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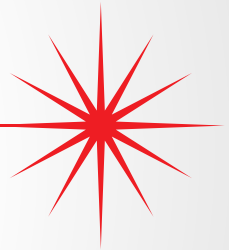

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Understanding Leading and Lagging Metrics

by Rich Overman, President,
Core Principles, LLC

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Leading and Lagging Metrics

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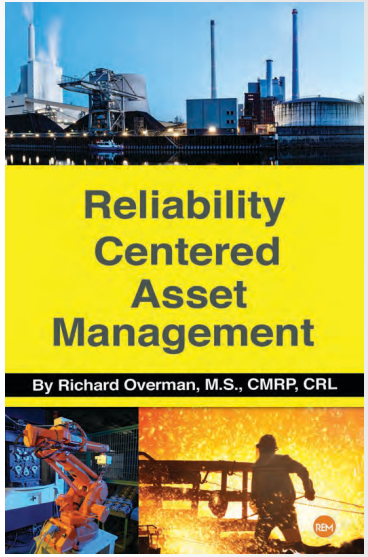
Available on Reliabilityweb.com



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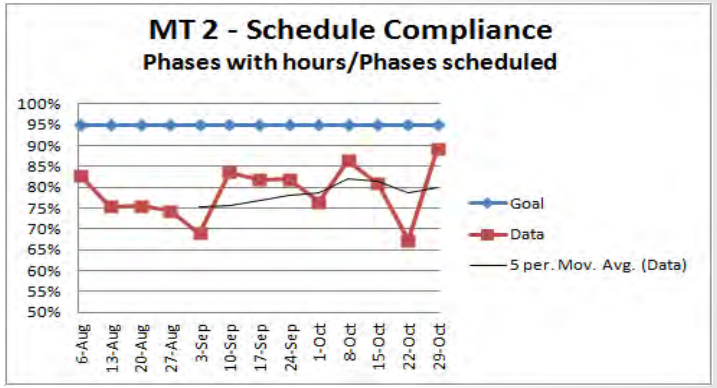
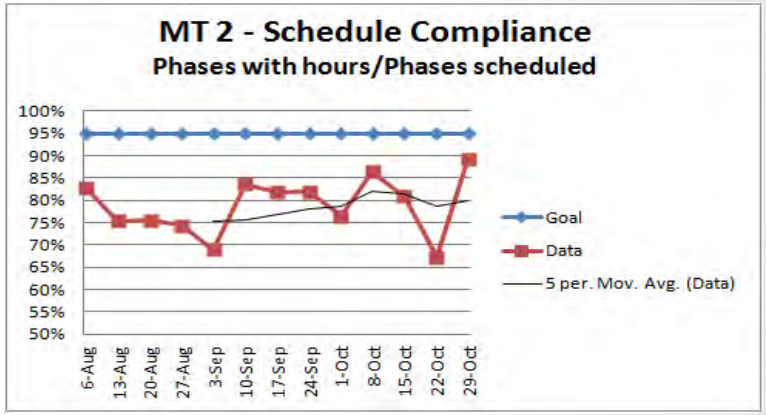
Uses of Measures

- Improvement
- Goal Setting
- Decision-Making
- Accountability



Measurements Should be SMART

- Specific
- Measurable
- Actionable
- Relevant
- Timely



Primary Categories of Measures

- Process Measurements
- Behavioral Measurements
- Operations / Facilities Measurements

Process Measures

- Objective is to establish control and stability of the work processes
- Indicators to focus management attention on problem areas
- Shows trends and improvements

Behavioral Measures

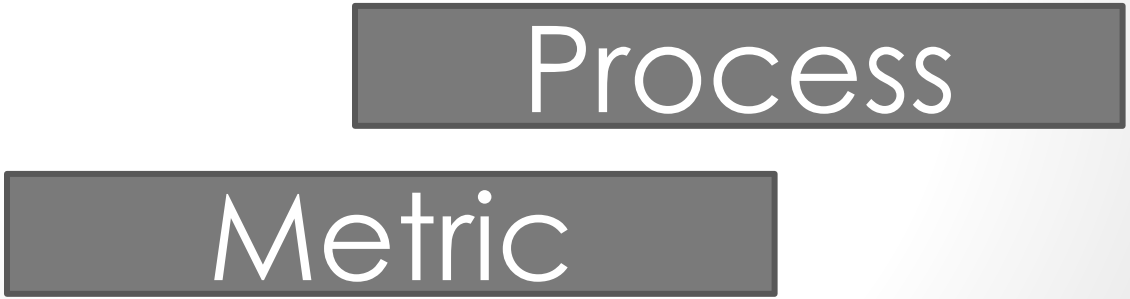
- Objective is to reinforce the desired organizational culture
- Objective is to sustain control and stability
- Indicators that measure personnel's actions related to the work processes

Operations / Facilities Measures

- Objective is to identify the significant changes in costs
- Indicator of organizational fiscal responsibility

Lagging Indicator

An indicator that measures performance after the business or process result starts to follow a particular pattern or trend. Lagging indicators confirm long-term trends, but do not predict them.



Leading Indicator

An indicator that measures performance before the business or process result starts to follow a particular pattern or trend. Leading indicators can sometimes be used to predict changes and trends.

When considering a leading measure, it is beneficial to express it in terms of what it is a leading measure for (e.g., What is the lagging measure that will be affected?)

Process

Metric

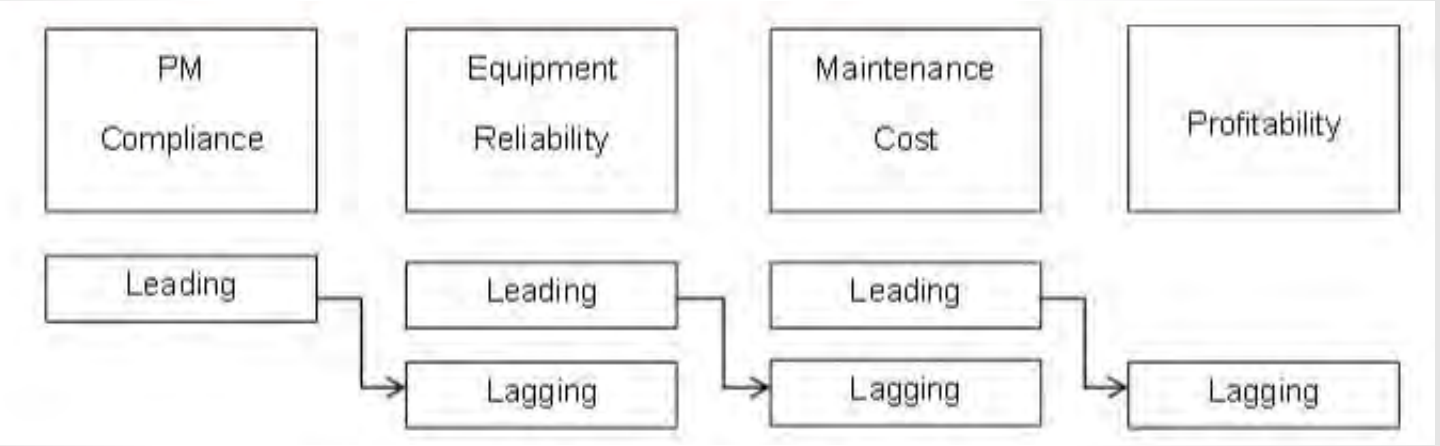
Using Leading and Lagging Metrics

Maintenance and reliability metrics can be both leading and lagging indicators, depending on where in the process the indicators are used.

There is a cause and effect relationship between leading and lagging; the action being measured will cause a resulting action or effect which is also being measured.

A given measure could be both a lagging measure for a previous cause in the chain and a leading measure for a following effect. There are a series of causes and effects in the chain until the final lagging measures are reached.

