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Electricity Substation Construction

The Re-use of Civil, Structural and Building Engineering Assets

Design Handbook

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Authorised by:

Keith Hanley

Technical Assurance Manager

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1 GENERAL

1.1 SCOPE

- 1.1.1 This document details a methodology for determining whether existing, permanent 'Civil, Structural and Building Engineering' assets on National Grid substation sites are suitable to be re-used as part of a construction project. It shall not be applied to Overhead Line infrastructure (e.g. tower foundations).
- 1.1.2 It has been developed to be utilised throughout the life of a project from the early stages as a feasibility tool to establish the general possibility that an asset might be suitable for re-use through to supporting the final design decision to incorporate the asset, or any part of it, into the permanent works.
- 1.1.3 The basis of the methodology is a relative, risk based approach whereby the attributes of the existing item are compared directly with those of their new build equivalent and marked and summed accordingly. Provided the total score of the existing asset can be shown to fall within defined limits it shall be deemed suitable for re-use, if not it shall be replaced.
- 1.1.4 For the purposes of this document the term 'Civil, Structural and Building Engineering' shall be applied to those permanent assets which fall into the following categories;
- Access roads
 - Footpaths
 - Drainage
 - Oil containment works
 - Fencing
 - Site security
 - Surfacing
 - Ducts & trenches
 - Buildings
 - Site and Building services (excluding electricity and telecommunications services)
 - Foundations
 - Piling works
 - Earthworks
 - Ground Improvement/Stabilisation
 - Plant support structures
 - Holding down systems
 - Fire protection & control systems
 - Cable Tunnels
 - Acoustic enclosures/barriers
 - Site Lighting
 - Landscaping
 - Other enabling infrastructure (operational & non-operational) - e.g. retaining structures, bridges, culverts etc.
- 1.1.5 Notwithstanding any of the conclusions that this methodology may reach National Grid shall reserve the right to explicitly determine whether or not an existing asset shall be re-used or replaced. It must be noted that in such a circumstance National Grid will be undertaking the role of 'Designer' under the Construction (Design and Management) Regulations (CDM 2007) and consequently such decision cannot be taken solely for unrelated reasons (e.g. economic and programme). The decision shall consider the full range of relevant factors but must be fundamentally based on specialist advice in relation to the Health and Safety requirements of CDM (i.e. integrity of the asset, hazards during construction and subsequent maintenance activities)

1.2 METHODOLOGY

- 1.2.1 The methodology is based on the philosophy that every electricity substation asset, independent of its type, function or condition, comprises seven distinct attributes which, in combination, define the whole. Each of these asset attributes is assigned a weighting indicating the percentage that it is deemed to contribute to the whole with the sum of all these being 1 (i.e. 100%).
- 1.2.2 The weightings of the individual attributes are not (necessarily) the same, reflecting the fact that some are considered more vital to the assets overall function than others, however they are fixed relative to each other and their proportional contribution to the whole is identical whether the asset is existing or new build.
- 1.2.3 Each of the defined attributes of an existing asset is assessed using that of the corresponding, theoretical new build option as a benchmark and marked in accordance with a scoring matrix (see section 3). A score of less than one indicates that the particular attribute contributes less to the overall function of the existing asset than does its counterpart new build alternative (it is 'detrimental'), a score of one means the contribution is effectively the same or 'NULL' and a score of greater than one indicates that there is a 'beneficial' relative contribution.

INFORMATIVE: The terms 'detrimental' and 'beneficial' are used to indicate the philosophy of this Design Handbook in that the preferential option is to re-use an asset wherever this proves possible. Consequently a particular attribute of an existing asset will achieve a score of more than one if it is deemed to be relatively more beneficial in achieving this objective than its new build counterpart. Conversely one that supports the new build replacement is detrimental. For example if it is considered that construction operatives will be exposed to less Health and Safety Risks should an existing structure be re-used as opposed to installing the new build alternative this attribute will score greater than one.

The two terms should therefore not be regarded as pejorative and are purely used in this handbook in a relative context. It is not absolutely detrimental to a project should it be proven that an existing asset is not suitable for re-use.

