



# Mechanical Pressure Gauges 101

# Today's Agenda

- Importance of Mechanical Gauges
- Gauge Design & Basic Principles
- Problematic Operating Conditions & Solutions
- Industry Trends
- FAST Services
- Summary & Questions

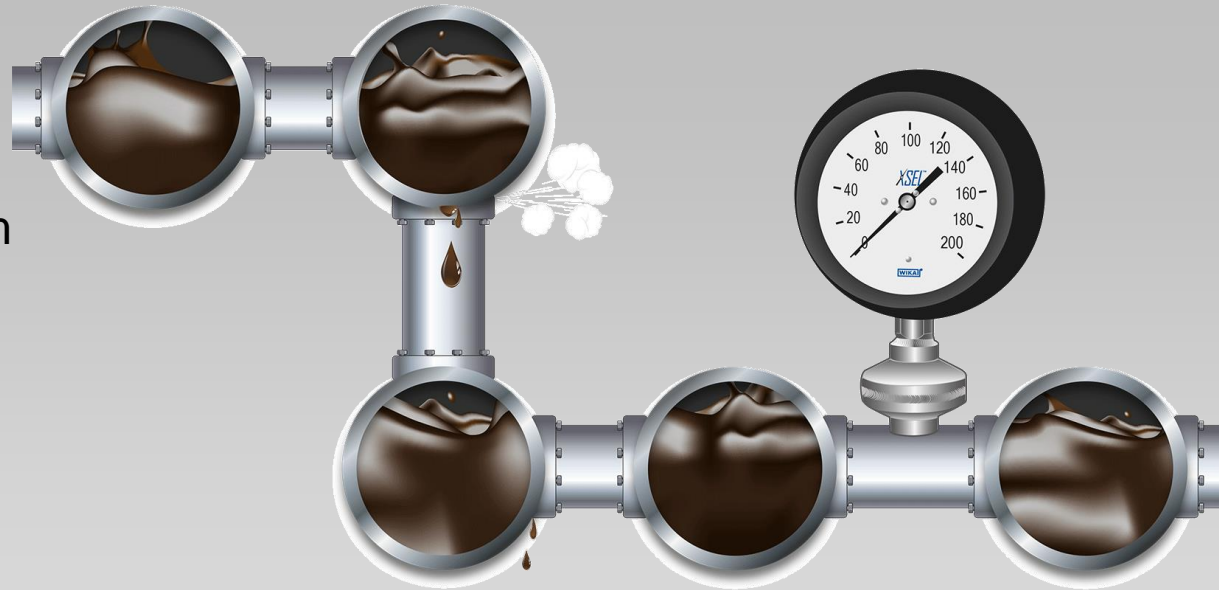
# Importance of Mechanical Gauges

Why Maintain Them?

# Importance of Mechanical Gauges

## Why Maintain Them?

- Provide a local pressure indication
- Detect signs of degradation in process performance not otherwise tracked through DCS equipment
- Identify potential loss of process or loss of containment
- Predict how long a piece of equipment can be safely and economically run
- Diagnose causes of system and production disruptions



# ***Pressure Gauges: Sole Source of Data***

- Discharge pressure
- Suction pressure
- Differential pressure
- Mechanical seal flush pressure
- Steam quench pressure





# Pressure Gauges: *Calculating Risks*

Pumps rank **1<sup>st</sup>**  
in failure incidents and  
maintenance costs. And,  
repairs account for **27%**  
of life cycle costs.

# The Pressure Gauge: *Current State*

At least **25%**  
of pressure gauges require  
immediate replacement. And,  
and additional **40%**  
need corrective action.



