

Angel Facility Operations Environment Plan Summary

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1. INTRODUCTION

Woodside Energy Ltd (Woodside) is the nominated operator of the North West Shelf Project's (NWS Project's) Angel Production Facility, located in Commonwealth waters in Production Licence WA-3-L, approximately 123 km north-west of Karratha. The Facility is operated as a Not Normally Manned facility, with remote operation and power supply from the Woodside Operated North Rankin Complex (NRC), located approximately 49km to the west.

The Angel facility was commissioned in 2007 and processes dry gas and condensate from the Angel reservoir. The facility processes the production fluids supplied by subsea wells where it is then transported via an export pipeline to the existing first trunkline from the North Rankin Complex and then onshore to the Karratha Gas Plant (KGP).

The revised Angel Operations Environment Plan (EP) has been prepared in accordance with the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (Environment Regulations). The EP has been reviewed and accepted by the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA).

This EP summary document has been prepared as per the requirements of Regulations 11(7) and 11(8) of the Environment Regulations.

2. LOCATION OF THE ACTIVITY

The Angel facility is located in Commonwealth waters on the North West Shelf (NWS) of Western Australia in Production Licence Area WA-3-L, approximately 123 km north-west of Karratha and 49 km east of the NRC (Figure 2-1). The facility stands in approximately 80 m of water and is connected to three subsea satellite wells.

Gas and condensate produced from the facility is exported from Angel via the 49 km export pipeline (Pipeline Licence WA-14-PL) to the first trunkline located near NRC.

The closest nearshore sensitive environmental receptors to the Angel facility are the Montebello Islands, located approximately 90 km to the south west, and the Dampier Archipelago located approximately 95 km to the south east. The closest offshore sensitive receptors are the Glomar Shoals and Rankin Bank, located approximately 25 km east and 110 km southwest respectively. The facility is also situated within the southern humpback whale migratory pathways. A description of the surrounding environment is provided in Section 3.

The coordinates and permit areas of the Angel facility and associated infrastructure are outlined in Table 2-1.

