Calgary Pump Symposium 2011

Overview of Changes:
API 610 11th Edition (ISO 21049)
API 682 4th Edition (ISO 13709)

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Agenda

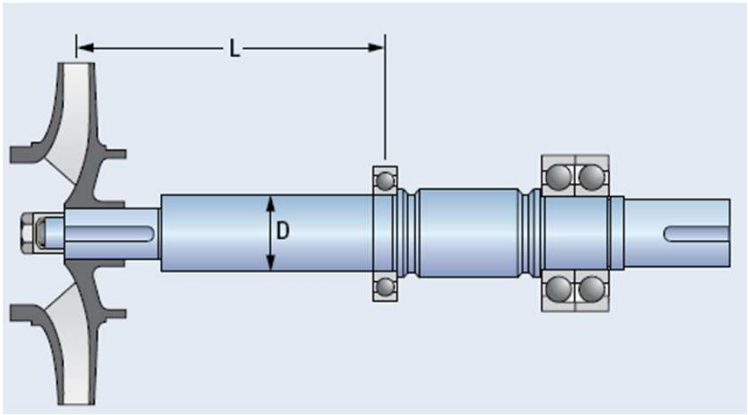
- Changes to API 610 for 11th Edition
  - Released Fall/2010
- Changes to API 682 for 4th Edition
  - Upcoming Release Planned for 2012
- Questions/Discussion

API 610 (ISO 13709) 11th Edition Significant Changes

- Shaft flexibility L^3/D^4 (9.1.1.3); Annex K.1
- Bearings & Brg. Housings (6.10); Annex K.2
- Torsional Analysis Rewritten (6.9.2.1)

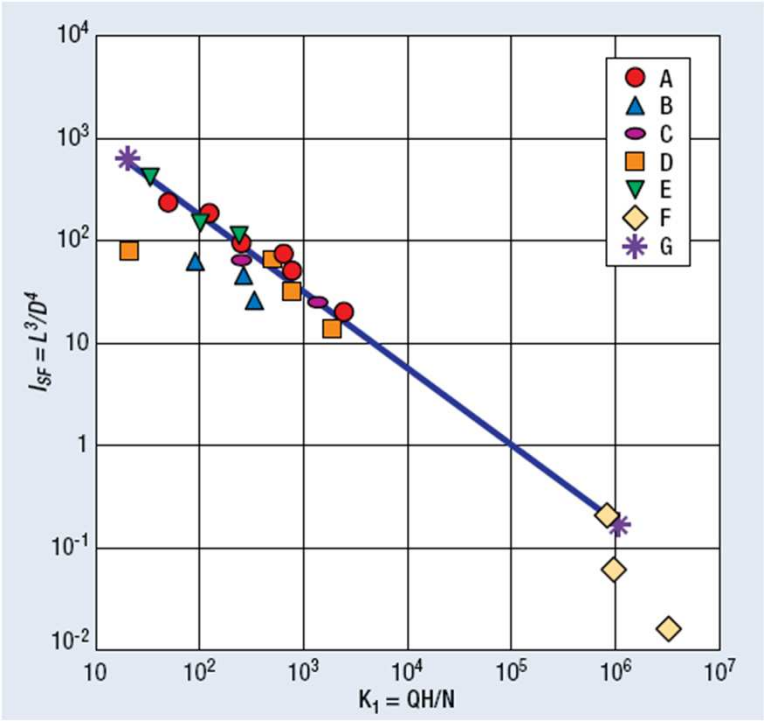
Shaft Flexibility Index

- Shaft flexibility calculations using L^3/D^4 have long been used to evaluate the stiffness of an overhung pump shaft
- Annex K.1 standardizes the calculation and provides guidance on acceptable values



Shaft Flexibility Index

- Uses Pump Sizing Factor and Shaft Flexibility Index
- Blue line defines acceptable level
- Ensures Robust Design
- Seek justification from OEM when >20% above the line



Bearing Life Calculation

- Shall be equivalent to at least 25,000 hrs, continuous operation at rated condition and at least 16,000 hrs at maximum radial & axial loads & rated speed (MCSF… minimum continuous stable flow)
- In the past, this was interpreted as “individual” bearing life
- Now the requirement applies to “system” bearing life using the formula given

Torsional Analysis

- Significantly expanded explanation of requirements
- Three types of analyses:
- a) undamped natural frequency analysis
- b) steady-state damped response analysis
- c) transient torsional analysis
- Flow chart defines the process of determining which type of analysis is required

API 610 11th Ed - Other Changes

- Wording “flammable and hazardous” have been removed from the entire 610 document
- Welded connections mandatory for all piping welds to casing and rest of drain or seal flush piping (when pipe is used). Only for CAST IRON casings (matl column I-1 and I-2) are screwed connections allowed.
- Spiral-wound gaskets are preferred over o-rings

API 610 11th Ed - Other Changes

- Customer must specify whether NACE MR0175 or MR0103 applies. MR0103 applies to Petroleum Refining Environments, MR0175 applies to Oilfield Equipment.
- All types of impellers (before was restricted to "enclosed" type only) are allowed
- Electronic Data Sheets – EDE capability and clarity on decision points and allowable entries

API 610 11th Ed - Other Changes

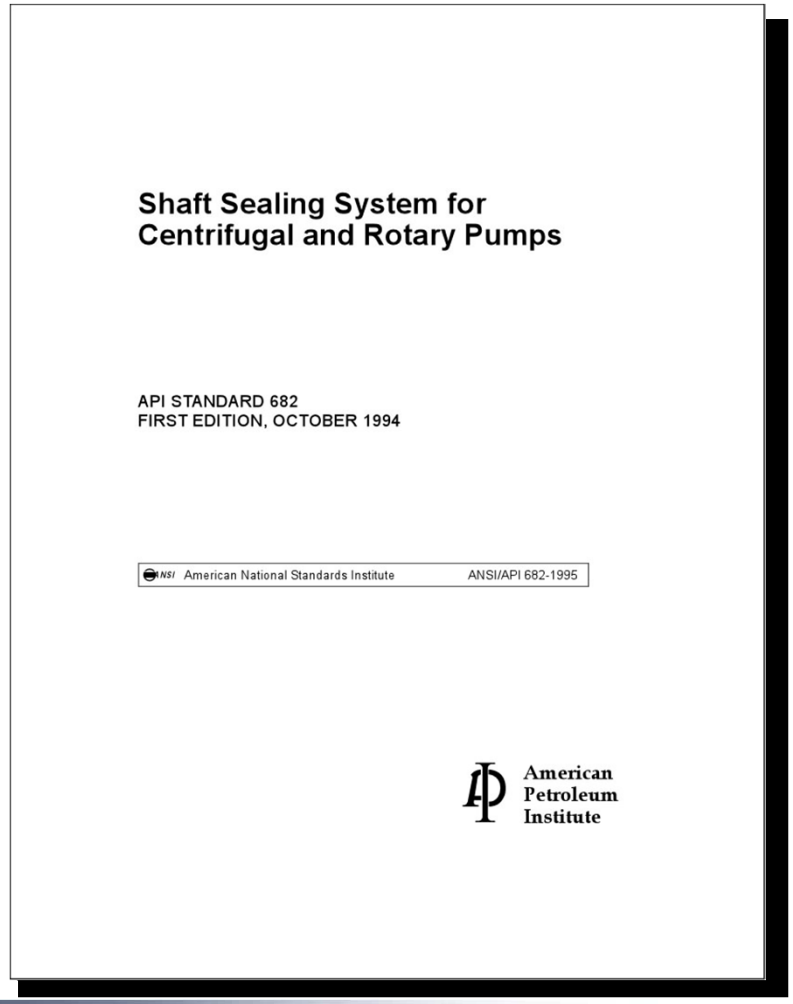
- 3 Inspection Classes designated for casing and nozzle inspection. Based on severity and hazard of service.
- Performance Testing – test tolerances and defined recorded data points have changed
- NPSH3 – used to be NPSHr. “3” designates 3% head drop when conducting NPSH testing
- BEP (best efficiency point) – is basis the rated impeller diameter (for Ns and Nss BEP is basis “max” diameter)

API 610 11th Ed - Other Changes

- Too many to discuss here
- Tutorial Paper from Proceeding of the 27th International Pump Users Symposium (Houston) has more extensive listing and explanation

Review of API 682 First Edition

- Created by industry leaders in rotating equipment
- Designed to capture field experience
- Defaults to proven solutions
- Applies to the most common applications



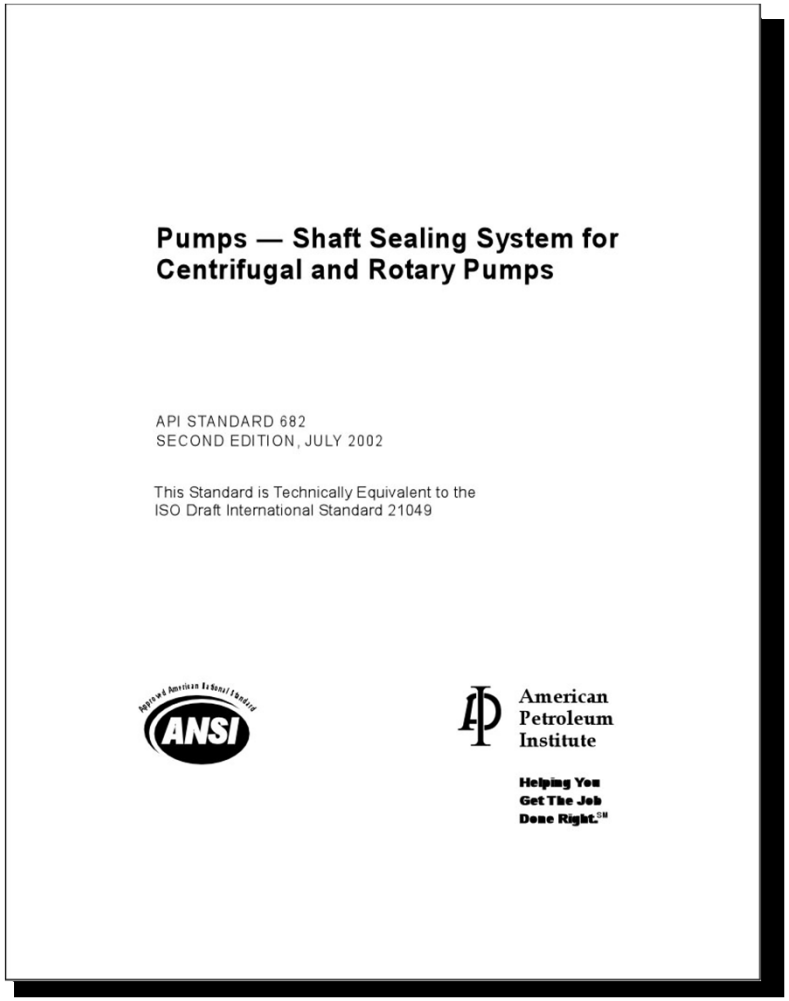
Mission Statement

from API 682 First Edition

"This standard is designed to default to the equipment types most commonly supplied that have a high probability of meeting the objective of a least three years of uninterrupted service while complying with emissions regulations."

