

Substation Design Instruction

Transformer oil containment

IMPORTANT DISCLAIMER

As the information contained in this publication is subject to change from time to time, Endeavour Energy gives no warranty that the information is correct or complete or is a definitive statement of procedures. Endeavour Energy reserves the right to vary the content of this publication as and when required. You should make independent inquiries to satisfy yourself as to correctness and currency of the content. Endeavour Energy expressly disclaims all and any liability to any persons whatsoever in respect of anything done or not done by any such person in reliance, whether in whole or in part, on this document

Document no. SDI 540

Amendment no. 5

51 Huntingwood Drive, Huntingwood NSW 2148

Postal address: PO Box 811 Seven Hills NSW 1730

Phone: 131 318 Fax: (02) 9853 6000



SUBSTATION DESIGN INSTRUCTION

PRIMARY SYSTEMS	Document no. Amendment no. Approved by Approval date	SDI 540 5 MPSB 04/03/2015
------------------------	---	------------------------------------

SDI 540 Transformer oil containment

Contents

1.0	PURPOSE	4
2.0	SCOPE.....	4
3.0	REFERENCES	4
4.0	DEFINITIONS AND ABBREVIATIONS.....	5
5.0	ACTIONS	5
5.1	General.....	5
5.2	Treated water discharge and regulatory requirements	6
5.3	Oil containment designs	6
5.3.1	<i>General.....</i>	6
5.3.2	<i>Transformer bunds with individual oil-water separator</i>	7
5.3.2.1	<i>Sump drainage arrangements.....</i>	7
5.3.2.2	<i>TX control panel door clearance</i>	8
5.3.3	<i>Transformer bunds connected to an interceptor tank with gravity oil-water separator system.....</i>	8
5.3.3.1	<i>Isolating valves.....</i>	9
5.3.3.2	<i>Flame traps.....</i>	9
5.3.4	<i>Bund capacity.....</i>	9
5.3.5	<i>Bund wall height, spray screens, steps and stair cases.....</i>	10
5.3.5.1	<i>Spray screens for oil spray discharge.....</i>	10
5.3.5.2	<i>Bund wall steps</i>	10
5.3.5.3	<i>Stair cases.....</i>	10
5.3.6	<i>Bund floor.....</i>	10
5.3.7	<i>Bund sump</i>	11
5.3.8	<i>Transformer fire walls.....</i>	11
5.3.9	<i>Transformer plinth and footing</i>	11
5.4	New bund construction.....	11
5.4.1	<i>General.....</i>	11
5.4.2	<i>Bund testing</i>	12
5.4.3	<i>Concrete quality</i>	12
5.5	Cable entry.....	12
5.5.1	<i>Power cable entry requirements</i>	12
5.5.1.1	<i>Power cable entry from outside of the bund</i>	12
5.5.1.2	<i>Power cable entry from trench below bund floor.....</i>	13

5.5.1.3	Power cable direct entry from basement	13
5.5.2	Control cable entry	13
5.5.3	Fire stopping (sealants).....	14
5.5.4	Earthing of steel reinforcement	14
5.6	Oil-water separator	14
5.6.1	General.....	14
5.6.2	Oil water separator discharge	15
5.6.3	Passive oil-water separator.....	15
5.6.4	Active oil-water separator.....	15
5.6.4.1	General.....	15
5.6.4.2	Location.....	16
5.6.4.3	Control panel and motor/gearbox/pump unit.....	16
5.6.4.4	Power supply.....	16
5.6.4.5	Level sensors	16
5.6.4.6	SCADA alarms	16
5.6.4.7	Earthing	17
5.6.4.8	Oil collection tank	17
5.6.4.9	Suction pipe.....	17
5.6.4.10	Footings.....	17
5.7	Existing bund modification.....	17
5.7.1	Sealing existing bunds of brick construction.....	17
5.7.2	Existing bunds with sumps.....	17
5.7.3	Existing bunds without sumps.....	17
5.8	Bund maintenance water tap with RPZD	17
5.9	Drawings	18
6.0	AUTHORITIES AND RESPONSIBILITIES	18
7.0	DOCUMENT CONTROL	18
	Annexure 1: Bund construction details	19
	Annexure 2: Cable entry/penetrations into bunds over basements	22
	Annexure 3: Discharge arrangement for restricted sites where switchyard gravel surface is not available next to the bund.....	24

1.0 PURPOSE

To set out in detail the minimum requirements for transformer oil containment in transmission and zone substations.

2.0 SCOPE

This Standard shall be read in conjunction with SDI 505.

It defines the minimum requirements for transformer oil containment.

All transformers and equipment containing oil volumes greater than 1,000 litres are required to be installed within a bund.

Reference shall be made to SDI 532 - Plumbing and drainage for the drainage requirements relating to the final stormwater discharge from within the substation to the outside of the site.

3.0 REFERENCES

- Company Policy 2.1 - Risk Management
- Company Policy 3.14 - Occupational Health and Safety Design Policy
- Company Policy 3.4 - Electrical Safety
- Company Policy 4.3 - Liquid Spill Prevention and Containment
- Company Policy 9.2.5 - Network Asset Design
- Network Management Plan December 2013 Review
- Earthing Design Instruction EDI 516 - Major substation earthing design, construct and commissioning
- Environmental Management Standard EMS 0001 - Environmental impact assessment and environmental management plans
- Mains Design Instruction MDI 0046 - Transmission underground cables – continuous current ratings
- Substation Design Instruction SDI 503 - Transmission and zone substation fire detection, control and suppression systems
- SDI 505 - Minimum requirements for design and construction of transmission and zone substations
- SDI 511 - Auxiliary AC supplies and switchgear
- SDI 515 – Drawings
- SDI 532 - Plumbing and drainage
- Drawing no. 364162. - Details of oil separator arrangement within a transformer enclosure
- NSW Work Health and Safety Act 2011
- NSW Work Health and Safety Regulation 2011
- ENA National Electricity Network Safety Code (Doc 01-2008)
- AS 1141.11:2009 - Method for sampling and testing aggregates - Particle size distribution - Sieving method
- AS 1530.4:2005 - Methods for fire tests on building materials, components and structures - Fire-resistance test of elements of construction
- AS 1940:2004 - The Storage and Handling of Flammable and Combustible Liquids
- AS 1657:2013 - Fixed Platforms, Walkways, Stairways and Ladders - Design, Construction and installation
- AS 3500.1:2003 - Plumbing and drainage Part 1 - Water services
- AS 3600:2009 - Concrete Structures
- AS 3735:2001 - Concrete structures for retaining liquids
- AS 3799:1998 - Liquid Membrane - Forming Curing Compounds for Concrete
- AS 3972:2010 - Portland and Blended Cement

- AS 4072.1:2005 - Components for the protection of openings in fire-resistant separating elements Part 1- Service penetration and control joints
- AS 4680:2006 - Hot-dip galvanised (zinc) coatings on fabricated ferrous articles
- Department of Environment and Climate Change NSW - Storing and handling liquids: Environment protection - Participant's manual
- Department of Environment and conservation (NSW) - Environment Compliance Report: Liquid Chemical storage, Handling and Spill Management

4.0 DEFINITIONS AND ABBREVIATIONS

active oil water separator	Oil-water separator comprising of a tank equipped with a parallel plate coalescing oil-water separator and an automatic pump system.
bund	An impervious embankment of concrete or other suitable material, that may form part of, or the entire perimeter of a compound that provides a barrier to retain liquid.
curing compound	A solution compound consisting of a film-forming material, such as a hard resin, acrylic or other polymer, or chlorinated rubber, dissolved in an organic solvent. ¹
FFL	finished floor level
fire-stopping	The system or materials used to maintain the fire resistance of the fire-separating element at joints or where services pass through the element.
HS&E	Health, safety and environment
NB	nominal bore
passive oil water separator	Oil separator comprising a gravity-fed oil separator tank consisting of several effluent separating chambers.
PCB	polychlorinated biphenyls
RPZD	reduced pressure zone device
RTU	remote terminal unit
SCADA	supervisory control and data acquisition
UV	ultraviolet

5.0 ACTIONS

5.1 General

All transformers and switchgear containing oil volumes greater than 1,000 litres shall be located within a bund to contain any oil spillage in the event of a tank rupture or leak. The bund shall be properly sealed to prevent any oil leakage to the surrounding ground.

Oil containment bunds shall be in accordance with AS 1940:2004.

All exposed metal components (ferrous articles), including items such as pipes and cable ladder supports, shall be hot-dip galvanised in accordance with AS/NZS 4680:2006. The coating thickness shall be a minimum of 85 microns (equivalent to an average coating mass of 600 g/m²).

