DRAFT

WORKING GROUP REPORT

Gas Insulated Switchgear (GIS)

Prepared by the Compliance Working Group for submission to the Grid Code Review Panel

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Date of Issue	
Prepared by	GIS Joint Grid Code and CUSC Working Group

I DOCUMENT CONTROL

a National Grid Document Control

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0.1	4/12/08	E. Carr	Draft for Working Group discussion
0.2	20/04/09	E. Carr	Draft for Working Group discussion

b Distribution

Name	Organisation
GCRP Members	GCRP

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1.0 INTRODUCTION AND SUMMARY

1.1 In November 2007, RWE raised a paper at the Grid Code Review Panel (GCRP) highlighting an issue with Gas Insulated Switchgear (GIS). As a consequence the GCRP established a joint Grid Code and CUSC Working Group under the governance of the Grid Code to address the issue and develop a solution, see Annex 1 for a copy of the Terms of Reference.

1.2 This report details the assessment by the Working Group including the Group's recommendation, which is summarised below.

1.3

2.0 BACKGROUND AND CURRENT POSITION

2.1 The issues raised by RWE's can be summarised as follows (please refer to Annex 3 for a copy of the proposal):

- GIS is not defined in the CUSC or the Grid Code
- Inconsistent ownership boundary between the CUSC and the Bilateral Connection Agreement's
- Lack of competition for the procurement and maintenance of GIS equipment

2.2 In addition, RWE made the following recommendations:

2.2.1 that the Transmission Ownership boundary should define to include all connected GIS assets at a GIS substation up to an external connection to the user's assets, such as the cable sealing end. These assets would then become part of the transmission system.

2.2.2 the ownership boundary is defined within the Grid Code Connection Condition.

2.3 In the context of this report GIS refers to all gas-insulated, metal-clad electrical equipment at electricity substations where both the substation busbars and the interfacing switchgear between those busbars and any connecting circuits are of metal-clad, gas-insulated construction, see photograph below.

2.4 The current position can be summarised as follows and is detailed further below:

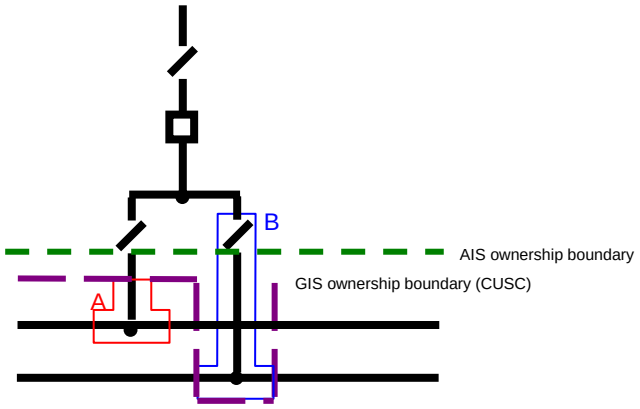
- Due to the nature of the equipment (i.e. intergrated, sealed and modular) it is difficult to identify a construction and on going operational ownership boundary for GIS connections,
- There is no international standard for GIS therefore different manufacturer's equipment is not compatible which has a direct impact upon competition for this equipment,
- The UK market lacks bargaining power within the global market for GIS equipment.

Code position

2.5 For the purposes of the Working Group report, GIS installations can be classified into two types. (It should be noted that the types of GIS will not change due to the outcome of this Working Group):

Type A - GIS substations where the bus selector disconnectors are not in the same gas zone as the busbars (i.e. where there are gas zone separators between the bus selector disconnectors and the busbars).

Type B - GIS substations where the bus selector disconnectors are in the same gas zone as the busbars.



A = GIS substations where the bus selector disconnectors are not in the same gas zone as the busbars

B =GIS substations where the bus selector disconnectors are in the same gas zone as the busbars

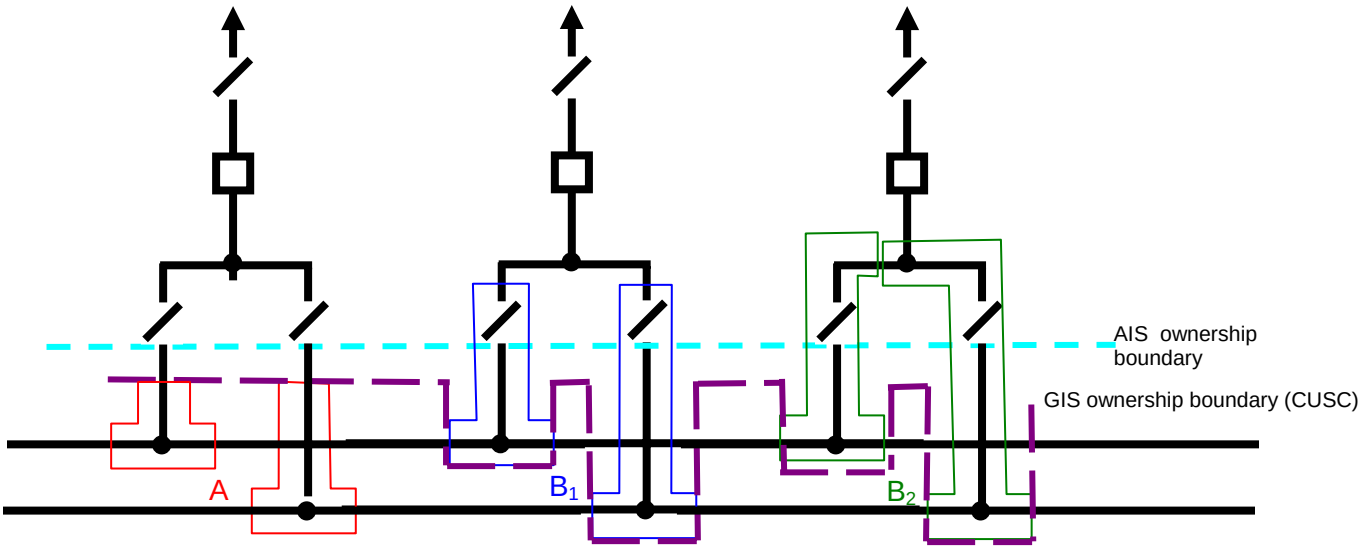
2.6 CUSC 2.12 defines the electrical boundary which in the absence of contrary agreement equates to the ownership boundary. The electrical (and therefore default ownership) boundary for Air Insulated Switchgear (AIS) is defined as the busbar clamp on the busbar side of the busbar disconnector.

2.7 The electrical (and therefore the default ownership) boundary for GIS is defined as the gas zone separators on the busbar side of the busbar selection devices.

2.8 Historically GIS equipment included a gas zone separator between the busbars and the busbar selector disonnectors, and the CUSC definition resulted in a GIS ownership boundary which mirrored the prevailing AIS ownership boundary. The majority of switchgear manufacturers, in National Grid's experience have, however, since adopted a different design which no longer includes a gas zone separator immediately adjacent to the busbar disconnector. It is now common

for the busbar selector disconnectors to be in the same gas zone as part of the busbars.

2.9 Hence, whilst the electrical boundary definition remains the same, this results in the potential for more than one party to own the busbar. See the diagram below – the purple dashed line represents the GIS electrical and default ownership boundary as defined in the CUSC.



