



IEEE Guide for Containment and Control of Oil Spills in Substations

STANDARDS

IEEE Power and Energy Society

Developed by the
Substations Committee

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IEEE Guide for Containment and Control of Oil Spills in Substations

Developed by the

Substations Committee
of the
IEEE Power and Energy Society

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IEEE SA Standards Board

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Abstract: The significance of oil-spillage regulations and their applicability to electric substations are discussed; the sources of oil spills are identified; typical designs and methods for dealing with oil containment and control of oil spills are discussed; and guidelines for preparation of a typical Spill Prevention Control and Countermeasures (SPCC) plan are provided. This guide excludes polychlorinated biphenyl (PCB) handling and disposal considerations.

Keywords: collecting pit, IEEE 980™, oil containment methods, oil containment system, oil discharge, oil spill, primary oil containment, retention pit, secondary oil containment, spill prevention control and countermeasures (SPCC) plan

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Introduction

This introduction is not part of IEEE Std 980-2021, IEEE Guide for Containment and Control of Oil Spills in Substations.

Many international governments, on federal or local levels, have implemented regulations prohibiting the discharge of oil into waterways and the environment. Often these regulations require the preparation of spill prevention and response plans for certain facilities, including electrical substations.

It is prudent to recognize that a potential for oil spills exists in almost every substation throughout the utility industry. It is consequently reasonable to identify the extent of the problem, if any, and to recommend plausible measures to control oil spills by means of an IEEE guide.

This guide was revised by members of Working Group E2—Guide for Containment and Control of Oil Spills (IEEE Std 980)—and is under the sponsorship of the Transmission and Distribution Substations Operations Subcommittee of the IEEE Power and Energy Society (PES) Substations Committee.

This revision includes metrication, a deemphasis on US regulations, containment comparison tables, and inclusion of updated design figures and photos. Additionally, significant historical survey data were removed from the text and relocated to the annex.

Contents

1. Overview.....	14
1.1 Scope.....	14
1.2 Purpose.....	14
1.3 Word usage.....	14
2. Normative references	15
3. Definitions.....	15
4. Statutory requirements	16
5. Oil spill sources	17
5.1 Oil-filled equipment	17
5.2 Cables.....	18
5.3 Mobile equipment.....	19
5.4 Oil-handling equipment.....	19
5.5 Oil storage tanks	20
5.6 Other sources.....	20
6. Criteria	21
6.1 Probability of oil spills.....	22
6.2 Application determination	23
6.3 Performance monitoring.....	23
7. Containment.....	24
7.1 Containment systems.....	25
7.2 Storm-water management and control.....	46
7.3 Warning alarms and monitoring.....	60
7.4 Maintenance of oil containment systems.....	61
8. Control and response	62
8.1 Typical spill response plan requirements.....	62
8.2 Control and cleanup in substations	65
8.3 Disposal.....	66
8.4 Maintenance of equipment	66
Annex A (informative) Typical information included in notification form and spill report ⁸	67
Annex B (informative) Collecting pit volume calculation.....	69
Annex C (informative) Summary of past IEEE oil containment surveys	71
Annex D (informative) Bibliography	79

List of Figures

Figure 1—Oil-filled 345 kV power transformer	18
Figure 2—120 kV oil circuit breaker	18
Figure 3—Ruptured transformer and resultant oil spill	18
Figure 4—Oil-filled cable pumping facilities	19
Figure 5—Cable terminations (potheads)	19
Figure 6—Containment for a mobile generator	19
Figure 7—Containment for tanker of transformer oil in the process of filling a transformer	20
Figure 8—Oil/fuel storage tank	20
Figure 9—Capacitors containing dielectric oil in storage	21
Figure 10—Oil/fuel storage containers	21
Figure 11—Typical stone used for the stone mat and in stone-filled containment	26
Figure 12—Installation of in-ground synthetic liner	27
Figure 13—Installation of in-ground synthetic liner	27
Figure 14—Installation of an impervious synthetic liner	27
Figure 15—Spray-in liner installation utilizing cinder block walls	28
Figure 16—Substation stone mat with perimeter stone berm	36
Figure 17—Typical oil containment system with retention pit	37
Figure 18—Typical oil containment system where the entire substation drains to a retention pond that has an oil/water separator (inverted pipe) outlet	37
Figure 19—Cross section of oil containment system with retention pit	38
Figure 20—Typical oil containment system with discharge control system	38
Figure 21—Typical oil containment system with a discharge control system with a stone-filled pit and aboveground fiberglass dike that drains through a polymer bead filter	39
Figure 22—Typical concrete pit	40
Figure 23—Subsurface concrete containment pit with concrete wall under construction	41
Figure 24—At-grade concrete containment with wall/dike	41
Figure 25—Concrete containment pit with access grating	41
Figure 26—Typical earthen pit with impervious liner	41
Figure 27—Earthen containment pit with impervious liner being installed	42
Figure 28—Stone-mat containment with fiberglass dike	42

