NSP/007/022 – Guidance on Substation Design: Oil Containment

1. Purpose

The purpose of this document is to specify the requirements for containing oil in the event of a minor or major leakage from plant containing oil in Northern Powergrid substations.

This document supersedes the following documents, all copies of which should be destroyed.

Reference	Version	Date	Title
NSP/007/022	2.0	Mar 2018	Guidance on Substation Design: Oil Containment

2. Scope

This document defines the design considerations and construction requirements of all Primary and Supply Point substations connected to the Northern Powergrid network. It provides guidance necessary for customers, external service providers and independent connection providers to construct substations to a standard that is suitable for adoption.

The guidance applies to both new build sites and where modifications are required to existing sites.

2.1. Table of Contents

3. Technical Specification

3.1. Oil Containment

This specification is applicable to containment of oil at all Primary and Supply Point transformer installations. Under the Water Resources Act, the Environment Agency (EA) is responsible for the protection of 'controlled waters' from pollution, either deliberate or accidental. The Designer is required to consult EA documentation and standards in order to carry out an appraisal of any site specific requirements which may be required, including any need for discharge consents.

Bunded oil containment areas shall be designed and constructed to meet the requirements of BS EN 61936-1:2021, ENA ER S39 and NSP/007/003.

Oil containment measures are required to prevent pollution of the ground, land drains and watercourses in the substation area and beyond caused by oil leaking from transformers and/or other oil containing plant.

3.2. Transformer Bunds

The foundations for the transformer and its cooler are to be contained within a common bund which shall allow reasonable access to the plant.

The bund wall and base of the oil retaining area shall be impermeable to both oil and water and shall be designed and constructed to provide, with proper maintenance, an effective life in excess of 40 years.

The installation and removal of the transformer and cooler should be considered in the design. Haulage bollards shall be provided for both installation and removal of the transformer.

- Bund Capacity:

All Primary or Supply Point transformers shall be bunded to contain 115% of the oil capacity of the transformer plus an additional 50mm tolerance in height for the application of a foam fire blanket.

The bund area shall be large enough to capture oil spillage projected from any oil containing part of the transformer and cooler, to determine the bund size with respect to projected oil the following method should be used: the length and width of the bund should be equal to the length and width of the transformer and cooler plus 20% of the height, the height should be measured from top of bund wall to the top of the highest oil containing part of the transformer and cooler including conservator (whichever is highest). As a minimum the internal walls of the bund shall not encroach within 0.75m of any oil containing parts of the transformer and cooler.

Calculations demonstrating volume of containment shall be made at design stage prior to construction.

- Segregation:

Each transformer, together with its cooler, shall be surrounded by an oil retaining bund. Bunds shall be segregated between transformers of different circuits in accordance with BS EN 61936-1:2021 and ENA ER S39 (2017).

- Enclosures:

The design of the bund and transformer/cooler foundations shall cater for the installation of a noise enclosure around the transformer which can be constructed at the same time as the bund or at some future date. See NSP/007/020 for guidance on transformer noise.

- Construction Material:

Oil-resistant materials must be used in the construction of bund walls, bases etc. The bund must prevent the spread of burning oil therefore bund walls etc must have sufficient strength, durability and fire resistance for this purpose.

- Cables:

All HV, auxiliary, multicore and earthing cables within the bunded area shall pass from above bund wall level via a chimney type cable pit constructed inside the bund, down through the floor slab and out below the bund wall foundation, the cable pit shall be at least as high as the bund walls so that the integrity of the bund is not dependent on cable duct seals. Cables shall exit via ducts which will be sealed after cable installation. It shall be possible to install or replace any cable without affecting the integrity of the bund. The cable chimney shall be constructed of a suitable material in keeping with the design of the bund and filled with sand with a suitable water tight screed applied after all cables have been installed.

The design of civil works for oil containment bunds should be undertaken so as to minimise excavation around existing cables. Where possible, the base slab of the bund should be above the depth of the existing cables.