Note: A, B1 and B2 represent 3 different types of GIS construction, all of which are in use or planned for use on the system. The GIS construction type "A" was originally installed on the transmission system and the CUSC boundary definition was based upon this type of construction, so as to produce a boundary equivalent to that for AIS installations.

2.10 The newer GIS construction types (type "B" – with the diagram above showing two different variants labelled "B_1" and "B_2") mean that the default ownership boundary as per the CUSC no longer result in a boundary equivalent to AIS installations. This has created a number of complex issues on a project by project basis for GIS connections for both National Grid and users. In particular at the construction phase, as it is difficult to draw a demarcation line between National Grid and user assets[1].

Market issues

2.11 At present there are 4 type tested designs of GIS equipment on the market that are or will be used on the transmission system. However, there is no international standard for design as a result different manufactures equipment are not compatible. This makes it difficult and costly to interface switchgear from one manufacturer with that of another[2].

[1] It should be noted that this issue does not apply to AIS connections as it not integrated or sealed.
[2] It should be noted that this is not the case for AIS connections as all type tested manufactures equipment is compatible.

2.12 This has an impact upon competition for GIS equipment, because once a manufacturer's design has been chosen only that manufacturer equipment can be used by both National Grid and the user. This limits a users procurement options for GIS transmission connections. In addition, the UK market represents a very small proportion of the global market.

2.13 This has resulted in National Grid and users having limited market bargaining power which can lead to an increase in prices.

3.0 SUMMARY OF WORKING GROUP DISCUSSIONS

3.1 The first meeting of the Working Group was held on 26th February 2008[3] where the Group debated and agreed the Terms of Reference, a copy is provided in Annex 1. RWE presented their paper and provided the Group with further background information in relation to the issues they have experienced.

3.2 In summary, RWE believe the ownership boundary should not be drawn within a gas zone for GIS, as this gives rise to issues regarding construction, maintenance and creates safety concerns. In addition, there is a lack of competition and procurement opportunity for GIS equipment because once the substation owner has decided upon a manufacturer the user must also use that equipment, as different equipment is not compatible. Other Group members confirmed that similar issues have been encountered by other DNO's.

3.3 The Group then debated the current issues raised by GIS. National Grid provided information regarding the types of GIS configurations which can be found upon the system (as explained in section 2.5 of this report). In addition, the Group agreed a definition of GIS equipment to focus and aid the Group, see section 2.3 for the definition.

3.4 One Group member raised the question of retrospective application, it was agreed that the preferred solution should be developed first and such issues considered at the end under implementation.

3.5 The Working Group undertook a brainstorming exercise which focused issues into three board categories, construction, operation and enduring ownership boundary. Each category is briefly described below.

Construction

3.6 National Grid confirmed that AIS is preferred and that GIS will only be installed when the circumstances of the connection requires this equipment, such as lack of space, coastal proximity, visual impact due to the area, i.e. near a city or national park etc. In summary, it was agreed that a single unit construction approach to GIS is likely to be most effective, that there is limited practical contestability with GIS due to market issues (which is not the case with AIS.)

Operations

3.7 The Working Group debated the issues at length and concluded that responsibility for operation should generally follow ownership and that maintenance costs should not be a significant issue for GIS compared with AIS.

[3] Please use this Link to National Grid's website for a copy of the minutes

Enduring Ownership

3.8 Enduring ownership was debated and National Grid raised concerns regarding the liability for Interruption Payments, which was introduced by CAP048. Interruption Payment is compensation paid to generators whose access is removed solely due to plant and apparatus forming part of the Transmission System. The RWE proposal would transfer users' assets, (in this case generators) from the user to National Grid and would effectively create a single circuit connection therefore increasing the risk of Interruption Payments. The Group agreed that further consideration is required regarding the enduring ownership.

3.9 The second meeting was held on 10th June 2008[4] the Group reviewed the output of the brainstorming session[5] undertaken during the first Working Group meeting, which was updated. A National Grid expert on GIS gave a presentation to the group on the main technical features and a copy of the slides can be found in Annex 4.

3.10 The third meeting was held on 4th September 2008[6] and National Grid presented a number of possible options for GIS, a copy of the slides can be found in Annex 4. Six options were presented to the Group for generation connections to the Transmission System and are detailed below:

- Option 1 RWE Model
- Option 2 As currently defined within the CUSC
- Option 3 Before the Circuit Breaker
- Option 4 Gas separator nearest the busbar
- Option 5 As per AIS with a jointly owned gas zone
- Option 6 Enduring ownership as per AIS but one party builds all the GIS assets

3.11 The Working Group debated each option in turn focusing on the benefits and the impacts and issues. The Working Group agreed that Option 1 had merits and should be developed further. Issues highlighted for development included any potential impact on the SQSS, charging and liabilities (Interruption Payment). It was agreed that the overall costs are unlikely to change due to the work of this Working Group, but that the allocation of CAPEX and OPEX costs would transfer to different parties compared to the current arrangements.

3.12 In relation, to liabilities the Group debate alternative option(s), as a number of members believed that interruption compensation would be an enhancement to the existing rights compared to AIS. It was suggested that greater transparency regarding maintenance could provide users with the comfort that they require. It was agreed that further information should be provided at the next meeting. The Group debated outages and secondary systems. All agreed that operation of equipment should remain as is and should only be changed if there is a justifiable reason. It was noted that this would also apply to a number of the other options.

[4] Please use this Link to National Grid's website for a copy of the minutes
[5] Please use this Link to National Grid's website for a copy of the brainstorming output
[6] Please use this Link (TBA) to National Grid's website for a copy of the minutes

3.13 Option 2 was briefly discussed and all agreed that this was not viable and no benefits could be derived from continuing with the current approach.

3.14 Option 3 was debated and also agreed that it was not a viable option as it failed to address the issues regarding construction.

3.15 Option 4 was debated and it was noted that there are less issues for type A circuits in terms of liabilities and potential SQSS impacts, however this was not the case for type B and as a consequence was not robust to changes in future design. The Working Group agreed to dismiss option 4.

3.16 Option 5 was briefly discussed and all agreed that joint ownership of a gas zone would create safety and liability concerns which were considered to be worse than the current situation.

3.17 National Grid explained that Option 6 the majority owner of the substation would build all the GIS assets and then transfer assets as per the AIS boundary with the majority owner retaining ownership of the gas zone which included the busbar. It was noted that this option has parallels with the self build concept between DNO's and National Grid. It was brought to the Groups attention that there could be significant issue in relation to the transfer of assets and was agreed that further investigation is required. The Group debated price volatility and market issues which are detailed in section 2.11 of this report.

3.18 The fourth meeting was held on the 27th January 2009[7] and National Grid presented options for DNO connections. National Grid concluded that only options 1 and 6 previously considered by the Group were workable solutions. The Group agreed and concentrated on the analysis of the benefits, impacts and issues associated with each option for both generation and DNO connections, see annex 4 for a copy of the slides.

