Subsurface Flow Controls
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- Locks and Landing Nipples – X®, R®, RPT, SRH

- Nippleless Plugs - Mirage® and Evo-Trieve bridge plugs

- DuraSleeve® Sliding Side-Door® circulating device

- Wellhead Plugs - SRP, SSP

- Accessory Items – flow couplings, blast joints
### Nipple Profiles/Lock Mandrels

#### Selective Completions

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<tr>
<td><strong>X</strong>&lt;sup&gt;®&lt;/sup&gt;</td>
<td><strong>R</strong>&lt;sup&gt;®&lt;/sup&gt;</td>
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<tr>
<td>STD Weight</td>
<td>Heavy Weight</td>
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<tr>
<td>FC - SSSV, Plug, Choke, Gauge</td>
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#### No-Go Completions

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<td><strong>RPT, RQ</strong></td>
<td><strong>SafetySet</strong>&lt;sup&gt;®&lt;/sup&gt;</td>
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<tr>
<td>FC - SSSV, Plug, Choke, Gauge</td>
<td>SSSV</td>
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#### Special Applications

- High Pressure and Flow Rate
- SRH HPHT
- BPV, Plugs

#### Monobore Completions

**Evo-Trieve**<sup>®</sup> RBP
FC - Plug, Choke, Gauge

**SRP**
Wellhead Plugs
X® & R® Selective Landing Nipple/Locking Mandrel System

Design Benefits

- Nipples installed in tubing string in any order- reducing workover risk
- Provides unlimited number of positions to set
- Running tool allows selection of nipple to land and set the lock
- Same ID in all nipples reducing flowing pressure loss and minimizing turbulence
- Maximum flow capacity from large, straight-through bore of locking mandrel
- Maximum versatility reducing completion and production maintenance costs
- Allows for repositioning of flow controls as well conditions change
- Keys of locking mandrel retracted into assembly while running and retrieving
Otis® RPT™ No-Go Type Nipple and Lock Mandrel

The Otis RPT No-Go landing nipple system provides a means of running a series of positive location landing nipples in a tubing string with minimum restriction.

The lock mandrel locates on top of the polished bore of the nipple, there are no secondary restrictions normally associated with bottom no-go profiles. The no-go nipple provides positive location of the lock and minimizes the possibility of mis-runs.

- **Applications**
  - High-pressure, high temperature, large bore completions
  - For running a series of nipples in a tubing string when positive location and minimal ID reduction are required

- **Features**
  - Large bore
  - Lock mandrel no-go locates on top of the nipples’ polished bore

- **Benefits**
  - No secondary restrictions normally associated with bottom no-go profiles
  - Lock mandrels in a particular size range use the same running and pulling tools
SRH Plug and Nipple System for HP/HT

- Uni-body style plug

- 3 x 45 deg loading surfaces on key above and below, maximizing key bearing area

- HP/HT non-elastomer seal stack “V0” Qualified to 25,000 psi and 450F

- MTM shear plug for equalizing
SRH Plug Operational Benefits

- Two plug types possible
  - Pump through capable plug
    - Prong installed for a positive plug to hold pressure from above
  - Conventional prong type plug (as shown)

- Two moving parts, expander sleeve and keys

- Running tool does not release unless lock is correctly and fully set
Case History - US Gulf of Mexico

**CHALLENGE:**
- Provide XHPHT landing nipples and plugs for an extreme depth gas well as part of the shallow water ultra deep (SWUD) gas play in the GOM
- Bottom hole pressures approaching 25,000 psi and wellhead flowing temperatures that exceed 400°F

**SOLUTION:**
- The SRH platform was specifically developed for XHPHT applications to withstand elevated pressures and temperatures
- “V0” type qualification assures robust performance in gas environments

**RESULT:**
- Operator deployed the SRH landing nipple and plugging system as part of their completion program
- Successful operation will lead to additional orders for future SWUD wells
Evo- Triever™ Bridge Plug Development Objectives

- Fully qualified to ISO 14310 V0 qualification
- Max pressure rating of 7,500 psi (above / below)
- Temperature 40°F to 325°F
- Plug design is as compact as possible
- Top sub equalize and release (GS profile)
Overview - Evo-Trieve™ Bridge Plug

Guide Sub

Packing Element

Slip System

Equalizing Sub
1. Autofill and Mirage plug are run to depth below a hydraulic set packer. The tubing is filled through the Autofill when running downhole.
2. Multiple pressure cycles against the Mirage plug allows closure of Autofill, tubing test and setting of packer.
3. Final pressure cycle dissolves Mirage plug matrix for full bore access.
Multi-Cycle Mirage® Disappearing Plug (MPB)

