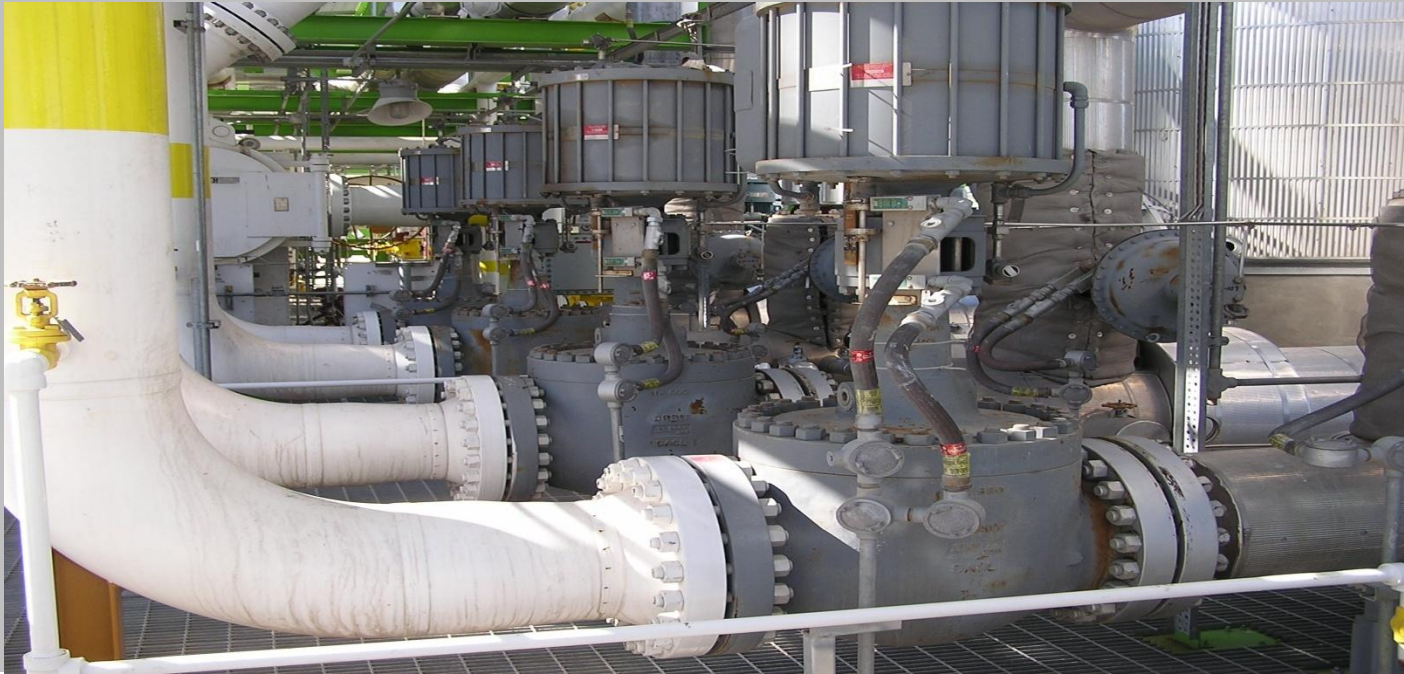




Qualification Standards on Performance Type Testing for Valves used Top Side and in Facilities

March 9th, 2012 → Valve Manufacturers Association
Technical Seminar

Major Oil Companies & Countries with Qualification Requirements



Shell



PETROBRAS

ExxonMobil



Current Qualification Codes

National and International Standards

- AMERICAN PETROLEUM INSTITUTE

- API 6A: *"Specification for Wellhead and Christmas Tree Equipment"* (Oct 2010)
- API 17D: *"Design and Operation of Subsea Production Systems -Subsea Wellhead and Tree Equipment"* (Nov 2011)
- API 591: *"Process Valve Qualification Procedure"* (Dec 2008)
- API 622: *"Type Testing of Process Valve Packing for Fugitive Emissions"* (Oct 2011)