# Gauge Design & Basic Principles

Gauge Design Review



## Types of Gauges



Bourdon Tube  
Process Gauge



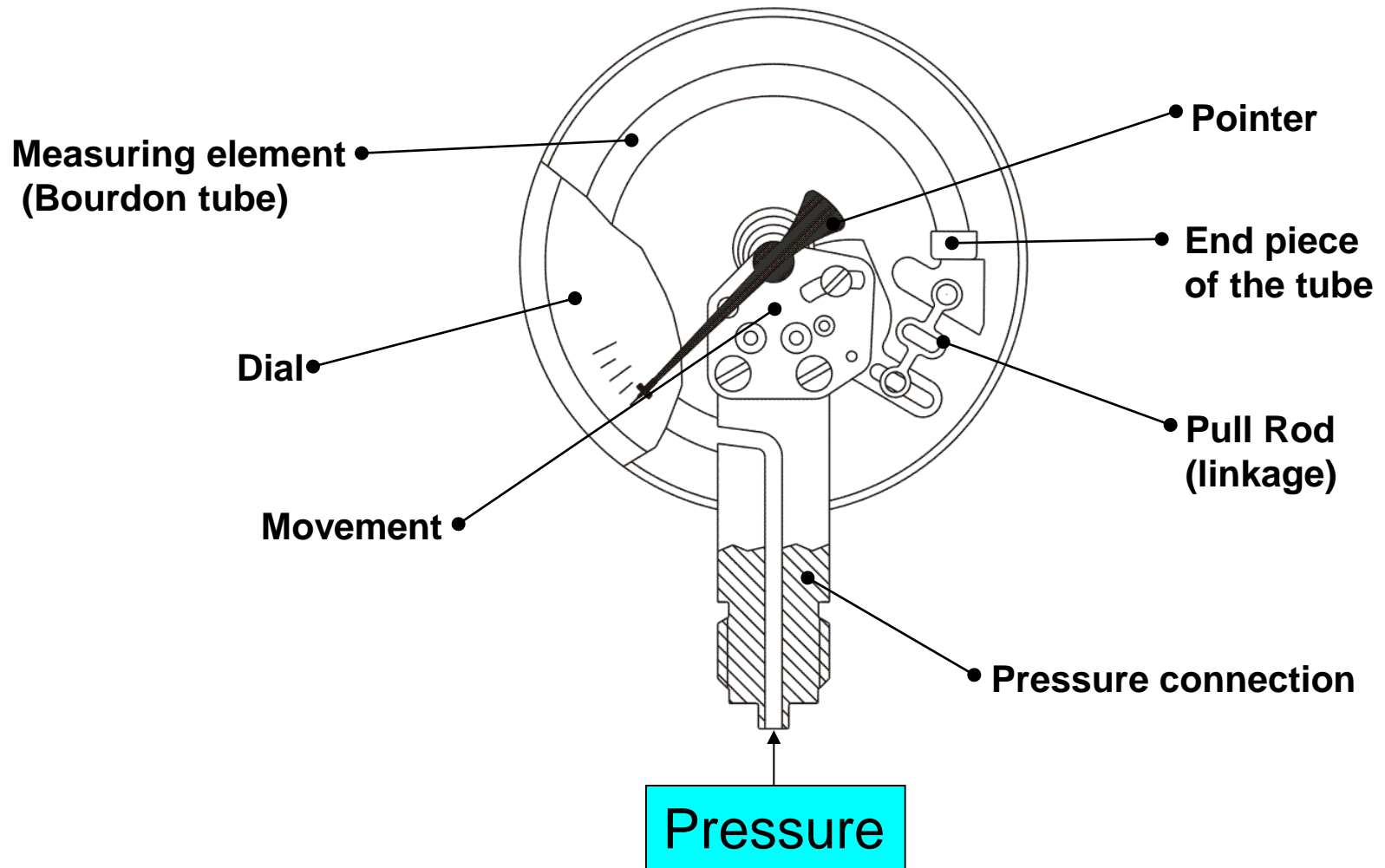
Direct Drive Process Gauge



Process Gauge with  
Diaphragm Seal



## Gauge Components



## Process Gauge

### ■ Process Gauge

- Excellent load-cycle stability and shock resistance
- Standard 0.6 mm restrictor
- NEMA 4X/IP65 weather tight case
- Standard overload stop
- Liquid fillable
- Safety case design



- Specifically designed for the chemical and petrochemical processing industries
- Suitable for corrosive environments and gaseous or liquid media that will not obstruct the pressure system