¹ AS 3799 – Liquid Membrane – Forming Curing Compounds for Concrete

The oil containment bunds shall be designed to provide adequate room to carry out maintenance on the power transformer or other assets. The design engineer shall make certain that this requirement is met by designing the bund to suit the physical orientations of the assets that will be installed.

Oil containment bunds shall be designed and certified by a chartered professional Structural Engineer on the National Professional Engineers Register (NPER).

Stormwater pipes shall not be located inside the bunded areas.

There shall be no interconnecting pipes between bunds. However, where bunds are connected to an interceptor tank, flame traps shall be used to prevent the spread of fire between the bunds and to the adjacent interceptor tank (refer to clause 5.3.3).

In situation of a catastrophic failure of a power transformer, the oil containment system shall reduce the risk of fire spreading beyond the site by containing the oil in the bund and/or by providing quick draining of the oil into the interceptor tank. The information on total quantity of oil anticipated to be contained within an oil containment system (bund) is available on the power transformer name plate. The total volume of oil in a power transformer is the summation of oil (in litres) in the main tank, cooling radiators, tap changer and the oil conservator.

5.2 Treated water discharge and regulatory requirements

Under all operating conditions, the treated water discharge from an oil containment system shall meet all regulatory and environmental requirements, and it shall not exceed the free and dissolved hydrocarbon concentration of 10 mg/l². There shall also be no visible sheen in the discharge.

Treated water discharge from the oil water separator shall not be directly connected to stormwater system leaving the substation premises as indicated in clause 5.6.2.

5.3 Oil containment designs

5.3.1 General

Oil containment designs for transmission and zone substations shall use an individual active oil-water separator, in accordance with clause 5.3.2, or an interceptor tank with a gravity oil-water separator system, in accordance with clause 5.3.3.

The design and location of the oil containment system shall take into consideration site constraints and site specific environmental risks together with an assessment of a Life Cycle Cost (LCC) analysis. The LCC analysis shall capture all site specific capital costs and include operation and maintenance (O&M) costs that accurately reflect the activities required to maintain the functional performance of the equipment.

The design of the oil containment system shall consider all relevant HS&E requirements for construction, operation and maintenance. The design shall cater for complete requirements for construction of power transformer footings and plinths. An environmental impact assessment will be prepared for this work.

The Network Environmental Assessment section shall be responsible for carrying out the environmental impact assessment.

² Disposal limits for treated surface water discharge adopted by various utilities

The environmental impact assessment shall be reviewed and endorsed by the Network Environmental Assessment Manager and Manager Project Development for regulatory compliance. Refer EMS 0001 - Environmental impact assessment and environmental management plans. The final design of the oil containment system shall be approved by the Network Substations Manager upon review of the provided environmental and fire risk assessment and LCC analysis.

The oil containment design shall take into consideration all current regulatory requirements and include environmental, local council and water authority requirements that are specific to the site.

Following completion of construction a final environmental risk assessment will be undertaken by the relevant Environmental Business Partner from HS&E for the site to review and address outstanding environmental risks and to confirm compliance to all pertinent standards.

5.3.2 Transformer bunds with individual oil-water separator

Active oil-water separator design utilises an individual oil-water separator unit for each bund, as shown in Figure 1.

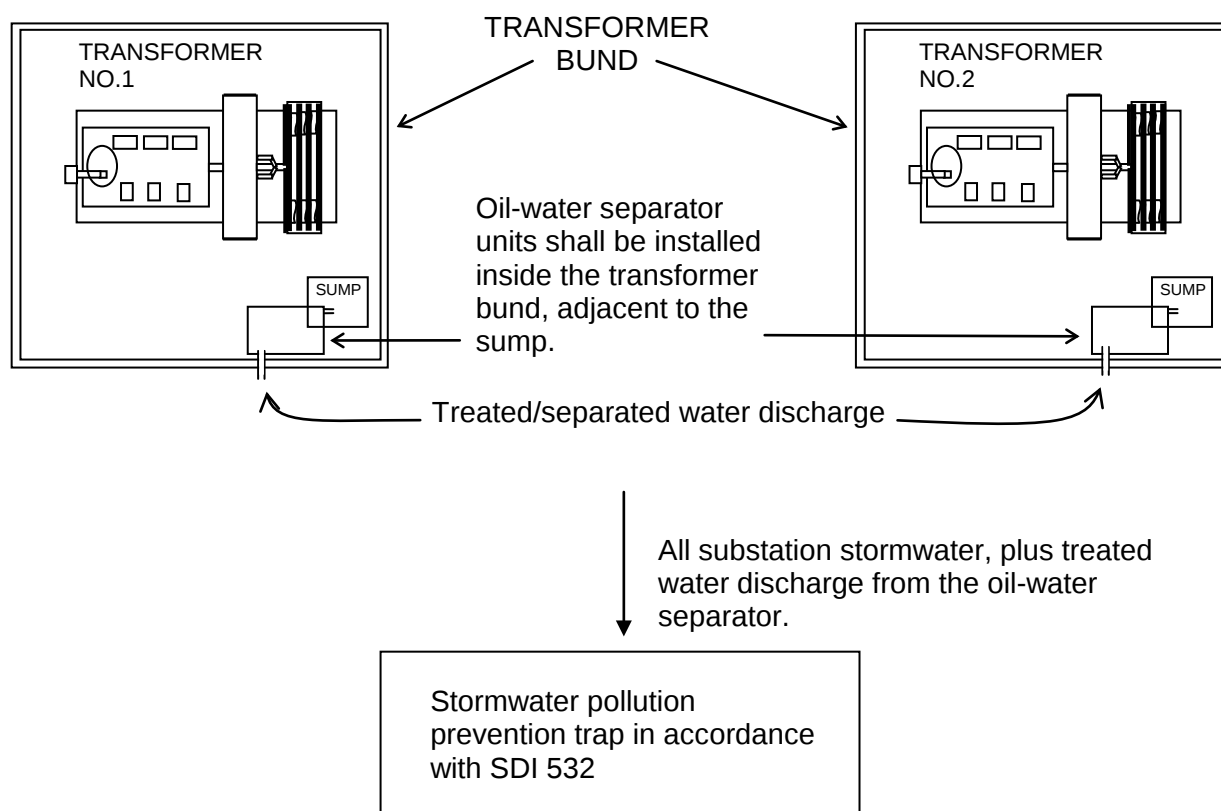


Figure 1: Typical two (2) transformer bund with oil/water separator systems

Note: Transformer oil containment bunds having individual oil/water separators are the least cost to build, therefore, an LCC analysis is not required for this design.

5.3.2.1 Sump drainage arrangements

The bund sump shall be drained by an automatic pump into an active oil-water separator system in accordance with clause 5.6.4.

5.3.2.2 *TX control panel door clearance*

A minimum clearance of 1,000mm shall be provided between the fully open control panel door edges and to the bund wall or steps, to allow staff to pass unobstructed.

5.3.3 *Transformer bunds connected to an interceptor tank with gravity oil-water separator system*

This type of design allows all liquid collected in the transformer bunds to be continuously drained to an interceptor tank with a gravity oil-water separator, as shown in Figure 2.