- BRAZILIAN NORM

- ABNT NBR 15827: *"Industrial Valves For Installations Of Exploration, Production, Refining and Transport of Petrol Products – Requirements for Design and Prototype Test"* (Oct 2007)

- INTERNATIONAL STANDARD ORGANIZATION

- ISO 15848-1: *"Industrial Valves - Measurement, Test and Qualification Procedures for Fugitive Emissions"* (2006)

- RUSSIAN

- GOST R 53402 *"Valves. Methods of monitoring and testing"* (2009)

Current Qualification Codes

Company Specifications

● **SHELL**

MESC SPE 77/300: *"PROCEDURE AND TECHNICAL SPECIFICATION FOR TYPE ACCEPTANCE TESTING (TAT) OF INDUSTRIAL VALVES"* (December 2008)

MESC SPE 77/312: *"FUGITIVE EMISSION PRODUCTION TESTING (AMENDMENTS/SUPPLEMENTS TO ISO 15848-2)"* (June 2007)

● **PETROBRAS**

ABNT NBR 15827: *"INDUSTRIAL VALVES FOR INSTALLATIONS OF EXPLORATION, PRODUCTION, REFINING AND TRANSPORT OF PETROL PRODUCTS – REQUIREMENTS FOR DESIGN AND PROTOTYPE TEST"* (Oct 2007)

● **CHEVRON**

SSM-PU-54.02-A: *"QUALIFICATION TESTING OF SUBSEA EQUIPMENT"* (Sept 2008)

● **EXXONMOBIL**

GP 03-12-09 *"GENERAL REQUIREMENTS FOR VALVES"* (March 2008)

Current Qualification Codes – Fire Testing

National and International Standards

- AMERICAN PETROLEUM INSTITUTE

API 6FA: *"Specification for Fire Testing of Valves"* (July 2006)

API 607: *"Fire Test for Quarter-turn Valves and Valves Equipped with Nonmetallic Seats"* (Nov 2011)

- BRAZILIAN NORM

"Accepts ISO 10497"

- INTERNATIONAL STANDARD ORGANIZATION

ISO 10497: *"Testing of valves - Fire type-testing requirements"* (2010)

Qualification Diversities

- **Australian projects** are driving the most onerous testing
 - Subsea valve qualifications being used on critical platform valves and onshore isolation valves
 - Onshore facility valves all to be qualified per ISO 15848-1
- **Chevron projects**
Platform valves on Congo River crossing to be qualified per API 6A appendix F and endurance per API 17D
- **ExxonMobil projects**
RasGas special qualification on ESD and HIPPS valves

PNG temperature and cycle testing of pipeline valves

Global demand for valves to be qualified is spreading from project to project

Qualification Requirements – API 6A

Table F.6 — Design validation for valves

Performance requirement level	PR1	PR2
Open/close cycling dynamic pressure test at room temperature	3 cycles	160 cycles as specified in F.2.3
Low-pressure seat test at room temperature	Objective evidence	1 h hold period at 5 % to 10 % of rated working pressure as specified in F.2.3
Open/close cycling dynamic pressure gas test at maximum and minimum temperatures	Objective evidence	20 cycles at each extreme as specified in F.2.3
Low-pressure seat test at maximum and minimum temperatures	Objective evidence	1 h hold period at 5 % to 10 % of rated working pressure as specified in F.2.3
Retained fluid compatibility	Objective evidence	As specified in F.1.13
Operating force or torque	As specified in F.2.2	As specified in F.2.2
Pressure/temperature cycling	Objective evidence	As specified in F.1.11

Qualification Requirements – API 6A

F.1.14.1 Scaling

Scaling may be used to validate the members of a product family in accordance with the requirements and limitations described in F.1.14.