3.19 The Group debate the potential impact option 1 could have on the GB SQSS and National Grid confirmed in its opinion that this was not an issue. National Grid is able to own generation circuits and remain compliant with the GB SQSS provided the generator did not exceed normal infeed loss risk, currently 1000MW see Annex 5 for extracts of the GB SQSS. DNO members of the Group took an action to consider if there are any issues from a DNO view point.

3.20 The Group then debated charging related matters, National Grid believed that no change to the charging methodologies. The Group debated this issue and National Grid would attempt to provide worked examples of connection charges at the next meeting. In addition, the CAPEX and OPEX transfer from one party to another was debated and how this interacted with how the recommended solution is implemented. The Group agreed to debate implementation of both options and any transitional arrangements at the next meeting.

3.21 The Group then discussed issues and impacts associated with liabilities, maintenance and outages for option 1. Generators members of the Group indicated that they were more concerned to identify and ensure that the correct incentives were place on National Grid to ensure good quality equipment and maintenance rather than Interruption Payments and compensation. The Group

[7] Please use this Link (TBA) to National Grid's website for a copy of the minutes

identified an option were bilateral agreements include a schedule of site routine maintenance with tolerance levels. It was agreed that this option would be considered further via proposed draft legal text.

3.22 Secondary systems were discussed and the Group agreed that the majority owner of the systems should own and install and this would be detailed in the Site Responsibility Schedules.

3.23 The Group then focused on option 6 and debated the liability and access issues in relation to two parties equipment contained with one gas zone and the requirement for an asset transfer. It was agreed that this could be addressed in the bilateral agreement. Finally, the Group noted that with option 6 there would be no visible boundary between busbar owner and user, and the user would be unable to physically remove their assets.

3.24 It should be noted that from this point forward the two preferred options will be referred to as Option A and B.

- Option A Majority Substation owner owns all the GIS assets (RWE Model)
- Option B Enduring ownership as per AIS but one party builds all the GIS assets

3.25

4.0 RECOMMENDATIONS OF THE WORKING GROUP

5.0 IMPLEMENTATION

6.0 IMPACT ON GRID CODE AND CUSC

7.0 IMPACT ON INDUSTRY DOCUMENTS

Impact on Core Industry Documents

No impact envisaged

Impact on other Industry Documents

Possible impacts on Relevant Electrical Standards, Charging Methodologies and NGET's licence – condition B3 (ownership and disposal of assets)

8.0 IMPACT ON GB TRANSMISSION SYSTEM

No impact envisaged

9.0 IMPACT ON GRID CODE USERS

10.0 ASSESSMENT AGAINST GRID CODE OBJECTIVES

10.1 The proposed changes outlined in the Working Group would better facilitate Grid Code Objectives:

ANNEX 1 – WORKING GROUP TERMS OF REFERENCE

Grid Code Working Group
Gas Insulated Switchgear (GIS)

Terms of Reference

Objectives

A paper was presented to the November GCRP by RWE highlighting a number of issues with GIS. The GCRP recommended establishing a joint working group with the CUSC but under the governance of the Grid Code.

The objective of the group is to discuss the issues and proposals under 'Scope of Work' and agree a way forward regarding possible modifications to the Grid Code and the CUSC. An overview of the formal governance process is detailed in a diagram in annex 1.

Membership

The membership of the working group will be drawn from the GCRP or their nominated representatives, the CUSC or their nominated representatives, the Relevant Transmission Licensees and Ofgem.

Proposed Definition

The abbreviation GIS (Gas Insulated Switchgear) is commonly used to designate gas-insulated, metal-clad electrical switchgear. For the purposes of this working group we shall use the term GIS to refer to all gas-insulated, metal-clad electrical equipment at electricity substations where both the substation busbars and the interfacing switchgear between those busbars and any connecting circuits are of metal-clad, gas-insulated construction.

Scope of Work

The group will consider the following issues, as agreed by the GCRP**:**

(a) Identify all current issues with GIS

(b) Identify all possible options to resolve issues for both generation and DNO connections

(c) Identify all the consequences of each option Grid Code, CUSC and any other associated documents within the framework

(d) Identify advantages and disadvantages of each option

(e) Identity any interactions and issues with AIS and propose solutions to resolve

(f) Agree a preferred option(s)

(g) Consider the implications on the Grid Code and CUSC in detail

(h) Consider implementation issues and propose a solution to resolve any issues

Issues out of scope

The issues surrounding DNO and generator GIS substation is outside the scope of the working group. However, the group will inform the Distribution Code via the GCRP and provide a copy of the final report.

Deliverables

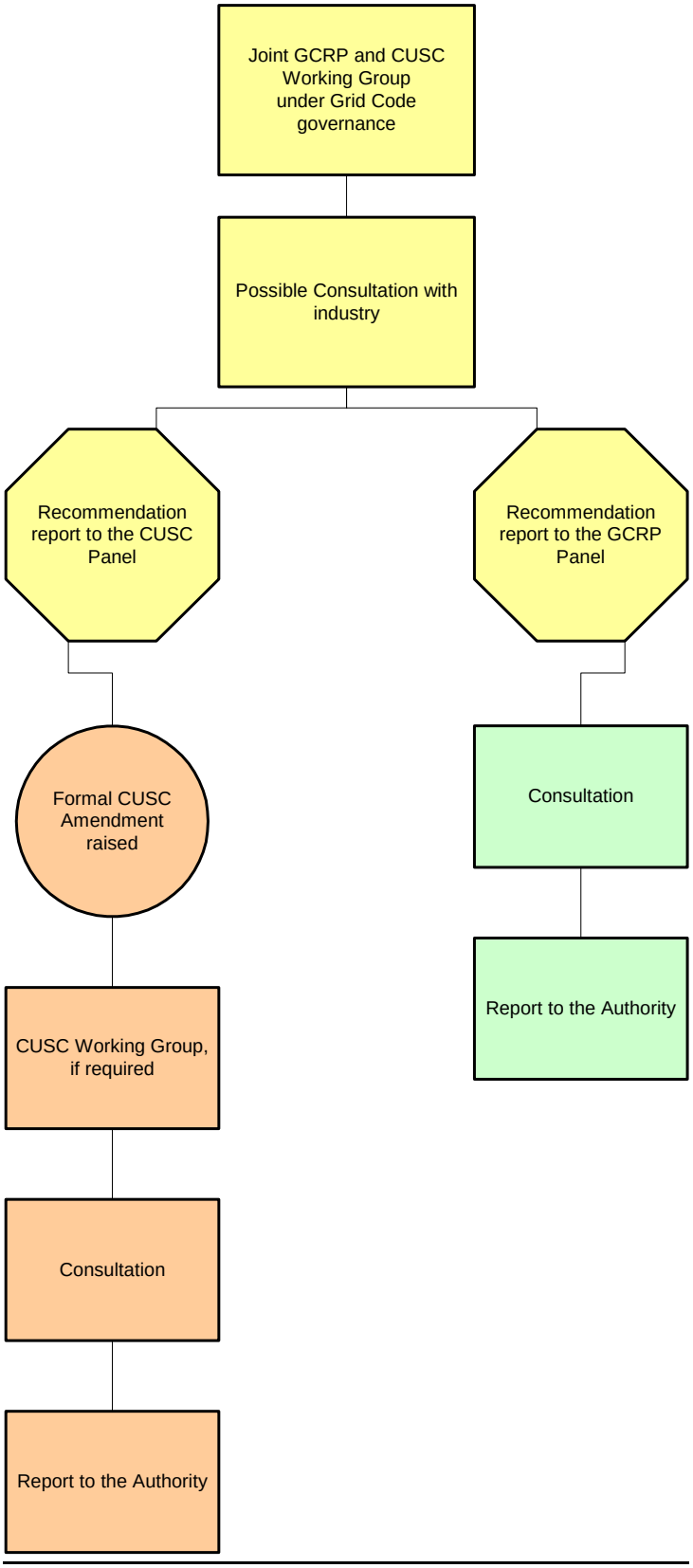
National Grid will produce:

- a GCRP paper recommending a way forward on the above issues, taking into account the group discussions
- a CUSC Panel paper recommending a way forward on the above issues
- draft legal text of any proposed Grid Code changes and CUSC changes as appropriate

Timescales

The working group will aim to complete its work [for the February 2009 GCRP meeting].

