

**OIL CONTAINMENT**

**TS 2.10.01**

**GENERIC ELECTRICITY SUBSTATION DESIGN MANUAL**  
**FOR CIVIL, STRUCTURAL AND BUILDING ENGINEERING**

**SECTION NO : 01**

**TITLE : OIL CONTAINMENT**

## OIL CONTAINMENT

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## **1 INTRODUCTION**

### **1.1 PURPOSE AND SCOPE**

- 1.1.1 This technical specification TS 2.10.01 defines National Grid's requirements in respect of oil containment at new and existing (i.e. retrofit) electricity substations and other relevant operational sites. It shall also apply, as appropriate and via agreement, to third party assets installed on National Grid owned land.
- 1.1.2 This specification forms part of a suite of documents, TS 2.10.xx, which define design requirements (including mandatory prescriptive and functional requirements and/or performance characteristics) relating to new build and existing 'Civil, Structural and Building Engineering' assets forming part(s) of substation construction projects. Refer to TS 2.10.00 for general introduction and description of the respective parts of the series.
- 1.1.3 These design requirements shall be used in conjunction with the construction specification which is included in the TS 3.10.xx series of documents. Refer to TS 3.10.00 for general introduction.
- 1.1.4 This specification shall be applied in conjunction with all relevant National Grid standards as appropriate. The Level 1 and 2 Specifications for substations, TS 1 and TS 2.01, cover high level requirements which are mandatory for all design and construction.

### **1.2 STATUTORY REQUIREMENTS**

- 1.2.1 The objective of this technical specification is to ensure National Grid discharges its legal and social responsibilities with regard to protecting the environment from the damaging effects of any Oil it uses in carrying out its business activities at electricity substations and other operational sites.
- 1.2.2 A key document in achieving this objective is the Control of Pollution (Oil Storage) (England) Regulations 2001 (known as the 'Oil Storage Regulations' or OSR) noting that much of the oil on electricity substation sites is technically exempt from these as it is in use rather than stored. Notwithstanding this, National Grid adopts the principles of the legislation and associated guidance (for example that issued by the Environment Agency and CIRIA) as a starting point and extends these as necessary to suit specific operational circumstances.
- 1.2.3 Quantities of oil in excess of 200 litres, stored in containers other than operational plant, outside of buildings, shall be subject to OSR.

### **1.3 BACKGROUND**

- 1.3.1 In the UK, oil is one of the most commonly reported types of water pollution and causes nearly a quarter of all pollution incidents. Adequate measures must be taken to prevent the risk of pollution of Surface Waters, groundwater, sewers and drains by Oil.
- 1.3.2 National Grid is committed comply with all relevant environmental laws. See National Grid Environment Policy for information.
- 1.3.3 The Environment Agency for England and Natural Resources Wales are responsible for protecting Controlled Waters from pollution. This responsibility extends to the prevention of pollution of the environment, harm to human health and detriment to local amenity by waste management activities.
- 1.3.4 It is an offence to pollute Controlled Waters either deliberately or accidentally and the formal consent of the appropriate Agency is often required for discharges to such waters, whether these are direct or via soakaways. Installations not specifically covered by this document shall, as a minimum, comply with current legislation and the relevant Agency guidelines, specifically those included in the References Section.

## **PART 1 – PROCEDURAL**

### **2 BASIS OF DESIGN**

#### **2.1 General**

- 2.1.1 Site drainage shall be in accordance with the general requirements given in TS 2.10.09 Site Drainage, supplemented by the specific requirements in this section for drainage requirements in and around plant areas containing oil.
- 2.1.2 All installations shall, as a minimum, comply with relevant guidance, specifically those included in the References Section 13. Attention is drawn in particular to CIRIA C736 Containment systems for the prevention of pollution
- 2.1.3 An Emergency Oil Containment and Drainage Plan and an Operating Manual shall be prepared for each site to aid maintenance and to enable National Grid and the emergency services to deal effectively with an incident involving an accidental spillage of Oil, in accordance with Section 7 and TP135.

