Onshore Oil and Gas Production Practices for Protection of the Environment

API RECOMMENDED PRACTICE 51
THIRD EDITION, FEBRUARY 2001

American Petroleum Institute

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Upstream Segment

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Onshore Oil and Gas Production Practices for Protection of the Environment

1 Scope

This standard provides environmentally sound practices for domestic onshore oil and gas production operations. It is intended to be applicable to contractors as well as operators. Facilities within the scope of this document include all production facilities, including produced water handling facilities. Offshore and arctic areas are beyond the scope of this document. Operational coverage begins with the design and construction of access roads and well locations and ends with abandonment/ restoration operations. Gas compression for transmission purposes or production operations, such as gas lift, pressure maintenance, or enhanced oil recovery is included; however, gas processing for liquids recovery is not addressed.

2 References

2.1 REFERENCE STANDARDS

This recommended practice includes by reference, either in total or in part, the following standards. Users should investigate use of the appropriate portion of the most recent editions of the standards listed below:

API

Bull E2 *Bulletin on Management of Naturally Occurring Radioactive Materials (NORM) in Oil and Gas Production*

Bull E3 *Well Abandonment and Inactive Well Practices for U.S. Exploration and Production Operations, Environmental Guidance Document*

API Environmental Guidance Document: *Onshore Solid Waste Management in Exploration and Production Operations*

API Remediation of Salt-Affected Soils at Oil and Gas Production Facilities

API Guidelines for Commercial Exploration and Production Waste Management Facilities

Spec 7B–11C *Specification for Internal-Combustion Reciprocating Engines for Oil Field Service*

RP 7C–11F *Recommended Practice for Installation, Maintenance, and Operation of Internal-Combustion Engines*

Bull 11K *Data Sheet for the Design of Air Exchange Coolers*

Spec 11N *Specification for Lease Automatic Custody Transfer (LACT) Equipment*

Spec 11P *Specification for Packaged High Speed Separable Engine-Driven Reciprocating Gas Compressors*

Spec 12B *Specification for Bolted Tanks for Storage of Production Liquids*

Spec 12D *Specification for Field Welded Tanks for Storage of Production Liquids*

Spec 12F *Specification for Shop Welded Tanks for Storage of Production Liquids*

Spec 12J S*pecification for Oil and Gas Separators*

Spec 12K *Specification for Indirect-Type Oil Field Heaters*

Spec 12L *Specification for Vertical and Horizontal Emulsion Treaters*

RP 12N *Recommended Practice for Operations, Maintenance and Testing of Firebox Flame Arresters*

RP 49 *Recommended Practices for Drilling and Drill Stem Testing of Wells Containing Hydrogen Sulfide*

RP 53 *Recommended Practices for Blowout Prevention Equipment Systems for Drilling Wells*

RP 55 *Recommended Practices for Conducting Oil and Gas Producing and Gas Processing Plant Operations Involving Hydrogen Sulfide*

NACE[1]

Std MR0175 *Standard Material Requirements Sulfide Stress Cracking Resistant Metallic Materials for Oilfield Equipment*

RP0475 *Selection of Metallic Materials to be Used in All Phases of Waste Handling for Injection Into Oil Bearing Formations*

3 Acronyms and Abbreviations

The following acronyms and abbreviations are used in this standard:

API	American Petroleum Institute
BOPE	Blowout Preventer Equipment
E&P	Exploration and Production
ESD	Emergency Shut Down
IC	Internal Combustion
LACT	Lease Automatic Custody Transfer
mg/l	milligrams per liter
NORM	Naturally Occurring Radioactive Materials
PCB	Polychlorinated Biphenyls

[1]NACE International (National Association of Corrosion Engineers), P.O. Box 218340, Houston, Texas 77218-8340.

RP	Recommended Practice(s)
SIC	Standard Industrial Classification
SOP	Standard Operating Procedure
TDS	Total Dissolved Solids

4 Government Agencies

Prior to drilling or construction, and, in some instances, prior to revision of onshore oil and gas production facilities, it may be necessary to obtain approvals from one or more government agencies. In addition to drilling and building permits, permits may be required because of air emissions, discharges to surface waters or sewer systems, injection activities, stormwater discharges (including during construction activities), impacts to threatened or endangered species or their critical habitat, impacts to wetlands and other environmental impacts, or impacts to other cultural resources. Operators should ensure that all necessary permits have been obtained prior to commencing operations.

5 Lease Roads

5.1 INTRODUCTION

Lease roads are constructed and used to support various exploration and production operations. The environmental impact of the construction of a roadway can have long lasting effects well beyond the limits of the right-of-way. Existing roads should be utilized, where feasible, to limit the extent of new road construction. When it is necessary to build new roadways, they should be developed in an environmentally acceptable manner consistent with landowner recommendations.

5.2 PLANNING

5.2.1 Road alignment and right-of-way selection is a multidisciplinary process. The total infrastructure that may later be developed should be considered during the selection process. Government agencies, landowners, tenants, and other users may need to be consulted during the planning process.

5.2.2 Standards should be established for the road based on its long-term function.

5.2.3 Alternative alignments should be developed considering the following parameters as appropriate:

a. Topography.
b. Hydrology and drainage.
c. Erodible soils.
d. Location and amounts of excavation and fill materials.
e. Type and location of materials for road construction.
f. Air, water, and noise pollution.
g. Wetlands and wetland drainage.
h. Consistency with community character and local government needs and plans.
i. Proximity to dwellings or other permanent structures occupied or used by the public.
j. Visual sensitivity.
k. Power lines and pipelines.

5.2.4 Road alignments and potential environmental impacts should be reviewed. Environmentally significant areas should be identified and avoided to the maximum extent practical, including:

a. Sensitive wildlife and fish habitats.
b. Areas with endangered and threatened animals and plants.
c. Cultural and historical sites.
d. Federal, state, or local areas of concern.
e. Areas with the potential for flooding or snow drifting.
f. Wetlands.

5.2.5 When required, mitigation strategies should be developed in the planning process, including:

a. Road operation schedules and/or use of special designs to minimize any adverse impacts in areas with sensitive wildlife and fish habitats, wetlands, existing facilities, crops.
b. Plans to take appropriate action on cultural and historic resources before changes are made.
c. Maintenance of existing traffic patterns on highways and local access roads.

5.2.6 Restoration plans should be developed and incorporated into the planning process.

5.2.7 Stormwater and air (dust) permit requirements should be considered during the planning phase of the roadway.

5.3 DESIGN AND CONSTRUCTION

5.3.1 The design and construction of a road should be site specific. Each road will have its own unique terrain, safety, operation, and maintenance requirements. Each area within a route will support a distinct ecology.

5.3.2 Design and construction documents, including plans and drawings (where appropriate), should be prepared during the planning and design phases prior to the construction of the project. Plans will enable proper and timely review of items of environmental concern. They will also be beneficial for later restoration work.

5.3.3 Construction work should be scheduled and the use of special designs and local construction practices should be considered to minimize or avoid undesirable effects on sensitive wildlife and fish habitats, wetlands, and designated federal, state, or local recreational areas. Seasonal restrictions, such as freeze-thaw cycles, potential flooding, and wildlife migration should be considered.

5.3.4 The operator should confirm that the construction contractor has implemented an environmental and safety program, including the training of construction personnel. This

program should include, where applicable, written procedures for a hazard communication program, hazardous material handling, spill reporting, emergency response, stormwater management, special environmental requirements within the project area, and blasting. The contractor should supply material safety data sheets (MSDS) for all hazardous materials brought on site. Regulatory agencies often require performance bonds when roads are to be constructed in environmentally sensitive areas.

5.3.5 The operator should hold a pre-construction meeting with the contractor(s) to establish environmental and safety responsibilities along with desired objectives of the project.

5.3.6 Field inspections and lab analysis of soil samples may be used to assess soil erosion hazards and slope stability. Properties of soils, length and gradient of slopes, and vegetative cover contribute to soil stability. Fitting the profile to topography, locating roads on moderate slopes, providing adequate drainage, and stabilizing slopes decreases surface disturbance and reduces erosion and sedimentation.

5.3.7 Means and methods for erosion control are numerous and often site specific. Revegetation with local species, riprap, gabions, woven jute, and energy dissipaters are effective measures that may be used to reduce erosion.

