PRELIMINARY DISCUSSION DOCUMENT

OFFSHORE OIL AND GAS PRODUCTION PLATFORMS (RIGS) WELLHEAD FIRES AND ASSOCIATED ENVIRONMENTAL HAZARDS

PREPARED FOR

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OFFSHORE OIL AND GAS PRODUCTION PLATFORMS (RIGS) WELLHEAD FIRES AND ASSOCIATED ENVIRONMENTAL HAZARDS

Primary Fire Hazards

- Ignition of high pressure oil stream which contains a percentage of flammable gases.

- Ignition of natural gas stream.

In both of the above cases the ignition sources could be identical, namely:

(a) Friction sparks from flying metal as a result of high pressure blow-out at the wellhead, secondary valving and/or pipe runs.

(b) High pressure blow-out impinging upon gas burn-off flare (methane).

(c) Friction sparks caused by the ejection of stones, rocks and metallic particles normally associated with wellhead blow-outs.

(d) Liquid or gaseous leak ignited by welding or other local energy sources.

(e) Direct lightning strikes.

(f) Ship/rig collisions.

(g) Seismic vibration (earthquake).

Of the above cases, (a), (b), (c) and (d) have occurred in various locations; there have been some minor incidents of lightning strikes without major disaster; near-miss incidents of ship/rig collisions have occurred; and we have no recorded incidents of earthquakes resulting in offshore disasters.

Secondary Fire Hazards

It should be recognized that in most incidents of oil wellhead blow-outs involving fire, major quantities of crude oil are not consumed in the fire, resulting in oil saturation of the platform and the adjacent ocean. These flammables can be and often are ignited from the primary fire source and result in major destruction of the rig and associated pollution.

Primary Environmental Hazards (Non-Fire Case)

It is noticeable that not all major blow-outs and spillages result in fire. In these cases, major oil spillage and ocean contamination is unavoidable, often resulting in major shoreline pollution.

Radiation Hazard

It has been established that in the case of oil wellhead blow-outs "gushers" in excess of 300' high have been recorded. Such a gusher would eject at a rate in excess of 100,000 barrels/day. Assuming that the oil is of a medium grade (viscosity), flame temperature would be in the region of 2000^{o}F (i.e., diffusion flame temperature). The flame would be optically thick and the surfaces being radiated (personnel quarters, etc.) would absorb all of the incident radiation. Radiation temperatures in the immediate vicinity could exceed 1000^{o}F under conditions of prolonged exposure. Assuming that the down-hole safety valve is closed within 30 seconds after wellhead rupture, the radiation energy emitted will be small. This would apply in both oil and gas cases. Reverting to the gas wellhead fire case, the largest fire of this nature was the 450' fire plume which occurred at Gassi Touil in the Sahara.

We should bear in mind that there are several hazard sources on offshore platforms other than the specifically mentioned wellhead fire. One that comes readily to mind is the oil separator failure and/or failure of the 20" (approximate) inlet line to high pressure separators.

General

The hazards described are major and occur fairly frequently, considering numbers of operational offshore platforms. All major cases have involved the high rate discharge of crude oil/gas mixtures which generally require high energy ignition sources. This is particularly true where high grade crude is produced and where the gas content of crude is low.

Identified fire hazards could be extinguished utilizing specially developed detection and suppression equipment. It is considered that the main requirement is to provide sufficient extinguishing agent at high rates of discharge for a prolonged period. Such systems could be explosively operated within milliseconds of ignition, thus avoiding heat radiation and major secondary ignition

problems. Such rapid extinguishment is essential if the wellhead is to be plugged or valved-off. In most cases of major spillage involving ignition, water has been used as a coolant. Consideration should therefore be given to the provision of ample traversing water monitors, preferably automatically operated and controlled, to provide voluminous quantities of water to adjacent decks and structures and to protect operations personnel. Such equipment could be manually overridden and/or synchronized to operate seconds after detection.

Detection methods should utilize state-of-the-art UV (Geiger Muller type tubes) cross-zoned or priority-zoned in couples to minimize inadvertent operation of the systems. Consideration should also be given to the use of pressure detectors located at the wellhead which could also be cross-zoned to the UV detector circuit.

In addition, ample manually-operated high-rate discharge extinguishing equipment in the form of both water and dry chemical (Purple K) should be available as secondary or back-up equipment.

The main objective of providing fire suppression equipment is to enable repair crews to plug the wellhead and/or operate shut-off valves as early as possible after the incident, thus minimizing oil pollution problems. With regard to "burn down" to sea surface fire cases, only large quantities of aqueous film-forming foam (AFFF) extinguishing agent would be effective. It is suggested that a high-rate discharge system, utilizing AFFF as an agent, discharging through outward-oriented nozzles at the rig perimeter could be developed for sea surface fires. Due to the size of such fires, the AFFF system would have to be backed-up by sea-going fire fighting craft.

With regard to major spillages involving fire, pollution could rapidly reach catastrophic proportions. Therefore, consideration should be given to the entrainment or entrapment of surface oil, perhaps by means of chemical oil-herding compounds supplemented by the provision of floating pumps. These methods would provide for localized control of the spillage and easier skim removal. The principal problem in wellhead blow-outs, associated malfunctions and major leaks, is to stop the flow as quickly as possible, to reinstate the normal supply method, and to make safe the production unit. It is suggested that due to the inseparable problems of plugging wellhead blow-outs, consideration should be given to a study of the current state-of-the-art in this specific engineering field. We feel that this is not our technology base, but would be willing to render assistance where possible.

The following suggested contract research phases have emerged as a result of our initial study:

Phase I

- Literature search to determine current state-of-the-art in detection and suppression of major offshore gas and oil fires.
- Conclusions of literature search in report form.
- Recommendations for future work.

Phase II

Selection and methodology of most feasible systems, consisting of:

- Development of wellhead detection and suppression system.
- Development of water deluge (coolant) system.
- Development of AFFF perimeter system.
- Dynamic large-scale or full-scale fire test.
- Phase II Report.

Phase III

- Development and evaluation of oil-herding chemicals and techniques involving dynamic tests in calm and turbulent fresh and salt water.
- Phase III Report.

Phase IV

- Participation in preparation of draft standards and codes of practice for fire detection, suppression and safety for offshore oil and gas platforms.
- Participation in preparation of standards for pollution control, oil-herding and oil removal.

We feel that a degree of flexibility would be desirable with regard to initial determinations of scope of work. We would at this time respectfully point out that our suggested programs could involve

large capital expenditure, due mainly to both the nature of the work and the magnitude of the problem, coupled with our opinion that large-scale dynamic fire tests would necessarily be involved to prove the efficacy of the hardware/agent combinations.

TO: John Dyer

API RP 2G
First Edition
January 1974

API
RECOMMENDED PRACTICE
FOR

PRODUCTION FACILITIES ON OFFSHORE STRUCTURES

OFFICIAL PUBLICATION

REG. U.S. PATENT OFFICE

AMERICAN PETROLEUM INSTITUTE
Washington, D. C.

Issued by
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Division of Production
300 Corrigan Tower Bldg.
Dallas, Texas 75201

TABLE OF CONTENTS:

Foreword

This *Recommended Practice for Production Facilities on Offshore Structures* is under the jurisdiction of the API Committee on Standardization of Offshore Structures.

It contains engineering guidelines and suggested installation practices pertaining to production equipment on offshore structures. These guidelines are based on sound engineering design principles and Industry experience gained during the development of offshore oil and gas resources.

This Recommended Practice is directed toward maximum safety of personnel, compliance with regulations, prevention of pollution for preservation of the environment, protection of the production facility and accessibility for operation and maintenance.

NOTE: *This is the first edition of the recommended practice. It was authorized for publication at the June 1973 meeting and reported in Circ PS-1464.*

Issued
January 1975

Supplement 1

to

API RP 2G (First Edition)

RECOMMENDED PRACTICE

FOR

PRODUCTION FACILITIES

ON

OFFSHORE STRUCTURES

Foreword

This supplement covers changes in API RP 2G (First Edition, Jan. 1974): *Recommended Practice for Production Facilities on Offshore Structures,* adopted at the 1974 Standardization Conference as reported in Circ PS-1486.

Page 11, Par 6.4c; *Replace existing paragraph with the following:*

c. **Gas Alarm.** Gas is usually detected at two Lower Explosive Limit Levels which are generally not more than 20% L.E.L. and 80% L.E.L. respectively. An alarm may be connected to sound at the lower level, and automatic shut-in sequences and emergency equipment may be activated at the higher level. Alarm signals may be interconnected to the fire alarm panel for combined functions.

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SECTION 1
SCOPE

1.1 Coverage. The intent of this Recommended Practice is to assemble into one document useful Procedures and Guidelines available in Industry pertaining to planning, designing and arranging production equipment on offshore structures for safe, pollution free and efficient production of oil and gas. This Recommended Practice is not to be construed as a specification, nor is it intended to be used as fixed rules without regard to sound engineering judgement. Also, it is not intended to override or otherwise supersede any existing code or Governmental Rule and Regulation.

1.2 Multiple Use of Structures. Multiple use of offshore structures may be necessary to perform the various functions required for the drilling and production of oil and gas. For new structure installations where production equipment requirements are reasonably known, equipment should be initially arranged in accordance with this Recommended Practice. Existing structures and those constructed prior to knowledge of actual production requirements, in many cases, require the physical placement and arrangement of equipment in the available space. In such cases, care should be taken to determine the best arrangement within the guidelines of this Recommended Practice. Placement of drilling and workover equipment is outside the scope of this Recommended Practice except that it should be given full consideration when planning the arrangement of production equipment.

1.3 Primary Considerations. In the tight confines of offshore structures, the primary considerations for placement of equipment are safety and prevention of pollution. The release of flammable liquids, or vapors, whether during normal operations or as a result of any unusual or abnormal condition should be considered. Equipment which may be a source of ignition under normal or abnormal operating conditions should be isolated or otherwise protected from major fuel sources.

SECTION 2
DEFINITIONS

Compressor A rotating or reciprocating machine, together with its driver and associated scrubbers, coolers, pipe, valves, controls, etc., used to compress gas or air from a lower to a higher pressure.

Deck, Main The uppermost deck on the structure.

Deck, Cellar A deck located immediately below the main deck.

Deck, Sub-Cellar A deck located below the cellar deck. Decks below the cellar deck will be designated as Sub-Cellar Deck A, Sub-Cellar Deck B, etc.

Deck Area, Central That portion of the main deck, cellar deck or sub-cellar deck within the boundary line of perimeter deck columns.

Deck Area, Rig That area of the deck necessary for support of drilling or workover operations.

Deck Area, Cantilever That portion of the main deck, cellar deck or sub-cellar deck area outside the boundary line of perimeter deck columns.

Direct Fired Vessel A vessel in which the temperature of fluids is increased by the addition of heat supplied by a flame. The flame is applied direct to the fluid container.

Fired Process Area That area in which a fired vessel is located.

Fire Wall A partition fabricated from non-combustible materials to prevent the spreading of flames and to provide a heat shield.

Generator, Electric A rotating machine together with its driver and associated switch gear used to generate electrical energy.

Header A pipe or chamber which receives the flow from two or more lateral lines.

Hoisting Equipment A piece of equipment used to vertically lift materials, supplies, etc. from boats or barges to one of the structure decks. This is usually a crane or stiffleg derrick located on the main deck and may be driven by internal combustion engine or an electric, pneumatic or hydraulic motor.

Indirect Fired Vessel A vessel used to increase the temperature of a fluid by the transfer of heat from another fluid which is heated by a flame in the same vessel. The flame is contained within a fire tube or tubes.

