GAS COMPRESSOR ASSOCIATION

Tech Updates

Presented by GCA Expo Exhibitors

March 21, 2018

GAS COMPRESSOR ASSOCIATION

Tech Updates

8 Presentations

Quick Overviews – 8 min. each

Please hold questions & visit with them at their booths this afternoon

GAS COMPRESSOR ASSOCIATION

Product Presentation	Presented By
The Evolution of Air Cooled Heat Exchangers	Alfa Laval ACE -*Chris Jungers*
Small Horsepower Gas Compressor Heaters	Hotstart -*Pat Norwood*
Dynamic Variable Orifice for Adjustable Pulsation Dampening and System Blow-Down Rate Control	ACI Services -*Roy Houston*
Dresser-Rand HSRC Product Improvements	Siemens -*Nancy Cortez, Marco Lugo*
Next-Generation Safety Shutdown and Control System for Gas Compression Packages and Other Critical Equipment	Altronic -*David Bell*
In-Field Diagnostic Capabilities of the EICS Control System	FW Murphy -*Chad Stovell*
Next Generation mCore® SDR Platform for Remote Monitoring, Telematics Applications & Edge Analytics	Monico -*Doyle Taylor, Chad Brahler*
Remote Monitoring: Measure, Analyze, Predict	WellCaddie -*Thompson Speir*

Technical Update: The Evolution of Air Cooled Heat Exchangers

How disruptive technology is innovating one of the industry's most mature products

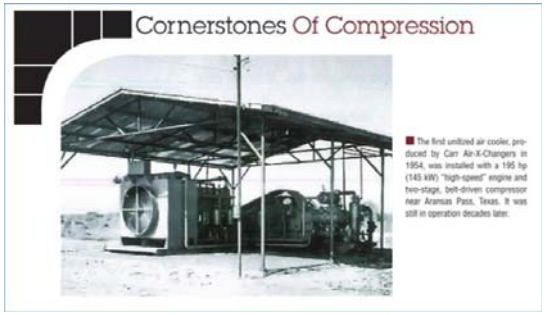
March 21, 2018

Chris Jungers
GM, Alfa Laval ACE

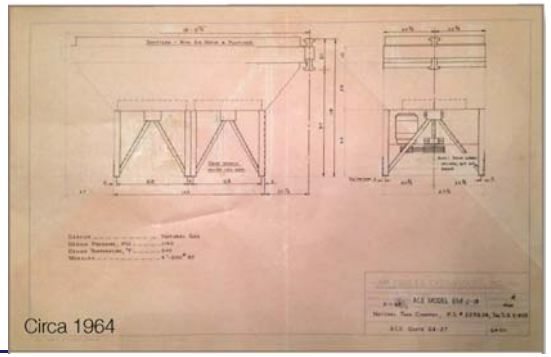
Technical Update: Air Cooler Evolution

- Yesterday to Today: First the history of North American air cooler companies

* Air cooler history by decade:
  - **Begin -** 1950s was the unofficial start of air cooler manufacturing in the USA,
  - **Boom -** By mid-1960s air cooler technology was firmly established and fostered an explosion of new suppliers,
  - **Protect -** Patents then became common in the 1970s due to competition from 1960s boom,
  - **Pause -** The 1980s oil and gas recession essentially stopped all growth and development,
  - **Reduce -** COGS reduction then became the focus in 1990s to early 2000s,
  - **Rules -** Lastly, regulatory guidelines engulfed manufacturers from the mid-2000s to mid-2010s



CompressorTech2, November 2016 issue



1964 ACE Air Cooler Drawing

Technical Update: Air Cooler Evolution

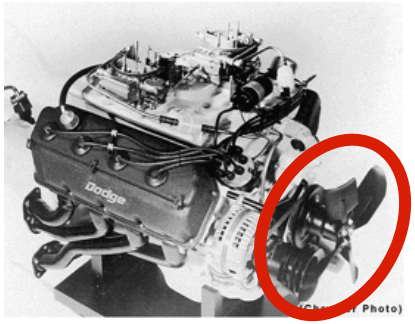
- Today: The air cooler business environment

- Air Cooled Exchanger Manufacturers
  - Private owners, private equity entities, and publicly traded organizations each have distinctly unique approach to business
- Packagers
  - Like air cooler manufacturers, packagers are cautious about adding costs but need to differentiate their products from the competition and be flexible for modern well production
- End Users
  - Demanding new equipment to be more flexible for changing operating conditions and be more self-sufficient
- People
  - Millennials, now the largest part of the workforce, think differently and don't accept status quo

Technical Update: Air Cooler Evolution

- Today: Air cooler challenges

* Overcooling
  - **The single largest challenge with an air cooler!**
  - Air coolers, in general, operate in an overdesigned condition 95-99% of the year
  - Excessive fluid cooling causes
    - Unnecessary liquid fallout
    - Field shutdowns
    - Unnecessary noise
* Antiquity
  - Minimal development over the last 40 years has led to a perception of:
    - Dead technology – even the DOE forgot about them!
    - Air coolers are an essential but basic commodity



www.alfalaval.com

Technical Update: Air Cooler Evolution

- So **WHY** is an air cooler company giving a technical update?