## Direct Drive Gauge

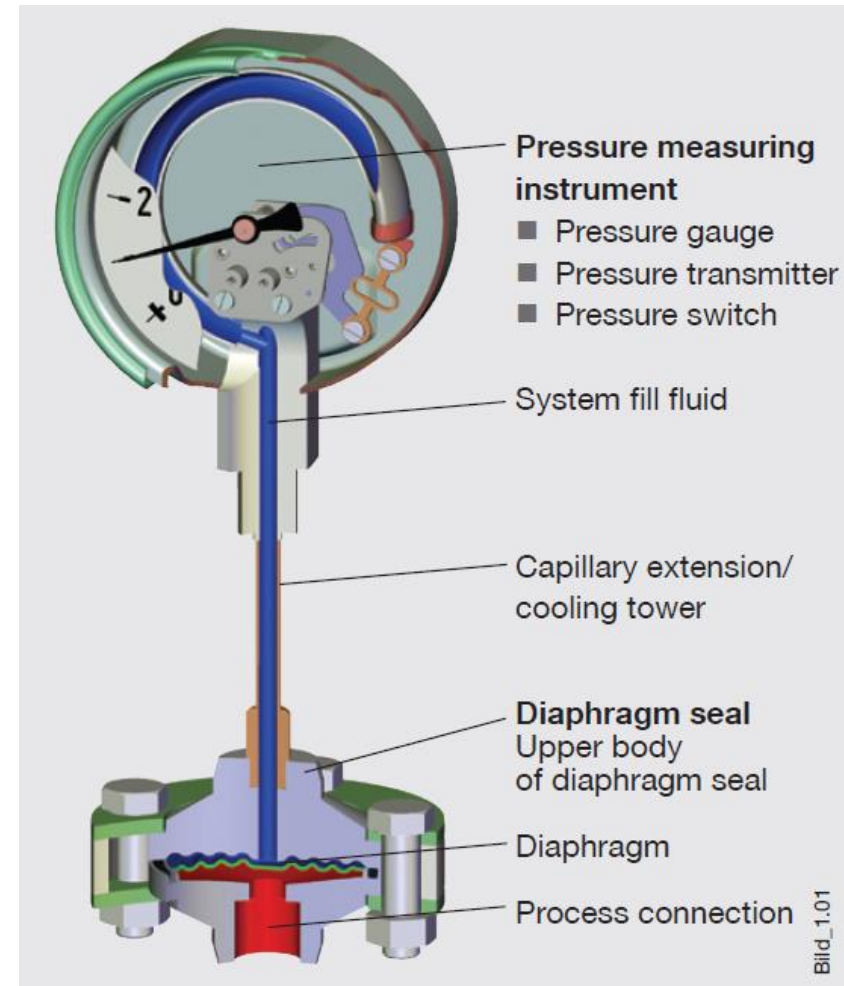
- A Direct Drive is ideal for heavy mechanical vibration
- Designed for high dynamic pulsation, vibration and shock
- Tube made of Inconel X-750 alloy, highly resistant to temperature extremes with excellent oxidation and corrosion properties
- No delicate internal movement
- No gears, linkages or springs to wear or break
- Safety case design





## Diaphragm Seal

- A diaphragm seal is ideal for severe duty applications
  - Pressure spikes
  - Pulsation
  - High temperatures
  - Corrosive media
  - Suspended solids
  - Highly viscous, crystallizing or clogging media
- Acts as a chemical barrier and/or thermal barrier



# Problematic Operating Conditions

## Gauge Failures & Solutions

## Most Common Gauge Failures

- The most common gauge failures (in order of criticality)



Spikes



Overpressure



Mechanical Vibration



Pulsation



Temperature



Corrosion

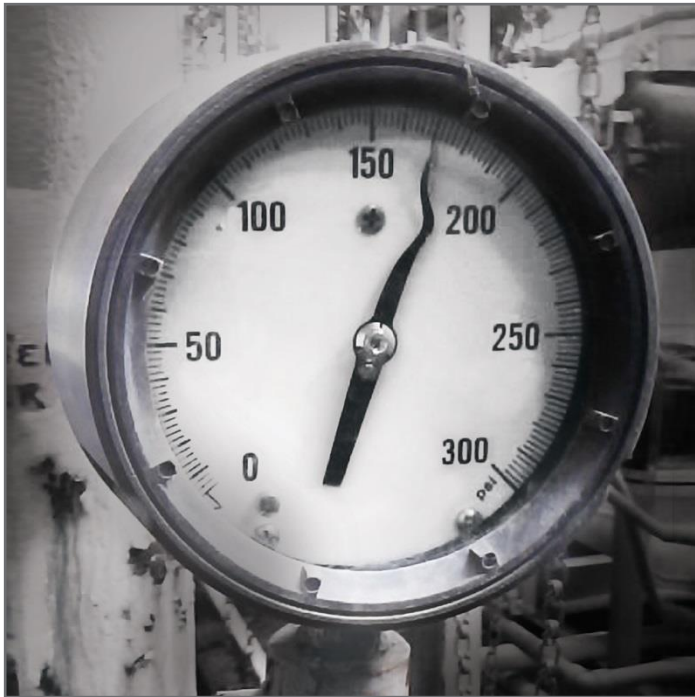


Clogging



Mishandling and  
Improper Use

## Risk: Bourdon Tube Rupture



### ■ Pressure Spikes

#### ■ Indicators

- Bent, broken, fish-hooked pointer
- Knicked pointer (hitting stop pin)

