

THE CONCERN OF GATE VALVES IN NON-HORIZONTAL INSTALLATIONS

Andrea Righini

Orion Valves Spa

Bader Al-Jarallah

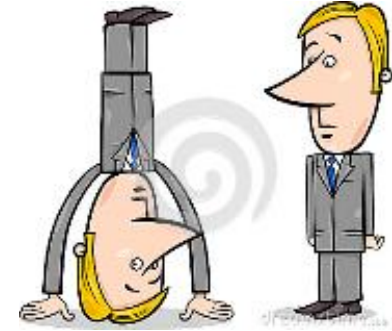
Saudi Aramco



- **INTRODUCTION**
- **DESIGN RELATED FAILURES**
 - **WEDGE TYPE GATE VALVE (API 600)**
 - **THROUGH CONDUIT SLAB GATE VALVE (API 6D)**
 - **UPSTREAM GATE VALVE (API 6A)**
- **SERVICE RELATED FAILURES**
 - **INTERNAL CORROSION**
 - **ACCUMULATION OF DIRT**
- **OTHER CONCERNS**
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Installation of Valves



The preferred installation for linear actuation valve is on HORIZONTAL LINE with the VERTICAL STEM UPWARD



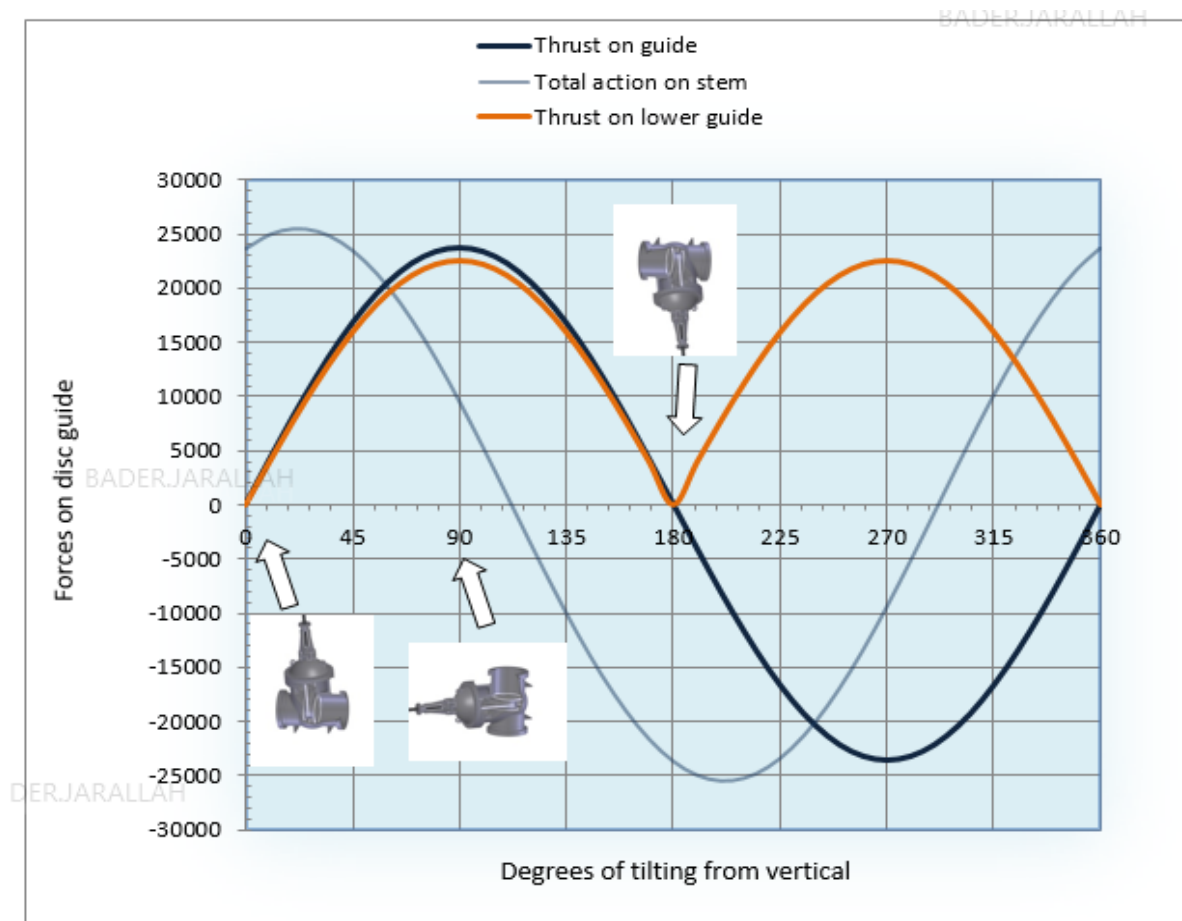
Installation of Valves

Why Non- Horizontal Installations ?