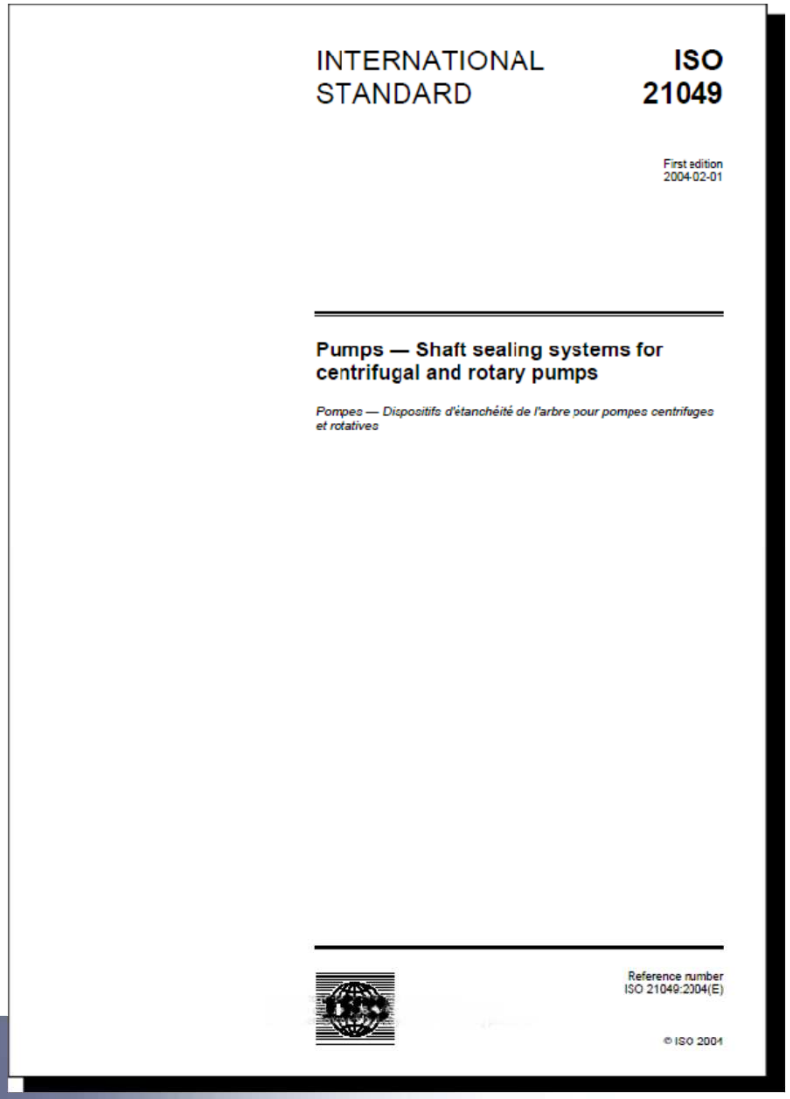
API 682 Second Edition

- Success of First Edition
- Applications outside of refineries
- Application to non-API 610
- Advancement in sealing technology
- Creation of an International standard



ISO 21049

- Review of API 682 Second Edition by worldwide ISO member countries
- Reorganization of some chapters
- Rewording of some clauses
- Error corrections
- Modified piping plan selection flowchart
- New piping plan


INTERNATIONAL STANDARD

ISO 21049

First edition
2004-02-01

Pumps — Shaft sealing systems for centrifugal and rotary pumps

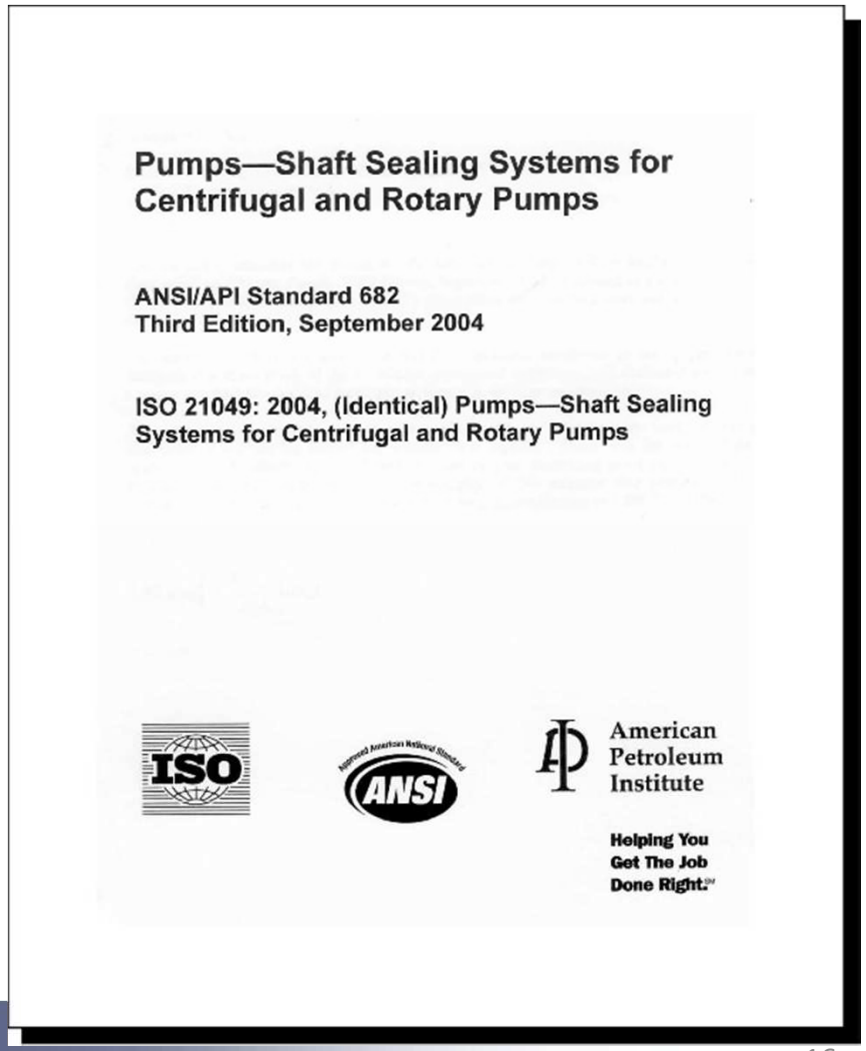
Pompes — Dispositifs d'étanchéité de l'arbre pour pompes centrifuges et rotatives

Reference number
ISO 21049:2004(E)

© ISO 2004

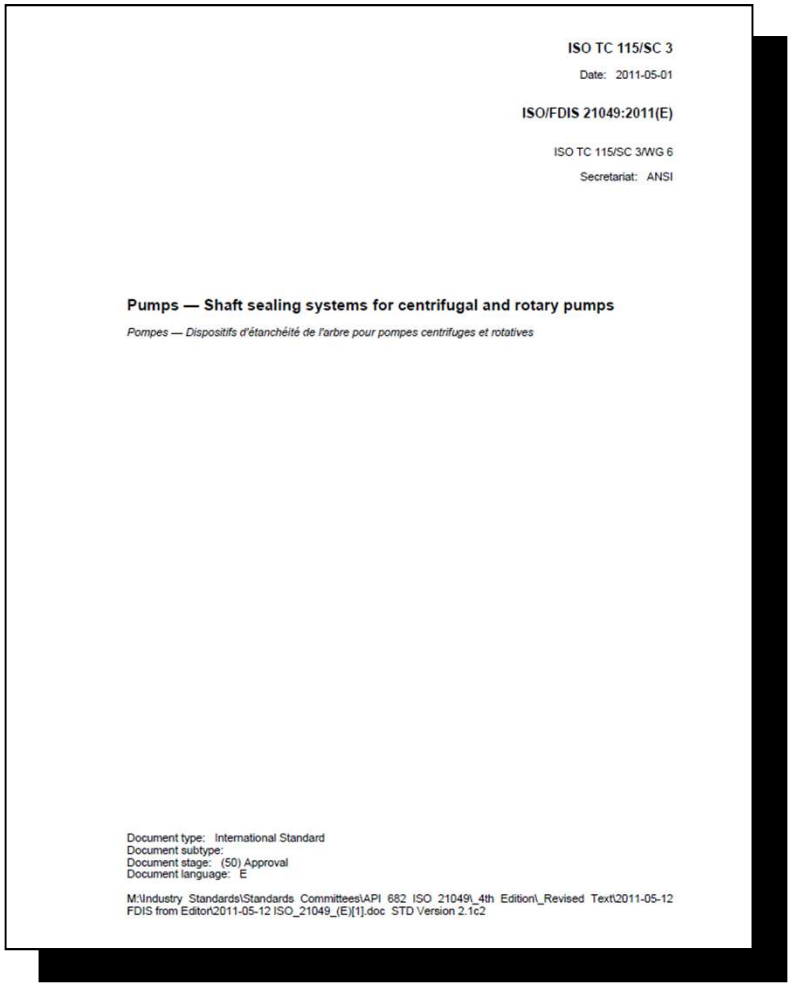
API 682 Third Edition

- Release of ISO 21049 created two standards that were not identical
- Third Edition released to make 682 identical to ISO 21049



Fourth Edition

- Comments on previous editions
- Conflicts within standard from expanded scope
- Capture latest technology
- Task Force began work in 4th Qtr 06
- Release 2012



ISO TC 115/SC 3

Date: 2011-05-01

ISO/FDIS 21049:2011(E)

ISO TC 115/SC 3/WG 6

Secretariat: ANSI

Pumps — Shaft sealing systems for centrifugal and rotary pumps

Pompes — Dispositifs d'étanchéité de l'arbre pour pompes centrifuges et rotatives

Document type: International Standard
Document subtype:
Document stage: (50) Approval
Document language: E

M:\Industry Standards\Standards Committees\API 682 ISO 21049_4th Edition_Revised Text\2011-05-12 FDIS from Editor\2011-05-12 ISO_21049_(E)[1].doc STD Version 2.1c2

Scope of Standard

Comparison of Editions

	First Edition	Second Edition, ISO 21049, Third Edition
Size	Seal sizes from 1.50” to 4.50” (30mm to 120mm)	Shaft diameters from 0.75” to 4.30” (20mm to 110mm)
Temperature	-40°F to 500°F (-40°C to 260°C)	-40°F to 750°F (-40°C to 400°C)
Pressure (absolute)	0 to 515 PSIA (0 to 34.5 bar)	0 to 615 PSIA (0 to 42 bar)
Fluids	Water, sour water, caustic, amines, some acids, most HCs	Water, sour water, caustic, amines, some acids, most HCs
Pumps	API-610, ISO 13709	ANSI/ASME B73.1 and B73.2, ISO 3069 Frame C, API-610, ISO 13709

Removed in API 682 Fourth Edition

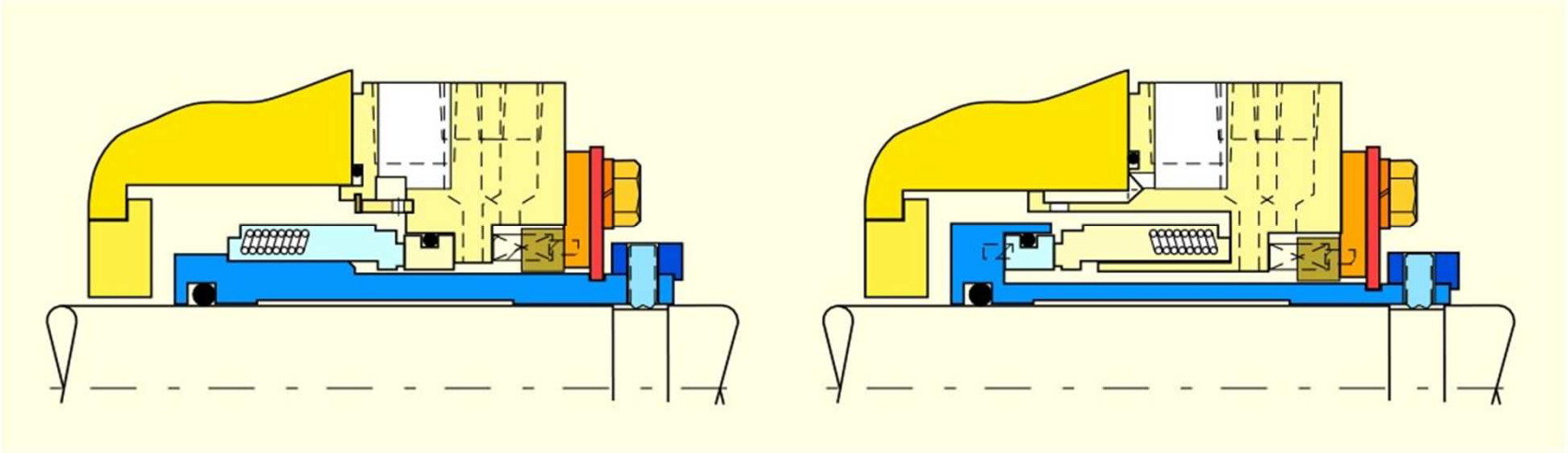
New Terminology

- Atmospheric Leakage Collector
- Auxiliary Sleeve
- Barrier/Buffer Fluid Chamber
- Containment Device
- Containment Seal Chamber Leakage Collector
- Dynamic Secondary Seal
- Engineered Seal
- External Circulating Device
- Fixed Bushing
- Fixed Throttle Bushing
- Pumped Fluid/Process Fluid
- Seal Sleeve
- Segmented Floating Bushing
- Strainer