#### ■ Root Cause/Effects

- Abrupt increase/decrease in pressure
- Often caused by pump on/off or valve open/close
- Bourdon tube rupture & media release



## Risk: Bourdon Tube Rupture



### ■ Overpressure/High Pressure

#### ■ Indicators

- Operating near or past maximum pressure
- Pointer pegged against stop pin

#### ■ Root Cause/Effects

- Using incorrect pressure range
- Bourdon tube rupture & media release



Pictures from actual gauge failures

## Risk: Bourdon Tube Rupture

### ■ Solutions/Recommendations

#### ■ Investigate

- Appropriate pressure range?
- External factors?

Best Practice: 2X normal operating pressure

#### ■ Model – Process Gauge

- Overload stop standard
- Liquid case fill to reduce internal wear
- Extreme cases – Diaphragm seal with internal super restrictor (0.3 mm)

#### ■ Accessories

- Snubber
- Overpressure protector



## Risk: Bourdon Tube Fatigue

### ■ Pulsation

#### ■ Indicators

- Pointer flutter

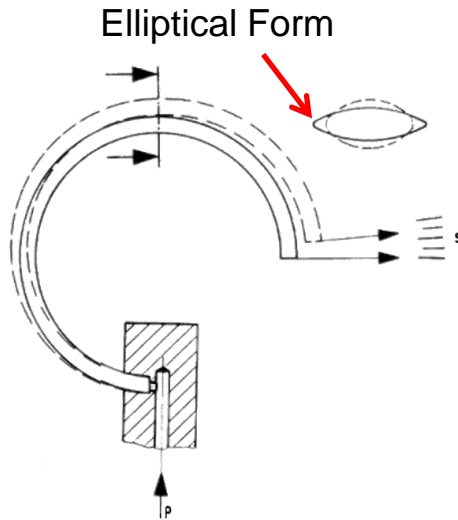
#### ■ Root Cause/Effects

- Media rapidly cycling through pressure system
- Dynamic (cyclic) loading wears movement components down



Video recorded in the field

## Risk: Bourdon Tube Fatigue

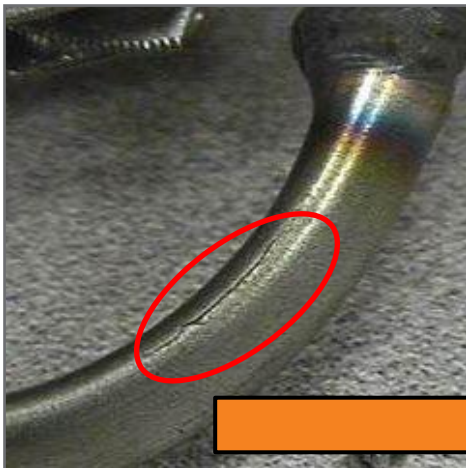


### ■ Pulsation

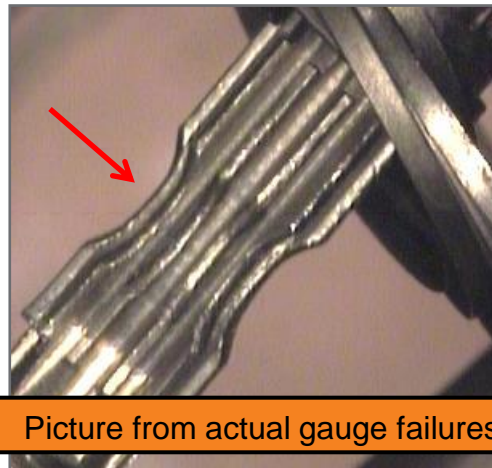
#### ■ Root Cause/Effects

- Movement no longer anchors Bourdon tube
- Thin wall of Bourdon tube fatigues and cracks
- Media release