Simply put, the status quo has been disrupted.

More specifically, today's business environment has enabled **disruptive technology** to finally and measurably advance portions of the air cooler industry.

Disruptive Technology is generally defined as an innovation, typically from another industry (*source*), that displaces existing and established technology within another industry (*application*).

Technical Update: Air Cooler Evolution

- Disruptive Technology - Source: Example courtesy of ExxonMobil (EM)

* **Problem**
  - Pumps moving refinery tar frequently ran dry causing repeated pump failures (12-20 times/year)
  - Existing VFD solutions on other equipment were not reliable enough for this installation
* **Solution**
  - Needed to slow the pump speed down to prevent the pump from running dry
  - EM installed a variable speed MagnaDrive solution
* **Results**
  - EM has operated the tar pump with no problems whatsoever since installation
  - The pump has not been replaced since the MagnaDrive installation (versus the previous 12-20 times/year)
  - EM estimates they save $15,000/year in energy savings

Picture courtesy of ExxonMobil in Baton Rouge, LA and MagnaDrive ASD solution

Technical Update: Air Cooler Evolution

- Disruptive Technology - Application

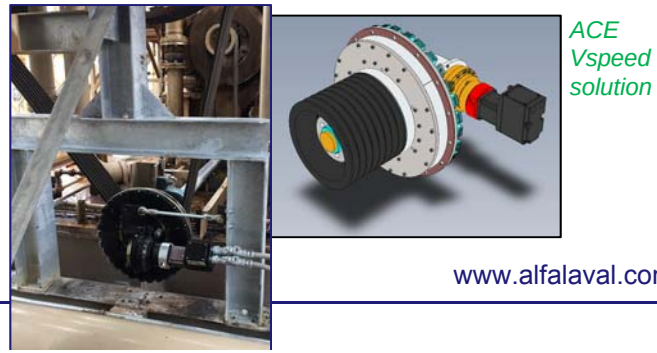
✱ Problem

- Gas compression coolers are constantly overcooling the gas, causing gas to condense at a rate which overwhelms the separators and controls, ultimately causing shutdown
- When units shut down production is lost and an operator must go to site to restart the equipment

✱ Solution

- Reduce excess cooling by slowing the fans / airflow down to what's needed at any given moment
- The Customer installed an explosion proof, magnetically variable speed solution called the ACE Vspeed

Confidential Customer, somewhere in West Texas



ACE Vspeed solution

Technical Update: Air Cooler Evolution

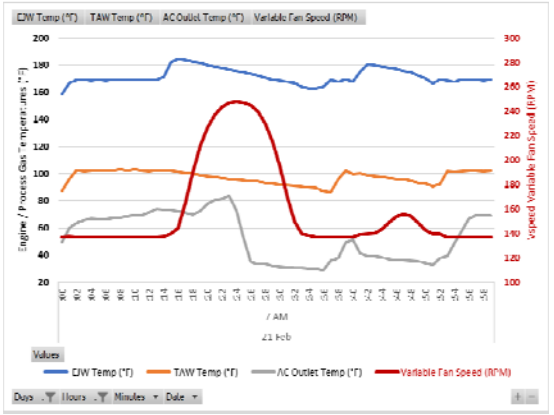
- Disruptive Technology - Application

✱ Results (at site)

- To date, fans typically spinning at ~50% of full design speed
- Fan speed, represented by the red line, only increases when process conditions require:
  - Example when EJW, TAW, AC temperatures exceed their set points
- Vibration and liquid fallout have all been reduced
- Reduction in parasitic horsepower have reduced engine's gas consumption
- ACE Vspeed monitors and quickly adapts to constantly changing engine, compressor and environmental conditions

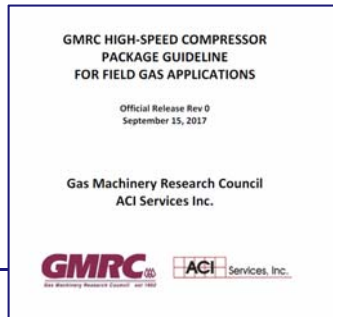
✱ Results (in industry)