#### **2.2 New and Improvement Work**

- 2.2.1 Works shall be divided into two categories New Work and Improvement Work as defined in Part 2. All relevant parts of a project shall be assumed to be New Work, unless specifically identified in the contract specification as Improvement Work.
- 2.2.2 Supplementary requirements for Improvement Work are provided in Section 8.

#### **2.3 Design principles**

**INFORMATIVE:** This section is intended to highlight the key 'building blocks' of the National Grid Oil containment requirements to assist the reader in understanding the detail of the specification and to ensure that these principles are consistently adopted in all designs.

- 2.3.1 Oil containment design within National Grid shall follow one of two types:

Type 1 - Secondary Containment System which shall comprise an above ground Oil Retaining Area (or 'bund') only.

Type 2 - Secondary Containment System which shall in addition to Type 1 incorporate an Underground Oil Containment Facility. This shall be in the form of either an underground integral moat or remote underground oil containment (dump tank).

- 2.3.2 Type 1 is the default and National Grid shall indicate in the project scope if Type 2 is required.
- 2.3.3 Where an Underground Oil Containment Facility is installed (Type 2) it shall always be connected to an Oil Retaining Area via a free draining closed gravity system such that leaked Oil, being a potential fuel supply, would quickly be removed from the source of the fire and then stored at a safe separation for a specified period of time.
- 2.3.4 A fluid draw-off system shall be installed for new transformer installations in all cases i.e. Type 1 and Type 2 except where a remote underground oil containment (dump tank) is installed. Appendix C gives a typical Draw-off system which should be modified to suite particular site conditions.

Key requirements of a draw-off pipe are

- There shall be a 25mm siphon effect over the bund wall

- Maximum of two directional changes shall be allowed
  - The max length of the pipe shall be 50m
  - All bends shall be encased in concrete.
- 2.3.5 Flame Traps shall be installed as necessary to ensure that any fire accompanying a catastrophic equipment failure is extinguished prior to the leaked Oil draining into an Oil Draw-Off system or an Underground Oil Containment Facility.
- 2.3.6 Where an Oily Water Drainage System necessitates lift pumps e.g. in Secondary Containment Systems and other non-free draining areas at risk from Oil contamination, a Bund Water Control Unit (BWCU) shall be used to manage the quality of discharge.
- 2.3.7 Penstocks and sampling chambers shall be installed at designated locations to manage the discharge and monitor its quality. See Appendix A for guidance.

INFORMATIVE: Type 1 and Type 2 construction came about as a result of a study in 2012 that concluded that the inclusion of underground oil containment or moat had no noticeable effect on the intensity of the fire and therefore no effect on the fire pool.

### 3 INTERFACE REQUIREMENTS

#### 3.1 Earthing

- 3.1.1 The designer shall ensure that all equipment and materials are installed in accordance with the earthing requirements outlined in TS 3.01.02 'Earthing'.

INFORMATIVE: The installation of Oil containment infrastructure is likely to involve the inclusion of metallic items such as pipes and access steps at Oil Retaining Areas etc. In such cases, there may be a risk to individuals from transferred touch potentials on the infrastructure during system fault conditions or where the installation may be subject to induced voltages or circulating currents.

- 3.1.2 All exposed metallic pipework shall be earthed.
- 3.1.3 Steps should be GRP wherever practicable, to avoid the requirement for earthing.

#### 3.2 Design Consultation

- 3.2.1 The designer is required to consult the Environment Agency Regional Office, local to site, to determine any additional site-specific factors which may need to be considered, including the need for consents. In addition, any other relevant authorities such as Internal Drainage Boards shall be contacted where necessary.

INFORMATIVE: Environment Agency consent cannot be assumed and consequently early application is essential if only to confirm formal approval is not necessary. EA consent may be necessary for the use of soakaways, for example.

#### 3.3 Flooding

- 3.3.1 Designers are required to take due account of the requirements of PS(T) 095 – Flood Mitigation Policy and TS 2.10.13 – Flood Defences for Electricity Substations when producing designs for Oil containment infrastructure.