Figure 29—Earthen containments with earthen berms all with stone-mat cover.....	42
Figure 30—Portable containment for temporary/spare equipment	42
Figure 31—Typical oil containment system with earth dike	43
Figure 32—Typical portable berms and tanks	44
Figure 33—Fiber/geotextile berm containing “windows” of polymer beads	45
Figure 34—Cross-section of fiber/geotextile berm showing layer of polymer beads	45
Figure 35—Sump pump that pumps accumulated liquids through an in-line polymer bead filter	45
Figure 36—End-of-pipe polymer-filled filters attached to a header system where high storm-water flows are expected	46
Figure 37—In-line oil-absorbing polymer bead filter ready for installation.....	46
Figure 38—Oil–water gravity separator (for warm climates).....	47
Figure 39—Simple inverted outlet, oil-water, gravity separator	52
Figure 40—Oil–water gravity separator (for cold climates).....	52
Figure 41—Oil–water separator at the oil retention pit	53
Figure 42—Simple oil–water separator.....	53
Figure 43—Oil-trap-type oil–water separator	54
Figure 44—Oil-absorbing polymer bead bed (installed in manhole).....	55
Figure 45—Imbiber valve concrete structure with valve removed showing concrete structure and outlet pipe.....	56
Figure 46—Oil-absorbing polymer bead bed (installed in drain pipe)	56
Figure 47—Oil stop valve	57
Figure 48—Specific gravity type oil stop valve ready for installation.....	57
Figure 49—Oil stop valve being installed in a manhole	57
Figure 50—Sump pump water discharge (with oil-sensing probe)	59
Figure 51—Oil-sensing pump system	60
Figure 52—Mud valve	60
Figure 53—Polymer bead filter fitted on end of manual valve	60
Figure B.1—Oil collecting pit.....	70

List of Tables

Table 1—Common secondary oil containment evaluation criteria	22
Table 2—Common equipment for which secondary containment is provided	22
Table 3—Containment method utilization	24
Table 4—Soil permeability characteristics	26
Table 5—Common containment pit liners	28
Table 6—IEEE comparison of containment systems	31
Table 7—Comparison of environmental storm-water control systems	48
Table C.1—Secondary oil containment evaluation criteria	71
Table C.2—Secondary oil containment equipment criteria	71
Table C.3—Containment method utilization	72
Table C.4—Containment pit liners	73

IEEE Guide for Containment and Control of Oil Spills in Substations

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1. Overview

1.1 Scope

This guide discusses the significance of oil spillage ~~regulations~~ in electric ~~supply~~ substations; identifies the sources of oil spills; discusses typical designs and methods for dealing with oil containment and control of oil spills; and provides guidelines for preparation of a typical spill prevention control and mitigation plan. This guide applies ~~only~~ to all types of non-polychlorinated biphenyl (non-PCB) insulating oil, fuel, and other oils typical of electrical substations.

It is not the intent of this guide to interpret government ~~governmental~~ regulations or the applicability of the oil containment systems presented with respect to compliance to those regulations. Interpretation is left to each individual user.

Note that much of the material and information in this guide is based on discussions, experiences, and research conducted by the IEEE Oil Containment Working Group. Part of this research includes industry surveys conducted in 1992 and 2012 in an effort to determine common practices for oil containment and control in electrical substations. Although generally not discussed in the body of this guide, the detailed survey results can be found within Annex C.