- Magnetic variable speed technology has fully been adopted within industry's most recent specification from GMRC



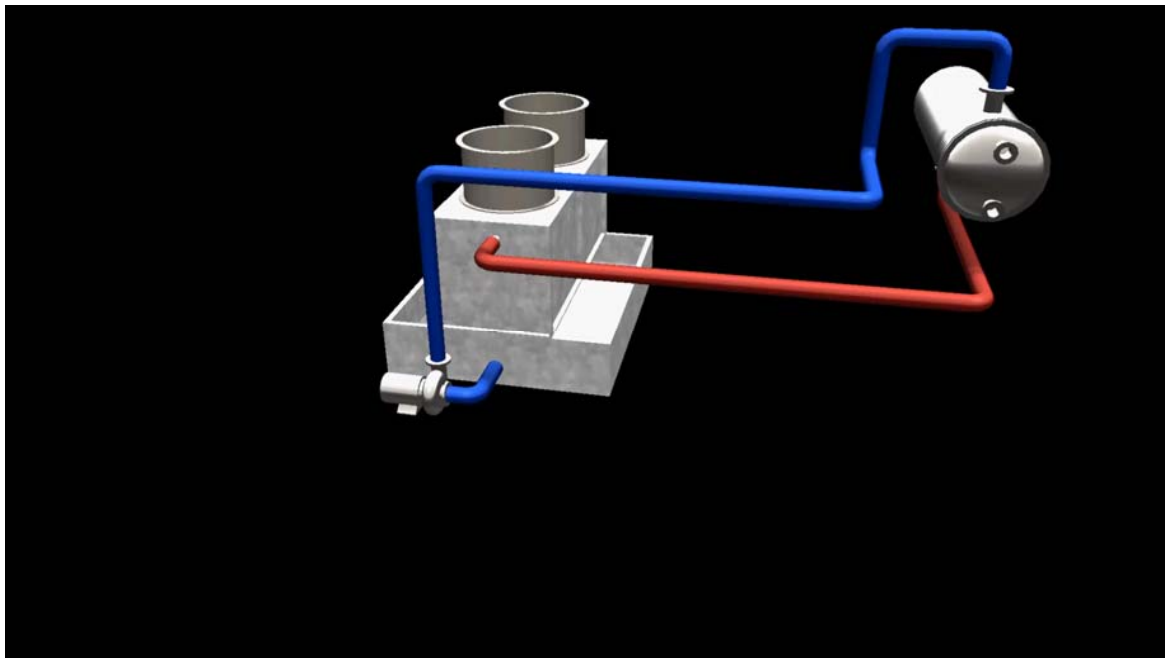
Actual site data from February 21, 2018

GMRC Compressor Package Guideline, dated Sept 15, 2017



Technical Update: Air Cooler Evolution

- Disruptive Technology – What else is happening?



- **Hybridization**
  - Air cooler technology combining with other technology to form newer types of heat exchangers
  - Resulting solutions are:
    - More efficient
    - Significantly reduce end user costs (capex and opex)
      - Plot space
      - Civil costs
      - Electrical costs
    - Greater process control

Thank You

Want to know more?

Stop by our booth or contact us:

Alfa Laval Inc., Air Cooled Exchangers (ACE)