Example



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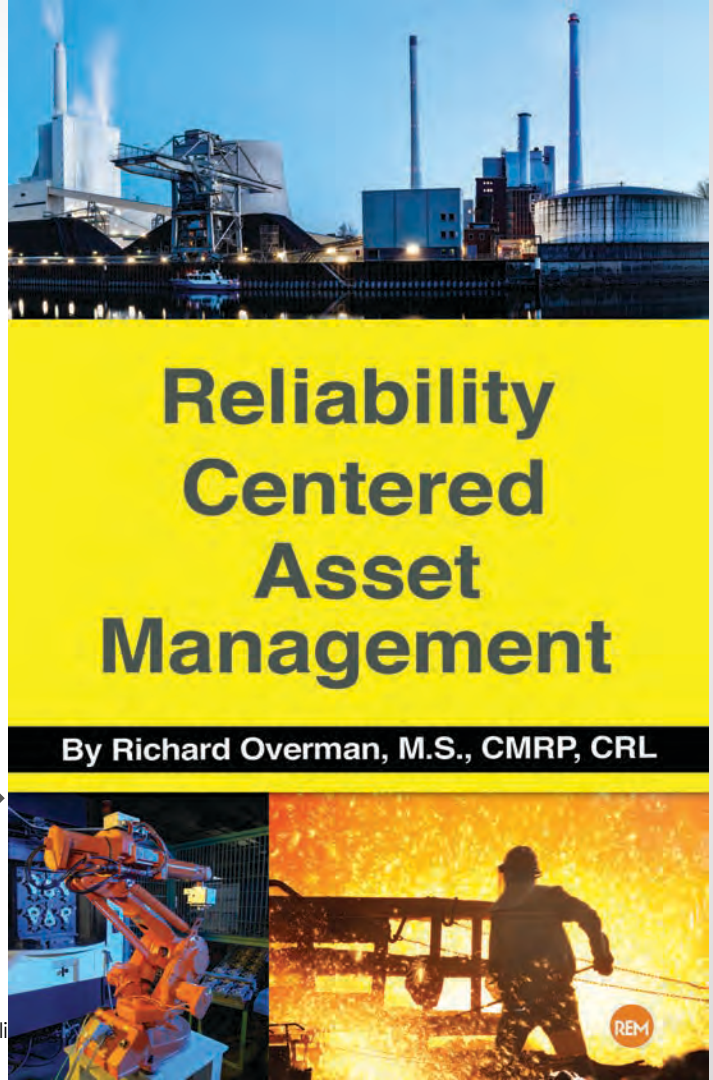

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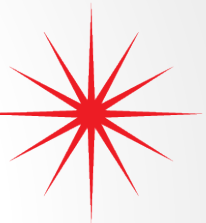

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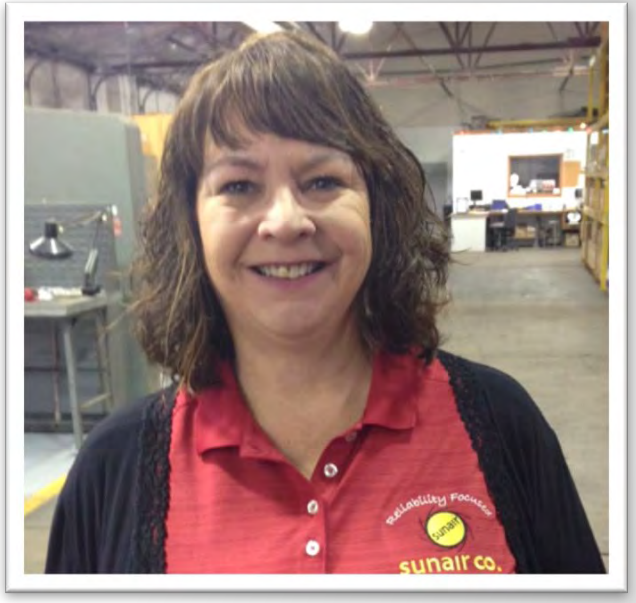
Women in Reliability and Asset Management

Sealing Systems for Mechanical Seal Reliability

by Cathy Wilson, Reliability Technology Manager, Sunair Co.



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Cathy Wilson, PE

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Reliability Technology Manager

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- Applications Engineering Manager
- National Account Manager
- Sales Engineer

Professional passions are training and promoting exceptional customer service

Interests Outside Work: Family, dogs, gardening and community theater

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43 years
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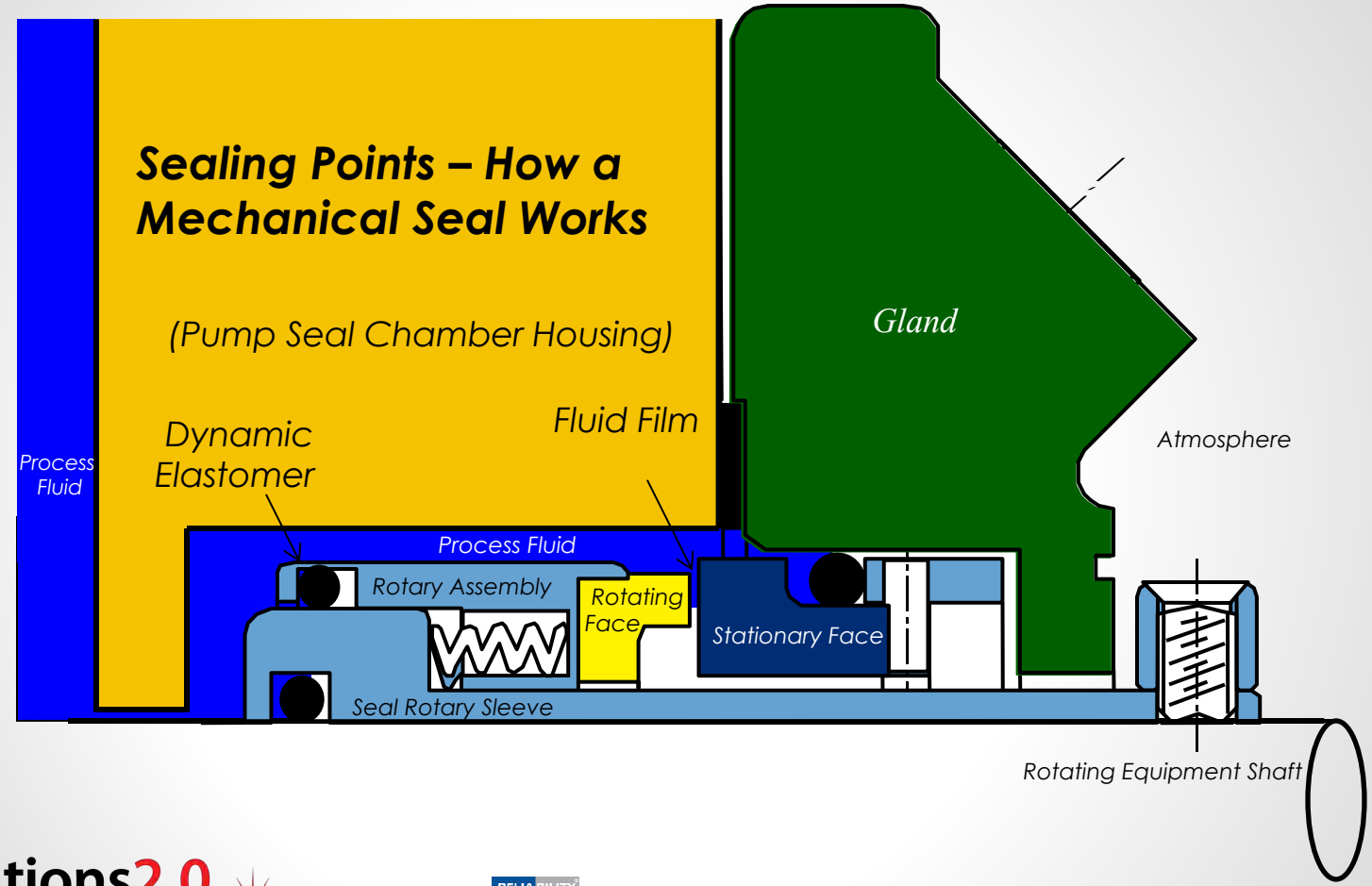
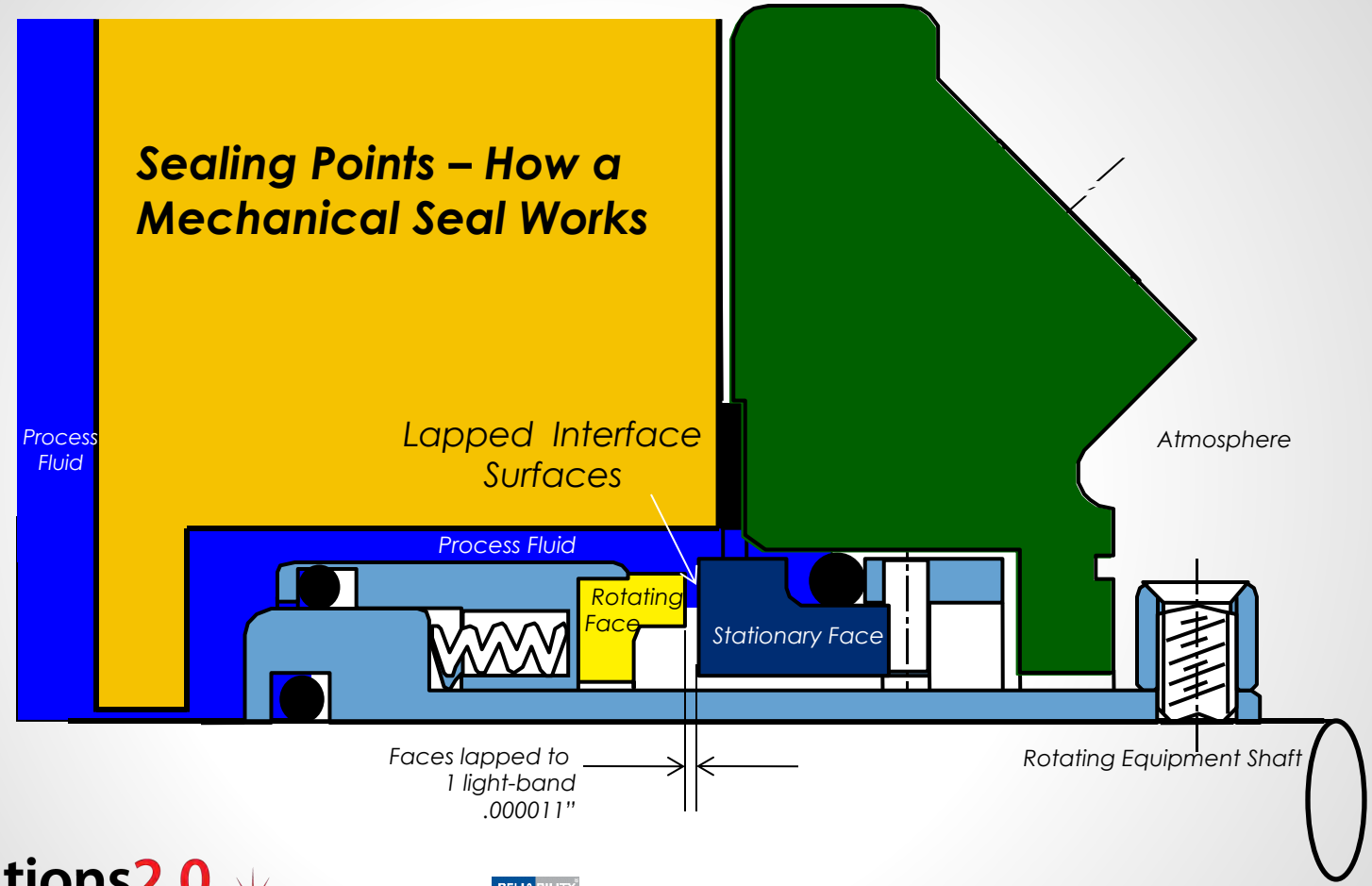


