commentary Network Policy	I sign to confirm I am satisfied with all technical aspects of the content and preparation of this functional specification.	
	Signature	Date Alan Creighton Senior Asset Management Engineer

Sponsoring Officer	I sign to confirm that I am satisfied with all aspects of the content and preparation of this functional specification.	
	Signature	Date Derek Fairbairn System Design Manager

Appendix 1

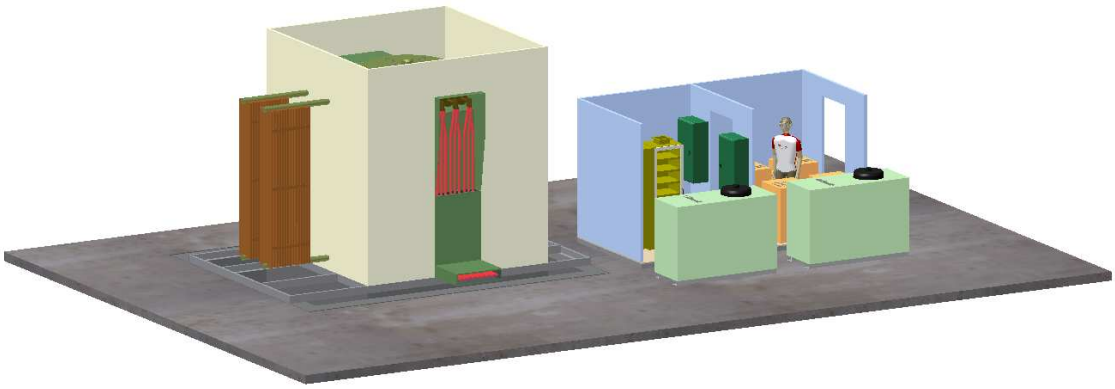
Superconducting Fault Current Limiter Specification

The superconducting fault current limiter (SFCL) comprises an oil filled stainless steel tank with copper AC windings wrapped around two iron cores. The windings are wrapped clockwise round one and anticlockwise round the other. The copper windings emerge through bushings and are connected to the cable boxes where terminations are made. On the outside of the tank are two toroidal (polo shaped) cryostats (vacuum insulated tanks) housing a winding of hundreds of turns of superconducting tape. The superconductor is also in close contact (although electrically insulated) with a copper thermal bus bar which provides cooling to keep the superconductor at its operating temperature. The tape carries approximately 100 Amps and 2 Volts is dropped over the cable/current lead (entry point into the cryostat) and winding arrangement.

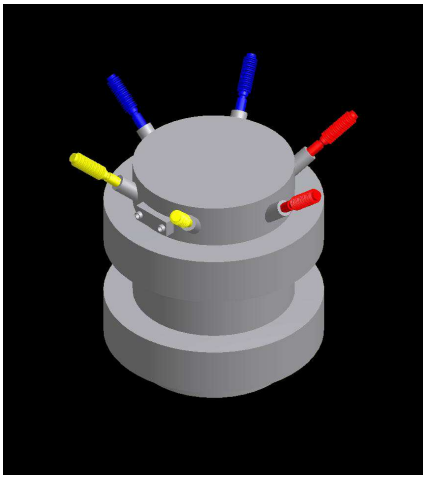
The superconducting winding drives the iron cores into saturation such that normal current sees the AC winding as an air cored reactor, but fault current sees it as an iron cored reactor. This reactor arrangement weighs approximately 20 tonnes, houses approximately 4000 litres of oil. It has dimensions approximately 5m by 6m with height 5m (based on the 11kV unit but allowing some additional height for bushings (height 4.3m->5m) and internal cable box spacing (4.1m->5m).

The thermal bus bar is cooled by a cryocooler, the cold head of which is housed in the cryostat. Vacuum insulated pipes containing helium gas are connected to compressors. These are housed in an auxiliary enclosure (4.2m long by 2.4m x 2.4m) as are the power electronics which generate the DC supplies.

The CAD drawing below is based on a cable connection. The proposed solution for Jordanthorpe would be a busbar connection. A CAD drawing of the proposed SFCL bushing arrangement is included on the following page.



CAD drawing showing SFCL reactor unit, auxiliary enclosure (blue) and two water chiller units



Proposed SFCL bushing arrangement

NORTHERN POWERGRID

EHV DESIGN, SUPPLY AND CONSTRUCTION FRAMEWORK AGREEMENT

WORKS ORDER REQUEST

SCHEDULE 2, PART 2

VERSION D7

PROJECT SPECIFICATION

CONNECTION OF SUPERCONDUCTING FAULT CURRENT LIMITER AT JORDANTHORPE

YSV0616

FEBRUARY 2012

1 PROJECT DETAILS

1.1 SCOPE OF WORK FOR THE CONNECTION OF A SUPERCONDUCTING FAULT CURRENT LIMITER AT JORDANTHORPE 275/33KV SUBSTATION

Northern Powergrid, under Ofgem's Low Carbon Network Fund (LCNF) scheme, is undertaking an R&D project deploying a superconducting fault current limiter (SFCL) at Jordanthorpe 275/33kV Substation. The project is a collaboration between Northern Powergrid and Applied Superconductor Limited (ASL) and will be installed for a trial period of three years, after which it will be removed.

Jordanthorpe 275/33kV substation is located near Sheffield. The SFCL will be installed in National Grid's Electricity Transmission (NGET) compound within the lv transformer circuit of SGT1, which is owned and operated by NGET. The SFCL and new equipment installed in association with its connection will be owned and maintained by Northern Powergrid but operated by NGET under their rules and therefore compliance with NGET rules, specifications and procedures is necessary. The requirements of the modification offer should also be adhered to. The modification offer is included as Appendix M.

Jordanthorpe 275kV substation (NGET owned) is a single switch mesh outdoor air insulated substation. There are two 275/33kV 100MVA transformers either side of the single switch, together these provide the grid supply to Jordanthorpe 33kV metal clad indoor substation (NPG owned). See proposed Operation Diagram Y432A5106.

This specification provides a description of the electrical network configuration and the works necessary to facilitate the connection of the SFCL, which includes the installation of a new 33kV circuit breaker, isolators and earth switches and associated protection.

This contract is for the design, engineering, supply, delivery to site, off loading, installation and erection, testing and commissioning, site clearance, replacement and/or adjustment of defective material and workmanship for the duration of the defect liability period for the works as detailed in Schedule 2.

1.2 SCOPE OF SUPPLY

1.2.2 General

The project works shall comprise of the following:

Design, supply and installation of:

- Isolators and earth switches / circuit breaker and associated structures and plinths;
- Associated control and protection and interlocking;
- Bus bars connections
- 100kVA auxiliary supply to the SFCL

Design and supply:

- if required of plinths for the SFCL and associated equipment.