Phone: +1 918-251-7477

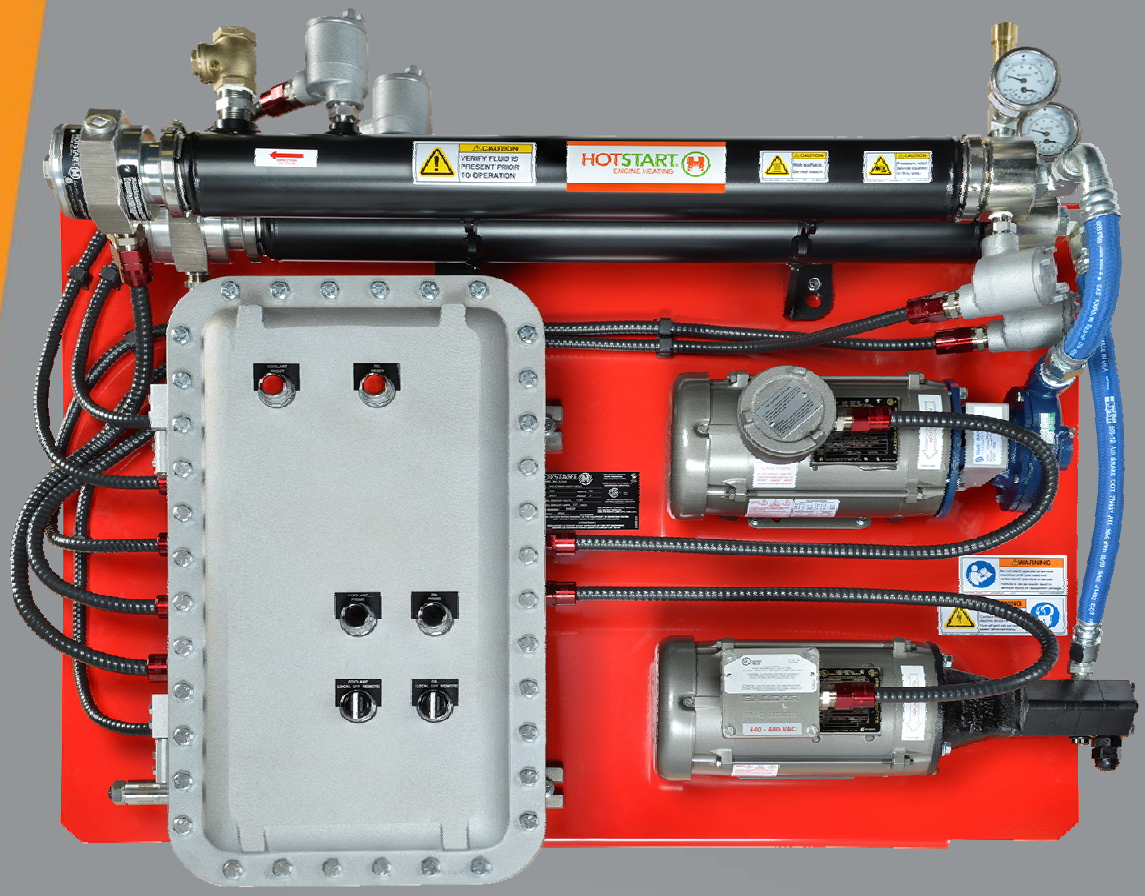
General questions / new equipment: ace.sales@alfalaval.com
Field service / parts: ace.partsorders@alfalaval.com
Company websites: www.aircooledexchangers.com
www.alfalaval.us