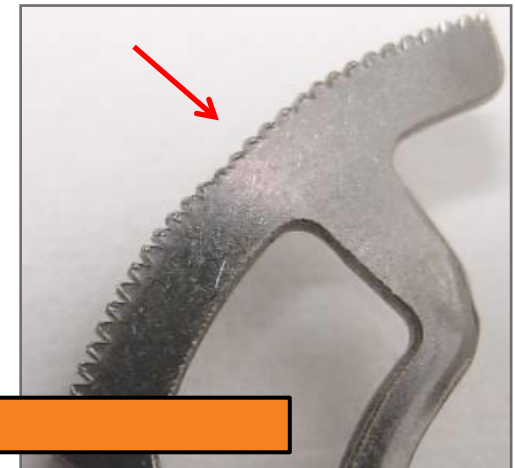
Bourdon Tube Crack



Worn Pinion Gear



Worn Segment Gear



Picture from actual gauge failures



## Risk: Bourdon Tube Fatigue



### ■ Vibration

#### ■ Indicators

- Missing pointer
- Black dust on dial
- Scrapes on dial from loose pointer
- Missing window, window ring or back plate

#### ■ Root Cause/Effects

- Misaligned pumps
- Reciprocating compressors
- Poor fixture mount

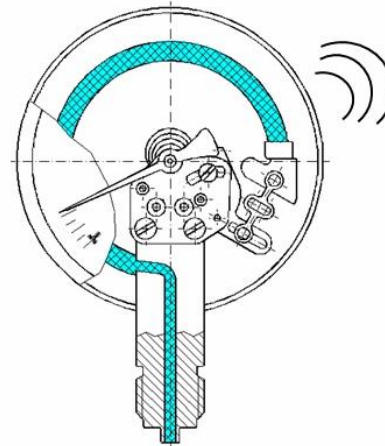
## Risk: Bourdon Tube Fatigue



### ■ Vibration

#### ■ Root Cause/Effects

- Vibration breaks movement
- Movement no longer anchors Bourdon tube
- Thin wall of Bourdon tube fatigues and cracks
- Media release



Pictures from actual gauge failures

## Risk: Bourdon Tube Fatigue

### ■ Solutions/Recommendations

#### ■ Investigate

- Determine root cause of vibration
- Other equipment in disrepair?

#### ■ Model – Process Gauge

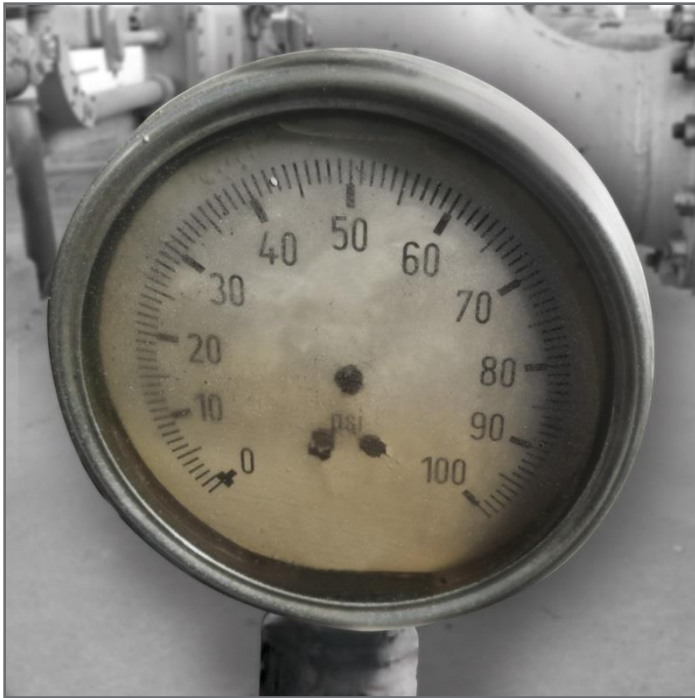
- Liquid case fill
  - Reduce internal wear
  - Lubricates and cools moving parts
  - Dampens the effects of vibration
- Extreme cases of pulsation: Snubber or diaphragm seal with internal restrictor

#### ■ Model – Direct Drive Gauge

- Made to withstand significant shock
- No internal movement
  - Direct connection between pressure system and pointer



## Risk: Material Deterioration



### ■ Corrosion (Ambient)

#### ■ Indicators

- Corroded dial or pointer
- Build-up in case
- Fogged window
- Discolored liquid case fill

#### ■ Root Cause/Effects

- Contaminants getting inside the case
- Missing fill plug
- Cracked case or window
- Corrosion of the Bourdon tube - media release



## Risk: Material Deterioration



### ■ Temperature (Media & Ambient)

#### ■ Indicators

- Breakdown of gauge components (window, dial and associated elastomers)
- Discolored dial or liquid case fill