- Water Retention:

On completion of construction and prior to oil containing equipment delivery, the bunded areas shall be subjected to a water retention test. The bund shall be filled with water to a level of 200mm below the top of the bund wall or 150mm above the transformer plinth, whichever is the greater, for 24 hours to allow the water to absorb into the bund materials. The level of the water shall then be reset and left for a further 24 hours of dry weather. The fall in level shall not be more than 3mm on completion of the test. If the water test is not satisfactory, remedial work shall be undertaken to seal the bund as necessary, and the bund re-tested. This test shall be witnessed and documented by the civil Clerk of Works.

- Gravel:

The bund shall contain a layer of 40-20mm washed rounded gravel. The depth of gravel shall be in excess of 75mm. The volume of air within the gravel to accommodate any spilled oil shall be taken as 30% of the volume of gravel for calculation purposes. The surface of the gravel shall be a minimum of 75mm below plinth level and shall be level with the ground surface adjacent to the bund.

- Walls:

The bund wall height shall be kept to a minimum, consistent with the above, to allow easy entry and exit to the bunded area for personnel.

Steps:

If a bund wall is higher than 300mm above ground level, two sets of steps with a minimum clear access width of 800mm shall be provided. The steps shall have equal rises of less than 200mm and equal treads of at least 250mm. Steps outside and inside the bund are to be equal in height. Where the steps are less than 1000mm wide they shall have a hand rail set 900 to 1000mm from the pitch line of the step nosings to the top of the handrail.

- Sumps:

A sump of minimum size 650 x 650 x 600mm deep shall be incorporated within each bund to collect rainwater falling into the bund area. It shall be located adjacent to the bund wall containing the cooler, and shall accommodate an 'intelligent' pump (see section 3.3). The pump must be installed and operational before installation of the transformer.

3.3. Concrete Bunds

Slabs and walls shall be constructed of reinforced concrete designed and constructed in accordance with the requirements of BS EN 1992-3:2006 Eurocode 2. Design of concrete structures. Liquid retaining and containing structures.

A fire resistance of four hours shall be provided in accordance with BS EN 1992-1-1:2004 Eurocode 2: Design of concrete structures. General rules and rules for buildings.

Walls shall be designed to be monolithic with the base slab. Transformer and cooler plinths shall be designed to be monolithic with the base slab. In addition, the design shall allow for shrinkage and contraction without the installation of contraction or expansion joints.

A proprietary water stop shall be placed or incorporated at every construction joint interface, this shall be in the form of a two part polyurethane grout pressure injected tube system, or other approved system.

Crack width shall be controlled by reinforcement as per BS EN 1992-3:2006 Eurocode 2. Design of concrete structures. Liquid retaining and containing structures.

Calculations demonstrating bund wall and floor structure and reinforcement adequacy shall be submitted.

All oil containment areas shall comprise a reinforced concrete base slab and single skin reinforced concrete bund wall not less than 225mm thick. All external horizontal edges shall have 25 x 25mm chamfers.

3.4. Other Bunds

Alternative bund materials can be considered in situations where a concrete bund is deemed inappropriate. All materials should allow the bund to conform to the requirements detailed in Section 3.2.1

- High Density Polyethylene (HDPE) Bunds:

HDPE bunds consist of plastic sheets nominally 18mm thick, cut to size and plastic welded together to form a bund. They shall be laid on either a concrete or a hardcore base. They can be used to form a bund around an existing transformer base by gluing and bolting to the existing concrete or to form a new bund before transformer delivery. The transformer and cooler must be positioned above a concrete foundation underneath the plastic base of the bund to support the weight.

The plastic bund walls shall be encased in interlocking preformed firebrick covers to protect the HDPE from ultraviolet degradation and to prevent heat damage in the event of fire.

The base of the bund shall be covered in gravel as detailed in section 3.2.

The transformer shall be positioned on a plinth within the bund constructed at such a height to raise the transformer above the gravel and any standing water.

- Enclosures:

If an enclosure is to be constructed around the transformer, then a suitable concrete foundation shall be constructed around the outside of the bund to accommodate the individual requirements of the enclosure.

- Earth Tapes:

Earth tapes shall pass over the bund wall into the bund.

The tapes shall be fastened either to the firebrick surround using appropriate fastenings and an anti-theft cover, or installed beneath the firebrick, adjacent to the HDPE.

