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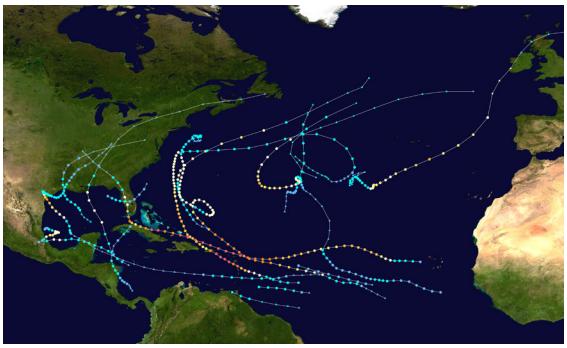
HURRICANES AND THE OFFSHORE OIL AND NATURAL GAS INDUSTRY

As the Atlantic Ocean warms every summer, America's coasts brace for the impact of hurricanes and tropical storms. The 2017 hurricane season was among the top 10 most active in history and was the most expensive hurricane season in U.S. history. There were more than 17 named storms and six major hurricanes including Harvey, Maria, and Irma, with more than $200 billion in damages.

Did you know:

- There were no reported deaths or injuries among offshore energy workers?
- There was no reported damage to offshore facilities?
- There were no reported oil spill or natural gas leaks from offshore facilities?
- There are nearly 3,000 active platforms and more than 27,000 miles of pipeline in the Gulf of Mexico?
- The Gulf of Mexico produces 17% of U.S. oil and 5% of U.S. natural gas?
- Hurricane Harvey temporarily curtailed about 25% of oil production and 26% of natural gas production from the Gulf of Mexico?
- Tropical Storm Nate temporarily stopped about 92% of oil production and 77% of natural gas production from the Gulf of Mexico?
- The offshore industry continuously works to improve its safety and environmental record, as well as improve the time needed to bring shut-in production back to consumers?



2017 Hurricane Season Summary Map

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Even the most damaged facilities are salvageable.

For example, Shell's Mars platform sustained serious damage during Hurricane Katrina (above), but dedicated and talented crews were able to repair the facility (below).

HURRICANE FACT: OFFSHORE PLATFORMS ARE DESIGNED TO SURVIVE DESTRUCTIVE STORMS

THE OFFSHORE PLATFORMS AND RIGS ESCAPED SERIOUS DAMAGE DURING THE 2017 HURRICANE SEASON

- Platforms are designed to withstand both gale force winds and and severe wave activity. Offshore facilities built since 1988 are designed to withstand "100-year Storms," a designation that includes everything up to Category 5 events.
  - These standards are defined by regulations from the Bureau of Safety and Environmental Enforcement (BSEE), a principal regulatory agency for offshore oil and gas operations. The specific regulations can be found in the Federal Register at 30 CFR 250.900
  - To address wave threats, regulations stipulate that the platform deck must exceed the average height of hurricane-driven swells, generally estimated to reach 80 feet. Category 3, 4 and 5 storms all generate waves of approximately the same height.
  - To address wind threats, offshore facilities work in advance of evacuation to prevent any section or piece of equipment being knocked loose and damaging the rest of the platform.
- 2005 was the last time there was significant damage to offshore platforms due to hurricanes, but virtually all platforms seriously damaged or destroyed had been built before the 1988 design specifications were implemented.
  - In 2005, Hurricanes Katrina and Rita destroyed a total of 113 platforms, of which 108 were built to pre-1988 specifications.
  - These "end-of-life" facilities only represented 1.5 percent of total Gulf of Mexico production at the time.

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Thousands of offshore personnel are evacuated in advance of approaching hurricanes

HURRICANE FACT: EMPLOYEE SAFETY ALWAYS TAKES PRIORITY

THE OFFSHORE ENERGY INDUSTRY HAS AN ENVIABLE RECORD OF PROTECTING THE LIVES OF ITS OFFSHORE WORKERS, AND COMPANIES PROVIDE CRITICAL SUPPORT DURING RECOVERY EFFORTS ONSHORE DURING EVERY HURRICANE SEASON.

- There are thousands of workers offshore at any given time. Despite the frequency and intensity of hurricanes in 2017, there were no injuries and no loss of life on offshore facilities. This safety record has been achieved consistently year after year.

- Prior to the arrival of a hurricane, offshore facilities evacuate all personnel.