#### 3.4 Areas to be drained via an Oil Separator

- 3.4.1 Areas to be drained via an Oil Separator are listed below.

- a) Oil handling areas, workshops, maintenance and test areas for Oil containing equipment;
- b) Tunnels containing oil filled cables;
- c) Interconnected trench systems that pass within 5 metres of any operational oil containing plant (containing over 200 litres of oil) or containment area. Alternatively where trenches are filled with sand there is no requirement for draining via an oil separator.

3.4.2 The following areas in substations have been deemed not to typically require drainage via an Oil Separator:

- a) Substation roads unlikely to be affected by an incident associated with items listed in 3.4.1;
- b) Access road and car parking areas which shall drain to the adjacent stone surfacing;
- c) Open areas surfaced by gravel;
- d) Roof drainage (excluding HV plant noise enclosures);
- e) Sections of roads or areas that are designated for the siting of plant/vehicles for servicing of Oil containing plant or storage tanks.

**INFORMATIVE:** There is no specific requirement for the car parking area to drain via an Oil Separator provided a site management system is in place that ensures plant, equipment or vehicles containing significant quantities (nominally 200 litres or more) of possible pollutant (e.g. Oil) will not located in that area.

**INFORMATIVE:** Historically tanker standing areas and skidways, provided to facilitate transformer installation/removal, were also routinely drained in this manner. This prescriptive requirement has now been purposely excluded.

3.4.3 Drainage to be routed via an Oil Separator shall be limited to those areas subject to Oil contamination as defined in Clause 3.4.1, and shall specifically exclude Surface Water drainage from areas defined in Clause 3.4.2 where practical. It is permissible to drain Surface Water from areas defined in Clause 3.4.2 through a separator where the impact on the size of the separator is small and where it is impractical to have a separate drainage system, e.g. discharge from small roofs.

3.4.4 Where the drainage system carries significant quantities of silt, provision shall be made for extracting the silt by either:

- a) Providing silt trap facilities, separate from and upstream of Oil Separators, or
- b) The use of an Oil Separator specifically designed and tested to accommodate silt.

3.4.5 Where pumps other than BWCU are used, they shall always be located downstream of an Oil Separator to prevent emulsified oil entering the Separator, since oil that has emulsified cannot be treated by the separator.

3.4.6 Compressor installations and blow down pits shall be drained via a discrete retention tank or chamber, for emptying by sludge/oil tanker for off-site disposal. The capacity of the tank shall be 1,000 litres per 100 CFM of compressor capacity with a minimum capacity of 1,000 litres.

**INFORMATIVE:** Oil condensates tend to emulsify and are not amenable to separation in oil separators. Proprietary water/oil demister filters are available to separate and collect all condensate and sludge from compressor installations.

### 3.5 Secondary Containment Systems

3.5.1 Secondary Containment Systems for large items of oil filled plant shall comprise an Oil Retaining Area only (Type 1) or an Oil Retaining Area in conjunction with an Underground Oil Containment Facility (Type 2). Criteria for determining which elements of the Secondary Containment System are required are shown below.

3.5.2 The following items of oil filled plant shall be installed in Oil Retaining Areas

- a) Transformers (including Supergrid, Converter, Earthing, Auxiliary and Station Transformers);
- b) Reactors;
- c) Quadrature Boosters;
- d) Diesel Generators;
- e) Oil storage Tanks;
- f) National Spare Transformers and similar 'non-operational' plant.

3.5.3 Suitable Secondary Containment Systems shall also be provided where the following features are present

- a) Sight gauges;
- b) Fixed interconnecting pipework;
- c) Fill and draw off pipes, excluding emergency draw off systems for Integral Underground Oil Containment Facilities.

3.5.4 Twin walled, non-corrosive pipework is the preferred method of providing Secondary Containment to pipes in permanent installations and is mandatory for temporary systems.