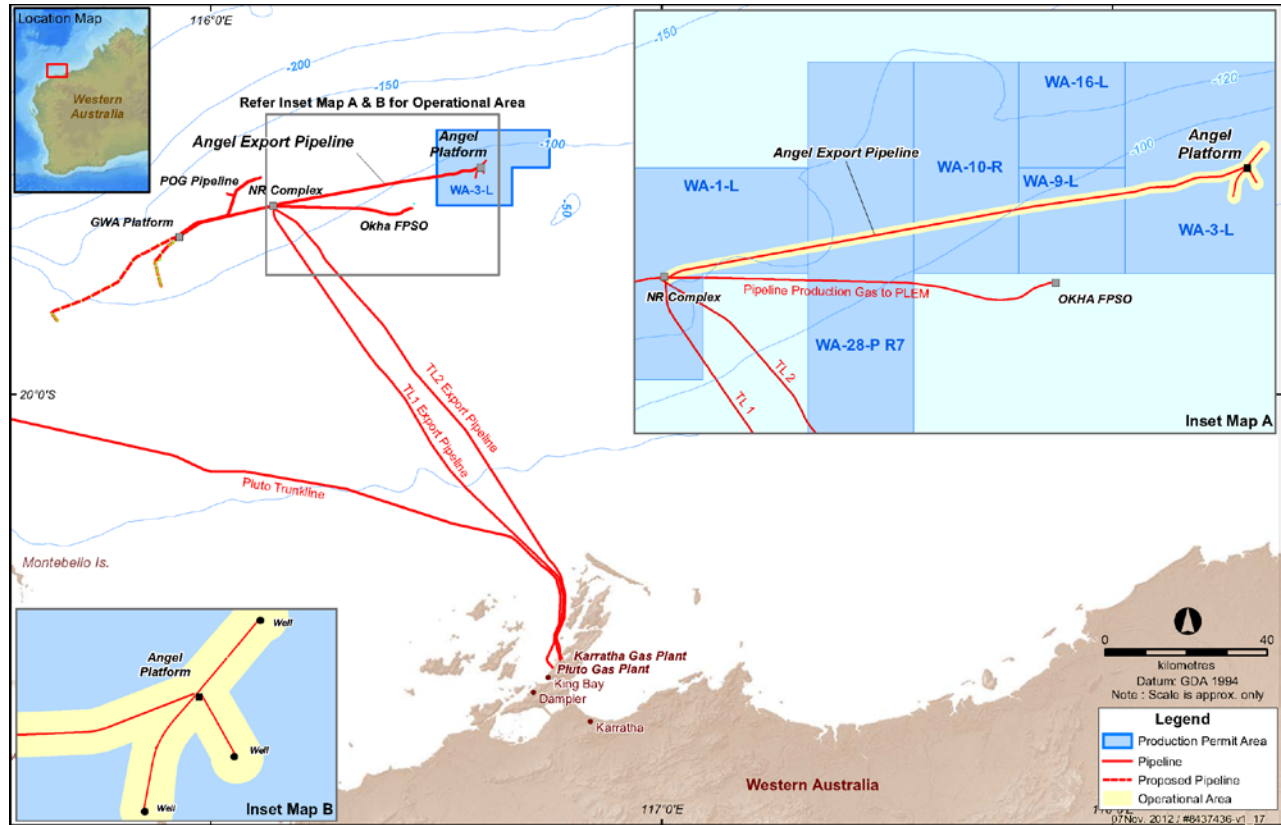


Figure 2-1: Location of Angel Facility and Operational Area

Table 2-1: Angel and Associated Infrastructure Locations and Permit Area

| Location | Eastings* | Northings* | Title |
|--|------------|--------------|----------|
| Angel Platform | 457 825.0E | 7 843 948.0N | WA-3-L |
| AP2 well | 459 113.3E | 7 845 652.9N | WA-3-L |
| AP3 well | 458 571.2E | 7 842 615.7N | WA-3-L |
| AP4 well | 456 675.6E | 7 841 394.1N | WA-3-L |
| East end of export pipeline (Angel facility) | 457 820.0E | 7 843 960.0N | WA-14-PL |
| West end of export pipeline (NRC) | 409 804.2E | 7 834 057.5N | WA-14-PL |

*MGA Zone 54 (GDA94 datum)

3. DESCRIPTION OF THE ENVIRONMENT

3.1 Regional Setting

The Angel facility operational area is located in the North West Shelf (NWS) province of the North-West Marine Region (NWMR) within Commonwealth waters, approximately 123 km from Karratha and in water depths of approximately 80 m. The NWMR is characterised by low salinity and nutrient poor tropical waters. As such, the NWMR is considered to have a low level of productivity, however, upwelling events are recorded and associated with higher productivity due to seasonal changes in the strength and direction of surface flows (DSEWPac 2012a).

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3.2 Physical Environment

The climate within the region is dry tropical, exhibiting a hot summer season from October to April and a milder winter season between May and September (BoM 2012). There are often distinct transition periods between the summer and winter regimes, which are characterised by periods of relatively low winds (Pearce *et al.* 2003).

Sea water temperature on the NWS primarily varies with depth and season. Surface waters are warm year-round due to the tropical water supplied by the Indonesian Throughflow and the Leeuwin Current, with temperatures reaching 30°C in summer and dropping to 22°C in winter (Pearce *et al.* 2003). Nearshore coastal waters are typically warmer than offshore waters in the summer months, while offshore waters don't cool as much during winter as nearshore waters, with offshore seasonal temperature changes lagging behind inshore by around one month (Pearce *et al.* 2003).

Offshore waters, such as those around the Angel facility, are generally very clear. Turbidity is primarily influenced by sediment transport by oceanic swells and primary productivity (Semeniuk *et al.* 1982; Pearce *et al.* 2003). Upwelling of nutrient-rich waters may increase phytoplankton productivity in the photic zone, which may increase local turbidity (Semeniuk *et al.* 1982; Wilson *et al.* 2003). In nearshore areas, turbidity is highly variable due to storm runoff, wind generated waves and large tidal ranges (Pearce *et al.* 2003). Periodic events, such as major sediment transport associated with tropical cyclones, may influence turbidity on a regional scale (CSIRO 2007).

