FMC Subsea High Capacity 20K Wellhead System Overview

Rigorous Qualification and Development Program
Qualification program

- Qualification testing is performed above and beyond industry requirements to give you greater confidence
- API requires proof of design through FEA, calculation, or testing – FMC does all three
- No scaling of PR2 testing
- All testing performed at in-house R&D facilities

Qualification Summary

- Developed 18-3/4" 20K Wellhead System using proven technology
- Analyzed system using latest FEA techniques
- Successfully tested all components and tools, simulating field conditions from installation through completion
Technology leadership

- Innovative ideas and a deep understanding of the application of technology set us apart

- FMC has remained committed to investing in subsea technology development
  - In-house R&D investments
  - Construction of new technology centers
  - Acquisitions
  - Partnerships & JIPs

- Our development approach uses proven processes and best practices
  - New Product Development Stage Gate
  - Engineering Execution Process

Next-generation drilling technology development

- Annular Monitoring
- Wellhead Fatigue Monitoring
- Riser Fatigue Monitoring
- Extreme HP/HT (20K, 350 F)

FMC Technologies
Wellhead Systems Overview
UWD-10 slimbore wellheads

- **Application**
  - Ideal to use with smaller riser systems
- **Features**
  - 16-¾”, 14-¾” and 13-5/8” nominal bore size
  - Surface or subsea BOP
  - Water depth range up to 10,000 ft (3,048 m)
  - 27” H4 hub profile
  - Modular, stackable design
  - Rated for 10,000 psi and 250 degrees Fahrenheit
- **Benefits**
  - Fewer installation tools required
  - Single trip tools reduce installation time and cost
  - Reliable metal-to-metal sealing

UWD-15 wellhead systems

- **Application**
  - Ideal for shallow and deepwater drilling and production
- **Features**
  - Water depth range up to 10,000 ft (3,048 m)
  - 27” H4 hub profile
  - Modular, stackable design
  - Rated for 15,000 psi and 250 degrees Fahrenheit
- **Benefits**
  - Fewer installation tools required
  - Single trip tool design reduce installation time and cost
  - Reliable metal-to-metal sealing
HC-15 and HC-20 systems

- HC-15 and HC-20 systems provide the highest casing hanger load capacities inside the high pressure housing
  - First position hanger can suspend up to 2.0 MM lbs of casing with a 15,000 psi BOP test
  - Second position hanger can also suspend up to 2.0 MM lbs of casing with a 20,000 psi BOP test

- HC-15 and HC-20 systems are identical except for the upper profiles and internal pressure ratings of the high pressure housings
  - HC-15 uses an H-4 profile with 27” OD mandrel and has an internal pressure rating of 15,000 psi
  - HC-20 uses an SHD H-4 profile with 30” OD mandrel and has a 20,000 psi internal pressure rating

Comparison of wellhead systems

<table>
<thead>
<tr>
<th></th>
<th>HC-15 System</th>
<th>HC-20 System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Casings</td>
<td>10-3/4</td>
<td>13-5/8</td>
</tr>
<tr>
<td>Pressure rating</td>
<td>15KSI</td>
<td>15KSI</td>
</tr>
<tr>
<td>Seals</td>
<td>15KSI annulus seal assembly</td>
<td>20KSI annulus seal assembly</td>
</tr>
<tr>
<td>BOP Test</td>
<td>15,000 psi</td>
<td>20,000 psi</td>
</tr>
<tr>
<td>Temperature</td>
<td>250°F</td>
<td>350°F</td>
</tr>
</tbody>
</table>

15KSI annulus seal assembly

13-5/8 casing hanger 15KSI

20KSI annulus seal assembly

10-3/4 casing hanger (20 KSI)
20K High Capacity Wellhead System

UWD-HC-20 18 ¾” Wellhead system

Applications
- High pressure
- High temperature
- Ultra deep water
- Increased well depths
UWD-HC-20 18 ¾” wellhead system – requirements

- System temperature – 0°F to 350°F
- Wellhead pressure and loads
  - 20,000 psi working pressure
  - 30,000 psi test pressure
  - Ability to suspend 4.0 Million lbs of casing inside the wellhead
- Casing pressure and loads
  - 2.0 million lbs running weight on production, intermediate, and 16” SML casing strings
  - 10% overpull for casing running tools (2.2 MM lbs total load)
- BOP tests
  - 15,000 psi on 16” or 13-5/8” hangers and wear bushings (1st position)
  - 20,000 psi on 11-3/4”, 10-3/4”, or 9-5/8 hangers and wear bushings (2nd position)

UWD-HC 18 ¾” casing options

- Casing flexibility (8 strings max)
  - LP housing: 42”, 38”, 36”
  - Openwater strings: 32”, 28” or both
  - Wellhead housing: 24” through 22”
  - Submudline systems: 18” and/or 16”
  - 1st position casing hanger:
    - 16” through 13 ¾”
  - 2nd position casing hanger:
    - 11 ¾” through 9 ¾”
18 ¾” UWD-HC wellhead system open water equipment

Multiple Open Water String Options
UWD-HC System
42”/38” X 32”/30” X 28”/26” X 22” 23”

