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Part 1: Creative Solutions to Secondary Containment at Electrical Substations

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Oil-filled, substation transformers are used in electric power substations and in a wide variety of commercial and industrial applications

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PART 1

An electrical substation is an integral part of an electrical generation, transmission and distribution system. Substations transform voltage from high to low, or the reverse, or perform any of several other important functions. Between the generating station and consumer, electric power may flow through several substations at different voltage levels.

A substation may include transformers to change voltage levels between high transmission voltages and lower distribution voltages, or at the interconnection of two different transmission voltages.

Electric power substations store insulation (dielectric) oil in transformers and other electrical equipment (i.e. oil circuit breakers, capacitors, regulators, etc.).

Because of this, environmental rules and regulations for electric power substations can be strict. For instance, the United States Environmental Protection Agency (EPA) Spill Prevention Control and Countermeasure (SPCC) rules require containment of the operating areas of a substation to prevent oil spills and contaminated runoff from reaching storm drains, streams, rivers, bays and other navigable waters.

National Pollutant Discharge Elimination System (NPDES) permits are required for any oil containment area discharging to stormwater drainage systems. Current discharge requirements may be as low as 10 mg/L for oil and grease or below the level of visibly free oil and grease (i.e. no visible sheen). Sewer Pretreatment Regulations also require a permit for oil containment areas discharging into a sanitary sewer. Although the discharge requirements may be higher, these permits are difficult to obtain and may have specific monitoring requirements.

In many cases national or local fire codes also require that these containment systems be designed to minimize the spread of fire within the substation or outside the operating areas so that any discharged oil will not create a hazardous situation to the public, neighboring buildings or equipment. As a result, proper secondary containment system design is essential to control oil contaminated drainage or leaks around electrical equipment and associated storage tanks, pipes, valves and fittings.

The Corella® oil/water separator is a stationary wastewater treatment tank, filled with water. It contains specially designed internal baffles and coalescers to accelerate the separation process.

The design of secondary containment systems varies as spills and leaks may occur during day-to-day operation of substations as well as in emergency situations. The substation most often uses poured concrete or protected steel dikes to provide secondary containment and control oil contaminated drainage. The dike storage is sized to retain all oil spills and/or firefighting operations, with a suitable margin (10%) for accumulated rainwater.

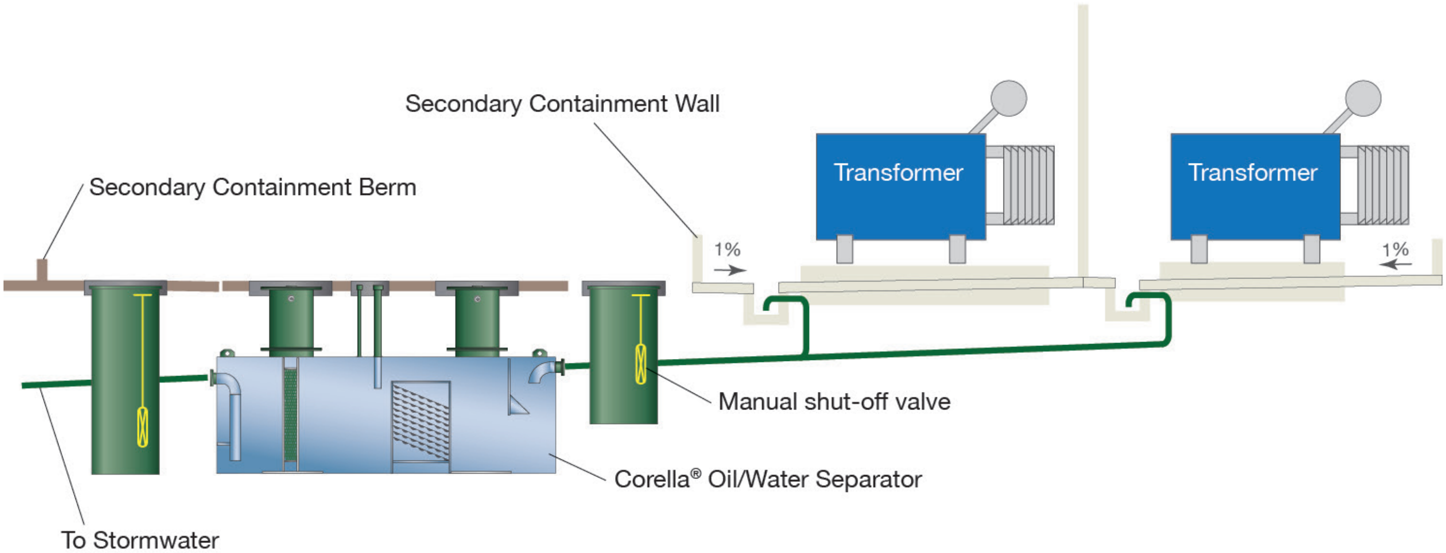
Unfortunately, these dike containment structures may accumulate significant amounts of water from rainwater. Also, snow melt and firefighting operations may actually overwhelm the storage capacity. Drain lines, which must be watertight, are usually installed through or over the dike walls and are used to drain this accumulated wastewater from the diked area. These lines are fitted with valves or other positive means of closure that are normally sealed closed and locked to prevent any oil discharges from escaping the diked area. These valves can be opened to drain the accumulated wastewater and resealed following drainage by trained and authorized facility personnel only.