ALFA
LAVAL

HOTSTART®

HOTSTART Product Innovation

Small Horsepower Gas Compressor Heaters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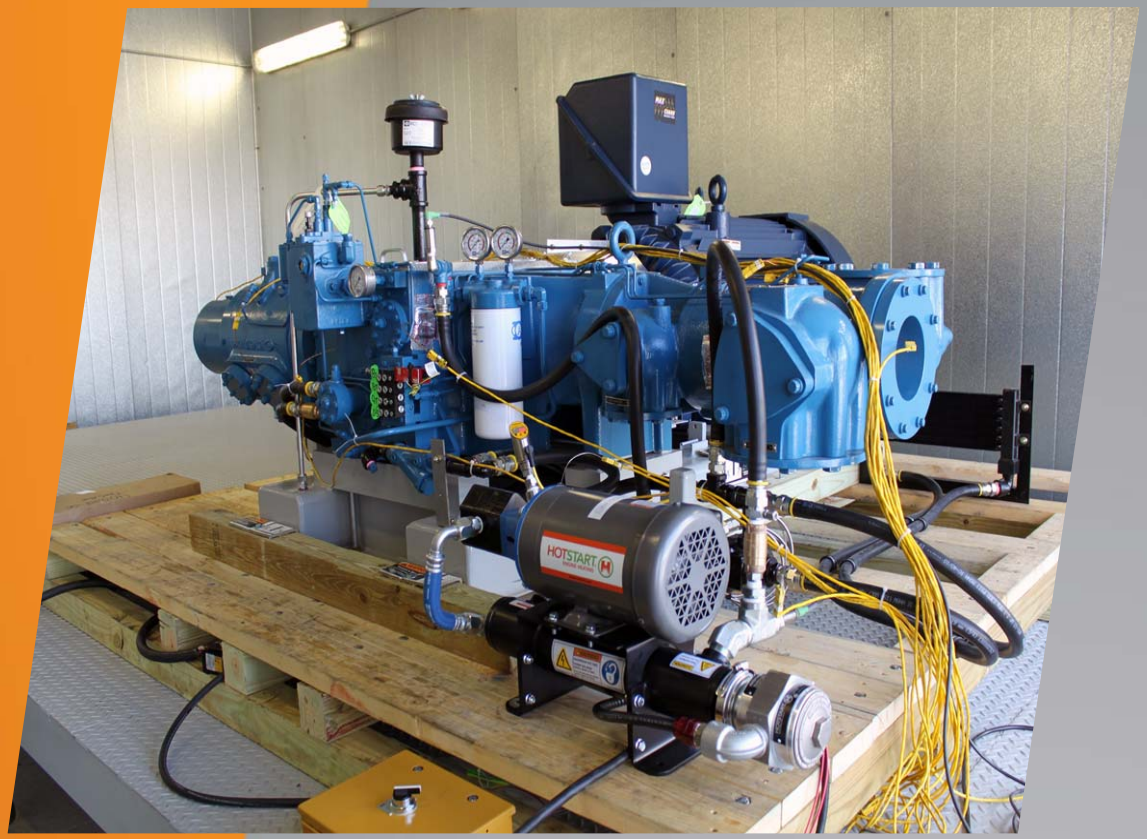