#### ■ Root Cause/Effects

- Incorrect mounting
- Incorrect accessories
- Elevated temperature stresses the pressure system
- Media release

## Risk: Material Deterioration

### ■ Solutions/Recommendations

#### ■ Investigate

- Determine cause of ambient corrosion or source of high temperature

#### ■ Model – Process Gauge

- Hermetically sealed pressure gauge (weather protection IP65/NEMA 4X)
- Liquid case fill
  - Insulates and protects internal components
  - Extreme cases – Diaphragm seal for media temperatures over 212°F

#### ■ Accessories

- Mini-siphon



## Risk: Loss of Functionality



### ■ Clogging

#### ■ Indicators

- Gauge shows no pressure when system is operating

#### ■ Root Cause/Effects

- Media that is highly viscous, crystallizing, hardens, or contains particles or solids that can clog the socket orifice
- Inoperable gauge
- Shows no pressure

## Risk: Loss of Functionality



### ■ General Maintenance/Mishandling & Abuse

#### ■ Indicators

- Cracked, broken or missing windows
- Leaking case fill
- Missing back plates or fill plugs

#### ■ Root Cause/Effects

- Old or neglected gauges
- Accelerated degradation and corrosion of the internal components

## Risk: Loss of Functionality

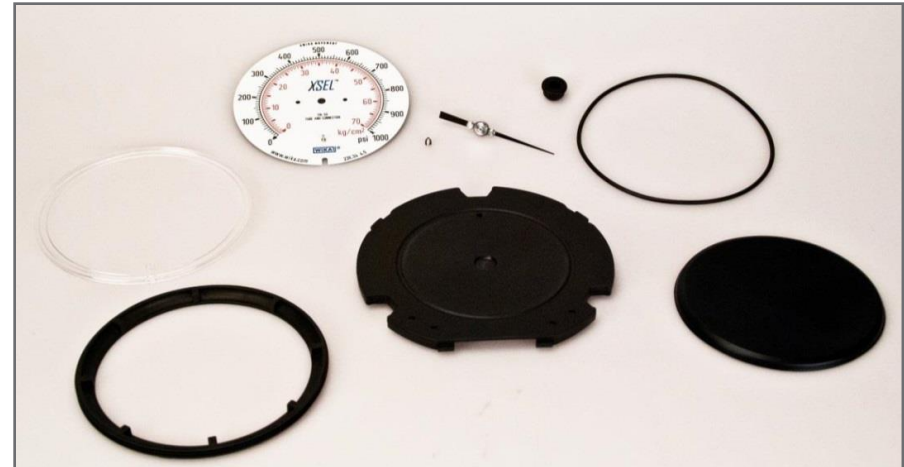
### ■ Solutions/Recommendations

#### ■ Investigate

- Implement maintenance plan
  - Inspect gauges on a routine basis
- Determine if gauge should be on diaphragm seal to address clogging

#### ■ Model – Process Gauge

- Designed to be easily serviced in the field
- Various spare parts available to address minor issues





## Accessories

### ■ SS Gauge Tags

- Mark each gauge with a stock number
- Ensures correct gauge replacement



### ■ Mini-Siphon

- Water hammer (pressure spike) & high temperature (media)
- Small form factor reduces gauge whip



### ■ Over-Pressure Protector

### ■ Snubber



### ■ Individual Gauge Components





# Industry Trends

Current state & Path Forward

## Complexity of Configurations

- Plants have unnecessary complexity from proliferation of configurations
  - Simplify configurations to reduce guesswork for operators and installers
    - Manufacturer, gauge type and model, pressure range, wetted materials, etc.
  - Develop an effective storeroom inventory that will:
    - Maximize field coverage
    - Minimize complexity of configurations
    - Eliminate redundant, obsolete or wasted inventory