Seal Types

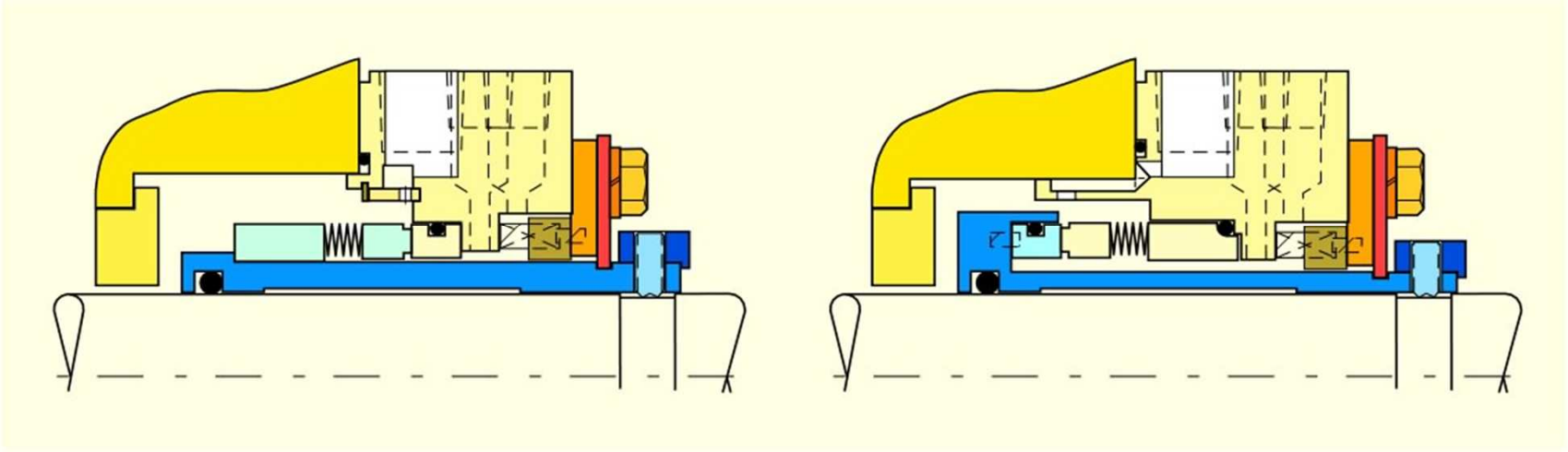
- Type definitions introduced in First Edition
- Captured seal design elements and materials
- No major changes in Fourth Edition

Type A Seal



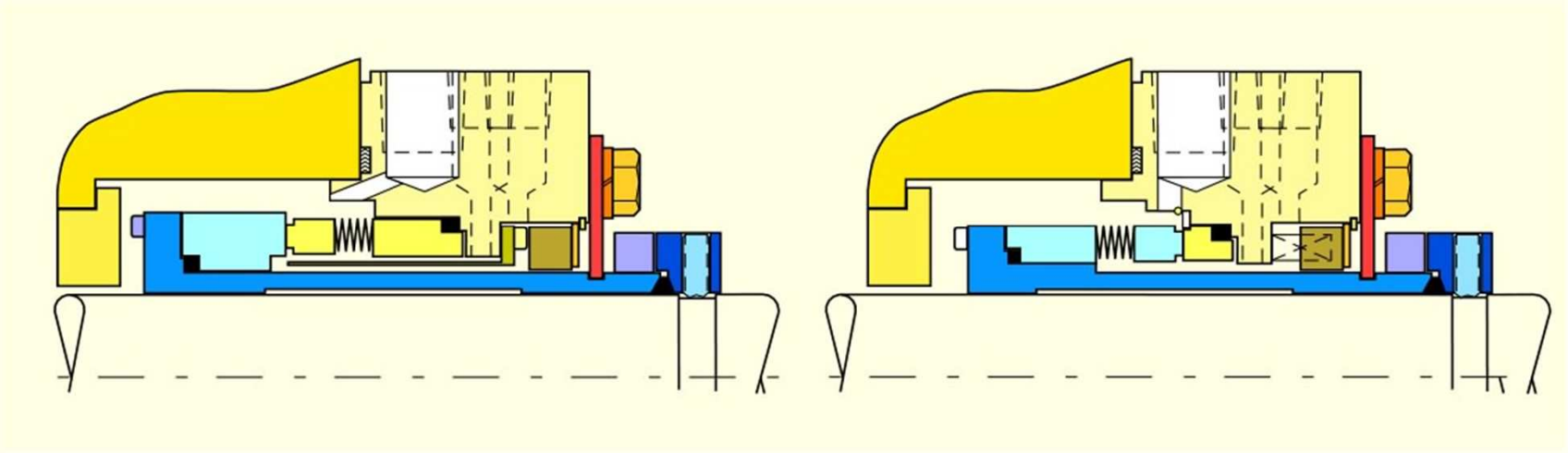
- Rotating flexible element, multiple springs, O-ring secondaries
- Silicon Carbide versus premium grade blister resistant Carbon
- Fluoroelastomer O-rings (FKM)
- Alloy C276 springs (316 for single spring option)
- Type 316 SS sleeve, gland, and other metal parts
- Throttle bushing in gland

Type B Seal



- Rotating bellows, O-ring secondaries
- Silicon Carbide versus premium grade blister resistant Carbon
- Fluoroelastomer O-rings (FKM)
- Alloy C-276 bellows (Alloy 718 optional)
- Type 316 SS sleeve, gland, and other metal parts
- Throttle bushing in gland

Type C Seal



- Stationary bellows, flexible graphite secondaries
- Silicon Carbide versus premium grade blister resistant Carbon
- Alloy 718 bellows
- Type 316 SS sleeve, gland, and other metal parts
- Premium carbon floating bushing in gland
- Bronze anti-coke device

Rotating vs Stationary

- The Fourth Edition recognizes the need to consider rotating and flexible rotating elements as equals
- Either design can be applied to Type A, Type B, and Type C seals
- High speed application (greater than 4500 ft/min (or 23 m/s) defaults to stationary flexible elements

Mixing Seal Types

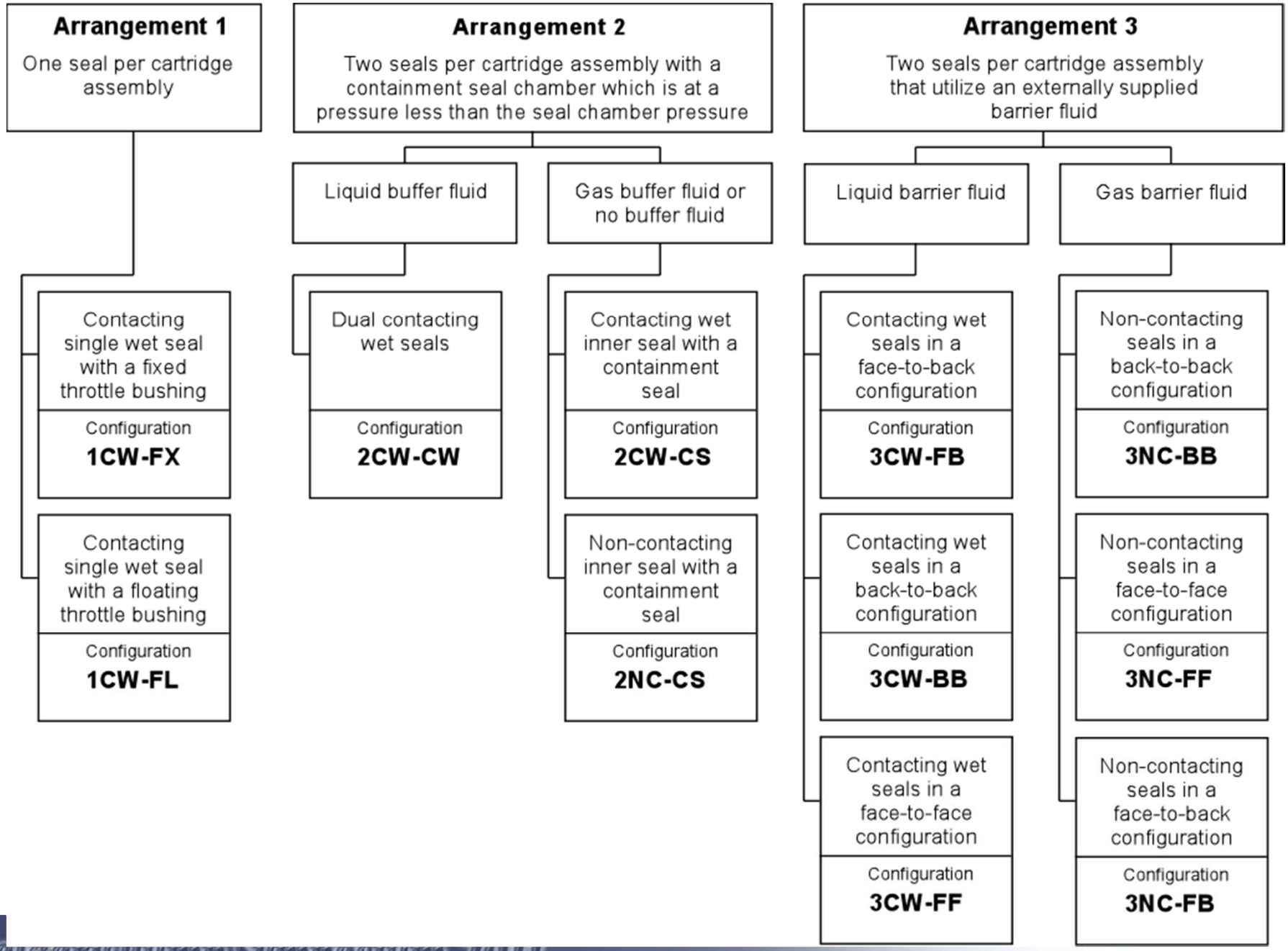
- Arrangement 2 and 3 seals contain two seals
- Historically these were the same same seal type (e.g. Type A inner seal with a Type A outer seal)
- Fourth Edition allows mixed types (e.g. Type B inner seal with a Type A outer seal)

Engineered Seal

- The term Engineered Seal refers to a seal outside of the standard
- Not a seal “Type”
- Does not need to follow design requirements of the standard
- Does not require qualification
- Can include coaxial seal

Seal Arrangements

- The seal arrangement defines the number or seals, their orientation, and details about the seal's operation
- Unchanged from previous editions


Arrangement 1
One seal per cartridge assembly
Contacting single wet seal with a fixed throttle bushing
Configuration
1CW-FX
Contacting single wet seal with a floating throttle bushing
Configuration
1CW-FL
Arrangement 2
Two seals per cartridge assembly with a containment seal chamber which is at a pressure less than the seal chamber pressure
Liquid buffer fluid
Dual contacting wet seals
Configuration
2CW-CW
Gas buffer fluid or no buffer fluid
Contacting wet inner seal with a containment seal
Configuration
2CW-CS
Non-contacting inner seal with a containment seal
Configuration
2NC-CS
Arrangement 3
Two seals per cartridge assembly that utilize an externally supplied barrier fluid
Liquid barrier fluid
Contacting wet seals in a face-to-back configuration
Configuration
3CW-FB
Contacting wet seals in a back-to-back configuration
Configuration
3CW-BB
Contacting wet seals in a face-to-face configuration
Configuration
3CW-FF
Gas barrier fluid
Non-contacting seals in a back-to-back configuration
Configuration
3NC-BB
Non-contacting seals in a face-to-face configuration
Configuration
3NC-FF
Non-contacting seals in a face-to-back configuration
Configuration
3NC-FB

Design Requirements - General

- API 682 First Edition states that the "…standard does not cover the design of the component parts of mechanical seals …"
- This statement is followed by 16 pages of specifications that directly affect the design of seal components
- The Fourth Edition follow the same direction and contains even more specifications on seal design
- These requirements attempt to capture design features that have proven to be successful in the field

Design Requirements - General

- Seal must handle normal and transient axial motions
- Minimum surface finish for O-rings
- O-ring grooves sized for FFKM
- For vacuum services, components that could be dislodged must be retained (mechanically or hydraulically)
- Minimum clearance between rotating and stationary components 3mm (with some exceptions)
- Major reductions in clearances for specific applications.