INFORMATIVE: There is inevitably an element of subjectivity in determining the attribute scores. Further the re-use of an existing asset introduces unknown factors that can make it an inherently more 'risky' decision than providing the new build alternative. Consequently if there is any doubt in the assessment of any asset attribute the judgement shall err on the side of caution i.e. towards the new build ('detrimental' score) option.

- 1.2.4 The weightings and scores of each individual attribute are multiplied to produce a total attribute contribution. These seven products are then summed to give an overall score for the existing asset which is a measure of its 'competence' relative to the new build equivalent which would have a score of 1 (i.e. 100%).

2 ASSET ATTRIBUTES

The following section describes each of the seven asset attributes and explains their weighting (percentage contribution to the whole) and the means of scoring.

2.1 CAPACITY

Description

- 2.1.1 The **CAPACITY** of the asset is the measure of its ability to perform a specified function within defined parameters. It shall be determined using, and be measured against, National Grid, National or, by agreement, International analytical and design methods, Standards, EuroNorms and Codes of Practice applied in full or in accordance with agreed departures or derogations.

*INFORMATIVE: **CAPACITY** will mean different things depending on the nature of the particular asset under review. It will generally necessitate the ability to perform a structural task (resist various load combinations) but in addition will involve specific functional requirements. For example a transformer foundation must also comply with National Grid's requirements pertaining to oil containment and fire control whilst a road shall have a specific minimum width depending on its purpose and location.*

*INFORMATIVE: Structural **CAPACITY** may be determined by employing conventional 'elastic theory' or more detailed Finite Element Analysis (FEA) techniques however it must be noted that the latter method, whilst more time consuming and costly, has consistently proven residual **CAPACITY** in National Grid assets under certain load conditions, specifically those due to short circuit effects, that the former approach would not..*

*FEA facilitates more accurate and detailed analysis than that produced by the more classical or conventional methods applied in accordance with British Standards. However the latter incorporate a degree of conservatism that allows for assumptions and unknown factors. Consequently when using the 'leaner' FEA techniques it is imperative that the whole asset is accurately modelled otherwise an overestimate of current and, critically, future **CAPACITY** may result.*

*Whichever method is employed to determine load effects the application of these may necessitate specific allowances/downgrading due to the vintage of the reinforced concrete structures on many substation sites. For example concrete and reinforcement material properties will change over time leading to the possibility of degradation in the bond between the two. It may be appropriate to increase the safety factors to account for this not only at the time of the assessment but also to allow for future degradation over the necessary **DESIGN LIFE**. Additionally concrete mix technology and the quality control of batching and workmanship in the 1950's and 1960's were far inferior to that which is employed today further exacerbating the potential problem.*

Weighting

- 2.1.2 The **CAPACITY** is a fundamental part of an assets overall competence or 'fitness for purpose' without which there is no point in the assets existence. Consequently it is deemed that **CAPACITY** constitutes 20% to the overall asset whole giving it a weighting of 0.20.

Scoring

2.1.3 **CAPACITY** shall be assessed as follows;

a) **'NULL' – Score 1.0**

The **CAPACITY** of the asset is compliant with all National Grid technical requirements current at the time of the assessment. It is directly comparable in every way to a new build item.

b) **'PARTIAL' – Score 0.9**

The **CAPACITY** of the asset accords with agreed minor departures from the National Grid requirements current at the time of the assessment providing these do not result in an overall reduction in **CAPACITY** when compared to the 'Fully Compliant' equivalent of more than 10%.

c) **'MINIMAL' – Score 0.8**

The **CAPACITY** of the asset accords with agreed minor departures from the National Grid requirements current at the time of the assessment providing these do not result in an overall reduction in **CAPACITY** when compared to the 'Fully Compliant' equivalent of more than 20%.

INFORMATIVE: Examples of minor departures are;

- *Reductions of Factors of Safety (FOS) – accepting that in all instances a FOS must not be less than one (1.0)*
- *Changes to Load Combinations, for example not considering short circuit forces together with wind load (ref. TS 3.1.4, 'Busbar Systems for AIS Substations')*
- *Allowance of overstress under certain dynamic load conditions for example wind or short circuit effects.*
- *Disregarding the minimum reinforcement requirements in BS 8110*
- *Modification in rainfall return periods*
- *Reduction in capacity of 'Secondary Containment System'*
- *Adoption of another organisation or countries (lesser) standard.*