F.1.14.2 Product family

A product family shall meet the following design requirements:

a) configuration:

The design principles of physical configuration and functional operation are the same. b)

design stress levels:

The design stress levels in relation to material mechanical properties are based on the same criteria.

Qualification Requirements – API 6A

F.1.14.3 Limitations of scaling

F.1.14.3.1 Design validation by pressure rating

The test product may be used to validate products of the same family having equal or lower pressure ratings.

F.1.14.3.2 Design validation by size

Testing of one size of a product family shall validate products one nominal size larger and one nominal size smaller than the tested size. Testing of two sizes also validates all nominal sizes between the two sizes tested.

Qualification Requirements – API 6A

F.1.14.3.3 Design validation by temperature rating

The temperature range validated by the test product shall validate all temperature classifications that fall entirely within that range.

F.1.14.3.4 Design validation by standard test fluid rating for non-metallic seals

The standard test fluid rating validated by the test product shall validate all products of the same product family and material properties as the test product. See Table F.5.

Table F.5 — Scaling for non-metallic seals

Material of products tested	Classes of products validated
AA/BB	AA, BB
CC	BB, CC
DD/EE	AA, BB, DD, EE
FF/HH	AA through HH

F.1.14.3.5 Design validation by PSL

Validation of equipment is independent of the PSL of the production equipment.

Qualification Requirements – API 17D

Table 3 — Minimum validation test requirements

Component	Pressure/load cycling test	Temperature cycling test ^a	Endurance cycling test (total cumulative cycles)
Metal seal exposed to well bore in production	200	3	PMR ^c
Metal seal not exposed to well bore in production	3	3	PMR ^c
Non-metallic seal exposed to well bore in production	200	3	PMR ^c
Non-metallic seal not exposed to well bore in production	3	3	PMR ^c
OEC	200	NA	PMR ^c
Wellhead/tree/tubing head connectors	3	NA	PMR ^c
Workover/intervention connectors	3	NA	100
Tubing heads	3	NA	NA
Valves ^b	200	3	600
Valve actuators	200	3	600

^b Before and after the pressure cycle test a low-pressure, 2 MPa (300 psi) ± 10 %, leak-tightness test shall be performed.

Qualification Requirements – API 17D

5.1.7.8 Product family validation

A product of one size may be used to verify other sizes in a product family, providing the following requirements are met.

- a) A product family is a group of products for which the design principles, physical configuration, and functional operation are the same, but which differ in size.
- b) The product geometries shall be parametrically modelled such that the design stress levels and deflections in relation to material mechanical properties are based on the same criteria for all members of the product family in order to verify designs via this method.
- c) Scaling may be used to verify the members of a product family in accordance with ISO 10423, Annex F.

Qualification Requirements – ABNT NBR 15827

- Covers all valves from class 150 to 2500
- Fire testing is per ISO 10497
- Calculation complete with FEA on each size and class valve only, actuator exempt
model has to be validated
tolerances have to be evaluated and justified
seal material design and choices justified

Qualification Requirements – ABNT NBR 15827

6.4.2 Regarding the nominal diameter

Tests under a given nominal diameter of a valve pattern qualify the designs of a larger nominal diameter and a smaller nominal diameter than the tested nominal diameter. Those qualification tests over than a nominal diameter, with a project of same construction aspect and same pressure rate, qualify two nominal diameters larger than the smallest tested prototype and two nominal diameters smaller than the largest tested prototype.

The utilization of the following nominal diameters $\frac{1}{2}$, $\frac{3}{4}$, 1, 1 $\frac{1}{2}$, 2, 3, 4, 6, 8, 10, 12, 14, 16, 18, 20, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42 and 48 is recommended. Other diameters are excluded from qualification range.

For diameters whose design has been accepted by extension, i.e., when this diameter design has been accepted, but it was not directly submitted to qualification tests, a valve from first batch shall be used for reference signature obtainment, according to Annex D, without cycling and at room temperature.