Indirect Heated Vessel A vessel or heat exchanger used to increase the temperature of a fluid by the transfer of heat from another fluid such as steam, hot water, hot oil or other heated media.

Manifold & Header System An assembly of pipe, valves and fittings by which fluid flow from one or more sources is selectively directed to one or more outlets. Commonly, the flow line from the wellhead is connected to a manifold and each manifold outlet is connected to a header which directs the flow to one of the production systems.
An injection manifold divides a common source of gas, water or other fluid among several injection wells.

Machinery Area An area where equipment incorporating rotating or reciprocating mechanical equipment in the form of internal combustion engines, gas turbines, electric motors, generators, pumps and compressor is located.

Personnel & Utility Area That area which contains living quarters and other personnel service equipment.

Personnel Landing A landing near the water level used primarily for transfer of personnel to and from boats and barges.

Pressurized Surge Vessel An unfired pressure vessel used to provide for fluctuations in liquid flow to pumps.

Protective Wall A barrier designed to withstand or deflect falling or flying objects, prevent flow of liquids from one area to another or restrain minor explosions.

Pump A rotating or reciprocating machine together with its driver and associated pipe, valves, pulsation dampners, etc. used to transfer fluids.

System, Flare A system for discharging gas through a control valve from a pressurized system to the atmosphere during normal operations. This discharge may be either continuous or intermittent, and may or may not be ignited.

System, Emergency Gas Relief A system for discharging gas by manual actuation or by an automatic pressure relief valve from a pressurized system to the atmosphere for the purpose of relieving an abnormally high pressure.

Separator An unfired pressure vessel used to separate gas and liquids by differential gravity settling and/or centrifugal action. Separators are commonly cylindrical, either vertical, horizontal or spherical in shape.

Unfired Process Area That area that contains process equipment that does not have a flame.

Wellhead An assembly of valves and fittings used for control of the flow from a producing well or to an injection well. A wellhead usually includes a casing head, tubing head, master valve(s), wing valve and automatic shut-in valve. A flow control valve or choke may be included. Offshore structures usually include several wellheads.

Wellhead Area That area of deck that surrounds the individual wellhead(s).

SECTION 3

CODES, RULES AND REGULATIONS

3.1 Governmental Rules and Regulations. Regulatory agencies have established certain rules and regulations which may influence the nature and manner in which production equipment is installed and operated on offshore structures. Listed below are the significant rules and regulations which should be considered when planning oil and gas production facilities or establishing operating practices on offshore structures:

a. Code of Federal Regulations, 30 CFR 250.
b. Notice to Lessees and Operators of Federal Oil, Gas Leases in the Outer Continental Shelf, Pacific Region, OCS Order No. 1 through 10.
c. Notice to Lessees and Operators of Federal Oil, Gas and Sulphur Leases in the Outer Continental Shelf, Gulf of Mexico Area, OCS Order No. 1 through 12.
d. List of Potential Items of Non-Compliance and Enforcement Action. U.S. Geological Survey, Conservation Division, Branch of Oil and Gas Operations, Gulf of Mexico Area.
e. U.S. Coast Guard Rules and Regulations for Artificial Islands and Fixed Structures on the Outer Continental Shelf — 33 CFR — Sub-Chapter N, Part 140 through 146 and Sub-Chapter C — Part 67.
f. Occupational Safety and Health Act of 1970, 29 CFR 1910.
g. Environmental Protection Agency Regulations on Discharge of Oil 40 CFR 110.
h. Coast Guard Regulations on Oil Spills. 33 CFR 153. 46 CFR 126.
i. Natural Gas Pipeline Safety Act. 49 CFR 192.

3.2 Industry Codes and Standards. Various organizations have developed numerous Standards, Codes, Specifications and Recommended Practices which have substantial acceptance by Industry and Governmental Bodies. These documents could be useful references and helpful in designing offshore production facilities. Documents referenced herein are some of the more commonly accepted and the listing is not intended to be all inclusive.

American Petroleum Institute

a. API RP 2A, *Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms*
b. API Spec 2B, *Specification for Fabricated Structural Steel Pipe*
c. API Spec 2C, *Specification for Offshore Cranes*
d. API RP 2D, *Recommended Practice for Operation and Maintenance of Offshore Cranes*
e. API Spec 5L, *Specification for Line Pipe*
f. API Spec 5LS, *Specification for Spiral-Weld Line Pipe*
g. API Spec 5LX, *Specification for High-Test Line Pipe*
h. API Spec 6A, *Specification for Wellhead Equipment*
i. API Spec 6D, *Specification for Pipeline Valves*
j. API RP 500B, *Recommended Practice for Classification of Areas for Electrical Installations at Drilling Rigs and Production Facilities on Land and on Marine Fixed and Mobile Platforms*
k. API RP 500C, *Recommended Practice for Classification of Areas for Electrical Installations at Petroleum and Gas Pipe Line Transportation Facilities*
l. API RP 520, *Recommended Practice for the Design and Installation of Pressure-Relieving Systems in Refineries*
m. API RP 521, *Guide for Pressure Relief and Depressuring Systems*
n. API Spec 7B-11C, *Specification for Internal-Combustion Reciprocating Engines for Oil Field Service*
o. API RP 7C-11F, *Recommended Practice for Installation, Maintenance and Operation of Internal Combustion Engines*
p. API Spec 12B, *Specification for Bolted Production Tanks*
q. API Spec 12F, *Specification for Small Welded Production Tanks*
r. API Spec 12J, *Specification for Oil and Gas Separators*
s. API Spec 12K, *Specification for Indirect Type Oil-Field Heaters*
t. API Spec 12L, *Specification for Vertical Emulsion Treaters*
u. API Spec 661, *Cooled Heat Exchangers for General Refinery Services*

The American Society for Testing and Materials

a. ASTM A 53, *Specification for Welded and Seamless Steel Pipe*
b. ASTM A 106, *Specification for Seamless Carbon Steel Pipe for High-Temperature Service*
c. ASTM A 134, *Specification for Electric-Fusion (ARC)-Welded Steel Plate Pipe, Sizes 16 in. and Over*
d. ASTM A 135, *Specification for Electric-resistance-Welded Steel Pipe*
e. ASTM A 139, *Specification for Electric-Fusion (ARC)-Welded Steel Pipe (sizes 4 in. and over)*
f. ASTM A 155, *Specification for Electric-Fusion Welded Steel Pipe for High-Pressure Service*
g. ASTM A 211, *Specification for Spiral Welded Steel or Iron Pipe*
h. ASTM A 333, *Specification for Seamless and Welded Steel Pipe for Low-Temperature Service*
i. ASTM A 381, *Specification for Metal-Arc-Welded Steel Pipe for High-Pressure Transmission Service*
j. ASTM A 539, *Specification for Electric-Resistance Welded Coiled Steel Tubing for Gas and Fuel Oil Lines*
k. ASTM A 372, *Specification for Carbon and Alloy Steel Forgings for Pressure Vessel Shells*

American Society of Mechanical Engineers

a. ASME *Boiler and Pressure Vessel Code: Pressure Vessels, Sections II, IV, VIII and IX.*

American National Standards Institute

a. ANSI B31.3 *Petroleum Refinery Piping*
b. ANSI B31.4, *Liquid Petroleum Piping Systems*
c. ANSI B31.8, *Gas Transmission and Distribution Piping Systems*

National Fire Protection Association

a. National Fire Codes, Volume 1 through 10

Tubular Exchangers Manufacturers Association

a. Standards of Tubular Exchangers Manufacturers Association

The Offshore Operators Committee

a. Crane Safety Manual
b. Manual of Safe Practices in Offshore Operations

SECTION 4

PLANNING — OPERATIONAL & DESIGN CONSIDERATIONS

GENERAL CONSIDERATIONS

4.1 Planning and arranging production equipment on offshore structures for safe, efficient operation and maintenance requires the consideration of many factors. Some of the more important factors are presented in this Section.

4.2 Space is an important factor in promoting a safe operation. As the density of production facilities on a structure increases, operating and maintenance problems and the chance of failure also increase. The use of other protective measures should be considered.

4.3 Adequate space should be provided around machinery, tanks, vessels and pipe headers to permit easy access for maintenance. Craneways or lifting points should be provided for the safe handling of equipment and supplies. Work areas should be well lighted and ventilated with adequate provisions for communication between personnel.

4.4 In determining spacing for production facilities on an offshore structure, many factors should be considered. Some of the major items to be considered are:

a. Space for operation and operating personnel.
b. Space for maintenance access.
c. Space to provide safety from inadvertent mechanical damage.
d. Space to protect against sources of ignition.
e. Space to provide access for control of fires.
f. Space to limit exposure of important equipment and utilities to possible fire.

4.5 It is recognized that the space limitations imposed by the very nature of offshore structures will make many compromises necessary. However, production facilities properly thought out can be arranged to provide a safe, pollution-free operation.

4.6 All equipment should be designed in accordance with the latest standards and in compliance with current governmental regulations.

4.7 Piping in all areas should be planned to minimize the number of bends, corrosion and erosion, and also provide easy avenues of access and egress from the functional parts of each piece of equipment.

SPECIFIC CONSIDERATIONS

4.8 **Personnel Safety.** The safety of operating personnel is the primary consideration in designing producing facilities. Requirements for means of escape, personnel landings, guards, rails and lifesaving appliances are specified in *U.S. Coast Guard Rules and Regulations for Artificial Islands and Fixed Structures on the Outer Continental Shelf.* For brevity, these requirements are not repeated in this Section.

4.9 Equipment should be arranged to provide well defined corridors of egress from all structure areas. Two exit routes, in opposite directions, from each area should be provided where possible. Enclosed areas containing a source of fuel should have at least two exits opening to a non-hazardous area.

4.10 **Utilities.** As noted elsewhere in this Recommended Practice there are many different types of structures utilized in offshore operations. These vary from single well structures to multiwell completely self-contained drilling and production handling structures. Similarly, the utilities and quarters required vary with the type of structure and how it is utilized.

4.11 Utilities on offshore structures may include potable water, non-potable water, sea water, electricity, gas, air for control of power, sewage, garbage disposal and communication systems.

4.12 In planning the utility systems, consideration should be given to number and type of wells, oil and gas processing facilities, remoteness from shore, anticipated production volume, number of people to be housed on the structure, type of fire fighting system, type of control system, and electric power source. For example, the single well structure may not require the installation of any utility system; whereas, the self-contained manned structure may require all utilities listed.

4.13 **Safety Shut-Down Systems.** A properly designed safety shut-down system will sense an abnormal operational or equipment condition and react to this condition by shutting in or isolating necessary system components, or even the entire system. Other actions such as sounding alarms, starting fire extinguishing systems and depressuring all piping and pressure vessels may also be initiated by the shutdown system. The actions to be taken will depend on the level of criticality of the abnormal conditions. The three primary purposes for installing shut down system are to:

a. Protect human life
b. Prevent ecological damage
c. Protect the investment

4.14 In planning and designing shut down systems, it is first necessary to determine what events could endanger life, environment or investment. Inspection, maintenance and failure documentation are definite considerations in planning shut down systems. Inspection procedures which call for in-place functional tests or component removal should be carefully planned. Location of shut down system components for easy access for the inspection and tests should be included in planning production facilities arrangements. Education and training of personnel performing inspections is necessary and should be conducted on a formal basis.

4.15 **Flare and Emergency Relief Systems.** Flare and emergency relief systems associated with process equipment should be designed and located considering the amount of combustibles to be relieved, prevailing winds, location of other equipment, including rigs, personnel quarters, fresh air intake systems, helicopter approaches and other factors affecting the safe normal flaring or emergency relieving of the process fluids and gases.