5.3.8 The use of geotextiles and geosynthetics should be considered in road planning and construction. These materials offer a variety of applications, aid in stabilizing the road, and minimize the utilization of road bed and surface materials.

5.3.9 An adequate drainage system should be incorporated into the design and construction of the road. This system should efficiently intercept, collect, remove, and discharge water from roads. A drainage system that is inadequate or blocked will result in excessive erosion, failures, and higher maintenance costs.

5.3.10 The number of river, stream (including ephemeral streams), lake, and wetland crossings should be minimized, where possible. Bridges, culverts, and other drainage structures should be incorporated to ensure the free flow of water when drainage ways are intersected. Different flood stages should be considered for the design and construction of the crossings.

5.3.11 The use of snow fences should be considered in areas with snow drifting characteristics. Minimization of snow build up will reduce the use of deicers on the roadway and will also reduce the problems associated with the disposal of the bladed snow/salt mix during maintenance operations.

5.3.12 Clearing widths should be kept to a minimum. These limits should be delineated and marked in the field. Sensitive areas or features should be marked or fenced as required.

5.3.13 Where practical, topsoil should be salvaged and stockpiled in a safe and accessible location and be protected from erosion. The stockpiled material should be utilized for revegetation and reclamation purposes.

5.3.14 Revegetation should be done with local plants, seeds, and grasses species. Means and methods will be dependent upon seasonal considerations, the specific project area, and government agency requirements.

5.3.15 Areas of excavation should be approved prior to the start of construction. Pit layout and restoration should be planned prior to opening of the pit.

5.3.16 Environmental impacts during coarse/fine borrow material extraction should be minimized. The following should be considered:

a. Use of recycled road surface material from abandoned roads and locations.
b. Use of existing mineral material sites.
c. Developing upland sites to maximize potential for revegetation and minimize adverse visual impact and possible erosion.
d. Maintaining a buffer of undisturbed vegetation between borrow pits and highways or other sites.

5.4 SELECTING NEW SITES THAT MINIMIZE ENVIRONMENTAL IMPACTS

5.4.1 Warning signs should be provided to comply with local requirements. The signs may include road crossings, animal crossings, speed limit, road hazards, pipelines, etc.

5.4.2 Existing pipelines and other subsurface facilities should be identified prior to construction. These facilities should be protected to prevent accidental damage during the construction and operation of the road.

5.4.3 Measures should be taken to ensure proper and adequate procedures for waste disposal, general housekeeping. An effective emergency response plan should be in place prior to initiating construction. The plan may simply be a listing of telephone numbers to call should a utility or product line be damaged. Many times, the existing emergency response plan for the field area may be adequate. Construction personnel should be familiar with these plans.

5.4.4 Construction activities should be carried out as described in the construction documents, including plans and specifications.

5.4.5 Construction supervision should be provided throughout operations. Many potential problems associated with incorrect interpretation of construction documents,

spills, waste disposal, poaching, and hunting can be avoided through proper supervision.

5.5 MAINTENANCE

5.5.1 Proper road maintenance is critical for the performance of the road and to prevent and control erosion and sedimentation. Maintenance personnel should be made aware of environmentally difficult and sensitive areas.

5.5.2 Maintenance work should be scheduled and the use of special designs and maintenance programs should be considered to minimize undesirable effects on sensitive wildlife and fish habitats, wetlands, and designated federal, state, or local recreational areas.

5.5.3 When performing scraping and leveling operations, care should be exercised to avoid disrupting ditches and shoulders, and creating undesirable berms with the bladed material.

5.5.4 Ditches, culverts, and drains should be regularly cleaned of debris and sediment to allow the free passage of water. Periodic inspections of all culverts should be conducted. Culverts found to be blocked should be cleared.

5.5.5 Borrow and surface materials should be readily accessible to be utilized during maintenance operations. Pits opened during construction should be used as a source for maintenance material, where feasible.

5.5.6 The use of dust control materials or measures should be evaluated prior to their utilization. The materials should not be detrimental to health, vegetation, wildlife, or water quality.

5.5.7 Cutting back weed and hedge growth is essential for road safety. This maintenance operation should be done with light equipment. Critical review should occur before herbicides or other chemicals used for weed control are applied.

5.5.8 There should be continuous monitoring of drainage and erosion control structures. They should be maintained and revised, as required, to provide for the intended function.

5.5.9 Erosion should be prevented and controlled. Areas should be revegetated, and slopes and soils should be stabilized.

5.5.10 There should be an environmental emergency response plan ready to be placed in action during construction and maintenance operations. The plan should include emergency procedures to be followed in the event major drainage ways are blocked, fail, or don't perform as required during or immediately after major storm events.

5.6 ABANDONMENT

5.6.1 Abandonment procedures should comply with regulatory requirements, contractual obligations, and lessor and landowner requirements. Consideration should be given to cost-effective measures that will minimize environmental impacts.

5.6.2 Abandonment procedures may include the following considerations:

a. Restoration.
b. Abandonment in place.
c. Restoration of original or improved drainage.
d. Agreement on maintenance requirements, if any, after discontinued use, to be reached between the operator and new user.

5.6.3 Restoration plans should be prepared in detail and should consider methods such as:

a. Priority of stabilization and revegetation of disturbed areas.
b. Use of native plant species.
c. Stockpiling where reclamation would be enhanced.

6 Producing, Injection/Disposal Wells

6.1 COMPLETION, STIMULATION, AND WORKOVER OPERATIONS

6.1.1 Planning

For a new wellsite, an effective planning process should be carried out and should incorporate the latest guidelines for waste management, pit location and construction, handling of water discharges, and waste disposal. The location and size of new pits and pads for completion and workover equipment should be selected so as to minimize disruption of the surface resources and retain the potential for reclamation of the site. Refer to API Environmental Guidance Document for environmental aspects of reserve pit construction, operation and closure.

For an existing wellsite, the planning process is just as important to provide for safe and environmentally acceptable completion and workover operations. Existing facilities, such as pits and production equipment, should be reviewed and assessed to determine whether the facility is suitable in its present condition for the intended well operations or if modifications are required. For both new and existing wellsites, a waste management plan for handling and storing all waste materials generated during completion and workover activities should be developed. Refer to API Environmental Guidance Document: *Onshore Solid Waste Management in Exploration and Production Operations*, for information on how to develop such a plan. The waste management plan should address the specific wastes which are expected to be produced by the particular operations being performed, as well as provide guidelines concerning the actions to be taken in the event unexpected waste materials, including hazardous

materials, are encountered during the operations. In addition to safe handling and storage of waste materials on the wellsite, provisions should also be made for the disposal of each type of waste. Refer to API RP 55 and API RP 49 for planning and conducting operations involving hydrogen sulfide. Refer to API Bulletin E2 for information regarding management of naturally occurring radioactive materials (NORM).

Since much of the work on producing and injection wells is performed by contract or service company personnel, the operating company should confirm that the contractor's personnel have appropriate safety training, including hazard communication training, and are aware of requirements of the site specific waste management plan. Consideration should also be given to requiring performance bonds, if appropriate. The operator should also confirm that the contractor's personnel are aware of all applicable safety and environmental requirements of the operator.

6.1.2 Equipment Selection

Temporary equipment required to carry out well completion and workover operations should be included in the overall operation plan. Equipment should be installed in a manner so as to utilize the smallest practical area for prudent operations. Equipment should be maintained to present an acceptable appearance.

6.1.3 Producing wells should completed so production zones and drinking waters zones are isolated and cannot be contaminated by other formations.

The well must be cased and cemented properly to provide this protection.

6.1.4 Injection/Disposal wells should be completed so the injected fluids enter the desired formations and do not enter other formations or drinking water zones.

Typical injections are completed with three levels of protection for drinking water formations:

1. Surface Casing and Cement.
2. Long String Casing and Cement.
3. Tubing and Packer.

Also, the area around the injection should be reviewed to see of any wells (active, inactive or abandoned) were drilled through the injection/disposal zone. If wells were drilled close to the injection/disposal well that penetrated the injection/disposal formation and those wells did not isolate those zones, the injected fluids could flow from the injection zone through the improperly plugged or completed well to other oil and gas zones or drinking water zones.

6.1.5 Remedial Cementing

For both new and existing wells, the known and anticipated needs for remedial cementing to protect underground sources of drinking water (USDW) should be considered in the planning stage.

