WORKING GROUP REPORT

Gas Insulated Switchgear (GIS)

Prepared by the GIS Working Group
for submission to the Grid Code Review Panel
and CUSC Amendment Panel

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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 The Working Group recommends that CUSC is modified such that a User requesting a connection to the NETS via a GIS substation will be able to elect one of the following standard boundary and construction options:

- Generator Standard Boundary
- DNO Standard Boundary – User builds all the GIS assets
- DNO Standard Boundary – User builds their own assets only

1.4 The development of a standard CUSC Exhibit for DNO Self Build Agreements.

1.5 The Working Group recommends that the TCMF consider two changes to the Connection Asset Charging Methodology as identified below and that a representative of the Working Group should take the issues to the TCMF.

- Introduce a specific Site Specific Maintenance Charge for GIS based assets, to take into account the expected lower lifetime operating cost for such technology;
- A new methodology for the calculation of the initial Gross Asset Value of GIS assets, including generic or site specific approaches.

2.0 GIS Issues Raised by RWE

2.1 The issues raised at the November 2007 GCRP by RWE 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 although it may be referred to in industry documents such as Bilateral Connection Agreements
- Inconsistent ownership boundary between that defined in the CUSC and the Bilateral Connection Agreements
- Lack of competition for the procurement and maintenance of GIS equipment
- Complexity associated with safety management and substation access
- Issues with licensed and unlicensed work

2.2 In addition, RWE made the following recommendations:

2.2.1 that the Transmission Ownership boundary should be defined 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 for GIS substations be defined within the Grid Code Connection Conditions.
2.3 In the context of this report GIS refers to all gas-insulated, metal-enclosed electrical equipment at electricity substations where both the substation busbars and the interfacing switchgear between those busbars and any connecting circuits are of metal-enclosed, gas-insulated construction, see photograph below.
3.0 Current Background

3.1 The current position can be summarised below:

- Due to the nature of the equipment (i.e. integrated, sealed and modular) it is difficult to identify a construction and on going operational ownership boundary for User connections at GIS substations,
- There is no recognised international standard for compatibility between GIS equipment manufactured by different GIS manufacturers which has a direct impact upon competition for the procurement and maintenance of this equipment,
- The UK market lacks bargaining power within the global market for GIS equipment.

GIS Boundaries

3.2 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: Switchgear 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: Switchgear where the bus selector disconnectors are in the same gas zone as the busbars.

A = Gas Insulated Switchgear where the bus selector disconnectors are not in the same gas zone as the busbars

B = Gas Insulated Switchgear where the bus selector disconnectors are in the same gas zone as the busbars

3.3 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.

3.4 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.

3.5 Historically GIS equipment included a gas zone separator between the busbars and the busbar selector disconnectors, and the CUSC definition resulted in a GIS
ownership boundary which mirrored the prevailing AIS ownership boundary. The majority of switchgear manufacturers have, however, now adopted a different design which no longer includes a gas zone separator between the busbars and the busbar disconnector. It is now common for the busbar selector disconnector to be in the same gas zone as part of the busbars.

3.6 With the electrical boundary as currently defined in the CUSC, this results in the potential for multiple parties to each own a separate section of a single or double busbar. See the diagram below – the purple dashed line represents the GIS electrical and default ownership boundary as defined in the CUSC. Also shown, for comparison, as the light blue dashed line is the equivalent AIS electrical and default ownership boundary as defined in the CUSC.

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

3.7 The newer GIS equipment types (type “B” – with the diagram above showing two different variants labelled “B1” and “B2”) results in a default ownership boundary, as per the CUSC, that is no longer equivalent to AIS installations. This has created a number of complex issues on individual projects 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 It should be noted that this issue does not apply to AIS connections as it not integrated or sealed.
3.8 In general, for sites at an interface between a Distribution Network Operator (DNO) and a Transmission Owner (TO), the DNO and TO will develop a connection via a cooperative design approach, and therefore the DNO is involved in the decision making process including the choice of whether AIS or GIS equipment is to be installed. In contrast, when a Generator applies for a connection the TO will determine the economic and efficient method by which to make that connection, including whether to use AIS or GIS equipment.

GIS Manufacturers

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

3.10 This has an impact upon competition for GIS equipment, because once a manufacturer’s design has been chosen, in practice, only that manufacturer’s equipment can be used by both National Grid and the User. This limits a User’s procurement options for connections to transmission substations using GIS equipment. In addition, the UK market represents a very small proportion of the global market. This has resulted in National Grid and other Users having limited market bargaining power which can lead to an increase in prices and prohibits any significant influence on asset design.

4.0 SUMMARY OF INITIAL WORKING GROUP DISCUSSIONS

Inaugural Working Group meeting

4.1 The initial meeting of the Working Group was held on 26th February 2008 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.

4.2 RWE believed the ownership boundary should not be drawn within a gas zone of GIS equipment, as this boundary would be normally inaccessible and gives rise to difficulties regarding construction, maintenance and safety management. In addition, there is a lack of competition and procurement opportunity for GIS equipment because once the substation switchgear owner has decided upon a manufacturer any other User must also use that equipment, as different equipment is not compatible. Other Group members confirmed that similar difficulties have been encountered.

4.3 In summary, given the extremely limited scope for competition, RWE believed that it would be appropriate for the GIS bay associated with a generating unit to be treated as a licensed asset in terms of construction and maintenance rather than being treated as an unlicensed asset.

4.4 Throughout the meetings, the Working Group split the issues down into several issues.

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2 It should be noted that this is not the case for AIS connections as all type tested manufactures equipment is compatible.

3 Please use this Link to National Grid’s website for a copy of the minutes.
broad categories, which are used for the basis of further discussion. In addition, it became apparent that whilst the issues identified broadly apply to both Generator and DNO Users, there are some distinct differences to both classes of User. Consequently, TO – Generator and TO – DNO interfaces have been discussed below separately and the relevant differences identified.

5.0 Transmission Owner – Generator Interface

5.1 This section examines all the TO – Generator GIS interface issues and those common to both the TO – Generator and TO – DNO interfaces.

Construction

5.2 National Grid confirmed that although AIS is the preferred connection technology GIS will 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. The Working Group discussed that there was additional complexity involved in constructing a GIS bay compared to an AIS bay, such as multiple assets being housed within a single SF6 gas zone.

5.3 It was noted by the Working Group that in the majority of new connection offers issued by National Grid which included a requirement to construct a new substation, the technology chosen by National Grid was GIS.

5.4 National Grid provided information on the proportion of generating projects which employed or were planned to employ GIS technology. The sample consisted of 50 future transmission connected generators that were representative in both magnitude and generating technology. 34% of the generators were connecting into an AIS substation with the remaining 66% connecting to a GIS substation.