Northern Powergrid Network Product Specifications (NPS) have been added in Appendix B, although NGET specifications will be applicable for some aspects of the work. The schedules within these NPS shall be completed and included in the Works Order Proposal. The design life for the proposal shall be 40 years, but will only be in operation for 3 years.

Atkins outline method statement defining the proposed work plan for the complete execution of the work as defined in the Works Order shall be included in the Works Order Proposal. The outline methodology statement shall also include details of all site staff and support facilities, the prices of which shall have been included for within the completed Schedule G, included in the Works Order Proposal. When carrying out the design it shall be taken into account that the SFCL and equipment installed in this contract will be removed in 3 years' time and hence the design should make it easy to disconnect equipment and protection.

Northern Powergrid has drawn up an overall project Construction Risk Mitigation Plan (CRMP) (Appendix C) which identifies outage requirements, and Emergency Return to Service (ERTS) requirements. The Works Order Proposal shall also include a method statement to detail how the contingency plans in the CRMP will be applied where required, during the proposed programme of works. Atkins is also required to identify the costs for providing this contingency as a separate item in the completed Schedule G.

Applied Superconductors Limited (ASL) will be responsible for supplying, installing and cold commissioning the SFCL. Atkins shall be responsible for ensuring that the plinth on which the SFCL is installed is suitable, that a 100kVA auxiliary supply is provided, alarms and protection between the SFCL and NGET are designed, installed and commissioned. Atkins will also provide a 'Competent Person' at all times including during the installation and commissioning work of the SFCL by ASL. Atkins shall provide a TP141 Commissioning Engineer for the works included in this Works Order and during the cold commissioning of the SFCL by ASL. The SFCL will be bus bar connected. The bus bar shall be supplied, installed and tested by Atkins. It shall be a requirement of this Works Order Request for Atkins to liaise closely with ASL and NGET to ensure that this interface point is managed and that all design, supply and install activities are undertaken to ensure a complete system is created.
The works are to take place within NG's compound and under NGET's Safety Rules including all persons to be authorised as 'Persons', have BESC substation cards and one 'Competent' person on site at all times. Once the SFCL gets a power supply and comes under rules Atkins will need to provide someone with full NSI 8 – movement of long objects in compounds authorisation and NSI 6 – demarcation. NGET procedures will be followed, including but not restricted to:
TP188;
TP106; and
TP153.
Where possible, NGET Technical Specifications will be followed and Atkins should identify which NGTS they propose to follow.
Atkins will use suitably authorised TP141 engineers to carry out the design verification and for commissioning and NGET will carry out design assurance. This is in addition to Northern Powergrid reviewing the design. Atkins will be required to attend Commissioning Panel Meetings however; NGET will provide the Commissioning Panel Chair and Officer. Atkins will also be required to attend weekly SHES and progress meetings. NGET are to provide the project SAP resource.

1.2.3 Existing Services and Site Establishment

Services

Drainage, BT and cable plans are provided in Appendix J – NGET Site Safety File. However, Atkins shall get up to date service records and confirm the location of the existing services prior to commencement of work on site.

Site Establishment

Atkins shall be responsible for all site establishments associated with this Works Order including providing welfare facilities for ASL. Atkins shall provide a drawing to indicate the proposed area for site establishment and access requirements as part of this Works Order and agree this with NG. The preparation and clearance of this area shall be the responsibility of Atkins. Works necessary for site establishment shall be incorporated into the site enabling works costs. A facility to enable a price for security to be entered has been included in Schedule G and Atkins should state what is included in any price submitted under this item.

All work areas including welfare facilities, office and storage areas shall be demarked with Heras fencing.

The site establishment shall be completed prior to works commencing. Atkins shall provide information detailing any changes to site establishment and security arrangements throughout the duration of works to Northern Powergrid and NGET.

Atkins shall confirm the arrangements to be made for provision of site services as follows:-

Mess room and toilets
Office accommodation
Telecommunications
Electricity supplies
Water, drainage and sewerage.

There is an electrical supply available from the oil plant room. However, there is no water supply.
Please note that there is a 20m exclusion zone surrounding some CT/VT HAM units, and liaison with NGET will be required in order to set up procedures for entry to the site and working procedures.

1.2.4 Hazardous Materials

An asbestos survey report was carried out in 2004 and no asbestos was found. However, it is possible that asbestos could be present in fuse holders.
A ground investigation survey has been conducted and can be found in Appendix I. Contamination has been found, but not in the area of construction. If further investigations are required, Atkins should allow for this and state any assumptions made in the Works Order Proposal.

1.3 CHARACTERISTICS OF THE POINT OF SUPPLY

The nominal system voltage is 33,000 volts.
Based on the 2011 Fault Level Survey the fault levels for the 33kV system are 846MVA break and 42.2kA make. The existing installed switchgear has a 3-phase break rating of 1000MVA, and a make rating of 43.7kA.

1.4 PLANT

The 33kV plant requirements are generally as shown in Y432A5016 drawing and the feasibility layout (YEDL drg no Y432A5104 rev B/C or D) and as per Table 1 below.

Equipment provided shall be in current production with a proven track record and EA Type Test certification as appropriate. A list of Northern Powergrid assessed products is included as appendix F.

1.4.1 Switchgear

The isolators shall comply with NPS/003/022 – Technical Specification for 33kV Disconnectors, Switch Disconnectors & Earth Switches or NPS/003/007 - Technical Specification for 66 and 132kV Disconnectors, Switch Disconnectors and Earth Switches and the circuit breaker shall comply with ENATS 41-36 issue 2.

Switchgear type	By-pass Disconnector / Circuit Breaker	In Series Disconnector with 2 earth switches
Quantity	1	2
Class	Outdoor	Outdoor
Number of poles	3	3
Voltage /kV	33	33
Rated normal current /A	2000	2000
Rated short time current /kA	25	25
Duration of short circuit /s	3	3
Rated peak withstand current /kA	54	54
Rated peak short-circuit making current /kAp	54	-
Rated supply voltage of closing and opening devices /V	110	110

Table 1 – switchgear specifications

It is preferable for the two disconnectors in series with the SFCL to have two earth switches. However, it is also acceptable to provide suitable earth points for portable earths to be connected in accordance with NGET specifications.

An interlock system is required between the 33kV bypass disconnector /CB and in series disconnector / earth switches and NGET's equipment.

The by-pass disconnector/CB and in series disconnectors shall be motorised but with the facility for manual operation. The earth switches shall be manual operation.

Currently there are no products that have been assessed by Northern Powergrid that meet the specifications for the by-pass disconnector / circuit breaker. The only products that are assessed by Northern Powergrid that meet the specifications for the in-series disconnector/earth switches are rated at 66kV.

Atkins should propose what switchgear they intend to use and agree with NGET the nomenclature for the switchgear.