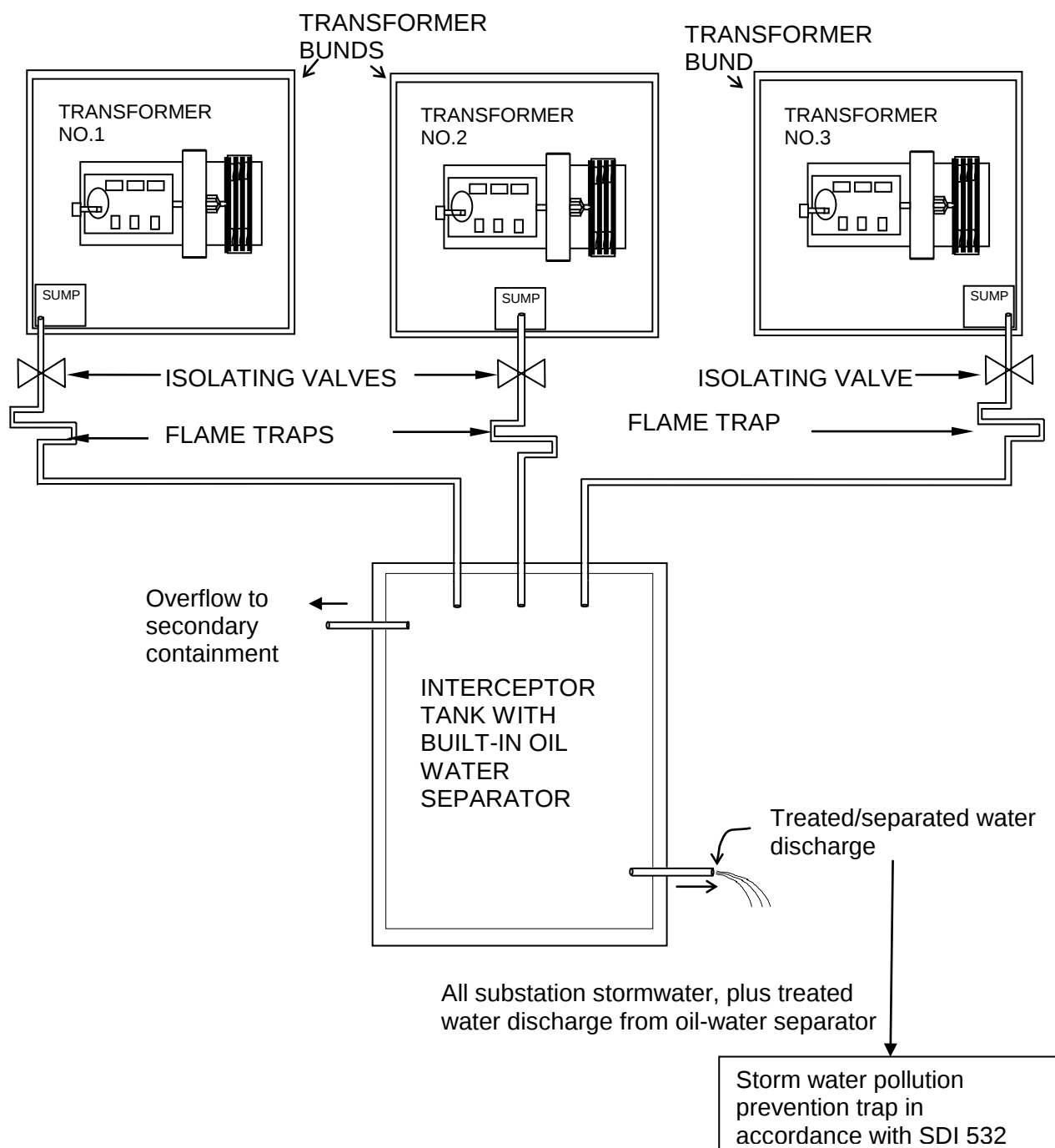


Figure 2: Typical three transformer bund connected to an interceptor tank

The design shall not allow substation stormwater to flow into the interceptor tank or into the bund.

This design is generally recommended for substations where there are no space restrictions. However, the design and location of the oil containment system shall take into consideration site constraints and site specific environmental risks together with an assessment of a Life Cycle Cost (LCC) analysis. Refer 5.3.1.

There shall be no common pipelines between bunds.

The interceptor tank shall be located away from transformers, buildings and outdoor switchyard equipment.

The design of the tank shall incorporate facilities for inspection and cleaning.

The interceptor tank shall be easily accessible for connecting a mobile tanker to pump out the collected liquids.

5.3.3.1 Isolating valves

Provision shall be made to allow the gravity oil-water separator discharge to be manually closed by an isolation valve at the tank outlet upon the application of firefighting water.

The isolating ball valves shall be made of corrosion resistant metal.

Valves shall be 100mm NB.

The valves shall not be buried. They shall be placed in pits to allow easy access for operation and maintenance. The isolating valves shall be lockable and capable of being locked in either the open or shut position using a padlock.

Valves are normally kept in the open position and signage shall be provided to indicate this requirement. Signage at each valve shall read: *Valve Normally Open*.

5.3.3.2 Flame traps

Flame traps shall be U-shaped where they connect to the isolating valve and they shall be suitable to match the pipe's 100mm NB. Material used for flame traps shall be hot dipped galvanised steel.

5.3.4 Bund capacity

The capacity of the bund shall have a minimum volume of 1.5 times the transformer oil volume or 100% capacity of the transformer oil volume plus the volume of rain water collected in a one in 20-year (24 hour storm in that location), whichever is the greater.

Bund designs shall accommodate future needs by allowing for the largest anticipated transformer that could be installed at the site. Listed below are the typical minimum oil volumes for various transformer ratings. The oil holding capacity of a bund shall consider all structures that will become integral part of the oil containment such as plinths, concrete steps or stair cases, concrete cable entry aprons or similar.

Minimum typical TX MVA and voltage ratings	Typical oil volumes (litres)
25 MVA (33/11kV)	15,000
25 MVA (66/11kV)	20,000
35 MVA (66/11kV)	22,000
60 MVA (132/11kV)	47,000
120 MVA (132/33kV)	43,000

5.3.5 Bund wall height, spray screens, steps and stair cases

All bund containment walls shall be installed as set out in clause 5.8.3 of AS 1940:2004 - Crest Locus Limit.

5.3.5.1 Spray screens for oil spray discharge

The use of spray screens is not preferred, however where the crest locus limit cannot be practically met, spray screens can be installed.

Spray screens near the transformer radiators shall be louvered to allow adequate air flow around the radiators and they shall be removable to allow easy access for maintenance.

All bund walls and spray screens shall be positioned so that they do not restrict the safe movement around the transformer, and they shall maintain at least one metre clearance from the external edges of any part of the transformer.

5.3.5.2 Bund wall steps

Bund walls over 450mm in height shall have two sets of bund steps to enter and exit the bund. The steps shall be mirrored on each side of the bund wall.

Bund wall steps, with handrails, shall comply with AS 1657:2013.

Steps shall be positioned in areas that are clear and safe within and around the bunds. For example, steps shall not be installed in areas where overhead hazards exist, such as high voltage conductors, or in a position where a person exiting the bund could walk onto the transformer runway/access road and risk being struck by a vehicle.

Generally, steps should be positioned away from equipment both inside and outside the bund and they shall be clear from items such as cable trenches.

The two sets of bund steps shall be installed diagonally opposite. Where this is not practical, the two sets of bund steps shall be alternatively positioned as far apart as possible.

The horizontal surface of each step shall be made non-slip by brushing the steps before the concrete cures.

Steps shall be provided with at least one handrail, which shall have a smooth continuous top surface throughout its length.

To allow staff to safely carry tools and other heavy objects over the stairs, the width of the steps shall be a minimum of 1,000 mm, with a tread width of 300mm, as indicated in Annexure 1 - Bund construction details, Figure 1.

5.3.5.3 Stair cases

Where power transformer bunds FFL's are below driveway levels, hot dipped galvanised steel stair cases can be installed to access bund area. The design engineer shall measure physical height required for the construction of the stair case. The stair case assemblies shall be constructed from hot dipped galvanized steel. The width of step shall be minimum 1,000mm and tread width shall be 300mm.

Where oil containment bunds are accessed through control building, stair cases or concrete steps can be installed to access the bund area.

5.3.6 Bund floor

The floor of each bund shall be sufficiently raked and sloped to drain all liquid into the sump.

The floor surface shall be made non-slip by brushing the floor surface before the concrete cures.

5.3.7 Bund sump

Each bund shall be fitted with a sump that allows the collected liquids to be pumped out. The bund sump shall be located at the lowest point on the bund floor. The nominal sump dimensions shall be 600mm square and 600mm deep. The sump shall be covered with a grate, installed flush with the bund floor, so that it can be walked on safely.

The sump grate shall be made of hot dipped galvanised steel, flat bar (for example 25 x 4.5mm) in a grid like configuration as an example 20mm gaps. In order to prevent leaf penetration a perforated mesh or grill shall be installed atop the grate.

The hot dipped galvanising coating thickness for sump grate shall be in accordance with section 5.1.

The grate along with the perforated mesh or grill shall be easily removable to allow sump cleaning.

5.3.8 Transformer fire walls

If fire walls are required, they shall not be built on top of the bund walls. Refer SDI 503 - Transmission and zone substation fire detection, control and suppression for design and construction of fire walls. The bund structure shall be independent from the fire walls and any other adjoining structures.

5.3.9 Transformer plinth and footing

Power transformer foundation and plinth are an integral part of the oil containment bund construction. Therefore, the oil containment bund design shall cater for complete requirements of the footing and plinth size, dimension considering capacity, gross weight and profile of the power transformer. The final plinth dimension values shall be incorporated into the overall containment capacity calculation. Concrete pour for transformer plinth foundations shall be independent from bund floor concrete pour.