6.4.3 Regarding the pressure rate

Prototype tests for design qualification may be used in order to qualify designs under same pressure rate, or under the next previous rate, respecting restrictions related to construction and nominal diameter features.

Qualification Requirements – ABNT NBR 15827

6.5 Valve performance tests

Performance tests shall be carried out for valves through opening and closing cycles in the valve prototype, at number of cycles shown in Table 7.

6.5.1 The presented cycle values are minimum values, and the manufacturer may carry out a higher number of cycles to demonstrate the higher reliability of its valve.

6.5.2 The opening and closing cycles shall be monitored by torque sensors, ensuring the values are kept within those specified by this Standard.

6.5.3 At each interval of cycles defined in Table 7, seat sealing tests shall be performed in backseat, when applicable. Backseat monitoring shall be performed by means of individual pressure readings (ports), exclusively foreseen in the prototypes.

6.5.4 The prototype test on check valves, besides the seat sealing tests, a slam test shall be performed to each interval of cycles defined in Table 7.

6.5.5 The prototype test in check valves shall be performed on specific dynamic flow benches allowing the slam test performance.

Qualification Requirements – ABNT NBR 15827

Table 7 — Cycling For Ball, Gate, Globe, Butterfly, And Check Valves

Nominal Diameter (ND) (NPS)	Estimated service life of 20 years		Cycling				Seal Test	Performance (Signature)	Number of Cycles applied at maximum operating torque (MOT)
	Number of Cycles		Prototype quantity and number of cycles			Reliability (10 years of useful life)			
	Minimum	Maximum	Prototype (min, quantity)	Minimum cycle by prototype	Total of cycles				
15 to 40 (1/2 to 1 ½)	500	5000	5	1000	10000	98%	See Table 8	6 signatures at low pressure and 6 Signatures at high pressure shall be performed. At the beginning and end of the cycling, 6 signatures at medium pressure shall also be collected.	50
50 to 150 (2 to 6)	100	200	2	500	2000	98%			50
200 to 300 (8 to 12)	50	100	1	250	1000	98%			30
350 to 600 (14 to 24)	50	100	1	250	500	95%			20
> 600 (>24)	50	100	1	250	500	95%			10

Qualification Requirements – API 591

- This standard is a quality qualification whereas the others are performance qualifications.
- Valve is factory tested per API 598 then based on a suggested sized a quantity is disassembled.
- Components are dimensionally checked.
- Material is examined per table 1
- Stem/drive train is tested for strength.

Table 1—Material Examination

Tests	Body	Cover/ Bonnet/ Tailpiece	Seat Ring	Stem	Yoke Nut ^e	Disc/ Plug/ Ball	Back Seat ^e	Body/ Bonnet RTJ gasket	Bonnet/ Tailpiece Bolts ^c
Chemical Composition	x	x	x ^a	x	x	x ^a	x	x	x
Tensile Strength	b	b	—	—	—	—	—	—	x ^d
Yield Strength	b	b	—	—	—	—	—	—	—
Elongation	b	b	—	—	—	—	—	—	—
Reduction of Area	b	b	—	—	—	—	—	—	—
Hardness (HB)	x	x	x	x	x	x	x	x	x
NOTE RTJ = ring type joint. ^a If seating surfaces are welded, chemical analysis shall be made on both metals (weld metal and base metal). If seating surfaces are applied in the form of thin plates welded to the disk, chemical analysis shall be made on the disk, the thin plates, and the attachment welds. Any welds attaching seats or seating surfaces shall be dye-penetrant examined. Neither cracks nor lack of fusion is allowed. ^b These test results may be taken from mill test reports except when physical testing is required per 6.4.12. ^c Four sizes of bonnet bolts and nuts shall be tested, randomly selected from two of the largest and two of the smallest valve sizes in the sample lots from Table A.3 to Table A.7. ^d Bonnet bolt tensile strength shall be estimated using the measured hardness readings and the correlations (hardness to tensile strength) in ASTM A370. ^e These examinations apply to gate and globe valves only.									

