Appendix 1

Table 1: Assessment Summary

Site	Requirement for works on the National Electricity Transmission System where such works are not at a Connection Site	Requirement for works To the National Electricity Transmission System at a Connection Site (Grid Supply Point) for thermal capacity	Requirement for works To the National Electricity Transmission System at a Connection Site (Grid Supply Point) for fault Level	Necessity for Site Specific Requirements (at the site of connection) of the Power Station
ABHAM	Yes See Section 3.	Greater than 50MW head room at the GSP	None	Yes See notes below
ALVERDISCOTT	Yes See Section 3.	Yes SGT 1 and SGT2 are loaded above 100% in reverse under N-1 and N-2 conditions. See Table 2.	None	Yes See notes below
AXMINSTER	Yes See Section 3.	Greater than 50MW head room at the GSP	None	Yes See notes below
BRIDGWATER	Yes See Section 3.	Greater than 50MW head room at the GSP	None	Yes See notes below
EXETER	Yes See Section 3.	Greater than 50MW head room at the GSP	Circuit breaker 250 overstressed.	Yes See notes below
INDIAN QUEEN	Yes See Section 3.	None identified at this moment, however connection of generation in this GSP is limited by its effect on Alverdiscott SGT overloads	None	Yes See notes below
IRON ACTON	No	Greater than 50MW head room at the GSP	None	Yes See notes below
LANDULPH	Yes See Section 3.	Greater than 50MW head room at the GSP	Circuit breaker 280 and 180 overstressed	Yes See notes below
MELKSHAM	No	Greater than 50MW head room at the GSP	None	Yes See notes below
SEABANK	No	Greater than 50MW head room at the GSP	None	Yes See notes below.
TAUNTON	Yes See Section 3.	Greater than 50MW head room at the GSP	None	Yes See notes below

Notes on Site Specific Requirements

Voltage Regulation - there are issues regarding voltage regulation that will prevent connection of further Embedded Generation unless mitigated by the conditions below:

The User should be aware that Embedded Large and Embedded Medium Power Stations are required to satisfy the reactive capability and voltage control requirements of CC.6.3.2, CC.6.3.8 Grid Code.

For new Small Embedded Power Stations, the User shall ensure that each Generating Unit or Power Park Module within each Embedded Small Power Station shall have a reactive capability of between 0.95 Power Factor Lead to 0.95 Power Factor Lag at Rated MW Output at the User System Entry Point. During the operational timeframe, the User shall instruct each Generating Unit or Power Park Module within each Embedded Small Power Station of its required operating Power Factor which shall be within the capability range.

Initially the power factor setting is likely to be 0.95 lead on generation capable of significant output in overnight. The network is at the high voltage limits during the overnight period. For generation that only has the ability to generator during the day, e.g. Solar 0.98-0.99 Lead.

There is no restriction on the User if they wish to employ an alternative method to manage MVAr transfers at the Grid Supply Point, for example through the installation of reactive compensation equipment, intertripping Embedded Generation or the application of other suitable control schemes.

Emergency Instructions – to ensure control of the transmission system can be maintained at all times:

In accordance with the requirements of BC2.9.1.4, of the Grid Code, using the principles set out in Grid Code OC6.7.1, the DNO shall maintain a facility such that under emergency conditions on the National Electricity Transmission System, the User shall have the ability to de-energise new Embedded Generation detailed, upon instruction from the GBSO.

Table 2: SGT overloads

Contingency Name	Overload SGT	Stage 1 overloading	Stage 2 overloading
ALVE SGT1 or 2 (n-1)	ALVE4 SGT 2 or 1	None	108% or 29MVA
INDQ-ALVE-TAUN 1 or 2 (n-1)	ALVE4 SGT 2 or 1	None	111% or 35MVA
INDQ-ALVE-TAUN 1 or 2 with INDQ-LAND 1 or 2 (n-2)	ALVE4 SGT 1 or 2	None	120% or 54MVA
INDQ-ALVE-TAUN 1 or 2 with INDQ SGT 1, 2, 3 or 4 (n-2)	ALVE4 SGT 1 or 2	None	119% or 51MVA
INDQ-ALVE-TAUN 1 or 2 with WPD 132kV cct INDQ – St Tudy or INDQ – Pyworthy (Simulated by opening the CB at INDQ only.) (n-2)	ALVE4 SGT 1 or 2	None	146% or 105MVA
WPD 132kV cct IDQ – St Tudy and INDQ – Pyworthy (Simulated by opening the CB at INDQ only.) (n-2)	ALVE4 SGT 1 and 2	None	105% each SGT or 30MVA total

Notes on SGT Overloads

The GSP SGTs have been assessed against 100% output of the DG in the groups. The only issue is at Alverdiscott, the Indian Queens – Alverdiscott paralleled group has 1221MW of DG included in the assessment. It is therefore unlikely that in practice all this generation will operate at once and, therefore, occasions when some of the overloads could occur could also be considered unlikely.