4.16 Flare and emergency relief systems may include a vertical stack, a cantilevered boom, an underwater flare or remote flare pile. They will be be designed and located such that the release of flammable vapors will not constitute a hazard to personnel or the facility.

a. **Relief System:**

The relief system is an emergency system for discharging gas by manual or controlled means or by an automatic pressure relief valve from a pressurized vessel or piping system to the atmosphere for the purpose of relieving pressures in excess of rated working pressures. The relief system may include the relief valve or rupture disc, the collection piping, a gas scrubber for liquid separation, and a gas vent.

In planning and designing relief systems API RP 520: *Design and Installation of Pressure-Relieving Systems in Refineries, Parts I and II*, API RP 521: *Guide for Pressure Relief and Depressuring Systems*, API Std 2000: *Venting Atmosphere and Low-Pressure Storage Tanks*, and *ASME Boiler and Pressure Vessel Code Section VIII, Pressure Vessels, Division I* should be used as references.

Some facilities include systems for automatically depressuring pressure vessels in the event of an emergency shutdown. The depressuring systems control valves may be arranged to discharge into the relief or flare systems.

b. Flare System:

The flare system is a system for discharging gas through a control valve from a pressurized system to the atmosphere during normal operations. This discharge may be either continuous or intermittent. The flare system may include the flare control valve, collection piping, the gas-liquid scrubber and gas vent.

Normally, gases discharged into the flare system are at low pressures and low flow rates. The back pressure requirements are not defined in the various codes and operating orders; however, flare systems should be designed to insure that vessels and tanks will not be over-pressured and accommodate the maximum volume that could be vented.

4.17 Ventilation. A thorough review of existing rules and regulations and the API RP 500 Series recommended practices should be conducted when ventilation is being considered. The following comments are offered in addition to these writings: Enclosed structures require a thorough review to insure adequate ventilation. Areas enclosed on all sides which contain those items of equipment considered only a source of ignition should be pressurized to prevent entry of hydrocarbons. The air intake for the pressurizing system should be located such to preclude entry of hydrocarbons into that system. Enclosed areas containing hydrocarbon handling facilities or equipment utilizing a hydrocarbon fuel source should be ventilated with an exhaust system to insure removal of any escaping hydrocarbons. In addition, enclosed areas should be protected in accordance with recommendations presented in the fire protection section. Also, enclosed work areas where welding is to be conducted should be ventilated with an exhaust system to insure removal of gas evolved during welding operations. The air intake for this system should be located to preclude entry of hydrocarbons.

4.18 Equipment areas located on open type structures should be arranged to allow the natural ventilation caused by winds and convection currents. Care should be taken around fired process equipment to insure that adequate draft for the equipment is provided. Also, the equipment should be arranged to take advantage of the prevailing winds in order to minimize escaping hydrocarbons from being carried toward equipment considered a source of ignition. Special care should be taken in the use of protective walls to insure proper ventilation. Special consideration should be given to ventilation of the wellhead areas. This area should be as open as possible with a minimum of two sides of the structure open. The interior of the quarters building should have adequate exhaust system to preclude accumulation of smoke and odors.

4.19 Transportation. In designing support facilities for the transportation of personnel and equipment on offshore structures, one must consider the prevailing meteorological and oceanographic conditions. The location of transportation facilities relative to prevailing winds, waves and currents may control the orientation and layout of the entire structure.

4.20 Boat landings and docks should be located on the lee side of the structure. Cranes in turn must be located over the boat landing for convenience in loading and offloading equipment. Storage areas for pipe and bulk materials should be located within or adjacent to the area covered by the crane boom.

4.21 On manned structures the primary means of escape will be the stairway from the cellar and main decks to the personnel landing. Location of the personnel landing and primary escape route should be taken into consideration when arranging the production facilities and quarters.

4.22 Helicopter pads should be located so as to give clear landing approaches for the helicopters. Stacks, guy wires, crane booms, antennas etc. should be arranged so as not to intrude into the approach or departure paths of the helicopters. The lack of other structures in the area may dictate the need for landing space for two or more helicopters.

4.23 Pollution Prevention

a. General Considerations:

Planning and construction of offshore production facilities must include methods for containment and proper disposal of any type contaminent. Contaminents may be defined as any foreign or undesirable substance, but as used herein, are meant to be liquids or solids containing liquid hydrocarbons, relatively high concentrations of caustic or acidic chemicals, raw sewage, trash and unedible garbage.

b. Containment of Spilled Oil:

Methods must be provided for collecting spilled hydrocarbons from all deck areas. For example, solid deck areas may be drained to a gutter and routed through a system of gutters or piping to a central point. This may also be done by providing a number of drain openings in the decks which are then piped to a central point. From the central point the collected liquid material may be discharged into a tank or container where separation takes place due to specific gravity difference. Liquid hydrocarbons may then be skimmed off and routed into the production system and the remaining water treated by further separation, filtration, etc. as needed.

All deck areas which have a source of oil leakage, spills, or drips, must be liquid tight with the periphery surrounded by a curbing or a continuous gutter. Alternatively, drip pans may be installed under equipment, provided liquids are routed to a central point and treated as described above.

c. Sewage Disposal:

On installations where toilets are installed and human waste is discharged into surrounding waters, the effluent must meet requirements of applicable governmental regulatory agencies.

d. Solid Waste Disposal:

Combustible solid wastes such as paper or wood products, or other organic material such as garbage, may be disposed of by incineration in a suitable container in an area which permits an open fire. Alternatively, the waste may be placed in containers and transported to shore for proper disposal.

Non-combustible waste material should be collected in containers and transported to shore for proper disposal.

c. Toxic Waste:
In general, toxic materials, after being properly treated and neutralized, may be discharged into the waters surrounding the installation.

4.24 Corrosion, Erosion and Preventative Maintenance. Preventive maintenance and the control of corrosion and erosion are an integral part of failure prevention, pollution control, and safety. Most of the control and maintenance techniques developed and utilized onshore are applicable in offshore operations. However, space limitations, the salt air environment, and other special requirements inherent to platform design and operation make it important that they be considered in initial planning and design.

4.25 The prevention of **internal failures** requires that equipment be properly designed, monitored for loss of wall thickness, and if necessary, includes corrosion resistant materials, coatings, cathodic protection and/or provisions for inhibition of corrosion. Internal failures can be minimized by limiting the number of bends, the length of piping, and designing for reasonable flow velocities. The type fluids being handled should be considered and allowance made for fluids that are particularly corrosive or erosive. Corrosion due to heat exchange media, dehydration media, and fuels must be considered as well as corrosion due to produced fluids. Care taken in choosing locations for taps, tees, flow restrictions, and short-radius bends can also limit corrosion due to dead spaces and erosion due to turbulence. Consideration should be given to providing space, clearance, fittings, etc., for such operations as injection of inhibitors, insertion and removal of internal monitoring and safety devices, collection of samples, internal cathodic protection, and non-destructive methods of inspection. Some type of monitoring program is desirable to locate points of potential internal failure.

4.26 The minimizing of **external failure** requires selecting the proper cathodic protection system and proper external coatings. External coatings should be properly applied and failures correctly repaired as soon as practical. External contact with fluids should be considered in the design and eliminated where possible. Where intermittent or continuous external contact with fluids is necessary such as in splash zone areas, consideration should be given to the use of special coatings, extra wall thickness for corrosion allowance, cathodic protection, etc.

4.27 The proper securing and support of piping systems and process equipment is also important in preventing failures due to external corrosion and wear. Seal welding or other protection of areas where external corrosion and or wear could occur should be provided in the original design of offshore facilities.

ENVIRONMENTAL CONSIDERATIONS

4.28 In establishing structure orientation prevailing seas, swells, currents and winds should be considered. Likewise, when planning for heliports, docking facilities, flare and relief systems, support cranes and hoists, and escape systems oceanographic and meteorological influences should be introduced.

4.29 Weather conditions such as temperature, precipitation, humidity and winds have a significant effect upon the overall arrangement of structure production facilities. For example, in cold climates enclosed structures are desirable. Enclosures in turn affect the design considerations such as ventilation and communication systems.

4.30 Sea conditions can have considerable influence on the logistical support and storage requirements when laying out structure facilities. Rough sea conditions with attendant resupply problems dictate increased storage space.

GEOGRAPHICAL CONSIDERATIONS

4.31 Structures installed in remote locations require considerably more preplanning than those located near fabrication facilities and supply points. The production facilities should be arranged to permit utilization of prefabricated and unitized equipment.

4.32 The distance between the platform and shoreside terminal will be a definite consideration when planning pipelines, shipping pumps, gas compressors, storage requirements and waste water handling facilities.

GOVERNMENT REGULATIONS AND INDUSTRY CODES AND STANDARDS

4.33 Government regulations and Industry Codes and standards are listed in Section 3 of this Recommended Practice. The Outer Continental Shelf Orders and Occupational Safety and Health Act in particular will have a definite influence on the arrangement of production equipment. As such, they must be ever present in the designer's mind when laying out and arranging platform facilities.

SUMMARY

4.34 Many factors and variables must be taken into consideration when arranging production equipment on offshore platforms. The above considerations are not intended to be all inclusive, but instead are intended to show diversification of factors which must be taken into account when preparing for offshore operations.

SECTION 5
PRODUCTION EQUIPMENT ARRANGEMENTS

GENERAL CONSIDERATIONS

5.1 It is recommended, as far as possible, production equipment be arranged in groups or areas in accordance with six (6) specific categories described in Table 5.1 and these equipment groups be separate or otherwise protected from each other.

5.2 Adequate space between equipment groups is an important factor in promoting a safe operation. However, factors such as platform design, water depth, size and extent of the hydrocarbon accumulation, method of operation, investment required, governmental regulations, etc., will influence the size and the number of the structures required.

5.3 One (1) to six (6) production equipment areas can be located on a single structure. The producing equipment areas do not necessarily have to be contiguous. In addition to considering space or separate structures for equipment the following should be considered in supporting the equipment arrangements; i.e., special barriers, compartments, safety, fire detection and fire extinguishment equipment, force ventilation and/or other safeguards as outlined in other sections of this Recommended Practice. In locating more than one production equipment area on a structure, consideration should be given to the objectives and equipment area combinations given in Table 5.1 and discussed in this section. Safety systems should be designed to shut off the flow of fuel into specific equipment areas in event of abnormal conditions. Equipment areas should be located so as to streamline the process flow and simplify piping systems. Within each equipment group, the size and configuration of the equipment will, to some extent, determine the distance between individual pieces of equipment.

5.4 Illustrated in Appendix A are some examples of equipment arrangements in accordance with this RP for situations where as many as six areas of production equipment are on a single platform. These are not the only arrangements, but are shown to indicate some of the variations possible in accordance with this RP to meet differing producing requirements and conditions. Other arrangements are considered acceptable as long as the RP is followed. Although arrangements of equipment when more than one platform is used at a given location are not included, these attachments can be used as a guide for those areas on each platform in a multiple platform installation.

QUARTERS AREAS

5.5 Living quarters should be protected from external fires, explosions and noise. Escape routes from the quarters should be readily accessible to at least one of the two primary means of escape required by the Coast Guard Regulations. Escape routes should be designed to minimize exposure to potential heat and flame sources. Because living quarters are a source of ignition, they should be isolated from fuel sources to the greatest extent practical. Where living quarters are located on a drilling or production platform, a firewall or adequate space should separate the quarters from other platform areas. The fire wall may be an integral part of the quarters building. Windows should be eliminated and other openings minimized on these sides.