5.5 It was noted that there was a limited amount of competition for construction of GIS bays since Users only had the choice of constructing the GIS bays themselves or asking National Grid to do this via the Alliance Partners as unlicensed work. It was noted that if the user chose to construct the GIS bay itself, they would need to contract with the same manufacturer directly. As indicated above, the use of another manufacturer’s GIS equipment is not feasible.

5.6 A further complication associated with the use of GIS equipment was that other elements of the construction (e.g. civil engineering works) were generally incorporated into the overall project reducing the ability for competition.

5.7 Working Group generator representatives agreed that an opportunity to mutually agree the design specification of the GIS generator bay would be required if the Transmission Owner was to construct the bay, and this requirement may form part of the Construction Agreement.

Enduring Ownership – Operation, Maintenance and Liability

5.8 The Working Group concluded that responsibility for operation, safety management and maintenance of switchgear should generally follow that of ownership. However, the Generator would continue to require the ability to open and close the GIS generator bay circuit breaker associated with the Generator’s circuit, exclusively for energising, synchronising, desynchronising and
deenergising of the generator circuit. This would avoid the potential requirement for two circuit breakers connected in series in the Generator’s circuit. The TO would retain operational control responsibilities such as dictating safety rules and the authorisation of access to assets.

5.9 National Grid stated that under the scenario where the TO owned the generator circuit breaker, the TO would require the ability to open the breaker under emergency conditions.

5.10 The Working Group debated the operation of secondary systems and agreed that operation of such equipment should be determined on a site specific basis.

5.11 It was also noted that the operational arrangements for both primary and secondary equipment would need to be reflected in the Site Responsibility Schedule (and possibly in the Bilateral Connection Agreement), as appropriate, to enable one operator to operate the assets of another party.

5.12 A Working Group member, who was a Generator representative, stated that maintenance of Generator User assets in substations in England and Wales, was currently almost exclusively carried out by National Grid as an unlicensed activity, which may demonstrate the impracticability of applying competitive maintenance for these assets. Possible reasons for this approach include safety management requirements and the inherent arrangements for gaining access to transmission substations. Given the other additional difficulties presented by the use of GIS equipment, such as its specialized nature, it was considered that there was even less likelihood of competitive maintenance being applied to GIS equipment and it was suggested that maintenance by National Grid as a licensed activity would therefore be preferable to it being carried out as an unlicensed activity.

5.13 It was established that alternative service providers who were able to carry out maintenance on GIS equipment were available and that such organisations had been developing their capability and resources levels in order to partake in the maintenance of transmission assets, although this is an emerging market.

5.14 UKES, National Grid’s unlicensed business, upon request, provided the Working Group with a summary of the current service level agreements at the 64 transmission substations where connections to DNOs or generator are provided at which they have contracts. The proportion of these sites at which the following activities are preformed by UKES is:

- Outage Maintenance\(^4\): 67%
- Non Outage Inspections\(^4\): 100%
- Call out: 97%
- Safety Management Service: 23%
- Operational Switching: 3%

5.15 The Working Group discussed the identified liability issues associated with the enduring ownership of generator bay GIS assets by the Generator. National Grid argued that if, as consistent with the original proposal, the enduring ownership of

\(^4\) Includes associated safety management service
all GIS assets were transferred to the Transmission Owner, National Grid would have concerns regarding the liability for Interruption Payments, which were introduced by CAP048. Interruption Payment is compensation that is paid to Generators whose access i.e. ability to export to the Transmission System, is removed solely due to outages on 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 (as opposed to the current inherent redundancy associated with being connected to a transmission system busbar), therefore increasing the risk of National Grid being exposed to Interruption Payments.

5.16 The Working Group discussed a potential risk under an ownership boundary option where a generator or DNO would own a short section of the transmission substation busbars. If the generation company went into receivership there is a risk that this part of the busbar, an integral part of the substation, could be removed. The Working Group concluded that this could be contractually remedied in the BCA, so that the asset was required to be left intact. The same issue will arise when the power station closes, regardless of the circumstances of closure, and could be addressed as part of any termination agreement, which would be required on decommissioning.

Licensed/ unlicensed construction
5.17 The Working Group discussed the background and nature of the current position of the ownership boundary for AIS equipment, namely at the bay busbar clamp. National Grid explained that this was the defined electrical boundary point where the transmission system met the distribution or generation systems. It is also the ownership boundary point, where Transmission Licensee owned assets meet the User’s assets. Following the implementation of the shallow PLUGS methodology the depth of connection between a generator and Transmission Owner was greatly minimized so that, under a standard connection, there are no connection assets and transmission infrastructure assets where directly connected to Generator assets via the busbar clamp.

5.18 Historically, a User’s asset would be air insulated and therefore, such an ownership point, allows competition for who and how a User choices to construct its connection bay. Consequently, unlicensed businesses under the same parent companies as Transmission Licensees were established to compete for business in construction and operation of such assets. However for GIS equipment, as set out in 5.5, such competition in its construction does not effectively exist.

Initial Option Analysis
5.19 At the third meeting held on 4th September 2008 National Grid presented a number of initial options for GIS ownership and operational boundaries and the slide pack is shown 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

5.20 The Working Group debated each option in turn focusing on the benefits, 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 National Electricity Transmission System Security and Quality of Supply Standard (NETS SQSS), charging and liabilities ( Interruption Payments). It was agreed that the overall costs of constructing connection assets 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.

5.21 In relation to liabilities the Working Group debated alternative option(s), as a number of members believed that interruption compensation would give the User additional rights over and above the existing rights of AIS connected Users. Instead, it was discussed whether the greater transparency regarding forecast GIS maintenance could provide Users with the comfort that they require, such as a description of the anticipated service level included in either the Bilateral Connection Agreement or within an unlicensed agreement. A different type of service from the Transmission Owner was considered whereby a higher charge would be levied for a predefined maintenance and response Service Level Agreement.

5.22 Generator representative within 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 identified an option where bilateral agreements include a schedule of site routine maintenance with tolerance levels relating to timescales over which maintenance is carried out.

5.23 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, unchanged.

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

5.25 Option 4 was debated and it was noted that there are fewer 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.

5.26 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.

5.27 National Grid explained that under 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 (but not the disconnectors, the ownership and operation of which would reside with the owner of the associated circuit breaker) which included the busbar. It was noted that this option has parallels with the ‘self build’ arrangements often used at joint DNO and National Grid substations where the DNO would build the switchgear and...
transfer the relevant equipment to National Grid on commissioning. It was brought to the Group’s attention that there could be significant issues in relation to the transfer of assets and was agreed that further investigation is required. The Working Group debated price volatility and market issues which are detailed in section 3.10 of this report.

5.28 The Working Group debated the liability and access issues in relation to two parties equipment contained with one gas zone and the requirement for an asset transfer under Option 6. It was agreed that these could be addressed in the Bilateral Connection Agreement. In addition, the Working 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 unilaterally.