Broad-scale surveys within the general area conducted by Woodside have confirmed the seabed as homogenous and featureless, similar to the wider-scale NWS area (as recorded from side scan sonar). Seabed sediment sampling (RPS 2011) of the surrounding area revealed soft sediment composition typical of the NWS comprising coarse sand, gravel and silt, low metal contamination, low nutrient concentrations (TN and TP), and no detection of hydrocarbons or Naturally Occurring Radioactive Materials (NORMs).

3.3 Biological Environment

No Critical Habitats or Threatened Ecological Communities, as listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), occur within the Angel Operational Area, as indicated by the EPBC Act Protected Matters Search Report undertaken for the Angel Operational Area.

3.3.1 Benthic Communities

Studies have revealed that the infauna associated with soft unconsolidated sediment habitat in the NWS area is widespread and homogenous along the continental shelf and upper slopes (Rainer 1991; Bowman Bishaw Gorham 2000; LeProvost, Dames & Moore 2000; Woodside 2004; SKM 2006; Brewer *et al.* 2007; RPS 2011). Benthic grab sampling around the Goodwyn A facility (located approximately 72 km from the Angel facility) revealed a low abundance, high variability and diversity of infauna dominated by polychaetes and crustaceans. More recent sampling for the Greater Western Flank Phase 1 Project (located approximately 72 km from the Angel facility) showed that the area supports a highly diverse invertebrate fauna, dominated by burrowing polychaete worms (Phylum *Annelida*) and crustaceans (Phylum *Crustacea*) (RPS 2011). Epifauna of the offshore, deeper region is typically sparse, patchy and associated with areas of hard substrate.

Sedimentary infauna associated with soft unconsolidated sediments around the Angel Operational Area is widespread and well represented along the continental shelf and upper slopes in the NWS region (Woodside 2004; SKM 2007; Brewer *et al.* 2007; RPS 2011). Consequently, benthic habitat within the Angel Operational Area, which consists of soft unconsolidated sediments, is considered to be of relatively low environmental sensitivity.

3.3.2 Marine Mammals

Cetacean species identified as potentially occurring within the Angel Operational Area by the EPBC Protected Matters Database included seven cetacean species listed as Endangered, Vulnerable or Migratory under the EPBC Act.

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The most common whale species in the NWMR in winter months is the humpback whale (*Megaptera novaeangliae*), which is listed under the EPBC Act as Vulnerable and Migratory (DSEWPaC 2012b). Southern Hemisphere Group IV humpback whales migrate from Antarctic waters to calving grounds located in inshore northern WA waters, between the Lacepede Islands and Camden Sound (DSEWPaC 2012c, Jenner *et al.* 2001). Humpback whales are most likely to occur in the Angel Operational Area between June and August during the migration period and are most likely to be transiting through the area, rather than resting, breeding or feeding.

Other species given a high level of protection which may occur in the area include the blue whale (*Balaenoptera musculus*), bryde's whale (*Balaenoptera edeni*), killer whale (*Orcinus orca*), Antarctic minke whale (*Balaenoptera bonaerensis*), sperm whale (*Physeter macrocephalus*) and the Indo-Pacific bottlenose dolphin (also called Indian Ocean or spotted bottlenose dolphin) (*Tursiops aduncus*).

3.4 Socio-economic Environment

A number of Commonwealth (beyond 200 m isobath) and State (within 200 m isobath) managed fisheries occur in the region. The Angel Operational Area is situated within State and Commonwealth managed fisheries areas. State fisheries, however, have not recorded significant catches beyond the 50 m isobath, and the Commonwealth fisheries such as the North West Slope Trawl Fishery occur beyond the 200 m depth contour.

Commonwealth-regulated fisheries which overlap the Angel Operational Area include the Western Tuna and Billfish Fishery, the Southern Bluefin Tuna Fishery and the Skipjack Tuna Fishery. However, activity in the region associated with these fisheries is typically very low or absent, and is therefore not expected within the Angel Operational Area.

State-regulated fishing activity within the Angel Operational Area is most likely to be associated with the North Coast Demersal Scalefish Fishery. The fishery consists of several management units targeting a range of species using several gear types (trawl, trap and line). The Pilbara Trawl Fishery lands the largest component of the catch and operates in waters between 50 and 200 m water depth (DoF 2011). The Pilbara Trawl Fishery is a high intensity fishery (DoF 2010) and the fishing activity is not expected within the Angel operational area.