Excess cement, cement returns, and water used to wash cementing equipment should be contained and disposed of in an environmentally sound manner. Refer to API Environmental Guidance Document: *Onshore Solid Waste Management in Exploration and Production Operations* for additional information.

6.1.6 Selection, Use, and Storage of Fuels and Completion Fluids

Completion fluid selection should take into account the safety and logistics of transporting, handling, storing, and disposing of clean and contaminated fluid.

For both new and existing wellsites, all fuels, treatment chemicals, completion brines, and other similar liquids should be properly stored in labeled containers intended for that purpose. Containment should be constructed so spilled fuels or chemicals do not reach the ground.

Wherever practical, tanks or existing drilling pits should be used for completion and workover operations. Completion brines and other potential pollutants should be kept in lined pits, steel pits, or storage tanks. If a new earthen pit is necessary, it should be constructed in a manner that prevents contamination of soils, surface water, and groundwater, both during the construction process, during the life of the pit and after the pit is closed. Consideration should be given to the use of tanks or lined pits to protect soil and groundwater, especially for brines and oil-based fluids.

Normal operations should preclude oil in pits; however, in the event well completion operations dictate use of pits containing oil for a brief period of time, they should be fenced, screened, netted and/or flagged, as appropriate, to protect livestock, wild game, and fowl. Refer to the Migratory Bird Treaty and Enforcement Improvement Act for additional guidance. Oil accumulated in pits should be promptly removed and recovered, recycled, or disposed.

All liquids and other materials placed in pits should be recovered, recycled, or disposed in an environmentally acceptable manner (determined by the constituents in the material and the environmental sensitivity of the location).

When operations are completed, pits not required for well operation should be closed in accordance with the environmental sensitivity of the location. The surface area should be restored to a condition compatible with the uses of the adjacent land area. Any pit retained should be of minimum size commensurate with well operations. Refer to API Environmental Guidance Document: *Onshore Solid Waste Management in Exploration and Production Operations* for additional information and permitting requirements.

6.1.7 Stormwater Runoff

Natural drainage patterns of the area should be considered in the location of equipment, pads, and pits so that stormwater runoff does not create an environmental hazard by erosion of base material, which could lead to equipment instability, or by flooding of pits, which could cause a discharge of oil or other fluids into the local surface waters.

Discharges of stormwater from inside exploration and production facilities such as bermed areas around tank batteries (including oil and gas exploration, production, processing, or treatment operations or a transmission facility), which can reach waters of the United States, require a stormwater discharge permit and submittal of a stormwater pollution plan to the EPA. Contamination includes stormwater that comes into contact with any overburden, raw materials, or waste products on the site.

6.1.8 Blowout Prevention Equipment

All blowout prevention equipment (BOPE) should be selected, installed, and properly maintained in order to prevent uncontrolled releases to the environment. Refer to API RP 53.

All BOPE should have a working pressure rating that exceeds the maximum expected surface pressure.

Training exercises or drills should be held as necessary to ensure crew familiarity and that the BOPE is in good working order.

6.1.9 Control of Noise and Other Nuisances

Engines and production equipment should be provided with noise abatement measures, if appropriate, to reduce noise levels to the extent practical, considering the local environment. Other nuisances such as odors and dust should be controlled as considered appropriate for the location. Consideration should be given to minimizing traffic in general, particularly in or near urban areas.

6.1.10 Solids Removal or Capture

All produced fluids, drill cuttings, cement, cement returns, NORM scale, and other solids should be captured and classified, then reused, recycled, or disposed. Hazardous waste should be segregated in order to prevent contamination of nonhazardous materials.

6.2 WELL OPERATIONS

6.2.1 Equipment Operation and Maintenance

All well producing equipment should be kept neat, clean, painted and in good working order. Equipment should be painted to blend into the surroundings, if required or appropriate and kept clean to present an acceptable appearance. Selected moving equipment may be painted different colors to enhance visibility.

Safety guards necessary to protect humans, livestock, wildlife, and promote public safety should be maintained around equipment. Refer to API RP 11ER for information on guarding of pumping units. Equipment lockout/tagout procedures should also be developed and implemented.

Drip pans should be provided under equipment and storage containers potentially subject to minor leaks. These drip pans should be monitored on a routine basis to recover and recycle or dispose of accumulated oil and other liquids.

Bulk storage, recyclable, and reusable containers should be considered in order to reduce the number of containers that must be maintained and disposed. All reusable containers should be well marked to denote contents and the fact that they are to be reused.

The installation or use of double stuffing boxes, leak detectors, and shutdown devices should be considered in areas of particular environmental sensitivity.

Well cellars should be kept clean, dry, and guarded to prevent accidental falls. Well cellars should be filled if they may fill with sour gas and present a safety hazard to people.

6.2.2 Metallurgy and Corrosion

All equipment should be manufactured from materials which are suitable for the environment in which they are to operate. NACE Standard MR0175 and NACE RP0475 should be consulted for more information.

Equipment operating in known corrosive conditions should be inspected on a routine basis for signs of corrosion, with corrective action taken, as needed, to assure the equipment continues to operate in an environmentally acceptable manner.

If well production or injection conditions change in terms of hydrogen sulfide or carbon dioxide content, pressure, water cut, or any other parameter, the metallurgy of the well equipment should be reassessed to assure its suitability for the new conditions.

6.2.3 Leak Detection

All equipment should be inspected on a routine basis for signs of leakage, with corrective action taken, as needed, to assure the equipment continues to operate in a safe and environmentally acceptable manner.

All injection and disposal wells equipped with tubing and packed should periodically monitor the tubing casing annulus pressure to test the integrity of the tubing and packer. If a well is not completed with a packer then other methods should be used, such as tracer logs or temperature logs to be sure the fluids injected are properly controlled and are going into the proper injection/disposal formation. Frequency of test is dependent on the operating conditions. For example, if an

area has a high number of corrosion failures testing for the mechanical integrity of the well should be frequent.

6.2.4 Inspection and Certification

Equipment should be manufactured, refurbished, inspected, and installed according to manufacturer, API or other industry standards, and legal requirements.

6.3 WELL TESTING

6.3.1 Venting and Flaring

Venting and flaring should be restricted to a safe location. Where possible, the flare or vent should be located downwind considering the prevailing wind direction at the well location. When practical, all gases released to the atmosphere should be burned.

6.3.2 Flare Pits

Flare pits, sometimes called blowdown or emergency pits, should not be used for storage or disposal. The primary purpose of a flare pit is to catch any incidental fluid that might be associated with the gas stream that does not burn. Fluids in a flare pit should be removed daily, or as quickly as practical.

Siting and construction of flare pits should minimize the risk of surface and groundwater contamination. The size of the flare pit should be commensurate with the volume of liquid effluent that might be expelled from the gas flare. Use of a knockout vessel should be considered.

6.3.3 Control of Noise and Other Nuisances

Flares may need to be provided with noise abatement measures to maintain noise levels compatible with the local environment. The noise intensity, duration, location relative to public areas and natural resources, as well as the flare/vent exit design should be considered, where applicable.

Other nuisances, such as light emittance from a lighted flare, odors, and dust, should be controlled as considered appropriate for the location.

6.4 PLUGGING AND ABANDONMENT

Permanent abandonment is done when the wellbore has no further utility and is permanently sealed against fluid migration. Temporary abandonment operations may be performed when a wellbore has future utility, such as for enhanced oil recovery projects, and must be maintained in a condition where routine workover operations can restore a wellbore to service. The same environmental concerns exist in both cases. Refer to Bull E3 *Well Abandonment and Inactive Well Practices for U.S. Exploration and Production Operations, Environmental Guidance Document* and Surface Operating Standards for Oil and Gas Exploration and Development for both operations.

6.4.1 Subsurface

Several environmental concerns related to well abandonment should be addressed. The primary environmental concerns are protection of freshwater aquifers and underground sources of drinking water (USDW), as well as isolation of downhole formations containing hydrocarbons or used for injection. Additional issues, which should be evaluated, are the protection of surface soils and surface waters, future land use, and permanent documentation of abandoned wellbore locations and conditions.