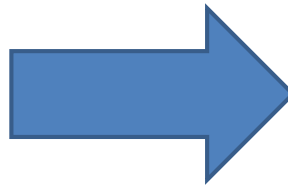
- Piping Layout
- Space Limitation
- Accessibility
- Achieve Fail-Safe Scenarios



1) WEDGE TYPE GATE VALVE



Cock & Lock Syndrome



Case Study

- 56" Class 150 Wedge Gate Valve
- 45 Degree below to achieve Fail open installation
- Stem overload and failure



Recognized best practices to ensure gate alignment

BS1414 /ISO10434

10.4 Guide slots or lugs to engage the body guides shall be provided on the wedges of all valves. The slots or lugs shall be of ample length and shall extend below the horizontal centre line of the wedge. Wedges shall be provided with a suitable slot at the top to receive the button or tee-head of the stem.

API600

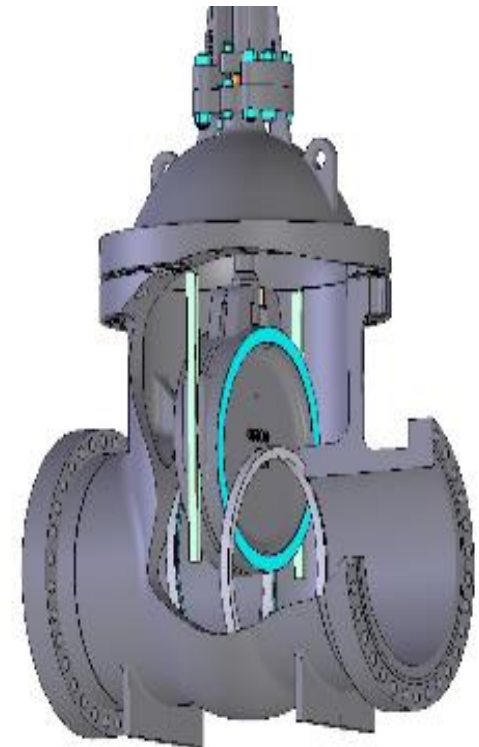
BADERJARALLAH

5.6.3 The body and gate shall have guide surfaces to minimize wear of the gate seats during operation of the valve, to accurately position the gate throughout the travel distance to its seat, and to ensure the alignment of the gate and stem in all orientations without gate binding or galling. For sizes DN 650 (NPS 26) and above, as a minimum, wedge guides and body guides shall be hardfaced and machined with appropriate tolerances and clearances to allow for proper valve operation in any orientation, including effects of wear or galling. Wedge guides and/or body guides shall not protrude beyond the seat rings into the port area of the valve. The manufacturer shall provide in their installation and operation manual any operational limitations as a result of stem and valve orientation.

API615

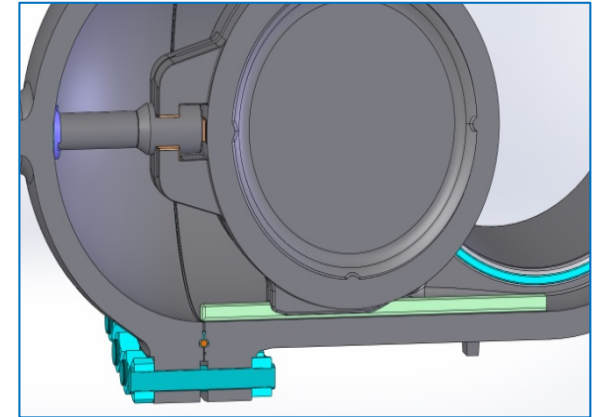
5.1.1.6 Orientation Considerations

While somewhat dependent on pressure class, gate valves larger than about NPS 8 oriented in any position other than with the stem vertical may result with the disc getting hung up against the inside body guides such that the valve may get stuck and not be operable. Special attention to guiding details including clearances, avoidance of sharp corners on the disc leading edge, and the possible use of machining/hardfacing on the guides is recommended. Even with the stem vertical there may be an accumulation of dirt and other deposits between the seats such that the valve may not close fully. Installation of a bleed valve between the body seats to provide a purge connection may be considered to address this potential build-up.



