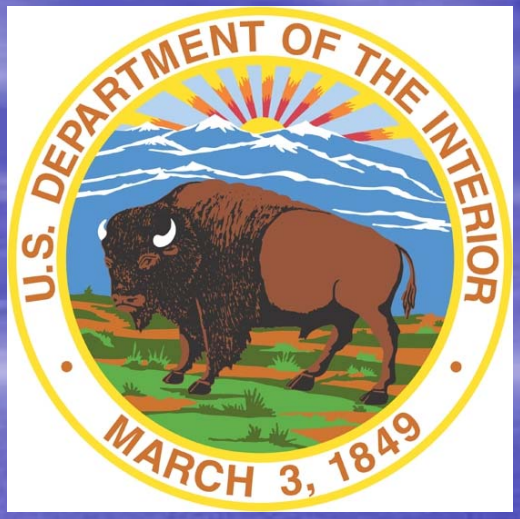

Bureau of Ocean Energy Management, Regulation and Enforcement

Gulf of Mexico Region

Worst Case Discharge Overview

March 25, 2011

Resource Evaluation

Reserves Section

Worst Case Discharge Scenario

(WCD)

GOM Region

Point of Contact

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Worst Case Discharge (WCD) Verification

WORST CASE DISCHARGE (WCD) SCENARIO

EP AND DOCD PLANS

DEFINITION from NTL N-06 FAQs

The daily rate of an uncontrolled flow from all producible reservoirs into the open wellbore. The package of reservoirs exposed to an open borehole with the greatest discharge potential will be considered the worst case discharge scenario. Shallower producible reservoirs isolated by casing and cement will not be considered in the uncontrolled flow.

Regulations: 30 CFR 250.219(a)(2)(iv) for EPs

30 CFR 250.250(a)(2)(iv) for DOCDs

http://www.gomr.boemre.gov/homepg/regulate/regs/ntls/2010NTLs/10-n06-FAQs.pdf

Worst Case Discharge (WCD) Verification

WCD CALCULATIONS

EXPLORATORY AND DEVELOPMENT WELLS

30 CFR 254.47(3)(b)

"For exploratory or development drilling operations, the size of your WCD scenario is the daily volume possible from an uncontrolled blowout. In determining the daily discharge rate, you must consider any known reservoir characteristics. If reservoir characteristics are unknown, you must consider the characteristics of any analog reservoirs from the area and give an explanation for the selection of the reservoir(s) used."

Analog drilling or production data, rock and sand strength, formation age, variance in pore pressures, and other relevant geologic and engineering factors submitted by the operator in support of the determination will be considered.

Worst Case Discharge (WCD) Verification

POTENIAL PRODUCIBLE HYDOCARBON SANDS

30 CFR 250.116(b)(4) considers “A resistivity or induction electric log of the well showing a minimum of 15 feet (true vertical thickness except for horizontal wells) of producible sand in one section” as one method to qualify your well as capable of production. However, there are several reservoirs that currently produce from sands less than 15 feet (true vertical thickness except for horizontal wells). Thus, you must consider any analog reservoir less than 15 feet in a field that is capable of flowing liquid hydrocarbons and is exposed to the open hole.

WCD Examples of Data Submittals

ATTACHMENT A

SUMMARY SHEET

WORST CASE DISCHARGE (WCD) EXAMPLE DATA

GERERAL INFORMATION:

PLAN NUMBER	OCS AREA	OCS BLOCK	LEASE NUMBER

WELLBORE DATA:

Water depth at proposed well location (feet):						
CASING DATA						
INTERVAL NUMBER	HOLE SIZE	SIZE CASING	WEIGHT	GRADE	SETTING DEPTH	
					MD	TVD