1.5 CIVIL WORKS

One of the two existing NGET supergrid transformer plinths, see drawing TD/IE/28100 is proposed to be used to mount the SFCL on. One plinth should be suitable for mounting the entire SFCL of reactor mass 30 tonnes including oil, with a bund capable of containing 4000 litres of oil. Dimensions of the SFCL reactor are approximately 2.2m diameter x 3.7m tall to the top of the bushings.

Chiller Enclosure 3.2(L) x 2.7(W) x 2.0(H) weighing approx. 500kg (tbc) plus two chillers each weighing 361kg plus 260 Litres of water glycol (total ~1500kg)

Auxiliary Enclosure 4.2(L) x 2.2(W) x 2.2(H) weighing approx. 4000kg

DC cables and helium lines will run from the side of the SFCL to the auxiliary enclosure and these have a maximum length of 40 feet. The auxiliary enclosure therefore needs to be within 40 feet of the SFCL.

The chiller enclosure can be anywhere close by but there will be pipe and cable runs to the auxiliary enclosure which will need to be lagged and covered.

Atkins will be responsible for ensuring that the plinths are suitable for the SFCL and auxiliary equipment to be mounted on, or for providing new plinths. Equipment layout drawings will be required. ASL will install the SFCL and associated auxiliary equipment on the plinths.
A bund test will be carried out by others to determine if the bund is watertight. If it is found to be leaking then Atkins will be responsible for making it watertight by lining it with Decothane or using omnibund. Atkins should include a separate item for the design, supply, installation and commissioning of remedial works for the bund, which shall be agreed with NGET and Northern Powergrid.
Atkins shall remove an existing lamp post adjacent to the SGT1 auxiliary transformer and install a new one in the SFCL compound at a location proposed by Atkins and agreed with NGET.
Atkins shall also remove some existing concrete steps, on one of the transformer plinths to make it level.
Atkins shall include for the design, supply and installation of plinths and structures as necessary for all equipment, which shall be in accordance with NGET specifications.

1.5.1 Temporary Works

Atkins shall include for the design, installation, maintenance and removal of all temporary works required. This includes Atkins's working area, car parking and access for all contractors and sub-contractors, together with all temporary fencing which shall be 'Heras' or similar approved.

1.6 PROTECTION, CONTROL & TELECOMMUNICATION DESIGN SPECIFICATION (PCTDS)

1.6.1 Protection, Control, Monitoring & Communications – General

There is a common protection room for the 275kV substation; this contains the protection equipment associated with the NGET assets. There is a common protection room for the 33kV substation (separate building to the indoor 33kV substation building); this contains the protection equipment associated with the NPG assets. The proposed protection arrangements are shown in figure 1.

All new protection equipment will need to comply with NGET specifications where applicable and be accepted by Northern Powergrid, except for the PQM which will be to Northern Powergrid's specification.

1.6.2 SGT1 Protection

The existing protection for SGT1 (as detailed below), and associated SCS interfaces will be retained in its current arrangement. The existing 275kV protection equipment is located within floor mounted panels with top entry and wall boxes. The existing 33kV protection equipment is located within floor mounted panels with below ground entry.

Item	Application	Existing Relay Type
1	2 STAGE O/C	PBO
2	DIRECTIONAL O/C	NPO2
3	HSOC	CAG69
4	HV RESTRICTED E/F	FV2
5	INTERLOCKED O/C	PBOK
6	LOW FREQUENCY TRIP	BEI.81.0/U
7	LV RESTRICTED E/F	FV2
8	NEUTRAL E/F	FGL
9	O/C GUARD	CAG69
10	SBEF STAGE 1	PG3
11	SBEF STAGE 2	PG3
12	STAGE 2 TIMER	AKA2
13	TRANSFR I/T TIMER	AKH3
14	TRANSFR OVERALL	DT2
15	VOLTAGE SUPVN	VB
16	WINDING TEMP	ARIC

It is not expected that there will be any changes to the existing protection philosophy implemented on this circuit due to the addition of the SFCL. The SFCL provides a nominal reactive impedance during normal (passive) operation (see SFCL tech data), this is understood to have a minimal effect upon the existing overall protection on SGT1.

A protection settings check will be carried out, with results presented to Northern Power Grid and National Grid to confirm the suitability and sensitivity of the existing settings.

1.6.3 SFCL Protection General Arrangements

The SFCL is supplied by Applied Superconductor Ltd (ASL), this includes specific mechanical protection for the SFCL. This protection will need to be interfaced to the existing protection systems on SGT1 circuit to effect correct tripping under fault conditions. Details of the tripping requirements are shown on figure 1.

The protection arrangements for the SFCL will follow the philosophy of NGET TS 3.24.10, noting that some of this protection will be provided by the existing SGT1 transformer protection. Consequently, as a minimum, a new overall unit based protection scheme, specific to the SFCL, is to be provided under this contract. This is to provide discrimination / identification of the SFCL under fault conditions and will be installed in a new relay panel to be provided by Atkins and located in the 33kV control room.

A separate overcurrent overload alarm relay is to be provided. Upon operation this will notify NGET via the SCS systems and initiate closing of the bypass circuit, thus off-loading the SFCL.

Marshalling of alarms/indications/analogues from the SFCL to the NGET SCS shall be provided – Atkins shall provide details of the proposed in Appendix G.

All marshalling of tripping, control and SCS data from the SFCL shall be via a dedicated marshalling kiosk, located adjacent to the SFCL.

Any associated fuses/links will be front mounted on the box – RS20 type or equivalent. The box should be connected by Atkins to the substation earth grid in accordance with NGET Earthing requirements. Atkins should liaise with ASL regarding the design of the marshalling kiosk.

1.6.4 Unit Protection

A single overall unit protection is required. The protection shall be responsive to both phase faults and earth faults on the SFCL and associated connections.
If a biased differential principle is used, the protection shall comply with the requirements of IEC 255-13.

The protection shall not give an unwanted operation under all normal operating conditions and all external fault conditions up to the maximum through-fault current limited only by the impedance of the SFCL itself.

Operation of a main protection function shall:
(a) Trip the associated circuit breakers providing a fault infeed.
(b) Initiate the existing CB fail protection where appropriate.
(c) Initiate trip relay reset where required.
(d) Block DAR
(e) Initiate disconnector sequential isolation where required.

1.6.5 Back Up Protection

Back up protection shall be provided in accordance with NGTS 3.24.38 and shall consist of two IDMT earth-fault protections, one on each side of the SFCL reactor.

Since the SFCL is installed within another circuit (SGT1), account shall be taken of the back-up protection already provided for that circuit.

1.6.6 Mechanical Protection

Gas and oil actuated relays (as identified by the SFCL manufacturer) shall be provided by ASL to protect each separate oil filled tank associated with the SFCL against loss of oil and oil surge.