1.2 Purpose

Containment, control, and mitigation of oil spills are a concern for owners and operators of electric ~~supply~~ substations. The environmental impact of oil spills and their mitigation is regulated by [some](#) governmental agencies, necessitating increased attention in substations to the need for secondary oil containment. Beyond the threat to the environment, mitigation costs associated with oil spills continue to escalate⁷, and the adverse community response to any spill is becoming increasingly unacceptable. This guide identifies some governmental regulations, the sources of oil spills, and typical methods and plans used to contain, control⁴, and mitigate them.

Note that [use of the term “oil” in this document](#) includes mineral oil and [other](#) alternative insulating fluids.

1.3 Word usage

[The word *shall* indicates mandatory requirements strictly to be followed in order to conform to the standard and from which no deviation is permitted \(*shall* equals *is required to*\).^{1,2}](#)

[The word *should* indicates that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required \(*should* equals *is recommended that*\).](#)

[The word *may* is used to indicate a course of action permissible within the limits of the standard \(*may* equals *is permitted to*\).](#)

[The word *can* is used for statements of possibility and capability, whether material, physical, or causal \(*can* equals *is able to*\).](#)

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2. Normative references

The following referenced documents are indispensable for the application of this document (i.e., they must be understood and used, so each referenced document is cited in text and its relationship to this document is explained). For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

U.S. Code of Federal Regulations, Title 40 (40 CFR), Protection of Environment, Parts 110 and 112.^{3 4}

3. Definitions

For the purposes of this document, the following terms and definitions apply. The *IEEE Standards Dictionary Online* should be consulted for terms not defined in this clause.^{4 2}

alternative insulating fluid: Any dielectric fluid of low relative permittivity, such as synthetic or natural esters, that may be used to insulate electrical current in transformers and other equipment in lieu of a refined high-alkane petroleum product such as mineral oil.

collecting pit: A pit built under oil-filled equipment to collect any accidental discharge of oil from that piece of equipment.

dewatering: To remove water from.

gallon: One U.S. gallon (gal); equivalent to equals 3.785 liters-(L.).

^{3 4} CFR publications are available from the U.S. Government Printing Office (~~https~~ ~~http~~://www.gpo.gov/).

^{4 2} IEEE Standards Dictionary Online ~~subscription~~ is available at: ~~http://dictionary.ieee.org~~. An IEEE account is required for access to the dictionary, and one can be created at no charge on the dictionary sign-in page ~~http://www.ieee.org/portal/innovate/products/standard/standards_dictionary.html~~.

harmful quantity of oil: [A legal term of art defined by US regulation \(40 CFR, Part 110\), and it is defined to be](#) a discharge of oil that (1) violates applicable water quality standards, (2) causes a film or sheen upon or discoloration of the surface of the water or adjoining shorelines, or (3) causes a sludge or emulsion to be deposited beneath the surface of the water or upon adjoining shorelines.

impervious liner: [Any lining comprising woven or nonwoven synthetic fabric, compacted natural clay soils, or a man-made cementitious mixture that prohibits the flow of fluid from one side of the barrier to the other.](#)

oil: Any of numerous mineral, ~~vegetable, and~~ [synthetic, or biological lipid](#) substances ~~and animal and vegetable fats~~ that are generally slippery, combustible, viscous, liquid or liquefiable at room temperatures, [hydrophobic](#), ~~soluble in various organic solvents such as ether but not in water~~ and used in a great variety of products, especially [as lubricants](#) ~~and~~, fuels, [and electrical insulation media](#).

oil containment system: A system designed to collect and retain oil in order to prevent (1) its migration beyond the boundaries of the system and (2) the contamination of [the environment](#) ~~navigable waters~~.

oil spill: Any leak or spillage of oil, regardless of volume and including those that do not reach navigable waters. A spill includes but is not limited to any discharge, leaking, pumping, pouring, emitting, emptying, or dumping of oil.

permeability: The drainage characteristic of [a porous material](#) ~~soil~~ that denotes its capacity to conduct or discharge fluids under a given hydraulic gradient.

primary oil containment: A tank or enclosure designed for continuous containment of oil for operating or storage purposes.

retention pit: A pit designed to retain (hold) oil-contaminated liquids.

secondary oil containment: A system designed to contain the oil discharged from an oil-filled piece of equipment in situations of primary oil containment failure.