Additionally, manual or automatically operated pumps may be employed to pump the wastewater over the dike walls. Diaphragm pumps are preferred in these applications as they minimize the mixing or blending of oil and water which results in emulsions that are difficult to separate in an oil/water separator.   Where a high flow rate pump is required (i.e. in association with a deluge system), a non-emulsifying screw pump may be used. However, these pumps are prone to seizing from debris and do not tolerate no flow conditions well, so careful pump lift station design is required.

Considerable effort is made to minimize the potential for rainwater to become contaminated with oil. But when rainwater does come into contact with oil, there creative solutions available to manage the resulting wastewater discharge and any potential oil contamination.

GRAVITY DRAINAGE SYSTEMS

Typical Gravity Drainage System

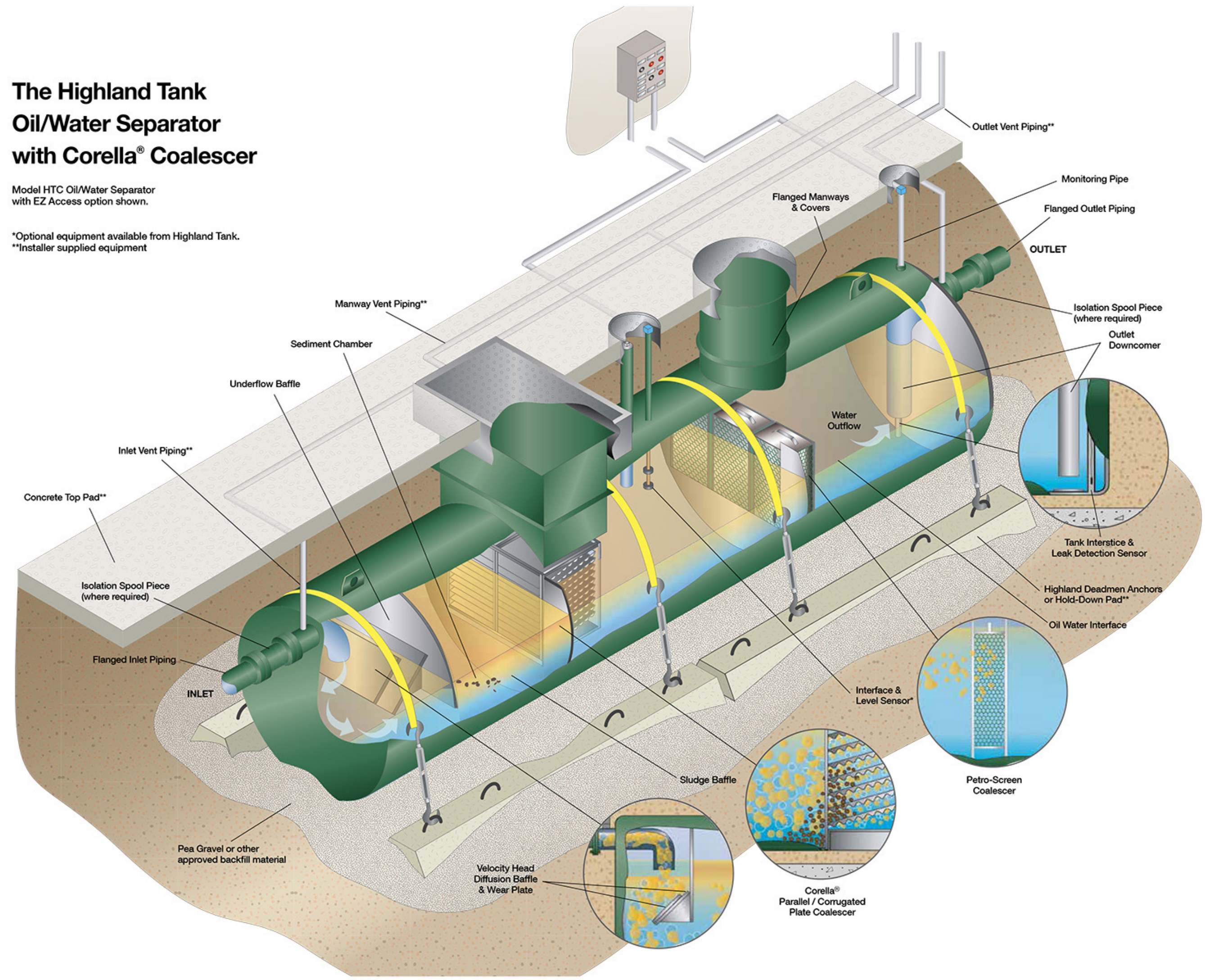


A gravity drainage system allows for any contaminated water to be drained to a Corella® oil-water separator to recover spilled oil and prevent a hazardous oil discharge to the environment. This arrangement is popular at remote locations where space is not an issue and emergency response and travel time are problematic.