5.6 It is important in arranging the quarters to provide sufficient recreational area for personnel so as to provide a means for relaxing, entertainment and resting in their off duty hours.

5.7 Quarters should be located in an area and so designed to provide personnel a sense of safety and remoteness from the operations. Walkways should be constructed on the exterior sides of the quarters building opposite the operational areas. This will provide safe avenues of egress and assist in providing a comfortable and relaxing atmosphere during off duty hours.

5.8 Utilities such as electrical generating equipment, sewage treatment facilities, and air conditioning equipment can be located in the same area as the quarters. The designer should insure that proper precautions are taken to control noise and unpleasant odors such that they do not impair the usefulness of the quarters.

WELLHEAD AREAS

5.9 The location of the wellhead area (or areas) on a structure is influenced by several factors. Wellheads must be located where they will be accessible to the drilling rig, remedial equipment and where adequate structural support can be provided. Wellheads should be separated or protected from sources of ignition, fuel, machinery and falling objects.

5.10 The highest pressures encountered on an offshore platform will normally be associated with the wellheads. Uncontrolled flow from the wellheads can be very difficult to contain. Therefore, protection of the wellhead areas should receive high priority, second only to the protection of personnel.

UNFIRED PROCESS AREAS

5.11 Equipment located in this area may be potential sources of fuel and should be separated or protected from ignition sources. Unfired process equipment should not be placed directly above or below fired equipment without special protection.

5.12 Unfired process vessels can be placed nearer wellheads than other production equipment, since equipment in both areas are potential sources of fuel, and should contain no sources of ignition. The normal flow pattern is frequently from the wellheads to the unfired process vessels, so placing the two areas near each other should simplify interconnecting piping.

PETROLEUM STORAGE AREAS

5.13 Petroleum storage tanks may be potentially hazardous due to the liquid fuel contained, and the associated venting of gases. Location of petroleum storage tanks should be remote or otherwise protected from wellheads and potential sources of ignition such as fired vessels, machinery, and quarters. Petroleum storage tanks may be located in the vicinity of unfired process vessels since both types of equipment represent potential sources of fuel. Precautions should be taken to prevent spilled liquids from flowing into other production equipment areas.

FIRED PROCESS AREAS

5.14 Equipment located in the fired process area can be considered potential sources of ignition, al-

though some sources of fuel will of necessity be present. Fired process vessels should be remote or protected from wellheads, unfired process vessels and petroleum storage tanks. If fired vessels are located on the same structure with other process equipment, the potential ignition hazard should be minimized by taking the precautions discussed in other sections of this Recommended Practice.

5.15 Fired process equipment and machinery are potential sources of ignition. These two equipment areas may be located in proximity to each other.

MACHINERY AREAS

5.16 Machinery includes both potential ignition and fuel sources. The machinery area should be located remote or protected from wellheads, unfired process equipment, petroleum storage tanks, and quarters areas. Machinery and fired process equipment are similar in type and degree of hazard and may be located in proximity to each other.

TABLE 5.1

ACCEPTABLE EQUIPMENT — AREAS

Wellhead Area	Unfired Process Area	Petroleum Storage Area	Fired Process Area	Machinery	Quarters
Location Objective: Minimize sources of ignition and fuel.	Location Objective: Minimize sources of ignition	Location Objective: Minimize sources of ignition	Location Objective: Minimize fuel supply	Location Objective: Minimize fuel supply	Location Objective: Personnel safety
PRIMARY EQUIPMENT TO BE PLACED IN AREA					
Equipment Type	**Equipment Type**	**Equipment Type**	**Equipment Type**	**Equipment Type**	**Equipment Type**
(F) Wellheads (F) Choke Manifolds (F) Headers	(F) Separators (all WP) (F) Sump Equipment (Pressurized and atmospheric) (F) Gas Sales Station (F) Pig Traps (F) Indirect Heated Vessels Water Treatment (F) Small (100-bbl or less) Petroleum Tanks	(F) Petroleum Liquid Tanks	(I) Fired Vessels Water Treatment Aids to Navigation	(I) Compressors, A or B (I) Pumps, A or B (I) Generators, Electric (I) Hoisting Equipment Type A or B (I) LACT, A or B (I) Air Compressor, A or B	(I) Living Quarters Sewage Disposal Fire Fighting Buildings (I) Water Maker
OTHER MISCELLANEOUS EQUIPMENT THAT MAY BE ACCEPTABLE TO AREA					
Hoisting Equipment (Type A) Fire Fighting Aids to Navigation (F) Indirect Heated Vessels	(F) Choke Manifolds (F) Headers Hoisting Equipment (Type A) Fire Fighting Aids to Navigation (I) Air Compressor, (Type A)	(F) Pig Traps (F) Gas Sales Station Water Treatment Hoisting Equipment (Type A) LACT, Type A Pumps, Type A Fire Fighting Aids to Navigation	(F) Sump Equipment Fire Fighting Buildings (I) Water Maker (I) Hoisting Equipment (Type A or B)	Aids to Navigation Water Maker Fire Fighting Pig Traps	(I) Hoisting Equipment (Type A or B) Aids to Navigation Generators

(F) — Fuel Source

(I) — Ignition Source

Equipment (Type A) — Manual, fluid powered, or explosion proof electric motor powered

Equipment (Type B) — Internal combustion engine or electric motor powered

SECTION 6
FIRE PROTECTION

GENERAL

6.1 There are many types of platforms and combinations of installed equipment and facilities. Establishing fire protection criteria to fit all situations is not possible. However, criteria can be established for each functional area depending on the hazards and whether the area is enclosed or open.

6.2 A protective wall and/or fire wall should be considered when the designer believes space does not provide adequate separation of equipment areas. Precaution should be taken in the use of walls to insure proper ventilation.

6.3 Platform Fire Fighting Systems

a. **General** Water hose and/or chemical systems may be desirable for most platforms. Open or enclosed platforms housing personnel on a continuous basis should be provided with a reliable method of applying an extinguishing medium on any kind of fire.

b. **Pumps** For maximum reliability on enclosed platforms, two independent sea water pumps, each capable of furnishing the maximum fire demand should be utilized. One of the pumps may be primarily used for utility water. Power supplies should be independent for at least one pump; i.e., diesel drive, emergency battery power, diesel generator, gas turbine generators, etc. For open platforms, one pump independent of well shut-down fuel supply, capable of furnishing primary needs, shall be sufficient.

c. **Chemical** Chemical systems should be designed commensurate with the complexity of the production facility. Types of chemical systems such as dry powder, inert gases, halon, and light water, etc., are acceptable.

6.4 Platform Emergency Alarm System

a. **General** All manned platforms should be provided with a fire alarm system. The fire alarm system will usually consist of a few manual stations strategically located near evacuation routes and an alarm sounding device. On larger platforms, the fire alarm system could also be used to receive signals from automatic fire and gas detection systems. Large enclosed platforms may utilize the fire alarm system as a means of locating the fire emergency by annunciation panel at supervisory locations.

b. **Fire Alarm** The system should be complete and separate unit supplied by the platform electrical power with integral trickle charger and batteries floating or other independent power source. General alarm and platform shut-down can be automatically initiated by alarm signals from the fire alarm panel if desired.

c. **Gas Alarm** Gas is usually detected at two levels; (20-25% L.E.L. and 60-75% L.E.L.) with an alarm generally sounded at the lower level. Alarm signals may be interconnected to the fire alarm panel for combined functions.

WELL AREA AND UNFIRED PROCESS AREAS

6.5 Automatic Fire Extinguishing

a. Open high hazard areas may be protected by a waterspray fixed system capable of wetting critical surfaces with a water density of not less than .25 gpm per square foot. Waterspray protection may not be necessary for open areas, where the wells are shut-in automatically when a fire is detected. Chemical systems may be used in lieu of a water system if determined to provide sufficient fire protection control.

b. Enclosed high hazard areas may be protected by waterspray and chemical systems. The waterspray system should be designed for a minimum density of .25 gpm per square foot and the chemical system should be designed for total flooding.

6.6 Detection

a. **Fire Detection.** The automatic extinguishing systems should be actuated by a fast reacting detection system.

The selection would depend on the particular area and arrangement for effective operation. Each section or room on the platform should be separately annunciated. Upon fire detection in these areas, the wells should be automatically shut-in.

b. **Gas Detection.** In inadequately ventilated enclosed areas, a detector should be located at the ventilation outlet as well as near equipment where gas releases are possible. Gas alarm signals may be transmitted over the fire alarm system for common annunciation.

6.7 Manual Fire Fighting Equipment

a. On platforms housing personnel on a 24-hour basis, fire fighting equipment should be provided and located so as to facilitate fire attack from two directions. Water can be used with other agents to improve effectiveness.

b. Extinguishers suitable for Class B fires should be located near accessways.

FIRED PROCESS AREAS

6.8 Automatic Fire Extinguishing

a. Open process areas may be protected by a waterspray fixed system capable of wetting critical surfaces with a water density of not less than .25 gpm per square foot. Waterspray protection may not be necessary for open areas where wells and process equipment are shut-in when a fire is automatically detected. Chemical systems may be used with or in lieu of water systems if determined to provide sufficient fire protection control.

b. Enclosed areas may be protected by waterspray and chemical systems. The waterspray system should be of design for a density of .25 gpm per square foot; and the chemical system should be designed for total flooding.

6.9 Detection

a. **Fire Detection.** The automatic extinguish-

ing systems should be actuated by a fast reacting detection system. The selection would depend on the particular area and arrangement for effective operation. Each section or room on the platform should be separately annunciated.

b. **Gas Detection.** In inadequately ventilated enclosed process areas, a detector should be located at ventilation outlet as well as near equipment where gas releases are possible. Gas alarms may be annunciated over the fire alarm system.

6.10 Manual Fire Fighting Equipment

a. On platforms housing personnel on a 24-hour basis, fire fighting equipment should be provided to facilitate fire attack from two directions. Water can be used with other agents to improve effectiveness.

b. Extinguishers suitable for Class B fires should be located near accessways.

MACHINERY AREA

6.11 Automatic Fire Extinguishing

a. In general, automatic fire control systems are not required for open or adequately ventilated enclosed areas.

6.12 Detection

a. **Fire Detection**

Fire detection should be provided for enclosed inadequately ventilated machinery areas to provide automatic notification of a fire and for activation of automatic fire fighting systems.

b. **Gas Detection**

Gas detection is not required for open areas. Gas detection is recommended in enclosed machinery areas containing hydrocarbon handling equipment.

6.13 Manual Fire Fighting Equipment

a. On enclosed platforms housing personnel on 24-hour basis fire fighting equipment should be provided to facilitate fire attack from two directions. Water can be used with other agents to improve effectiveness.

b. One or more extinguishers should be located near accessways, capable of extinguishing Class A, B, and C fires.

QUARTERS

6.14 Automatic Fire Extinguishing

In general, automatic fire extinguishing systems are not required. Depending on the size and situation, a range hood extinguishing system may be desirable in the galley.

6.15 Detection

With the installation of a water flow switch on a sprinkler system, no other fire detection is needed. If sprinklers are not installed a fire detector should be provided. The use of smoke detectors should be considered.

6.16 Manual Fire Fighting Equipment

Extinguishers suitable for A, B, and C fires should be strategically located throughout the quarters.