- Allows for 6 - 7 tubing pressure cycles of 4000 psi (minimum cycle pressure)
  - Note: hydrostatic overbalance from tubing to annulus must be <600 psi
- On final pressure cycle, the fresh water is introduced into the plug and expends
- Applications In:
  - Horizontal wells
  - Setting production or isolation packers
  - Testing tubing
  - Wells where slickline or CTU intervention after completion is undesirable
Single-Cycle Mirage® Disappearing Plug (MPR)

- Uses rupture disc for controlled pressure activation
- Accurate expend pressure (+/- 2%)
- Good for high hydrostatic pressure applications
- Up to 17K – applied + hydrostatic

Rupture Disc – Plug will expend when the disc is opened by applying a pre-defined tubing pressure
Case History – Mirage Plug replaces POP in Malaysia

- **CHALLENGE:**
  - Design a simple and effective open hole completion for an 18 well campaign for a major operator in Malaysia
  - The original completion design included a pump out plug (POP) for tubing testing and packer setting

- **SOLUTION:**
  - Replace the POP with the Mirage disappearing plug and Autofill sub
  - Eliminates the need to pump down a ball to expend the POP, which can be problematic and time consuming in horizontal or highly deviated wells

- **RESULT:**
  - The operator chose the simplicity and time savings of the Mirage plug for the campaign
  - Mirage plug has become the standard for all the customers horizontal openhole wells
DuraSleeve® Non-Elastomer Circulation / Production Sleeve

Applications in:
- Producing alternate zone in single-selective completions
- Circulating kill fluid eliminates expense of perforating tubing
- Secondary recovery
- Washing above packer

Design Capability:
- Sizes 1 ½-in. to 7 in.
- Pressure rating equal to tubing rating
- Open-up and open-down options using B shifter
Shifting forces for Nitrile Seal, PEEK seal, and the DURATEF™ ECM seal are less than 1/5 the force required for sleeves with competitive materials such as PEEK.
Slimline Sliding Side-Door® Device

- Small OD SSD designed for concentric string gravel pack completions
- Allows for running larger size tubing inside small ID casing
  - 2 3/8-in. – 2.72 v. 3.25 OD
  - 2 7/8-in. – 3.22 v. 3.92 OD
  - 3 ½-in. - 3.92 v. 4.50 OD
- OD’s comparable to CS Hydril upset
- 5000 psi rating (more with material upgrade)
- Tensile rating 60-70% of N-80 tubing
- Standard B shifting tool
SRP Wellhead Plugs

- Deepwater development has created demand for wellhead plugs
- Used primarily in subsea trees
- Ultra-compact design allows for use in horizontal trees
- Available in equalizing and non-equalizing models
- High-pressure rating above and below
- No-go design with minimum restriction
SRP Wellhead Plug

Design Features

- Compact length reduces space requirements of wellhead
- Single leak path is through two full packing stacks
- High pressure rating from above and below
- Multiple shear pin hold down mechanisms for redundancy
- Simple design for high reliability. Only two moving parts: keys and expander sleeve
SRP Wellhead with Added Back Pressure Valve

- Redundant seal stacks
- Equalizing plug w/ M-T-M seal plus redundant seal
- Back pressure valve uses M-T-M seal with redundant seal stack
- Hold-down pins engage expander mandrel after set
SRP Wellhead Back Pressure Valve

- Optional test prong isolates the back pressure valve to allow pressure testing of SRP plug from above
SSP Wellhead Plug

- MTM seal plus a single packing stack, compatible with FMC wellhead
- Compact length
- Test pressures up to 15,000 psi
- API 17D, API 14L, PR-2 and vibration tested
- Static after set
  - Hydrostatic running tool applies predetermined force into expander sleeve taper
  - 3 degree taper statically sets key into profile for no plug movement
- Secondary interference locking sleeve
- Three fishnecks
  - Two fishnecks on expander sleeve
  - Additional fishneck on plug body
Accessory Items
Flow Couplings

- Important part of life-of-the-well completion planning
- Wall thickness greater than the corresponding tubing to inhibit erosion caused by flow turbulence
- Should be installed above and below landing nipples or other restrictions that may cause turbulent flow

Applications
- Help inhibit erosion caused by flow turbulence
- Installed above and below landing nipples, tubing retrievable safety valves, or any other restriction that may cause turbulent flow

Benefits
- Help extend the life of the well completion
Blast Joints

- Installed in the tubing opposite perforations in wells with two or more zones
- Heavy walled and are sized to help prevent tubing damage from the jetting action of the zone perforations
- Blast joints should be installed above and below landing nipples or other restrictions that may cause turbulent flow

Applications
- Help inhibit erosion caused by jetting action near perforations
  - Installed opposite perforations in one or more zones

Benefits
- Help extend the life of the well completion