Qualification Requirements – API 591

- Pressure containing castings are examined with radiography
- Pressure containing components are examined with magnetic particle and two valves are destructively tested for compliance.

**Table A.7—Suggested Size and Class to be Tested for Steel Gate Valves
Made in Accordance with API 603 ¹**

NPS	Class	Strength Test (NPS) ²	Quantity (Each NPS)
4, 12, 24	150	4, 12	1
3, 12	300	3, 12	1
3, 12	600	—	1
¹ Unless otherwise requested, all selected valves shall have flanged ends. ² See Annex B for test details.			

**Table A.8—Suggested Size and Class to be Tested for Each Type Ball Valve
(Floating Type: End Entry, Split Body, Three Piece and Top Entry; Trunnion Type: Split Body, Three Piece)
Made in Accordance with API 608 ¹**

NPS	Class	Strength Test (NPS) ²	Quantity (Each NPS)
4, 8	150	4	1
3, 6	300	6	1
¹ Metal-seated valves are not covered by this table. ² See Annex B for test details.			

Qualification Requirements – ISO 15848-1

8 Extension of qualification to untested valves

Upon the successful completion of the test program as defined in this part of ISO 15848, this qualification may be extended to untested sizes and classes of valves of the same type if the following criteria are met:

- a) the stem (or shaft) seals and body seals are of the same material, design (shape) and construction, independent of the size;
- b) loading arrangement applies a similar sealing stress to the seal element as that applied in the test valve;
- c) the type of motion of the stem (or shaft) is identical;
- d) tolerances classes and surface finishes specifications of all valve components which affect sealing performance are identical;

NOTE The tolerances classes are in accordance with ISO 286.

- e) stem diameters are within the range of 50 % lower and 200 % higher of those of the test valve;
- f) the valve Class or PN designation is equal or lower;
- g) the required temperature class falls between the room temperature and the test temperature of the qualified valve;
- h) the tightness class required is equal to, or less severe than that of the qualified valve.

The use of gearbox or other actuator does not require separated qualification, provided above criteria are met.

Qualification Requirements – GOST R 53402

Most Russian customers now accept API 6D without a qualification test.

Gazprom still requiring qualification testing on some sizes- categorized as Special tests.

GOST standards from one edition to the next one more and more comply to ISO standards, especially with respect to leak class (GOST 9544-2005 Class A).

Latest edition of GOST 9544-2005 has more or less similar requirements and criteria as ISO5208 and/or API6D, API598.

