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.

<table>
<thead>
<tr>
<th>Ref</th>
<th>Version</th>
<th>Date</th>
<th>Title</th>
</tr>
</thead>
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<td>NSP/007/022</td>
<td>1.1</td>
<td>Mar 2013</td>
<td>Guidance on Substation Design: Oil Containment</td>
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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
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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 the EA regional office local to the site to determine any additional site-specific requirements which may need to be considered including any need for discharge consents.

Bunded oil containment areas shall be designed and constructed to meet the requirements of Engineering Recommendation S2/4 and NSP/007/010 for guidance on fire hazards & precautions.

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 etc.

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 access and egress of the transformer.

- **Bund Capacity:**

  All Primary or Supply Point transformers shall be bunded to contain 115% of the oil capacity of the transformer in accordance with Engineering Recommendation S2/4 plus an additional 50mm tolerance in height for the application of a foam blanket.

  The bund area shall be large enough to capture oil spillage from any part of the transformer and cooler and shall not encroach within 1.5m of any oil containing part of the transformer or 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 Engineering Recommendation S2/4.

- **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.
- **Cable Access and Egress:**

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 footing, 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 20mm single size 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 25% 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 to be equal in height. Where the steps are less than 1000mm wide they shall have a hand rail set 900 to 1000mm to the top of the handrail to the top of the handrail from the pitch line or floor.

- **Sumps:**

A sump of minimum size 450 x 450 x 600mm deep shall be incorporated within each bund to collect rainwater falling in to 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 8007 ‘Design of Concrete Structures for Retaining Aqueous Liquids’.

A four hours fire resistance shall be provided in accordance with BS8110 Structural Use of Concrete Part 2 Code of Practice for Special Circumstances, Table 4.6.

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.

Where the bund slab abuts a separate adjacent plant foundation, a movement joint shall be formed comprising non-absorbent joint filler and oil-resistant flexible sealant, or other approved means.

Crack width and spacing shall be controlled by the reinforcement, which shall be designed to limit crack widths to 0.2mm. All construction joints shall have continuous reinforcement.

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 sheets of plastic 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 pebbles 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 footing 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.

<table>
<thead>
<tr>
<th>No mains drainage available</th>
<th>Bund pump to discharge into a soakaway</th>
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<tbody>
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<td>Foul water drainage available</td>
<td>Connect bund pump discharge directly to foul water drainage system</td>
</tr>
<tr>
<td>Combined foul &amp; surface water drainage available</td>
<td>Connect bund pump discharge directly to foul &amp; surface water drainage system</td>
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<tr>
<td>Surface water drainage only available</td>
<td>Connect bund pump discharge to surface water drainage via a suitable interceptor</td>
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</tbody>
</table>

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.

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 shall be suitably sealed after alarm and power cable installation to prevent smells and fumes entering the substation building.

Drains to oily-water drainage systems shall be of vitrified clay and have a minimum of 150mm thick concrete surround.
4. References

4.1. External Documentation

<table>
<thead>
<tr>
<th>Reference</th>
<th>Title</th>
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<tbody>
<tr>
<td>BS 8007</td>
<td>Design of Concrete Structures for Retaining Aqueous Liquids</td>
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<td>BS 8110</td>
<td>Structural Use of Concrete</td>
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<td>Engineering</td>
<td>Limitation of Fire risk in Substations at 132kV and below and in Enclosed Cableways</td>
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<tr>
<td>Recommendation S2/4</td>
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<td>PPG3</td>
<td>Environment Agency Pollution Prevention Guidelines – Use and Design of Oil Separators</td>
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4.2. Internal documentation

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<tr>
<td>NSP/007/010</td>
<td>Guidance on Substation Design: Fire Hazards and Precautions</td>
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<td>NSP/007/020</td>
<td>Guidance on Substation Design: Transformer Noise</td>
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4.3. Amendments from Previous Version

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<th>Description</th>
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<td>n/a</td>
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5. Definitions

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<thead>
<tr>
<th>Reference</th>
<th>Definition</th>
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6. Authority for issue

6.1. CDS Assurance

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<th>Sign</th>
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<tr>
<td>Faye Wilson</td>
<td>01/02/2018</td>
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6.2. Author

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

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Should this document be displayed on the Northern Powergrid external website? Yes

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<td>Steve Wilkinson</td>
<td>12/03/2018</td>
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6.3. Technical Assurance

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<td>Gordon Walker</td>
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<td>Environmental Manager</td>
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6.4. Authorisation

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