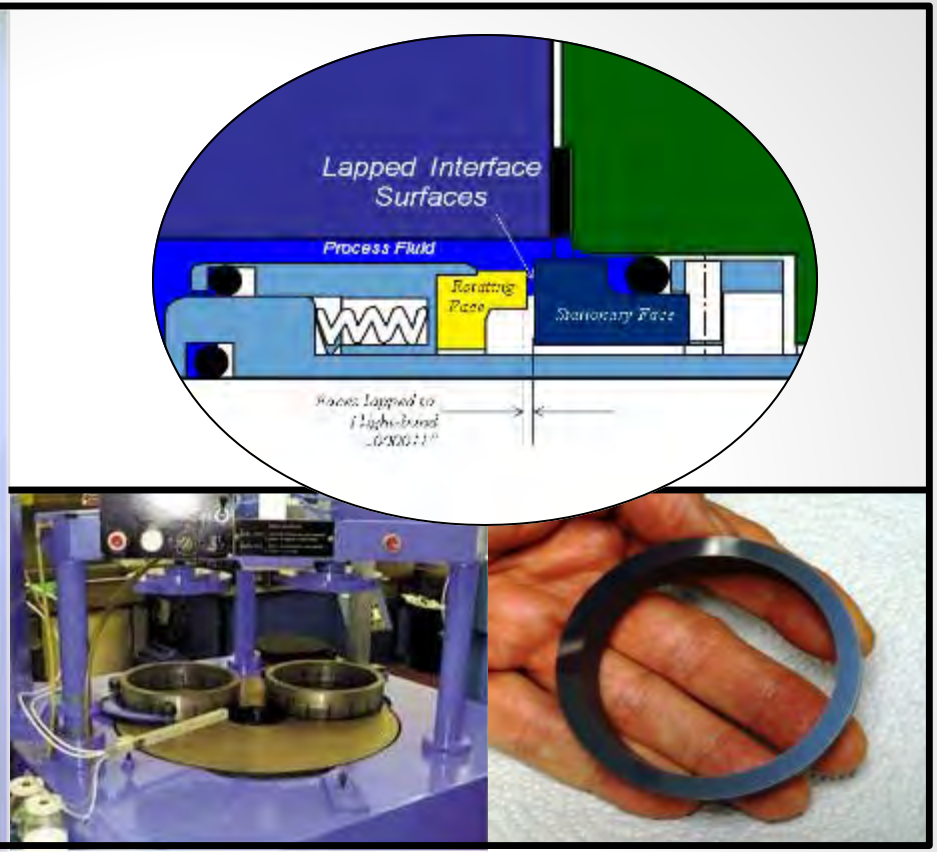
Sealing Points – How a Mechanical Seal Works



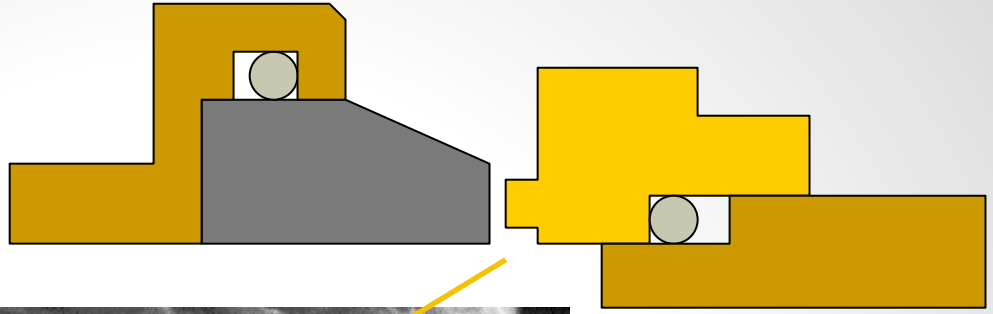
Face Flatness Mechanical Seal Face Lapping Procedures

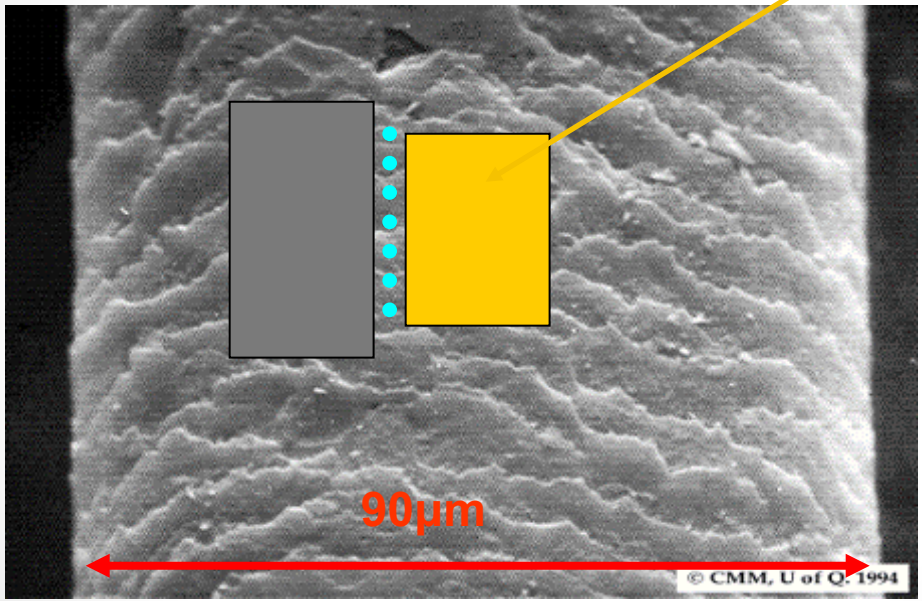
The primary rotary and stationary seal face is the basis of the mechanical seal design. The interface surface is precision lapped. A fluid film between the faces provides lubrication. The width or thickness of the fluid film is exaggerated in the graphic. The fluid film interface can be: contact, boundary our mixed lubrication.