PETROLEUM STORAGE AREA

6.17 Automatic Fire Extinguishing

a. Atmospheric tanks should be adequately vented. Automatic fire protection-extinguishment systems should be considered by the designer.

b. Waterspray may be needed to protect tank skins from exposure to fires depending on arrangement of equipment.

c. Adequate normal and emergency drain systems should be provided to assure that burning flammable liquids will not be transmitted to other parts of the platform.

6.18 Detection

Combination fixed temperature/rate of rise or other suitable detector system is recommended for actuation of automatic extinguishment and alarm systems.

6.19 Manual Fire Fighting Equipment

a. Fire fighting equipment should be provided to attack the tank area from two directions. It may be desirable to have water and wet and dry chemical systems.

b. Extinguishers capable of controlling Class B fire should be located at all accessways.

APPENDIX A

TYPICAL EQUIPMENT ARRANGEMENTS ON OFFSHORE OIL AND GAS PRODUCTION FACILITIES

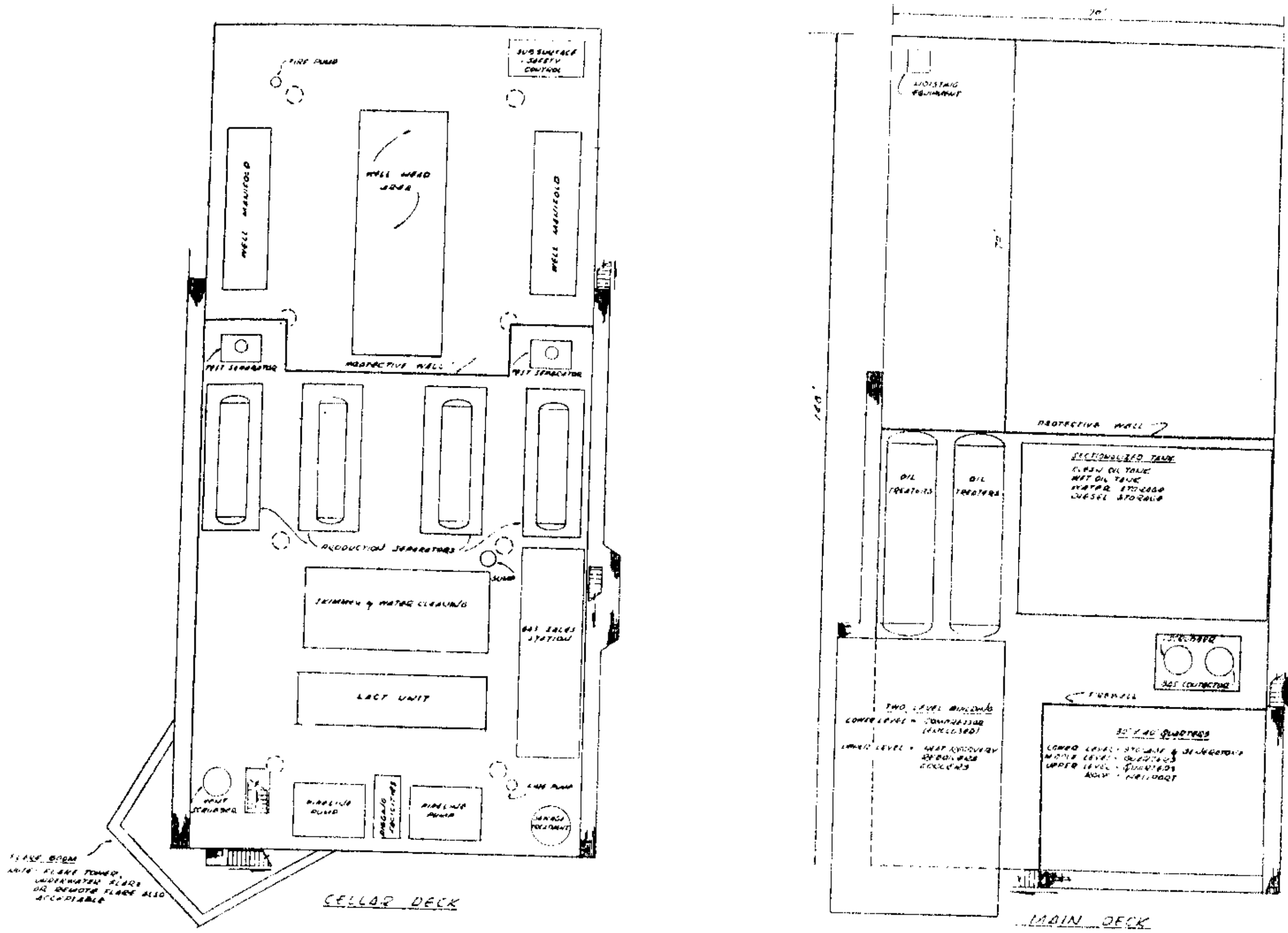

FIG. A1
OIL PRODUCTION FACILITY
70 X 148 FT. PLATFORM