Due to water depths and distance offshore, recreational fishing is unlikely to occur in the Angel Operational Area and recreational fishing vessels are subject to a 500 m exclusion zone around the Angel facility.

The Angel Operational Area is shown to be outside the main shipping fairways in the area. Whilst the fairways are not mandatory, the Australian Maritime Safety Authority (AMSA) strongly recommends commercial vessels remain within the fairway when transiting the region.

3.5 Marine Conservation Reserves

The Western Australian State government is working to establish a comprehensive, adequate and representative network of marine protected areas (MPAs) in the state waters of North Western Australia. The network includes a number of existing State and Commonwealth MPAs and a number of proposed State MPAs that contain environmental assets of high value or sensitivity, from a regional, State or national perspective. These values and sensitivities include habitats or species that are particularly vulnerable or that provide valuable ecological services such as coral reefs, mangroves, seagrass meadows and macroalgae.

There are four State MPAs, four gazetted Commonwealth MPAs and the Ningaloo Coast World Heritage Area (WHA) within the region. The Angel Operational Area does not overlap with any established or proposed marine protected areas. The marine protected areas within close proximity to the Operational Area are the Ningaloo Coast World Heritage Area, Ningaloo Commonwealth Marine Reserve and Marine Park, and the Gascoyne Commonwealth Marine Reserve. The Operational Area is approximately 90 km

from the Montebello Commonwealth Marine Reserve and approximately 155 km from the jointly managed Montebello Islands Marine Park / Barrow Island Marine Management Area (West Australian waters). The Operational Area is also approximately 95 km away from the Dampier Archipelago Marine Park and 95 km away from the Dampier Commonwealth Marine Reserve.

4. DESCRIPTION OF THE ACTION

The main operations associated with the Angel facility are summarised below:

4.1.1 Operational Area

The operational area applicable to the scope of the Angel EP is shown in Figure 2-1. The area includes:

- Angel and the area within a 500 m exclusion zone around the facility;
- The export pipeline from Angel to NRC covered by Pipeline Licence WA-14-PL and an area within 500m around the infrastructure; and
- Angel subsea facilities, including wells and flowlines, and an area within 500 m around the infrastructure.

Vessel related activities within the Operational Area will comply with the EP. Vessels supporting the Angel facility when outside the Operational Area will adhere to all applicable maritime regulations.

4.1.2 Operational Details

The Angel facility commenced production in 2008. The facility operates 24 hours a day, 365 days a year as a Not Normally Manned facility. Normal daily operation of the Angel facility is controlled remotely via two dedicated operating consoles in the NRC Central Control Room (CCR) which is manned 24 hours per day.

Operations and Maintenance Technicians routinely visit the Angel facility. When Angel is manned, primary control is retained by NRC, with personnel on Angel communicating with NRC via the radio communication links. Operational control of equipment is handed to 'local control' on Angel on an as required basis.

Small teams are routinely deployed to the Angel facility for maintenance. This comprises:

- Planned maintenance undertaken as campaigns during routine interventions, executed by campaign teams. Eight routine interventions are conducted per year, each lasting nominally seven days, with teams of up to 24 personnel; and
- Corrective (breakdown) maintenance, executed by intervention teams deployed from the NRC as required. Teams are up to 10 personnel.

In addition to the campaign maintenance regimes, a number of shutdown maintenance programs are required over the Angel facility life. Shutdown maintenance requires the process to be depressurised and gas free to carry out activities such as vessel inspections and relief valve re-certification. Planned shutdowns occur over approximately five to six days per year at Angel, with five days unplanned downtime estimated per year.

The Angel facility receives well fluids from the subsea production wells for topside processing via gas dehydration and condensate dewatering. The facility then exports the processed gas and condensate onshore to the KGP.

Key operational activities related to the production of gas and condensate include:

- Operational and emergency flaring; and
- Treatment and discharge of Produced Formation Water (PFW).