3.5.5 Secondary Containment Systems shall be gravity draining to a sump or remote underground tank. Rainwater shall be removed from the sump or tank by a BWCU discharging into a closed drainage system that incorporates an Oil Separator to remove Oil prior to discharge from site. The sump shall be integral with the foundation and sized to ensure the operation of the BWCU in the presence of up to 100 litres of Oil. It is not necessary for the base of an 'underground moat' type Secondary Containment System to be built to a fall.

### 3.6 Pumps

3.6.1 Unless the topography of the site dictates otherwise, pumps (except for a BWCU) shall not be used in Oil containment systems. Where it can be demonstrated that there are no alternatives, pumps shall always be installed downstream of any Oil Separators to avoid the possible emulsification of Oil and water prior to treatment. In this situation, a standby pump shall be provided to operate in the event of failure of each and any duty (i.e. main) pump. All such pumps shall be designed to operate after long periods of inactivity. Suitable alarm systems shall indicate the failure of any pumps (see TPS 2.7.1).

## 4 DIMENSIONAL REQUIREMENTS AND CLEARANCES

### 4.1 General Clearances

4.1.1 Where practical, no part of any Oil filled equipment, Oil storage area, or mobile tanker shall be sited within:

- a) 50m of any borehole or well used for water abstraction
- b) 10m of any Surface Watercourse
- c) 5m of any drain through which Oil could enter and discharge directly into Controlled Waters

4.1.2 Where such separation is not possible, alternative solutions shall be agreed with National Grid.

4.1.3 Oil separators, Remote 'Underground Oil Containment Facilities' ('dump tanks') or similar buried systems shall be sited away from areas where they may be subjected to accidental wheel loading. In locations where this is not possible (as confirmed via risk assessment) they shall either be designed to accommodate the appropriate loads or protected from such condition by safety fencing, bollards or other agreed method.

### 4.2 Oil Containment/Storage Requirements

4.2.1 The volumetric requirements for the various components of a Secondary Containment System depend on numerous variables including the type of plant served and the presence of fire protection systems etc. Bund design shall comply with the recommendations given in CIRIA C736 Containment systems for the prevention of pollution, Section 6

4.2.2 However, for National Grid sites specific requirements for Oil Retaining Areas and Underground Oil Containment Facilities are given in Appendix B. The 'Gross' volume shall be taken as the total area enclosed by the external walls of the item under consideration with no deductions. The 'Net' volume shall be taken as the 'Gross' volume minus the volume displaced by items of plant or other permanent features.

**INFORMATIVE:** On a significant number of substation sites, remote Underground Oil Containment Facilities ('dump tanks') have been discovered to be full of water. This has been variously due to ground water ingress caused by poor installation (e.g. differential settlement, inadequate backfilling, damage during construction) and/or a build-up of rain water due to the failure of poorly maintained BWCU. Should there have been a catastrophic failure of the equipment associated with these 'dump tanks' accompanied by the release of large quantities of Oil a major environmental incident would have resulted.

As a consequence of this risk all 'bunds' (Oil Retaining Areas) connected to 'dump tanks' are required to have a minimum gross capacity, see Appendix B (i.e. it is not necessary to remove the volume occupied by the Oil containing equipment) as stated. Where an active automatic fire protection system is fitted to the associated equipment there is no requirement to increase this capacity to allow for the additional volume of fluid.

The requirement does not apply to 'moat' type foundations because as these are integral with the equipment foundations as opposed to being sited remotely as is often the case with 'dump tanks' it is considered less likely that an overfilling problem will go unnoticed.

### 4.3 Oil Retaining Area dimensions and clearances

- 4.3.1 The height of all Type 1 Oil Retaining Area walls shall be high enough to retain the contents of the primary storage, with appropriate allowances for rainwater, fire-fighting water, freeboard allowance for fire-fighting foam and for surge.
- 4.3.2 Notwithstanding the above, all bund walls shall be a minimum of 400mm above finished substation ground level or the support plinth(s) of the associated Oil containing equipment, whichever is the greater.

**INFORMATIVE:** This minimum requirement is consistent with guidance in CIRIA C736 Containment systems for the prevention of pollution. Section 6.3.1 notes a surge allowance of 250mm in the absence of detailed calculation and an allowance for fire-fighting agents of 100mm.