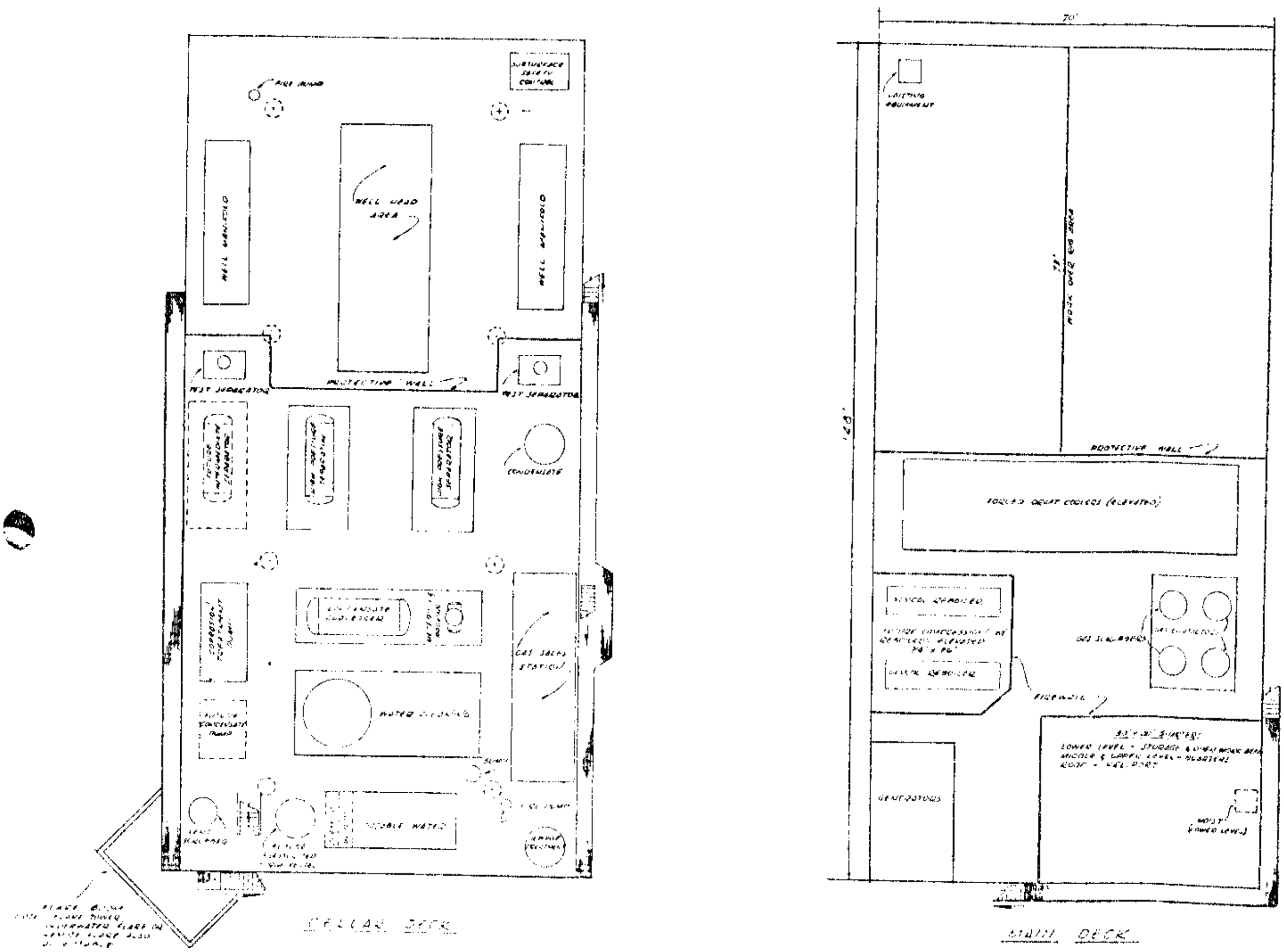

FIG. A2
GAS PRODUCTION FACILITY
70 X 148 FT. PLATFORM

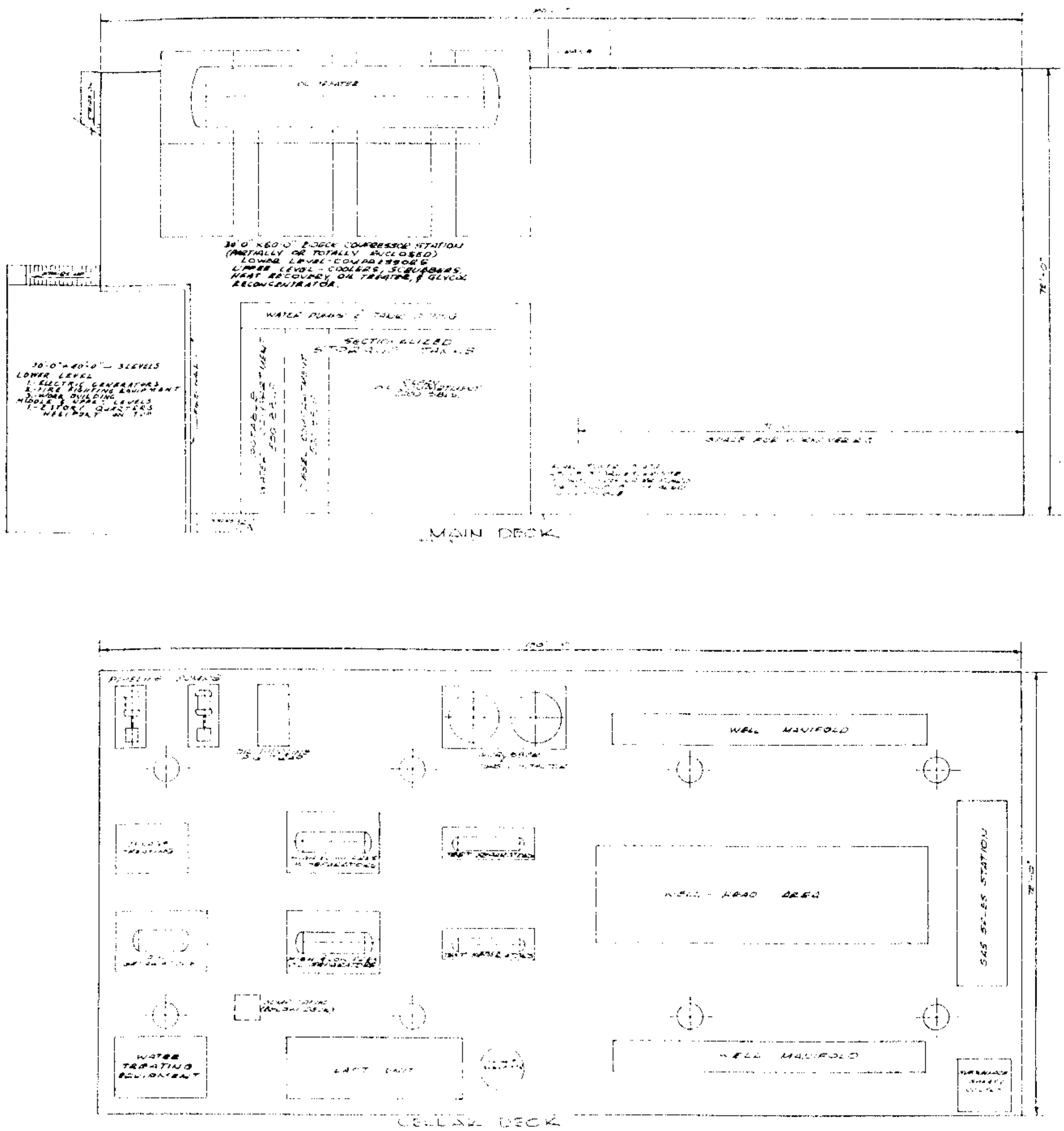

FIG. A3
OIL PRODUCTION FACILITY
72 X 150 FT. PLATFORM

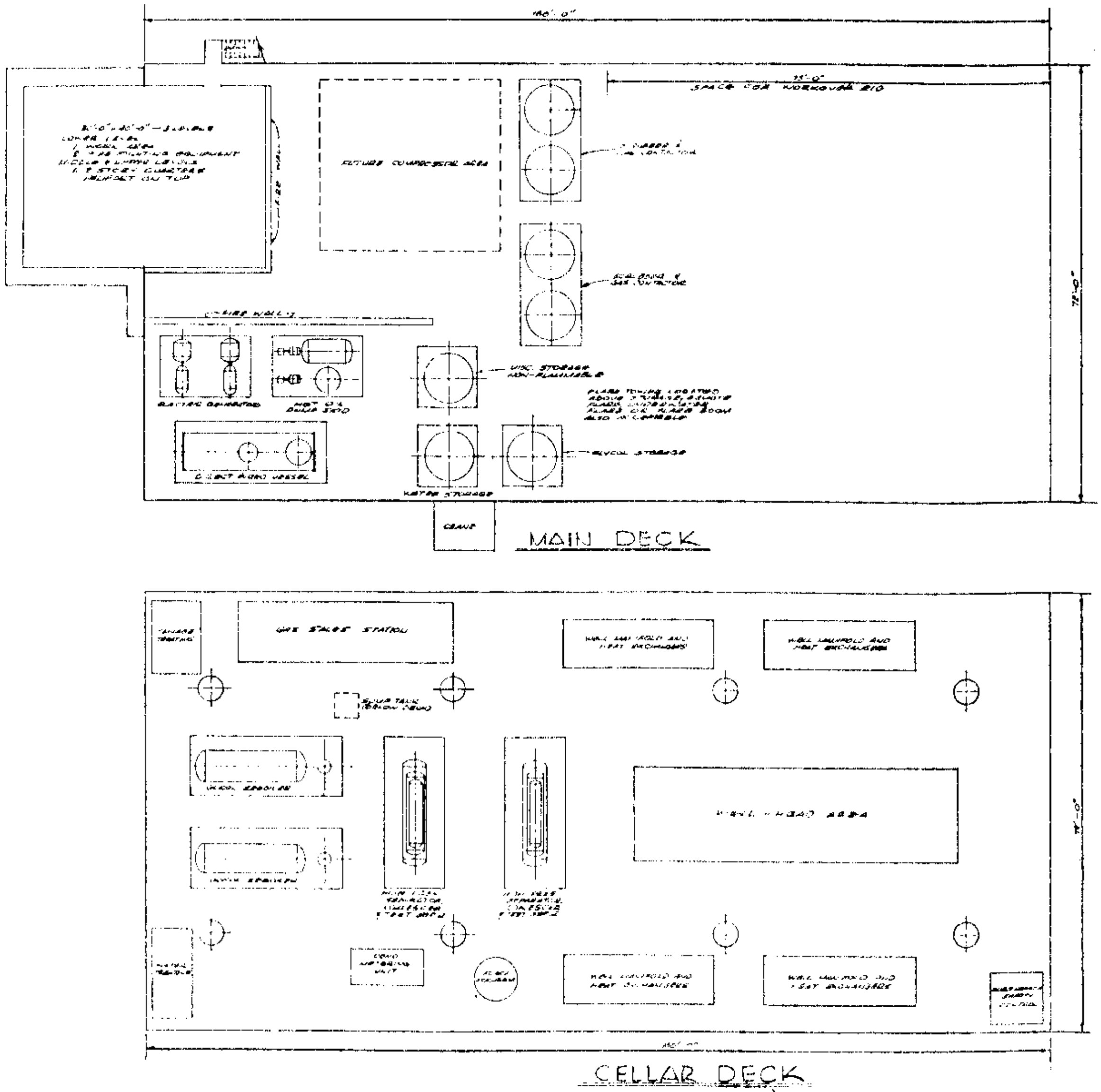

FIG. A4
GAS PRODUCTION FACILITY
72 X 150 FT. PLATFORM

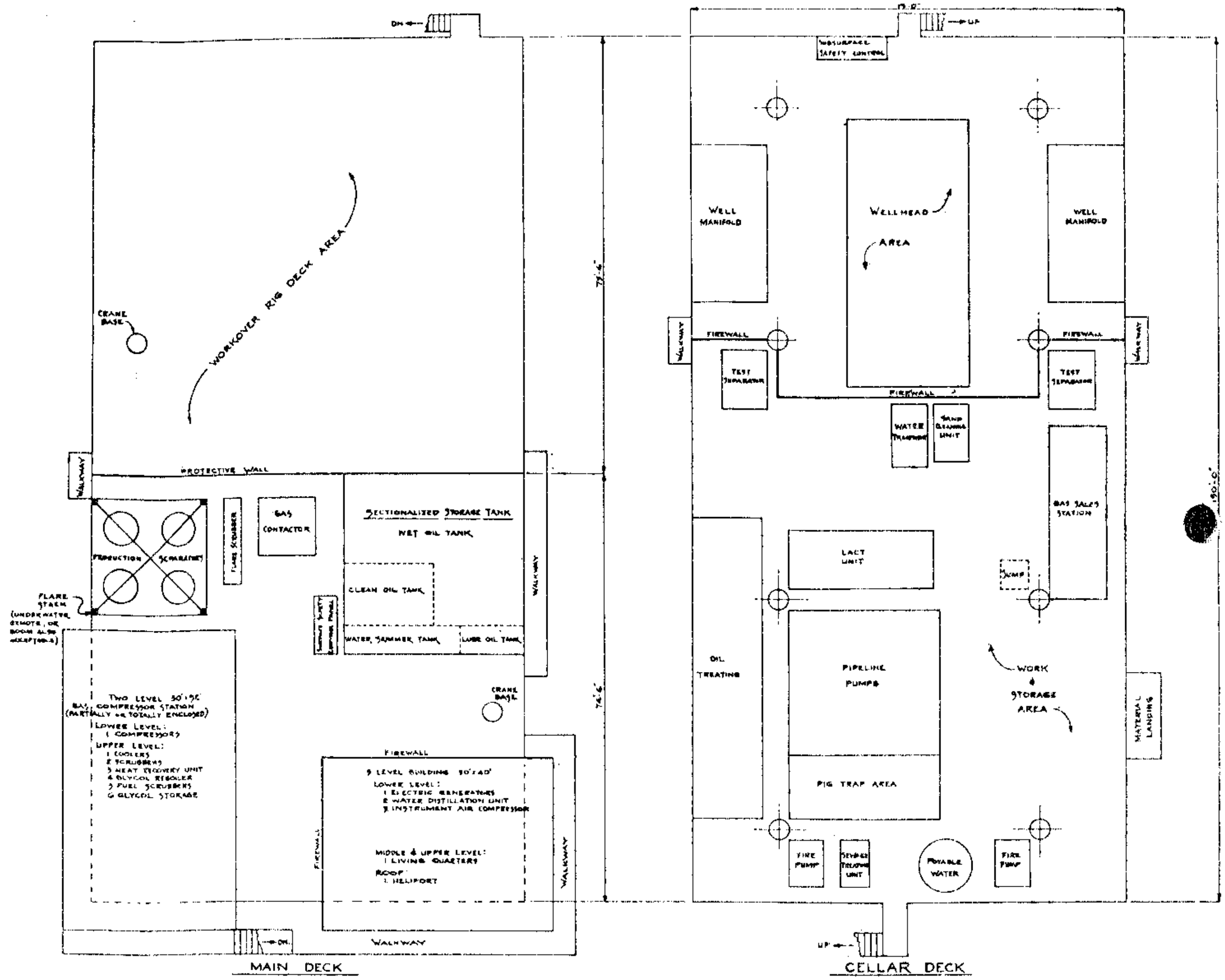

FIG. A5
OIL PRODUCTION FACILITY
75 X 150 FT. PLATFORM

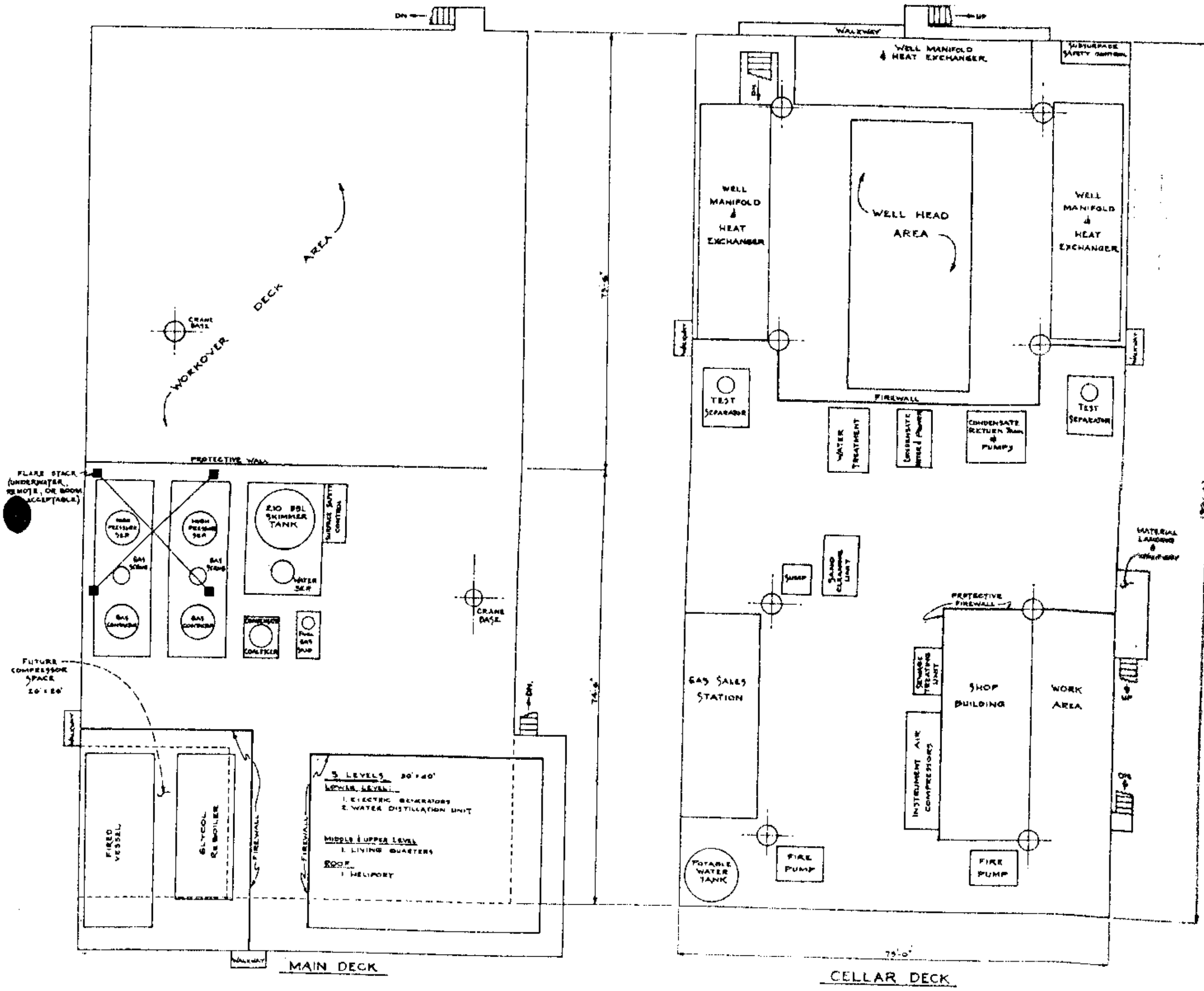

FIG. A6
GAS PRODUCTION FACILITY
75 X 150 FT. PLATFORM

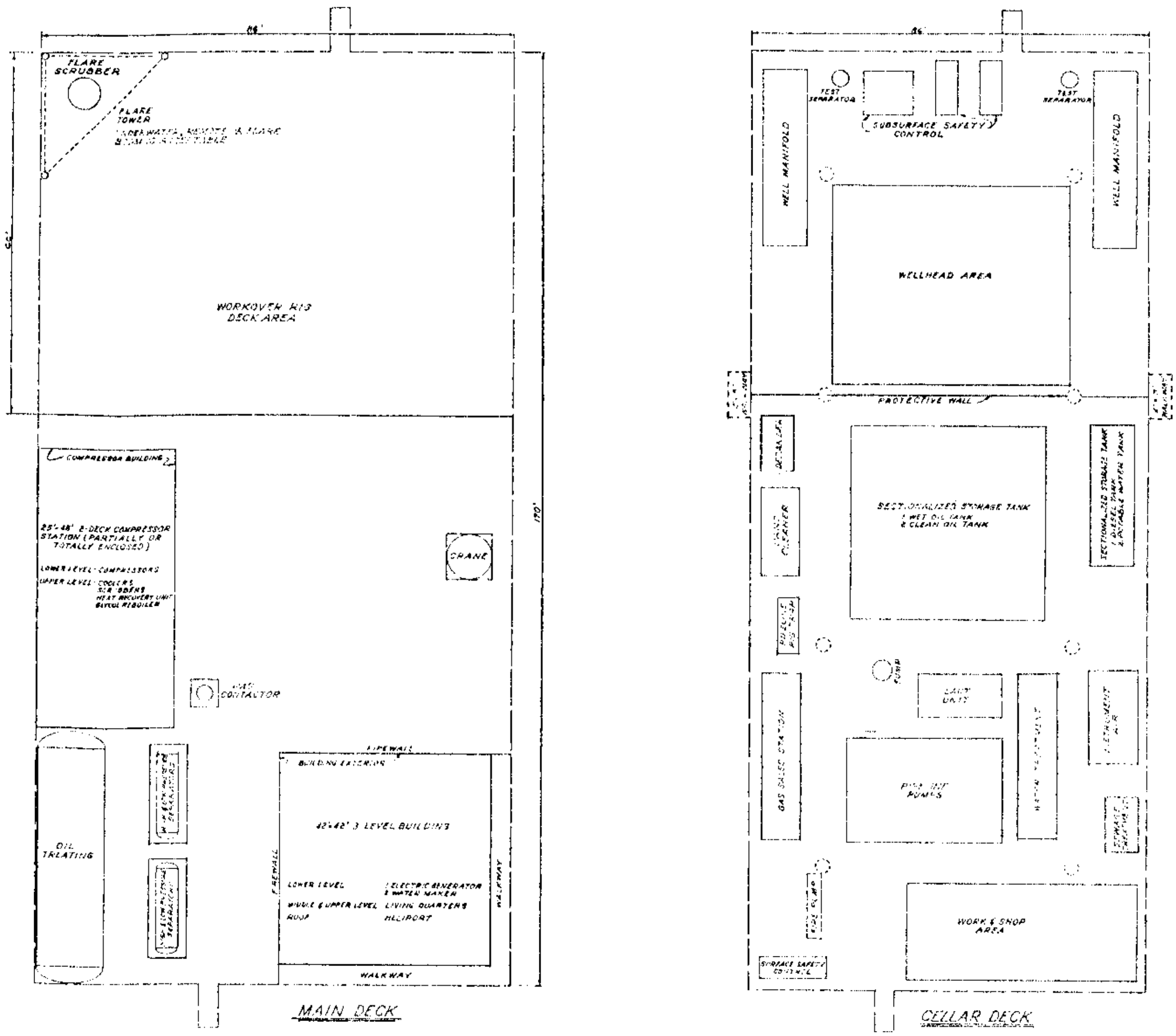

FIG. A7
OIL PRODUCTION FACILITY