~~SPCC: Spill Prevention Control and Countermeasures.~~

porosity ~~void-volume ratio~~: The volume of the void space in a porous material ~~spaces between stones~~ divided by the total volume occupied by the porous material ~~stones in a stone-filled collecting pit~~.

4. Statutory requirements

4.1 ~~U.S. federal~~

Many countries and local units of government have generally adopted regulations prohibiting discharges of oil into the environment, with an increased focus on waterways. These regulations may be more encompassing and restrictive than the US federal regulations referenced in this document. The applicability and requirements for spill prevention and containment plans in foreign countries and local government jurisdictions vary and are not discussed in detail within this guide. It is the responsibility of the reader to investigate and determine the applicable regulatory statutes and requirements within his or her own governmental jurisdiction.

The US federal requirements~~of the U.S.~~ for discharge, control, and countermeasure plans for oil spills are contained in the *Code of Federal Regulations*, Title 40 (40 CFR), Parts 110 and 112. ^{5 3} The purpose of these regulations is to prevent the discharge of oil in harmful quantities into navigable waters, which also includes shorelines, wetlands, or areas that would adversely affect the natural resources of the U.S., and to provide for containment systems in lieu of only providing cleanup measures after a spill has occurred. Definitions and specifics regarding navigable waters and other terms that are covered by these regulations are contained in the publication. The regulations are very dynamic and have been amended many times since their inception.~~They were last amended on November 5, 2009,~~ and may have changed since the publication of this guide. The user is cautioned to check the latest regulations for revisions.

^{5 3} Information on references can be found in Clause 2.

The application of these federal regulations to oil-spill containment and control in substations is governed by several key points that have been subject to revision or interpretation. These include the following:

- a) Appropriate containment is required if volumes exceed the minimum storage capacity in a single container or the entire substation, at which level ~~before~~ a Spill Prevention Control and Countermeasures (SPCC) plan ~~and appropriate containment is~~ also required. Any change from the current limits may significantly impact the number of transformers, circuit breakers, and other oil-filled substation equipment where secondary containment is required. At the time of this publication, the current criteria are: aggregated above ground oil storage capacity greater than 4997 L (1320 gal) ~~U.S. gallons~~, or completely buried oil storage capacity greater than 158 987 L (42 000 gal) ~~42 000 U.S. gallons~~. Containers with a storage capacity equal to or less than 208 L (55 gal) ~~55 U.S. gallons~~ of oil are not included in the calculation of the total aggregated capacity.
- b) Regulations listed in ~~What constitutes a bulk storage tank for which~~ 40 CFR, Part 112, ~~regulations~~ currently require secondary oil containment: for what can be considered a "bulk storage tank." The proposed rules currently indicate that transformers ~~(and other electrical equipment)~~ containing oil for *operational* rather than storage purposes will not be considered "bulk storage tanks."
- c) The term "navigable waters", as currently written in 40 CFR, Part 110, is broad and encompassing. As defined by the U.S. Environmental Protection Agency (EPA), it can include, in addition to the major lakes and waterways, tributaries of rivers, lakes, and streams, as well as mud flats and wetlands.
- d) The amount of discharged oil that constitutes *harmful quantities*.

~~As stated earlier,~~ Interpretation of the specific regulations is left to each individual user.

These regulations prohibit the discharge of oil in harmful quantities into navigable waters of the [United States, U.S.](#) Through the implementation of an SPCC plan, which may include secondary containment, the regulations require that effective containment plans be made to prevent the discharge of oil, and specify that a cleanup procedure or contingency plan be established to be implemented in the event of an oil spill. A contingency plan alone can be utilized only where containment is shown to be impractical. Oil containment may be deemed impractical in situations where constraints prevent the installation of oil-containment systems and/or it is highly unlikely that oil would reach and contaminate navigable waters in the event of a discharge. Financial considerations alone are not a valid argument for not providing oil containment, as any contamination of navigable waters is unacceptable. Also, the cost associated with the expeditious cleanup of a spill [could](#) ~~will most likely~~ exceed the cost of providing secondary oil containment.