22-23” Casing
28” Casing (optional; can be run without running 32” casing)
32” Casing (optional)
38”-42” Casing

18-¾” UWD-HC wellhead system submudline hangers

22” x 18” hanger is rated for 5,000 psi and 1.0 million lbs of casing

22” x 16” hanger is rated for 5,000 psi and 2.0 million lbs of casing

23” x 16” hanger is rated for 10,000 psi and 2.0 million lbs of casing
20K High Capacity Wellhead Components

UWD-HC-20 18 ¾” Wellhead System

• 38” HC Conductor Housing with SWF Receptacle
• 32” and 28” SWF Housings
• HC-20 18-3/4 Wellhead Housing w/ SHD H4 Profile
• HC 16” Submudline System
• 18” Submudline System
• 14” Casing Hanger
• 10-3/4” Casing Hanger
Major components and features

- Low pressure housing
  - 42”, 38”, or 36” casing options
  - 1.0 M lbs casing weight capacity
  - Optional shallow water flow receptacle
- Run with HC SFB drill ahead tool
  - Field proven design and functionality
  - Field proven installation procedures

Major components and features

- Shallow water flow housings
  - 32” and/or 28” housings available
- Can be run together or independently
  - 1.0 M lbs casing weight capacity (each size)
- Run with 28/32 cam tool
  - Field proven design and functionality
  - Field proven installation procedures
Major components and features

• Wellhead housing
  – HC-20 is 20,000 psi rated working pressure with SHD H4 profile (30” mandrel)
  – HC-15 is 15,000 psi rated working pressure with H4 profile (27” mandrel)
  – Preloaded to low pressure housing with HC rigid lock seal assembly
  – Two independent sets of seat segments
    • 1st set: rated for 2.0 M lbs + 15,000 psi pressure end load
    • 2nd set: rated for 2.0 M lbs + 20,000 psi pressure end load
  – 16” string can be set in the wellhead housing

Major components and features

• 18” Submudline System
  – System is rated for 1.0 M lbs casing weight with 6,500 psi working pressure
  – Casing hanger
    • Solid Body
  – Annulus seal assembly
    • 6,500 psi working pressure
  – Receptacle
    • Run below wellhead housing (and 16” receptacle)
    • Feature a collapsing load ring to support the casing hanger
Major components and features

- HC 16” submudline system
  - System is rated for 2.0 M lbs casing weight with 10,000 psi working pressure
  - Casing hanger
    - Expanding load ring
  - Annulus seal assembly
    - 10,000 psi working pressure
  - Receptacle
    - Provides landing point for the casing hanger

- 1st position casing hanger
  - 2.0 M lbs casing weight capacity
  - 15,000 psi working pressure
  - 16” or 13-3/8” intermediate casing

- Run with HC 1st position single trip tool
  - Field proven design and functionality
  - Field proven installation procedures
  - Load tested to 2.2 million lbs and 15,000 psi
Major Components and Features

• **2nd position casing hanger**
  – 2.0 M lbs casing weight capacity
  – 20,000 psi working pressure
  – 11-3/4”, 10-3/4”, or 9-5/8” production casing
• **Run with HC 2nd position single trip tool**
  – Field proven design and functionality
  – Field proven installation procedures
  – Load tested to 2.2 million lbs and 20,000 psi

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Major components and features

• **HC 18-3/4” annulus seal assemblies**
  – Metal-to-metal
    • 20,000 psi working pressure – bore pressure for HC-20
    • 15,000 psi working pressure – bore pressure for HC-15
    • Rated for 0°F – 350°F production fluid temperatures
  – Elastomer seal assemblies available
  – Field proven design and functionality
Specialty tooling

- Isolation test tool
  - Isolates BOP from annulus seal assembly test pressure (20,000 psi)
  - Operates with straight in/straight out of hole function

Existing tools used in HC system

- UWD-15 wellhead running tool
  - 15,000 psi BOP test pressure
  - 1.5 million lbs load capacity

- UWD-15 spring loaded tool
  - Increased pressure capacity for 20,000 psi BOP test pressure
Installation of the 20K Wellhead System

Current Installations and Orders

- 1st FMC and Industry 20K Subsea Wellhead System installed in 2012
- Current customer schedules indicate 3 more 20K Wellhead Systems to be installed in 2013
- Quotes currently out for 12+ 20K wellhead systems
Why Operators Are Choosing 20K Wellhead Systems

- Increased Casing Capacity (Longer, Heavier Casing Strings Possible)
  - Starting to see 1,000,000+ lbs string weights for each casing hanger inside of the wellhead due to industry shift to 14” heavy wall casing
  - 2,000,000 lbs of casing capacity available in each of the 16” Submudline, 14”, and 11¾” casing strings
- Increased Temperature Rating
  - Metal Annulus Seal Assemblies rated for 350F
  - Elastomer Annulus Seal Assembly (Emergency) rated for 300F
- Working Pressure of 20,000 psi
  - Shut-in pressure calculations are indicating pressures could reach or exceed 15,000 psi at the wellhead (conservative)
  - Newer fields have seismic data indicating production pressures greater than 15,000 psi