5.4 New bund construction

5.4.1 General

New transformer bunds shall be constructed in a single pour by concreting the bund floor and walls at the same time (except for plinth foundations as mentioned in section 5.3.9). This method is required to minimise the likelihood of concrete shrinkage.

In situations where this is not practical, and two pours are required, the first pour of concrete shall be used to construct the floors, followed by the second pour to construct the walls. There shall be no cracks or gaps in the concrete between areas (that is, these shall be adequately sealed for all temperature and environmental variations).

In all cases care shall be taken to minimise concrete shrinkage.

When constructing bund walls and floors, a minimum of two rows of steel reinforcement shall be used at all times.

The bund walls, foundations and plinths (footings) shall be independent from all adjoining structures, including fire walls.

The ground shall be prepared in accordance with the design requirements and it shall be thoroughly compacted prior to the laying of sand, waterproof membrane (vapour barrier), reinforcement and concrete layers.

A 50mm bed of free draining coarse sand shall be laid. After laying the sand, a waterproof membrane shall be installed.

Bund floor reinforcement and concrete shall be laid on top of the waterproof membrane. This is to minimise the occurrence of oil seepage through the floor slab.

Reinforcement used in bunds shall be inspected prior to the concrete being poured.

5.4.2 Bund testing

After completion of the construction, the containment structure including all discharge channels and pipe work drainage shall be tested for leaks using water, in accordance with the testing methods specified in AS 3735:2001. Bund leak tests shall be witnessed and reviewed by a qualified structural engineer.

Any evidence of seepage of the test liquid to the outside faces of the bund shall be suitably rectified. Any remedial treatment shall be focused on the inside surfaces of the bund.

5.4.3 Concrete quality

The concrete quality shall be in accordance with AS 3600:2009 and the following specification:

Specification	Description
Type of cement	SL, as in AS 3972:1997
Concrete grade	32 MPa at the rate of 28 days compressive strength
Maximum aggregate size	20mm
Slump	80mm
Approved liquid proofing concentrate	Approved admix, applied in accordance with the manufacturer's instructions shall be used in the concrete mix to make it impervious to liquids such as oil and water.

The following methods shall be adopted during the concrete application:

Application method	Description
Compact concrete method	Mechanical vibrator
Curing of bunds	Curing as mentioned in AS 3799:1998 (PVA and wax products are not acceptable).
Floor and step finish	Floor to be brush finished.

The bearing pressure for transformer bund sub-grade shall be based on a geotechnical report and shall not be less than 100kPa (excludes transformer footing sub-grade bearing pressure).

5.5 Cable entry

5.5.1 Power cable entry requirements

The design engineer shall consider all factors that include the power transformer physical orientation and dimensions, maintenance and lifting requirements. A least risk-cost justified option shall be chosen for each of the power transformer cable entry options when designing oil containment systems at substation sites.

In order of preference, the detail below provides options for power cable entry to the power transformer.

5.5.1.1 Power cable entry from outside of the bund

Cables shall be supported on cable ladders fixed to supporting steelwork attached to the bund walls and floor, as shown in Annexure 2 - Cable entry/penetrations into bunds over basements, Figure 2.

The horizontal run of the cable ladder attached to the transformer main tank shall slope towards the transformer to prevent oil spills spreading along cables to outside of the bunded area.

5.5.1.2 Power cable entry from trench below bund floor

Power cable entry from the trench below the bund floor shall be in accordance with the bund construction drawings in Annexure 1 - **Bund construction details**.

Additional minimum requirements relating to the bund construction are as follows:

The cable trench shall be designed and constructed to suit the transformer cable box position and orientation. In the design stage, positioning of future or spare power transformer cabling orientation shall also be taken into consideration.

The trench can be constructed in one or two pours. Where two pours are used, the first pour of concrete shall be used to construct the trench floors, followed by the second pour to construct the trench walls.

The design shall prevent liquid spreading through conduits or cable penetrations.

The design shall also allow for future power cable upgrading.

Cable conduits, with bell mouth openings, shall be uniformly spaced in accordance with the design before pouring concrete in the trench walls at the basement entry points.

The trench design shall be such that it will **not** become a confined space for staff who will carry out manual handling and pulling of power cables. The trench design shall have the following requirements:

After laying and installing the cables, the trench shall be completely filled with clean fine grain sand, required to fill all voids around cables and to aid in dissipating the heat produced by the cables. The sand shall be capable of passing the sieve test in accordance with the following table³:

Sieve aperture size	Expected % passing through
4.75 mm	100
2.36 mm	> 90
1.18 mm	> 88

Cable de-rating shall be calculated for the back fill material in accordance with MDI 0046 - **Transmission underground cables-continuous current ratings**.

A 15MPa concrete domed lid cover shall be constructed to surround the cables above the trench opening, as shown in Annexure 1, Figure 1, sections B-B and C-C.

5.5.1.3 Power cable **direct** entry from basement

Cable entry from a basement shall be in accordance with Annexure 2 - **Cable entry/penetrations into bunds over basements**, Figure 1, and clause 5.5.2.

5.5.2 Control cable entry

Control cable entries shall be designed and constructed to suit the transformer control cable box entry position and orientation.

³ - AS1141.11-2009: Method for sampling and testing aggregates - Particle size distribution - Sieving method

A concrete apron shall be constructed to encase the conduits on the top of bund floor in accordance with Annexure 1 - Bund construction details. Figure 1, section D-D.

The height of the apron shall be marginally higher or of the same height as that of the finished bund wall. However, this height doesn't always suit power transformer control cabinet box bottom height. To resolve this, the bund designer shall confirm height of the control cabinet from Senior Engineer, Transmission Substation Equipment or the Project Manager.

5.5.3 Fire stopping ⁴ (sealants)

All openings, such as joints, conduits and penetrations within the bund area, shall be sealed with fire stopping sealant having the following minimum properties:

Properties/characteristics	Description
Fire rating	4-hour fire rating ⁵
Imperviousness to insulating oil	Resistant to degradation from contact with transformer insulating oil.
Service temperature - continuous	-40 deg. C to +60 deg. C
Resistant to	Water, solvents, fuels and mineral oils
UV rating	UV stable

Note: Above properties/descriptions of fire stopping are minimum required. However, where a fire stoppings of these properties/descriptions are not available, use chemical resistant Sikaflex-Tank or similar.

Bell mouth conduit ends inside the trench shall be suitably sealed after the cable installation to prevent ingress of liquids and/or sand.

The fire stopping sealant shall be applied in accordance with the manufacturer's instructions.

5.5.4 Earthing of steel reinforcement

Steel reinforcement mesh joints shall be electrically continuous and shall be earthed in at least two locations to the nearest available main earth grid point, in accordance with EDI 516 - Major substation earthing design, construct and commissioning.

5.6 Oil-water separator

5.6.1 General

The oil-water separator shall be approved by the Office of Environment and Heritage (OEH) and the Environment Protection Authority (EPA) NSW. The oil/water separator can be passive or active.

Refer to clause 5.2 for allowable water discharge limits.

⁴ AS 4072.1:2005 – Components for the protection of openings in fire-resistant separating elements Part 1- Service penetration and control joints

⁵ AS 1530.4: Methods for fire tests on building materials, components and structures - Fire-resistance test of elements of construction

5.6.2 Oil water separator discharge

The discharge pipe from the oil-water separator shall drain the separated/treated water onto the bare ground or gravel. Where this cannot be achieved, and discharge can be made only onto a hard surface, such as concrete, the separated/treated water shall be discharged into the ground at a minimum depth of 450mm, in accordance with Annexure 3 - Discharge arrangement for restricted sites where switchyard gravel surface is not available next to the bund and Drawing no. 364162.

Ground or gravel surface at the discharge point shall be compacted and set to establish no ponding of water occurring at that location.

The pipe NB shall be no less than the inside diameter of the discharge weir pipe.

The discharge pipe shall not be located within 10m of stormwater drainage points and the discharge shall not run directly into areas including stormwater pits, substation gutters, culverts and adjacent properties.

In substations, where there is space or surface restriction for laying gravel or blue metal in empty yard, a suitable discharge system for the oil water separator will need to be designed and approved by Transmission Civil Development Manager in consultation with the Network Substations Manager.

5.6.3 Passive oil-water separator

A passive oil-water separator comprises an underground gravity-fed oil separator tank consisting of several effluent separating chambers. This type of oil separator shall have:

- a life expectancy of at least 50 years;
- low maintenance;
- interceptor tank capacity as specified in clause 5.3.4: and,
- all required maintenance access covers shall be at ground level and shall be air tight.

The overflow from the oil separator tank shall be directed to a secondary containment area. The form of secondary containment can vary depending on the site locations, site constraints and the environmental constraints.