[Guidance and](#) ~~In addition to the~~ requirements [for reporting oil spills to the EPA are also incorporated in the regulations](#) prohibiting the discharge of harmful quantities of oil, [under](#) 40 CFR, Part 112, ~~contains requirements for reporting oil spills to the EPA.~~

EPA regulations require that each qualifying facility has a site-specific plan. Sufficient detail shall be included in the overall plan to identify location of equipment, quantity of oil, [grade and slope](#) ~~contour~~ of the site and surrounding area, and [area](#) ~~the~~ drainage patterns.

In summary, federal regulations require that each installation exceeding the specified storage capacity limitations be assessed for the possibility of contaminating navigable waters. If the potential for contamination exists, then an SPCC plan (see 8.1) shall be developed. Such a plan shall contain all requirements of 40 CFR, Part 112.7, including appropriate containment provisions and a countermeasures cleanup plan.

The above synopsis provides a brief regulatory overview of US federal regulations relating to oil containment in electrical substations. This is intended to provide a framework or background as to the need for oil spill control and mitigation measures at substations. Several other nations, and even local or state units of government, may also have similar regulations. Each user of this guide is encouraged to investigate the regulatory applicability of their respective operations. Many utilities and operators of electrical substations employ oil spill control measures as an act of corporate citizenship and environmental stewardship beyond just a regulatory obligation. These can also be motivating factors and criteria for consideration when evaluating the need for oil containment.

4.2 ~~Other regulations~~

~~Other countries and U.S. state and local governments have generally adopted regulations prohibiting discharges of oil. These regulations may be more encompassing and restrictive than the U.S. federal requirements referenced in this document. The procedure for the reporting of oil spills to other agencies varies but generally, the procedure could be more stringent than that required by the U.S. federal government. The procedure usually requires a report by telephone immediately following the spill and a follow-up written report that includes all the details of the oil spill. With respect to a cleanup plan, U.S. state agencies generally require that cleanup plans for oil spills be developed, written, and filed with the agency. Such a plan contains a written commitment of manpower, equipment, and materials that would be required to expeditiously control and remove any quantity of spilled oil.~~

5. Oil spill sources

Within this clause ~~Following~~ are descriptions of various sources of oil spills within substations. Spills from any of these sources are possible. The user should evaluate the quantity of oil present, the potential impact of a spill, and the need for oil containment associated with each source of oil. Spills may be caused by electrical failure, leaks, vandalism, sabotage, or accident.

5.1 Oil-filled equipment

Power transformers, reactors, regulators, and circuit breakers are common potential sources of both major and minor oil spills in substations, as shown in Figure 1, through Figure 3 since they typically contain large quantities of oil.



(New)

Figure 1 – Oil-filled 345 kV power transformer



(New)

Figure 2 – 120 kV oil circuit breaker



(New)

Figure 3—Ruptured transformer and resultant oil spill

5.2 Cables

Substation pumping facilities [shown in Figure 4](#) and cable terminations (potheads) that maintain oil pressure in pipe-type cable installations [shown in Figure 5](#) can be a ~~are another~~ source of oil spills.



(New)

Figure 4—Oil-filled cable pumping facilities



(New)

Figure 5—Cable terminations (potheads)

5.3 Mobile equipment

Although mobile equipment and emergency facilities containing oil, such as portable substations and emergency generators, [as shown in Figure 6](#) may be used infrequently, consideration should be given to the quantity of oil contained and associated risk of oil spill.



(New)

Figure 6—Containment for a mobile generator

5.4 Oil-handling equipment

Oil- is filled into equipment at completion of initial installation. The filling of a transformer with oil is shown in Figure 7. ~~transformers, circuit breakers, cables, etc., occurs when the equipment is initially installed.~~ In addition, periodic reprocessing or replacement of the oil may be necessary to maintain the proper insulation qualities of the oil. Oil pumps, temporary storage facilities, hoses, and so on etc., are brought in to accomplish this task. Spills from these activities can occur.