DIRECTIONAL SURVEY DATA					
MD	INCLINATION	AZIMUTH	TVD	DELTA X	DELTA Y

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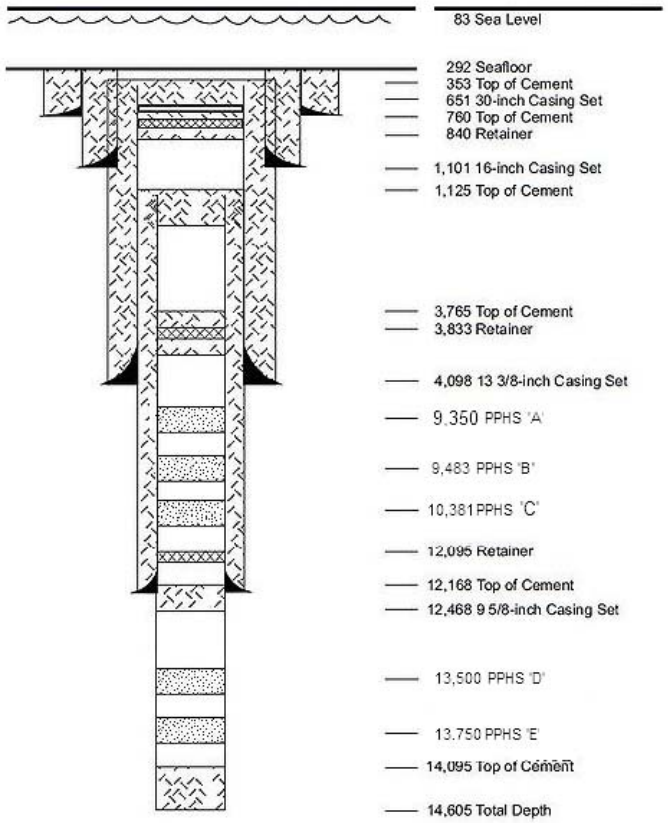
WCD Examples of Data Submittals

EXAMPLE WELL CASING PROGRAM with Potential Producible Hydrocarbon Sand (PPHS) Identified



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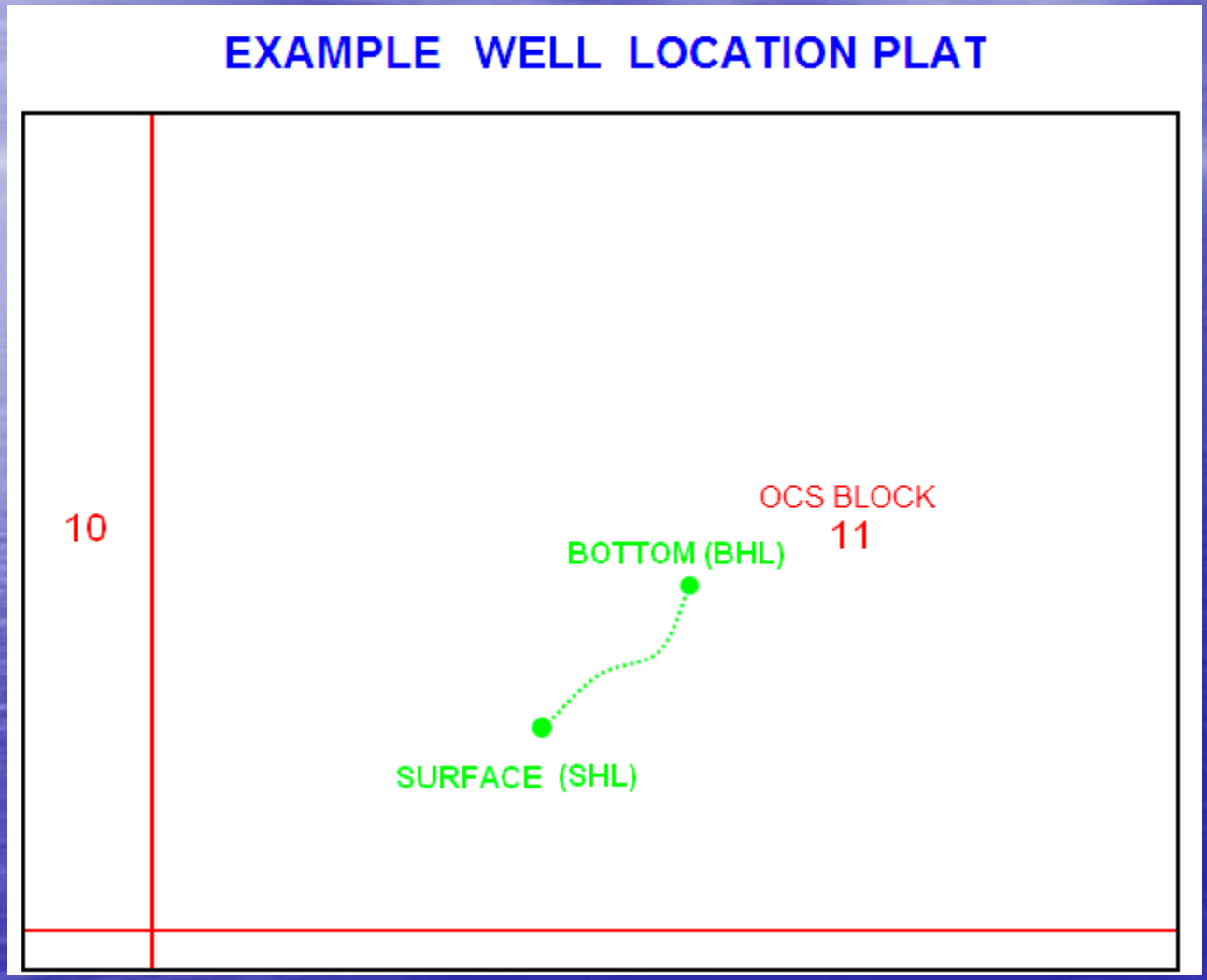
WCD Examples of Data Submittals