When designing secondary containment, all environmental risks shall be considered and included in the environmental impact assessment. Refer to EMS 0001 - Environmental impact assessment and environmental management plans.

5.6.4 Active oil-water separator

5.6.4.1 General

An active type oil-water separator shall consist of a tank equipped with oil-water separating chambers, strainers and an automatic pump system. The complete assembly shall be constructed from stainless steel.

The active type oil separator tank shall be:

- capable of holding a minimum of 200 litres of liquid;
- fitted with a cut-off switch (with remote indication), that stops the pump when full of oil; and,
- equipped with a manual dipstick and a 50mm NB drain pipe at the base of the tank, fitted with a 25mm ball valve.

The active oil separator shall have a manual override switch for pump operation, as required.

This type of separator shall use a single pump, have a minimum treatment capacity of 1000 litres/ hour, and have customised features to meet Endeavour Energy's requirements. The separator shall be suitable for use with PCB contaminated oil.

5.6.4.2 Location

The location of the active oil-water separator unit shall not cause interference with persons carrying out their duties, and it shall not affect the functionality of the substation.

The oil-water separator unit shall be installed inside the transformer bund, preferably adjacent to the bund sump.

Where practical, the separator unit, including the control panel, should be orientated to allow ready access by a person standing either outside or inside the bund.

Where power transformer bunds FFL's are below driveway levels or bunds with explosion walls around them, the control panel for the oil-water separator unit shall be located such that it can be accessed without entering into the bund.

Where practical, the oil-water separator unit shall be positioned so that any open valves drain back into the bund.

5.6.4.3 Control panel and motor/gearbox/pump unit

When installing the separator, the control panel base plate and the tandem motor/gearbox/pump arrangement shall be above bund wall height. This is to prevent the equipment flooding in the event of a full bund.

A cover shall be provided on the motor/gearbox/pump unit to protect it from the elements. The cover shall be designed so that it can be easily removed and replaced.

5.6.4.4 Power supply

The power supply to the oil separator system shall be through a dedicated supply from the substation AC panel. In the event of a major oil loss, the power supply to the separator shall be disconnected by a multi-trip relay operation. This is to minimise the possibility of contaminated water discharging beyond the bund area.

A 240V AC, 15Amp, IP class 55 power outlet shall be provided adjacent to the separator for maintenance purposes, in accordance with SDI 511 - Auxiliary AC supplies and switchgear.

5.6.4.5 Level sensors

Bund sump level sensing shall use float switches. The float switch cord shall have sufficient length to allow adjustment of the float switches. The following typical float switch settings are required:

Float switch settings	Description of settings
High-level bund alarm	at 50% of bund wall height
Pump cut in	at 50mm below sump grate level
Pump cut out	at 250mm below sump grate level

5.6.4.6 SCADA alarms

SCADA shall be used to communicate a common alarm condition for bund high liquid level, separator oil containment tank full, and loss of power supply to the separator pump.

The high-level alarm shall be activated by a float switch when the liquid level reaches 50% of oil containment wall height.

The common alarm shall be provided at the RTU and at the master station.

5.6.4.7 Earthing

The separator support frame shall be earthed to the substation's main earth grid, in accordance with EDI 516 - Major substation earthing design, construct and commissioning. A dedicated 12mm clearance hole shall be provided for this purpose.

Where required, the earthing conductor shall be neatly saddled over its length to eliminate the likelihood of persons tripping over the conductor.

5.6.4.8 Oil collection tank

The separator oil collection tank drain valve shall be fitted with a *camlock* fitting.

5.6.4.9 Suction pipe

The pump suction pipe shall be set so that when the pump cuts out, the open end immersed in the sump is flooded by at least 25mm.

5.6.4.10 Footings

The separator shall be levelled such that the oil skimmer that drains oil to the collection tank functions correctly. To enable the levelling of the separator, the footing and/or legs shall be adjustable.

5.7 Existing bund modification

Existing bunds, with bund volume storage capacity less than that specified in clause 5.3.4, shall be modified and rebuilt as required to meet the requirements of this Standard. These bunds shall be identified and recommended for renewal under the Strategic Asset Renewal Plan SARP.

Existing bunds that have equalising pipes shall be modified to comply with this Standard.

Existing bunds with minor defects in areas such as joints, conduits and cable penetrations shall be sealed using a suitable sealant, as indicated in clause 5.5.6.

5.7.1 Sealing existing bunds of brick construction

Existing bunds of brick construction shall be sealed by pouring an inner concrete bund inside the existing bund by using the existing brick walls as formwork. The application of a sealant for this purpose is not acceptable.

5.7.2 Existing bunds with sumps

Existing bunds that have a functional sump and oil/water separator system, with an associated bund drainage system, shall continue to be used.

5.7.3 Existing bunds without sumps

All bunds fitted with a separator shall have a sump. However, if a sump cannot be practically installed, the amount of water retained in the bund shall be minimised. Provision shall also be made to allow safe and dry staff access to the transformer by means such as walking grates.

5.8 Bund maintenance water tap with RPZD ⁶

A water tap fitted with a RPZD, connected to the mains water supply, shall be installed in close proximity to the oil containment bunds in accordance with SDI 532 – Plumbing and drainage. The location of the water tap shall be in an easily accessible position to allow maintenance on the bunds and oil-water separators.

6 AS/NZS 3500.1:2003 – Plumbing and drainage Part 1 – Water services

5.9 Drawings

All bund drawings shall be prepared and certified by a chartered professional Engineer on the National Professional Engineers Register (NPER). Refer SDI 515 – Drawings, for approval and storage of installation/construction drawings.

6.0 AUTHORITIES AND RESPONSIBILITIES

Chief Engineer has the authority and responsibility for approving this instruction.

Manager Primary Systems has the authority and responsibility for making recommendations to the Chief Engineer in respect to this instruction.

Network Substations Manager, Primary Systems has the authority and responsibility for updating this instruction based on industry best practice and in accordance with Endeavour Energy policies and procedures.

All **Endeavour Energy employees and/or contractors** have the authority and responsibility for:

- complying with the requirements of this instruction and that of SDI 505;
- working in accordance with local and statutory requirements;
- conforming with the safe design practices to manage public and worker safety; and
- working in accordance with Endeavour Energy's environmental guidelines and Endeavour Energy's Electrical Safety Rules.

Manager Project Development has the authority and responsibility for:

- designing each of the oil containment system designs in a safe manner and to comply all relevant with regulatory, environmental, local council and water authority requirements;
- preparing, reviewing and endorsing an environmental impact assessment for the oil containment system in accordance with the requirements of this standard;
- verifying that the Endeavour Energy employees and/or the contractors engaged to perform the work have appropriate qualifications;
- complying with the requirements of this instruction; and
- overseeing the work performed at site is carried out in accordance with local and statutory requirements.

Safety and Environmental Services has the authority and responsibility for undertaking safety and environmental risk assessment following the completion of oil containment construction works.

Project Manager has the authority and responsibility for construction of the oil containment system that complies with the plan and design works prepared by Project Development and this standard.