- 4.3.3 Bund walls of more than 500mm above finished substation level shall have access/egress steps which if made of steel shall be appropriately earthed (see TS 3.01.02).
- 4.3.4 Bund walls should generally not be greater than 1.5m in height. In circumstances where, for operational or conflicting safety reasons (for example, flood protection measures), it is necessary for a bund wall to exceed 1.5 m high then a risk assessment should be completed, adequate means of escape for personnel shall be provided and the deep bunds shall be made secure against unauthorised access.
- 4.3.5 The minimum clear horizontal distance (to facilitate access) between the internal face of an Oil Retaining Area wall and any Oil containing plant within it shall be 2.0 m for Transformers, Reactors and Quadrature Boosters and 1.0m for all other equipment unless it can be demonstrated that a lesser dimension is appropriate.
- 4.3.6 As far as is reasonably practicable bushings shall not project beyond the internal face of an Oil Retaining Area wall.

**INFORMATIVE:** The clear horizontal distance is specified to give some protection against 'jetting' failure and also provide a safety zone in the event of a cooler collapse – something which is known to be a real possibility in the event of a transformer fire.

- 4.3.7 Provided bushings have an independent, low pressure oil system (e.g. one which is separate to that of the main equipment) the clearance requirements do not apply to bushings. Bushings shall however be within the plan area defined by the internal faces of the 'bund' wall.
- 4.3.8 Where Oil Retaining Areas are connected to an Underground Oil Containment Facility, the system shall be capable of draining Oil at a rate of at least 7,000 litres per minute.
- 4.3.9 A new bund shall have no GRP walkway installed.

### 4.4 Fire Damage Zone

- 4.4.1 The Fire Damage Zone is an area around specified types of Oil filled plant within which all items are assumed to be at risk from the damaging effects of a fire due to a catastrophic failure of that Oil filled plant. This is an important concept when considering the siting of Oil Containment features. The process for calculating the dimensions of the Fire Damage Zone is detailed in TS 2.10.06 Limitation of Fire Risk in Electricity Substations.

4.4.2 The location of Penstock valves, surface inspection hatch covers and access roads for remote Underground Oil Containment Facilities ('dump tanks') and Oil Separators shall be positioned in accordance with the following hierarchy, in order to facilitate emptying of the contents of the containment tank during fire-fighting activities:

- a) Outside all Fire Damage Zones;
- b) Outside of the Fire Damage Zone of the HV equipment or plant they are directly associated with;
- c) Where this is not practicable due to site space constraints, alternative arrangements shall be agreed with National Grid to determine a suitable safe layout solution.

INFORMATIVE: It is acceptable for these elements (valves, covers, roads etc.) to be located inside the Fire Damage Zone for another piece of equipment, provided they are located outside the Fire Damage Zone for the equipment they are directly associated with. This may allow a more efficient configuration and reduce the overall space requirements for the plant. It is assumed that only one Fire Hazard will catch fire at any one time.

4.4.3 The outlets of riser pipes (as defined in clause 5.5.3) used for draining fluid from Type 1 and Type 2 oil containment systems following a fire shall be a minimum of 40m and maximum of 50m from the bund wall of the equipment they serve. A 1200mm X 1200mm fire barrier wall may be provided to reduce this 40m distance where necessary.

## 4.5 Control Panels

4.5.1 Control panels forming part of the oil containment system shall be sited within the associated substation compound. They shall be mounted as close as practicable to the controlled equipment a minimum of 800mm above ground level and more than 2m from the substation security fence.

## 5 ELEMENT DESIGN REQUIREMENTS

### 5.1 Oil Retaining Area Design

5.1.1 The Oil Retaining Area shall consist of a base slab, formed around plant foundations as necessary, and single skin reinforced concrete walls forming a container impermeable to Oil and water and constructed to provide an effective life in excess of 40 years with appropriate maintenance.