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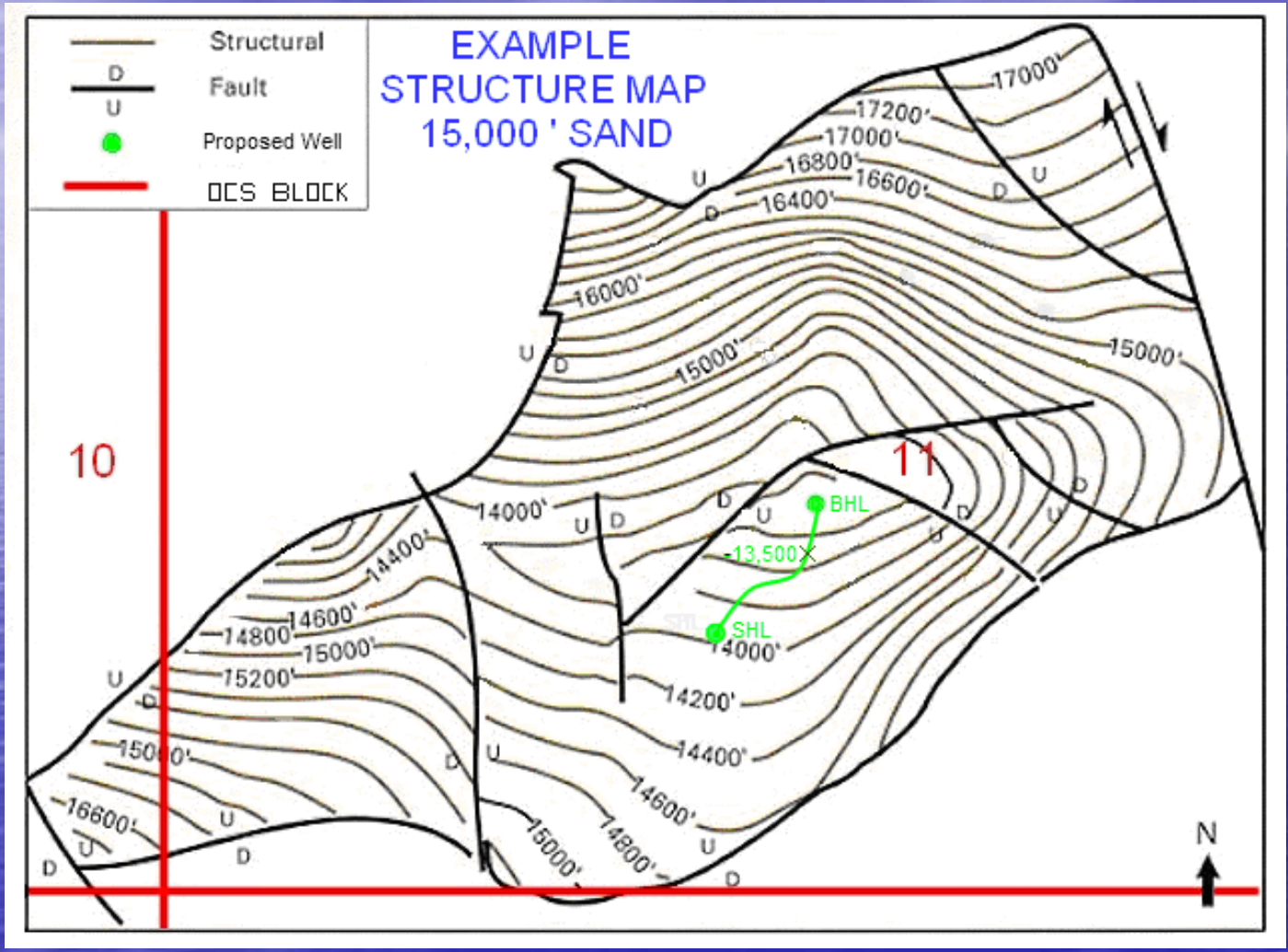
WCD Examples of Data Submittals