As the name implies, for gravity drainage systems, all drainage is accomplished by gravitational flow where possible. Basically, the oil containment dike floor is sloped towards the trench drain or collection sump(s). The drain pipes, which are sized for the maximum rainfall rate or flow rate of the fire-fighting water, connect to a flame trap reducing the potential of any fire to spread outside the containment dike. Flow is then directed to a properly sized Corella® oil/water separator. The oil/water separator is sized for the maximum flow rate and is designed to retain 110% volume of oil from one transformer.

In operation, the drainage enters the inlet section of the separator and is directed against the velocity head diffusion baffle to reduce flow turbulence and to distribute the flow evenly over the separator's cross-sectional area. In the sediment chamber, heavy solids that have not been removed in the trench drains or collection sumps will settle out and concentrated oil will rise to the surface.

The oily water then passes through the Corella® coalescer, an inclined arrangement of stacked, parallel, flat and corrugated plates. The corrugated underside of the Corella® plates causes the oil to coalesce into sheets. The oil globules then rise to the surface of the separation chamber, where the separated oil accumulates. Any remaining solids sink to the top of the plates and slide off the plates to the solids collection area. This "self-cleaning" design solves the problem of extensive separator shutdown and maintenance by simultaneously separating free oil droplets and settleable solids from water, without clogging the coalescer.