86 X 170 FT. PLATFORM

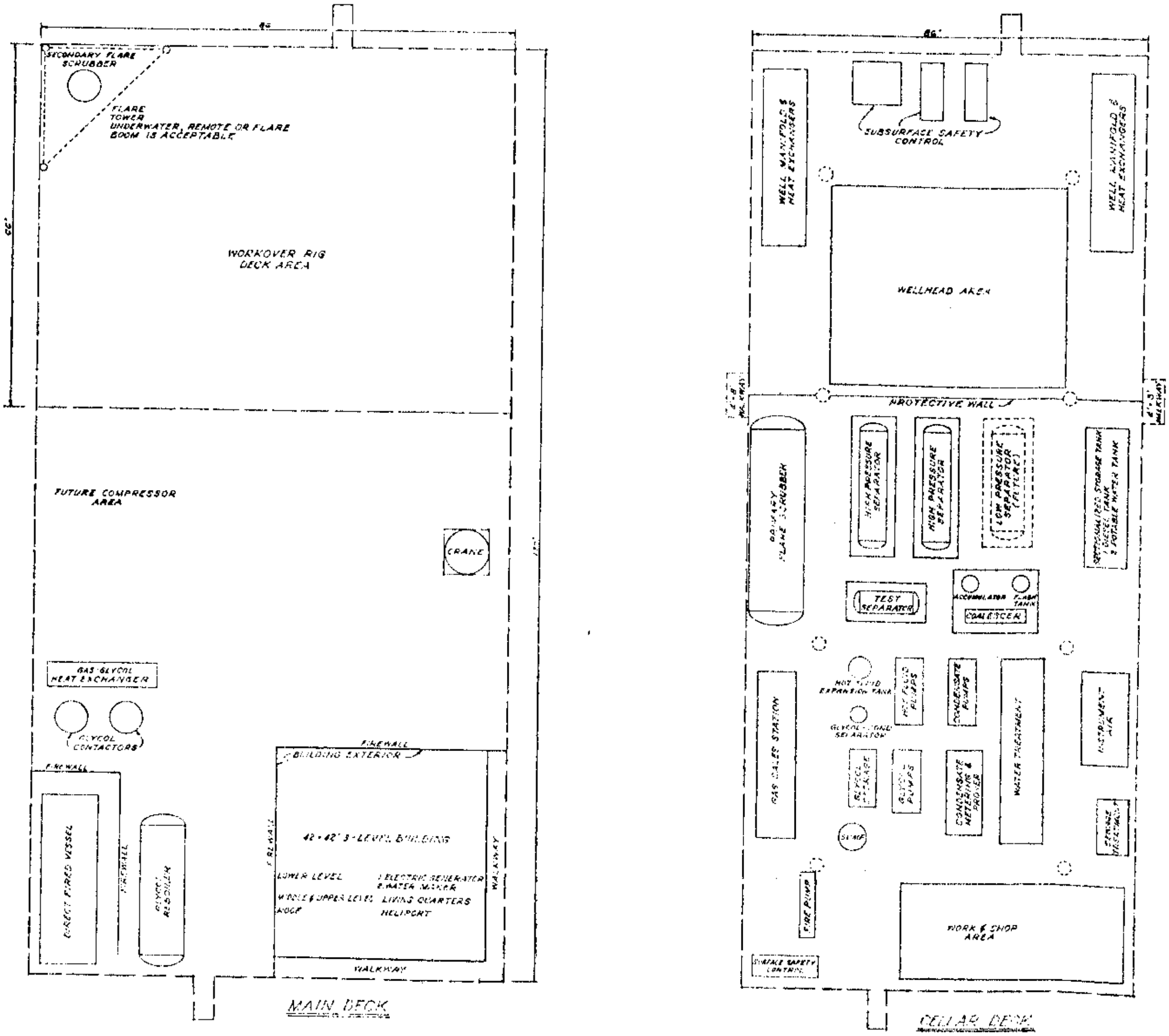

FIG. A8
GAS PRODUCTION FACILITY
86 X 170 FT. PLATFORM

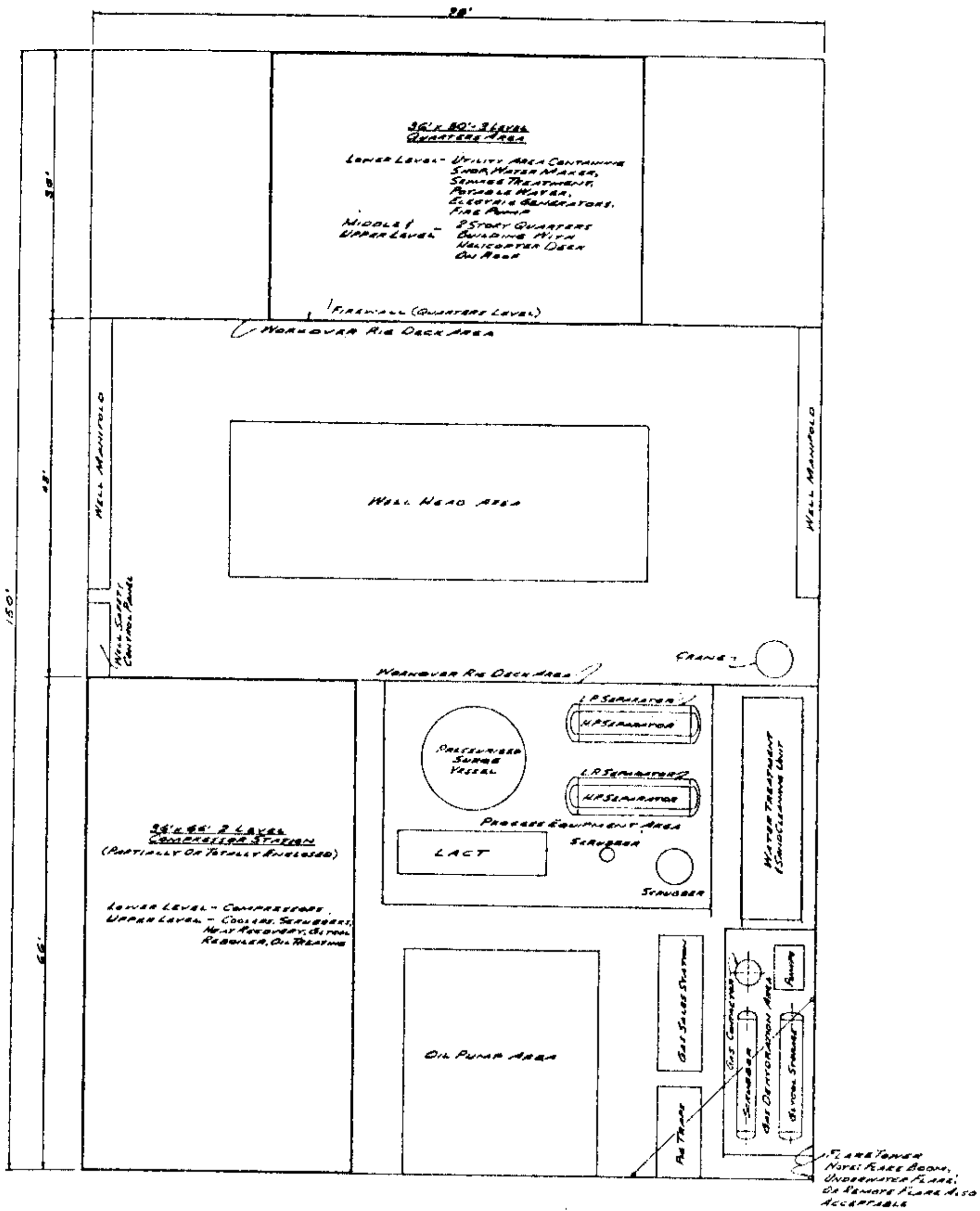

FIG. A9
OIL PRODUCTION FACILITY
98 X 150 FT. PLATFORM

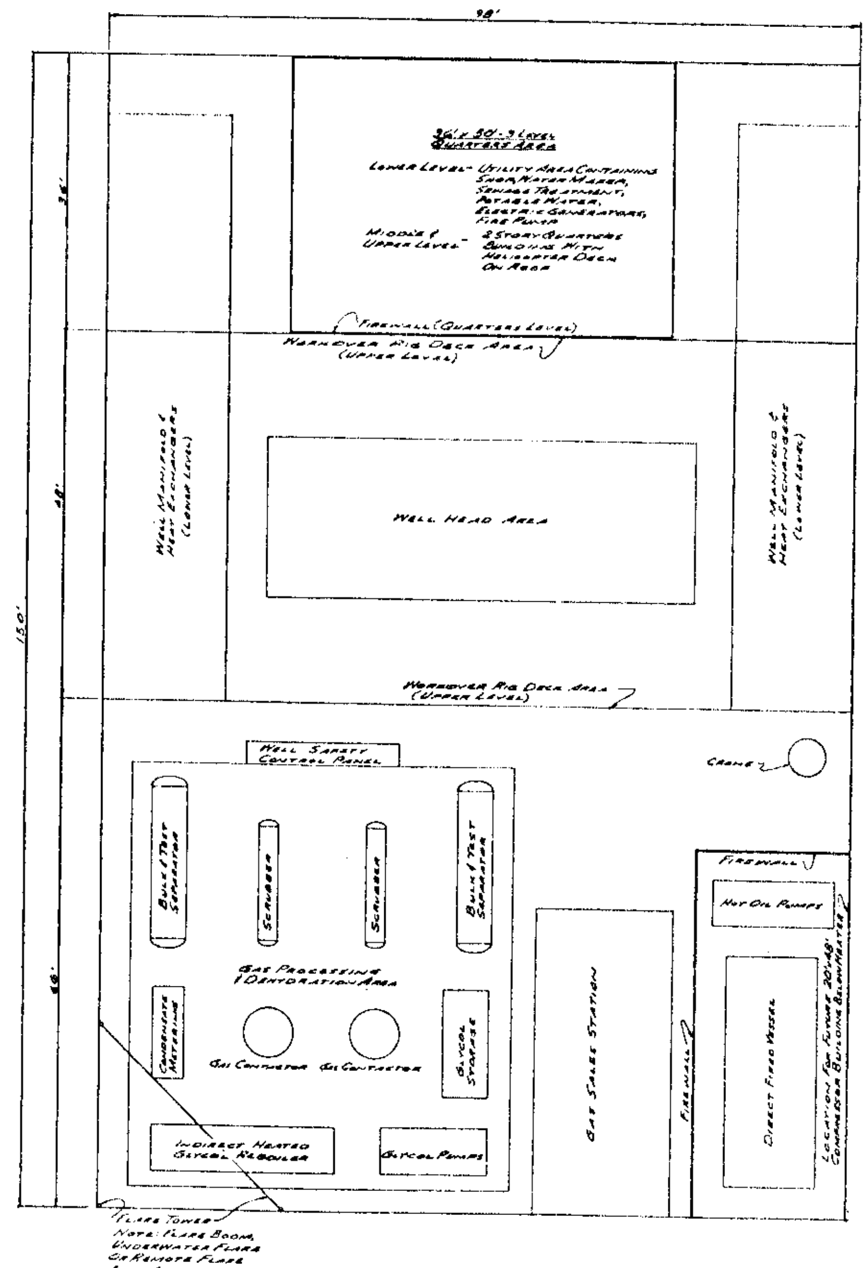

FIG. A10
GAS PRODUCTION FACILITY
98 X 150 FT. PLATFORM

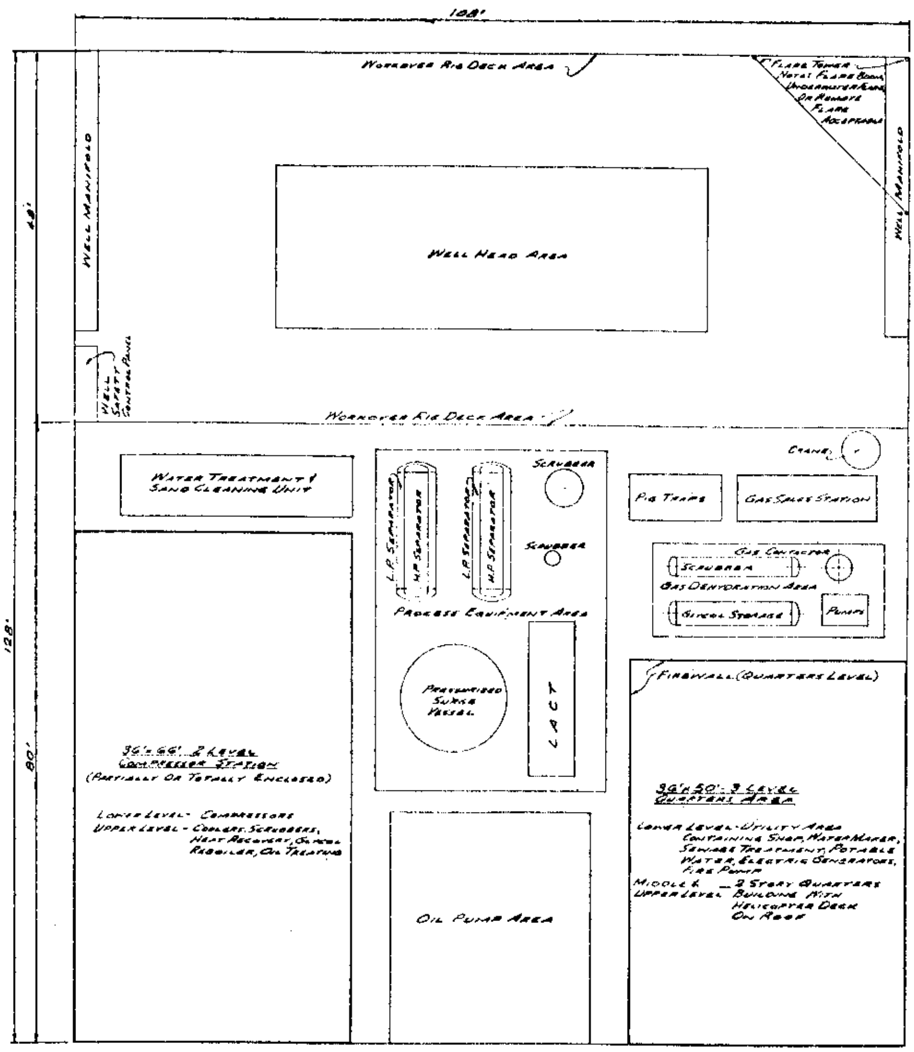

FIG. A11
OIL PRODUCTION FACILITY
108 X 128 FT. PLATFORM

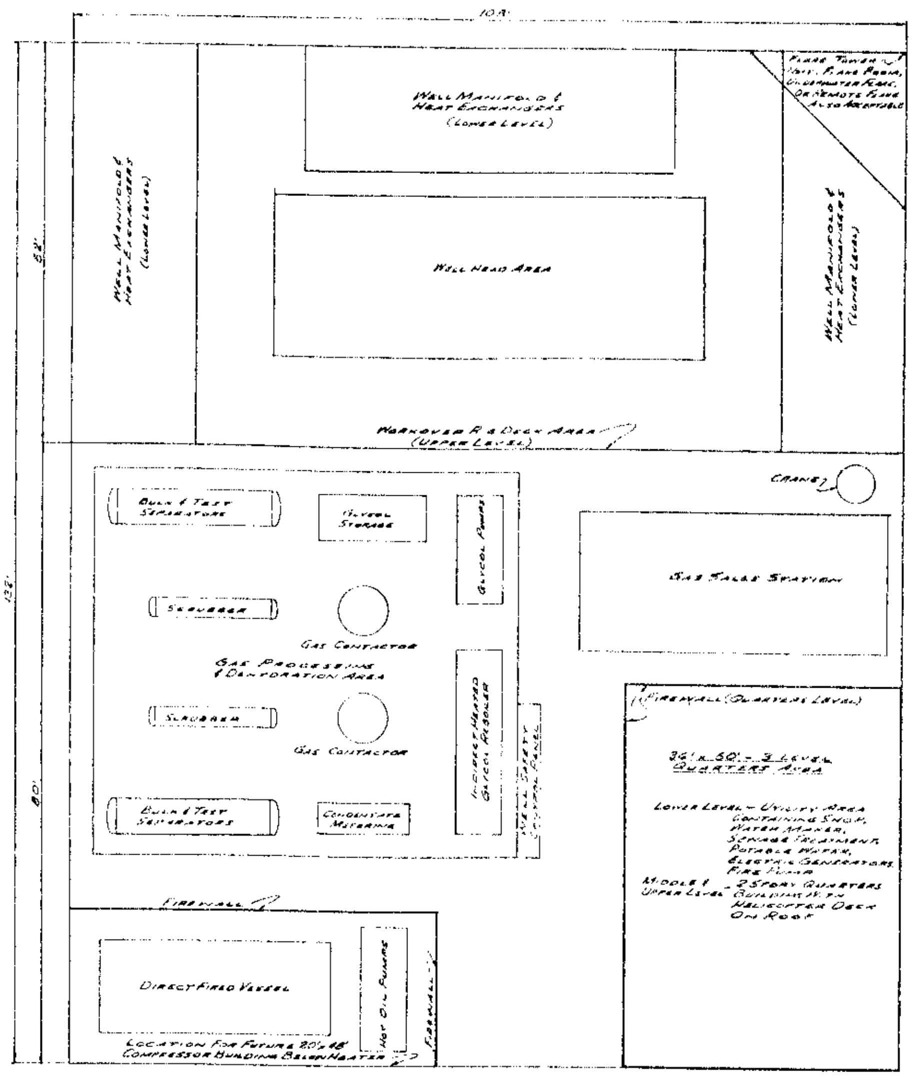

FIG. A12
GAS PRODUCTION FACILITY
108 X 132 FT. PLATFORM

2M—1-74—Johnston
1M—9-75—Johnston