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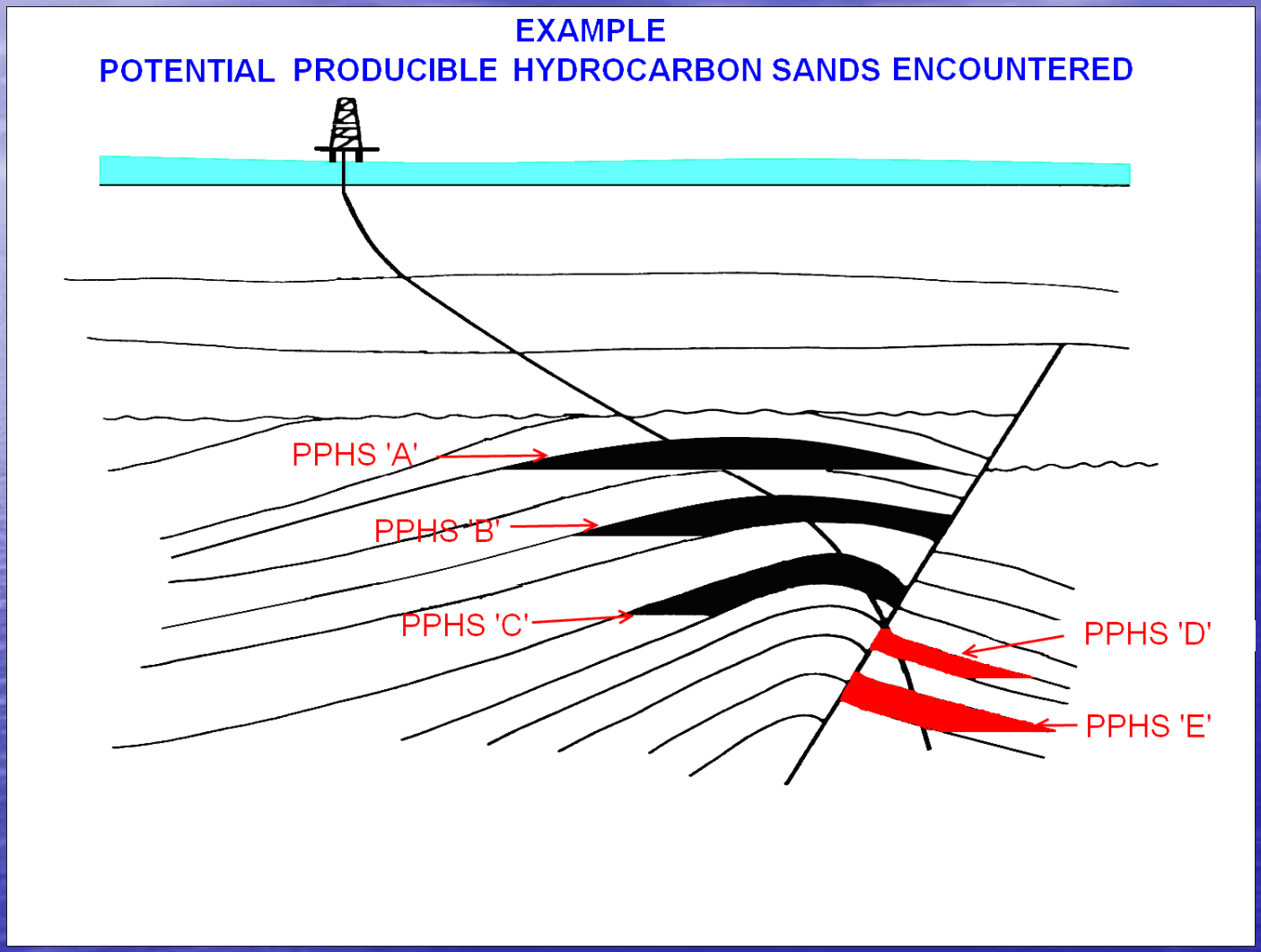
WCD Examples of Data Submittals