5.29 An initial draft of the legal text changes to the CUSC was reviewed by the Group. It was proposed that a definition of “Gas Insulated Switchgear” could be included in the Grid Code, given the increasing use of this term within the industry. Members considered the concept of compensation for loss of generation access via CAP048 payments and the concept of Service Level Agreements and “maintenance years”. These concepts were initially thought necessary if the TO owned the generator circuit breaker; however the group deemed these inappropriate as long as the TO applied the Grid Code OC2 process and best industry practice to the maintenance regime. National Grid stated that it still had some concern with the risk profile associated with the ownership of what are effectively single circuit generator circuits; however such concerns were removed during the later Working Group discussions relating to the precedent established in the Scottish Power Transmission region, as described in section 5.38.

Transmission Charging Methodologies

5.30 The Working Group debated transmission charging related matters where National Grid stated an initial view that if the ownership of the generator bay moved to the TO an upfront payment by the Generator for GIS assets may ensure a level of consistency with AIS assets which are owned by the Generator and therefore inherently self funded during construction. The Working Group believed that as it was not the User’s nomination to use GIS, but National Grid’s choice, that National Grid may benefit significantly in terms of reduced lifetime costs. Consequently it was stated that the funding of such GIS assets should be through an annuitised payment (connection charges) and not an upfront capital payment. The Working Group agreed that although this created some differences between the funding of User owned AIS assets, this was appropriate as the inherent modular nature of GIS assets justifies it.

5.31 National Grid stated that no material changes would be required to the Charging Methodologies and an adoption of an alternative ownership boundary can already be taken into account by the Connection Charging Methodology. Another Working Group member disagreed, stating that a GIS specific Connection Charge should be developed in order to reflect the perceived lower maintenance cost of such assets. The Working Group discussed how any such proposal would be discussed within the Transmission Charging Methodology Forum (TCMF) and would be assessed against the relevant charging objectives, and must be a balance of cost reflectivity with the appropriate clarity and transparency.

5.32 In addition, the potential transfer of capital and operating costs between parties was debated and how this interacted with the Working Group’s recommendations
for implementation timescales.

5.33 It was confirmed that the substation assets at the Offshore Transmission Owner/Transmission Owner interface are funded via the residual element of TNUoS and therefore not directly targeted to the connected Offshore Users.

**Apportionment of Transmission Owner and User Capital Costs**

5.34 Some Working Group members felt that currently there may be an incentive for the contractor constructing a GIS substation to over-apportion the GIS asset cost of the generator bay and understate the cost of general site infrastructure. It was suggested by Working Group members that it is difficult to accurately, transparently and consistently calculate the true element of the GIS substation works specifically relating to the GIS assets within the generator bay and National Grid’s alliance arrangements further exacerbated this difficulty.

5.35 Working Group members agreed that an arrangement where there was a single site GIS asset owner would allow the contract to build all the GIS assets to be awarded under more effective market conditions, although the visibility to the Generator, of how asset costs are apportioned between generator bays and wider infrastructure assets forming transmission infrastructure would remain unchanged. Division of costs will still be required in order to calculate connection asset charges (for the User bay) and wider TNUoS charges (for the remainder of the site infrastructure).

5.36 A proposal was made that rather than use a site specific calculated cost for the GIS generator bay (in order to calculate Connection Charging or a Capital cost, depending on bay owner) an alternative would be to apply a generic cost, based on historic data which varied with parameters such as voltage, MW rating, etc. If the GIS generator bay is owned by the TO and consequently, funded via a Connection Charge, such generic GIS bay charges would require amendment of the Connection Charging Methodology. Such an approach would provide the necessary transparency and predictability to GIS costs. National Grid highlighted that a generic GIS bay cost would simply be based on an average of recent historic bay costs received from the Alliance partners. Additionally, capital costs vary because of justified site specific reasons and the application of an average cost, would result in over and under charging specific Users.

5.37 The Working Group considered whether it would be more cost reflective to improve the transparency and robustness of the current method used to calculate the GIS asset capital costs (by National Grid Unlicensed business), rather than to implement a generic GIS bay charge. This could provide the industry with comfort that a cost reflective and consistent approach was being applied.

**Scottish Power Transmission Connection Precedent**

5.38 National Grid described how a commercial and contractual precedent had already been established for an ownership boundary similar to that being proposed in the original proposal. Within the Scottish Power Transmission region, the typical boundary for a generation connection was at the ‘substation fence’ and therefore the generator bay, which may contain GIS assets, is owned by the Transmission Owner. This is achieved via a User choice non-standard ownership boundary. Such connections fund the assets through Connection Charges and the generator bay assets are specifically identified within a Bilateral Connection Agreement, so that if loss of Generator access resulted from these
assets, Interruption Payment is not made. The Working Group therefore agreed that this sets the commercial standard for a potential, formal boundary at this point. The Working Group noted that such connections have resulted in designs with two series generator circuit breakers; the group did not consider such a design approach is required to implement these proposals.

5.39 The Working Group examined an example of a generic Bilateral Connection Agreement (shown in Annex 7) currently used for such connections in the SPT region, with non-standard ownership boundaries and the group discussed how Users who choose not to own their User bay would typically be required to have an agreement which is substantially of this format.

5.40 Within England and Wales, there are two examples of non-standard ownership boundaries which are legacy sites, where an additional Generator had located in close proximity to the existing transmission substation. In such cases, the generator had still been required to own its Generator bay assets but the short spur connecting the new and existing substations was owned by the Transmission Owner.

Security Standards
5.41 The Group debated the potential impact the original proposal would have on the NETS 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 NETS SQSS provided the generator did not exceed normal infeed loss risk, currently 1000MW see Annex 5 for extracts of the NETS SQSS.

6.0 Transmission Owner – DNO Interface

6.1 Whilst the Working Group found many of the commercial aspects and issues associated with DNO interface GIS assets are the same as those at the Generator interface, key differences existed. Consequently, this section specifically identifies and considers such differences.

Enduring Ownership – Liability, Operations and Maintenance
6.2 DNO representatives agreed that integrated maintenance arrangements are often used at shared DNO/ National Grid sites, in some instances the DNO will perform the maintenance on the TO assets and in others the TO will perform the maintenance themselves.

6.3 Similar to the interruption payments that are made to Generators if system access is lost, a scheme exists where the DNO is exposed to a financial penalty associated with interruptions to its customers arising from faults on the distribution system. Where the DNO is unable to supply its customers due to a fault on the transmission system, the present arrangement limits the DNO exposure, to 10% of the Customer Minutes Lost impact only, but under the RWE proposal the DNO would be exposed to 100% of the Customer Minutes Lost and the Customer Interruption risks arising from a fault on the SGT Low Voltage Circuit Breaker. The Group agreed that if the standard ownership of such assets were changed by the proposals further consideration may be required in order to take into account changes to the liabilities to the TO and DNO.