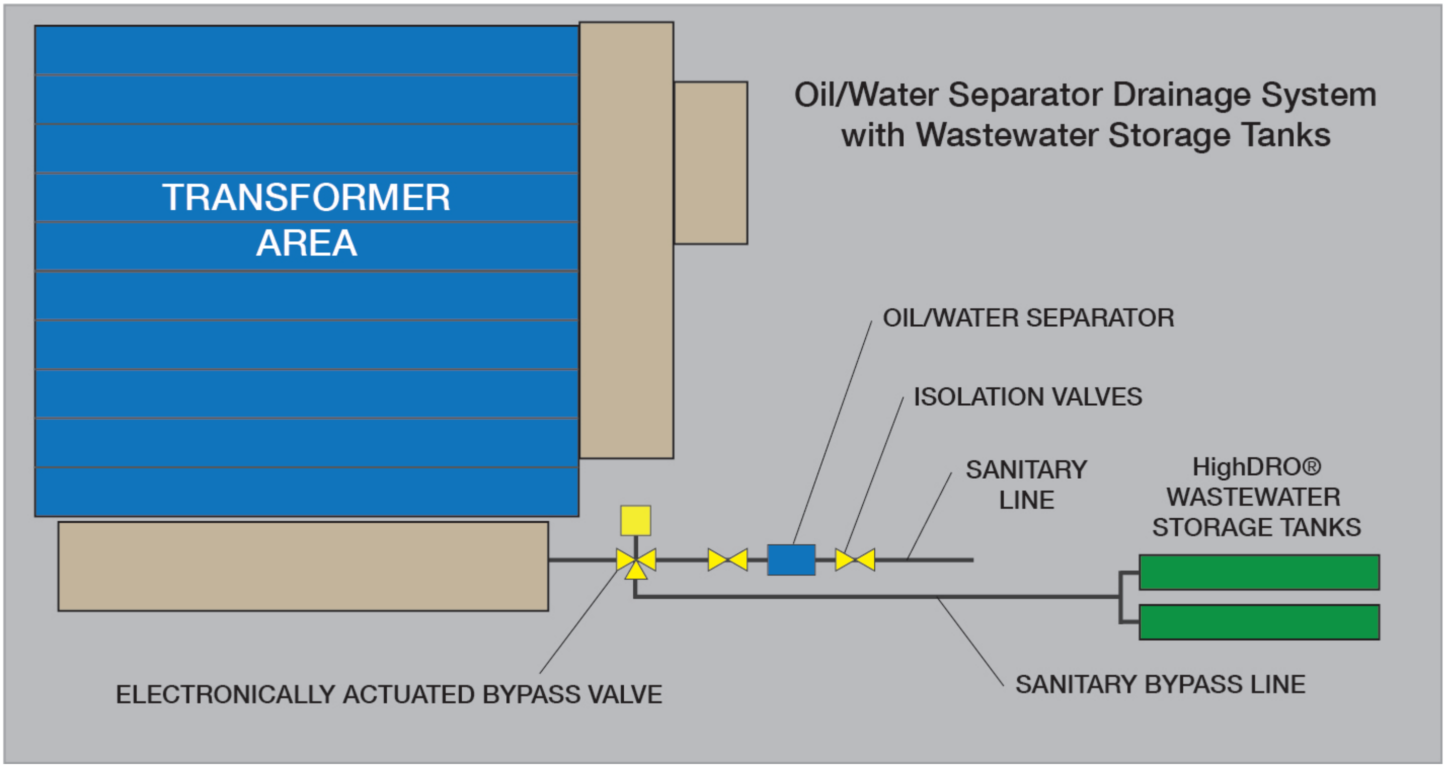
Further downstream, a Petro-Screen polypropylene impingement coalescer (an encased bundle of layered oil-attracting fibers) is used to intercept droplets of oil that are too minute to be removed by Corella® coalescer.

The effluent flows down and toward the outlet and is discharged by gravity displacement. Any accumulated oil will actuate the electronic oil level controls to sound an alarm at high oil levels. The waste oil can be pumped or removed from the separator for proper disposal and recycling.

For total shutdown in a high oil condition, the Corella oil/water separator can be fitted with a manual or automatic shut-off valve at the outlet of the separator to facilitate the closing of the oil containment system to prevent discharge of firefighting foam or an extraordinary oil spill off the site. Any overflow from the oil/water separator can be managed by directing it to a remote emergency secondary containment area or by the emergency response process.