Effective Guides

- ✓ **Proper Wedge to Guide Engagement**
- ✓ **Precise Dimension**
- ✓ **Hard Facing**
- ✓ **Surface Finish**



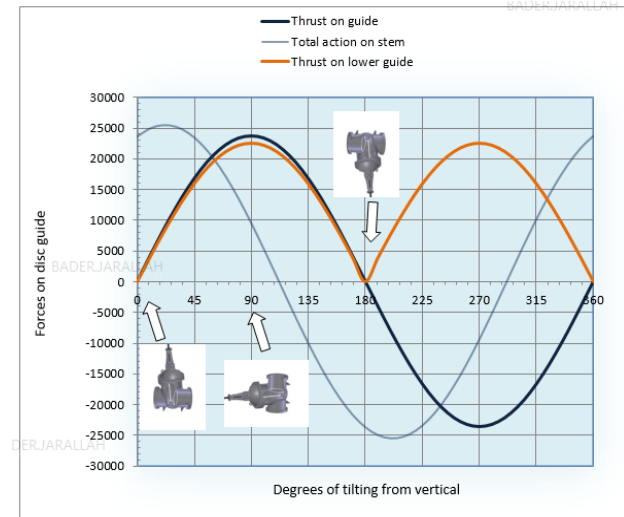
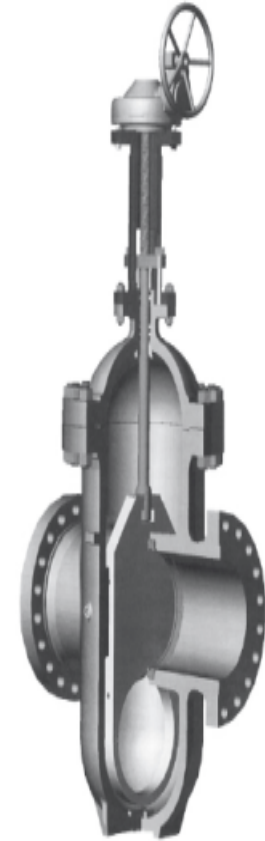
2) THROUGH CONDUIT SLAB GATE VALVE

More complex than wedge gate:

- Gate and Seats Always in Contact
- Gate Driven by Seats and by Body/Skirts

Common Failure Modes:

- Gate/Seat Damage
- Stem Leak



Scratches in the Seat Area

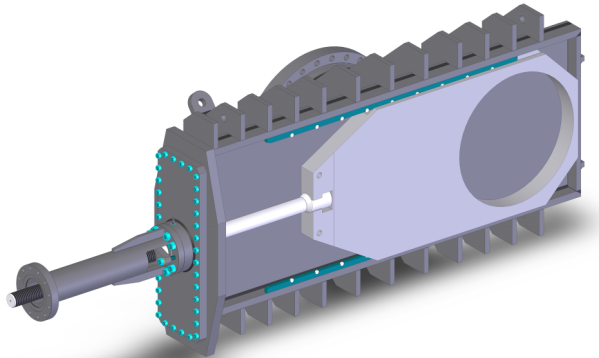


Premature Failure of Slab Gate Valve installed
horizontal Stem with vertical pipe