Initial Option Development and Analysis
6.4 At the Working Group meeting held on 27th January 2009\(^5\), National Grid presented options for DNO connections. The Working Group concluded that only options 1 and 6 previously considered by the Working Group for Generator – TO interfaces were viable solutions. Consequently the Working Group concentrated on the analysis and discussion of these two options.

6.5 In the discussions around the RWE proposal, the Working Group concluded that at a DNO owned substation if the DNO owned the SGT LV bay there would be an inherent incentive for the DNO to maintain it to an acceptable standard.

6.6 Regarding the potential approach of splitting the operation and ownership boundaries, a DNO representative suggested that this would need to be considered in more detail to ensure clarity of regulatory and industry code obligations where one piece of equipment was owned by one party but operated by another. This could be captured in the Site Responsibility Schedule (and possibly in the Bilateral Connection Agreement).

6.7 Whilst DNOs and Transmission Owners developing recent projects, using GIS technology, have not found the position of the enduring ownership boundary to be an issue, the development of site specific ‘self build’ agreements has been a problem. Working Group members reported that such agreements have to be developed, almost from scratch, for each project and those negotiations can be protracted and time-consuming.

**Licensed/ Unlicensed Construction and Apportionment of TO and User Capital Costs**

6.8 The Working Group discussed how there appeared to be contrasts in how TO / DNO ‘self build’ projects are commercially classified depending upon who is the site owner. If a TO / DNO interface substation is owned by the TO, for example because of multiple distribution parties connecting, the TO may be requested to construct all bays, including any GIS distribution User bays. Conversely, if the DNO is the site owner, the DNO may construct the Transmission SGT bay. When the TO, National Grid, constructs such assets this has been performed as an unlicensed activity, as such assets are not transmission assets as classified within its Transmission Licence. In comparison, the DNO have typically built the transmission user assets as licensed assets and simply transferred the assets at completion under agreed terms. The Working Group confirmed that the treatment of such activity as unlicensed was equally feasible, although the DNO representatives did not believe the volume of such works would justify setting up such a process.

6.9 At a DNO – TO interface substation, where there is only one DNO connected, the DNO will typically be the majority asset owner of the GIS Switchgear. In such cases the DNO would typically construct the TO owned LV SGT bays under a self build agreement. Under such arrangements the TO will pay a one off capital cost for such construction which will in turn form the basis for the Transmission Connection charges that the DNO will be subject to. Consequently the Working Group concluded that there was far less incentive for the inaccurate apportionment of capital costs under a DNO self build than the potential risk under Generator User builds, as all the costs were more open to scrutiny by

\(^5\) A copy of the minutes can be found at: [http://www.nationalgrid.com/uk/Electricity/Codes/gridcode/workinggroups/switchgear/](http://www.nationalgrid.com/uk/Electricity/Codes/gridcode/workinggroups/switchgear/)
6.10 There is currently no standard self build agreement and both the basic principles underpinning the bespoke agreement and the detailed clauses of the agreement often need to be developed for each project. The Working Group discussed the following general principles, presented by a Working Group member, which may be reasonably applied to self build contacts. These included:

- Both parties should work closely together in a spirit of trust and cooperation in order to develop a mutually beneficial relationship, and hence deliver the most economical, co-ordinated and efficient overall scheme, which the DNOs' customers will eventually fund.
- The agreement should be based on a reasonable and equitable sharing of the project risks including, procurement and construction risks between the DNO and TO.
- The transfer of assets between one part and another should be at a fair and equitable cost.
- The self build works should, unless otherwise agreed, be limited to those works where it naturally falls for one party to build. In the case of a substation with a GIS switchboard, this would limit the scope of the self build agreement to the GIS switchboard and the associated building and civil works.
- Regarding GIS assets, the works within the scope of the self build agreement should be classed as a licensed activity.

6.11 The Working Group also agreed that there would be merit in developing a standard self build agreement in the form of CUSC exhibit that captured these basic principles in addition to the detailed clauses.

**Security Standards**

6.12 A DNO member confirmed that there are potential issues associated with any potential change to the definition of the transmission system and the scope of the definition of the circuit. The issue was also raised in options that resulted in the transfer of assets from the transmission system to the distribution system changes the relevant security standards from NETS SQSS to P2/6.

**7.0 Conclusions of the Working Group**

**Options for Ownership Boundary**

7.1 The Working Group refined its preferred way forward down to two positions for a GIS standard ownership boundary, depending on the type of connection. From this point forward the boundaries will be referred to as the Generator Standard Boundary and the DNO Standard Boundary. The boundary description is intended to reflect the boundary that Generator and DNO Users would typically choose, but the recommendation will allow any User to choose either boundary.

7.2 The Generator Standard Boundary is the boundary at which Generators will typically elect to connect and is situated at the interface between the cable box socket and plug on the User's circuit, as shown in the diagram below. The commercial terms in relation to Interruption Payments of a connection at such a boundary will be consistent with those currently made within the Scottish Power Transmission Region, namely that Interruption Payments are not made for loss of access resulting from faults or maintenance on the generator GIS bay.
7.3 The DNO Standard Boundary is the boundary which DNOs will typically select, as currently defined in CUSC 2.12.1(e)(ii) which will result in the busbars of the GIS assets being owned by multiple parties. At GIS switchboards, where a single DNO interfaces with a TO the boundary would be that at which the TO connects to the DNO assets.

7.4 For the avoidance of doubt, Generators will be free to select at the DNO Standard Boundary and vice versa.

7.5 The proposed Standard Generator Boundary is currently available as a non-standard ownership boundary; the proposal effectively codifies this arrangement as a standard form.

7.6 The principle would be maintained that the electrical boundary is at the same point as the ownership boundary. Consequently, overall ownership and control of generator bay will move to the Transmission Owner under the Standard Generation Boundary although, the Generator (or DNO) will be able to operate the bay circuit breaker on the basis of switching agreements as recorded in the Site Responsibility Schedule.

**Options for Construction**

7.7 Under the Generator Standard Boundary, the TO would construct all the GIS assets.

7.8 The Working Group concluded that there are two effective options for the construction of GIS assets under the DNO Standard Boundary arrangement. The first is where the responsibility for the construction of the bay remains with the User. In this option the User has the choice to contract either with NGET unlicensed business or any other party (in reality limited to the GIS manufacturer) to install the User bay, thus, maintaining the ability for competition in construction. The second option is a self build arrangement under which the majority GIS asset owner would construct all the GIS assets on site and on completion the relevant assets would be transferred to the other party such that

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6 This is on the basis that all GIS equipment currently manufactured is of the Type B as described in section 3.2.
the enduring ownership boundary is at the DNO Standard Boundary. The majority GIS asset owner could be either the TO or the User.

7.9 The majority Working Group opinion was that under the self build arrangements the construction of GIS assets should be carried out as a licensed activity.

7.10 The Connection Application Form within the CUSC, would allow a User to nominate, which standard ownership boundary and construction approach would be preferred if the use of GIS technology was required.