The gas and oil actuated relay surge contact shall only be connected to trip where the supplier demonstrates that it is immune to operation on through faults and start of pumps or other cooling equipment. Where this is not demonstrated the surge contact is only required to be connected in parallel with the alarm contact.

The SFCL manufacturer has identified that there are specific conditions that require the SFCL plant to be tripped and isolated and other conditions where simply closing the bypass disconnector is required.

Operation of the mechanical protection and/or SFCL AC tank pressure low/high signal shall:
(a) Trip the associated circuit breakers providing a fault infeed.
(b) Initiate the existing CB fail protection where appropriate.
(c) Initiate disconnector sequential isolation where required.
(d) Initiate trip relay reset where required
(e) Block DAR.

The remaining SFCL signals (shown in red on the SFCL signal list, Appendix G) shall initiate the closing of the bypass CB / disconnector.

The auxiliary supply for the main protection relay shall be from the battery system that supplies the first tripping system.

All DC supplies to the relays shall be monitored and provide an alarm for loss (i.e. watchdog; MCB).

A relay test block (MMLG) will be provided and mounted within the new protection cubicle.

Trip Circuit supervision is provided as part of the existing SGT protection trip circuits.

1.6.7 Indication

Switchgear Indication
Informative: The available control points are local, substation and remote. Local is at the plant being controlled. Substation is at some central point in the substation. Remote is at the National Control Centre (NCC) or National Operations Centre (NOC)

The new switchgear associated with the SFCL circuit shall provide indications of position to all control points.

The earth switches shall provide ‘open and closed’ indication to local and substation control points.

Each function shall provide alarms and indications as appropriate to the National Grid substation control system (SCS).

Each protection function shall be provided with a time reference.

1.6.8 Current Transformers

General
CTs will be supplied and installed in the bushings of the SFCL by ASL.

The CTs will be specified by Atkins to NGET standards and agreed by Northern Powergrid.
CTs shall usually be conventional electromagnetic devices as specified in NGTS 3.2.4 and NGET TS 3.2.5. ASL will provide a suitable CT marshalling box.

Please refer to Figure 1 for the CT arrangements. All CTs shall have a rated continuous thermal current of the SFCL including its overload capacity, and shall be capable of thermally withstanding the 3 second fault rating of the switchgear.

CTs shall be supervised.

The CT supervision functions shall be capable of being selected to:
(a) Inhibit operation of the function on CT failure and alarming the inhibited condition.
(b) Giving an alarm on CT failure.

Protection
The main overall protection functions shall be connected to class X type A current transformers, or to protection/measurements class current transformers (class 5P20) where it can be demonstrated that the protection offered will work satisfactorily with this class of CT for all system conditions.

Backup protection functions shall be connected to protection class current transformers such as class 5P20 (See NGET TS 3.2.4).

1.6.9 275kV Mesh Corner Protection and 33kV Busbar Protection

The existing Mesh corner / busbar protection arrangements shall be retained. No modifications are envisaged to the existing protection arrangements.

1.6.10 CB Fail (CBF) Protection and Interlocked Over Current Protection

No change is envisaged on the 275 kV side. CBF not fitted at 33kV, existing interlocked overcurrent to be retained.

1.6.11 Power Quality/Disturbance Recorder

National Grid PQ Monitoring

A PQ sensor to enable high bandwidth monitoring of harmonics, will be installed on the existing 275kV CVT on the Brinsworth circuit at Jordanthorpe 275kV. Details of this modification are within TS 3.02.05.

On the 33kV side, it is required to utilise existing appropriate CT/VT to facilitate connection to a PQ monitor. Is it assumed that these existing transducers are connected to the existing wound VT and CTs on the 33kV side adjacent to 33kV MCCB. Where this is not the case, Atkins are to propose an alternative compliant solution.

NGET are to provide details of the specification of the PQ monitors and it should be assumed that they will be free issued to Atkins.

The following NG specifications should be considered:

TS 3.02.05 – Voltage Transformers

TS 3.24.69 – Quality of Supply Monitoring

Northern Powergrid PQM

A PQM meter shall be connected to the existing and unused metering CTs and VTs within the 33kV relay room.

Shall comply with the following specification:

A multi-mode high speed, high accuracy measurement device is required to be installed.

The unit shall be provided with an Events On/Off switch which when selected to OFF will disable event recording in the device, this to be used during panel maintenance and commissioning. This may be implemented by switching on/off event DC field supply.

The primary function of this device will be to monitor power quality. This will be obtained by the measurement of three phase voltage and currents on the SGT1 feeder including: V, I, F, P, Pf, H (63), THD, K-factor, voltage and current unbalance, impedance and sequence components.

The recorder shall be powered from the substation dc Aux. supply and mounted on or in, the associated relay panel.

Specifically the unit shall provide:

- A minimum of 6 digital inputs and 1output for the disturbance recorder function are required. Digital inputs shall be driven from trip relay contacts, customer protection equipment and the WF CB auxiliary contacts (open and closed status).

- An IRIG B adaptor for support of substation IRIG B signal.
- A minimum of 4 AC voltage and 4 AC current measurement inputs comprising:

    1) 3-phase and neutral current
    2) 3-phase and neutral voltage

- A minimum of 256MB of additional memory for data storage.
- Interrogation of the PQ information stored in the device shall be via an RS232 connection presented on the front of the relay panel.

The unit shall comply with the following technical specification:

- 2 Waveform recorders that can capture input signals at 128 samples/cycle (6.4/7.68 KHz) up to 100A symmetrical. Sampling rates of 32 or 64 samples/cycle, as well as 256 samples/cycle on a reduced number of channels.
- 2 separate disturbance recorders with selectable sample rates of 1-3600 cycles
- Long-term trend data of up to 230 selectable parameters
- Sequence of Event Recording of 5000 events time stamped to 1 microsecond
- Automatic event notification via Ethernet or serial
- Extensive on-board non-volatile memory for recording
- Simultaneous recording of all recorders
- Triggering with hysteresis from any analogue threshold value, rate-of-change of analogue value, digital input, internal parameters, or “virtual” input (GOOSE message)
- User selectable pre- and post-trigger times, and three trigger modes
- 1 RS232 and 3 configurable RS232/RS485 ports supporting baud rates from 9600 to 38400.
- Supports DNP3.0 Level 2, DNP3.0 TCP/IP, DNP3.0/UDP & Modbus

- Ultra-fast RMS voltage and current updates each 1/4 cycle
- Full measurement set including: V, I, F, P, Pf, H (63), THD, K-factor, voltage and current unbalance, impedance, sequence components
- High accuracy measurement (voltage and current better than 0.1% of reading)
- 128 samples/cycle sampling rate

Areva M871 or equivalent.

1.6.12 High Accuracy/ Settlement Metering

The existing settlement metering system, adjacent to the 33kV Cable Sealing End, will be retained. During the outage National Grid, may undertake the replacement of the existing CTVT metering unit. Details of this will be confirmed once known.