Annex 1


Joint GCRP and CUSC Working Group under Grid Code governance
Possible Consultation with industry
Recommendation report to the CUSC Panel
Recommendation report to the GCRP Panel
Formal CUSC Amendment raised
Consultation
CUSC Working Group, if required
Report to the Authority
Consultation
Report to the Authority

ANNEX 2 – PROPOSED GRID CODE CHANGES

ANNEX 3 – RWE GCRP PAPER

PAPER TO THE GRID CODE REVIEW PANEL

USER CONNECTIONS TO THE GB TRANSMISSION SYSTEM VIA GAS INSULATED SWITCHGEAR (GIS)

Introduction

GIS is increasingly being chosen by National Grid at connection sites which are part of the GB Transmission System (substations). GIS may be used at new connection sites and/or at existing connection sites where the existing assets are being replaced by National Grid. GIS is likely to be chosen in preference to Air Insulated Switchgear (AIS) possibly due to its lower cost to National Grid, reduced land requirement and reduced profile being easier to consent.

Treatment of GIS assets within the Grid Code and CUSC

Whilst GIS assets may be referred to in Users bilateral agreements with National Grid, GIS is not defined within either the CUSC or Grid Code, although it is noted that the GIS technical specification is detailed in Section 17 (page 171) of the RES.

CUSC 2.12.1 (e) (ii) describes the electrical ownership boundary for metal clad SF_6 switchgear as being the gas zone separators on the busbar side of the busbar selection devices. However, for GIS switchgear, this ownership boundary fails to acknowledge that it is not practically possible for a User to make a physical connection to the busbar within the gas zone. This issue may be recognised in the bilateral connection agreements, where the ownership boundary is considered to be “non-standard”.

Issue for Users

In addition to the lack of definition of ownership boundary, the use of GIS at substations that forms a connection site with a User(s) presents particular problems for the User(s) when compared to AIS. The design of GIS is such that the User’s assets at the substation need to be integrated within the structure of the substation and would not be readily accessible or detachable from the substation / GB transmission system. Furthermore, the need to share a common gas system and adapt equipment if provided by a different manufacture to that of the substation means that it is not practicable for such User assets to be competitively procured or maintained by the User.

The User is therefore effectively forced to contract for the installation and maintenance of its User assets at a GIS substation with National Grid who is, in effect, the only party able to carry out these User works. This work would be carried out by National Grid as an unlicensed activity and separate from the

licensed works carried out under the provisions of the construction agreement. The third party alliance arrangements that National Grid may have entered into with respect to transmission asset works means that it is extremely difficult for the User to form a view whether the price being charged by National Grid is reasonable and competitive.

Recommendation

1. It is acknowledged that the design of GIS substations is such that the User is effectively unable to design, procure, install or maintain the GIS User assets independently of the GIS substation manufacturer / provider. It would appear to be both inefficient and of little technical benefit for the User continuing to retain ownership of such assets, which would be more efficiently managed within a single ownership boundary. It is therefore proposed that the transmission ownership boundary be defined to include all connected GIS assets at a GIS substation up to an external connection to the User's assets, such as a cable sealing end, as licensed assets.

2. Given the increasing use of GIS substations, it is unreasonable for the User ownership boundary at such substations to continue to be considered as being "non-standard". It is proposed that the ownership boundary (as amended) be defined in the Grid Code Connection Conditions.

The Grid Code Review Panel is invited to: -

1) Consider the issues relating to GIS raised in this paper.

2) Endorse from a technical perspective the recommendation given in this paper and the need to define the GIS ownership boundary within the Grid Code Connection Conditions.

3) Recommend to the CUSC Panel any changes that may be appropriate for the CUSC Panel to consider

4) Consider whether any additional change / clarification to the Grid Code is required

ANNEX 4 – WORKING GROUP SLIDES

Gas-insulated switchgear (GIS)

Paul Coventry
Asset Policy

nationalgrid

Gas-insulated switchgear

- 'Metal-enclosed switchgear in which the insulation is obtained, at least partly, by an insulating gas other than air at atmospheric pressure' (IEC 60050 (441))

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Benefits of GIS

- Compact size:
  - May be built closer to load centres
  - Replacement/extension within existing substation boundaries
  - Low visual impact – easily screened, may be housed within building of appropriate style
- Immunity to pollution:
  - Low number of exposed insulators
  - May be sited in exposed coastal areas or near sources of industrial pollution

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Substation Primary Insulation

National Grid policy is:

- 'Outdoor Air Insulated switchgear will be used at pollution severity Class III (or less) sites, except where other elements of this policy are overriding.'
- 'Gas Insulated Switchgear (GIS) substations shall only be considered where lifetime related conditions (such as pollution, permanent space restriction or public visual amenity) preclude the use of open terminal equipment and the terms of this policy are met.'

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Why does National Grid install GIS substations?

- Historically substations were AIS as this was the only available technology.
- However, this resulted in a number of difficulties
  - Pollution when in close proximity to industrial or coastal
  - Insufficient space for AIS when constructing new substations/extensions (e.g. inner cities)
  - Planning laws for National Parks, AONBs and Green Belts only permit AIS substations where there is 'no demonstrable alternative'.

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Considerations for GIS compared to AIS

- GIS designers need to take into account the following:
  - Extension involves using equipment of the same type or special adapters
  - Possible requirement for future extension

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Considerations for GIS compared to AIS

- Isolation gas density dependent
- Availability of adjacent circuits
- Safety issues limiting work adjacent to pressurised gas compartment partitions
- Leads to partitioning of GIS into gas compartments

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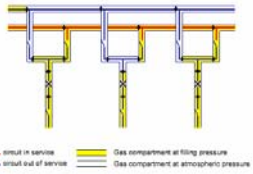
Impact of partitioning on availability



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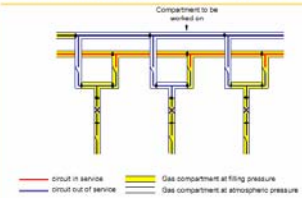
Impact of partitioning on availability



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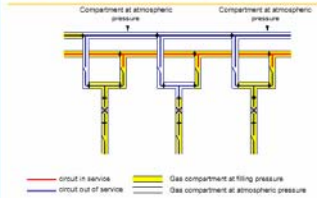
Impact of partitioning on availability



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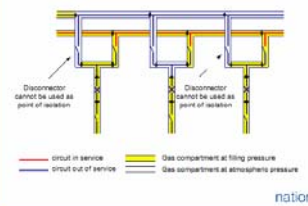
Impact of partitioning on availability



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Impact of partitioning on availability

- This intervention would require 3 circuits to be out of service simultaneously
- Such a design would not be acceptable to National Grid

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Impact of partitioning on availability

Technical specification for Substations:

- 'The design of a substation shall permit installation, extension, operation and maintenance (preventive and corrective) with a maximum of one circuit (including any circuit requiring intervention) and one section of busbar out of service simultaneously.'