75%

Average Reduction in Unique Gauge Configurations\*

Eliminate Duplicate Configurations

Reduce Make/Model Complexity

Standardize on Common Pressure Ranges

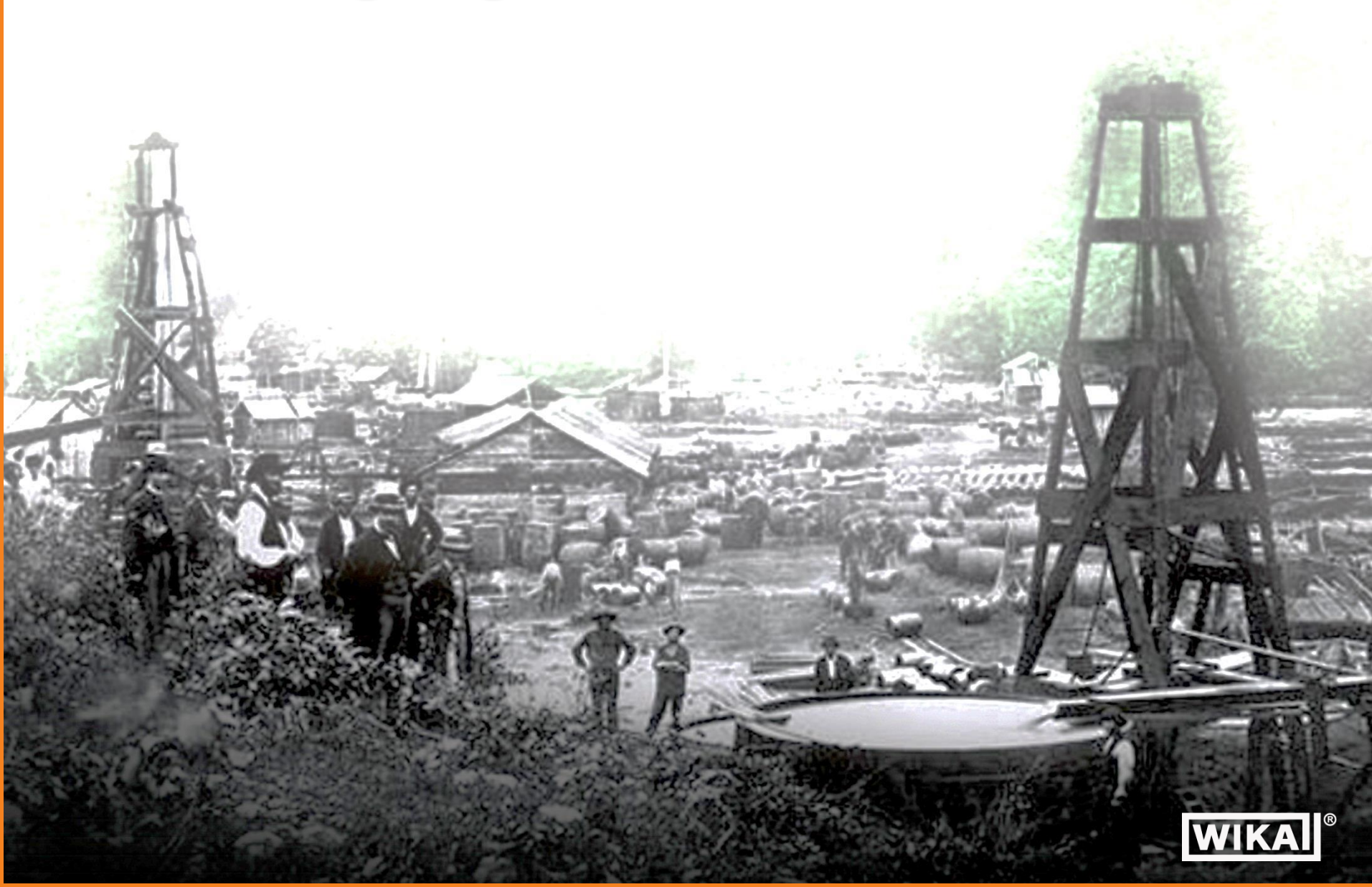
\* Averages from WIKAL FAST Instrument Audits