6.4.1.1 Plugging Purpose

The purpose of plugging wells is to prevent interzonal migration of fluids; the contamination of freshwater aquifers, surface soils, and surface waters, and to conserve hydrocarbon resources either in the production interval or potential production intervals. Generally, contamination by an improperly plugged and abandoned well can occur in two ways:

a. The abandoned well can act as a conduit for fluid flow between penetrated strata, into underground sources of drinking water, or to the surface.
b. Contaminated water can enter the abandoned wellbore at the surface and migrate into underground sources of drinking water.

Such contamination is prevented when a well is properly plugged. Not only do the plugging operations prevent an abandoned well from becoming a conduit for contamination to occur, but, well construction and completion methods also contribute to the prevention of contamination.

Well plugging operations are focused primarily on protecting underground sources of drinking water, isolating downhole formations productive of hydrocarbons or used for injection, and protecting surface soils and surface waters. A surface plug prevents surface water runoff from seeping into the wellbore and migrating into underground sources of drinking water. Cement plugs isolating hydrocarbon and injection/disposal intervals and a plug at the base of the lowermost underground sources of drinking water accomplish this primary purpose.

Surface water entry into an abandoned well is a concern because the water may contain contaminants from agricultural, industrial, or municipal activities. Note that the cement plugs also work to protect surface soils and water from wellbore fluids by confining those fluids in the well. API Environmental Guidance Document: *Well Abandonment and Inactive Well Practices for U.S. Exploration and Production Operations* recommends that operators set a cement plug at the base of the lowermost freshwater aquifer or underground sources of drinking water during plugging and abandonment operations applicable to the well.

In addition to the cement plugs described herein, many state and federal regulatory agencies require cement plugs

across the base of the surface casing and in, or between, each producing and potential producing zone.

6.4.1.2 Fluid Confinement

It is essential that all formations bearing usable quality water, oil, gas, or geothermal resources be protected and/or isolated. The prevention of gas or fluid migration to other zones or to the surface is of primary importance. Open hole plugs, casing plugs, or cement squeezed through casing perforations will isolate the target formations in most cases. However, special procedures, such as perforating casing and circulating cement, may be necessary to isolate that potential production or injection formations existing behind uncemented casing. It is important to prevent interzonal flow in an abandoned well so that such cross-flow does not interfere in the commercial exploitation of the zones through nearby wellbores.

6.4.2 Surface

The cleanup and remediation of the surface may include cutting off the surface casing below ground level, restoring the surface to conditions near those that existed prior to the well being drilled, and marking the surface of the wellbore by installing an upright marker. The operator should restore the well site consistent with the criteria presented in API Environmental Guidance Document: *Onshore Solid Waste Management in Exploration and Production Operations*; however, the landowner should be consulted prior to beginning wellsite remediation. Some states require that the landowner be notified that a well is to be plugged. The landowner may have a right to use the well for a freshwater source.

6.4.2.1 Cleanup and Remediation

Assuming the landowner elects not to use the well as a freshwater source, the operator should set the required surface plugs; remove the wellhead; weld a steel plate on the surface casing stub, if required; fill in the well cellar, rat hole and mouse hole; and level the area. Casing strings left in the well should be cut off 3 to 6 feet below ground level, or deeper if required by the landowner.

Pits should be emptied and reclaimed to a condition similar to the rest of the reclaimed pad area. Pits should be allowed to dry or be solidified in situ prior to filling. The pit area may be mounded to allow for settling. Prior to removing or abandoning pipelines or flowlines, fluid displacement and line purging should be considered and fluid reclaimed, recycled, or properly disposed of according to fluid type.

Open burning can be used in some areas to dispose of nonhazardous, hydrocarbon-containing wastes that are unsuitable for recycling. Burning should be restricted to materials such as oily sorbents and paraffin and should be conducted only with approval of state or local air pollution regulatory agencies. Burning should be conducted during daytime hours and with due regard to wind direction and velocity. The results should not cause a nuisance that could result in black smoke or particulates.

Off-site commercial facilities should be used for other nonhazardous and hazardous waste disposal. The offsite facilities should be permitted and care should be taken with site selection. Refer to API Environmental Guidance Document: *Onshore Solid Waste Management in Exploration and Production Operations, API Remediation of Salt-Affected Soils at Oil and Gas Production Facilities* and *API Guidelines for Commercial Exploration and Production Waste Management Facilities.*

6.4.2.2 Soil Erosion

Disturbed areas, such as roads, pits, and wellsites, may need to be further remediated depending on lease agreements.

6.4.2.3 Inspection

Final abandonment is complete only after all surface equipment is removed, all pits are closed, and the surface is restored. A vertical steel monument may be considered that indicates the well location, operator, and well number. Thereafter, the abandoned wellsite can more easily be located and the former operator determined.

7 Lease Gathering and System Lines

7.1 INTRODUCTION

In planning lease gathering and system lines, including electrical distribution systems, it is important to consider the impact that construction operations and maintenance activities will have on people, animals, plants, and the land itself, both surface and shallow subsurface. The impact on current use, as well as possible future uses, should be evaluated along with potential future facilities expansion.

7.2 ROUTE SELECTION

7.2.1 The following environmental factors should be considered in planning lease gathering and system lines:

a. Proximity to lakes, streams (including dry washes and ephemeral streams), wetlands, drainage and irrigation ditches, canals, flood plains, and shallow water wells. These features should be evaluated in terms of disturbances during construction and routine operations, and in the event of accidental releases.

b. Depth to, and quality of, groundwater. The potential impact to groundwater, particularly from any releases from buried lines should be considered.

c. Removal of trees, disturbances to dikes, levees, and terraces, and destruction of growing crops. These impacts

should be evaluated with a focus on construction and routine maintenance activities.

d. Impacts to migratory bird habitat or critical habitat of threatened or endangered plant and animal species, including noise and dust.

e. Proximity to buildings or other facilities occupied or used by the public. Particular consideration should be given to homes, churches, schools, and hospitals.

f. Impact on cultivated lands.

g. Areas of special historical, archeological, recreational, biological, or scenic significance.

h. Land ownership.

i. Location of recently active shallow faults.

7.2.2 The selection of routing for lease gathering and EOR Injection and produced water disposal system lines, consistent with production, EOR and disposal requirements and overall economics, should consider:

a. Foreseeable uses of surfaces areas by either the landowner or tenant.

b. Possible exposure to future construction and excavation work.

c. Topography, when it is an important factor in:

1. Line design.
2. Right-of-way maintenance.
3. Possible land erosion.
4. Emergency response and containment of releases.

d. Location of existing rights-of-way.

e. Location of existing roads.

7.3 DESIGN

7.3.1 In design of lease gathering and system lines, appropriate industry codes should be followed.

7.3.2 Lease gathering and system line design should consider:

a. Estimated life of the line.

b. Line environment (nature of the soil, presence of water-saturated soil, alkaline flats, depth of frost, etc.).

c. Nature and quantity of product throughput, initially and as production matures, including the potential for enhanced oil recovery processes.

d. Impacts on existing facilities.

e. Consequences of possible line failure. Release of oil, water, or gas should be qualitatively evaluated. Consideration should be given to installing block valves to isolate line segments located in or near environmentally sensitive areas (such as wetlands), on either side of stream crossings, and in close proximity to areas occupied by the public. Consideration should also be given to sleeving lines or using heavier walled pipe in these areas.

The qualitative evaluation should consider the following:

1. Public impact.
2. Environmental impact (including potential natural resource damage assessment liability).
3. Damage to crops and domesticated animals.
4. Cleanup costs.

f. Corrosion inhibition measures (external and internal). All equipment should be manufactured from materials which are suitable for their operating environment. NACE Standard MR0175 should be consulted for further guidance, as applicable.

g. Burial to optimum depth to reduce exposure to hazards such as plowing, freezing, and other construction.

h. Provisions for various crossings (roads, streams, and other lines).

i. Optimum location for blowdown tanks, valves, etc.

j. Noise abatement (where appropriate).

k. Miscellaneous variable factors including operating pressures, temperature changes, line expansion, and desired safety factors.

l. If electrical distribution lines are to be installed in areas where raptors are likely to use them as perches, consideration should be given to installing wooden perch guards or cross members on the poles above the lines to prevent the birds from coming in contact with the charged lines.

7.4 CONSTRUCTION AND INSTALLATION

7.4.1 Lease line routes and applicable rights-of-way should utilize the smallest practical surface area, consistent with prudent operations.