Design Requirements - General

Inside Diameter	Outside Diameter		Minimal Diametral Clearance	
ID seal chamber and gland plate	OD rotating seal part	CW seal type	6 mm (0.25 in)	Figure 1
		NC seal type	3 mm (0.125 in)	
ID of stationary seal part	OD rotating seal part	shaft < 60 mm	1 mm (.039 in)	Figure 1
		shaft > 60 mm	2 mm (.079 in)	
ID stationary gland part	OD internal circulation device	shaft < 60 mm	1 mm (.039 in)	Figure 2
		shaft > 60 mm	2 mm (.079 in)	
ID containment fixed bushing	OD rotating seal part	shaft < 60 mm	1 mm (.039 in)	Figure 3
		shaft > 60 mm	2 mm (.079 in)	

Clearances Between Rotating and Stationary Components

Design Requirements - General

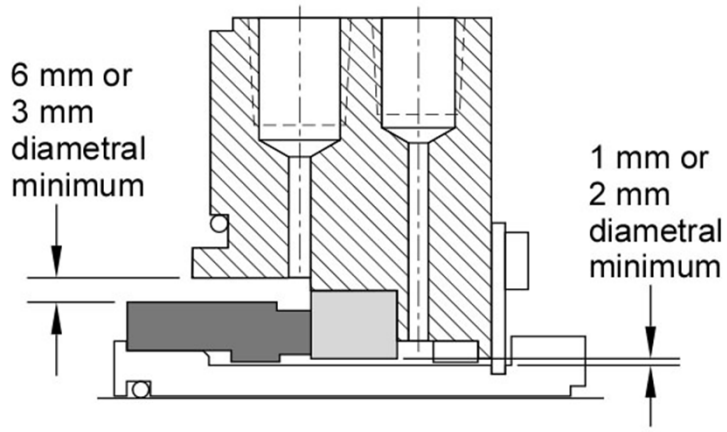


Figure 1

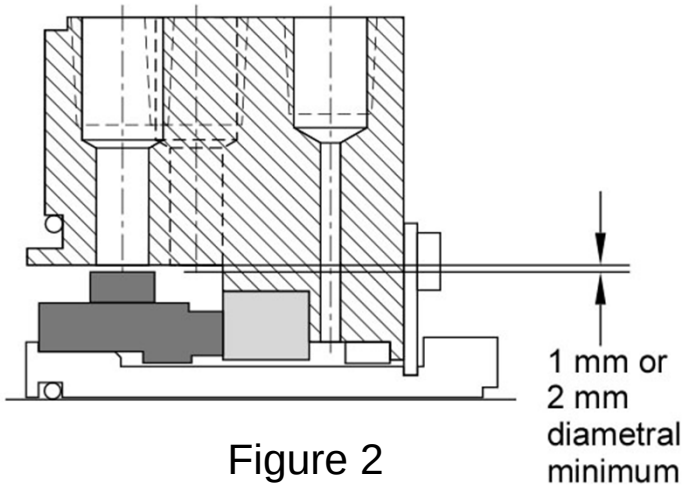


Figure 2

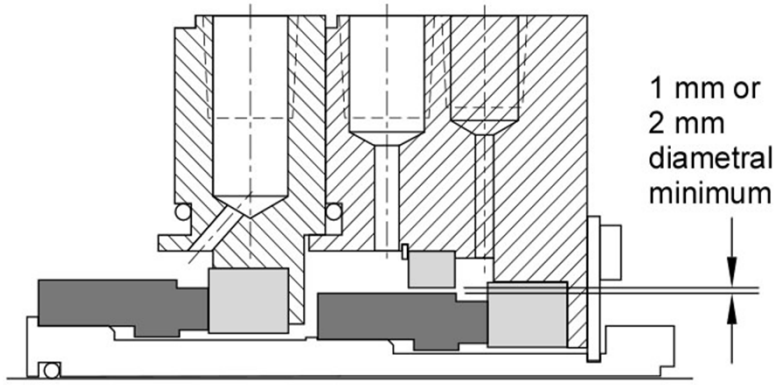


Figure 3

Design Requirements - General

- Glands designed for MAWP of pump
- Glands provided with holes (not slots)
- Shoulder at least 3mm behind face in gland
- Seal designed for seal chamber perpendicularity of 0.0005 in./in. of bore
- Seal chamber pressure must be at least .35 bar (5 PSI)
- Vapor pressure margins must be maintained at 30% pressure margin or 20ºC (36ºF) temperature margin (50 PSI minimum vapor pressure margin)
- Floating throat bushings may be required
- Gland and seal chamber connections must be permanently marked

Connections

Configuration	Symbol	Connection	Location	Type	Size Cat I	Size Cat II and III	Required
1CW-FX	F	Flush	0	Process	½ (Note 3)	½	Required
1CW-FL	FI	Flush In (Plan 23 only)	180	Process	½ (Note 3)	½	WS
	FO	Flush Out (Plan 23 only)	0	Process	½ (Note 3 & 6)	½	WS
	D	Drain	180	Atmo	3/8 (Note 5)	3/8	Required
	Q	Quench	90	Atmo	3/8 (Note 5)	3/8	Required
	H	Heating	-	Utility	½ (Note 3)	½	WS
	C	Cooling	-	Utility	½ (Note 3)	½	WS
	PIT	Pressure sensing port	90	Instrument	3/8	3/8	WS
2CW-CW	F	Flush (Inner Seal)	0	Process	½ (Note 3)	½	Required
	LBI	Liquid Buffer Fluid In	180	Process	½ (Note 4)	½	Required
	LBO	Liquid Buffer Fluid Out	0	Process	½ (Note 4)	½	Required
	D	Drain (Outer Seal)	180	Atmo	3/8 (Note 5)	3/8	WS
	Q	Quench (Outer Seal)	90	Atmo	3/8 (Note 5)	3/8	WS

Note 3 A 3/8 NPT connection may be used if ½NPT not possible due to space constraints.
Note 4 A ½ NPT required for shaft diameters 63.5 mm (2.5 inch) or smaller, ¾ NPT for larger sizes
Note 5 A ¼ NPT connection may be used if 3/8 NPT is not possible due to space constraints

Design Requirements - General

- Threaded connections shall be plugged with red plastic plugs installed in ports and metal plugs with seal drawing in a bag
- Connections and tubing shall be suitable for max hydrostatic test pressure
- Drill throughs minimum 5mm (3/16”) diameter

- Fixed and floating bushing clearances defined

Floating carbon throttle bushing diametrical clearances

Sleeve Diameter mm	Sleeve Diameter inch	Max diametrical clearance mm	Max diametrical clearance inch
0 to 50	0 to 2.00	0,18	0.007
51 to 80	2.01 to 3.00	0,225	0.009
81 to 120	3.01 to 4.74	0,28	0.011

Design Requirements - General

- Sleeves furnished by the seal OEM
- Sleeve to shaft clearances defined by ISO 286-2 F7/h6
- Rotating components must have a means to be positively located
- Sleeve gasket O-ring shall be located at the impeller end

- Sleeves thickness to be minimum of 2,5 mm (0.100 in)
- Sleeve in areas of set screws defined

Shaft Diameter mm	Sleeve Diameter inch	Minimum Sleeve Radial Thickness mm	Minimum Sleeve Radial Thickness Inch
< 57	< 2.25	2,5	0.100
57 to 80	2.25 to 3.25	3,8	0.150
> 80	> 3.25	5,1	0.200

Design Requirements - General

- Minimum thickness does not include setting plate groove
- Sleeve OD and ID concentric within 25µm (0.001 in)
- Sleeve piloted on both ends, relieved in the middle
- Drive collar set screws not allowed in piloted area
- Drive collar set screws sufficiently hard to embed shaft
- Use of nine or more set screws only with approval
- Set screws must hold 150% of max load
- Other drive devices (e.g. shrink disk or split ring drive collars) are allowed with approval
- Single spring allowed on Type A seals if specified
- Flexible elements shall not rely on lapped joints for sealing

Seal Face Materials

Third Edition

- Category1 – SSSiC vs C
- Category 2 – RBSiC vs C
- Category 3 – RBSiC vs C
- Hard vs Hard allowed SiC vs SiC

Fourth Edition

- Category 1 – SiC vs C
- Category 2 – SiC vs C
- Category 3 – SiC vs C
- Select the correct SiC for the application
- Other face materials allowed – WC, graphite loaded SiC, coatings allowed to enhance performance

Pumping Rings

- Devices to circulate fluid in Plan 23, 52 or 53 systems
- Actual design not specified
- Allowance for use of
  - Tangential porting
  - Cutwaters
  - Volutes
  - Axial flow designs

Categories

- Different applications may require different levels of seal sophistication
- Current practice of specifying “modified” API-682 seals
- Size restrictions based on pump construction
- Cost impact of seals
- Designated as Category 1, 2, and 3

Comparison of Categories

FEATURE	CATEGORY 1	CATEGORY 2	CATEGORY 3
Seal chamber size	ISO 3069 Type C, ANSI/ASME B73	ISO 13709/API 610	ISO 13709/API 610
Temperature range	-40°C to 260°C -40°F to 500°F	-40°C to 400°C -40°F to 750°F	-40°C to 400°C -40°F to 750°F
Pressure range absolute	22 bar 315 PSIA	42 bar 615 PSIA	42 bar 615 PSIA
Face materials	Carbon vs self-sintered SiC	Carbon vs reaction bonded SiC	Carbon vs reaction bonded SiC
Distributed flush requirements	When Required or Specified	When Required or Specified	Required
Gland plate metal to metal contact	Required	Required inside and outside bolt circle diameter	Required inside and outside bolt circle diameter

NEW - Allowances for other seal face materials including SiC with porosity, SiC with graphite, and diamond coating.

Removed in API 682 Fourth Edition

Comparison of Categories

FEATURE	CATEGORY 1	CATEGORY 2	CATEGORY 3
Seal sleeve size increments	None	10mm increments	10mm increments
Throttle bushing requirements	Fixed carbon, floating carbon optional	Fixed non-sparking metal, floating carbon optional	Floating carbon
Pumping ring HQ curve required	If specified	If specified	Required
Scope of vendor qualification test	Test as Category 1 unless core tested as Category 2 or 3	Test as Category 2 unless core tested as Category 3	Test as Category 3 as entire seal assembly
Proposal document requirements	Minimal	Minimal	Rigorous including qualification tests
Contract data requirements	Minimal	Minimal	Rigorous

Removed in API 682 Fourth Edition

Accessories

- Accessories are components other than the seal that are required to create an acceptable sealing environment. Third Edition included:
  - Auxiliary piping systems
  - Cyclone separators
  - Orifices
  - Seal coolers
  - Reservoirs
  - Pumping rings
  - Condensate collection reservoirs
  - Gas supply panels

Accessories

- Fourth Edition adds:
  - Air cooled seal coolers
  - Strainer
  - Bladder Accumulators
  - Piston Accumulators
  - Collection Reservoirs for Plan 65

Seal Flush Coolers

- Seal flush on tube side of cooler
- Both process and cooling water sides must be able to be completely vented and drained
- Drain valve must be provided on water side

Seal Flush Coolers

- Two sizes of coolers:
  - For shaft sizes over 60mm (2.5 inch) – 0.750 inch diameter tube with 0.095 inch wall thickness
  - For smaller shaft sizes – 0.500 inch diameter tube with 0.065 inch wall thickness

- Size selection now based on application conditions

Seal Flush Coolers

- Air cooling is a supported alternative
- Only solution when high temperatures fluid must be cooled due to the potential of fouling
- Same requirements on water cooled and air cooled seal
- Tubing (minimum 0.500”, 0.065 wall 316 stainless steel, welded)
- Sizing is now based on application
- Fins may be aluminum or stainless steel.

Bladder Accumulator

- Pressurization of barrier fluid in Plan 53B systems
- Challenges in selecting a bladder accumulator is selecting a size
- Annex F in the Fourth Edition provides guidance on how to size, pre-charge, and operate Plan 53B

Bladder Accumulator

- Define basic features of an accumulator
- Standard sizes are 20 L [5 gal] and 35 L [9 gal] depending upon shaft size.
- Selected to provide a minimum of 28 days of operation without operator intervention
- Shell of the accumulator shall be carbon steel and the bladder material will be recommended by the manufacturer based on available options and operating conditions
- Tags and labeling requirements are also included.

Piston Accumulator

- Used to provide barrier fluid pressurization in Plan 53C systems.
- Defined in two sizes: maximum 2,8 L [0.7 gal] for shaft sizes 60mm or less and maximum 5,1 L [1.28 gal] for shaft sizes larger than 60mm
- The metallic material should be the same as the seal gland
- Gasketing elements (O-rings, lip seals) shall be suitable for exposure to both the process and barrier fluid.

Leakage Collection Reservoir

- Liquid leakage which leaves the seal gland can be monitored with a Plan 65
- Been used extensively in some industries
- Plan 65 system is considered part of the pressure boundary
- Shall have a capacity of at least 3 L [0.75 gal] and be equipped with a locally indicating level transmitter.
- Constructed from schedule 40 pipe.