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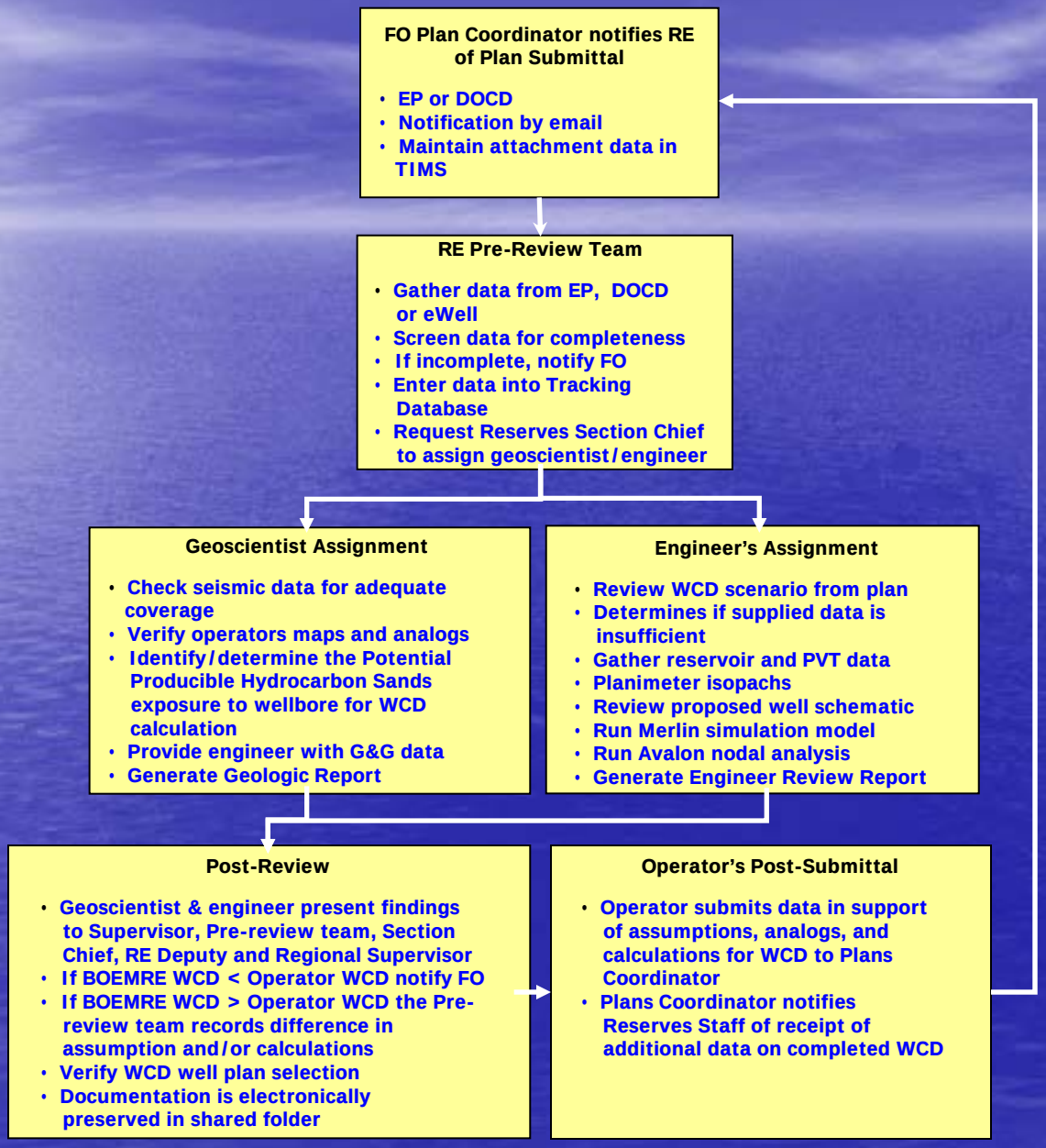
BOEMRE WCD Workflow