7.0 DOCUMENT CONTROL

Documentation content coordinator: Network Substations Manager, Primary Systems

Documentation process coordinator: Standards Process Coordinator

Annexure 1: Bund construction details

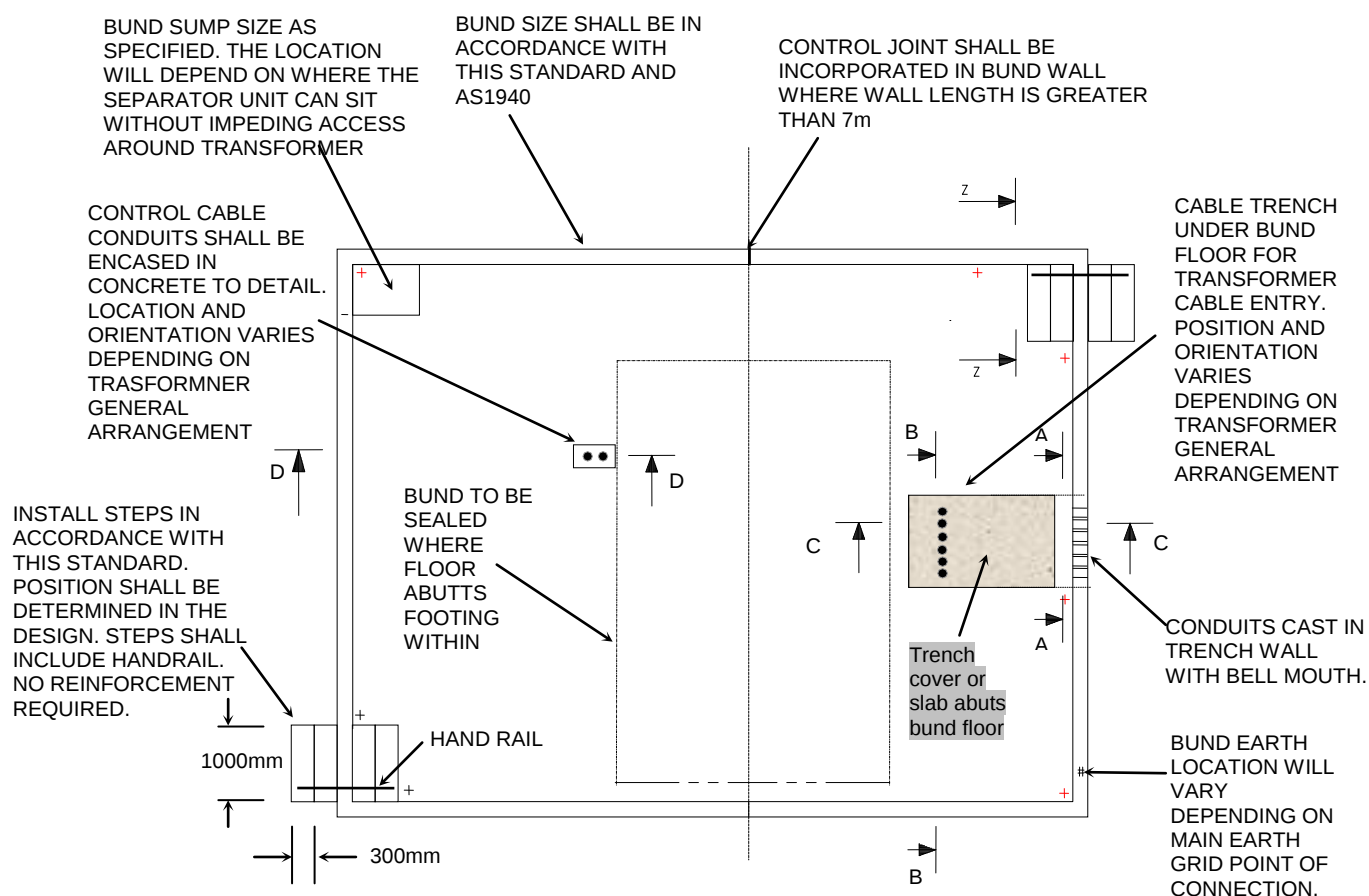
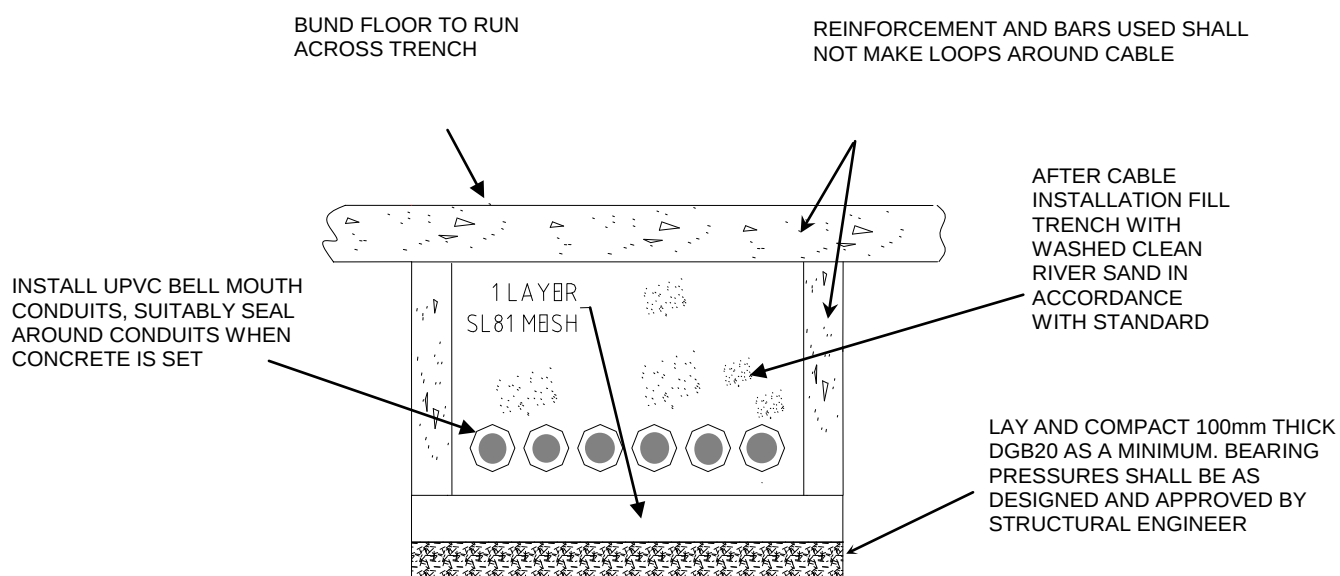
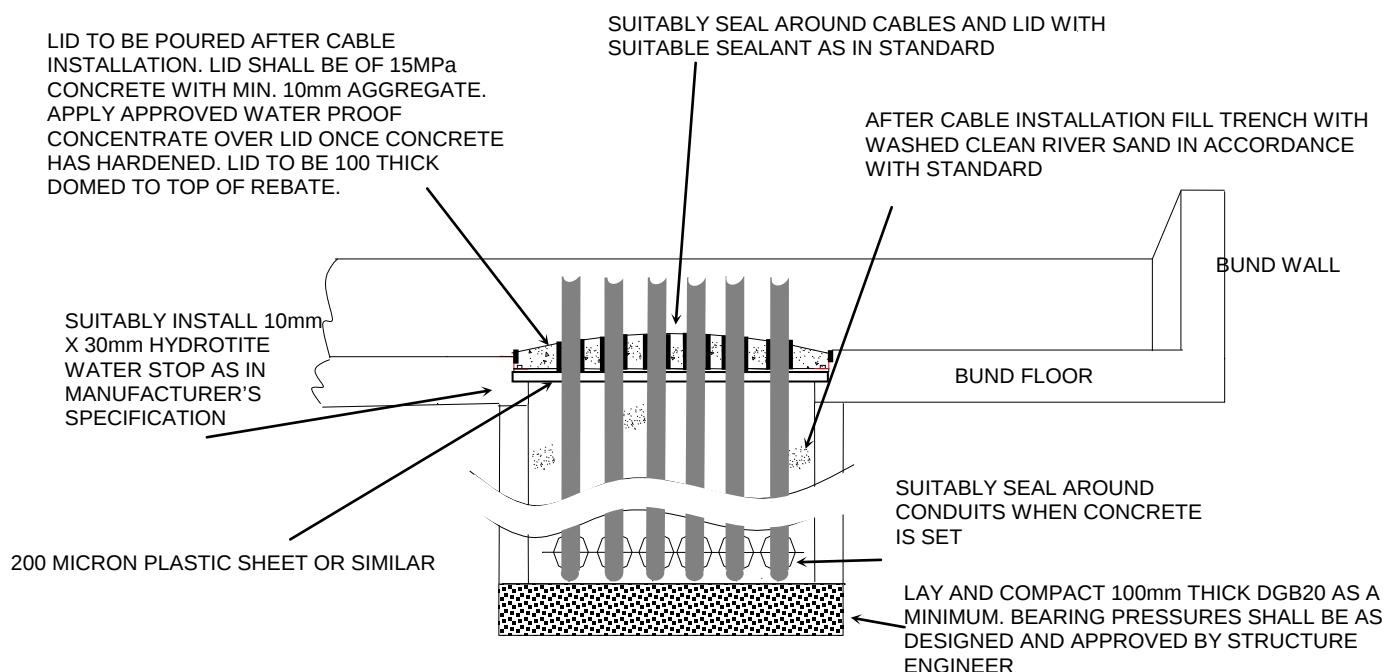