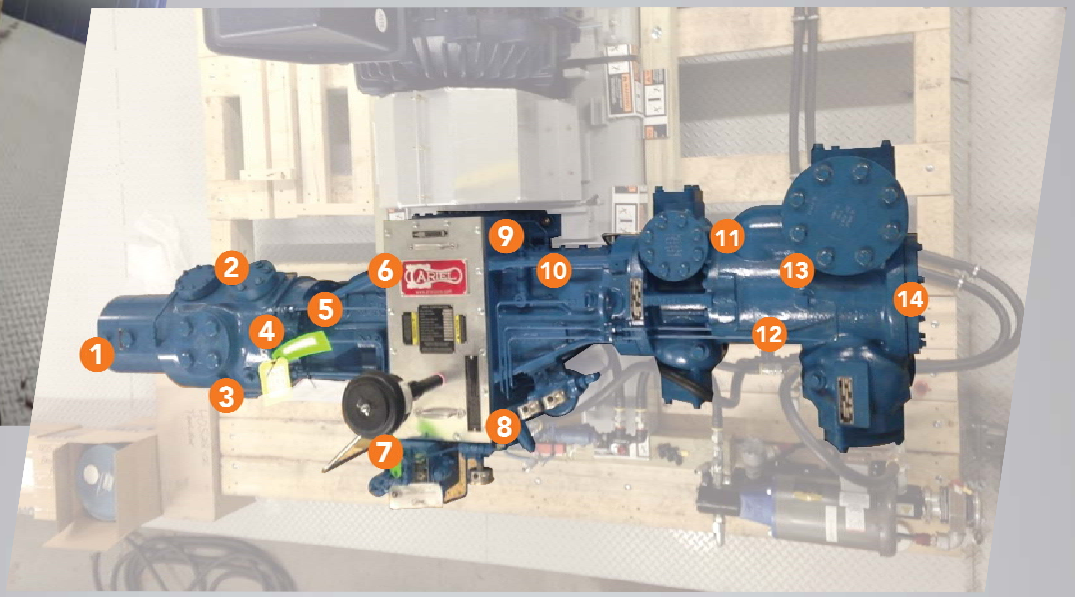
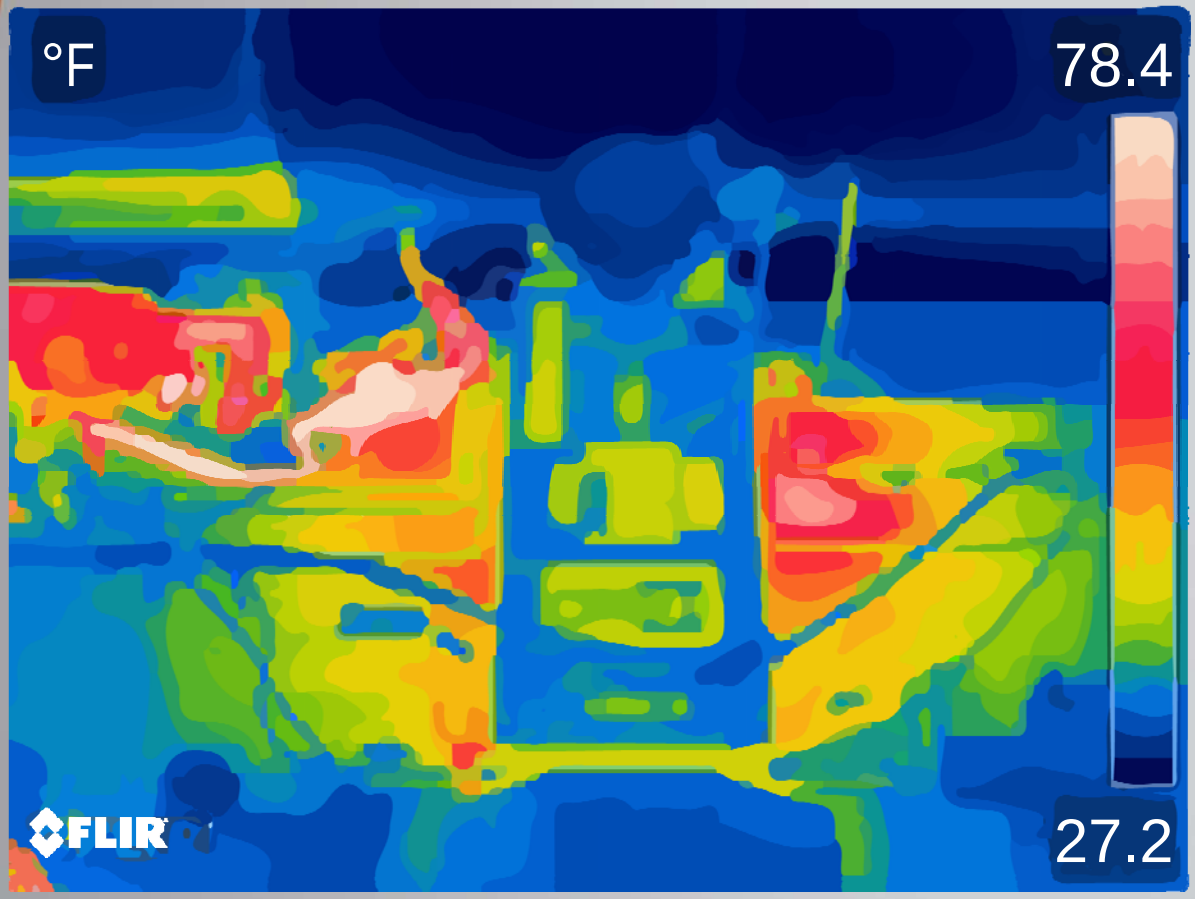
VERIFY FLUID IS
PRESENT PRIOR
TO OPERATION
HOTSTART
ENGINE HEATING
WARNING