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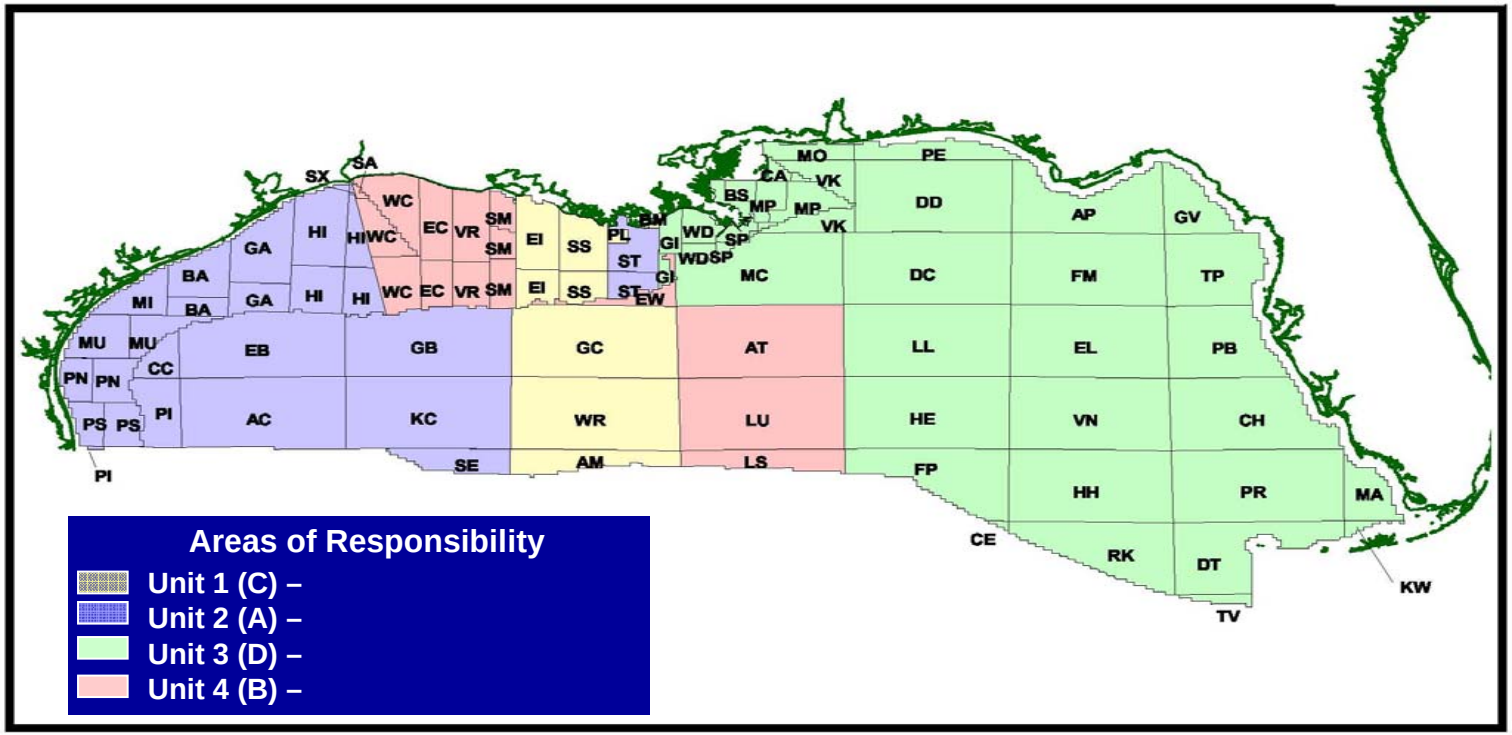
Reserves Units Areas of Responsibility



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Worst Case Discharge (WCD) Verification

BOEMRE's SOURCE OF DATA

- Corporate database (TIMS) reservoir properties and sand characteristics derived by Reserves Section
- Operator's submitted data not associated with WCD:
  - Logs
  - Cores
  - Pressure Data
  - Production Data
- Data submitted in Plans in support of Operator's WCD scenario