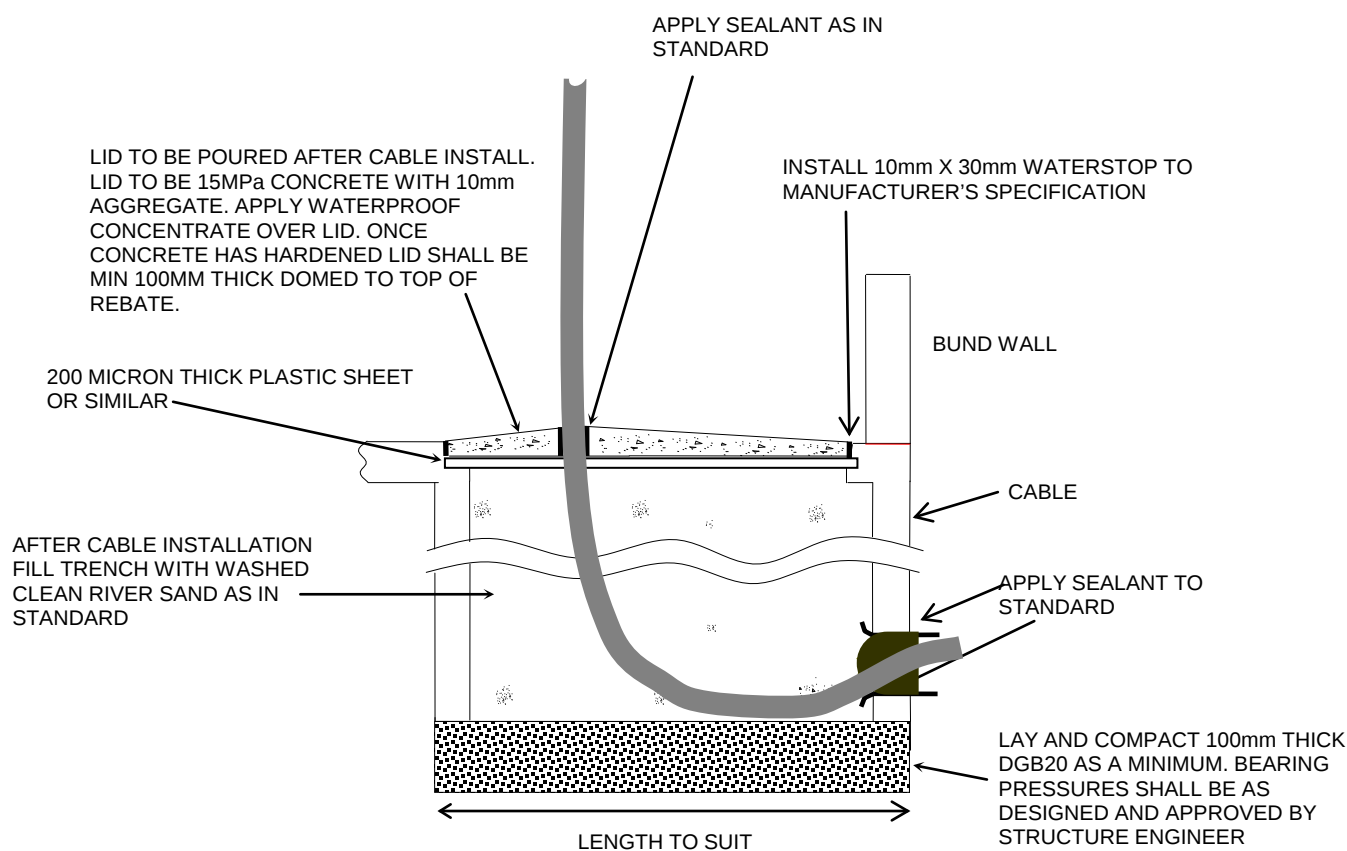
Figure 1: Transformer bund plan view - conceptual
 (assuming transformer is of HV bushings and LV cable box design)



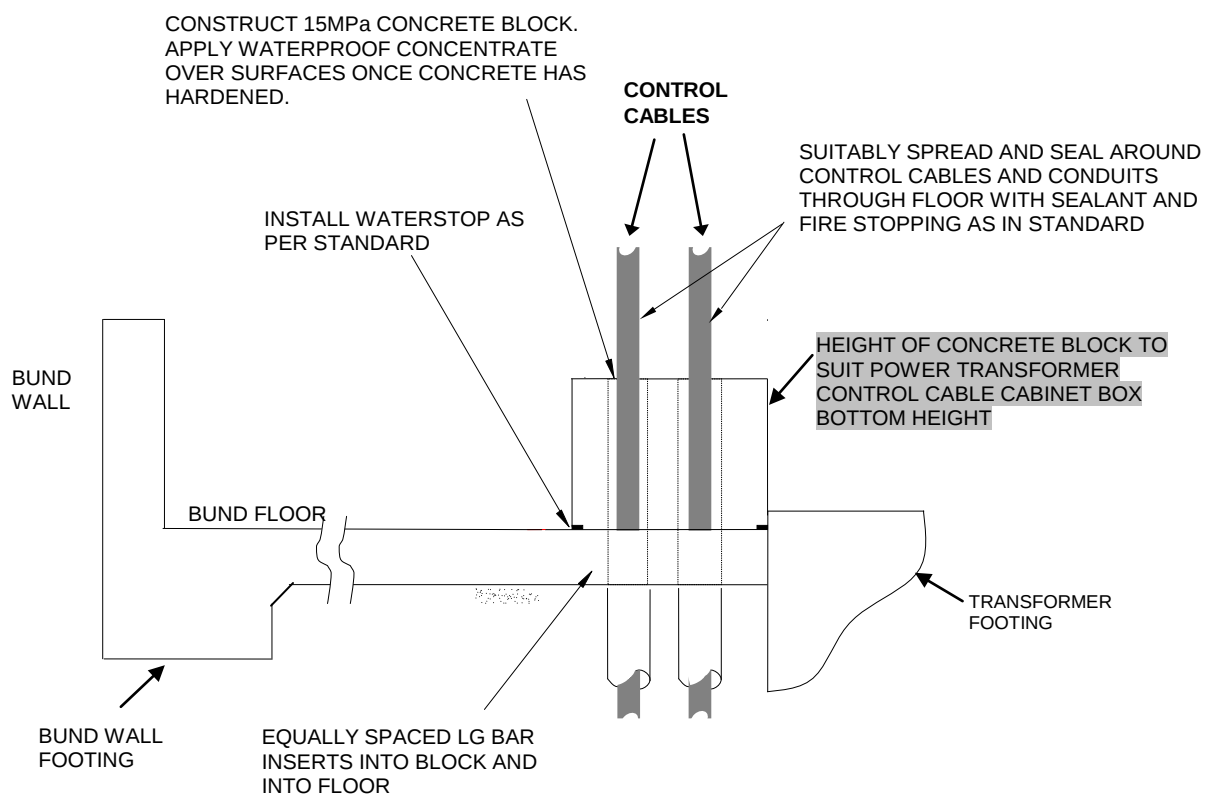
Section A-A: Power cable trench sectional view (reinforcement not shown)



Section B-B: Power cable trench sectional view without bund wall (reinforcement not shown)



Section C-C: Power cable trench sectional view without bund (reinforcement not shown)



**Section D-D: Control cable concrete block sectional view
(reinforcement not shown)**

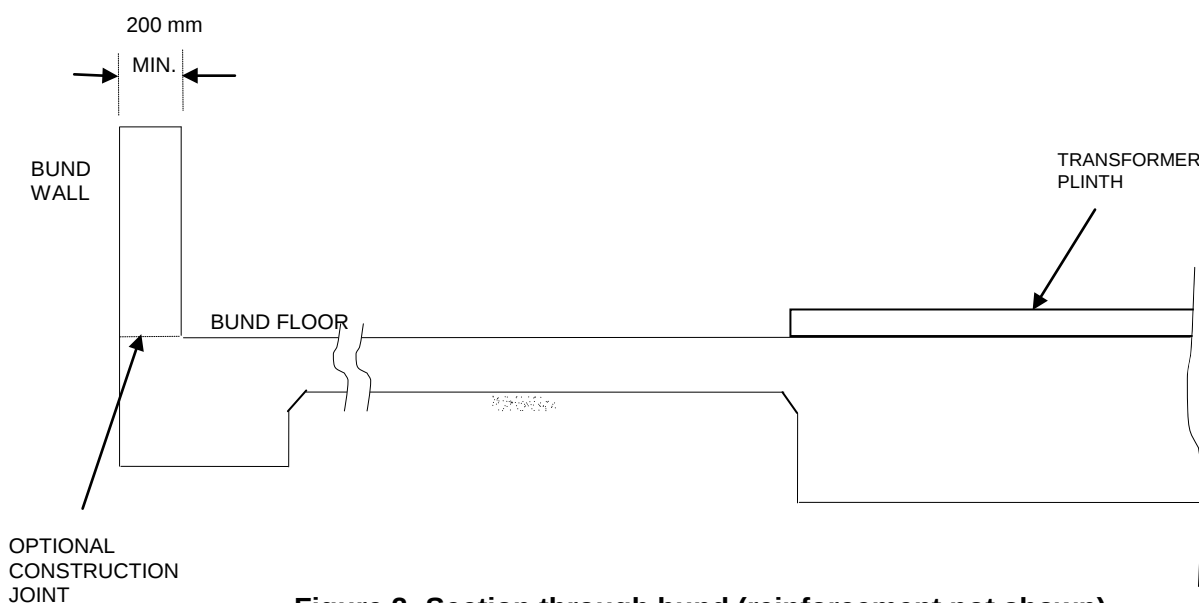


Figure 2: Section through bund (reinforcement not shown)