7.4.2 Unnecessary damage to trees and other vegetation adjoining lease line routes should be avoided.

7.4.3 If contractors are used to install lines, the operator should verify that the contractor has implemented a safety program that includes a written hazard communication program. The contractor should supply MSDSs for all hazardous materials brought on site.

7.4.4 Appropriate inspections should be performed during construction to ensure design specifications are met.

7.4.5 Upon completion, lines should be inspected and pressure tested for possible leaks in accordance with state and local codes. Pressure test fluids should be collected and disposed the API Environmental Guidance Document: *Onshore Solid Waste Management in Exploration and Production Operations* for recommendations for disposal of these test fluids.

7.4.6 After installation of a new line, all lease line routes and rights-of-way should be cleaned up and restored to conditions compatible with existing land use, unless other arrangements have been made with the landowner. Disposal of all waste should be in accordance the API Environmental Guid-

ance Document: *Onshore Solid Waste Management in Exploration and Production Operations*.

7.4.7 Line routes and burial depth should be adequately documented to aid in preventing ruptures and/or accidental leaks during future excavation activities. Crossings should be marked.

7.5 OPERATION AND MAINTENANCE

7.5.1 All applicable personnel (both company and contractor) should receive training to provide for proper operation and maintenance of the lines. This training should include startup and shutdown procedures, normal operating procedures, and emergency response procedures. In the event of a leak or spill of a hazardous substance,

7.5.2 Line routes and facilities should be inspected at intervals dictated by evaluation of exposures and/or failures.

7.5.3 Appropriate steps should be taken to prevent surface and environmental damage from the use of hot oil, chemicals, and other treatments that are used to maintain lease gathering and system lines.

7.5.4 Proper maintenance practices should be exercised with respect to crossing markers, blowdown tanks, venting equipment, and corrosion protection equipment. Blowdown fluids should be collected and placed in the production system to recover hydrocarbons. Waste materials should be recycled, reclaimed, or disposed. Refer to API Environmental Guidance Document: *Onshore Solid Waste Management in Exploration and Production Operations.*

7.5.5 Pressure tests, profile surveys, and other means should be considered to meet operating safety requirements.

7.5.6 Operating procedures should provide for early identification of developing corrosion problems, failure prone equipment, and malfunctions so that corrective action can be taken before environmental or safety consequences occur. Frequency of failure analysis should be considered to aid in scheduling line replacements.

7.5.7 Appropriate industry codes should be followed with respect to maintenance of records, repairs, reporting of leaks, etc.

7.5.8 Whenever modifications are made to existing lines or there are significant changes in physical parameters (temperature, pressure, composition, etc.), the changes should be considered for evaluation pursuant to management of change principles. Where appropriate, facility drawings should be updated to show modifications and the superseded drawings should be destroyed.

7.6 ABANDONMENT OF GATHERING AND SYSTEM LINES

7.6.1 All surface lines should be removed. Lines should be purged prior to removal.

7.6.2 Surface and subsurface equipment connected to buried lines should be removed to a depth consistent with subsequent land use or, pably, to the depth of the buried lines.

7.6.3 Deleterious or hazardous materials should be displaced from any lines abandoned in place.

7.6.4 Where appropriate, each outlet of abandoned lines should be permanently sealed.

7.6.5 All crossing markers and other line markers should be removed.

7.6.6 The location of abandoned lines should be identified on facility maps.

7.6.7 Upon completion of abandonment activities, all disturbed surface areas should be cleaned up and restored to conditions similar to the adjacent lands.

7.6.8 Disposal of all waste. Refer to API Environmental Guidance Document: *Onshore Solid Waste Management in Exploration and Production Operations*.

8 Production and Water Handling Facilities

8.1 REQUIREMENT DETERMINATION (PRE-PLANNING CONSIDERATIONS)

The overall basis for siting, designing, constructing, and operating oil, gas, and water production, handling, and disposal/injection facilities should be to minimize adverse effects on the environment, consistent with providing an economical means of accumulating well, lease, or unit production from primary, secondary, or tertiary recovery methods and producing the ultimate recoverable reserves. Impacts on local population, land, surface and subsurface waters, air quality, and animal and plant species, including habitat, should be considered.

Water handling facilities are typically located adjacent to, or within, production facilities. Initial planning for these facilities within a field should consider future development potential in order to minimize surface disturbance. When practical and economic, central field locations should be considered to avoid the use of multiple facilities. Facility sizing should consider future throughput increases to minimize the need for additional tankage and treating vessels.

Production and water handling facilities should be planned to utilize the smallest practical surface area consistent with safe, prudent, and economic operations. In addition, produced water may be saline and corrosive. Therefore, special care

should be taken to minimize the possibility of environmental damage due to equipment upsets, spills, and leaks.

8.2 SITE SELECTION CONSIDERATIONS

8.2.1 Land Use

Topographic, population, environmental hazard, zoning, and other maps should be consulted, where applicable, to locate sensitive or high exposure areas [such as churches, schools, hospitals, residential areas, surface waters, freshwater wells, flood zones, active fault areas, threatened and endangered plants and animals (including habitat), migratory bird habitat, wetlands, archeological, recreational, biological, or scenic areas]. Where feasible, the site should be located away from these sensitive areas. The potential impact from upset conditions, such as oil or produced water spills and leaks, should be considered.

Final well patterns should be considered, if possible, to minimize right-of-way requirements for roads and lease lines. Existing roads and rights-of-way should be utilized to the maximum extent possible.

The land owner and/or surface tenant should be consulted to consider present and future uses of affected and adjacent land.

Production and water handling facilities should be planned to utilize the smallest practical surface area consistent with safe and prudent operations. Future expansion possibilities should be considered.

8.2.2 Erosion and Drainage

A site should be selected that minimizes the amount of surface terrain alteration to reduce environmental and aesthetic damages. Cuts and fills which pose possible landslide or slump problems should be avoided. Consideration should be given to stock piling topsoil, if feasible.

The natural drainage patterns of the land should be considered in selecting the site. Adequate culverts and drainage ditches should be provided, as required by the terrain. Soil stabilization, such as sod or grass seeding, should be provided to prevent erosion. Unnecessary removal of trees or alteration of other natural features should be avoided.

8.2.3 Subsurface Soil Conditions

Subsurface soil conditions should be considered for adequate foundation support of buildings, pumps, engines, tankage, and equipment used in the construction process.

Soil characteristics should be evaluated for construction of dikes, firewalls, and emergency containment areas. Lining of containment areas with compacted clay or synthetic liners should be considered where porous soil conditions exist or groundwater could be impacted.

Soil corrosiveness or resistivity should be evaluated to determine whether coating or wrapping of lease lines will be necessary to prevent or control corrosion. Cathodic protection should be considered for highly corrosive conditions or sensitive areas.

8.2.4 Fire Protection

Production and water handling facilities should not be located where the equipment will create a potential fire hazard. As applicable, proper fire safety equipment should be stored nearby.

8.2.5 Public Exposure

In noise control planning, production and water handling facilities should be located as far as practical from buildings or facilities occupied or used by the public.

Facilities should be located to minimize risk of public exposure from potential hazardous material releases, considering prevailing winds and topographic elevations to the maximum extent practicable.

8.3 FACILITY DESIGN

8.3.1 Equipment Sizing, Specifications, and Design

Consideration should be given to the following items in designing and constructing production facilities:

a. Production related equipment should be sized and designed to provide appropriate safety and utility. Future development and exploration plans should be considered when sizing equipment. Where appropriate, the facilities should be sized to handle current and future production to minimize retrofitting and improper use of equipment. Equipment should be designed with appropriate spill control devices, such as high/low level indicators or high/low pressure indicators, to improve safety and protection of the environment.

b. The anticipated time the equipment is expected to remain active should be considered. Proper design and installation can minimize future equipment failures and downtime.

c. Equipment and foundations should be designed and installed giving consideration to adverse natural conditions common to the area, such as floods, excessive snow and rain, earthquakes, tornadoes, hurricanes, and dust storms.

d. Equipment installations should comply with industry standards. Air pollution control facilities should be installed whenever practical, economical, and technically feasible. Flaring versus venting should be evaluated based on gas volume and composition, safety, economics, and local environmental impact.

e. Pressure requirements for vessels, lines, and other equipment should be considered. Any variance from the manufacturer's recommended rates or pressures should be

evaluated thoroughly. Refer to API Specification 12J for information on sizing and designing lease pressure vessels.

f. The following items should be considered in installing fired lease vessels:

1. Consideration should be given to surrounding facilities when selecting the placement of fired lease vessels.

2. Manufacturer's recommendations should be followed. Any variances from these recommendations should evaluated thoroughly.