Inspection, Testing, and Preparation for Shipment

- General inspection by vendor
- Inspection of seal components
- Qualification testing
- Hydrostatic testing of glands
- Air testing
- Pump manufacturer seal test

Qualification Testing

- Easy for a standard to create a goal of 25,000 hours of service but difficult to prove it
- Concern from users that seals should be tested under real world conditions
- Testing is designed to provide the user with a level of confidence that the seals will perform as required by the standard

Qualification Testing

- Testing will qualify a seal model so testing only needs to be done once for a specific seal
- Not intended as testing for actual job seals
- Two sizes need to be tested: a small size with a balance diameter between 50mm to 75mm (2.0 to 3.0 inch) and a large size with a balance diameter between 100mm to 127mm (4.0 to 5.0 inch)
- Category 1 seal requires 38mm – 75mm (1.5 – 3.0) and 75mm – 127mm (3.0 to 5.0 inch)

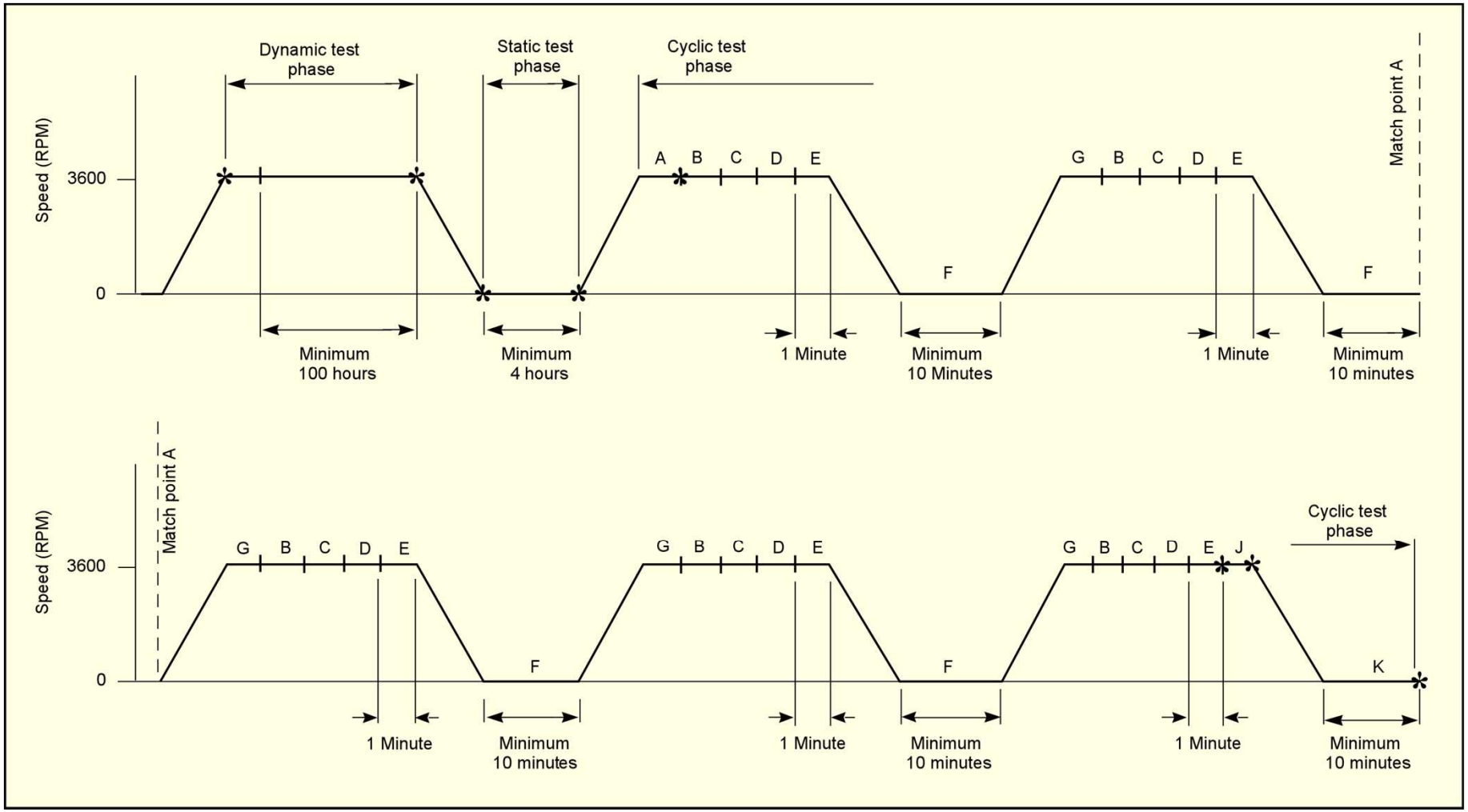
Qualification Testing

- Testing requirements are different between the seal categories
- Category 3 seals must be tested in the same configuration as is being offered
- Category 1 and 2 seals may be tested in the same configuration as is offered or it may be designed with seal faces that have been qualified in other testing defined by core components
- Allowance for seal face materials to be qualified as a mating pair to cut down on the number of tests required

Qualification Testing

- End users identified typical refinery applications based on process fluids, temperatures and pressures
- Selected five test fluids that are representative of these applications and that were acceptable for lab testing
- Developed a set of steady state and cyclic conditions that would simulate actual field conditions

Test Cycle for Liquid Seals



Test Qualification Form

MECHANICAL SEAL TEST QUALIFICATION FORM

Date: 6-8-92
Revision #2

Manufacturer: ________________ Seal Model/Type: ________________

API 682 Seal Type: _______ A _______ B _______ C _______ ES

Matl. of construction: Rotating Face ____________ Stationary Face ____________

Secondary Seals ____________ Metal Hardware ____________

Seal Size: ________ API Code: ________ API Plan: ________ Shaft Speed: 3600 RPM

Rotating Face Matl.: ____________ Stationary Face Matl.: ____________

Fluid Service: (From table 1: section V) _______ Non-Hydrocarbon (water, caustic, acid) _______ Non-Flashing Hydrocarbon _______ Flashing Hydrocarbon

Shaft Run Out ________ Sleeve Run Out ________ Face to Sleeve Concentricity ________

Fluid: ____________ Base Point Temp °F/°C _____ /_____ Base Point Pressure PSI _____ /_____

SG _______ V. Pressure _______ Solids _______ Particle Size _______

*Dual Seals

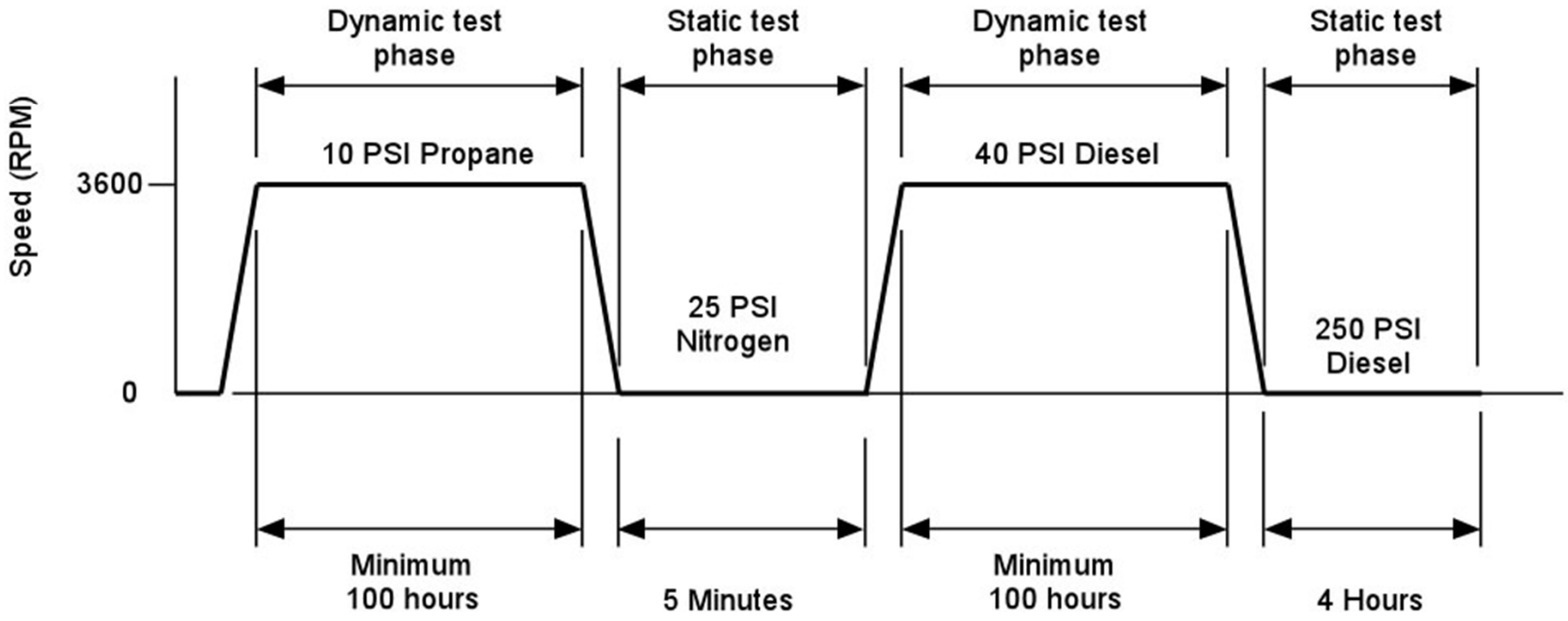
Date	Time	
	Start	Stop
DYNAMIC TEST 100 hr. minimum		
STATIC TEST 4 hr. minimum		
CYCLIC TEST 5 Cycle minimum		

Pressure (PSIG)	Process Temp	Flush Temp IN	Flush Temp OUT	Flush Flow Rate (GPM)	Seal Chamber Temp	Barrier Fluid Press.*	Barrier Fluid Temp IN*	Barrier Fluid Temp OUT*	Sleeve to Box Concentricity	Horse Power Consumption	Hydrocarbon Leakage (cc/min)	Non-Hydrocarbon Leakage (cc/min)	Circulating Device (GPM)	

Containment Seal Testing

- In the Second Edition, testing requirements were defined for containment seals
- Testing would demonstrate performance under steady state conditions as well as simulated failure of the inner seal
- Recorded data include leakage rate past containment seal

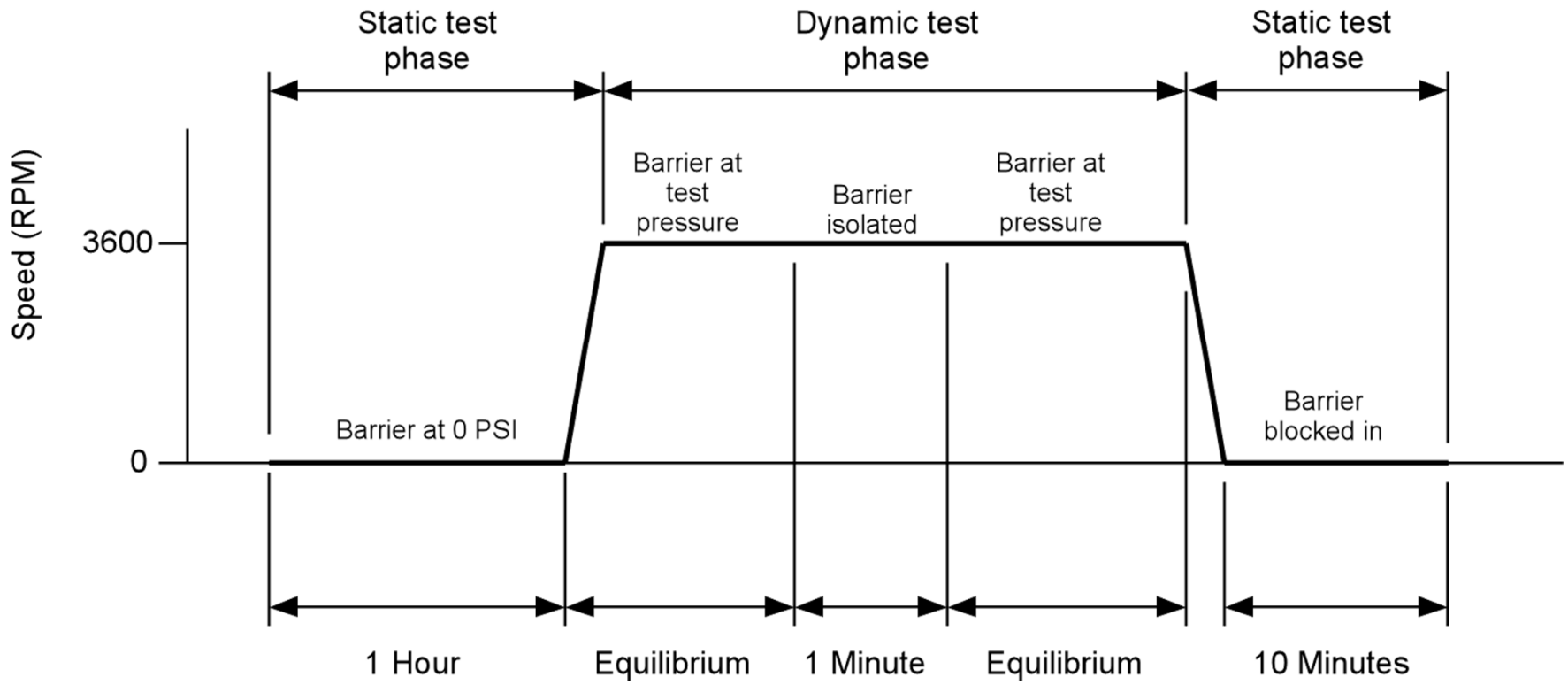
Test Cycle for Containment Seals



Dual Gas Seal Testing

- Dual gas seal testing is designed to evaluate the seals on the process fluid with an inert barrier gas
- Testing involves steady state testing as well as the cyclic testing precedures defined for liquid seals
- Also involves simulated disruptions of the barrier gas supply