MESC SPE 77/300 and 77/315 are consolidated in T-2.973.873

Flow Management **SOLUTIONS**

Qualification Requirements - Shell

TYPE TEST @ AMBIENT TEMP (NITROGEN 100%) per Shell MESC description										Date:					
Step	Activity	Press	Description	Number	Hold Time	Measure	Reference Doc		Measured Values				Acceptance Criteria		
	Item	(barg)		cycles	(min)		Test Procedure	Para	BTO (Nm)	ETC (Nm)	Time Start	Time Finish	Seat Leakage Rate [cm3/min]	Allowable Leakage Seats	
1	a	2	Seat A	5	1	brque (BTO-ETC) at 1st cycle+ leak (N2)	T-2.973.873								
	b	2	Seat B	5	1	brque (BTO-ETC) at 1st cycle+ leak (N2)									
2	a	35%	Seat A	0	5	leak (N ₂)	T-2.973.873								
	b	70%	Seat A	0	5	leak (N ₂)									
	c	110%	Seat A	0	5	leak (N ₂)									
2a	a	35%	Seat B	0	5	leak (N ₂)	T-2.973.873								
	b	70%	Seat B	0	5	leak (N ₂)									
	c	110%	Seat B	0	5	leak (N ₂)									
3	a	110%	Shell + Cycle	21	Time to Mech Cycle Valve	Mech cycle (He)	T-2.973.873								
4	a	100%	Shell + FE	0	See Table 4.4.3.1	leak (He)	T-2.973.873 SPE 77/312						See FE results below		
5	a	100%	Seat A	1	1	torque (BTO-ETC) + leak (N2)	T-2.973.873						0		
	b	100%	Seat B	1	1	torque (BTO-ETC) + leak (N2)							0		
FUGITIVE EMISSION @ Ambient (HELIUM) per Shell MESC description															
			Static Measure		Dynamic Measure										Allowable Leakage Fugitive Emission
			Highest measured value		Highest measured value										
Stem/Stuffing Box															
Body/ Bonnet															
Body / Closure A&B															
End. Clos A (ref)															
End. Clos B (ref)															
Sealant Injection SEAT															
Drain															
Vent															
Warming up procedure - Measure temperature: DN150 < every 30 mins, DN 200 to DN 350 every 45 mins DN 400 > every 60 mins															
Time	Room Temperature (Amb) °C	Closure member Temperature (Internal) (TV 1) °C		Stem packing area Temperature (outside) (TV3) °C		Valve body Temperature (outside) (TV2) °C		Notes							

- 6 cycles per seat & 21 cycles for stem
- Repeated at ambient, maximum temperature and minimum temperature

Qualification Requirements - Shell

NOM SIZES		PRESSURE CLASS:					
INCHES	DN	150	300	600	900	1500	2500
3	80			T		T	T
4	100						
6	150						
8	200						
10	250			T		T	T
12	300						
14	350						
16	400						
18	450			T		T	T
20	500						
24	600						

FE coverage from SPE 77/312

T = Valve selected for testing.

Qualification Requirements - Chevron

Excerpt from SSM-PU-54.02-A: “*QUALIFICATION TESTING OF SUBSEA EQUIPMENT*”

4.5 Subsea Ball Valves

1. Ball valves shall be qualification tested to meet or exceed API 6A/17D PR2 requirements as follows (per Annex F test procedures for subsea gate valves):
 - a. 200-cycle dynamic pressure test for PR2 valves per API 6A Annex F;
 - b. 3-cycle pressure/temperature cycle test per API 6A Annex F;
 - c. 200 additional cycles of dynamic pressure testing under hyperbaric conditions for rated water depth;
 - d. 200 additional cycles of dynamic pressure testing to meet endurance cycle requirements;
 - e. Cumulative total number of pressure/temperature cycles shall include a minimum of 603 cycles as defined in 1a–1d above.

Qualification Requirements - Chevron

10.2. Design Qualification Testing

Unless the option to require API 6A PR2 two-hundred cycle testing is invoked, Design Qualification Testing (DQT) shall conform to the following:

For valves requiring fire safe certification, fire related DQTs compliant with API Spec 6D / ISO 14313 and API Spec 6FA shall be submitted for review.

Design qualification testing does not require consideration of externally applied piping loads; however the CONTRACTOR shall demonstrate by calculation that the valve design is suitable for the external piping loads agreed upon by the CONTRACTOR and the COMPANY.

Prior to seat and stem tightness tests, the valve shall be cycled thirty (30) times with the valve initially pressurized to the full valve pressure rating with water on one (1) side, with the downstream side vented to atmosphere. One cycle is defined as full closed to full open, and back to full closed. Breakaway and running torques are to be recorded on the first, middle, and last cycles.