**Standard agreements for construction where joint ownership of assets**

7.11 The DNO representatives explained how the existing GIS boundary position and self build arrangements broadly appear to be effective for DNO connections; however there appeared to be some inconsistency of the Self Build Agreements between DNOs and National Grid. The Working Group concluded that, rather than having to develop unique agreements at the start of each 'self build' connection, a standard exhibit for a t should be included within the CUSC, such as that used for the Bilateral Connection Agreement or Transmission Related Agreement. The Working Group felt the development of such an agreement would require specific expertise from DNOs and TOs and therefore a recommendation should be made to the CUSC Panel, to establish a CUSC Working Group to develop an associated CUSC Amendment Proposal.

7.12 The following general principles should be considered in the development of the CUSC exhibit Self Build Agreement:

- Both parties should work closely together in a spirit of trust and co-operation in order to develop a mutually beneficial relationship, and hence deliver the most economical, co-ordinated and efficient overall scheme, which the DNOs’ customers will eventually fund.
- The agreement should be based on a reasonable and equitable sharing of the project risks including, procurement and construction risks between the DNO and TO.
- The transfer of assets between one part and another should be at a fair and equitable cost.
- The self build works should, unless otherwise agreed, be limited to those works where it naturally falls for one party to build. In the case of a substation with a GIS switchboard, this would limit the scope of the self build agreement to the GIS switchboard and the associated building and civil works.
- The works relating to GIS assets, within the scope of the self build agreement should be classed as a licensed activity.

7.13 The Working Group concluded that the construction of GIS assets by a TO, and where appropriate a DNO, that are to be transferred to another User should be classed as licensed activity.

**Transmission Charging**

7.14 The members of the Working Group recommend that the TCMF consider two changes to the Connection Asset Charging Methodology:

- Introduce a specific Site Specific Maintenance Charge for GIS based assets, to take into account the expected lower lifetime operating cost for such technology;
7.15 A new methodology for the calculation of the initial Gross Asset Value of GIS assets, including generic or site specific approaches.

A representative of the Working Group should take the issues to the TCMF.

Summary of Working Group Recommendations

7.16 The Working Group recommends that CUSC is modified such that a User requesting a connection to the NETS via a GIS substation will be able to elect one of the following standard boundary and construction options:

- Generator Standard Boundary
- DNO Standard Boundary – User builds all the GIS assets
- DNO Standard Boundary – User builds their own assets only

7.17 The development of a standard CUSC Exhibit for DNO Self Build Agreements.

7.18 The Working Group recommends that the TCMF consider two changes to the Connection Asset Charging Methodology as identified below and that a representative of the Working Group should take the issues to the TCMF.

- Introduce a specific Site Specific Maintenance Charge for GIS based assets, to take into account the expected lower lifetime operating cost for such technology;
- A new methodology for the calculation of the initial Gross Asset Value of GIS assets, including generic or site specific approaches.

8.0 IMPLEMENTATION

8.1 At the meeting of the 13th May 2009 the Working Group considered a number of options for implementation timescales. The five options were:

- Option I – a date following an Ofgem decision i.e. 3 months for all the future GIS substations not yet connected but may be in construction
- Option II – a date following an Ofgem decision i.e. 3 months for all future GIS substations not yet connected or in construction (but may have a supplier agreement in place)
- Option III – a date following an Ofgem decision i.e. 3 months for all future GIS substations not yet contracted
- Option IV - at the next Price Control Period for National Grid for all future GIS substations having a completion date post 2012/13
- Option V – Retrospective application to all GIS substations connected to the Transmission system

8.2 Members agreed that option IV was the most attractive and practical option since the proposals would only significantly benefit those future connections where construction had not started, supplier agreements and contracts with National Grid had yet to be signed.

8.3 It was felt that Option IV had the limited advantage of simplicity as it does not have Capex or Opex implications for National Grid’s current Transmission Price Control, as there was no retrospection and would not impact current construction projects. The existing issues over GIS construction would remain until the agreed implementation period.
8.4 A Working Group member stated that although Option IV works well for the generator/TO interface, it does not work so well for the TO/DNO interface as it is part way through the Distribution Price Control period. It was suggested that alignment with the DPCR period is as sensible.

8.5 The recommendation to develop a standard CUSC exhibit for the DNO self build agreement, will require the raising of a CUSC Amendment Proposals after which the proposal will follow the timescales for the CUSC governance process.

8.6 The charging issues will be raised a future TCMF meeting and discussed by the industry representatives, and any resulting Charging Modifications will follow the respective change process.

9.0 IMPACT ON GRID CODE AND CUSC

Grid Code To be agreed by the Working Group

CUSC To be agreed by the Working Group

10.0 IMPACT ON INDUSTRY DOCUMENTS

Impact on Core Industry Documents

There is no impact envisaged on the Core Industry Documents

Impact on other Industry Documents

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

11.0 IMPACT ON NATIONAL ELECTRICITY TRANSMISSION SYSTEM

Currently at GIS transmission substations, the boundary between the NETS and Distribution Systems and the boundary between the NETS and Generation Systems is determined on a site by site basis and there is no effective standard boundary. This Amendment Proposal will introduce a Standard Ownership Boundary for each scenario.

12.0 IMPACT ON GRID CODE USERS

Generation and DNO Users requesting a connection to the NETS will have a clear and predictable choice between two standard ownership boundaries, if GIS technology is employed. Under the Generation Standard Ownership Boundary the User will not construct or own the GIS User bay assets and therefore the issues previously identified, as described in Section 2, would be avoided.
13.0 ASSESSMENT AGAINST GRID CODE OBJECTIVES

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

(i) to permit the development, maintenance and operation of an efficient, co-ordinated and economical system for the transmission of electricity;
(ii) to facilitate competition in the generation and supply of electricity;

13.2 This amendment better meets objective (i) as the construction and operation of generator bays using GIS technology will be performed and managed in a commercially and contractually more efficient, co-ordinated and economical manner. The proposed standard exhibit for DNO Self Build agreements will also better meet objective (i) as it will avoid the requirement to develop such agreements from scratch on a site specific basis. The provision of the ability for the generator or DNO User to choose whether the User constructs and/or owns its GIS connection bay or whether this is carried out as Licence activity by the majority site asset owner better facilitates competition and therefore Objective (ii)
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

CUSC Working Group, if required

Consultation

Report to the Authority

Consultation

Report to the Authority
ANNEX 2 – PROPOSED CUSC and GRID CODE CHANGES

To be agreed by the GIS Working Group
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 SF₆ 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 – RELEVANT WORKING GROUP SLIDES

Gas-insulated switchgear (GIS)
Paul Cerveny
Asset Policy

Gas-insulated switchgear
• Metal-enclosed switchgear in which the insulation is obtained, at least partly, by an insulating gas other than air at atmospheric pressures (IEC 80750 (441))

Benefits of GIS
• Compact size:
  • May be built closer to load centres
  • Replacement/insertion 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

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.