3. Fired lease vessels should not be located immediately adjacent to oil, gas, or any other flammable or explosive storage facilities. It should be noted that some states have minimum distance requirements between fired vessels and storage facilities. Facilities should have a grade established so that releases of flammable fluid drain away from fired equipment.

4. Vessels should be well maintained and free of unnecessary debris or flammable products.

5. Fencing or some form of guarding should be considered to protect the public, livestock, and wildlife.

6. Refer to API Specification 12K and API Specification 12L for some information on selecting and designing fired lease vessels.

7. Consideration should be given to air permitting requirements for fired lease vessels.

g. The following items should be considered in installing bulk storage and loading facilities:

1. Adequate fire/retaining walls or other containment measures should be provided around tanks, where necessary to comply with regulatory requirements, in order to contain accidental discharges and prevent environmental damage. No open pipes should extend from within the firewalls which might allow contaminated fluids to be drained or siphoned from inside the containment area.

2. Installation of impervious foundations or liners under storage tanks should be considered to allow detection and containment of fluid releases.

3. Installation of high level alarms and/or monitors should be considered on tankage.

4. Installation of drip pans or other containment should be considered at truck or barge loading/unloading hose connections to contain any spillage.

5. Emission permits, if required, should be obtained prior to installation of facilities.

6. The following API recommended practices and specifications should be considered in designing storage and loading facilities:

Spec 11N	*Specification for Lease Automatic Custody Transfer (LACT) Equipment*
Spec 12B	*Specification for Bolted Tanks for Storage of Production Liquids*
Spec 12D	*Specification for Field Welded Tanks for Storage of Production Liquids*
Spec 12F	*Specification for Shop Welded Tanks for Storage of Production Liquids*
RP 12N	*Recommended Practice for Operation, Maintenance and Testing of Firebox Flame Arresters*
Spec 12P	*Specification for Fiberglass Reinforced Plastic Tanks*

h. The following items should be considered in installing internal combustion engines and compressor facilities:

1. Consideration should be given to minimizing noise disturbance. Internal combustion (IC) engines and compressor facilities should be located as far as practical from areas accessible to the general population. If feasible, alternate types of prime movers, such as electric motors, should be considered.

2. The emissions generated by the engine(s) exhaust should be of concern. Appropriate lead-time for permitting should be allowed, as it may require from 6 months to 1 year to permit compressor facilities. All required construction and emissions permits must be obtained before construction, modification, or relocation of an engine is initiated. The type of fuel should be selected to minimize pollutants. Electric power should be considered, where feasible.

3. Consideration should be given to installing drip pans or placing engines and compressors on impervious pads to minimize the impact of potential oil and chemical drips and spills. If drip pans or impervious pads are used, special attention should be given to ensuring that they are kept clean and that any oil or chemical collected is removed, recovered, and recycled or disposed in a timely and proper manner.

4. Piping for the relief valves of compressors should be of adequate size and piped to an appropriate vent or flare.

5. Placing fences, guard walls, or buildings around all engines and compressors should be considered for the protection of the public and any livestock or wildlife.

6. The following API standards and publications should be considered when installing and maintaining IC engines and compressor facilities:

Spec 7B–11C	*Specification for Internal Combustion Reciprocating Engines for Oil Field Service*
RP 7C–11F	*Recommended Practice for Installation, Maintenance, and Operation of Internal Combustion Engines*
Bul 11K	*Data Sheet for the Design of Air Exchange Coolers*
Spec 11P	*Specification for Packaged High Speed Separable Engine-Driven Reciprocating Gas Compressors*

i. The following items should be considered in planning, installing, and using pits, firewalls, and dikes:

1. Whenever practical, tanks should be used instead of pits.

2. Existing pits should be minimized and alternate means considered, where feasible. Pits should only be used for the purpose they were intended. Personnel should be advised on the specific use of the pit and what substances are allowed in the pit.

3. During the design and construction of pits and firewalls, necessary precautions should be taken to protect ground and surface water, crops, trees, livestock, and wildlife.

4. Pits should be designed and constructed to have sufficient freeboard, or provide adequate reserve capacity, to prevent overflow under maximum anticipated operating requirements and precipitation.

5. Pits should be fenced or otherwise equipped, as necessary, for public safety and to protect livestock and wildlife.

6. Netting of pits should be considered to protect migratory birds from exposure to the pit contents if there is a potential for the pit to have an oily surface or to contain potentially harmful substances.

7. Burn pits should be located where prevailing winds will reduce fire hazards and smoke nuisance.

8. Storage vessels for liquid hydrocarbons, saltwater, chemicals, or other fluids that are not acceptable to be discharged into the local environment should have dikes constructed around their perimeters.

9. Dikes and firewalls should be constructed of material to prevent the release of fluids to the local environment during an accidental or emergency discharge from their original containment.

10. Consideration should be given to designing dikes and firewalls with a sufficient perimeter and wall height to contain the maximum volume of the largest vessel or tank contained within, and with sufficient freeboard for maximum rainfall and snow melt. Any drain lines through dikes should be equipped with valves/blinds that are normally closed and locked.

j. The following items should be considered in using utilities at production sites:

1. Existing utilities should be considered in the design of production and water handling facilities.

2. If electricity is available, the use of electric motors/prime movers should be considered to minimize air emissions and noise.

3. Storage facilities should not be located under or near major electrical transmission lines.

4. All electricity, potable water, sewage, and municipal gas lines should installed in accordance with any applicable codes or regulations.

k. The following items should be considered in designing and installing flares/vents at production sites:

1. Flares/vents utilized in production facilities should be located downwind (with respect to prevailing wind direction) from the installation and at a proper safe distance from the related equipment.

2. The surrounding environment should be considered when designing flares. The flare should be located far enough from trees and other vegetation to ensure they will not be ignited during times of maximum flare and strong winds. Installation of liquid scrubbers should be considered.

3. Flares and vents, assuming vent ignition, should be of sufficient height to protect workers and the public during maximum flaring/venting and strong winds.

4. Fencing around flares should be considered to protect the public, livestock, and wildlife.

5. Installation of automatic igniters, rather than standing pilots, should be considered, where feasible, to conserve natural gas and reduce emissions.

6. Flares should be of a smokeless design, if possible.

7. Consideration should be given to design features which will prevent raptors or other birds from perching on flares.

l. Safety systems for protecting the environment should be considered as follows:

1. Installation of safety equipment and systems should be considered, i.e., emergency shut down (ESD) systems which have the ability to shut wells in, shut down compressors or other engines, or divert production during malfunctions or accidental releases. Where appropriate, alarm systems should be installed to notify the public or company officials of equipment failure or accidental releases. Equipment for fire protection should be installed and maintained, such as, fire extinguishers, spray nozzles, fire pumps, water storage, and automatic extinguishers.

2. API Recommended Practice 2350 *Overfill Protection for Petroleum Storage Tanks*, should be considered in the design of safety systems.

m. Corrosion abatement procedures should be considered as follows:

1. The corrosiveness of the anticipated gas or fluid should be considered during the design and selection of the equipment.

2. Where corrosion problems are anticipated, a corrosion abatement program should be established to minimize the potential for leaks.

3. Soil corrosiveness or resistivity should be evaluated for necessity of coating or wrapping of lines to be buried. In some cases, cathodic protection may be necessary.

Special consideration should be given to reducing air emissions associated with production and water handling facilities. The following items should be considered during design and construction of these facilities:

1. Vapor recovery units and flares.

2. Catalytic converters on fired equipment exhaust.

3. Minimization of benzene, hydrogen sulfide, and other hazardous emissions from tanks, glycol reboilers, and other equipment.
4. Minimization of operational gas vents, leaks, and discharges from pneumatic controls and other equipment.
5. Electric powered prime movers.
6. Valves installed on dead end piping should be capped, plugged, or sealed by a blind flange.