(New)

Figure 7—Containment for tanker of transformer oil in the process of filling a transformer

5.5 Oil storage tanks

Consideration should be given to the presence of bulk oil storage tanks as shown in Figure 8 (either above ~~aboveground~~ or below ground) in substations. The ~~resulting~~-applicability of certain local or federal regulations, such as the 40 CFR, Part 112, ~~rules~~ for those storage tanks could require increased secondary oil containment for the entire substation facility.



(New)

Figure 8—Oil/fuel storage tank

5.6 Other sources

Station service, voltage, and current transformers, oil circuit reclosers, capacitor banks, and other pieces of electrical equipment typically found in substations, may contain small amounts of insulating oil, as shown in Figure 9 and Figure 10. Although they may contain less oil than qualifying thresholds stated within certain regulations ~~the qualified threshold in 40 CFR~~, they may be considered ~~to be~~ as sources of oil.



(New)

Figure 9—Capacitors containing dielectric oil in storage



(New)

Figure 10— Oil/fuel storage containers

6. Criteria

Based on the applicability of the latest regulatory requirements, or when unacceptable risk factors have been identified, a program may be put in place to mitigate the risk of a spill to the environment. ~~problems~~. Typical criteria for implementing oil spill containment and control programs include equipment type and oil volume, potential environmental impact, severity of potential damage, adjacent natural features, ~~incorporate~~ regulatory requirements, corporate policy, frequency and duration of occurrences, cost of occurrences, safety hazards, ~~severity of damage, equipment type, potential environmental impact~~, substation location, and quality of service requirements.

The decision to install secondary containment at new substations (or to retrofit existing substations) is usually based on predetermined criteria. Based on industry feedback, historical ~~The 1992 IEEE surveys (Annex C) survey addressed the factors used to determine where oil spill containment and the research conducted by control programs are needed. Based on~~ the IEEE Oil Containment Working Group, 1992 survey the criteria in Table 1 are commonly considered when evaluating the need for secondary oil containment. ~~A similar survey was distributed among IEEE members and industry peers in 2012 (see Annex C). This survey represented a much smaller sample set than that of the 1992 survey (only 27 respondents); however in general, the results generally supported the conclusions of the 1992 survey.~~

Rarely is all of the equipment within a given substation provided with secondary containment. Table 2 identifies equipment for which secondary oil containment is commonly provided. The greatest focus is on equipment that contains the largest quantities of oil.

Table 1—Common secondary oil-containment evaluation criteria

Criteria
Volume of oil in individual device
Proximity to navigable waters
Total volume of oil in substation
Potential contamination of groundwater
Soil characteristics of the station
Location of substation (urban, rural, remote)
Emergency response time if a spill occurs
Failure probability of the equipment
Age of station or equipment

(New)

Criteria	Utilities responding that apply this criteria (%)
Volume of oil in individual device	88
Proximity to navigable waters	86
Total volume of oil in substation	62
Potential contamination of groundwater	61
Soil characteristics of the station	42
Location of substation (urban, rural, remote)	39
Emergency response time if a spill occurs	30
Failure probability of the equipment	21
Age of station or equipment	10

(Deleted)

Table 2— Common equipment for which secondary ~~Secondary oil~~
containment is provided ~~equipment criteria~~

Equipment
Power transformers
Aboveground oil storage tanks
Station service transformers
Oil circuit breakers
Three-phase regulators
Below-ground oil storage tanks
Shunt reactors
Oil-filling equipment
Oil-filled cable reservoirs/pumping stations
Single-phase regulators
Oil circuit reclosers

(New)

Equipment	Utilities responding that provide secondary containment (%)
Power transformers	86
Aboveground oil storage tanks	77
Station service transformers	44
Oil circuit breakers	43
Three-phase regulators	34
Below-ground oil storage tanks	28
Shunt reactors	26
Oil-filling equipment	22
Oil-filled cables and terminal stations	22
Single-phase regulators	19
Oil circuit reclosers	15

(Deleted)

Other criteria not captured in Table 1 2, but considered common in industry practice ~~reported by some respondents in the 2012 survey,~~ include (1) modeling software to determine the potential for oil spills to migrate off-site and into surface water and (2) the individual piece of electrical equipment being equipped with supervisory control and data acquisition (SCADA) monitoring capabilities.