There are instances where gravity systems are required but complete gravity drainage to discharge is not possible. Here, fixed sump pumps with automatic level controls may be installed in the outlet clearwell of the oil/water separator. The pumped effluent can then be routed to discharge. In the event of an extraordinary oil spill, the level controls will shut the pumps off allowing any overflow to be properly managed.

In congested areas that do not have access to remote emergency secondary containment areas, the extraordinary spill can be directed to an underground, double-walled Spill Tank(s) installed near to the oil/water separator.



The operation is somewhat similar to the above except that the automatic shut-off valve is placed at the inlet of the oil/water separator.

In operation, the valve is inter-connected to the sprinkler or fire alarm control panel. In a normal operation, the valve is open and wastewater can flow from the trench drain or collection sumps to the oil/water separator normal processing. In the event of a major spill or fire, the valve is actuated by the sprinkler or fire alarm control panel and closes the line to the oil/water separator. The spill and any fire foam is diverted to the discharge line draining to the underground Spill Tank(s). When the tank is 100% full, the valve will reopen and any remaining spill or hose down water is directed back into the oil/water separator for treatment.

After an emergency it will be necessary to pump out the Corella oil/water separator or empty the underground Spill Tank and undertake cleanup of any impacted areas of the substation as required. Clean up work must be undertaken in accordance with appropriate environmental guidelines. A properly designed oil/water separator or Spill Tank will have EZ-Access openings on the top of the tank to allow convenient access for inspection and maintenance from above. Following the emergency use of the system, the system will need to be recharged and recommissioned for future operations.

GENERAL - IMPORTANT POINTS TO CONSIDER PRIOR TO INSTALLATION, OPERATION AND MAINTENANCE OF THE OIL/WATER SEPARATOR (OWS) AT AN ELECTRICAL SUBSTATION:

- Oil/water separators will not separate oil and foam [Aqueous Film-Forming Foam (AFFF)] contaminated water. In such cases, secondary containment with a closed drainage system is recommended.
- Oil/water separation systems will not work properly with oil degreasers or surfactants. Detergents and solvents must not enter the OWS. The OWS will not remove chemical emulsions or dissolved hydrocarbons, and their presence retards the recovery of oils that would otherwise be separated. Installation of an appropriately sized Advanced Hydrocarbon Filtration System is recommended for treatment of wastewater contaminated with these pollutants.
- The oil water separator does not treat any contaminants other than transformer oil, i.e. it will not remove PCBs.
- Wastewater containing high concentrations of dissolved solids (such as untreated sanitary sewage) must be excluded due to its emulsifying tendency. Wastewater, which exhibits high Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and Total Suspended Solids (TSS) may require additional treatment after the OWS.
- Waste oils should not be intentionally drained into the OWS. Filling the OWS with waste oils adversely affects OWS performance. Waste oil should be dumped into a separate waste holding tank for proper disposal.
- The amount of debris, such as sand, gravel, dirt, leaves, wood, rags, etc., permitted to enter the OWS must be minimized for maximum effectiveness. Installation of an appropriately sized Collection Catch Basin or other similar device upstream of the OWS is recommended.
- The OWS needs to be maintained to remain as free of accumulated oil and sediment as possible. Suction removal of waste, as needed, is the best and recommended method of maintenance.
- Piping should be designed to minimize turbulence and promote laminar flow.
- An absence of gravity flow to the OWS will necessitate wastewater pumping. Pumping should be restricted to the clean water, effluent end of the OWS. If pumping occurs at the influent end, it will mix the oil and water, increasing the emulsified and dissolved oil content and may cause separation failure. If a pump is installed upstream of the OWS, it must be a positive displacement pump (e.g. progressive cavity diaphragm or screw pump), set at minimum flow rate/RPM and installed as far upstream as possible to minimize any oil/water mixing.
- The OWS must be kept from freezing at all times. The OWS and piping should be installed below local frost levels. If necessary, a thermostatically controlled steam or electric heating device may be installed.

See Part 2: Creative Solutions to Secondary Containment at Electrical Power Facilities

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