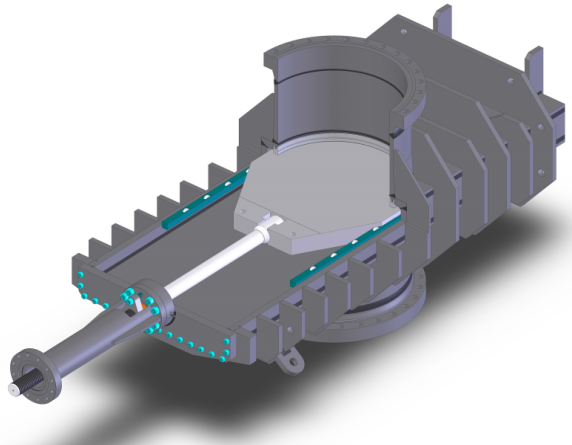


56" 300 NEW slab gate
Failure during Hydro test at Horizontal position

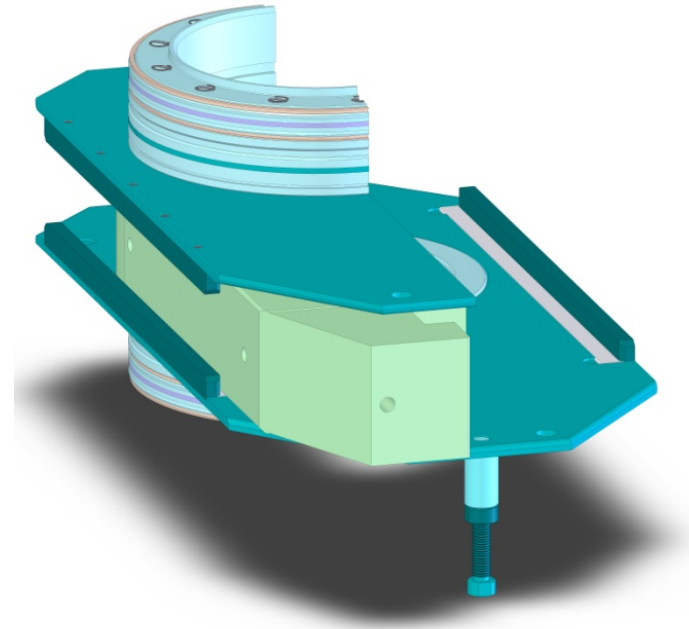
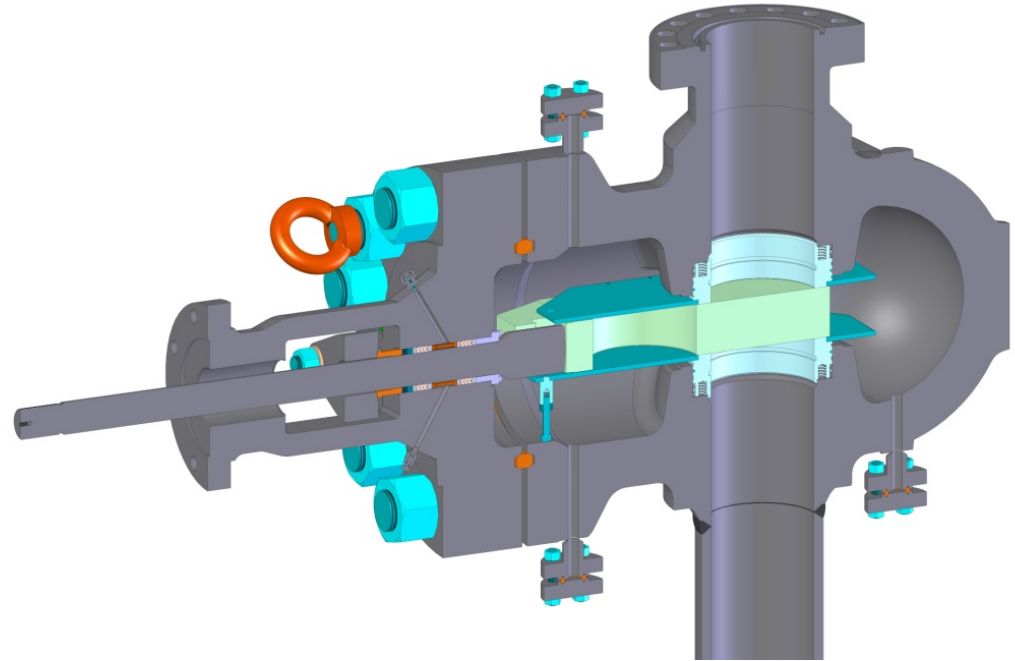
Rollers and sliders