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 sites)
• Planning laws for National Parks, AONBs and Green Belts only permit AIS substations where there is no demonstrable alternative.
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

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

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
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.”

Design and construction of GIS

From Siemens website via google.com

Design and construction of GIS

From ABB website via google.com
Gas compartments and partitioning

- Initially CEBG/Rational 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

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

Maintenance (typical)

GIS general
- General condition of equipment, support structures, earthing connections
- Gas pressure/leakage level and trend
- Gas quality (H2, CO2, CO, H2O)
- Calibration of pressure/leakage gauge/transducer
- Alarm setting and operation

Disconnector 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
GIS service experience

- Major failure rate for GIS 300-500 kV commissioned after 01/01/1995:
  - 2.56 per 100 circuit-breaker bay years

### Main component involved in failure, 300-500 kV

<table>
<thead>
<tr>
<th>Component</th>
<th>Failure Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circuit breaker or switch</td>
<td>31.3%</td>
</tr>
<tr>
<td>Disconnector</td>
<td>36.8%</td>
</tr>
<tr>
<td>Isolating switch</td>
<td>6.5%</td>
</tr>
<tr>
<td>CT</td>
<td>1.9%</td>
</tr>
<tr>
<td>VT</td>
<td>4.0%</td>
</tr>
<tr>
<td>Bushing</td>
<td>6.2%</td>
</tr>
<tr>
<td>Support and interconnecting parts</td>
<td>24.7%</td>
</tr>
<tr>
<td>SF6 bushing</td>
<td>9.3%</td>
</tr>
<tr>
<td>Cable box</td>
<td>0.0%</td>
</tr>
<tr>
<td>Transformer interface</td>
<td>2.5%</td>
</tr>
<tr>
<td>Surge arrester</td>
<td>1.9%</td>
</tr>
<tr>
<td>Other</td>
<td>0.8%</td>
</tr>
</tbody>
</table>

### Classification of symptoms, 300-500 kV

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Failure Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service-manual failures</td>
<td>1.9%</td>
</tr>
<tr>
<td>Breakdown across open poles</td>
<td>1.9%</td>
</tr>
<tr>
<td>Breakdown to earth, GIS insulation</td>
<td>35.8%</td>
</tr>
<tr>
<td>Breakdown to earth, gas insulation</td>
<td>26.2%</td>
</tr>
<tr>
<td>Failure to open on command</td>
<td>13.2%</td>
</tr>
<tr>
<td>Failure to close on command</td>
<td>13.2%</td>
</tr>
<tr>
<td>Loss of mechanical function</td>
<td>9.8%</td>
</tr>
<tr>
<td>Loss of SF6 gas</td>
<td>4.4%</td>
</tr>
<tr>
<td>Fault of pressure relief device</td>
<td>4.4%</td>
</tr>
<tr>
<td>Enclosure burned through</td>
<td>1.3%</td>
</tr>
<tr>
<td>Partial discharge</td>
<td>1.3%</td>
</tr>
<tr>
<td>Locking in open or closed position</td>
<td>2.7%</td>
</tr>
<tr>
<td>Other</td>
<td>10.0%</td>
</tr>
</tbody>
</table>

GIS service experience

- CIGRE WG A3.08 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
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 buildings and the interfacing switchgear between those buildings and any connecting or control areas of metal-clad gas-insulated construction.
- Generally GIS zones can be classified into two broad types:
  1. GIS substations where the bus selector disconnectors are not in the same gas zone as the buildings (i.e., where there are gap joint separations between the bus selector disconnectors and the buildings).
  2. GIS substations where the bus selector disconnectors are in the same gas zone as the buildings.

NB: The type of GIS switchgear will not change due to the outcome of the working group.

GIS – as currently defined

- CIGRE 2.12 defines the electrical boundary and the ownership boundary for GIS as the gas zone, extensions on the bus side of the bus selector disconnectors, and the bus selector disconnectors and the GIS, which define a GIS boundary that is separate and distinct from the GIS substations. It is the same as the previously defined GIS boundary in CIGRE 2.12.
- The extent of metering GIS installations in National Grid’s experience do not correspond to CIGRE boundary definitions for the electrical boundary and the ownership boundary which are set to be the same. It is the same as the previously defined GIS boundary in CIGRE 2.12.
- Regardless of type the issues surrounding definition and ensuring ownership remain.

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 seating/GIS to AIS termination.
Option 1 – RWE model

Benefits
- Addresses construction issues and interconnection of licensed and unlicensed areas
- Maintains consistency for future GIS sites
- Enhances connectivity for safety management and 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 (CSPF and GIS
  owner are included in the price control)
- Potential SUDS impact
- Increased consistency with AUS
- Liability, maintenance and compensation
- Secondary control systems

Option 2 as currently defined

Benefits
- Existing issues are not addressed
- Inconsistency across site depending on manufacturer's design

Impacts and issues
- Generation sites
- Transmission cables
- Operational area boundary

Option 3 before the CB
**Option 3 before the CB**

**Benefits**
- Visible boundary at the gas zone separation
- 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 licensed off-site interaction not addressed
- No point of reception
- No overall significant change to codebook or change to site with the assets (GAPES, DPF, etc.)
- Inconvenience to minor faults with the system
- Potential SSO impact
- Inability to incorporate with AIS
- Liability, maintenance and compensation
- Secondary control systems
- Not robust if manufacturer 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 separation
- 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 off-site interaction not addressed
- Major inconsistency across sites depending on GIS type; at some sites generation and the bus selector disconnectors but not at others
- Not robust if manufacturer change designs

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**Option 5 as AIS and jointly own the gas zone**
### Option 6 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 stable boundary (within gas zone)
- Users not able to physically remove the bus selector disconnectors (some GIS types)
- Construction issues and licensed unlicensed interaction not addressed
- Liability and access issues regarding the gas zone

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

**Advantages**
- Construction issues and licensed unlicensed 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 stable boundary (within gas zone)
- Users not able to physically remove the bus selector disconnectors (some GIS types)
- Complications regarding asset
- Ongoing maintenance
- Liability and access issues regarding the gas zone

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Date: 13th May 2010  
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Option 1 – B – NOET-Owned Substation

Benefits
- Addresses construction issues and
  violation of barriers and overhead
  wires.
- Removes interconnection for future ONS
  usage.
- Removes complexity for maintenance.
- More economical solution for one party
  to build and maintain.

Impacts and Issues
- No overall significant change to costs
  for a change to one side of the assets
  (CAPEX and OPEX implications that has
  not been included in the price control).
- Creates interconnection with AGS.
- Liabilities and maintenance for dents
  and o2.
- Secondary control systems.