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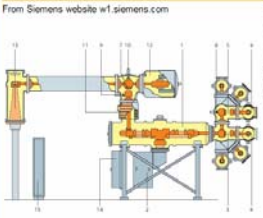
Design and construction of GIS

From Siemens website w1.siemens.com



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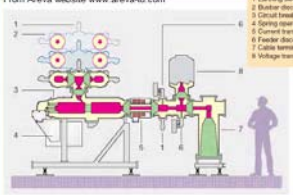
Design and construction of GIS

From Areva website www.areva-td.com



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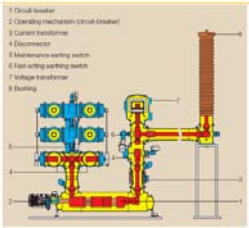
Design and construction of GIS

From ABB website www.abb.com



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Gas compartments and partitioning

- Initially CEGB/National Grid procured equipment from British manufacturing base
- GIS designs incorporated bus selector disconnectors in separate gas compartments to the Main and Reserve Busbars
- Long busbar gas compartments

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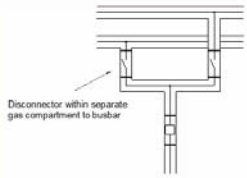
Gas compartments and partitioning



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Gas compartments and partitioning

- Since the early 1990's National Grid has procured from a European wide manufacturing base
- Most European GIS designs incorporate bus selector disconnectors within Main and Reserve busbar gas compartments

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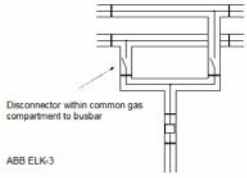
Gas compartments and partitioning



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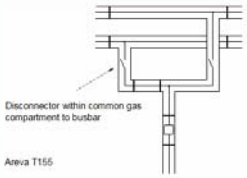
Gas compartments and partitioning



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Maintenance (typical)

GIS general

- General condition of equipment, support structures, earthing connections
- Gas pressure/density level and trend
- Gas quality (HF/SO_2, O_2, H_2O)
- Calibration of pressure/density gauge/transducer
- Alarm setting and operation

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Maintenance (typical)

Disconnectors and earthing switches

- Mechanism heater operation
- Number of operations
- Trial operations
- Motor operating time and current
- Operation of position indicating device
- Condition of auxiliary switches, wiring and connections
- Condition of linkages and gears, lubrication
- Operation of interlocks

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Maintenance (typical)

Circuit-breakers

- Number of operations
- Trial operations
- Contact timing/travel record
- Checks according to type of mechanism (spring/ hydraulic/pneumatic)

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GIS service experience

- CIGRE WG 23.02, 'Report on the Second International Survey on High Voltage Gas Insulated Substations (GIS) Service Experience', Ref. 150, February 2000
- Major failure rate for GIS 300-500 kV commissioned after 01/01/1985:
- 2.58 per 100 circuit-breaker bay years

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GIS service experience

Major Failure *– failure of a major component or element of the GIS which causes the lack of one or more of its fundamental functions. NOTE: A major failure will result in an immediate change in the system operating conditions, e.g. the protective equipment being required to remove the fault, or will result in the mandatory removal from service within 30 minutes for un-scheduled maintenance.'*

$$\text{Major failure rate} = \frac{\text{Number of major failures}}{\text{Sum of circuit-breaker bays x years in service}}$$

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Main component involved in failure, 300-500 kV

Circuit-breaker or switch	27.3%
Disconnector	20.5%
Earthing switch	0.6%
CT	1.9%
VT	4.3%
Busbars	6.2%
Busducts and interconnecting parts	24.2%
SF6/air bushing	9.3%
Cable box	0.6%
Transformer interface	2.5%
Surge arrester	1.9%
Other	0.6%

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Classification of symptoms, 300-500 kV

Breakdown between poles	1.9%
Breakdown across open poles	1.9%
Breakdown to earth, solid insulation	25.8%
Breakdown to earth, gas insulation	36.5%
Failure to open on command	13.2%
Failure to carry current	-
Loss of mechanical function	0.6%
Loss of SF6 gas	4.4%
Failure of pressure relief device	-
Enclosure burn through	1.3%
Partial discharge	1.9%
Locking in open or closed position	2.5%
Other	10.0%

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GIS service experience

- CIGRE WG A3.06 is conducting a reliability survey of High Voltage equipment at present
- The survey covers circuit-breakers, disconnectors, earthing switches, instrument transformers and includes both AIS and GIS equipment
- The results are not yet published

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Gas Insulated Switchgear

Working Group Options for Generation connections to the Transmission System

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Current position

- For the purposes of the working group the term GIS refers to all gas-insulated, metal-clad electrical equipment at electricity substations where both the substation busbars and the interfacing switchgear between those busbars and any connecting circuits are of metal-clad, gas-insulated construction
- Generally GIS zones can be classified into two broad types
  a. GIS substations where the bus selector disconnectors are not in the same gas zone as the busbars (i.e. where there are gas zone separators between the bus selector disconnectors and the busbars)
  b. GIS substations where the bus selector disconnectors are in the same gas zone as the busbars

NB: The types of GIS switch gear will not change due to the outcome of the working group

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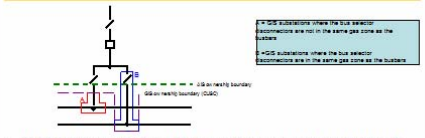
GIS – as currently defined



- CUSC 2.12 defines the electrical boundary and the ownership boundary for GIS as the gas zone separators on the busbar side of the busbar selection devices
- Historically there was a gas zone separator between the busbar and the bus-selector disconnectors and the CUSC definition produced a GIS ownership boundary comparable to that for AIS installations
- The majority of newer GIS installations, in National Grid's experience, do not incorporate a gas zone separator between the busbar and the bus-selector disconnectors and the CUSC boundary definition results in a default ownership and electrical boundary which includes sections of busbars as Users' assets
- Regardless of type the issues surrounding construction and enduring ownership remain

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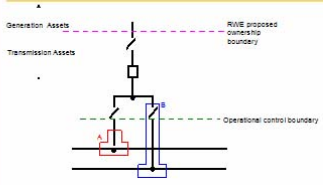
Option 1 – RWE's Proposal



- Ownership and electrical is moved to include all connected GIS assets at a GIS Substation e.g. up to the cable sealing/GIS to AIS termination