    - Personnel secure the platform and leave in pre-determined stages. A standard hurricane preparation process includes:

        - Evacuation Phase 1 - Receive Storm Notification
            - Review operations forecast.
            - Communicate with air and marine transportation providers.
            - Perform safety system checks.

        - Evacuation Phase 2 - Complete Preparations
            - Secure all equipment.
            - Test communications systems that enable monitoring from shore.
            - Evacuate non-essential personnel.

        - Evacuation Phase 3 - Shut Down and Evacuation
            - Shut-in wells and subsurface safety valves
            - Close incoming and exit pipelines
            - Shut down operating systems
            - Transport remaining personnel to shore

- After Hurricane Harvey, as with past hurricanes, offshore companies stepped in to provide support services, emergency funds, housing and other assistance to their employees, and also donated millions to the Red Cross and similar organizations.

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HURRICANE FACT: ENVIRONMENTAL SAFEGUARDS ARE BUILT IN TO THE OFFSHORE INFRASTRUCTURE

- All offshore platforms are equipped with safety valves that shut-in oil and natural gas in the event of storm damage. These valves lock closed at regular intervals so that oil or gas cannot flow if equipment is broken or separated. Every single safety valve held during the 2017 hurricane season.

Full Opening Safety Valve

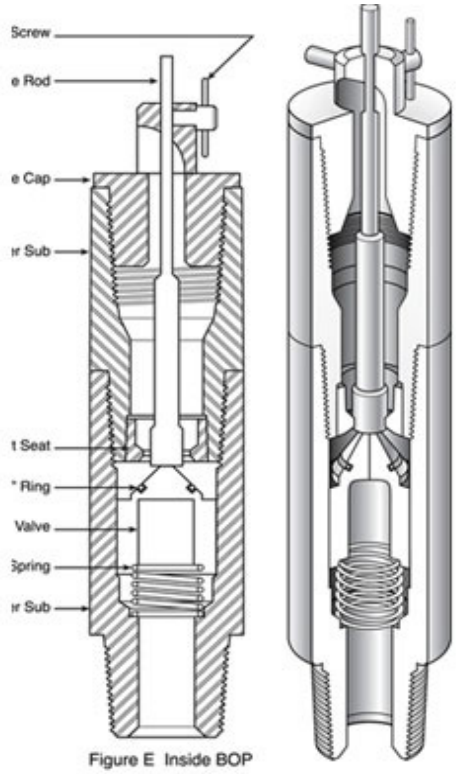

Figure E Inside BOP

Safety valves at all major junctures prevent oil and natural gas leaks when hurricanes cause damage

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Jack-up Rig

BACKGROUND INFORMATION: A BRIEF INTRODUCTION TO OFFSHORE TECHNOLOGY

UNDERSTANDING THE TECHNOLOGY: RIGS VS. PLATFORMS

An **offshore drilling** rig is a facility housing equipment to drill for oil and natural gas from underground reservoirs. Sometimes a drilling rig is also used to complete (prepare for production) the well. The rig itself is not involved with the extraction of the oil, however. Its primary function is to make the hole in the ground so that the oil can be produced.

Drill Ship

An **offshore oil platform** is a structure used to house workers and machinery needed to produce oil and natural gas in the ocean. Depending on the circumstances, the platform may be attached to the ocean floor or float. A typical platform may have many wellheads and access reservoirs using directional drilling both at different depths and at remote positions miles away from the platform. Platforms may also connect to many subsea wells on the seafloor miles away.

DRILLING PLATFORM TYPES:

- Jack-up rigs are towed to the drilling site, three or four 'legs' are lowered until they penetrate the ocean floor to the point of resistance. This allows the working platform to rest above the surface of the water, as opposed to a floating barge. However, jack-up rigs are suitable for shallower waters, as extending these legs down too deeply would be impractical. These rigs are typically safer to operate than drilling barges, as their working platform is elevated above the water level.

Semi-submersible platform

- Drill ships have a broadly conventional ship's hull, but also feature a large aperture, known as a "moon pool", through which drilling takes place. Drill ships use either anchors or dynamic positioning to maintain station. Drill ships can operate in more than 10,000 feet of water.