1.6.13 AVC (Automatic Voltage Control) / ATCC (Automatic Tap Changer Control)

A review of the existing AVC/ATCC system shall be carried out and modified accordingly.

It is thought at this stage, that there will be no modification required as the SFCL response time is in the order of ms rather than seconds, as typical of the AVC/ATCC system. Thus under fault conditions (when the SFCL is actively operating), the AVC/ATCC will be to slow to respond and the fault will have been cleared accordingly.

Under steady state normal conditions, the SFCL presents nominal impedance to the system (see SFCL technical data – appendix H). Inclusion of this impedance within the SGT1 leg is not envisaged to cause significant problem with AVC/ATCC scheme, as the ATCC scheme operates by maintaining selected LV target voltages.

However, the impedance of the two parallel SGT circuits differ due to the addition of the SFCL (SGT1+SFCL~26% and SGT2~21% on 100MVA) and potentially will cause a load imbalance between the two parallel legs. This can be managed through tap staggering between the two transformers.
This operating arrangement needs to be simulated, preferably in conjunction with the ATCC manufacturer, to confirm that the existing ATCC algorithm will operate as required to maintain the LV voltage, minimise the circulating current and keep the tap stagger within the required NGET limits.
Atkins are required to seek early confirmation of this.

It is accepted that following further investigation, (simulation with the manufacturer), additional works maybe necessary. (NB: A database change/update for this in likely to be combined with the SCS update).

For reference the existing SGT1 and SGT2 impedances are quoted as 21%[1] on 100MVA base and the steady state impedance of the SFCL is 5.97% on 100MVA.

[1] Source: NGET Transformer Database

1.6.14 Substation Control System

The existing substation control system for the 275kV is a "Cruickshanks" system with centralised architecture with each bay having its own I/O unit. The new protection equipment shall be interfaced with the above control systems.

NG will be responsible for carrying out the database changes necessary in their SCS. Atkins shall provide all necessary connections to the SCS system and any necessary I/O cards. This shall be done to NG's standards.

Augmentation of NGET SCS shall include, but not be limited to:

- Change in the SGT1 circuit parameters (impedance change due to SFCL)
- Interfacing of the new HV equipment as per the proposed Operations Diagram Y432A5106 with the NGET SCS systems.
- Atkins to provide information to NGET who will update the NGET SCS databases and displays to reflect the new equipment.

1.6.15 Jordanthorpe 275/33 kV Synchronising & Voltage Selection Scheme

It is not thought that modification to the existing synchronising and voltage selection schemes will be required.

1.6.16 Substation Interlocking

An interlock system is required between the 33kV by-pass CB/ disconnector and in series disconnector / earth switches and NG's equipment. The existing substation electrical and mechanical Interlocking system on the 275 kV and 33 kV side will need to be modified to accommodate the new 33kV equipment. Please refer to Appendix L – Additional Interlocking. Atkins shall liaise with NGET to agree on the details of this system. Mechanical interlocks are required between the earth switches and their associated disconnectors such that the earth switch can't be closed with the circuit being live. Electrical interlocking is required between the 33kV disconnector/CB and NGET equipment.

1.6.17 Relay Settings

The scope under relay settings shall be:

a) The new SFCL mechanical protection shall be setup and tested by the manufacturer (ASL).

   The new SFCL unit protection shall be calculated, setup and tested by Atkins for these works. Where necessary, the relay manufacturer can be proposed to configure the relay.

b) The existing SGT1 protection settings shall be checked by Atkins to ensure compliance with the relevant NGTS and policy documents and grading is maintained with the 33kV OC and EF protections, due to the additional item of plant within the SGT1 circuit.

c) Atkins will verify all new and revised protection settings using the appropriate NGET TP141 authorised setting engineers. All settings will be agreed with NGET and NPG. NGET will carry out design assurance.

All new and revised relay settings will be produced by Atkins. Specifics to the SFCL will be provided by the SFCL manufacturer.
Following approval, Atkins will upload and issue the new and revised settings using the NGET Livelink database.

1.6.18 Testing and commissioning

Atkins will provide all documentation as necessary to comply with NGET commissioning practises eg TP106 and shall be carried out by suitably competent and authorised engineers eg TP141.This commissioning documentation will clearly show the activity to be carried out, test documentation to be used, duration of test and include witnessing hold points for Northern Powergrid and NGET. The name and CV of the proposed Commissioning Engineer shall be provided with the Works Order Proposal.

The SFCL will be tested and cold (stage 1) commissioned by the manufacturer. They will also be present during hot (stage 2) commissioning. However, Atkins will provide a suitably competent and authorised engineer to represent ASL for the commissioning of the SFCL.

1.6.19 Marshalling Kiosks

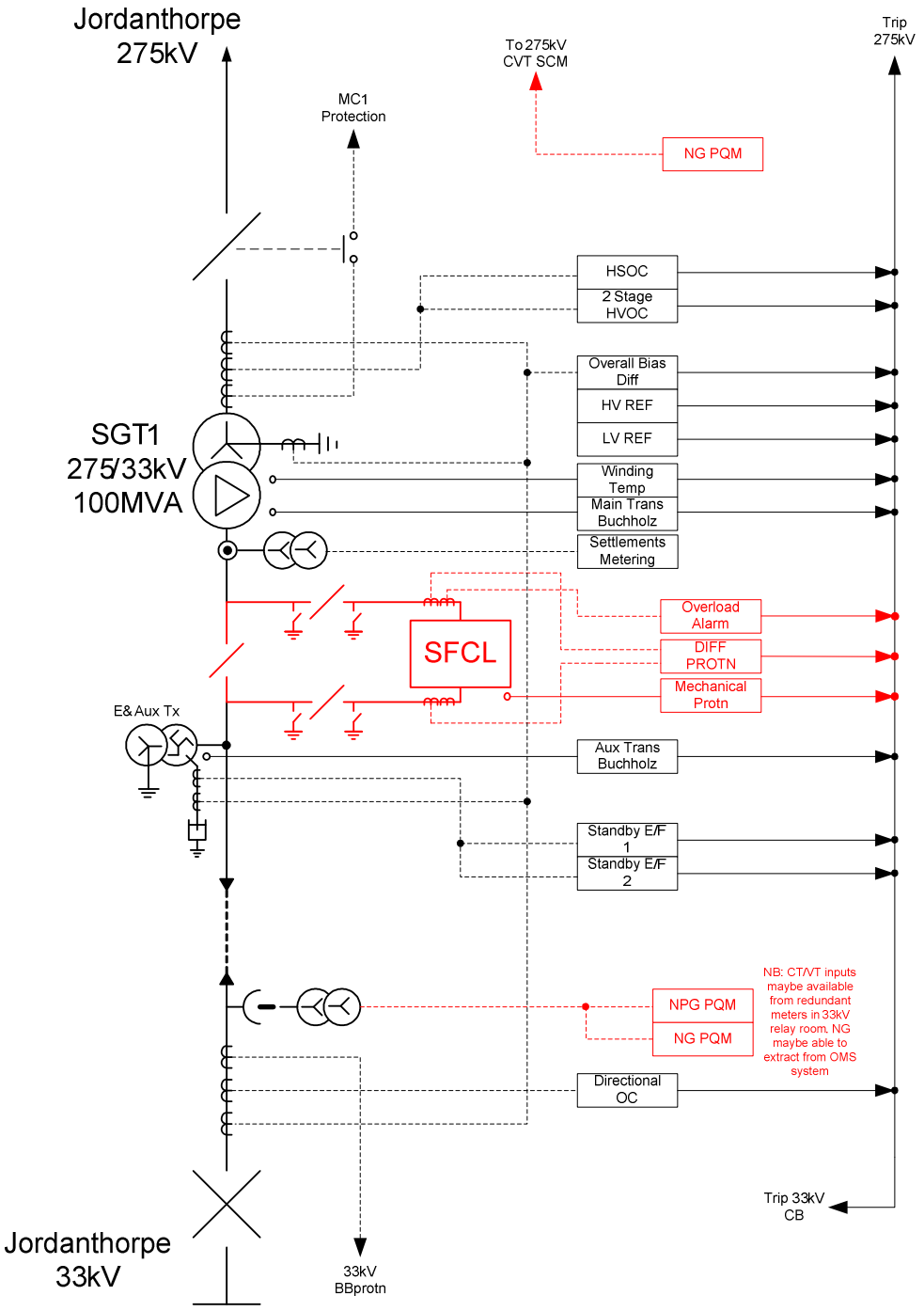
A new marshalling kiosk shall be provided by ASL, this will be located adjacent to the SFCL. Unless specifically excluded by request, all interface cabling between the SFCL and existing substations shall be via this point.