The photo shows the stationary face being held. The surface is placed downward on the Lapping Machine.
The face is placed in one of the two retaining rings and the lower plate rotates under the seal faces. The bottles on the left contain diamond lapping compound. With the aid of a timer, diamond compound is injected onto the lapping plate. The hard diamond polishes "laps" the faces.



Fluid Film





The film is only 2–3µm thick
A human hair is 90µm thick!

Why do Seals Fail?

- **Load**
- **Heat**
- **Contamination**

Load

- **Sealing Chamber Pressure**
  - In pumps typically suction pressure plus a percentage of discharge pressure
  - Pump manufacturer can assist with estimated sealing chamber pressure
  - Best way to know is to measure

- **Understand the Equipment Operation**
  - Sealing chamber pressure changes with pump speed
  - Process changes affect sealing chamber pressure
  - Fast closing valves can cause water hammer with pressures exceeding mechanical rating of seal components
  - Shaft deflection from off BEP operation can cause seal parts to contact
  - Reactor applications can have pressure swings from vacuum to 1000 psi; seal must be designed to handle the pressure range

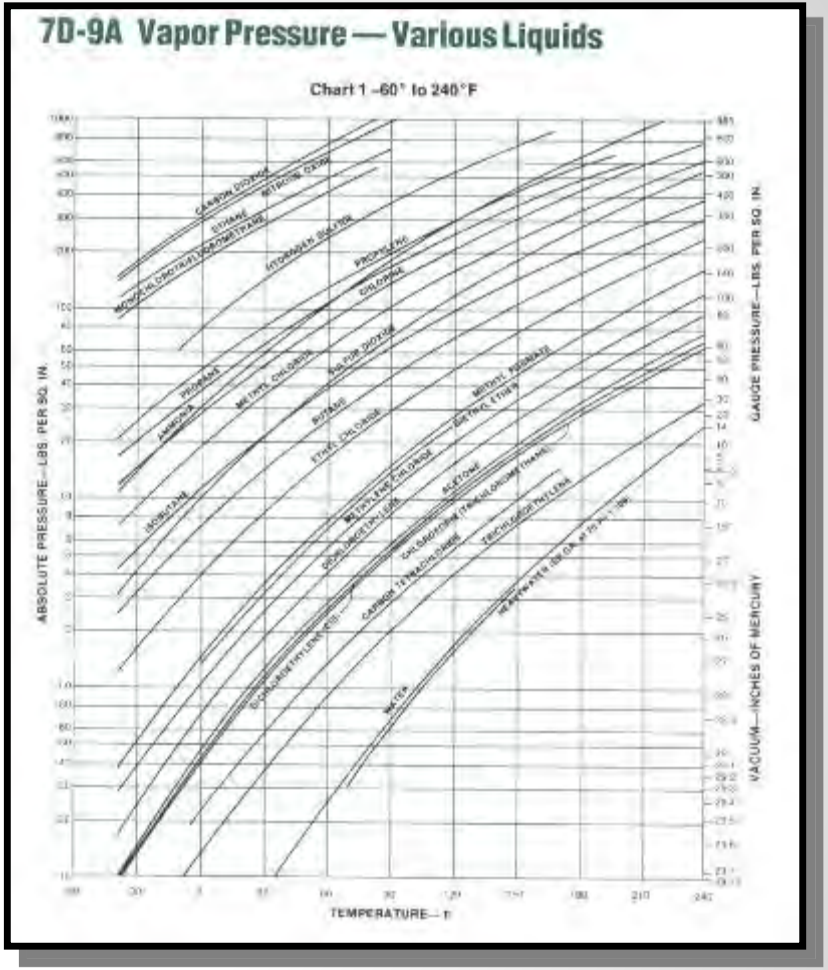
Heat

- **Proper Seal Materials**
  - Face combinations to minimize excess heat generation, seal faces can generate 40-50F locally causing fluid to evaporate
  - Correct elastomers
  - Can eliminate dynamic elastomer with bellows seal

- **Understand the Equipment Operation**
  - Process can be one temperature then equipment is "steamed out"
  - Pump speed can affect sealing chamber temperature
  - Off BEP operation and Cavitation generate heat
  - Improper seal chamber venting generates heat

Heat

- **Process Fluid Vapor Pressure**
  - Fluid Based
  - Temperature Based
  - Stay below vapor pressure to maintain liquid state
  - Prevent Fluid Film loss



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Heat: Loss of Fluid Film

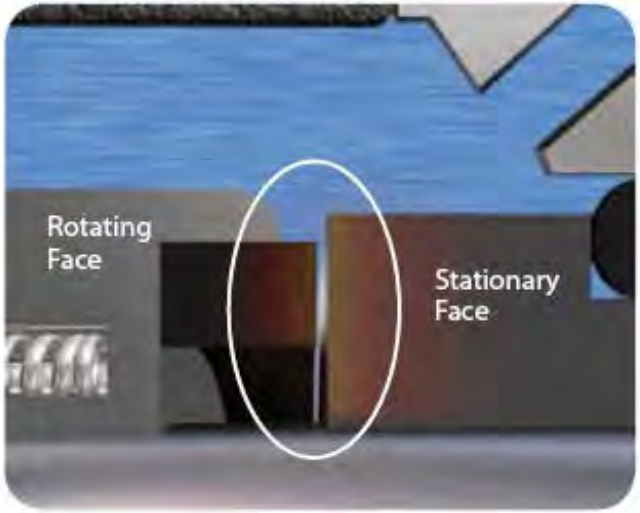


Figure 3 - Mechanical seal faces with a fluid film of fresh, clean water will run cooler and longer