Each substation should be evaluated by considering appropriate criteria to determine the need for oil-containment systems (both new and retrofit). Use of electrical criteria (e.g., phase-to-phase voltage) is discouraged because nonelectrical characteristics (e.g., oil volumes) are more important when judging the risks of oil spills. Substations with planned equipment replacements ~~change-outs~~ may be considered for retrofits at the time of the change-out.

6.1 Probability of oil spills

~~Both~~The frequency ~~and magnitude~~ of oil spills in substations reaching navigable waters or adjoining shorelines can be considered ~~very~~ low based on historical survey results. The probability of an oil spill at any particular location depends on the number ~~and volume~~ of oil sources and their volume in addition to other site-specific conditions. The probability of a spill was surveyed ~~verified~~ by ~~the results of~~ two questionnaires submitted in 1977 to utility members of the IEEE Substations Committee by the Oil Spill Prevention, Control, and Countermeasures Task Force of the Environmental Subcommittee.

The information gathered from responding utilities ~~showed that during the ten-year period from 1965 to 1974, these utilities had a total of less than one discharge for each 330 pieces of equipment in service. Over the two-year period from 1975 to 1976, these utilities had less than one discharge for each 1200 pieces of equipment in service. The figures also~~ showed that during the 10 ten-year period, from 1965 to 1974, responding utilities had less than one discharge per 330 pieces of in-service, oil-containing equipment. For the same period, reaching a ~~reached a~~ waterway was even less likely, with less than one discharge reaching a navigable waterway for each 5275 pieces of in-service, oil-containing ~~in-service. During~~ equipment.

Over the two-year period from 1975 to 1976, responding utilities had less than one discharge ~~reached a waterway~~ for each 1200 pieces of equipment in service. For the same two year period, less than one discharge for every 6640 pieces of in-service, oil-containing equipment. ~~The 2012~~ reached a navigable waterway.

A survey conducted in 2012 by the IEEE Oil Containment Working Group, along with evidence gathered during Working Group meetings, showed similar results. While ~~in that~~ it can be concluded ~~is rare~~ that an oil discharge actually reaching reaches a navigable waterway or adjoining shorelines; could be considered rare, however the ~~survey~~ results also indicated that is not uncommon for more minor oil spills and discharges to occur within substations. Note that this could also be the result of oil containment being more of a common practice in substation design and planning within the utility industry, thus lowering the probability of an oil spill reaching a waterway ~~although a waterway is rarely affected.~~

The task force concluded that, while available ~~this~~ empirical data was not precise, it ~~clearly~~ indicated that the probability of spills per piece of equipment in service per year is low ~~small~~.

Computer-based modeling software is available to assess the probability of oil migrating off-site and reaching navigable water. Such tools can be useful for determining a specific oil containment strategy for a substation.

6.2 Application determination

After determining the requirement for oil containment, the design process may include [a](#) ~~consideration of~~ cost analysis, operations and maintenance considerations, [review of](#) applicable governmental regulations, and [consideration of](#) community acceptance.

6.2.1 Economic aspects

Economic aspects can be [studied](#) ~~considered~~ when determining which containment system or control method to employ. The initial installation cost, as well as the operating and maintenance cost associated with the containment method, may be considered. ~~Also,~~ Factors such as proximity to waterways, volume of oil, and [utility](#) response time following a spill may allow for the use of alternative methods at some locations.

6.2.2 Governmental regulations

Due to the changing nature of environmental [laws](#) ~~regulations~~, some methods described in this guide [may](#) ~~could become in~~ conflict with governmental regulations or overlapping jurisdictions. [after publication](#). Therefore, determination of which containment system or control method to use should [always](#) include research into [and confirmation of](#) current applicable laws and regulations.

6.2.3 Community acceptance

Community acceptance of the oil spill containment and control methods may also be considered. Certain levels of unacceptability are intangible and may be dictated by company policies, community acceptance, and customer relations. Additional information on this topic can be found in IEEE Std 1127™ [[B8](#) ~~B3~~].^{[6](#) ~~4~~}

^{[6](#) ~~4~~}The numbers in brackets correspond to those of the bibliography in Annex D.