Atkins shall provide a new outdoor marshalling kiosk to contain all interface cabling between the SFCL and associated switchgear and NGET.

1.6.20 Protection and Control Accommodation Requirements

A new protection cubicle shall be supplied and installed by Atkins for the new SFCL equipment at Jordanthorpe 33kV Substation. The new cubicle shall be equipped with the required protection and control IEDs together with associated switches, fuses, links, test points and pushbuttons.

Figure 1 – KLD + tripping



1.7 ANCILLARY WORK

The ancillary work shall include:

Atkins is required to design, install and commission the earth grid for the new equipment installed, including the SFCL.

Installation of all multicore cables required, including aux and power cables, to suit the equipment, protection schemes etc. and including any temporary cabling and/or wiring required to expedite the works. The SFCL requires a 100kVA 3phase supply which may be taken from a spare 160A switch in the oil plant room. Atkins will be responsible for providing the 3 phase supply to the SFCL. A proposed route is shown for the lv cable in drawing Y423A5107.

This LV supply for the SFCL will require a dedicated metering point to be established.

Supply and installation 110V battery / charger unit if necessary or utilise the existing 110V system. There is one existing spare way on the 110V DC board.

1.7.1 Earthing

Atkins is required to design, install and commission the earthing for the new equipment installed, including the SFCL and connect all new equipment to the existing substation earth grid, as necessary in accordance with NGET specifications. Existing earth points are in place on the transformer plinths. If these are used, checks should be made to make sure they are connected to the existing earth grid.
All new equipment shall be permanently connected to the earth grid, using conductors of a suitable material and cross section for their purpose and joints/connections.
All materials and details of jointing and connection systems to be used shall be agreed with NGET and Northern Powergrid and a detailed earthing schedule shall be provided. A detailed 'as installed' drawing record of the earthing system shall be made by Atkins.
An Earthing Condition Assessment has been carried out for the site, refer to Appendix K. The remedial actions identified in this report have been carried out

1.7.2 Multicore and Auxiliary Cables

Multicore and auxiliary cables shall be in accordance with NGET specifications.

The installation, testing of multicore and auxiliary power cables shall be in accordance NGET specifications and where possible with Schedule 2 – Part 1.

Multicore, multipair and auxiliary power cables, shall be installed as necessary to complete the works, and shall meet the full requirements of the substation equipment control and protection schemes etc.

1.7.3 LVAC Supplies

The new SFCL will require a 3phase 415V 100kVA AC supply for correct operation. Discussions with NGET have confirmed that this may be taken from an existing 160A switch located within the redundant oil processing building at Jordanthorpe 275kV substation. This supply will need to be metered to measure kWh consumption in order to determine the consumption of the SFCL.

1.7.4 110V Battery Charger

110V DC supplies may be taken from the existing 110V DC distribution board at Jordanthorpe 275/33kV substation, if it is proven that there is sufficient spare capacity; one spare way is available. Atkins should undertake a battery survey in order to assess whether there is sufficient spare capacity and submit the results of this survey to Northern Powergrid and NGET.

1.8 STRUCTURES, INSULATORS, CONDUCTORS AND FITTINGS

All structures, insulators, conductors and fittings required to accommodate the new 33kV switchgear and system arrangements shall be provided as necessary, and shall be in accordance with Schedule 2 – Part 1.

1.9 KEY DATES AND MILESTONES

Atkins shall provide a fully detailed graphical illustration of the intended method of constructing the project works; key dates and milestones within the Contract are to be defined.
These shall include: all design works, placing of orders for plant, equipment and site works, start date on site, civil works complete, plant delivery, installation complete, testing and commissioning. An initial draft plan has been completed and is attached as Appendix E.

Key dates are:

Notice to Proceed	17th February 2013
Energisation Date	22nd April 2013
Completion Date	20th May 2013

1.10 DECOMMISSIONING

Atkins shall provide a price for decommissioning all plant and equipment that has been installed in this contract in current day prices. This shall include amendments to drawings and decommissioning of protection. It is expected that this work will take place in approximately 3 years and an agreed rate of inflation will be used to inflate this price. The price shall be included in Schedule G, under G2, Demolition but will not form part of this Works Order. A separate Works Order will be agreed when the decommissioning is required.

1.11 DEFECTS

Atkins shall be responsible for any defects associated with the works in this contract for five years. On being informed of a defect Atkins shall provide an initial response within 48 hours. An office phone number should be provided to Northern Powergrid such that defects can be reported during normal working hours.

1.12 SITE DETAILS

The following information is applicable to Jordanthorpe substation.

1.12.2 Site Address

Bochum Parkway,
Sheffield
S8 8JR
Grid reference SK3608481626

1.12.3 Access

Jordanthorpe substation is located off Bochum Parkway, Sheffield, grid reference SK3608481626. The entry/exit route is off a dual carriageway. When approaching the site from the north-east, the site should be passed and a full circle of the roundabout should be made so that a right hand turn is made to enter the site, otherwise the angle of entry to the site is sharp.