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1

Option 1 – RWE model

Benefits

- Addresses construction issues and interaction of licenced and unlicenced works
- Removes inconsistency for future GIS sites
- Removes complexity for safety Management for maintenance
- More economical solution for one party to build and maintain

Impacts and issues

- No overall significant change to costs but a change to who funds the assets (CAPEX and OPEX implications that has not been included in the price control)
- Potential SQSS impact
- Creates inconsistency with AIS
- Liabilities, maintenance and compensation
- Secondary control systems

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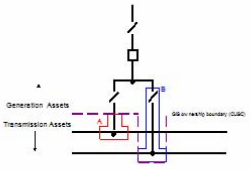
Option 2 as currently defined



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Option 2 as currently defined

Benefits

Impacts and issues

- Existing issues are not addressed
- Inconsistency across sites depending on manufactured design

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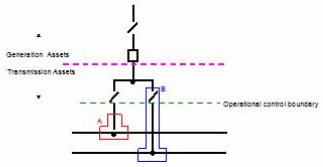
Option 3 before the CB



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Option 3 before the CB

Benefits
- Visible boundary at the gas zone separator
- User would be able to remove their assets if they wished
- Generator has control over their synchronising circuit breaker and circuit disconnector

Impacts and issues
- Construction issues and licenced unlicenced interaction not addressed
- No point of isolation
- No overall significant change to costs but a change to who funds the assets (CAPEX and OPEX implications that has not been included in the price control)
- Potential SQSS impact
- Creates inconsistency with AIS
- Liabilities, maintenance and compensation
- Secondary control systems
- Not robust if manufacturers change designs

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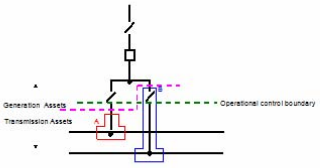
Option 4 gas separator nearest to busbar



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Option 4 gas separator

Benefits
- Visible boundary at the gas zone separator
- User would be able to remove their assets if they wished
- Generator has control over their synchronising circuit breaker and circuit disconnector
- Double circuit connection – no liability and compensation issues

Impact and issues
- Construction issues and licensed unlicensed interaction not addressed
- Major inconsistency across sites depending on GIS type; at some sites generators own the bus selector disconnectors but not at others
- Not robust if manufacturers change designs

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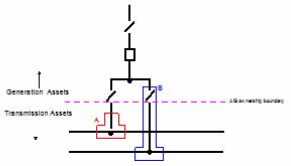
Option 5 as AIS and jointly own the gas zone



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Option 5 as AIS and jointly own the gas zone

Advantages
- Generator has control over their synchronising circuit breaker and circuit disconnector
- Double circuit connection – no liability and compensation issues

Disadvantages
- For some GIS types, no visible boundary (within gas zone)
- Users not able to physically remove the bus selector disconnectors (some GIS types)
- Construction issues and licenced unlicensed interaction not addressed
- Liability and access issues regarding the gas zone

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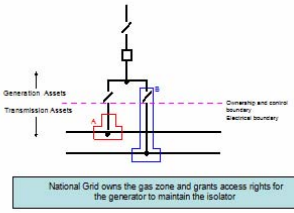
Option 6 enduring as per AIS but one party builds all GIS assets



National Grid owns the gas zone and grants access rights for the generator to maintain the isolator

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Option 6 enduring as per AIS but one party builds all GIS assets

Advantages
- Construction issues and licenced unlicenced interaction are addressed
- Enduring boundary consistent with AIS
- No change to proven methods of Operation
- Double circuit connection – no liability and compensation issues

Disadvantages
- For some GIS types, no visible boundary (within gas zone)
- Users not able to physically remove the bus selector disconnectors (some GIS types)
- Complications regarding asset transfer
- Ongoing maintenance
- Liability and access issues regarding the gas zone

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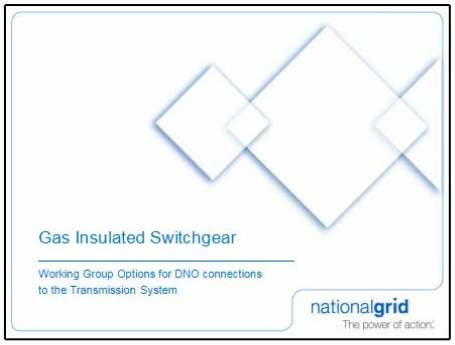
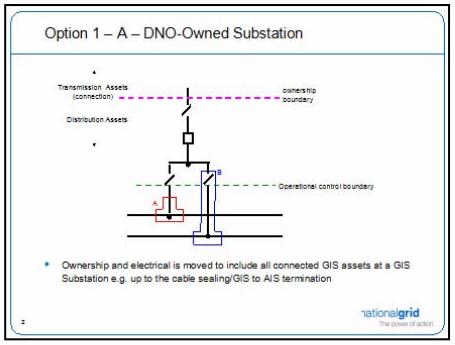
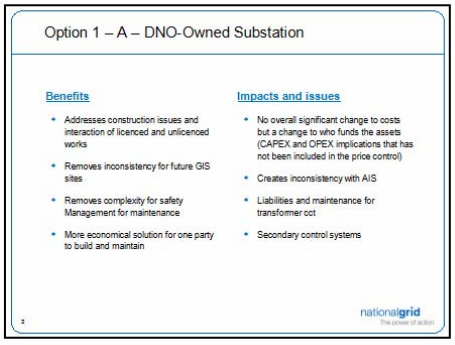
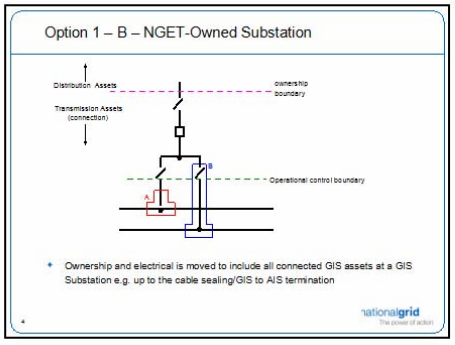
4


Gas Insulated Switchgear
Working Group Options for DNO connections to the Transmission System
nationalgrid
The power of action.


Option 1 – A – DNO-Owned Substation
Transmission Assets (connection)
Distribution Assets
ownership boundary
Operational control boundary
Ownership and electrical is moved to include all connected GIS assets at a GIS Substation e.g. up to the cable sealing/GIS to AIS termination


Option 1 – A – DNO-Owned Substation
Benefits
Addresses construction issues and interaction of licenced and unlicenced works
Removes inconsistency for future GIS sites
Removes complexity for safety Management for maintenance
More economical solution for one party to build and maintain
Impacts and issues
No overall significant change to costs but a change to who funds the assets (CAPEX and OPEX implications that has not been included in the price control)
Creates inconsistency with AIS
Liabilities and maintenance for transformer cct
Secondary control systems


Option 1 – B – NGET-Owned Substation
Distribution Assets
Transmission Assets (connection)
ownership boundary
Operational control boundary
Ownership and electrical is moved to include all connected GIS assets at a GIS Substation e.g. up to the cable sealing/GIS to AIS termination