Test Cycle for Dual Gas Seals



Gas Seal and Containment Seal Test Qualification Form

MECHANICAL SEAL TEST QUALIFICATION FORM
2CW-CS, 2NC-CS, 3NC-FF, 3NC-BB, 3NC-FB

Manufacturer _____ Seal Type/Model _____
Arrangement _____ 2CW-CS _____ 2NC-CS _____ 3NC-FF _____ 3NC-BB _____ 3NC-FB
Material of Construction Rotating Face _____ Stationary Face _____
Fluid Service ____Non-Hydrocarbon (water, caustic, acid) ____Non-Flashing Hydrocarbon ___Flashing Hydrocarbon
Shaft Run Out _____ Sleeve Run Out _____ Face to Sleeve Concentricity _____
Test Fluid _____ Base Point Temperature _____ Base Point Pressure _____
SG _____ Vapor Pressure _____ Solids _____ Particle Size _____

Test Procedure _____ 10.3.1.2.8 (for 2CW-CS, 2NC-CS Arrangements)
_____ 10.3.1.2.9 (for 3NC-FF, 3NC-BB, 3NC-FB Arrangements)

Data Point	Date	Time	Inner Seal		Buffer/Barrier			Speed	Seal Leakage			
			Pressure Bar (PSI)	Temp °C (°F)	Medium	Pressure Bar (PSI)	Temp °C (°F)	RPM	Inner	Outer		
									cc/Hr	PPM	cc/Hr	Nl/Hr

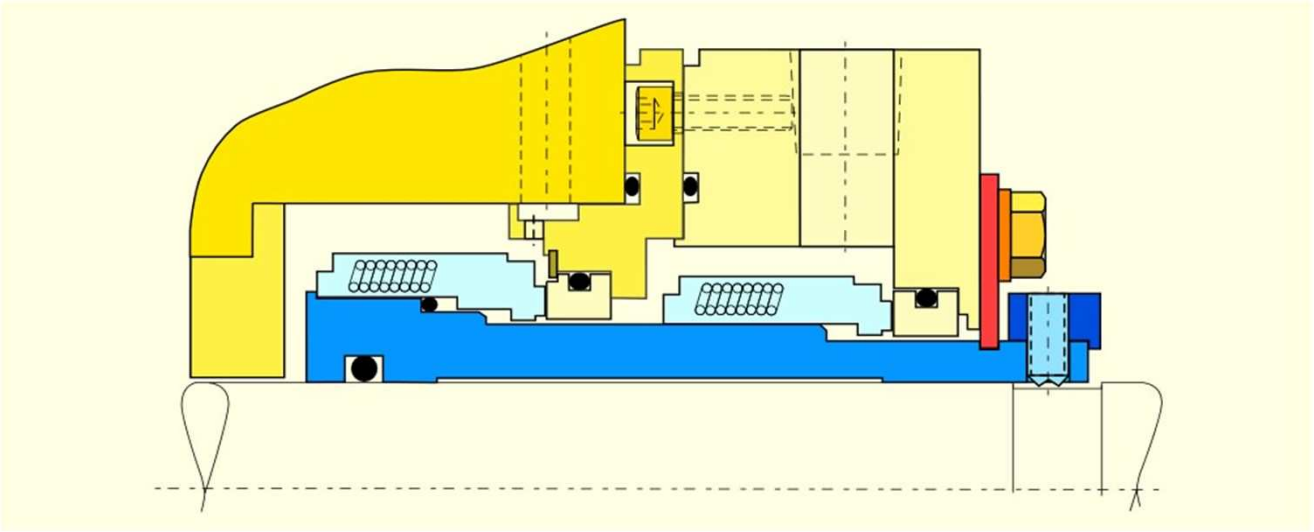
Outer Seal Face Wear Stationary Face_____ Rotating Face_____ mm (in.)
Inner Seal Face Wear Stationary Face_____ Rotating Face_____ mm (in.) (10.3.1.2.9 only)

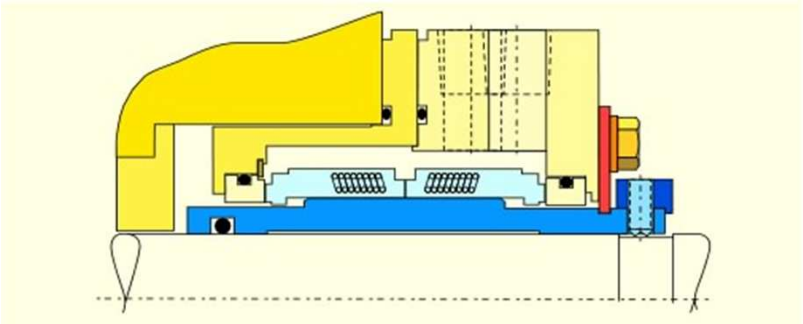
Figure I.2 — Mechanical seal test qualification form (2CW-CS, 2NC-CS, 3NC-FF, 3NC-BB, 3NC-FB)

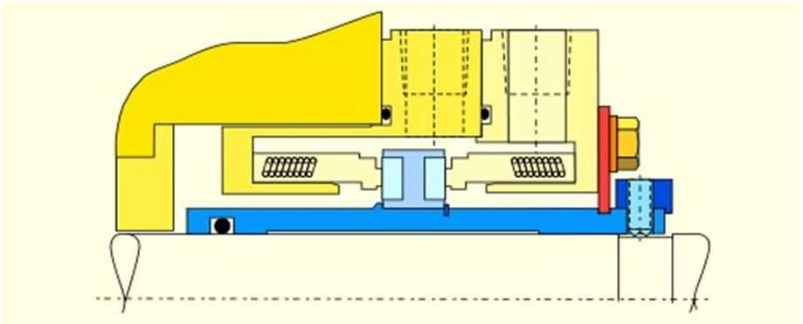
Testing Arrangement 3 Seals

- Test inner seal alone
- Test complete seal
- Established for 3CW-FB orientation
- If applied to test 3CW-BB or 3CW-FB, inner seal becomes ID pressurized
- Difficult to pass test
- May require seal OEMs to design seals for the test and not the application

Arrangement 3 Options







Testing Arrangement 3 Seals

- New test requirements for 3CW-BB and 3CW-FB
- Test complete assembly per test procedure
- Reduce barrier pressure to zero dynamically for one minute
- Repressurize and reach stabilize
- Shut down with base point on inner seal and barrier pressure at zero for one hour

Air Testing of Assemblies

- Every seal assembly shall be air tested by the seal OEM
- Dual seals tests must have ability to test each sealing section independently
- Seals tested at 1.8 bar (26 PSI) with a gas volume of a maximum of 28 l ($1ft^3$)
- Maximum pressure drop of 0,14 bar (2 PSI) over a five minute period
- Seals tagged after successful completion
- No changes in Fourth Edition

Overview of Annexes

- Annexes comprise almost exactly half of the pages in API 682 and ISO 21049
- Contain support material for the standard
- Consists of both normative and informative sections
- Normative annexes are enforceable parts of the standard
- Informative annexes are for information only

Annexes Fourth Edition

- Annex A – Recommended seal selection procedure
- Annex B – Typical materials and material specifications for seal chambers and mechanical seal components
- Annex C – Mechanical seal data sheets
- Annex D – Seal codes
- Annex E – Mechanical seal data requirement forms
- Annex F – Technical tutorials and illustrative calculations
- Annex G – Standard piping plans and auxiliary hardware
- Annex H – Inspectors' checklist for all seals
- Annex I – Seal qualification testing protocol
- Bibliography

Seal Selection Procedure

- First Edition introduced a seal selection procedure
- Procedure was developed to capture selection methods that have proven successful in the field
- Systematic method of selecting a seal type, arrangement, and piping plans for a number of common applications
- Does not cover every service
- Continued into Fourth Edition

New Seal Selection Procedure

- Alternative seal arrangement selection method using Material Safety Data Sheet information
- Chemicals are catagorized in by risks and harzards in accordance GHS and EC standards
- R-phrases and H-statements
- Associate higher risk applications to “higher” seal arrangments

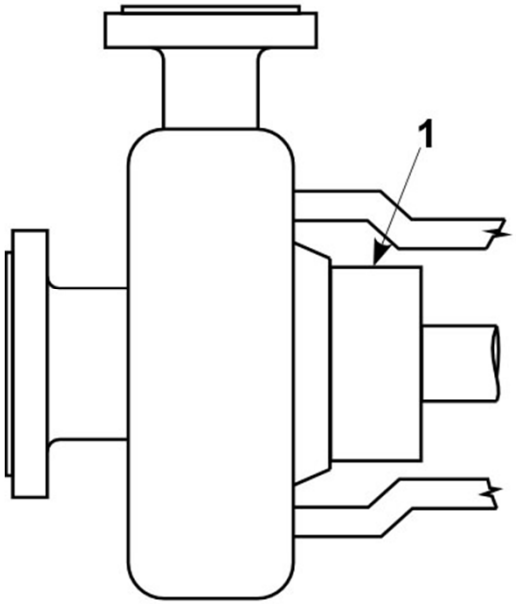
Piping Plans

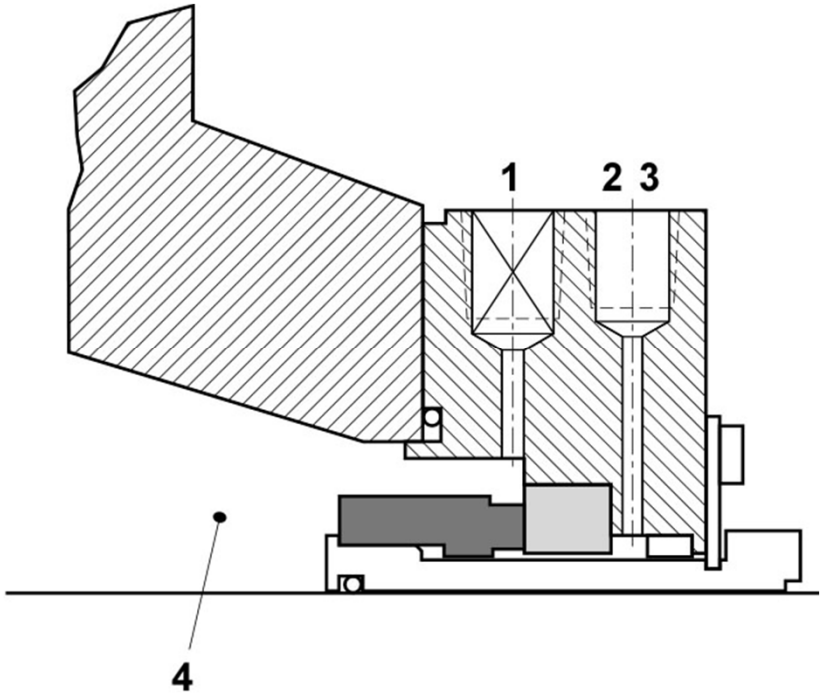
- New piping plans introduced in ISO 21049-2011 / API 682 Fourth Edition:
  - General changes
  - Seal flush created by seal chamber design
  - Low pressure buffer fluids systems
  - Alternatives in leakage detection
  - Leakage reduction and detection plans
  - Engineered piping plan