- Semi-submersible drilling platforms are supported primarily on large pontoon-like structures submerged below the sea surface. The operating decks are elevated perhaps 100 or more feet above the pontoons on large steel columns. This design has the advantage of submerging most of the area of components in contact with the sea and minimizing loading from waves and wind. Semi-submersibles are usually anchored with six to twelve anchors tethered by strong chains and wire cables, which are computer controlled to maintain stationkeeping.

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PRODUCTION PLATFORM TYPES:

- Fixed Platforms sit on legs anchored directly in the seabed, supporting a deck with space for drilling rigs, production facilities and crew quarters. Fixed platforms are economically feasible for installation in water depths up to about 1,700 feet (520 m).

- Compliant Towers consist of narrow, flexible towers and a piled foundation supporting a conventional deck for drilling and production operations. Compliant towers are designed to sustain significant lateral deflections and forces, and are typically used in water depths ranging from 1,500 and 3,000 feet (450 and 900 m).

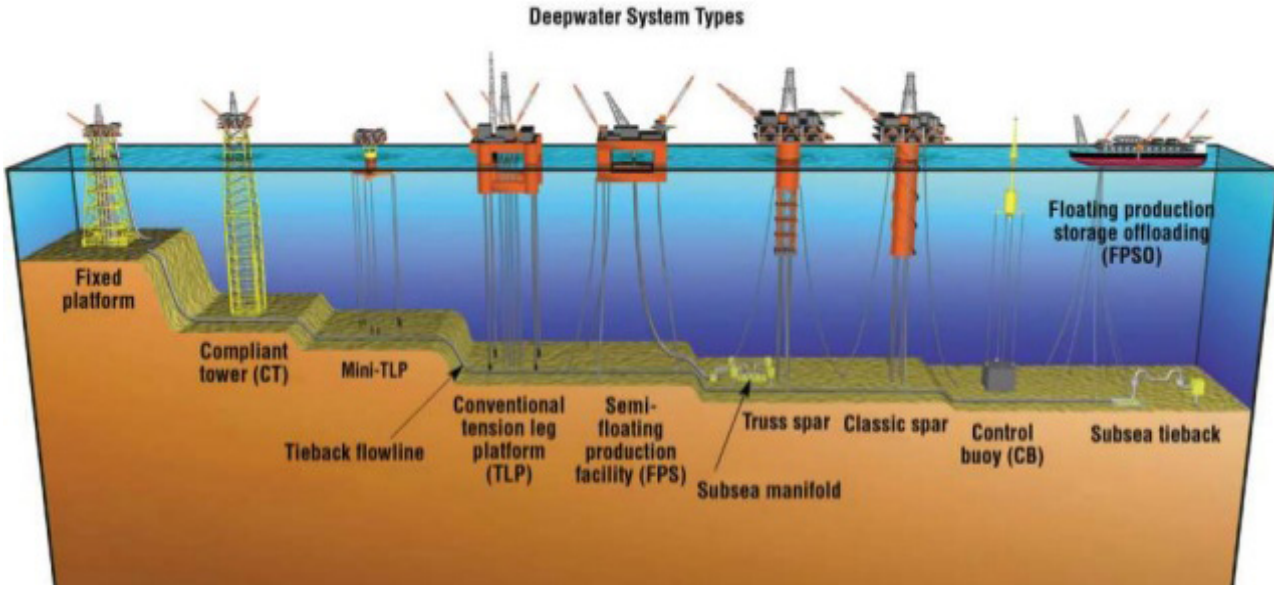
- Tension-Leg Platforms (TLPs) consist of floating rigs tethered to the seabed in a manner that eliminates most vertical movement of the structure. TLPs are used in water depths up to about 6,000 feet (2,000 m).

- Semi-Submersible Platforms have several "legs" which have sufficient buoyancy to cause the structure to float. Semi-submersibles can be moved and are generally anchored by mooring cables and anchors. Semi-submersibles are used in depths greater than 600 feet (200 m).

- Spar Platforms are moored to the seabed like the TLP, but use more conventional mooring lines. The Spar has more inherent stability than a TLP since it has a large counterweight at the bottom. It also has the ability, by use of chain-jacks attached to the risers, to move horizontally over the oil field.

- Floating production, storage and offloading systems (FPSOs) are large ships equipped with processing facilities and moored to a location for a long period.

There are numerous types of offshore platforms. Most of the platforms destroyed by Hurricanes Katrina and Rita in 2005 were the older, fixed-leg type.



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