5.1.2 Sumps shall be included in Type 1 and Type 2 Oil Containment Facilities and shall accommodate a BWCU.

5.1.3 The base slab and walls shall be designed and constructed in accordance with TS 3.10.04 and CIRIA C736 Containment systems for the prevention of pollution Section 7 to achieve an impermeable and durable structure. Crack width and spacing shall be controlled by the reinforcement which shall be designed to achieve 'Tightness Class 1' as defined in BS EN 1992-3 Clause 7.3 and the associated UK National Annex.

5.1.4 Walls shall be designed to be monolithic with the base slab. In addition no contraction or expansion joints shall be incorporated in the design of walls and slabs, which should allow for full restraint of shrinkage and thermal contraction. All construction joints shall have continuous reinforcement, and shall be prepared in accordance with TS 3.10.04.

5.1.5 Oil Retaining Areas shall be designed in accordance with the general requirements given in TS 2.10.06 Limitation of Fire Risk in Electricity Substations, supplemented by the specific fire design requirements in this section.

- 5.1.6 All impermeable internal surfaces shall be designed to maintain their load bearing function (criteria 'R') and integrity (criteria 'E') in the event of a fire for the standard fire exposure up to 240 minutes in accordance with BS EN 1991-1-2, BS EN 1992-1-2 and the associated UK National Annexes.
- 5.1.7 Oil Retaining Area walls shall be a minimum 230mm thick with an axis distance of 50mm to reinforcement (i.e. distance from face of exposed surface to centroid of main reinforcement).

INFORMATIVE: BS EN 1991-1-2 permits fire design using alternative design procedures, including prescriptive rules and performance based analysis.

The above minimum requirement is based on the prescriptive approach taken from the tabulated method of BS EN 1992-1-2, Table 5.4 for load bearing walls, for criteria REI 240 with wall exposed on one side with ratio of axial load = 0.35.

More advanced calculation methods may be used in accordance with BS EN 1991-1-2 subject to agreement with National Grid.

- 5.1.8 No external holes shall be allowed through any part of the Secondary Containment System. All services, pipes, cables etc. shall be carried over walls to maintain their integrity.
- 5.1.9 Oil Retaining Area walls may be detailed to facilitate the installation of HV plant by allowing sections to be cast after the main construction. Continuity of such sections should be achieved by conventional lapped reinforcement. However, where this is not practicable, continuity may be provided by the use of reinforcing bar couplers. Where couplers are to be used, allowance shall be made at the design stage to ensure the required cover is maintained to both the reinforcement and the couplers.

INFORMATIVE: TS 3.10.07 contains requirements for 'Testing of Bunded Areas' and permits the water level for the retention test to be reduced to the top of the transformer plinth by agreement with National Grid where this demonstrably benefits the project without compromising functionality. A project benefit may be, for example, testing ahead of transformer installation to achieve a shorter programme, and this may require that a section of the 'bund' wall be omitted to facilitate the later installation of the HV plant. The purpose of the test is to prove the integrity of the underground compartments (particularly the construction joints) on which this level reduction will have a minimal effect.

- 5.1.10 Slabs formed within Oil Retaining Areas between transformer/plant plinths shall be laid to a minimum fall of 1 in 80 to collecting sumps or channels (or Flame Traps where an Underground Oil Containment Facility is present).
- 5.1.11 The above ground 'bund' floor shall have sufficient fall to prevent the build-up of surface moss, silt and other detritus or the formation of ice, in addition to providing any necessary flow rates. It is preferred to lay the floor without a screed.
- 5.1.12 All pedestrian access areas shall have an approved slip resistant surface and be capable of supporting a minimum imposed load of 5kN/m<sup>2</sup>. The surfacing shall not comprise stone chippings, cobbles, pebbles or other loose media. Major Maintenance and General Maintenance requirements shall be identified and suitable additional provision (e.g. load from scaffold) accommodated in the design as necessary. Areas or surfaces not suitable for loads greater than pedestrian access shall be marked with suitable warning signage indicating their limitations (e.g. 'Pedestrian Access Loading Only'). This shall also be recorded in the SHES File (see TP 137).