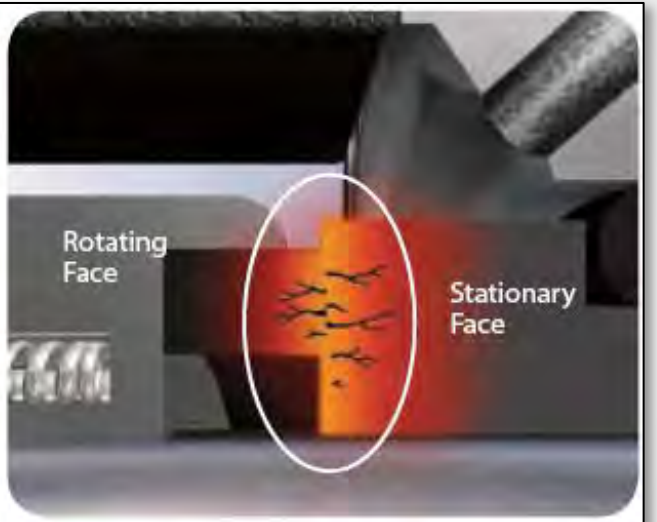
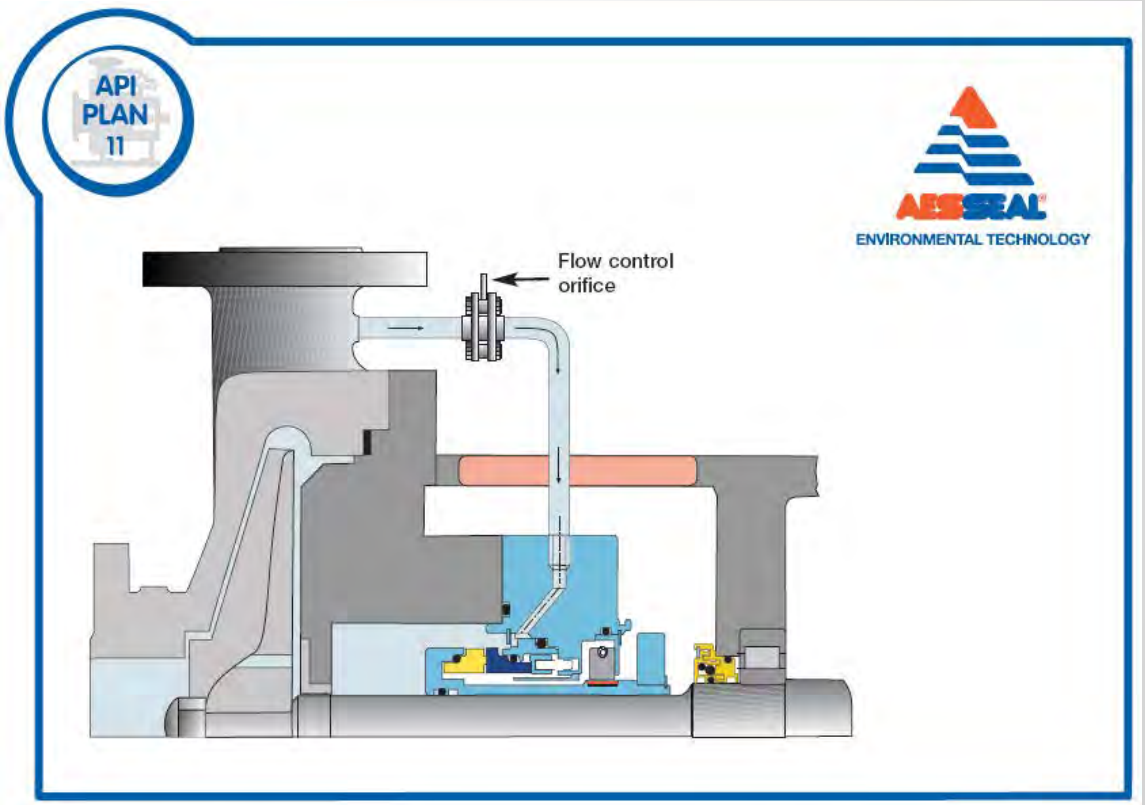


Figure 4. Dry- running of mechanical seal faces destroys the fluid film, resulting in overheating and failure.

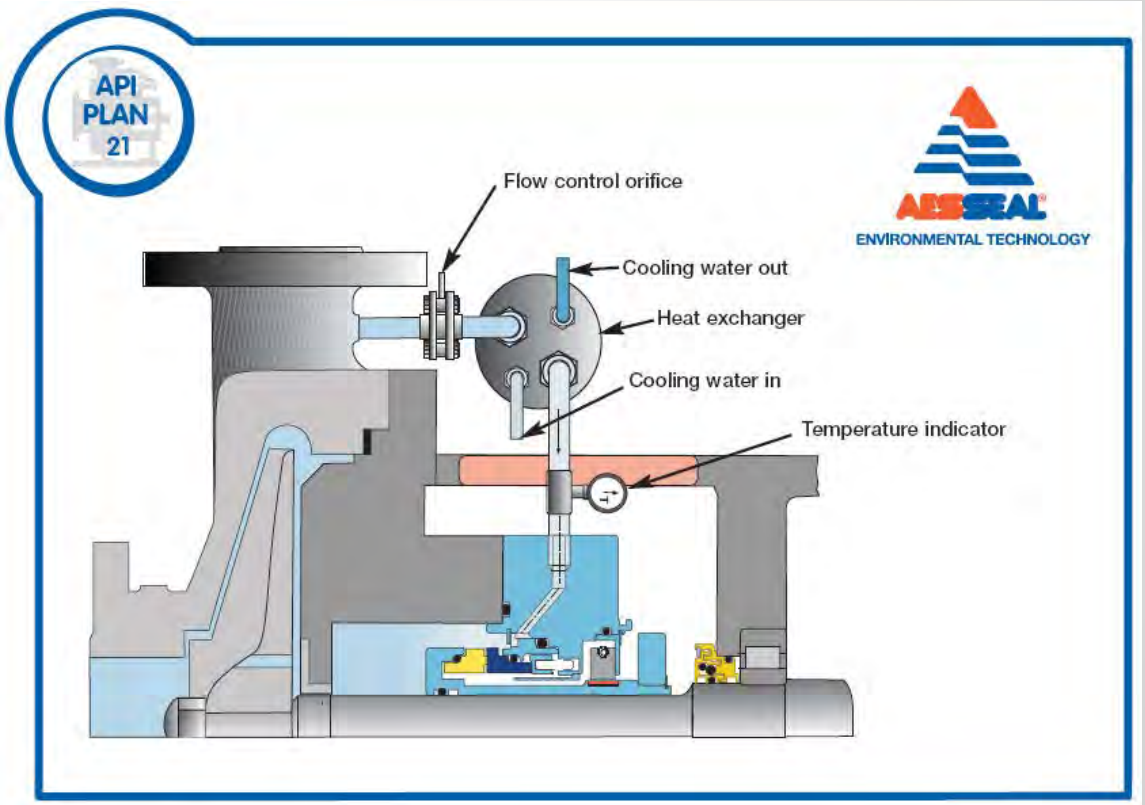
API Plan 11

- Used with single seals
- Product recirculation from discharge to seal chamber
- Keeps product pressure above vapor pressure
- Clean liquids at moderate temperatures



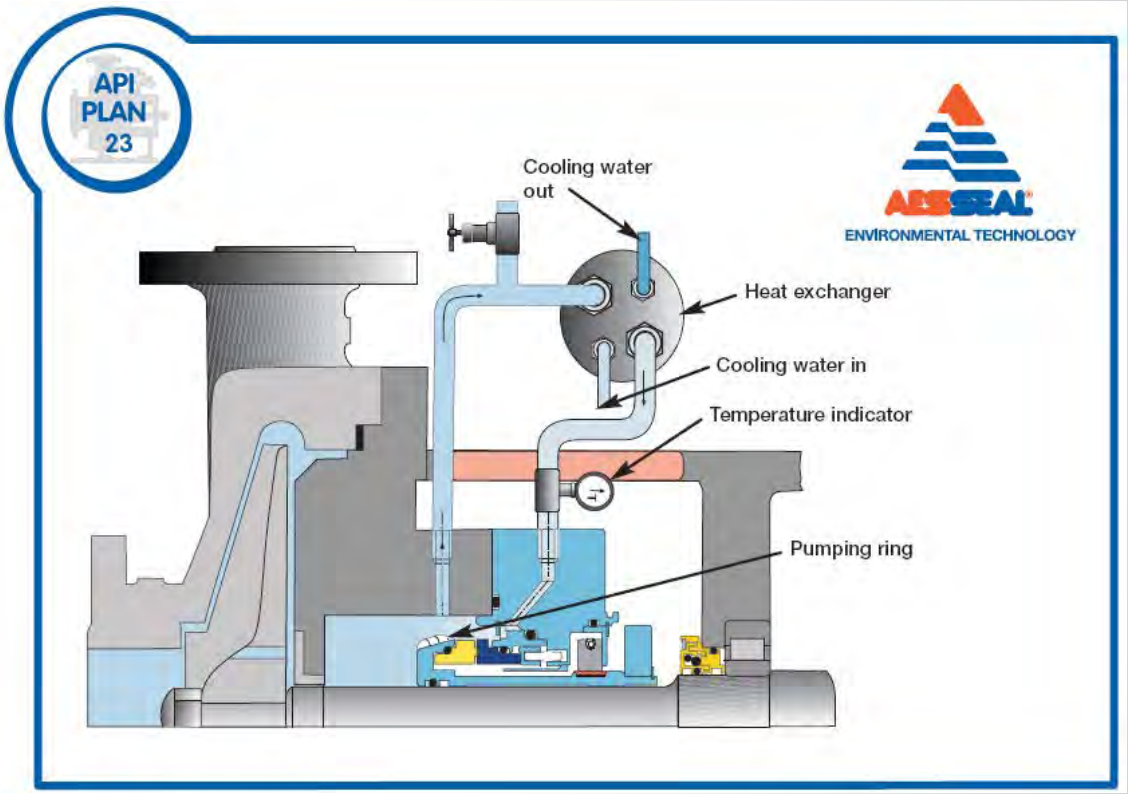
API Plan 21

- Used with single seals
- Product recirculation from discharge to cooler to seal chamber
- Cools product and adds pressure
- Clean liquids at moderate temperatures