Option 2 – A – NOET-Owned Substation enduring as per AIS but one party builds all GIS assets

Option 3 – B – DNO-Owned Substation enduring as per AIS but one party builds all GIS assets

Option 4 enduring as per AIS but one party builds all GIS assets

Benefits
- Construction issues and licensed
  interconnection are addressed.
- Endurance boundary consistent with AIS
  usage.
- No change in power methods of
  Generation.
- Similar situation already exists for “self-
  build” scenarios.
- No transfer of CAPEX and OPEX costs.
- No impact on charging.

Impacts and Issues
- For some GIS, no visible boundary
  (within gas zones).
- Users are able to physically remove the
  bus section transformers (some GIS
  types).
- Security systems issues.
- Liability and excess issues regarding the
gas zone.
- Increased complexity of ongoing
  maintenance.
Impacts and issues – Option 1

- **Principle**: majority owner builds GIS assets
- **Potential SSSI Impact for Generation connections**
  - No impact on SSSI
  - “Real” SSI assets would be classified as Generation/Cables and not Transmission circuits
  - Single circuit connected, but would not run counter to GIS/SSIs
  - Therefore, would be compliant with the GIS/SSIs as long as the generation capacity connected did not exceed normal/reheat load (175MW)
- Lessons to learn for future sessions advised

Impacts and issues – Option 1

- **Charging – Generation connections**
  - Currently no connection charges would apply
  - Identified as Generation/Cables = Connection Asset
  - Generation option = Option to connect at no cost: no need to change in the Charging Methodology
  - Does this place GIS connections in a more favourable position than A/S connections?
  - Should the charging methodology be changed to ensure GIS connections make a realistic contribution rather than an unrealistic payment?
Impacts and issues – Option 0

Asset transfer
- Do we need a new classification of works?
- Current licensed, unlicensed and Public Services
- Do we need O&G’s view now before progressing further?
- Similar to customer - build now - use hand tools
- If possible asset transfer agreement would be required
- What provisions would be required?

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 could build the system?
- Liabilities – what if the equipment affects the other parties due to fault etc.
- Maintenance

Impacts and issues – Option 0
ANNEX 5 – EXTRACT FROM NETS 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.”
ANNEX 6 – EXAMPLE PHOTOS OF A GIS SUBSTATION UNDER CONSTRUCTION

Figure 1: The three phases of a GIS circuit

Figure 2: The side elevation of a GIS Busbar under construction
Figure 3: Four adjacent GIS bays
ANNEX 7 – EXAMPLE GENERIC BILATERAL CONNECTION AGREEMENT FROM THE SCOTTISH POWER TRANSMISSION REGION

DEFINITIONS, INTERPRETATION AND CONSTRUCTION

Circuit A  the transmission assets between the top of the Transmission bushing on the 33kV cable sealing end on the transmission system side of the 33kV cable and the Transmission busbar clamp on the transformer SGT1 side of disconnector [***] at [***] substation.

Circuit B  the transmission assets between the top of the Transmission bushing on the 33kV cable sealing end on the transmission system side of the 33kV cable and the Transmission busbar clamp on the transformer SGT2 side of disconnector [***] at [***] substation.

Circuit C  the transmission assets between the top of the Transmission bushing on the 33kV cable sealing end on the transmission system side of the 33kV cable and the Transmission busbar clamp on the transformer SGT3 side of disconnector [***] at [***] substation.

Condition A  the planned unavailability of Circuit A.
Condition B  the planned unavailability of Circuit B.
Condition C  the planned unavailability of Circuit C.
Condition K  the unplanned unavailability of Circuit A, Circuit B or Circuit C.
Condition Period  the period of time during which the Conditions apply.
1.2 *The nomenclature of the circuits and assets in the above definitions is indicative and NGC will notify the User of the final nomenclature and make any necessary revisions to this Bilateral Connection Agreement to reflect the same as soon as practicable.*

**COMMENCEMENT**

This Bilateral Connection Agreement shall commence on the date hereof.

**THE CONNECTION SITE AND TRANSMISSION CONNECTION ASSETS**

The Connection Site and Transmission Connection Assets to which this Bilateral Connection Agreement relates is more particularly described in Appendix A.

**CONNECTION CHARGES**

4.1 The Connection Charges payable by the User in accordance with the CUSC in respect of the Transmission Connection Assets set out in Appendix A (including the One-Off Charge) are set out in Appendix B. The Connection Charges shall be payable by the User from the Charging Date.

4.2 The One Off Charge shall be payable on the Charging Date.

**USE OF SYSTEM**

The right to use the GB Transmission System shall commence on and Use of System Charges shall be payable by the User from the Charging Date.

**CREDIT REQUIREMENTS**

The amount (if any) to be secured by the User is set out in the Secured Amount Statement issued from time to time and as varied from time to time in accordance with Section 2 of the CUSC.
7. **CONNECTION ENTRY CAPACITY AND TRANSMISSION ENTRY CAPACITY**

7.1 The Connection Entry Capacity in relation to the Generating Units and the Connection Site and the Transmission Entry Capacity in relation to the Connection Site, are specified in Appendix C.

7.2 Appendix C Part 3 will set out the BM Unit Identifiers of the BM Units registered at the Connection Site under the Balancing and Settlement Code. The User will provide NGC with the information needed to complete details of these BM Unit Identifiers as soon as practicable after the date hereof and thereafter in association with any request to modify the Transmission Entry Capacity and NGC shall prepare and issue a revised Appendix C incorporating this information. The User shall notify NGC prior to any alteration in the BM Unit Identifiers and NGC shall prepare and issue a revised Appendix C incorporating this information.

7.3 NGC shall monitor the Users compliance with its obligation relating to Transmission Entry Capacity against the sum of metered volumes of the BM Units set out in Part 3 of Appendix C submitted by the User for each Settlement Period.

8. **COMPLIANCE WITH SITE SPECIFIC TECHNICAL CONDITIONS**

   The site specific technical conditions applying to the Connection Site are set out in Appendices F1 to F5 to this Bilateral Connection Agreement as modified from time to time in accordance with Paragraph 2.9.3 of the CUSC.

9. **ELECTRICAL BOUNDARY**

9.1 The division of ownership of Plant and Apparatus shall be at the top of the six Transmission bushings on the 33kV cable sealing ends on the transmission system side of the 33kV cables. For the avoidance of doubt, nothing in this Clause 9.1 shall effect any transfer of ownership in any Plant or Apparatus.

10. **RESTRICTIONS ON AVAILABILITY**

10.1 The division of ownership of Plant and Apparatus in Clause 9.1 above is contrary to the principles of ownership set out in CUSC Paragraph 2.12.
10.2 In addition the User acknowledges that the connection design which provides for connection to the GB Transmission System is a variation to the connection design as provided for in Chapter 2 of the GB Security and Quality of Supply Standards (version 1) issued under Standard Condition C17 of the Transmission Licence (as amended, varied or replaced from time to time) ("GBSQSS").