1.12.4 CDM

The following CDM roles will apply on this contract:

Client – Northern Powergrid
Designers – Atkins, Northern Powergrid, ASL
CDM Coordinator – Anna Stevenson-Trippitt, Northern Powergrid
Principal Contractor – Atkins.

The work Atkins will carry out on this contract will be ‘Designer’ and ‘Principal Contractor’.

1.12.5 Reporting

In addition to Northern Powergrid’s requirements for reporting as detailed in Contractor Procedure Manual, the Atkins will fulfil NG’s requirements for reporting.

1.12.6 Liquidated Damages

With reference to the terms of the DSC contract the rate of liquidated damages which will apply to this project are 1% per week up to fifteen weeks.

APPENDIX A

SCHEDULE A

MILESTONES FOR THE PURPOSE OF PAYMENT AND HAND – OVER TO THE PURCHASER

SCHEDULE B

TIME PERIODS FOR PROCUREMENT, DESIGN, MANUFACTURE, INSPECTION, TESTING, DELIVERY, INSTALLATION, COMMISSIONING AND HANDOVER

SCHEDULE C

MANUFACTURERS AND PLACES OF MANUFACTURE, TESTING AND INSPECTION

SCHEDULE D

PART 1 – TECHNICAL PARTICULARS REQUIRED

SCHEDULE E

TECHNICAL DOCUMENTATION/DRAWINGS AND OPERATING AND MAINTENANCE INSTRUCTIONS

SCHEDULE F

DEVIATIONS FROM THE TECHNICAL SPECIFICATION

SCHEDULE G

QUANTITIES AND PRICING

APPENDIX B

Document Ref.	Title	Version	Issue Date
NPS/003/022	Technical Specification for 33kV Disconnectors, Switch Disconnectors & Earth Switches	1	Mar 06
NPS/003/007	Technical Specification for 66 and 132kV Disconnectors, Switch Disconnectors and Earth Switches	3	Apr 10
N/A	There is no NPS for 33kV outdoor circuit breakers, instead it should meet the requirements of ENATS 41-36 issue 2 and then be Northern Powergrid assessed.		

SCHEDULE A – MILESTONES FOR THE PURPOSE OF PAYMENT AND HAND – OVER TO THE COMPANY

(Information to be provided with tender)

Atkins is to indicate all milestones identified within the programme for the works as defined in this Project Specification. The milestones should align with those included in the priced (fixed sum) activity schedule. The milestone payments should fall in line with the value of work done on site. Alternative milestone payment profiles may be considered and may be offered as an alternative for consideration in Schedule F.

Milestone No.	Description of milestone (including details of how completion of milestone will be determined)	% Payment	£ Payment	Approx. date for Payment

SCHEDULE B – TIME PERIODS FOR PROCUREMENT, DESIGN, MANUFACTURE, INSPECTION, TESTING, DELIVERY, INSTALLATION, COMMISSIONING AND HANDOVER

NOT USED

SCHEDULE C: MANUFACTURERS AND PLACES OF MANUFACTURE, TESTING AND INSPECTION

(Information to be supplied with Proposals)

MAIN EQUIPMENT

Item No.	Description	Manufacturer	Place of Manufacture	Place of Testing and Inspection

SCHEDULE D: TECHNICAL PARTICULARS REQUIRED

PART I

(For information only)

Item No.	Description	Information provided by Purchaser
	NOT USED	

SCHEDULE E: TECHNICAL DOCUMENTATION/DRAWINGS AND OPERATING AND MAINTENANCE INSTRUCTIONS

Technical documents and drawings shall be submitted over the period of the contract in accordance with Schedule 2 – Part 1.

The following is a list of drawings / documents supplied by the Purchaser and attached to this Specification:-

Drawing / Document	Date/Rev	Title
Y432A5104	B/C/D	Jordanthorpe Compound Modifications Feasibility Study
Y432A5106	B	Operation Diagram
TC/IE/28100	1968	Details of New Foundation for National Spare Transformer
Y432A5107	00	Jordanthorpe Compound Layout Showing Cable Easement
Appendix C	V1 0	Construction Risk Mitigation Plan
Appendix D	01	Pre-Construction Information Pack
Appendix E	D2	Jordanthorpe Draft Programme
Appendix G		I/O Schedule Requirements
Appendix H		SFCL Technical Data
Appendix I	Mar 1999	Ground Investigation Survey
Appendix J	Issue 6	NG Site Safety File
Appendix K	16/03/04	Earthing Condition Assessment
Appendix L	V3	Additional Interlocking
Appendix M		Modification Offer

SCHEDULE F: DEVIATIONS FROM THE TECHNICAL SPECIFICATION

(Information to be provided with Proposal)

Atkins shall set out below a tabulated statement showing clearly section by section any deviations from the Project Specification and details of alternative proposals. Atkins will be deemed to have complied with the Project Specification in all respects and as written unless qualified in this Schedule.

Section	**Departure from the requirements of the Project Specification with details of alternative proposals**

PREAMBLE TO SCHEDULE G

The prices inserted in Schedule G shall include all the requirements in the Request for Preliminary Proposal. The quantities, rates and prices in Schedule G shall include all design, testing, inspection, plant, labour, supervision, materials, erection, maintenance, transportation, handling, storage, supply and use of Contractor's equipment, temporary works, insurance, profit; together with all general risks, liabilities and obligations set out or implied in the Contract.

The cost of items against which Atkins has failed to enter a price shall be deemed to be covered in the Tender price. The whole cost of complying with the provisions of the Works Order Request shall be included in the items provided in Schedule G and where no items are provided, shall be deemed to be distributed among the rates and prices for related items of work.