A number of activities also support the overall operation of the facility, these include:

- Utility systems such as lighting, heating, ventilation and air conditioning;
- Collection, treatment and disposal of sewage and putrescible wastes;
- Lifting operations;
- Transfer of supplies from vessels including food, equipment and fuel;
- Helicopter operations for transporting personnel and urgent freight; and
- Subsea inspection, maintenance and repair activities.

5. MAJOR ENVIRONMENTAL HAZARDS AND CONTROLS

Woodside has undertaken an environmental risk assessment to understand the potential environmental risks associated with the operation of the Angel facility to ensure they are reduced to As Low As Reasonably Practicable (ALARP) and will be of an acceptable level using a method consistent with Woodside standards.

The environmental risk assessment for the Angel facility identified 24 sources of environmental risk. These risks are divided into two broad categories: Planned (routine and non-routine); and Unplanned (accidents/incidents) activities.

5.1.1 Planned (Routine and Non-Routine) Activities

The majority of the sources of environmental risk identified for the Angel facility relate to those activities which are planned and either undertaken on a routine or non-routine basis. Examples of these sources of risk include:

- Physical presence of the facility generating light and noise emissions;
- Routine atmospheric emissions from gas flaring and fuel combustion;
- Routine discharges to the marine environment, such as Produced Formation Water (PFW); and
- Storage, handling and disposal of waste.

Generally, the sources of risk from planned activities present a lower environmental consequence compared to the potential impact from unplanned accident or incident events. However, as these sources of risk relate to planned activities which occur routinely or more frequently, the EP contains a variety of mitigation and control measures which ensure potential impacts and risks will be reduced to ALARP and will be of an acceptable level.

For example, the routine discharge of PFW is measured to ensure the oil in water content meets Regulatory requirements prior to discharge. In addition, a comprehensive PFW monitoring program is in place to manage potential impacts and risks from this activity on an ongoing basis.

5.1.2 Unplanned (Accidents/Incidents) Activities

During the risk assessment process a number of potential environmental impacts which may occur from unplanned activities were also identified. These sources of risk range from small scale chemical spills with a low environmental consequence to large scale hydrocarbon spill events with high environmental consequence.

The risk assessment for the Angel facility identified that of these unplanned activities, there are five which would be considered a Major Environment Event (MEE). The classification of a MEE is based on the potential for a higher level of environmental consequence if a credible worst case scenario were to occur.

Due to the potential consequence of a MEE a further level of rigour is applied to the assessment, including analysis using the 'Bowtie Technique'. This process assists in identifying the critical barriers to prevent the event occurring as well as mitigation measures to limit the potential consequence.

The MEEs identified for the Angel facility are:

- Hydrocarbon release caused by a well loss of containment;
- Hydrocarbon release caused by a subsea loss of containment;
- Hydrocarbon release caused by a loss of structural integrity;
- Hydrocarbon release caused by loss of marine vessel separation; and
- Hydrocarbon release caused by loss of control of suspended load.

A summary of the key environmental hazards and control measures for the MEEs identified for the Angel facility is presented in Appendix A.

6. MANAGEMENT APPROACH

The Angel facility will be managed in compliance with the EP accepted by NOPSEMA under the Environment Regulations, other relevant environmental legislation and Woodside's Management System (e.g. Woodside Environment Policy).

The objective of the EP is to ensure that potential adverse impacts on the environment associated with the Angel facility, during both planned and unplanned activities, are identified, and will be reduced to ALARP and will be of an acceptable level.

The EP details each environmental aspect (identified and assessed in the Environmental Risk Assessment), specific performance objectives, and identifies the range of controls (summarised in Appendix A for the identified MEEs) to be implemented to achieve the performance objectives. It also identifies the specific measurement criteria used to demonstrate that the performance objectives are achieved.

The implementation strategy detailed in the EP identifies the roles and responsibilities and training and competency requirements for all personnel (Woodside and its contractors) in relation to implementing controls, managing non-conformance, emergency response and meeting monitoring, auditing, and reporting requirements during the activity. The EP details the types of monitoring and auditing that will be undertaken, the reporting requirements for environmental incidents and reporting on overall compliance with the EP.

7. CONSULTATION

Woodside conducted a stakeholder assessment for the proposed activity to identify relevant and interested stakeholders. A consultation fact sheet was sent electronically to all identified stakeholders prior to lodgement of the EP with NOPSEMA for assessment and acceptance.