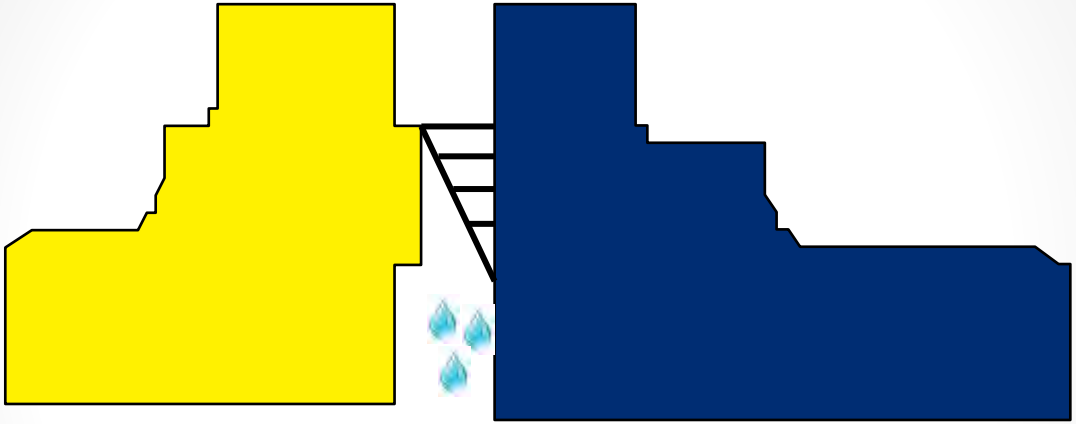
API Plan 23

- Used primarily with single seals
- Product recirculation from seal chamber to cooler to seal chamber
- Efficiently cools product
- Clean liquids at moderate temperatures



Pressure Gradient

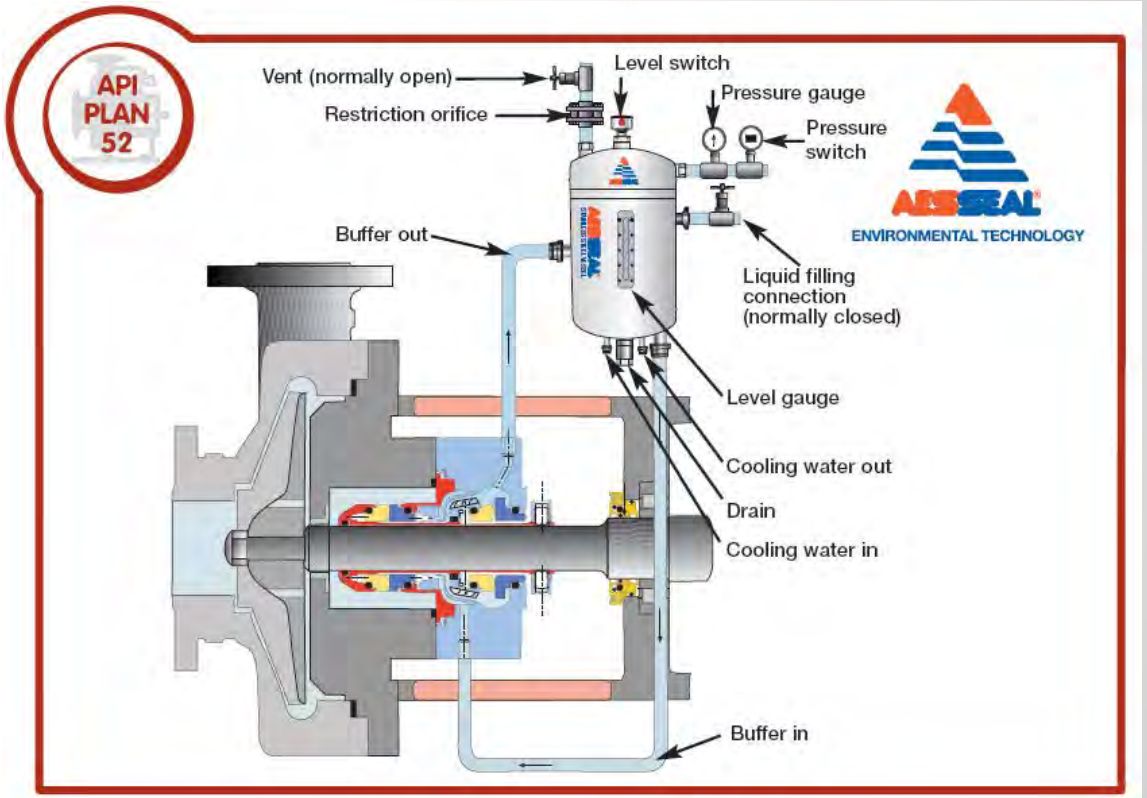
Seal Chamber Pressure



Atmospheric Pressure

API Plan 52

- Used with tandem seals
- Buffer fluid vessel
- Not Pressurized
- Prevents contamination of process fluid
- No process leakage to atmosphere
- Removes heat from seal



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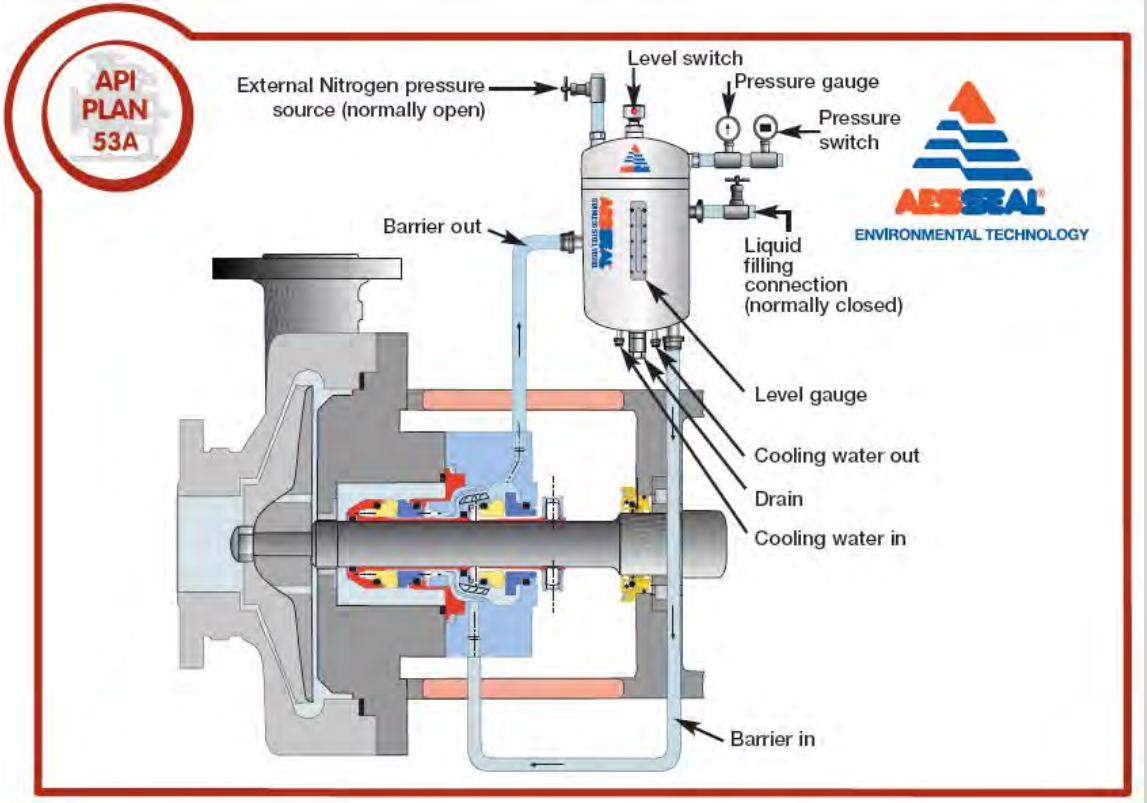
API Plan 53A