6.3 Performance monitoring

Some means should be put in place for evaluating the effectiveness of any containment and control measures that have been applied. Records should be kept for each substation to record the method used, date of application, and the history of oil spills. A record [assists monitoring](#) ~~helps monitor~~ the performance of applied [methods](#) ~~method~~ to evaluate the feasibility of future applications. [Selection and type of record keeping should be determined by the individual owner/operator. Performance testing of secondary containment may be modeled after existing testing procedures, such as ACI 350.1 \[B2\] for concrete containment structures and Chapter VI and Chapter VII-Part 10 of ASME B31.3 \[B3\] for pipes.](#)

7. Containment

~~There are~~ Many systems and strategies ~~that~~ can be [used](#) ~~utilized~~ to provide secondary containment for oil-containing electrical equipment at substations. The containment systems and strategies can prevent or mitigate the environmental impacts of a release or spill. These impacts can range from increased operating costs due to the clean-up and mitigation involved to contamination of private/regional domestic water sources and fish and/or wildlife mortalities. As there are many approaches to providing secondary containment, each site [should](#) ~~needs to~~ be evaluated based on potential environmental impacts in the vicinity of the site, soil characteristics, topography, response time, and the type of equipment containing the material. In some cases, providing containment for individual pieces of equipment might be the best approach, [whereas](#) ~~while~~ in other cases providing a single site-wide solution or drainage control might better fit the aspects of the site. Economics and constructability are also integral factors when considering secondary containment, especially for retrofit installations. There is no universal solution for secondary containment or containment dewatering, and each site should be evaluated for site-specific solutions.

It is beyond the scope of this guide to make specific recommendations as to which type of oil-containment system is best suited for specific instances due to the wide range of site variables that can exist. However, as an aid to those engaged in the design of oil-containment systems, this clause provides information on factors that may be considered in the design of containment and containment dewatering systems and gives examples of various types that have been used ~~utilized~~ in the industry.

Based on industry feedback, historical survey results (Annex C), and the research conducted by the IEEE Oil Containment Working Group, no single containment system or discharge control method is preferable or fits all situations. However, all methods listed in Table 3 have been used successfully. All users need to determine which method applies best to their containment need and site conditions. Constructability, installation restrictions, future maintenance requirements, and cost all need to be considered by each user. The U.S. Department of Agriculture, Rural Development Utilities Programs, Bulletin 1724E-302 [B14 B7], provides additional information on oil containment methods in substations.

Table 3—Containment method utilization-~~(1992 survey)~~

Containment system or discharge control method	Figure reference
Perimeter or equipment berm	Figure 31 and Figure 32
Fire-quenching and oil-retention pit	Figure 22, Figure 26, and Figure 41
Oil-retention pit	Figure 17 and Figure 19
Oil-water separator	Figure 46
Oil-detection-triggered sump pump	Figure 50 and Figure 51
Gravity separator	Figure 38 and Figure 40
Oil-water stop valve	Figure 47
Oil trap	Figure 43
Oil-absorbing polymer bead bed	Figure 44, Figure 45, and Figure 46

(New)

Containment system or discharge control method	Figure reference	Utilities responding that employ method	
		For new substations (%)	For retrofits (%)
Perimeter or equipment berm	Figure 6, Figure 7	67	58
Fire-quenching and oil-retention pit	Figure 4, Figure 5, Figure 10	60	42
Oil-retention pit	Figure 1, Figure 2	48	43
Oil-water separator	Figure 11	41	27
Oil-detection-triggered sump pump	Figure 16	31	39
Gravity separator	Figure 9	24	15

(Deleted)

Table 3—Containment method utilization (1992 survey) (continued)

Containment system or discharge control method	Figure reference	Utilities responding that employ method	
		For new substations (%)	For retrofits (%)
Oil-water stop valve	Figure 15	22	35
Gravity separator	Figure 8	15	10
Oil trap	Figure 12	8	14
Oil-absorbing polymer bead bed	Figure 13, Figure 14	8	17

(Deleted)