N-1 Overloads

If the generation is reduced to a level still above 90%, the N-1 overloads on National Grid equipment are removed. While SGT reinforcement may be a possible solution to this issue, the low probability of the overload occurring means National Grid would consider the use of "Variation to connection Designs (SQSS 2.15)" controlled by non-firm access or an Automatic Network Management scheme as an efficient alternative should WPD and its customers consider this appropriate.

N-2 Overloads

Resolution of the N-2 overloads, i.e. a planned circuit outage followed by a fault is required. There are differing methods to achieve this ranging from investment in additional capacity to curtailment of generation, typically via a tripping or ANM scheme. The National Grid requirement would be to resolve the overloads by whatever method deemed to be most economical to the industry.

Section 3: 400kV Circuit overloads

National Grid (NG) has assessed the proposed DG connections against the generation connection and wider system criteria. In doing so believe it is necessary to consider realistic load factors across the proposed DG capacity. This ensures that investment decisions are economic. Work is ongoing to determine appropriate economic load factors, this will be the subject of a revised proposal under GSR16. This Statement of Works(SOW) has therefore been assessed using draft factors: STOR 100% (headroom), Solar PV 85%, and other technologies 70%.

Pre-fault criteria.

The pre fault thermal criteria is the minimum thermal requirement to be able to connect generation. Any generation beyond this criteria will not be able to connect on a firm basis. It is suggested that any generation beyond this limit should be subject to a Modification Application to determine appropriate reinforcements, at this stage NG will determine if it is appropriate to allow early connection ahead of any works on a non-firm basis.

Planned Outage (N-1)	Overloaded Circuit Stage 1	Overloaded Circuit Stage 2
HINP4-MELK4 1 or 2	N/A	HINP4-MELK4 2 or 1 (100%)

There is a requirement to secure the wider network to the N-1, N-1 post fault criteria and to have an economic solution to the N-1, N-D post fault criteria. (Effectively there must be an economic way to secure outages.) Under the Connect and Manage Regime it is possible to offer connection before these works are complete, providing the resultant transmission constraints are not deemed unreasonable. A Modification Application will be required to cover the works to make the system compliant.

Planned Outage (N-1)	Unplanned Fault (N-1-1)	Overloaded Circuit	Stage 1	Stage 2
		None identified		

Planned Outage (N-1)	Unplanned Fault (N-D)	Overloaded Circuit	Stage 1	Stage 2
INDQ-ALVE4-TAUN4 1 or 2	LANG4-ABHA4-EXET4 1 & 2	INDQ-ALVE4-TAUN4 2 or 1	110MW O/L	237MW O/L
LANG4-ABHA4-EXET4-1 or 2	INDQ-ALVE4-TAUN4-1 & 2	LANG4-ABHA4-EXET4 2 or 1	87MW O/L	387MW O/L
HINP4-MELK4-1 or 2	MANN4-FAWL4, MANN – NURS – LOVE dc	HINP4-MELK4-2 or 1	163MW O/L	884MW O/L
HINP4-MELK4-1 or 2	MANN- CHIC, MANN – CHIC-AXMI	HINP4-MELK4-2 or 1	295MW O/L	939MW O/L
HINP4-MELK4-1 or 2	EXET – AXMI, EXET - CHIC DC	HINP4-MELK4-2 or 1	452MW O/L	1036MW O/L
MANN4-FAWL4 OR MANN – NURS – LOVE	HINP4-MELK4-1 & 2	MANN – NURS – LOVE or MANN4-FAWL4	-	414MW O/L
MANN- CHIC or MANN – CHIC-AXMI	HINP4-MELK4-1 & 2	MANN -CHIC-AXMI or EXET- CHIC	-	469MW O/L
MANN – CHIC-AXMI or EXET -CHIC	HINP4-MELK4-1 & 2	EXET –CHIC or MANN – CHIC-AXMI	-	498MW
EXET – AXMI or EXET -CHIC	HINP4-MELK4-1 & 2	EXET -CHIC or EXET – AXMI	-	566MW O/L

Notes on 400kV circuit overloads

The prefault criteria

This has been met for both stages of this SOW as so this criteria will not delay the connection of any generation. It should be noted that for the worst outage, Hinkley Point – Melksham 1 or 2 400kV cct, the network is at 100%, i.e. on the limit for stage 2.

The post fault criteria

Under connect and manage it is possible to connect generation ahead of the works for the post fault criteria providing works to achieve full compliance are achieved as soon as reasonably practical and any resultant constraint costs are not excessive.