Qualification Requirements - Chevron

Pressure testing shall conform to the requirements of API 6D. The following additional requirements apply:

- The minimum holding time for shell pressure tests is to be two (2) hours per DNV-OS-F101.
- Minimum holding time for any seat leakage test shall not be less than thirty (30) minutes (longer periods shall apply when specified).
- Acceptance criteria for seat tightness tests on metal seated valves shall be ISO 5208 Rate C unless more stringent requirements are specified on the valve data sheet. This rate is applicable to both mandatory and supplementary seat tests.
- API 6D seat leakage tests shall be performed in two stages. The first stage shall consist of pressurizing the appropriate section of the valve to the full test pressure and holding for thirty (30) minutes. The valve is then to be fully opened and the pressure reduced to atmospheric. Immediately following the first stage, the valve is to be fully closed and re-pressurized to full test pressure. Full test pressure is to be held for sixty (60) minutes, during which time the seat leakage is to be evaluated in five (5) minute intervals. Seat leakage in any single interval shall not exceed permissible limits. This procedure is to be used for each seat test performed, and is applicable to both mandatory and supplementary seat tests.

Qualification Requirements - ExxonMobil

Excerpt from GP 03-12-09 “*GENERAL REQUIREMENTS FOR VALVES*”

- 6) [S] [A] [R] All valves designed with elastomer seals and or O-rings shall be qualified for the service and design conditions (pressure/temperature range) for each type of valve construction offered by the manufacturer. Each seal material and configuration (seal groove size versus seal shape and groove fill) shall be evaluated for the specified duty (refer to [GP 29-01-37](#) for appropriate elastomer selection).
 - a) The valve "type test" using the performance method and qualification range as per [API SPEC 6A](#) Annex F is considered a basis to qualify each type of valve construction (including ball and globe types). A modified [API SPEC 6A](#) Annex F performance test may be acceptable, provided the proposed test procedure is approved by the Owner's Engineer prior to use.
 - b) Valves shall be "type" tested if any of the following applies:
 - i) Manufacturer has made changes to the qualified design of the elastomer seal configuration and or material (i.e. change in seat, stem or seal design configuration, materials, design parameters, etc)
 - ii) The manufacturer has no previous qualified project experience with the particular seal material and or configuration.

Qualification Goals

- ✓ Confirm ability to seal against through leakage over a given number of cycles
- ✓ Confirm seals perform at maximum and minimum temperatures
- ✓ Validate valve operating torque/thrust at ambient, maximum and minimum temp
- ✓ Determine fugitive emission performance at ambient, max. and min. temp
- ✓ Prove environmental containment
- ✓ Prove robustness/stability of metallic trims
- ✓ Prove soft seal combinations

Qualification Groups - examples

- **Material classes**
 - ❖ Carbon & low alloy steel
 - ❖ Austenitic alloys
 - ❖ Duplex alloys

- **Seal classes**
 - ❖ Nitrile elastomers
 - ❖ Fluorocarbon elastomers
 - ❖ PTFE seals
 - ❖ Graphoil
 - ❖ Metal

- **Temperature classes**
 - ❖ -20°C to 120°C
 - ❖ -20°C to 150°C
 - ❖ -46°C to 150°C

Qualification Range

- Coverage is for a single model design
- Pressure class and size – adopt range from Shell spec 77/312
- Seal classes - have to be tested

NOM SIZES		PRESSURE CLASS:					
INCHES	DN	150	300	600	900	1500	2500
3	80			T		T	T
4	100						
6	150						
8	200						
10	250			T		T	T
12	300						
14	350						
16	400						
18	450			T		T	T
20	500						
24	600						

T = Valve selected for testing.

- Material classes - a reduced number of tests may be agreed with certifying authority provided test performance is proven to be unaffected
- Temperature class or range may be per standard or agree with CA.

Qualification – Way Forward

- Form under ISO or API a new work group to expand FE standard or create a new performance one
- Timing - now, otherwise subsea standards will migrate in to the void
- How – Volunteer to participate in a work group
- Why - This assures the interest of your company and country are represented

THANK YOU

**PLEASE PUSH FOR A STANDARD
AND NOT HAVE THE VOID FILLED
WITH SOMETHING WE DO NOT WANT**