Horizontal stem Horizontal pipe



Horizontal stem Vertical pipe



Packing Leak

Why



- **Accumulation of Dirt**
- **Orientation Induced Stress**



Slab Gate 48" 150 in Crude oil terminal Suffer Stem-Seal leak

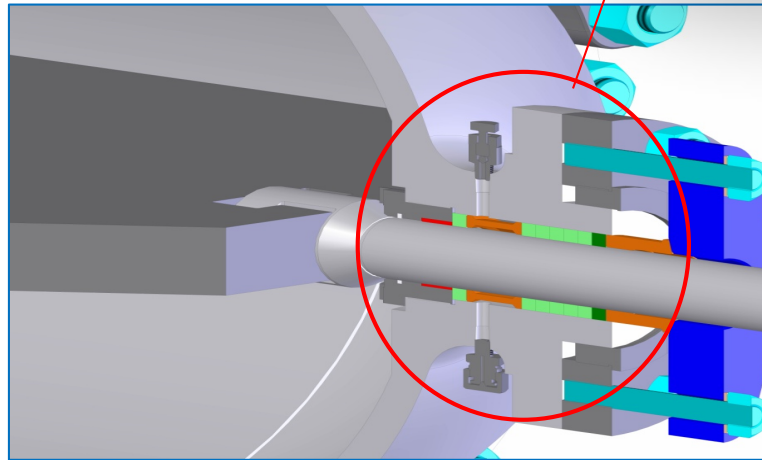
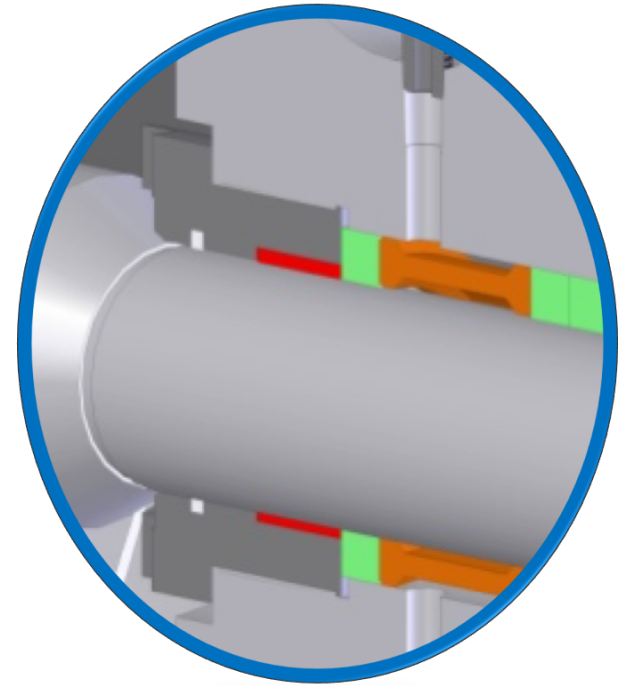
Bearings and Scrapers

- **SCRAPER:**

The scraper avoids dirt particles to damage the stem seal.

- **BEARING:**

The stem weight is supported by the bearing and not by the packing.

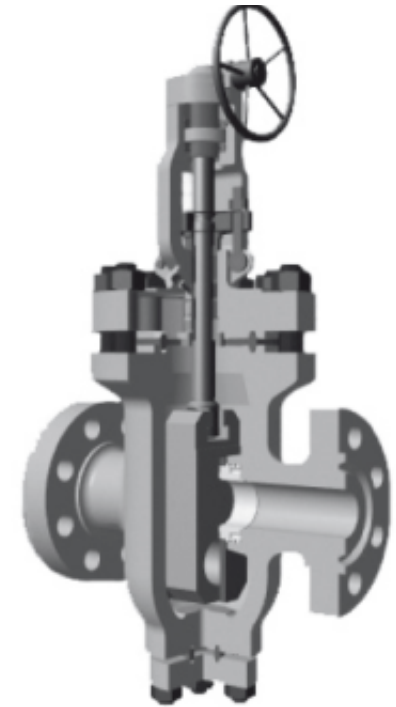
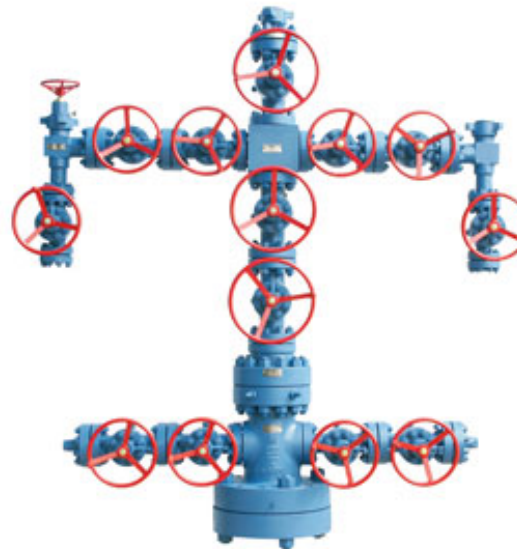