SCHEDULE G: QUANTITIES AND PRICING

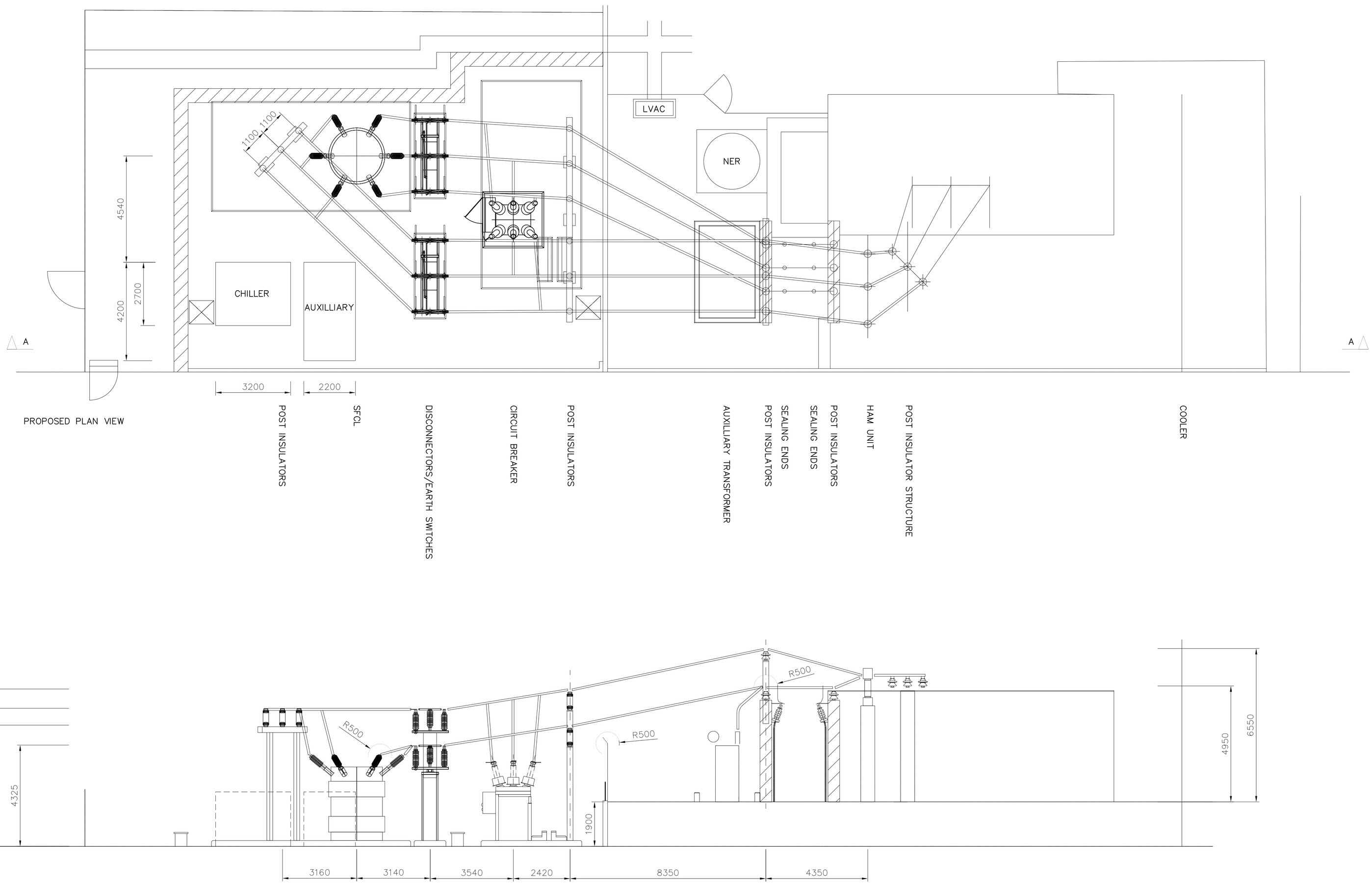
(Information to be provided with Proposal)

ALL PRICES IN £ STERLING EXCLUSIVE OF VAT

WORKS AT JORDANTHORPE 275/33KV SUBSTATION

Item no.	Description	Qty	Unit cost for supply, delivery and insurance to site	Unit cost for installation, commissioning and insurance at site	Total Price
	Jordanthorpe				
G1	Site Enabling Works	1 lot			
G2	Demolition Works	n/a			
G3	Civil Works	1 Lot			
G3a	Equipment structures	1 Lot			
G3b	Bund remedial works	1 Lot			
G4	33kV Equipment	X			
G4a	By-pass circuit breaker	1			
G4b	Disconnector (motorised)	2			
G4c	Earth switch	4			
G4d	Current transformers	n/a			
G4e	Voltage transformers (inc fuse boxes)	n/a			
G4f	AIS busbar / clamps etc	1 lot			
G5	Protection and Control	1			
G6	110V Battery	1			
G7	24V battery	n/a			
G8	LVAC Distribution Panel	n/a			
G9	Installation of miscellaneous free issue plant	X			
G9a	TALUS (free issue)	n/a			
G10	Multicores and Auxiliary Cabling	1 lot			

	(includes all jointing, terminations)				
G11	Earthing	1 lot			
G12	Telecommunications	n/a			
G13	Engineering and design	1 lot			
G14	Testing and commissioning	1 lot			
G15	Project management	1 lot			
G16	Preliminaries (costs in this section to be fully scoped in the Works Order)	1 lot			
G17	Security	1 lot			
G18	Construction Risk Mitigation Costs	1 lot			
G18a	Preparatory Works	1 lot			
G18b	Costs for implementing Emergency Return to Service strategy (Provisional Sum)	1 lot			
G19	Cost of Bonds	X			
G19a	Performance Bond	1no.			
G19b	Retention Bond	1no.			
	Total				



SECTION 'A–A'

MAXIMUM UNSUPPORTED BUSBAR SPANS

76mm H.D.H.C. Cu TUBE 10 S.W.G 7925mm.
90mm ALUMINIUM WITH UNIVERSAL CONNECTIONS 10400mm.

CLEARANCES

NOMINAL SYSTEM VOLTAGE	33kV
STANDARD BUSBAR CENTRES	1220mm
PHASE TO EARTH	500mm
PHASE TO PHASE	430mm
SAFETY CLEARANCE (TO LIVE METAL)	2900mm
INSULATION HEIGHT (PEDESTRIAN ACCESS)	2400mm
HORIZONTAL DESIGN CLEARANCES:	33kV
ALLOWING FOR HYDRAULIC PLATFORM	7300mm
ALLOWING FOR PORTABLE ACCESS EQUIPMENT	3300mm
ALLOWANCE FOR NO ACCESS EQUIPMENT	3050mm
DELINEATED BARRIER CLEARANCE	2300mm

NOTE – ALL DIMENSIONS TO CONFIRM
ON SITE FOLLOWING SURVEY

ATKINS

REV	DESCRIPTION	BY	DATE	CHK'D	REV'W	AUTH

ATKINS
Atkins Limited
Woodcote Grove
Ashley Road
Epsom, Surrey
KT18 5BW
England
Telephone +44(0)1372 726 140
Fax +44(0)1372 740 055

CLIENT: NORTHERN POWERGRID

PROJECT: CONNECTION OF SFCL AT JORDANTHORPE SUBSTATION

TITLE: PROPOSED LAYOUT AND SECTION

SCALE:	ORIGINAL SIZE:	ORIGINATOR:	CHECKED:	REVIEWED:	AUTHORISED:
1:250	A3	SJ	JI	MR	MR
	OFFICE: EPS	DATE: 14.02.12	DATE: 14.02.12	DATE: 14.02.12	DATE: 14.02.12

Project No:	Element Type	Drawing Number:	Status/Rev:
5108464	00.09	0100	0