Piping Plans

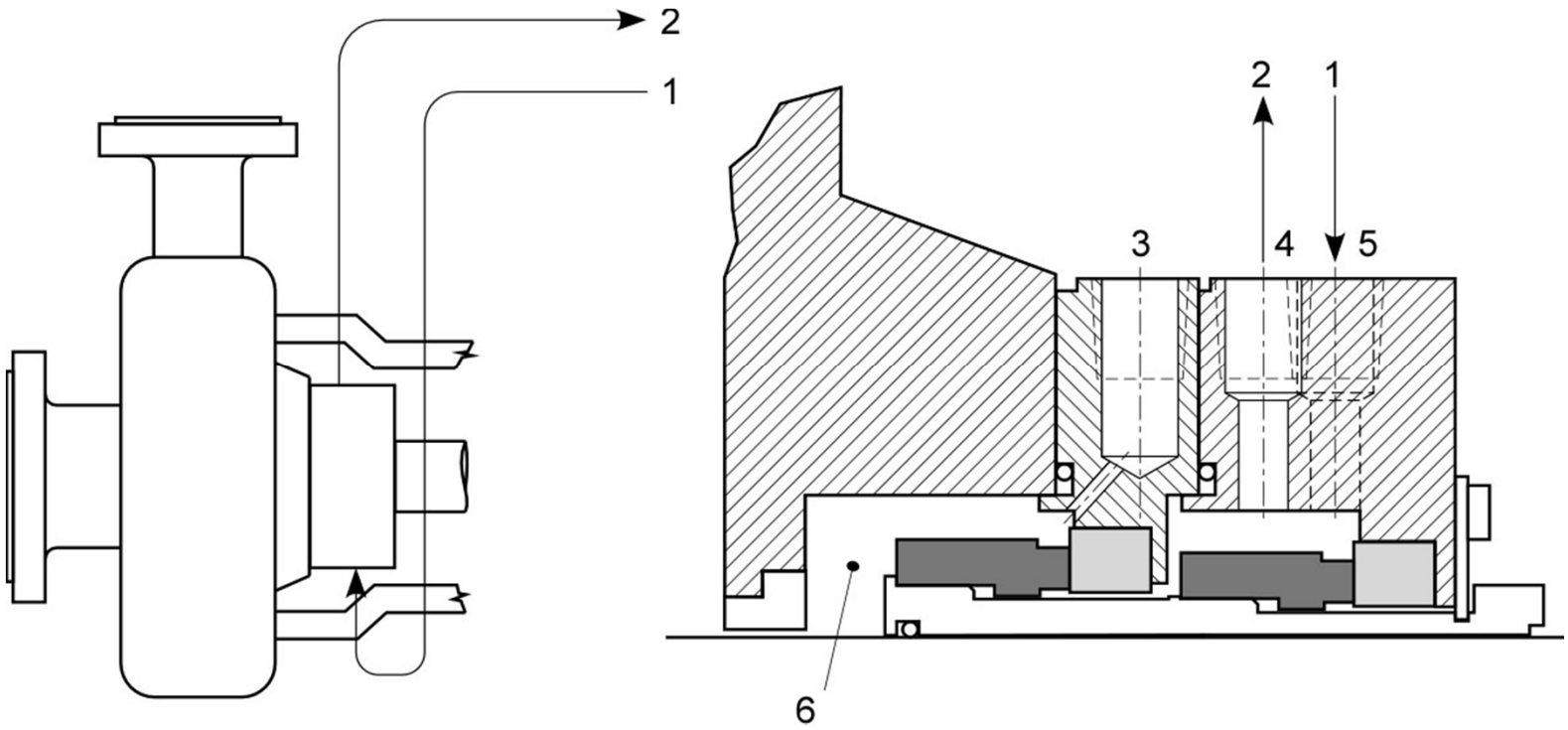
- Eliminated the term Flush Plan and replaced with Piping Plan
- Consolidated information on one page
- Stressed that seal drawings are typical for illustrating plans only
- Change from “indicator and switch” to transmitter
- Allows minor changes
- Major changes require engineered plan