3.5. Intelligent Pumps

Intelligent pumps shall comprise a mains-operated electronic control unit, sensor assembly, pump and delivery pipework complete with anti-syphoning device. The sensor and the pump shall be housed within the bund sump. The sensor must be capable of differentiating between water (conductive) and oil (non-conductive). The delivery pipework shall discharge to the site drainage system. Under normal operating conditions the system will automatically monitor the collection of water in the sump and operate the pump between a pre-determined range of levels. The pump must automatically stop if the sensor detects oil, ensuring that no oil is pumped out of the bunded area.

The control unit shall be located within the control room. It shall incorporate fail safe devices to provide a warning of power or pump failure and a high level alarm to indicate when the bund needs to be emptied of oil. Alarms shall be connected through the SCADA system.

3.6. Bund Water Discharge

The following table shows the method of discharging the water from the bund in order of preference.

No mains drainage available	Bund pump to discharge into a soakaway
Foul water drainage available	Connect bund pump discharge directly to foul water drainage system
Combined foul & surface water drainage available	Connect bund pump discharge directly to foul & surface water drainage system
Surface water drainage only available	Connect bund pump discharge to surface water drainage via a suitable interceptor

Where an interceptor system is required, the system shall incorporate a ”full retention” Class 1 Oil-Petrol Interceptor complete with integral silt collection and quality of discharge sampling facilities, coalescing and ‘dead-stop’ mechanisms. If site space cannot accommodate a conventional interceptor tank, a bund mounted separator which utilizes the existing bund capacity as oil storage can be used.

The interceptor shall incorporate a high-level oil alarm system connected to the substation alarm and SCADA system. The interceptor shall also be vented as required by the manufacturer and positioned in an area on site which allows easy access for maintenance and silt removal without having to enter LIVE areas.

Ducts running between the tank and the substation building shall be suitably sealed after alarm and power cable installation to prevent smells and fumes entering the building and prevent ingress of ground water into the interceptor.

Drains which could potentially convey oil contaminated water shall be of vitrified clay and have a minimum of 150mm thick concrete surround.

4. References

4.1. External Documentation

Reference	Title
BS EN 1992-3:2006 Eurocode 2	Design of concrete structures. Liquid retaining and containing structures
BS EN 1992-1-1:2004 Eurocode 2	Design of concrete structures. General rules and rules for buildings
BS EN 61936-1:2021	Power installations exceeding 1 kV AC and 1,5 kV DC
ENA ER S39 (2017)	General fire precautions in substations at 132 kV and below and in enclosed cableways
PPG3	Environment Agency Pollution Prevention Guidelines – Use and Design of Oil Separators

4.2. Internal Documentation

Reference	Title
NSP/007/003	Guidance on Substation Design: Construction Details
NSP/007/020	Guidance on Substation Design: Transformer Noise

4.3. Amendments from Previous Version

Reference	Description
v1.1	Spill containment increased from 750mm to 1.5m beyond any oil containing part
v2.0	References updated. Section 3.2 Bund Capacity updated.
V3.0	References updated. Minimum sump size increased. Bund capacity section changed. Other updates in line with currently approved practices.

5. Definitions

Reference	Definition
n/a	n/a

6. Authority for Issue

6.1. CDS Assurance

I sign to confirm that I have completed and checked this document and I am satisfied with its content and submit it for approval and authorisation.

		Date
Liz Beat	Governance Administrator	13/03/2024

6.2. Author

I sign to confirm that I have completed and checked this document and I am satisfied with its content and submit it for approval and authorisation.

Review Period - This document should be reviewed within the following time period.

Standard CDS review of 3 years	Non Standard Review Period & Reason	
Yes	Period: n/a	Reason: n/a
Should this document be displayed on the Northern Powergrid external website?		Yes

		Date
Mark Thompson	Major Projects Specification and Design Manager	28/03/2024

6.3. Technical Assurance

I sign to confirm that I am satisfied with all aspects of the content and preparation of this document and submit it for approval and authorisation.

		Date
Mark Hague	Substation Design Engineer – email approval	27/03/2024

6.4. Authorisation

Authorisation is granted for publication of this document.

		Date
Dave Sillito	Head of Major Projects	21/03/2024