8.3.2 Equipment Location

a. Production and water handling facilities should be located where they do not present a fire hazard to near by facilities. Fired vessels, internal combustion engines, flares, or other equipment that produce sparks or flames should be appropriately separated from oil and gas storage facilities. Topographic and other maps should be consulted to determine if operational problems would effect the local environment. This could include, but is not limited to, the possibilities of oil or water discharges draining into surface waters. Minimization of damage to vegetation crops, forests, animal habitation, etc. should also be considered. Unnecessary removal of trees, excessive grading, or alteration of other natural features should be avoided.

b. In populated areas, the location of equipment should take advantage of prevailing winds in order to ensure public safety in the event of equipment malfunction, release, or fire. In all cases, production and water handling facilities should be located as far as practical from buildings occupied or used by the public.

c. Noise levels of production and water handling facilities should be considered when operating near populated areas.

d. Equipment should be located with consideration given to subsurface soil conditions such that there is an adequate foundation to support the facilities to be constructed and the equipment to be used in the construction processes.

e. The location of all wells should be considered to minimize rights-of-way requirements for lease roads and gathering lines.

8.3.3 Waste Management

a. Equipment and facilities should be located and designed to minimize the wastes generated by operations and maintenance activities.

b. Recyclable products should be used, where possible. Bulk storage, recyclable, and reusable containers should be considered to minimize waste.

c. Appropriate methods of collecting and recycling or disposing of waste generated during construction, operation, and maintenance of the facility should be considered.

d. Operators should develop waste management plans. Refer to API Environmental Guidance Document: *Onshore Solid Waste Management in Exploration and Production Operations* for additional information.

8.4 CONSTRUCTION CONSIDERATIONS

The following steps must be taken priot to initiating construction:

8.4.1 Site Preparation

a. Soil characteristics should be checked to determine the appropriate foundation design for the site.

b. The size and type of equipment to be used during construction should be considered to allow sufficient room to work in a safe manner.

c. Adequate culverts and drainage ditches should be provided as required by the local environment.

d. The open end of lines under construction should be temporarily capped at the end of each workday if a line could be accessible to wildlife.

8.4.2 Inspection and Testing

a. During construction, qualified personnel to ensure that design specifications are met should perform appropriate inspections to ensure that design specifications are met.

b. Upon completion, equipment and facilities should be inspected for possible leaks. If necessary, equipment should be pressure tested in accordance with applicable codes. If fluids are used to pressure test, collect and dispose of the fluids to API Environmental Guidance Document: *Onshore Solid Waste Management in Exploration and Production Operations* for applicable information.

c. X-raying of welds should be considered in critical areas where extreme pressure or corrosiveness is anticipated or where potential risk to the local environment is of great concern.

8.4.3 Qualification of Personnel

The qualifications of personnel working on the construction site should be evaluated to aid in ensuring the work will be properly performed.

8.4.4 Selection of Contractors

Consideration should be given to requiring contractors to have performance bonds should be considered when facilities are to be constructed in environmentally sensitive areas.

8.4.5 Equipment Installation

All equipment should be installed in accordance with the original design of the equipment. Any variations from the original specifications should be evaluated thoroughly to ensure safety of the operations. Refer to API RP 12R1 and API RP 7C–11F for information regarding equipment installation.

8.4.6 As-Built Drawings

Upon completion of facilities, the original drawings or schematics should be updated, as required. Changes or modifications from the original design or drawings should be noted for future reference.

8.4.7 Site Cleanup

Unused and excess construction materials should be properly stored or removed from the site upon completion. During construction, the site should be kept as clean and free of debris as possible. Where feasible, unused material should be removed from the construction site as it is determined to be surplus. Where applicable, construction waste should be recycled. Refer to API Environmental Guidance Document: *Onshore Solid Waste Management in Exploration and Production Operations* for additional information regarding management of waste.

8.5 OPERATION AND MAINTENANCE

8.5.1 Operational Procedures

a. Development of a standard operating procedure (SOP) manual applicable to each major facility should be considered. The SOP should contain information as to the equipment located at the facility, safe-operating practices for the equipment, startup and shut down procedures, and emergency procedures.

b. Consideration should be given to the analysis of failures or malfunctions so that corrective action can be taken to minimize future environmental incidents.

8.5.2 Personnel Training

Personnel should be trained in the safe and efficient use of facility equipment.

8.5.3 Equipment Inspection

Routine inspections should be considered on all equipment operating in corrosive environments. All safety equipment should be tested on a routine basis to ensure proper operation

8.5.4 Corrosion Monitoring and Treatment

Monitoring should be considered if produced fluids are suspected of being corrosive. If produced fluids are determined to be corrosive, a corrosion abatement program should be considered. This is especially important in populated or environmentally sensitive areas. Operating procedures should provide for early identification of potential corrosion problems in failure prone equipment. Reference API Corrosion Documents.

8.5.5 Housekeeping

a. The facilities should be kept clean, maintained, and operated in a safe and environmentally sound manner.

b. Facilities should be fenced in a manner to prevent access to the facility by the general public, livestock, or wildlife, where appropriate.

c. Signs should be posted in conspicuous locations to notify employees and the public of any dangerous situations such as, flammable conditions, high voltage, and hydrogen sulfide. State or local regulations may specify certain posting requirements.

d. Emergency phone numbers should be posted at the entrance to the facility, if located near a populated area.

e. Weeds should be controlled to a degree compatible with the local environment by cutting, mowing, or spraying to improve appearance and reduce the fire hazard. When herbicides are used to control weeds, the chemicals should be properly applied by trained personnel.

f. All equipment should be painted and/or kept clean to present an acceptable appearance and to provide protection from external corrosion.

g. Waste receptacles should be provided at appropriate locations for collecting discarded paper, rags, etc. and emptied on a regular basis.

8.6 WASTE AND RESIDUAL MANAGEMENT

Waste and residual management practices for production operations should be conducted consistent with lease and landowner obligations. This should include solid wastes and residuals, such as tank bottoms, drilling fluids and cuttings, liquid wastes and residuals, such as produced water and used oil, and gaseous wastes, such as hydrocarbons and carbon dioxide. A sound waste management plan is important to protect human health and the environment and minimize long-term liabilities to the operator.

A waste or residual management plan should utilize one or all of the options listed below, in order of pence, to protect human health and the environment:

a. Source Reduction—Minimize or eliminate the volume and/or toxicity of the waste generated.

b. Recycling—Reclaim or reuse the maximum amount of waste possible.

c. Treatment—Utilize techniques to minimize the amount and the toxicity of waste after it is generated, thereby minimizing the amount that has to be disposed.

d. Disposal—Employ environmentally sound and approved methods to properly dispose of generated wastes.

8.6.1 Source Reduction

Source reduction involves decreasing the volume or toxicity of wastes or other residuals that are generated. Product substitution is an example of source reduction. Production

and workover chemicals should be evaluated to determine if less toxic substitutes are available that meet the performance and economic criteria of the operator.

Reviewing common-sense housekeeping practices can be effective in reducing waste or other residual generation. Installing drip pans, as an example, on valves and fittings allows the collection of leaked oil before it contacts the soil and becomes a waste.

8.6.2 Recycling and Reclaiming

After all of the reduction options are considered, recycling or reclaiming the residual material should be evaluated. Examples of recycling and reclaiming are recovering waste oil, hydraulic oil, and oily sump water by reintroduction into the oil stream or transportation to a refinery. Drums, batteries, and scrap metal can be sold or returned to the vendor, where possible. Tank bottoms and sludges can be sold to reclaimers, where feasible.

8.6.3 Treatment

Following reduction and recycling efforts, treatment of waste should be considered to minimize the waste volume and the toxicity of the waste.

Filtration, centrifugation, evaporation, and flocculation are examples of reduction techniques that can reduce the volume of the actual waste that must be disposed. The toxicity of certain wastes can be reduced by chemical treatment, thermal treatment, and biodegradation prior to disposal.

8.6.4 Disposal

The final option for management of a waste, after source reduction, recycling, and treatment options have been considered and incorporated, is disposal. The operator should take into consideration the long-term fate of the waste and its constituents prior to disposal. Considerations that should be evaluated when choosing either an onsite or an offsite commercial disposal method are as follows:

a. General site review of the topographical and geologic features.

b. Groundwater review to determine the presence of groundwater and aquifers.

c. Area weather patterns to estimate rainfall and flooding potential.

d. General soil conditions.

e. Natural drainage areas.

f. Identification of environmentally sensitive conditions.

g. Air quality.