Worst Case Discharge (WCD) Verification

DATA SUBMITTAL PROBLEMS

ASSOCIATED WITH WCD SCENARIO VERIFICATION

- Operator identifies only one target sand in the open hole
- Operator's target sand(s) is deeper than shallower sands that may have a higher WCD
- Operator's plan submittal indicates significant deeper drilling below target sand
- Operator does not identify the WCD well in a multi-well Plan
- Operator ignores recent non-proprietary data that might influence the analysis
- Critical nodal analysis factors such as permeability, sand thickness, reservoir pressure and gas-condensate yield are not sufficiently documented

Worst Case Discharge (WCD) Verification

WCD PREMISE

- Verification of Operator submitted analogs, assumptions, and calculations through independent analysis
- Proprietary and non-proprietary data from corporate database (TIMS) used for verification
- Verification of parameters assuming a worst case mode
- Reservoir and rock characteristics must occur in nature
- WCD calculated at location of BOP stack
- WCD considered a cradle to grave process

Worst Case Discharge (WCD) Verification

WCD ISSUES

- Industry software applications not fully developed to calculate uncontrolled flow in a WCD scenario
- Application of sand thickness in modeling (MDT vs TVT vs TST)
- Drastic reduction of liquid hydrocarbons in gas flow based upon sonic velocity
- Consistent permeability determination

WCD Examples of Data Submittals

Geologic Summary Sheet

Plan Number	OSRP	Product Type	WCD Well	Area/Block	OCS Lease

Project Name

Open Hole Interval for WCD

Top	Base

WCD Well TD (MD)
WCD Well TD (TVD)

Analog Well(s)

Area/Block	OCS Lease	Well Number

Analog Field(s)

Area/Block

Formation Data

Sand Name	Estimated Top TVD	Estimated Base TVD	Estimated Pay Height MLT	Estimated Pay Height TVT	Fluid Type	Used in WCD?
						☐
						☐
						☐
						☐
						☐
						☐
						☐
						☐
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						☐
						☐
						☐

Seismic Survey Used

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WCD Examples of Data Submittals

Engineering Summary Sheet

Plan Number	Area/Block	OCS Lease	Water Depth

Analog Well(s)

Area/Block	OCS Lease	Well Number

Analog Field(s)

Area/Block	Field Name

	WCD Engineering Items
WCD (STB/Day)	
Flow Correlation	
Reservoir Skin Factor	
Outlet Pressure	
Gas Turbulence Factor	
Software Model Used	

WCD Calculated at mudline ☐
WCD Calculated at atmosphere ☐

Formation Data

	Sand 1	Sand 2	Sand 3	Sand 4	Sand 5
Sand Name					
Net Sand Height (ft)					
Permeability (mD)					
Initial Pressure (PSIA)					
Reservoir Temperature (F)					
Porosity (0.00)					
Water Saturation (0.00)					
Rock Compressibility (microsips)					
Water Salinity (ppm)					
Drive Mechanism					
Area (acres)					

Oil Reservoir Data

Bubble Point Pressure (PSIA)					
Initial Bo (RB/STB)					
Bo (RB/STB) @ Bubble Point					
Rsi *GOR (SCF/STB)					
Initial Oil Viscosity (CP)					
Oil Viscosity (CP) @ Bubble Point					
Oil Compressibility (1/PSIA)					
Oil API Gravity (API)					

Gas Reservoir Data

Condensate API Gravity (API)					
Specific Gas Gravity (0.00)					
Yield (STB/MMCF)					

Permeability from MDT ☐
Permeability from sidewall core ☐
Permeability from NCS core ☐
Permeability from rotary core ☐
Permeability from coventional core flood ☐
Permeability from CMR or NMR log analysis ☐
Permeability from other source ☐

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Worst Case Discharge (WCD) Verification

WCD WORKLOAD

As of March 22, 2011

Reserves verify the validity of the operator's assumptions, calculation, and analogs submitted in support of their WCD scenario.

WCD Verification Requests:	**143**
Prescreened for Data Content:	**141**
Request to Operator for Additional Data:	**46**
Additional Data Received from Operator:	**44**
WCD Scenario Completed:	**128**
Reserves WCD Greater than Operator's:	**59**

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Thank You

Questions

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