- Used with dual seals
- Barrier fluid vessel
- Pressurized 15-30 psi over seal chamber pressure
- Maintains clean, stable fluid film across both sets of seal faces
- No process leakage to atmosphere
- Removes heat from seal



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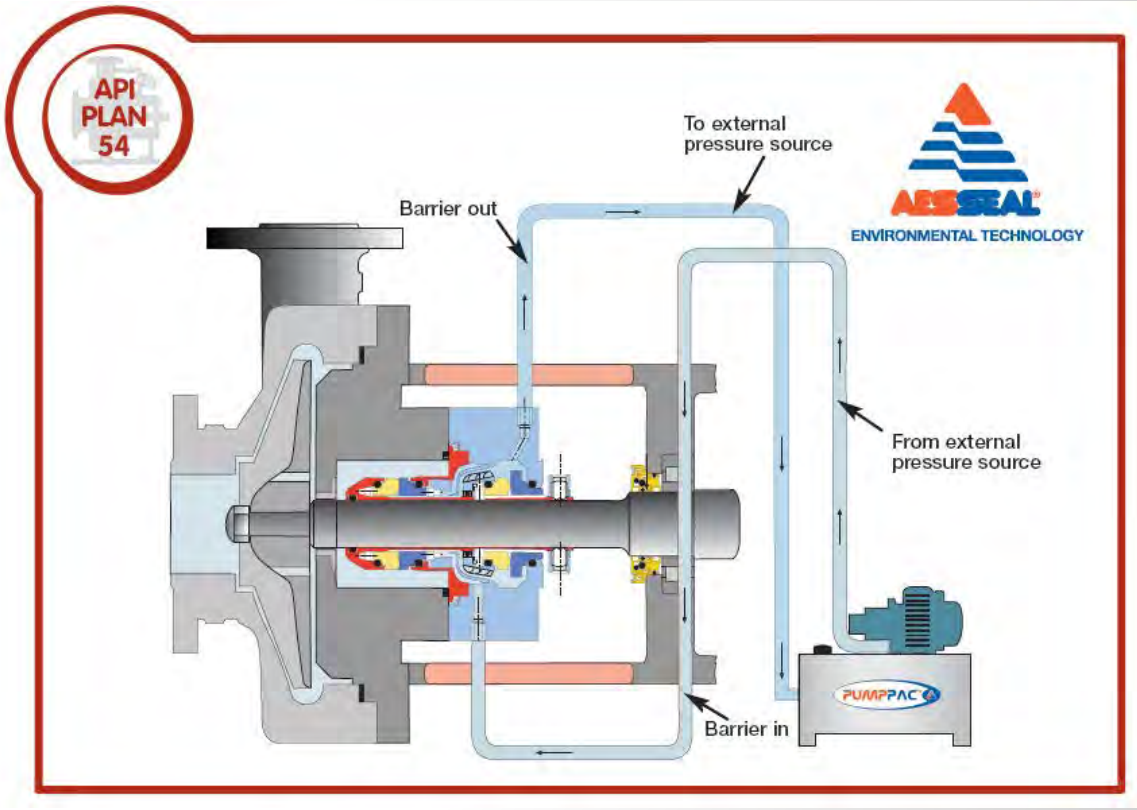
API Plan 54

- Used with dual seals
- External reservoir with pump for forced circulation of barrier fluid
- Back pressure control valve to maintain pressure15-30 psi over seal chamber pressure
- Maintains clean, stable fluid film across both sets of seal faces
- No process leakage to atmosphere
- Removes significant heat from seal

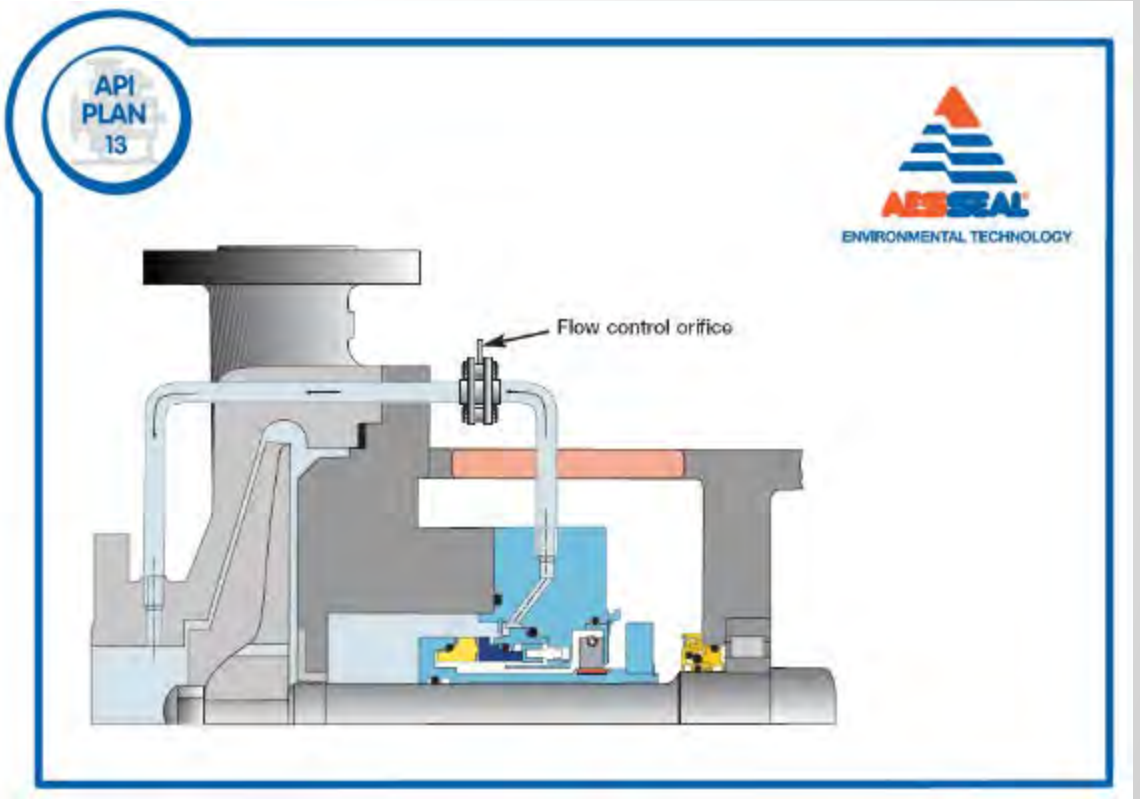


Contamination

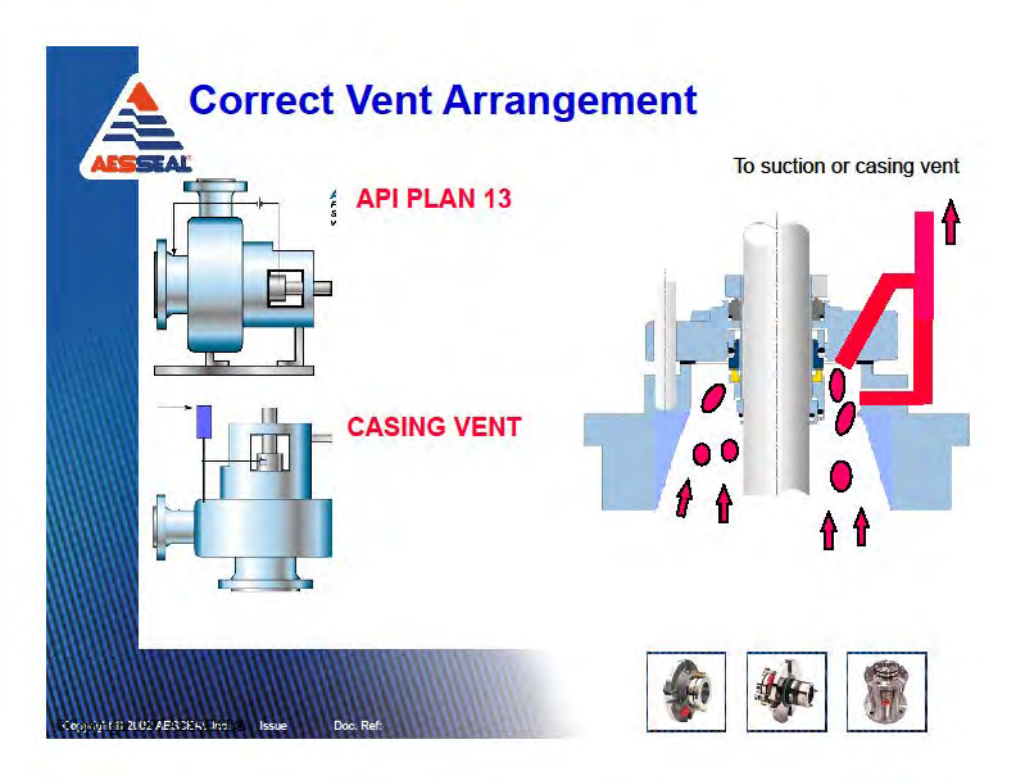
- **Proper Seal and System Selection**
  - Very Light slurries can use single seals (Plan 13 or Plan 32)
  - Hard faces are used for abrasion resistance
  - Springs can be kept out of the process fluid to prevent contamination
  - Heavier slurries use dual seals with pressurized barrier fluid support systems (Plan 53A or Plan 54)