These criteria will help determine a waste disposal option that protects human health and the environment and limits future liability for the operator. Examples of waste disposal options that can be considered are:

a. Landspreading.
b. Roadspreading.
c. On-site burial.
d. On-site pits.
e. Annular injection.
f. Underground injection wells.
g. Regulated and permitted discharge of fluid.
h. Incineration.
i. Off-site commercial facility.

The operator should maintain adequate documentation of waste management activities. Development of a long-term records retention policy should be considered.

Refer to API Environmental Guidance Document: *Onshore Solid Waste Management in Exploration and Production Operations* and *API Guidelines for Commercial Exploration and Production Waste Management Facilities.*

8.7 SPILL PREVENTION, RESPONSE, AND CLEANUP

Accidental spills (including oil and saltwater) can, besides potentially damaging the environment, create difficult operational, legal, and public relations problems. It is very important to conduct operations in a manner that minimizes the potential for unauthorized spills. Outlined hereunder are some recommended operating practices which can be implemented by operators to minimize waste volumes and impacts on the environment.

8.7.1 Prevention

The best way to avoid adverse effects of spills is to prevent their occurrence. The key factors in spill incident prevention are adequately trained supervisors and field operating personnel. Four basic steps that can be taken to prevent accidental spills are:

a. The facility design should be reviewed to determine where the potential for spills exists. Information on prior spill incidents should be included in the review to assess areas where changes in equipment or practices may be needed. Using the results of the review, the following should be considered, as appropriate:

1. Modification of existing facilities or installation of new equipment or instrumentation, as needed, to reduce the possibility of spills, commensurate with the risk involved. Consideration should be given to the use of alarms, automatic shutdown equipment, or fail-safe equipment to prevent, control, or minimize potential spills resulting from equipment failure or human error.
2. Maintenance and/or corrosion abatement programs to provide for continued adequacy of all equipment.

3. Routinely scheduled tests and inspections of lines, vessels, dump valves, hoses, and other pollution prevention equipment where failure(s) and/or malfunction(s) could result in a potential spill incident. These tests and inspections should be commensurate with the complexity, conditions, and circumstances of the facility.
4. Operating procedures that minimize potential spills. These operating procedures should be clearly written and available to all operating personnel.
5. Examination of field drainage patterns and construction of oil traps in drainage ditches at strategic points to contain spilled oil before it reaches streams or water basins.

a. Training programs should be developed on spill prevention fundamentals and presented to operating personnel as often as necessary to keep them well versed on spill prevention practices.
b. Contingency and shut down plans should be developed for coping with hurricanes and other disasters (both natural and man made) so as to minimize the potential for oil spills or incidents causing pollution or other environmental damage.

8.7.2 Mitigation

Some other associated steps that should be taken to reduce the potential for oil spills are:

a. "Dead" piping and temporary connections should be removed when they are no longer required.
b. Piping subject to vibration should be braced to reduce movement and resulting fatigue failures.
c. Tanks should be checked for uneven settlement of the foundation, corrosion, and leaks.
d. Installation of pressure relief valves should be considered for liquid lines, which, if left full, could potentially rupture from liquid expansion due to heat.
e. Sleeve-type line couplings should not be used when there is a chance of line movement.

8.7.3 Spill Contingency Plan

In the event a spill occurs, it is extremely important for all responsible operating personnel to know how to respond quickly and effectively to control, contain, and clean up the spill. To ensure this capacity exists, a contingency plan should be prepared for inland areas as well as for areas near water. The plans should provide utilization of capabilities of oil spill cooperatives, whenever advantageous.

Spill plans should address the needs to advise the public about significant releases. The plan should include procedures to advise government officials and provide appropriate information and access to the press.

8.7.4 Control and Containment

In the event a spill occurs, the source of the spill should be to stopped, or reduced as much as possible, in a safe manner. The spread of the spilled substance should be controlled or contained in the smallest possible area to minimize the adverse effects. Some methods which can be used to control and contain discharged substances, particularly oil, include:

1. Retaining walls or dikes around tanks and other spill prone equipment.
2. Secondary catchment basins designed to prevent the spread of oil if it escapes the primary wall or dike.
3. Permanent booms in water basins adjoining the facility.
4. Temporary booms deployed in the water after the spill occurs.
5. Use of special chemicals to jell or biodegrade the oil to prevent the spread of oil spilled into or on water.

Operators should evaluate the potential for spills and damages and use this information to determine the type and size of primary and secondary containment necessary.

The type and footage of containment boom installed or stored for deployment will vary with the type, size, and location of the facility and spill potential. This information should be developed for each main area or facility and be stated in the facility contingency plan. In addition, the contingency plan should list where emergency equipment is located.

The contingency plan should state the type(s) of chemicals that can be used effectively and list sources and procedures for applying these chemicals. Spill response drills/simulations should be considered, with regulatory agency and contractor personnel participating.

8.7.5 Cleanup

Cleanup procedures should be developed and included in the facility contingency plan. Up-to-date lists of effective cleanup materials and equipment and a list of potential contractors who can supply needed assistance should also be included and maintained in the contingency plan.

Depending on the spill potential at each area, a stock of appropriate cleanup materials sufficient to handle small spills should be maintained on hand at all times. The amount of cleanup material will depend on the time required to obtain more material if the size of the spill should increase.

The following suggested cleanup practices should be considered:

a. Using cleanup materials and equipment on hand, immediate action should be taken to clean up any spilled oil or other substance. Depending on the substance spilled, personnel

performing and supervising cleanup operations may require specific training.

b. Advance planning and arrangements should include availability and ready access to vacuum trucks and to similar pickup equipment to recover the spilled material.

c. Advance arrangements should be made for rights of ingress and egress to public and private property that may be affected by a spill or the ensuing cleanup operation.

d. Landowners should also be notified of spills and kept informed of spill cleanup progress.

e. Plans, procedures, and programs should be improved and updated by analyzing previous spill incidents. Prevention, control and containment, and cleanup procedures should be revised accordingly to make them more effective for future responses.

8.8 ENVIRONMENTAL ASSESSMENT PRIOR TO PURCHASE OR SALE OF EXISTING FIELDS AND LEASES

Prior to the purchase or sale of an existing field or lease, consideration should be given to documenting the environmental condition of that property. By documenting the presence or absence of surface, subsurface, or groundwater contamination, an operating company may be able to reduce its exposure to significant future liabilities. Aerial photographs may be beneficial during this process.

Documentation of audits, assessments, and operating practices is important to identify potential problem areas. Care should be taken to document actions taken to correct deficiencies identified by audits.

8.9 ABANDONMENT OF FACILITIES

8.9.1 Purging and Flushing of Equipment Prior to Removal

All equipment such as tankage, separation vessels, meter runs, flow lines, and pumps should be purged and flushed, as appropriate. Whenever possible materials recovered should be recycled, reclaimed, or disposed. Refer to API Environmental Guidance Document: *Onshore Solid Waste Management in Exploration and Production Operations* for additional information.

8.9.2 Equipment Removal

The following equipment removal issues should be considered:

a. Tanks, separation vessels, meter runs, surface lines, pumps, and any other exposed surface equipment should be removed. Removal of the associated equipment foundations should be considered.

b. Exposed piping segments from surface or subsurface equipment connecting to buried lines should be removed to a depth consistent with subsequent land use or, pably, to the depth of buried lines. Where feasible or where desired to limit potential future liabilities, consideration should be given to removing buried lines.

c. Where appropriate, each outlet of any abandoned lines should be permanently sealed.

d. Operators should consider removing all crossing markers and other line markers.

e. Where appropriate, the location of abandoned lines should be identified on facility maps.

8.9.3 Pit Abandonment

All pits and surface impoundments should be closed and backfilled. The location of abandoned pits should be documented. Materials removed from pits should be reclaimed, recycled or disposed. Refer to API Environmental Guidance Document: *Onshore Solid Waste Management in Exploration and Production Operations* for additional information. Documentation should be kept for disposed materials.

8.9.4 Land Restoration

Upon completion of abandonment activities, all disturbed surface areas should be cleaned up and restored to conditions similar to the adjacent land or to landowner requirements. Restoration should include stabilization and revegetation of disturbed areas using native plant species or agency approved seed mixes. Drainage and maintenance requirements should also be considered.

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