Analysis of the overloads in the above table and likely cost for constraining the generation indicate any overload above 190MW will trigger the need for an operational tripping scheme to economically mange the overloads. An overload above 800MW could lead to excessive constraint costs and so generation above this level cannot immediately be connected under the Connect and Manage Regime.

Stage 1 of Statement of Works

All generation can connect to the required date. The connection of the final 262MW of scaled generation[1] in the Bridgwater, Taunton, Alverdiscott, Indian Queens, Landulph, Abham, Exeter and Axminster GSP's will trigger works, to manage outages in the most efficient way. It will be possible to connect this generation on a connect and manage basis ahead of works, but to ensure costs are managed in the most economical way as soon as reasonably practical, National Grid will required a

Modification Application within 90 Business days of this Statement of Works response. (This should also cover all generation in stage 2, if required.)

Stage 2 of Statement of Works

It will not be possible to connect the final 236MW of scaled generation[1] in the Bridgwater, Taunton, Alverdiscott, Indian Queens, Landulph, Abham, Exeter and Axminster GSP's on a form basis ahead of works. It is likely that National Grid would be able to offer a Non-firm connection ahead of works, if this is requested via the modification application that will be required in order to connect this generation. (The non-firm generation would be asked to disconnect during Hinkley – Melksham 1 + 2 outages if other users were using their full capacity.)

[1] The overload has been calculated by using the scaled generation, WPD will need to reverse the scaling in order to determine which generators are above the trigger point.

Intertrips / Active Management Schemes

The likely works National Grid will be developing on recite of modification application will be a SWPEN wide system intertrip scheme and a possible hotwire on Hinkley – Melksham. The most appropriate generation to select to the intertrip scheme will be determined during the Modification Application process. It is likely, particularly for the higher level of generation this will include DG. When responding to the SOW clauses WPD should therefore consider the need to reserve the right to add intertrip if required in future.

Section 4 Fault Level Analysis

The table below shows the approximate headroom to the worse NG owned CB at WPD controlled site, or any owners CB at a NG controlled site.

Site	Fault Level	Fault Type	Headroom	Notes
ABHAM	CB 180/280	Single Phase RMS	1.8kA see note	Because this site is interconnected to Landuph and Exeter there is no fault level headroom until the issues at these GSP's are resolved.
ALVERDISCOTT	CB 180/280	Single Phase RMS	4.58kA	
AXMINSTER	CB 180/280	Single Phase RMS	Several KA	Shared site with SEPD. Studies on SEPD DG ongoing, likely to still be headroom at this site
MELKSHAM	All	Single Phase RMS	Some headroom over WPD SoW	Shared site with SEPD. Studies on SEPD DG ongoing.
BRIDGWATER	CB 180/280	Single Phase RMS	8.64kA	
EXETER	CB250	Single Phase RMS	-1.73kA	CB 250 is overstressed with

						all stage 1 and stage 2 generation connected.
INDIAN QUEENS	CB150	Single Phase RMS		0.54kA		
IRON ACTON	All	Single Phase I peak	Single Phase RMS	13.65kA	5.91kA	
LANDULPH	CB 180/280	Single Phase RMS		-0.65kA		CB 180 and 280 are overstressed with all stage 1 and stage 2 generation connected
SEABANK	CB 480	Single Phase RMS		6.24kA		
TAUNTON	280	Single Phase RMS		22.91kA		

Notes on fault level

Fault levels modelled using the data provided by WPD for in feeds at the 33kV busbars or a 132kV equivalent for generation with a connection point at this voltage level.

Exeter 250 is shown to be overstressed if all generation is connected, with the site modelled running solid in parallel with Abham and Landulph as per the agreed running arrangement. WPD may wish to consider an alternative running arrangement on this site to resolve this issue.

Landulph 180 and 280 are shown to be overstressed if all generation is connected, with the site modelled running solid, 1 SGT on standby in parallel with Abham and Landulph as per the agreed running arrangement. NG will consult a switchgear specialist to determine if any enhancement is available on these CB's. Otherwise WPD may wish to consider an alternative running arrangement on this site to resolve this issue or submit a Modification Application to replace the CB's.

Section 5 Dynamic voltage Stability

The dynamic voltage stability limit has not been reached by the generation in this statement of works.

Notes on Dynamic voltage Stability

Approximate studies indicate this will be breached when non-synchronous sources approach 2.75GW. This limit covers GSP's: Mannington, Chickerell, Axminster, Exeter, Abham, Langage, Landulph, Indian Queens and Alverdiscott. When this draft limit is approached it is likely that full dynamic modelling of DNO networks and DG will be required, with a considerable increase in data requirements. It will not be possible to assess dynamic voltage stability in statement of works timescales.