Plan 03

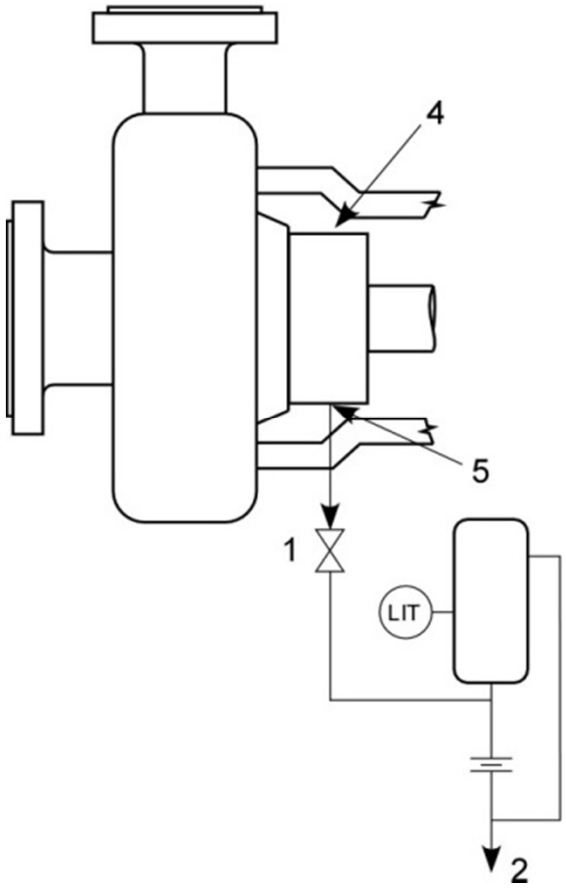


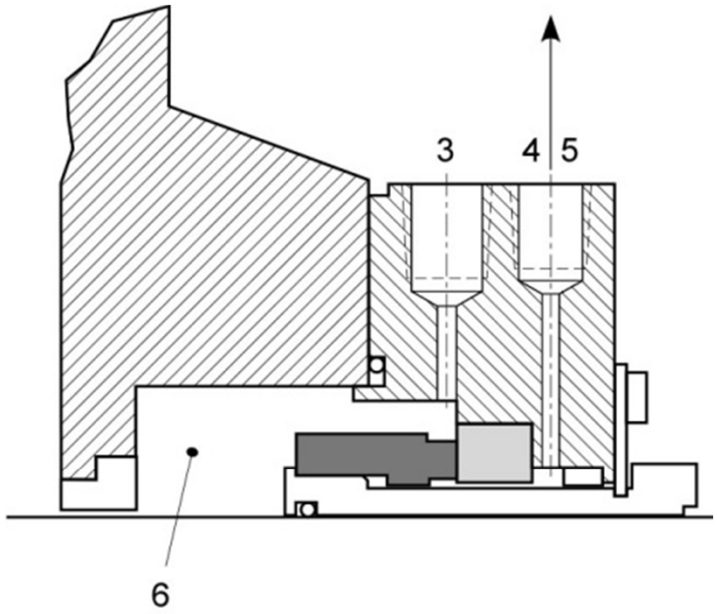


Plan 55



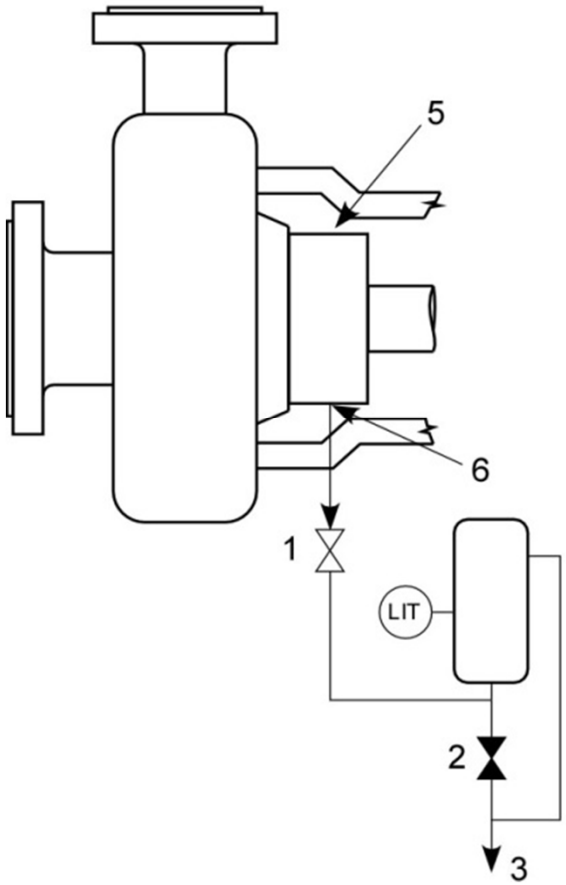
Plan 65A

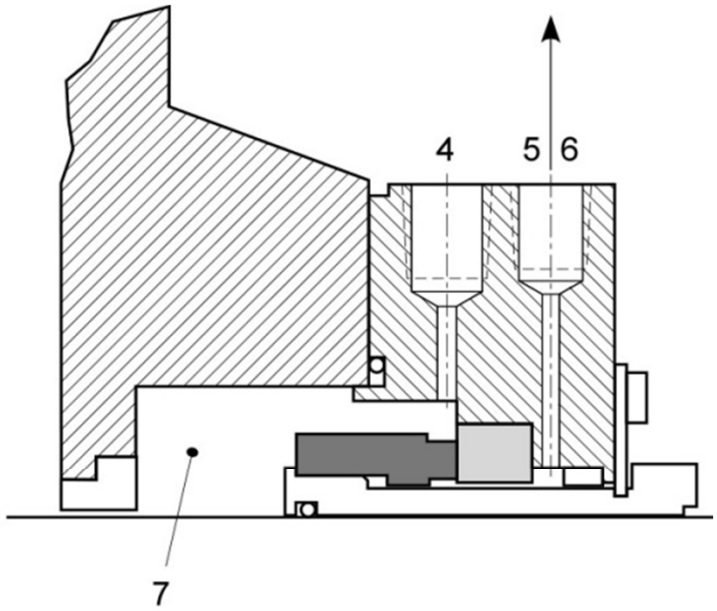




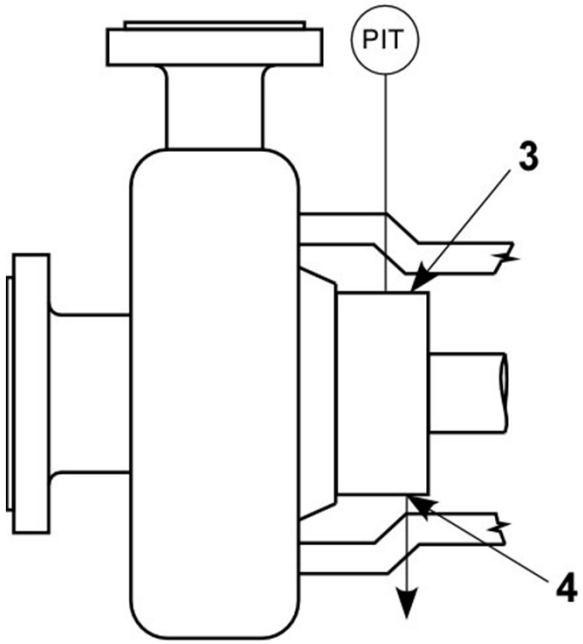
New in API 682 Fourth Edition

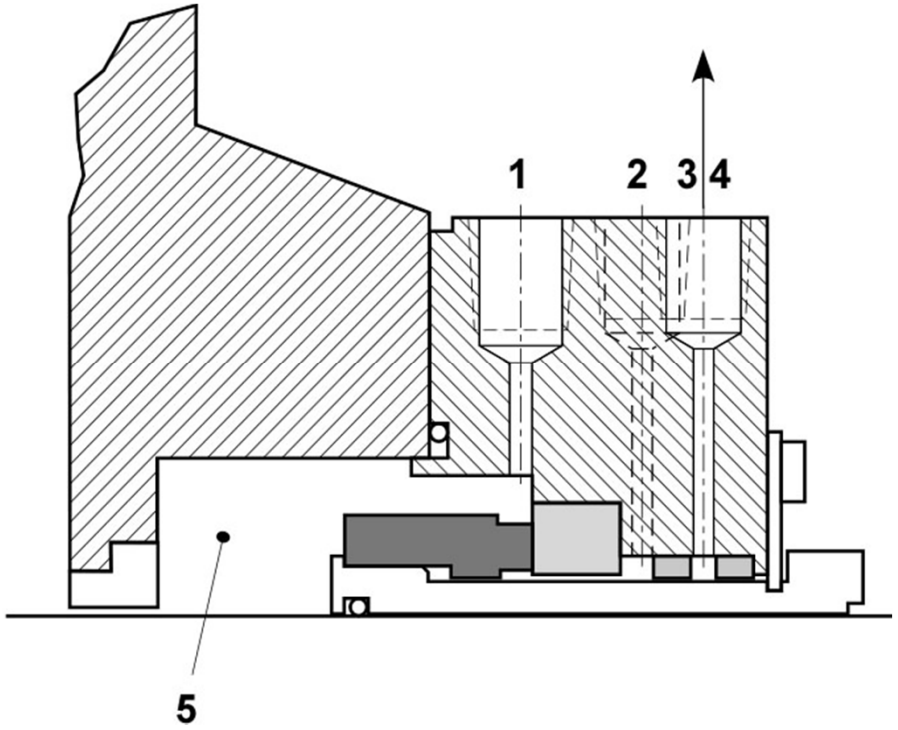
Plan 65B



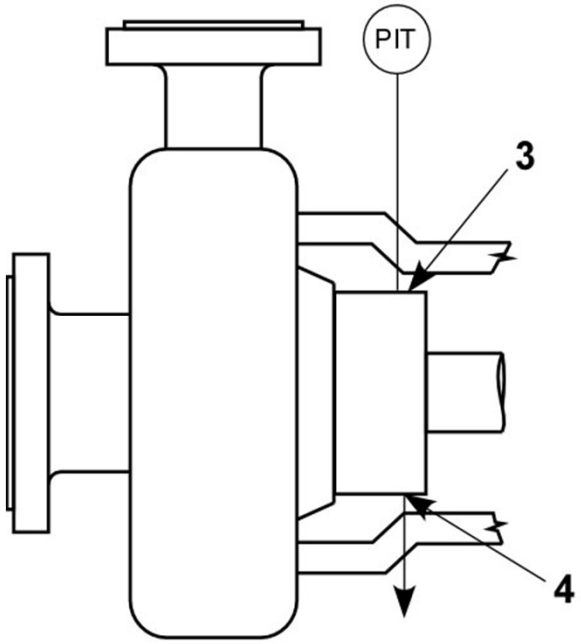


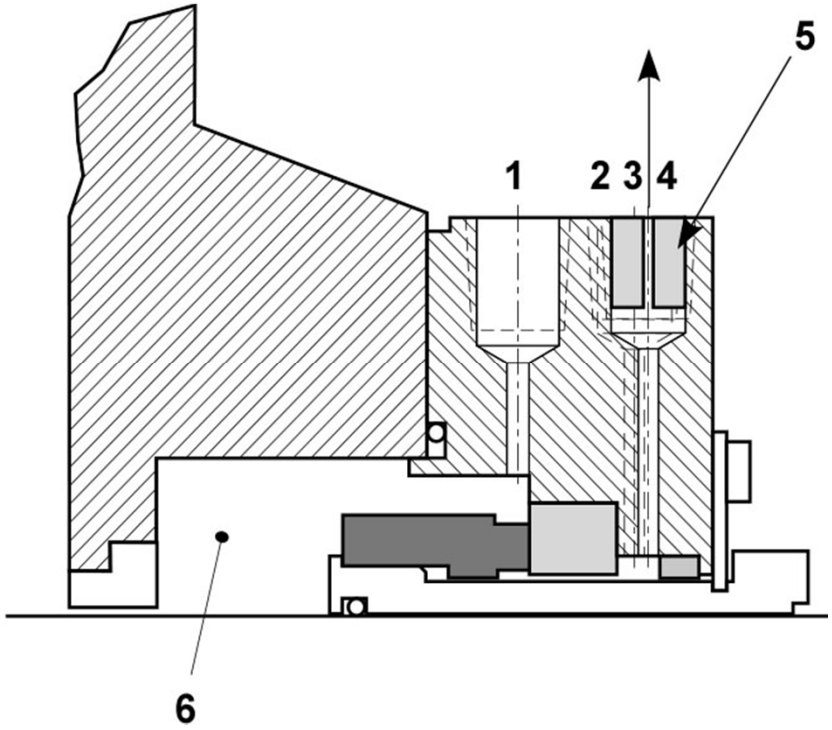
Plan 66A





Plan 66B



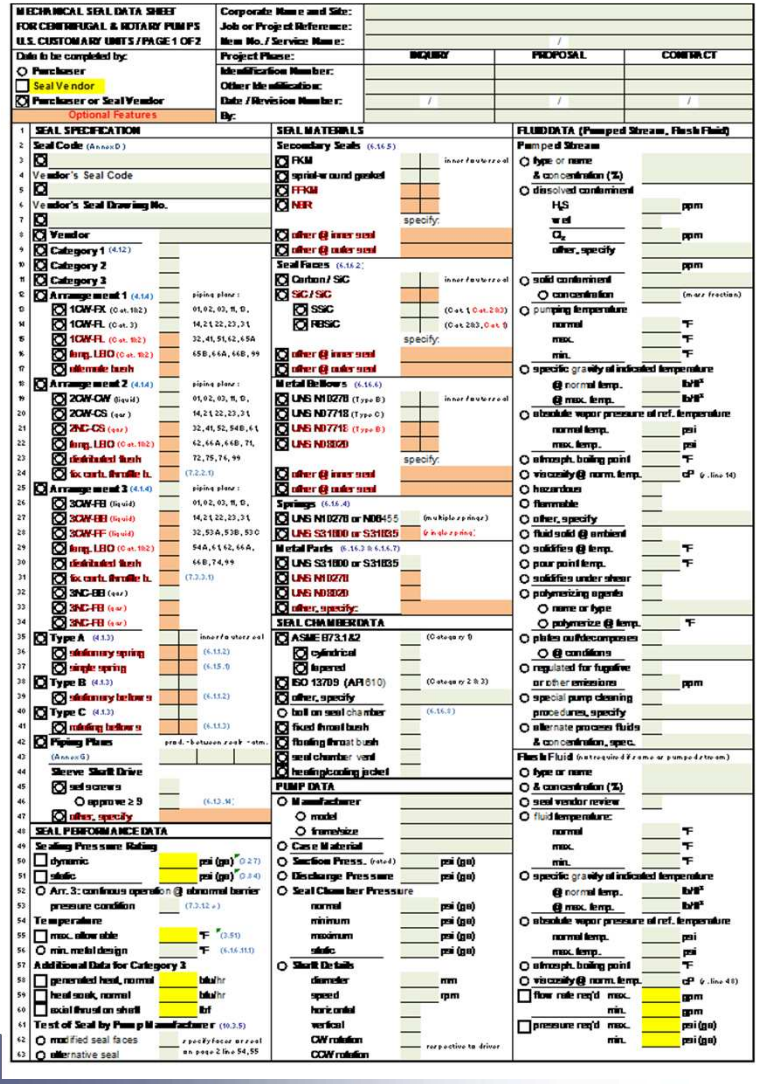


Plan 99

- Engineered piping plan
- Any piping plan not covered by standard piping plans
- Can be modification to existing plan
- Can be completely unique plan
- Described in purchase order or technical specification
- Must be specific

Data Sheets

- Fourth Edition has new sheets
- Two pages
- All categories
- Excel based
- Built in logic
- Unsure of distribution


MECHANICAL SEAL DATA SHEET
FOR CENTRIFUGAL & ROTARY PUMPS
U.S. CUSTOMARY UNITS / PAGE 1 OF 2

Corporate Name and Site:
Job or Project Reference:
Item No. / Service Name:

Data to be completed by:
Purchaser
Seal Vendor
Purchaser or Seal Vendor
Optional Features

Project Phase: | INQUIRY | PROPOSAL | CONTRACT
Identification Number:
Other Identification:
Date / Revision Number:
By:

SEAL SPECIFICATION
Seal Code (Annex D)
Vendor's Seal Code
Vendor's Seal Drawing No.
Vendor
Category 1 (4.1.2)
Category 2
Category 3
Arrangement 1 (4.1.4)
1CW-FX (Gr. 1B2)
1CW-FL (Gr. 3)
1CW-FL (Gr. 1B2)
Targ. LBO (Gr. 1B2)
alternate bush
Arrangement 2 (4.1.4)
2CW-CW (liquid)
2CW-CS (gas)
2NC-CS (gas)
Targ. LBO (Gr. 1B2)
distributed flush
6x carb. throttle b.
Arrangement 3 (4.1.4)
3CW-FB (liquid)
3CW-BB (liquid)
3CW-FF (liquid)
Targ. LBO (Gr. 1B2)
distributed flush
6x carb. throttle b.
3NC-BB (gas)
3NC-FB (gas)
3NC-FF (gas)
Type A (4.1.3)
stationary spring
single spring
Type B (4.1.3)
stationary bellows
Type C (4.1.3)
rotating bellows
Piping Plans
(Annex G)
Sleeve Shaft Drive
set screws
approve ≥ 9
other, specify

SEAL PERFORMANCE DATA
Sealing Pressure Rating
dynamic
static
Arr. 3: continous operation @ abnormal barrier pressure condition
Temperature
max. allowable
min. metal design
Additional Data for Category 3
generated heat, normal
heat soak, normal
axial thrust on shaft
Test of Seal by Pump Manufacturer
modified seal faces
alternative seal

SEAL MATERIALS
Secondary Seals (6.1.6.5)
FKM
sprial-wound gasket
FFKM
NBR
other @ inner seal
other @ outer seal
Seal Faces (6.1.6.2)
Carbon / SiC
SiC / SiC
SSiC
RBSiC
other @ inner seal
other @ outer seal
Metal Bellows (6.1.6.6)
UNS N10276 (Type B)
UNS N07718 (Type C)
UNS N07718 (Type B)
UNS N08020
other @ inner seal
other @ outer seal
Springs (6.1.6.4)
UNS N10276 or N08455
UNS S31600 or S31635
Metal Parts (6.1.2.3 & 6.1.6.7)
UNS S31600 or S31635
UNS N10276
UNS N08020
other, specify:
SEAL CHAMBER DATA
ASME B73.1 &2
cylindrical
tapered
ISO 13709 (API 610)
other, specify
bolt on seal chamber
fixed throat bush
floating throat bush
seal chamber vent
heating/cooling jacket
PUMP DATA
Manufacturer
model
frame size
Case Material
Suction Press. (rated)
Discharge Pressure
Seal Chamber Pressure
normal
minimum
maximum
static
Shaft Details
diameter
speed
horizontal
vertical
CW rotation
CCW rotation

FLUID DATA (Pumped Stream, Flush Fluid)
Pumped Stream
type or name
& concentration (%)
dissolved contaminent
H_2S
wet
O_2
other, specify
solid contaminent
concentration
pumping temperature
normal
max.
min.
specific gravity at indicated temperature
@ normal temp.
@ max. temp.
absolute vapor pressure at ref. temperature
normal temp.
max. temp.
at/mosph. boiling point
viscosity @ norm. temp.
hazardous
flammable
other, specify
fluid solid @ ambient
solidifies @ temp.
pour point temp.
solidifies under shear
polymerizing agents
name or type
polymerize @ temp.
plules out/decomposes
@ conditions
regulated for fugative or other emissions
special pump cleaning procedures, specify
alternate process fluids & concentration, spec.
Flies In Fluid
type or name
& concentration (%)
seal vendor review
fluid temperature:
normal
max.
min.
specific gravity at indicated temperature
@ normal temp.
@ max. temp.
absolute vapor pressure at ref. temperature
normal temp.
max. temp.
at/mosph. boiling point
viscosity @ norm. temp.
flow rate req'd max.
min.
pressure req'd max.
min.

New in API 682 Fourth Edition

Historical Seal Code

- Old API 610 still in use (ie. BSTFN)
- Used by engineering contractors and project groups
- Does not cover API 682 requirments
- Does allow for material definitons

Fourth Edition Seal Code

- Revisited reasons for code
- Considered use of old API 610 code
- Carry over some material codes
- Focused on project work
- Created a new seal code

Seal Code – Fourth Edition

Seal				Design Options				Size		Plans
Category	Arrangement	Type		Contain-ment Device	Gasket Material	Face Material		Shaft Size mm		Piping Plan
1	2	A	-	P	F	O	-	050	-	11/52

Category	designated as 1, 2, or 3
Arrangement	designated as 1, 2, or 3
Type	designated as A, B, or C

Seal Code – Fourth Edition

Seal				Design Options				Size		Plans
Category	Arrangement	Type		Contain-ment Device	Gasket Material	Face Material		Shaft Size mm		Piping Plan
1	2	A	-	P	F	O	-	050	-	11/52

Containment device

P – plain gland with no bushing (Arrangement 2 or 3 only)
L – floating throttle bushing
F – fixed throttle bushing
C – containment seal
S – floating, segmented carbon bushing
X – Unspecified (This will be specified separately)

Seal Code – Fourth Edition

Seal				Design Options				Size		Plans
Category	Arrangement	Type		Contain-ment Device	Gasket Material	Face Material		Shaft Size mm		Piping Plan
1	2	A	-	P	F	O	-	050	-	11/52

Gasket Material

F – Fluoroelastomer (FKM) gaskets
G – Polyflourotetraethylene (PTFE) spring energized gaskets
H – Nitrile gaskets
I – Perfuoroelastomer (FFKM) gaskets
R – Flexible graphite
X - Unspecified (This will be specified separately)

Seal Code – Fourth Edition

Seal				Design Options				Size		Plans
Category	Arrangement	Type		Contain-ment Device	Gasket Material	Face Material		Shaft Size mm		Piping Plan
1	2	A	-	P	F	O	-	050	-	11/52

Face Materials

M – Carbon vs nickel bound WC
N – Carbon vs reaction bonded SiC
O – Reaction bonded SiC vs nickel bound WC
P – Reaction bonded SiC vs reaction bonded SiC
Q – Sintered SiC vs sintered SiC
R – Carbon vs sintered SiC
S – Graphite loaded, reaction bonded SiC vs reaction bonded SiC
T – Graphite loaded, sintered SiC vs sintered SiC
X - Unspecified (This will be specified separately)

Seal Code – Fourth Edition

Seal				Design Options				Size		Plans
Category	Arrangement	Type		Contain-ment Device	Gasket Material	Face Material		Shaft Size mm		Piping Plan
1	2	A	-	P	F	O	-	050	-	11/52

Shaft size

size in mm rounded up to next whole integer
inch size change to mm (1” = 25.4mm = 26)
used only for rough sizing and not design

Piping Plans

Plan number
Multiple plans separated by “/”
Example: 11/52

API 682 Changes - Review

- Expanded offering
- Remove inconsistencies and clean up conflicts
- New equipment
- Modified test procedures
- New piping plans
- Tutorial Paper from Proceeding of the 27th International Pump Users Symposium (Houston) has more extensive listing and explanation

Comments and Questions