Option 1 – B – NGET-Owned Substation

Benefits

- Addresses construction issues and interaction of licenced and unlicenced works
- Removes inconsistency for future GIS sites
- Removes complexity for safety Management for maintenance
- More economical solution for one party to build and maintain

Impacts and issues

- No overall significant change to costs but a change to who funds the assets (CAPEX and OPEX implications that has not been included in the price control)
- Creates inconsistency with AIS
- Liabilities and maintenance for distrib. cct
- Secondary control systems

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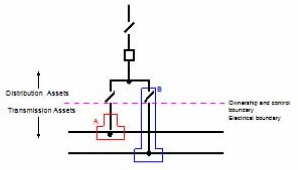
Option 6 – A – NGET-Owned substation enduring as per AIS but one party builds all GIS assets



National Grid owns the gas zone and grants access rights for the DNO to maintain the isolator

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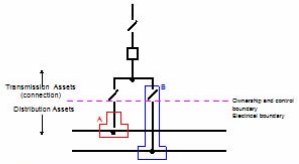
Option 6 – B – DNO -Owned substation enduring as per AIS but one party builds all GIS assets



DNO owns the gas zone and grants access rights for NG to maintain the isolator

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Option 6 enduring as per AIS but one party builds all GIS assets

Benefits

- Construction issues and licenced unlicenced interaction are addressed
- Enduring boundary consistent with AIS
- No change to proven methods of Operation
- Similar situation already exists for "self-build" contracts
- No transfer of CAPEX and OPEX costs
- No impact on charging

Impacts and Issues

- For some GIS types, no visible boundary (within gas zone)
- Users not able to physically remove the bus selector disconnectors (some GIS types)
- Secondary systems issues
- Liability and access issues regarding the gas zone
- Increased complexity of ongoing maintenance

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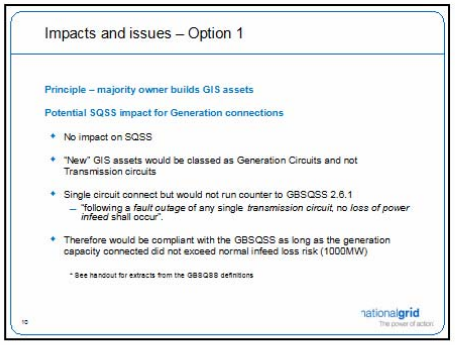
Impacts and issues
Option 1 – Generation and DNO connections
nationalgrid
The power of action.


Impacts and issues – Option 1
Principle – majority owner builds GIS assets
Potential SQSS impact for Generation connections
No impact on SQSS
"New" GIS assets would be classed as Generation Circuits and not Transmission circuits
Single circuit connect but would not run counter to GBSQSS 2.6.1
– "following a fault outage of any single transmission circuit, no loss of power infeed shall occur".
Therefore would be compliant with the GBSQSS as long as the generation capacity connected did not exceed normal infeed loss risk (1000MW)
* See handout for extracts from the GBSQSS definitions
10
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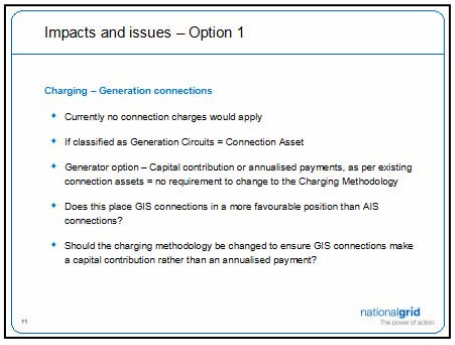
Impacts and issues – Option 1
Charging – Generation connections
Currently no connection charges would apply
If classified as Generation Circuits = Connection Asset
Generator option – Capital contribution or annualised payments, as per existing connection assets = no requirement to change to the Charging Methodology
Does this place GIS connections in a more favourable position than AIS connections?
Should the charging methodology be changed to ensure GIS connections make a capital contribution rather than an annualised payment?
11
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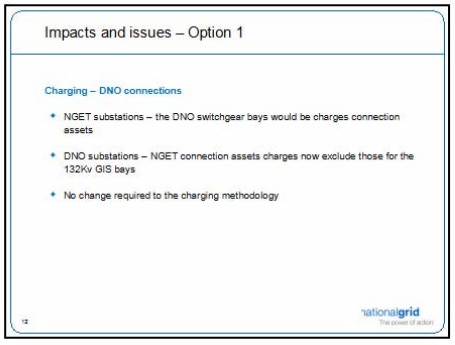
Impacts and issues – Option 1
Charging – DNO connections
NGET substations – the DNO switchgear bays would be charges connection assets
DNO substations – NGET connection assets charges now exclude those for the 132Kv GIS bays
No change required to the charging methodology
12
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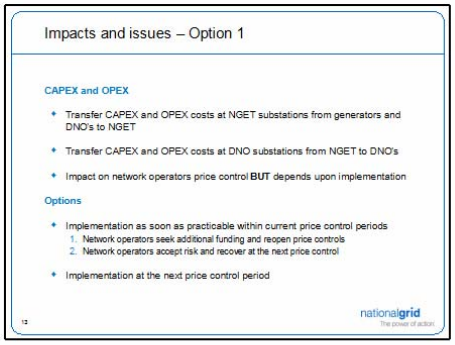
Impacts and issues – Option 1
CAPEX and OPEX
Transfer CAPEX and OPEX costs at NGET substations from generators and DNO's to NGET
Transfer CAPEX and OPEX costs at DNO substations from NGET to DNO's
Impact on network operators price control BUT depends upon implementation
Options
Implementation as soon as practicable within current price control periods
1. Network operators seek additional funding and reopen price controls
2. Network operators accept risk and recover at the next price control
Implementation at the next price control period
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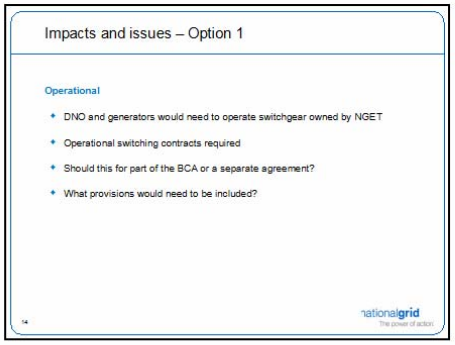
The power of action
12


Impacts and issues – Option 1
Operational
DNO and generators would need to operate switchgear owned by NGET
Operational switching contracts required
Should this for part of the BCA or a separate agreement?
What provisions would need to be included?
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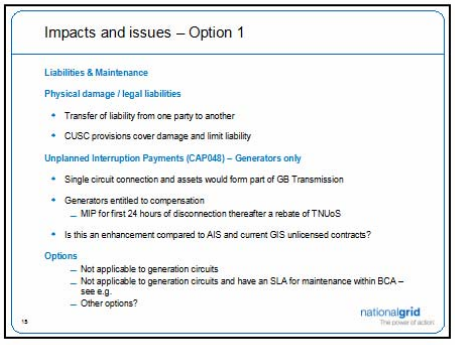
The power of action
14