Annexure 2: Cable entry/penetrations into bunds over basements

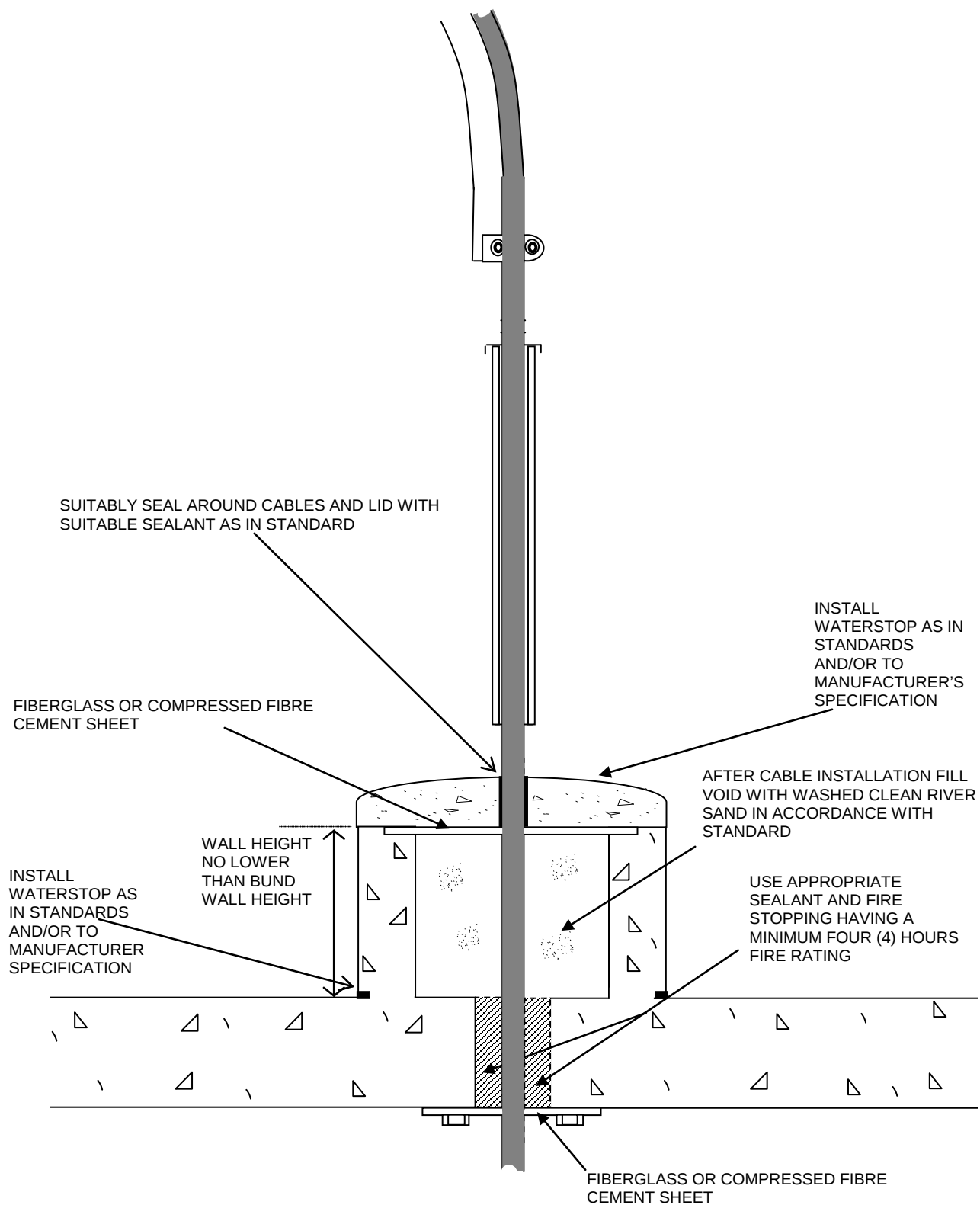


Figure 1: Sectional view cable entry/penetrations into oil containment bunds built over basements (reinforcement not shown)

Annexure 2: cont.

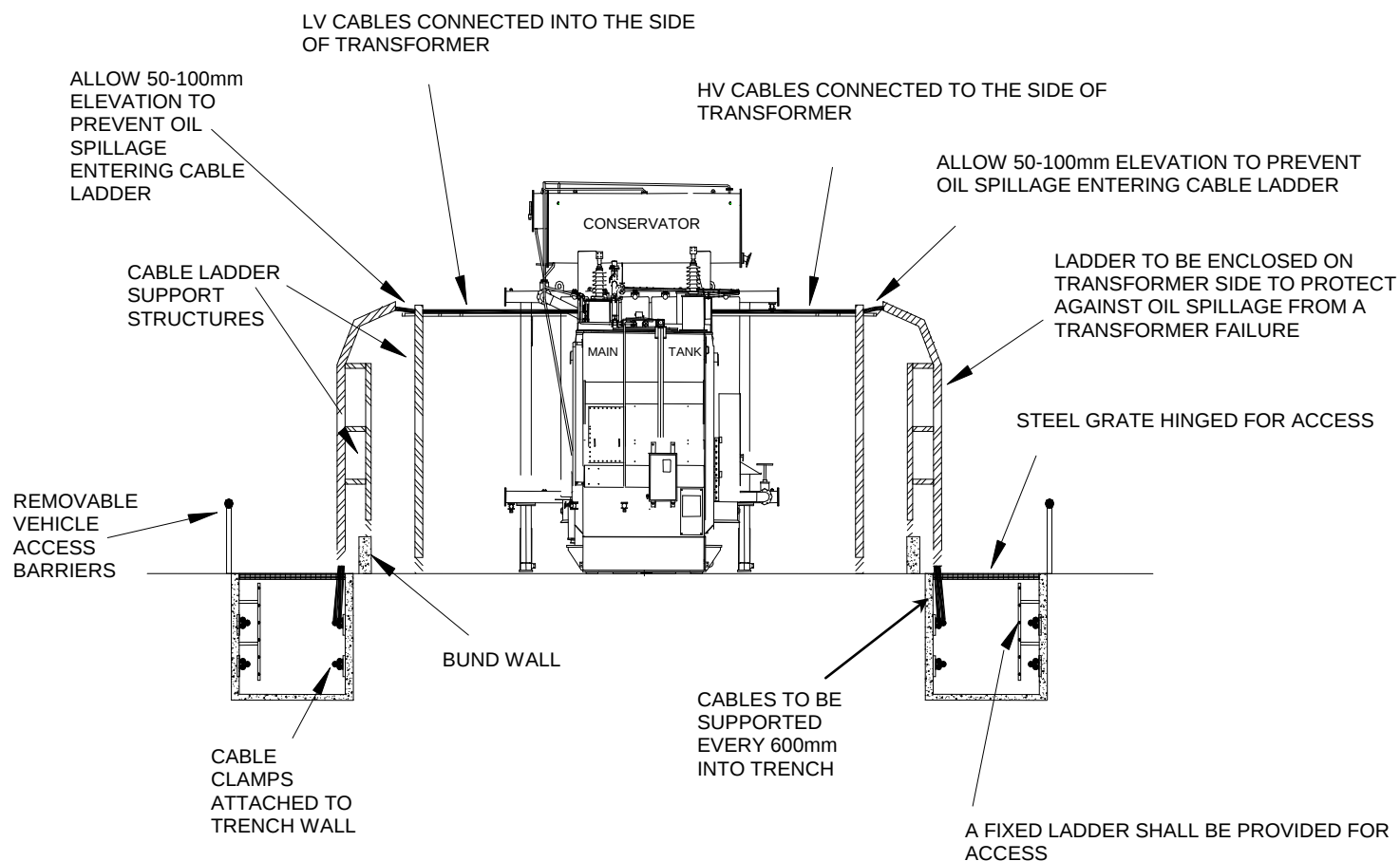


Figure 2: Transformer with elevated HV and LV cable connections

Annexure 3: Discharge arrangement for restricted sites where switchyard gravel surface is not available next to the bund