# How did we get here?

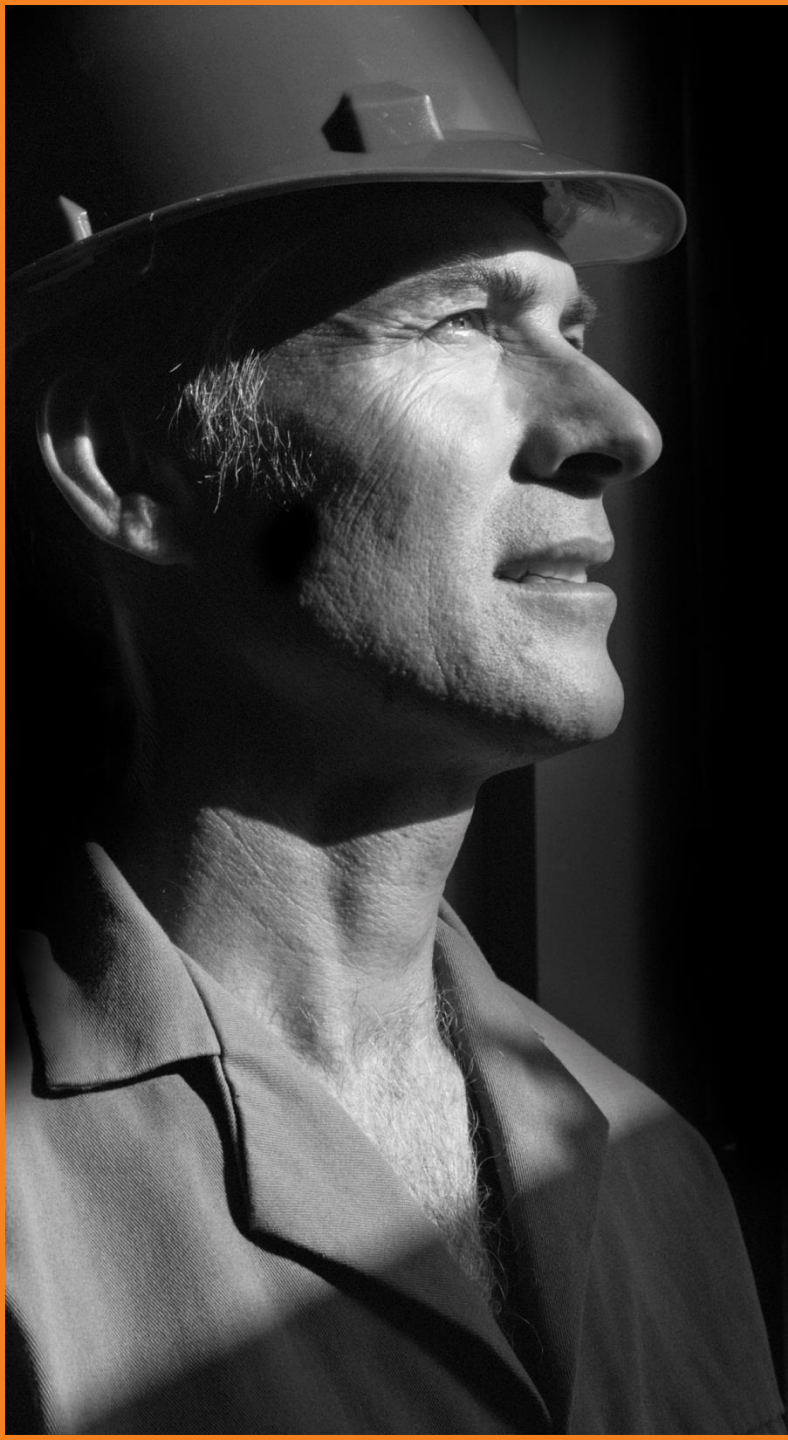




# Aging Infrastructure







More than **40%** of all  
oil and gas professionals  
will retire in the next  
**10 years.**



*Source: Cambridge Energy Research Associates*

## AGING INFRASTRUCTURE

Missing documentation  
Processes change, specs outdated



## RETIRING EXPERTS “BRAIN DRAIN”

Doing more with  
less experience



## UNDER INVESTMENT

Don't know what is failing  
or what to do about it



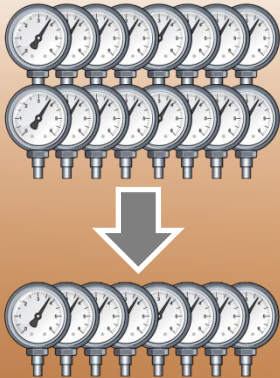
# Improving Reliability & Total Operating Costs

## OBJECTIVE

Reduce complexity and standardize

## RESULT

Eliminate misapplications and repeat failures



## OBJECTIVE

Specify correct configurations for process conditions

## RESULT

Improve reliability with configurations that can handle operating conditions



## OBJECTIVE

Prevent expensive, essential equipment failure

## RESULT

Provide functional gauges for trouble-shooting, PdM capabilities



# FAST Services

Offerings & Benefits



# FAST<sup>SM</sup> Services

**Instrument  
Audit**

**Turnaround  
Instrument  
Planning**

**Instrument  
Failure  
Analysis**

**Instrument  
Safety  
Training**



# *Questions*

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**FAST**

FULL AUDIT SERVICE TEAM

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