Woodside received feedback on the proposed activity from a range of stakeholders, including government agencies and commercial fishing representatives. Issues of interest included:

- the location of the platform in relation to shipping fairways;
- the roles and responsibilities associated with a hydrocarbon spill incident;
- invasive marine species; and
- potential impact to State managed lands and water.

Woodside considered this feedback in its development of management measures specific to the Angel facility. Woodside will continue to accept and assess stakeholder feedback throughout the duration of the life of the facility. In the event there is material change to the approved activities, Woodside will undertake additional consultation with all relevant stakeholders.

8. CONTACT DETAILS

For further information about this activity, please contact:

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APPENDIX A: SUMMARY OF KEY ENVIRONMENTAL HAZARDS AND CONTROL MEASURES FOR THE MEES IDENTIFIED FOR THE ANGEL FACILITY

| Source of Risk (Hazard) | Potential Environmental Impact | Control / Mitigation Measures |
|--|--|--|
| <ul style="list-style-type: none"> Hydrocarbon release caused by a well loss of containment; Hydrocarbon release caused by a subsea loss of containment; Hydrocarbon release caused by a loss of structural integrity; Hydrocarbon release caused by loss of marine vessel separation; and Hydrocarbon release caused by loss of control of suspended load. | <p>Biological and ecological impacts to megafauna, plankton, deepwater benthic communities, offshore fish species, fisheries, coral reefs, mangroves, subtidal flats and sandy beaches and seagrass communities.</p> | <p>Many of the critical barriers in place to prevent a MEE from occurring are relevant across all MEEs identified for the Angel facility, a summary of which is provided below:</p> <ul style="list-style-type: none"> Critical Communication Systems - Critical communication systems will facilitate prevention and response to accidents and emergencies. ESD Valves - ESD valves will isolate hazardous inventories within pipework and riser systems. ESD System - ESD systems will shut down plant and equipment. Reservoir Isolation - Reservoir isolation valves will isolate the reservoir from the facility. Subsea Isolation Valves - Subsea isolation valves will isolate the inventory in the pipeline from the riser and topsides affecting the riser. Depressurisation (Blowdown) - Critical blowdown valves will safely depressurise inventories to avoid, or prevent the escalation of a loss of containment. Surface Structures – Structural integrity of topsides and surface structures will be maintained to ensure availability of critical systems during a major accident or environment event. Pipeline Systems – Pipeline and riser system will contain associated liquids and gases. Lifting Equipment - Lifting and lifted equipment will be in a safe and serviceable condition to prevent dropped objects. Substructures - Structural integrity of substructures will be maintained to ensure availability of critical systems during a major accident or environment event. Wells - All primary and secondary barriers within the wells will isolate hydrocarbons from the reservoir. Sand Management Systems - Acoustic sand detectors will ensure the integrity of pressure equipment is not compromised by the presence of sand. |

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| Source of Risk (Hazard) | Potential Environmental Impact | Control / Mitigation Measures |
|-------------------------|--------------------------------|---|
| | | <ul style="list-style-type: none"> • Chemical Injection Systems - Corrosion inhibitor injection systems will prevent internal damage to equipment, piping and pipelines. • Nav aids- Nav aids and warning lights will alert marine vessels and aircraft of the position of the facility. <p>Oil Spill Response Framework</p> <p>Woodside maintains a detailed spill response framework to be implemented in the event of a major hydrocarbon spill incident. This framework includes the Woodside Corporate Oil Spill Response Plan, which is supported by North West Shelf Project (NWSP) Facilities (Level 1) Oil Spill Response Plan.</p> <p>The purpose of the Corporate Oil Spill Response Plan is to demonstrate Woodside’s ability to competently respond to an oil spill. The plan is also used to support assessment of the Angel EP.</p> <p>The North West Shelf Project (NWSP) Facilities (Level 1) Oil Spill Response Plan supports the Corporate Oil Spill Plan, and provides a concise outline of Woodside’s proposed operational response strategies for hydrocarbon spills to the marine environment. This plan includes the Angel First Strike Action Plan, which outlines specific guidance for immediately responding to a spill from the Angel facility.</p> |

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