10.3 It is a condition of the GBSQSS that any variation to the connection design satisfies the criteria set out in paragraphs 2.15 to 2.18 of the GBSQSS and on that basis and in light of the non standard principles of ownership the following provisions will apply.

10.4 NGC shall notify the User as soon as reasonably practicable of the occurrence of the Conditions and where practicable the expected Condition Period. Where practicable such notification shall be in accordance with Grid Code OC2 requirements.

10.5 NGC shall be entitled to revise the notification given under 10.4 above at any time.

10.6 The User will acknowledge receipt of such notification and where practicable shall revise its Output Useable forecast accordingly.

10.7 Following such notification:

10.7.1 in respect of Condition A, the User shall (i) reduce the Maximum Export Limit and Maximum Import Limit for the BM Unit to reflect the unavailability of Circuit A and (ii) shall not operate its Power Station such that the generation connected to the GB Transmission System via Circuit A exports or imports any Active Power for all Settlement Periods or parts thereof falling within the Condition Period;

10.7.2 in respect of Condition B, the User shall (i) reduce the Maximum Export Limit and Maximum Import Limit for the BM Unit to reflect the unavailability of Circuit B and (ii) shall not operate its Power Station such that the generation connected to the GB Transmission System via Circuit B exports or imports any Active Power for all Settlement Periods or parts thereof falling within the Condition Period;
10.7.3 in respect of Condition C, the User shall (i) reduce the Maximum Export Limit and Maximum Import Limit for the BM Unit to reflect the unavailability of Circuit C and (ii) shall not operate its Power Station such that the generation connected to the GB Transmission System via Circuit C exports or imports any Active Power for all Settlement Periods or parts thereof falling within the Condition Period;

...........

10.8 In the event of:

10.8.1 NGC notifying the User of reduced circuit capability of Circuit A or any part thereof the User shall (i) reduce the Maximum Export Limit for the BM Unit to reflect the reduction in capability of Circuit A and (ii) operate its Power Stations such that the generation connected to the GB Transmission System via Circuit A does not export more Active Power onto the GB Transmission System than the figure notified to the User by NGC;

10.8.2 NGC notifying the User of reduced circuit capability of Circuit B or any part thereof the User shall (i) reduce the Maximum Export Limit for the BM Unit to reflect the reduction in capability of Circuit B and (ii) operate its Power Stations such that the generation connected to the GB Transmission System via Circuit B does not export more Active Power onto the GB Transmission System than the figure notified to the User by NGC;

10.8.3 NGC notifying the User of reduced circuit capability of Circuit C or any part thereof the User shall (i) reduce the Maximum Export Limit for the BM Unit to reflect the reduction in capability of Circuit C and (ii) operate its Power Stations such that the generation connected to the GB Transmission System via Circuit C does not export more Active Power onto the GB Transmission System than the figure notified to the User by NGC;

........

10.8.11 if the User does not comply with Clauses 10.8.1 to 10.8.10 above then NGC shall issue Bid-Offer Acceptances to the User to reduce the Power Station export onto the GB Transmission System so that it is no greater than the figure notified to the User by NGC as the reduced capability of Circuit A, B, C,
D, E, F, G, H, I, J or K as appropriate and the provisions of the Transmission Related Agreement shall apply.

10.9 Where the User becomes aware of or is notified by NGC of any breach of Clauses 10.7 or 10.8 above the User shall forthwith take all reasonable steps to comply with the provisions of that Clause.

10.10 Where the User breaches in whole or in part the provisions of Clauses 10.7 or Clause 10.8 above NGC may give notice to the User reducing the Transmission Entry Capacity and Appendix C of this Bilateral Connection Agreement shall be varied accordingly. This Transmission Entry Capacity shall apply until such time as the User has explained to NGC's reasonable satisfaction the reason for the breach and has demonstrated that appropriate steps have been taken to ensure that such breach will not reoccur.

10.11 Where there is a breach by the User of Clauses 10.7 or 10.8 above such that NGC could take action under Clause 10.10 above NGC may treat such breach as an Event of Default for the purposes of Section 5 of the CUSC and following such breach may forthwith give notice of termination to the User whereupon this Bilateral Connection Agreement shall terminate and the provisions of CUSC Paragraph 5.4.7 shall apply.

10.12 To the extent that the User will not be able to export to or take demand from the GB Transmission System during the Conditions the User acknowledges and agrees that NGC is relieved from its obligations to the User under CUSC Paragraphs 2.3 and 2.4.

10.13 For the avoidance of doubt any Deenergisation resulting from the Conditions constitutes an Allowed Interruption.

10.14 In the event that the GB Transmission System conditions subsequently change such that the conditions required for a design variation under the GBSQSS are no longer met then NGC shall be entitled to revise Clause 1, this Clause 10 and the Conditions as necessary to ensure that such GBSQSS conditions continue to be met.

10.15 This Clause 10 and the Conditions apply on the basis that the User has one BMU for all the Power Park Modules within the Power Station and in the
event that this is not or at anytime ceases to be the case then NGC shall be entitled to revise Clause 1, this Clause 10 and the Conditions as necessary to reflect this.

11. TERM

Subject to the provisions for earlier termination set out in the CUSC this Bilateral Connection Agreement shall continue until the User’s Equipment is Disconnected from the GB Transmission System at the Connection Site in accordance with Section 5 of the CUSC.
12. **VARIATIONS**

12.1 Subject to Clause 12.2 to 12.6 below, no variation to this **Bilateral Connection Agreement** shall be effective unless made in writing and signed by or on behalf of both **NGC** and the **User**.

12.2 **NGC** and the **User** shall effect any amendment required to be made to this **Bilateral Connection Agreement** by the **Authority** as a result of a change in the **CUSC** or the **Transmission Licence**, an order or direction made pursuant to the **Act** or a **Licence**, or as a result of settling any of the terms hereof. The **User** hereby authorises and instructs **NGC** to make any such amendment on its behalf and undertakes not to withdraw, qualify or revoke such authority or instruction at any time.

12.3 **NGC** has the right to vary Appendices A and B and C in accordance with this **Bilateral Connection Agreement** and the **CUSC** including any variation necessary to enable **NGC** to charge in accordance with the **Charging Statements**, or upon any change to the **Charging Statements**.

12.4 Appendices A and B shall be varied automatically to reflect any change to the **Construction Works** or **Transmission Connection Assets** or charges as provided for in the **Construction Agreement**.

12.5 Appendices F4 and F5 shall be varied automatically to reflect the technical requirements to be notified by **NGC** to the **User** as provided for in Appendices F4 and F5.

12.6 **NGC** has the right to vary Clause 1, Clause 10 and the **Conditions** in accordance with Clause 10 of this **Bilateral Connection Agreement**

13. **GENERAL PROVISIONS**

Paragraph 6.10 and Paragraphs 6.12 to 6.26 of the **CUSC** are incorporated into this **Bilateral Connection Agreement** *mutatis mutandis*. 