Ariel JPG/2 Cold Room Testing

Overhead view of Thermocouple testing placement

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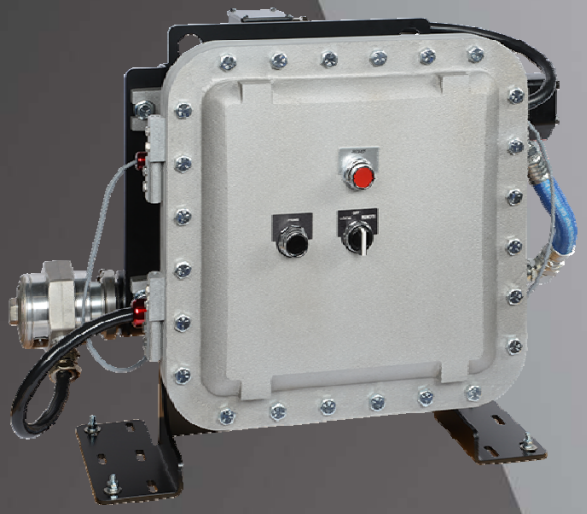
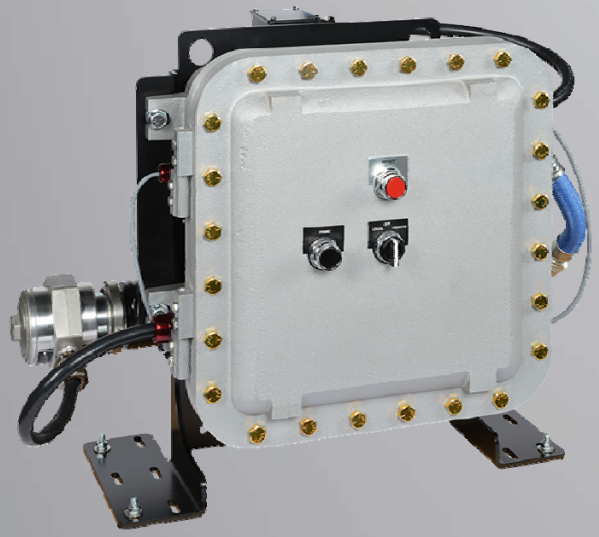
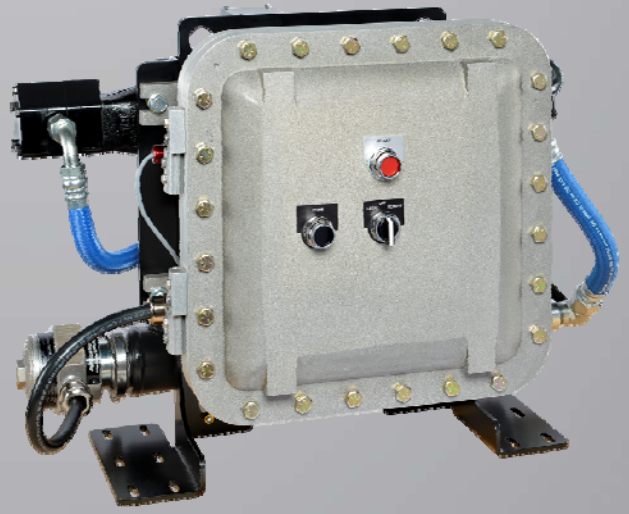
78.4
27.2
FLIR