API Plan 13

- Used with single seals
- Recirculation of light solids from sealing chamber to pump suction
- Used primarily as high point vent for vertical pumps



API Plan 13



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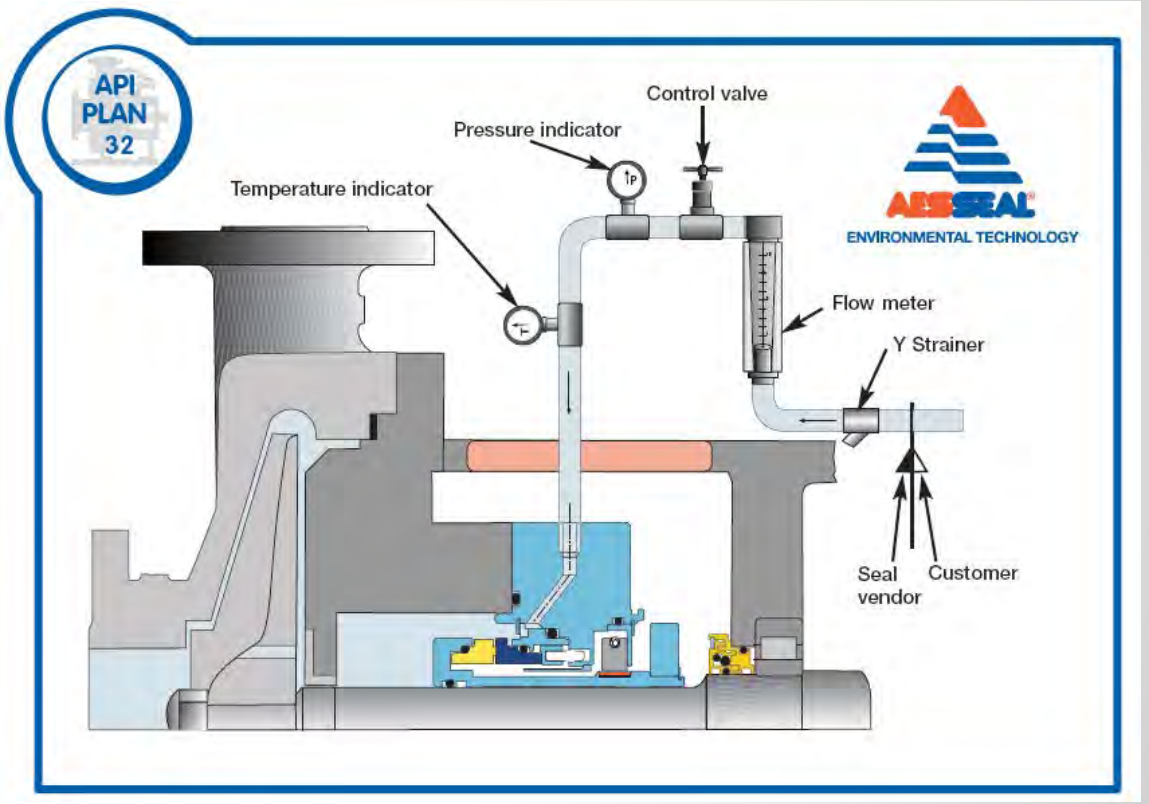
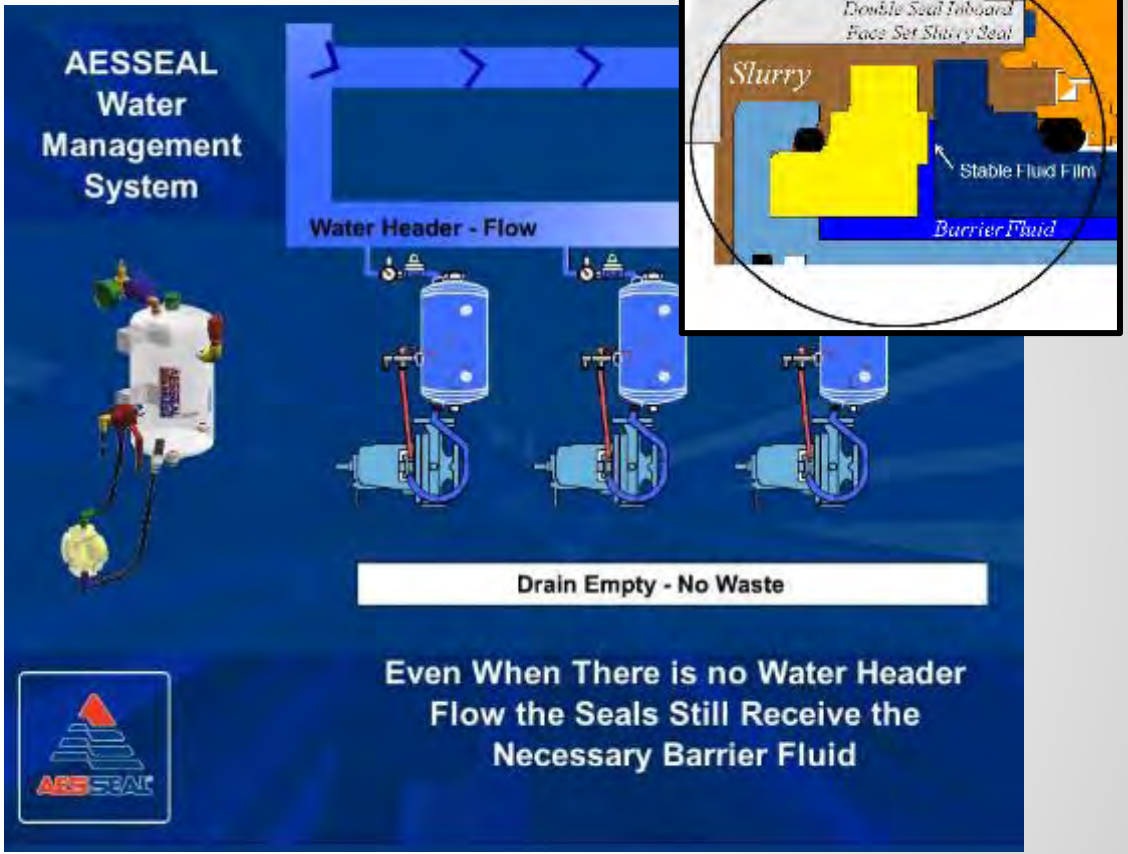
API Plan 32

- Used with single seals
- External clean water flush
- Pressurized 15-20 psi over seal chamber pressure
- Keeps fluid around seal faces clean
- Recommend throat bushing to keep water usage down
- One seal can use up to 1.3 million gallons of water a year



AESSEAL API Plan 53A

- Barrier vessel used with dual seals
- Pressurized 15-30 psi over seal chamber pressure
- Maintains clean, stable fluid film across both sets of seal faces even when water supply line pressure is reduced
- Automatically replenishes seal water
- No process leakage to atmosphere
- Eliminates 1.3 million gallons of water per pump from going down the drain



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