Impacts and issues – Option 1
Liabilities & Maintenance
Physical damage / legal liabilities
Transfer of liability from one party to another
CUSC provisions cover damage and limit liability
Unplanned Interruption Payments (CAP048) – Generators only
Single circuit connection and assets would form part of GB Transmission
Generators entitled to compensation
– MIP for first 24 hours of disconnection thereafter a rebate of TNUoS
Is this an enhancement compared to AIS and current GIS unlicensed contracts?
Options
– Not applicable to generation circuits
– Not applicable to generation circuits and have an SLA for maintenance within BCA – see e.g.
– Other options?
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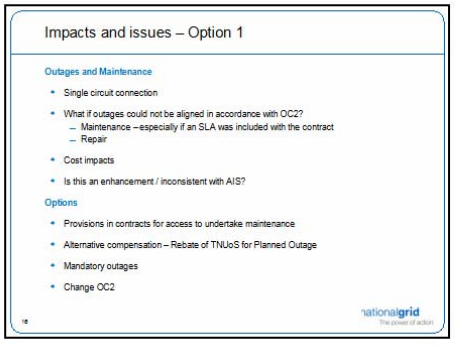
15


Impacts and issues – Option 1
Outages and Maintenance
Single circuit connection
What if outages could not be aligned in accordance with OC2?
– Maintenance – especially if an SLA was included with the contract
– Repair
Cost impacts
Is this an enhancement / inconsistent with AIS?
Options
Provisions in contracts for access to undertake maintenance
Alternative compensation – Rebate of TNUoS for Planned Outage
Mandatory outages
Change OC2
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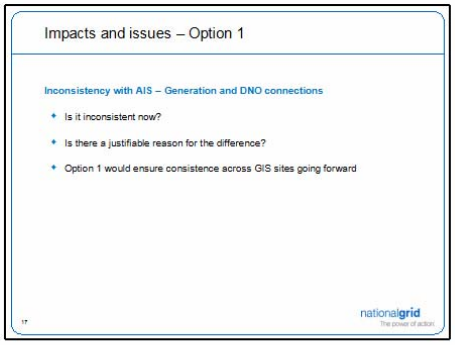
The power of action
16


Impacts and issues – Option 1
Inconsistency with AIS – Generation and DNO connections
Is it inconsistent now?
Is there a justifiable reason for the difference?
Option 1 would ensure consistence across GIS sites going forward
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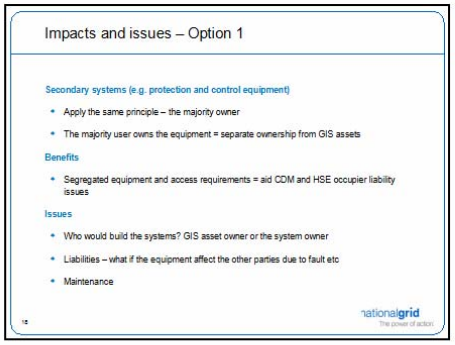
Impacts and issues – Option 1
Secondary systems (e.g. protection and control equipment)
Apply the same principle – the majority owner
The majority user owns the equipment = separate ownership from GIS assets
Benefits
Segregated equipment and access requirements = aid CDM and HSE occupier liability issues
Issues
Who would build the systems? GIS asset owner or the system owner
Liabilities – what if the equipment affect the other parties due to fault etc
Maintenance
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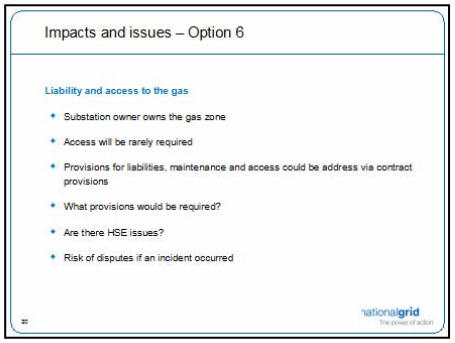
Impacts and issues
Option 6 – Generation and DNO connections
nationalgrid
The power of action


Impacts and issues – Option 6
Liability and access to the gas
Substation owner owns the gas zone
Access will be rarely required
Provisions for liabilities, maintenance and access could be address via contract provisions
What provisions would be required?
Are there HSE issues?
Risk of disputes if an incident occurred
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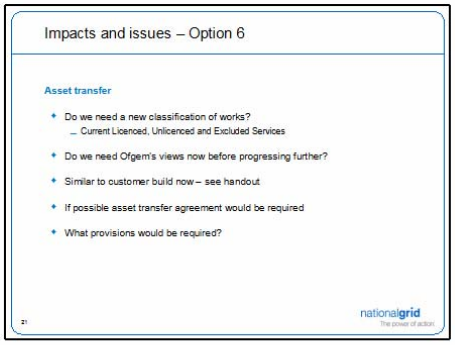
5


Impacts and issues – Option 6
Asset transfer
Do we need a new classification of works?
Current Licenced, Unlicenced and Excluded Services
Do we need Ofgem's views now before progressing further?
Similar to customer build now – see handout
If possible asset transfer agreement would be required
What provisions would be required?
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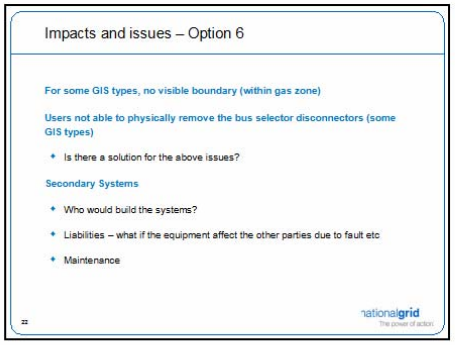
21


Impacts and issues – Option 6
For some GIS types, no visible boundary (within gas zone)
Users not able to physically remove the bus selector disconnectors (some GIS types)
Is there a solution for the above issues?
Secondary Systems
Who would build the systems?
Liabilities – what if the equipment affect the other parties due to fault etc
Maintenance
nationalgrid
The power of action
22

6

ANNEX 5 – EXTRACT FROM GB SQSS

GIS WORKING GROUP – January 2009

GQSS Definitions

"Generation Circuit The sole electrical connection between one or more generating units and the Main Interconnected Transmission System, i.e. a radial circuit which if removed would disconnect the generating units."

"Transmission circuit Part of the GB transmission system between two or more circuit-breakers which includes, for example, transformers, reactors, cables and overhead lines but excludes busbars and generation circuits."

"GB transmission system The system consisting (wholly or mainly) of high voltage electric lines owned or operated by a GB transmission licensee and used for the transmission of electricity from one power station to a substation or to another power station or between substations or to or from any external interconnection, and includes equipment owned or operated by a GB transmission licensee in connection with the transmission of electricity but does not include any remote transmission assets."

"Main Interconnected Transmission System (MITS) This comprises all the 400kV and 275kV elements of the GB transmission system and, in Scotland, the 132kV elements of the GB transmission system operated in parallel with the supergrid, but excludes generation circuits, transformer connections to lower voltage systems and external interconnections between the GB transmission system and external systems."

"Supergrid That part of the GB transmission system operated at a nominal voltage of 275kV and above."

"Power Station An installation comprising one or more generating units (even where sited separately) owned and/or controlled by the same generator, which may reasonably be considered as being managed as one power station."

"Generator A person who generates electricity under licence or exemption under the Electricity Act 1989."