3) Upstream Gate Valve

ROBUST DESIGN



- Small Sizes
- More Precise Assembly
- No Spring Loaded Seats
- Non Rising Stem
- Hardfaced



Service Related Failures

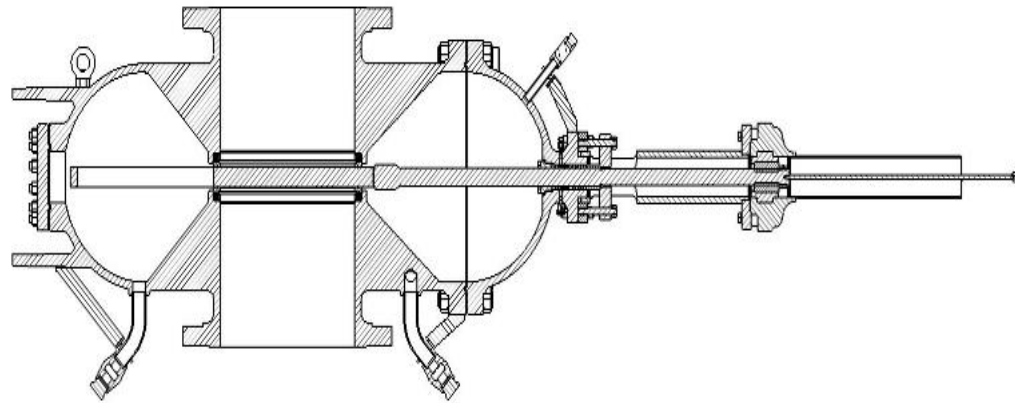
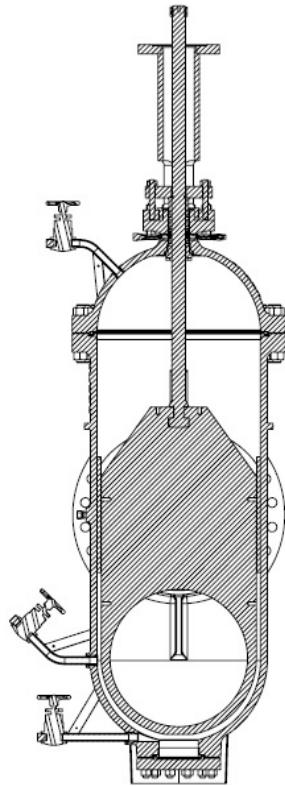
- **Internal corrosion**



- **Accumulations in the valve cavity**



Design Of Drain/Vent Connection



Internal Coating



- Economic alternative
- Upgrade of existing applications

Handling and Maintenance



Actuated Valves

- **Valve Top-mount Bending Stresses:**
 - Yield
 - Creep
 - Fatigue Induced Failures
- **Orientation of Controls/Accessories on the Actuator**
- **Maintenance and Handling for Large Equipment**



Yoke Overloading



Yield of the Yoke



Creep Failure

Special services

•CRYOGENIC SERVICE

•STEAM SERVICE



BS 6364

4.3 Valves in liquid service other than cold box applications shall be capable of operation with the valve stem at or above 45° above the horizontal position.



Take away note



- The Severity of the Case is a Factor: **Size, Pressure Rating and Service Condition.**
- Explore All Options During Valve Selection.
- Valve Can Be Designed For Any Installation ! **But Everything Has A Cost**
- Notify The Manufacturer Intended Installation Orientation.
- Consult The Manufacturers In Case Of Change In Installation.
- For critical Installations: Consider Valve **Functional** Testing at the Intended Installation Orientation.

QUESTIONS



Andrea Righini

a.righini@orionvalves.com

Bader Al-Jarallah

Jarallbm@aramco.com

Thank You

References

- **BS 6364:** *Specification for valves for cryogenic service*
- **BS 1414/ISO 10434:** *Specification for steel wedge gate valves*
- **API 600:** *Steel Gate Valves*
- **API 615:** *Selection of Valves*
- **API 6D:** *Specification for Pipeline Valves*
- **API 6A:** *Specification for Wellhead and Christmas Tree Equipment*
- ***Caution: Horizontal Stem Installation Ahead* . GREG JOHNSON,**
Valve Magazine, 27 Sep 2016