OSE Oil Heating
1.5-4 kW

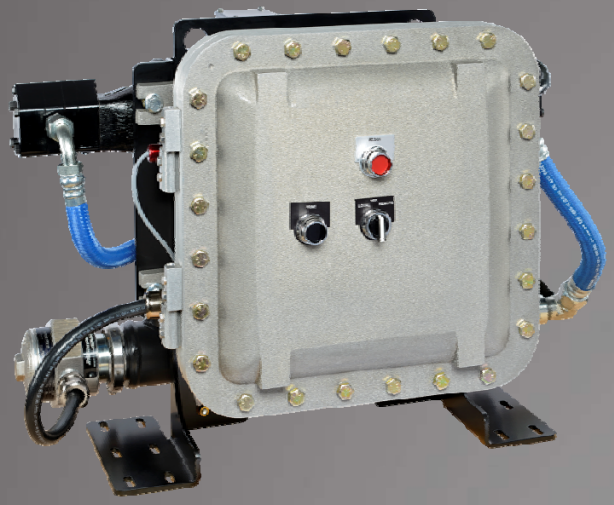


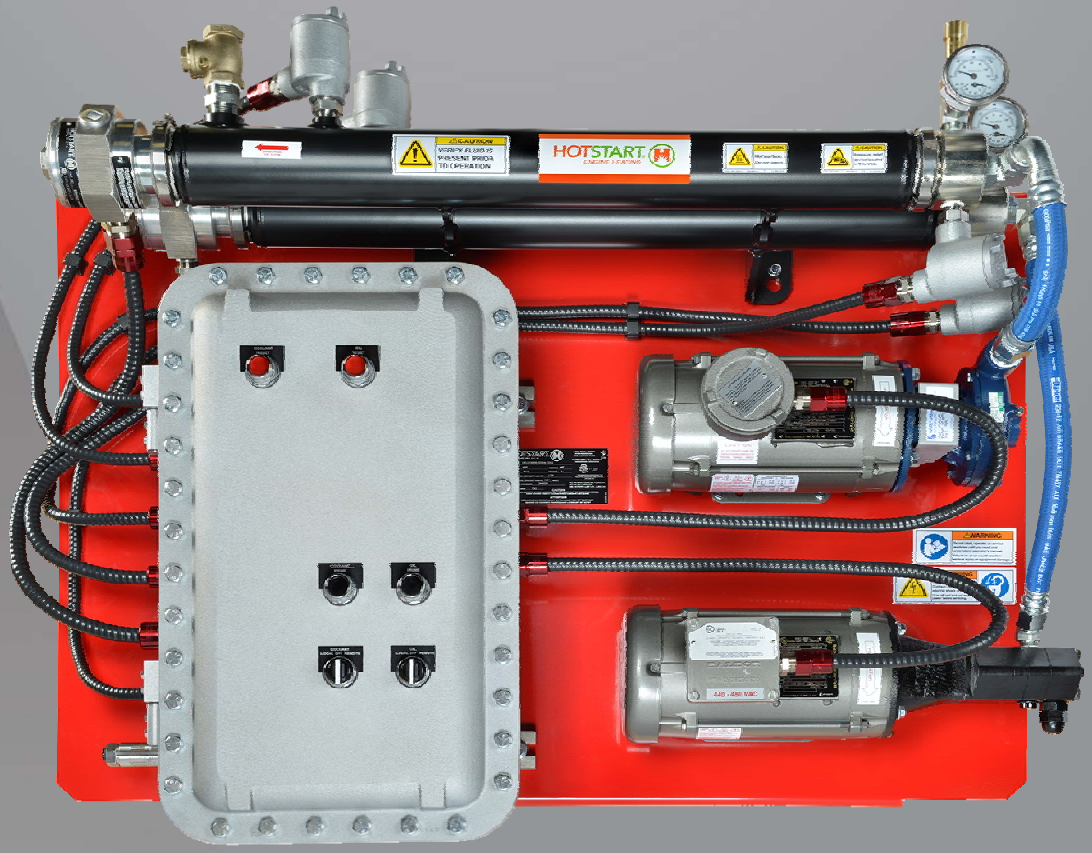
CSE Coolant Heating
3-12 kW

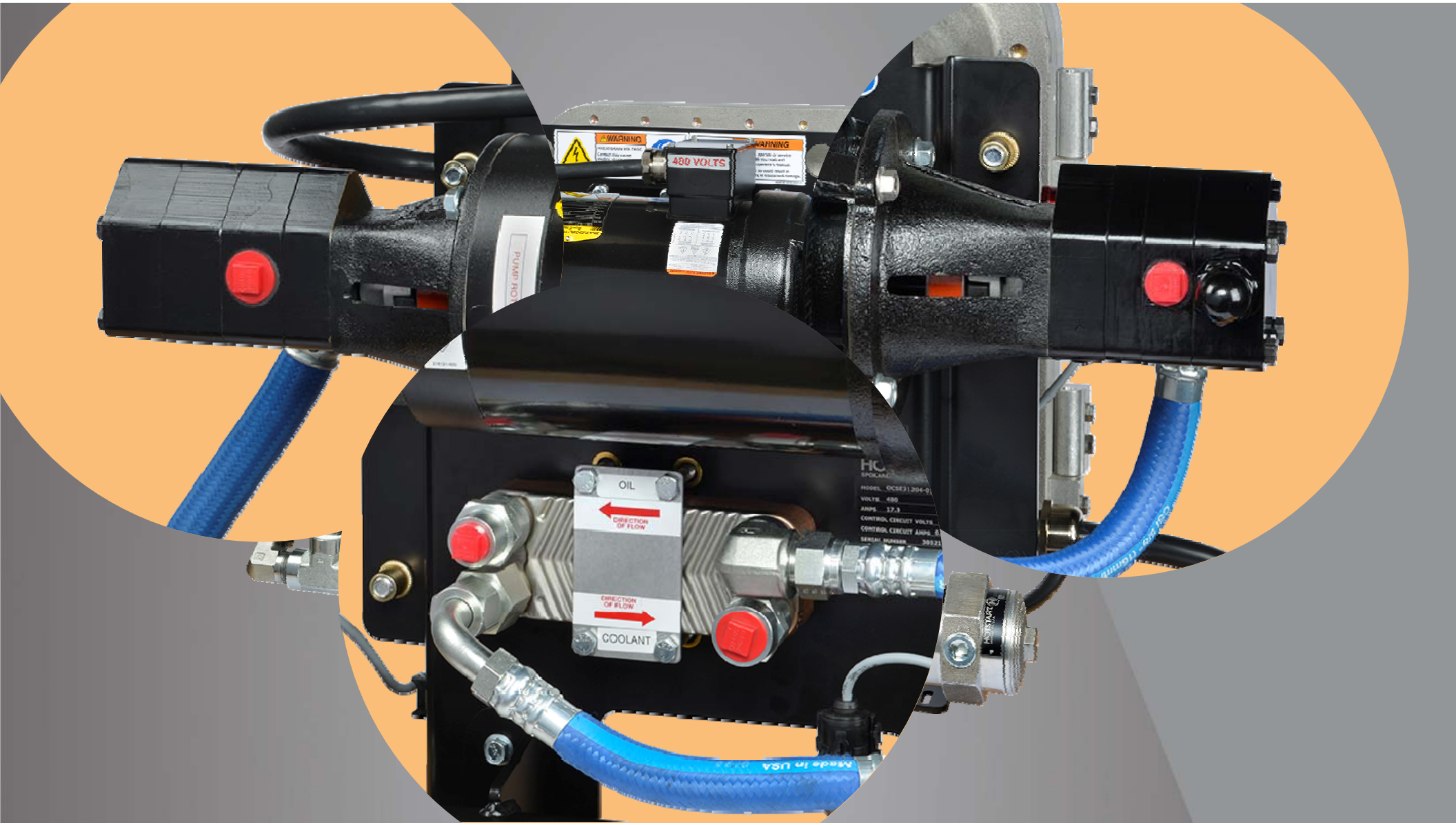


OCSE Oil/Coolant Heating
6-12 kW

35% smaller






WARNING
480 VOLTS
OIL
DIRECTION OF FLOW
DIRECTION OF FLOW
COOLANT
Made in USA

Thank You

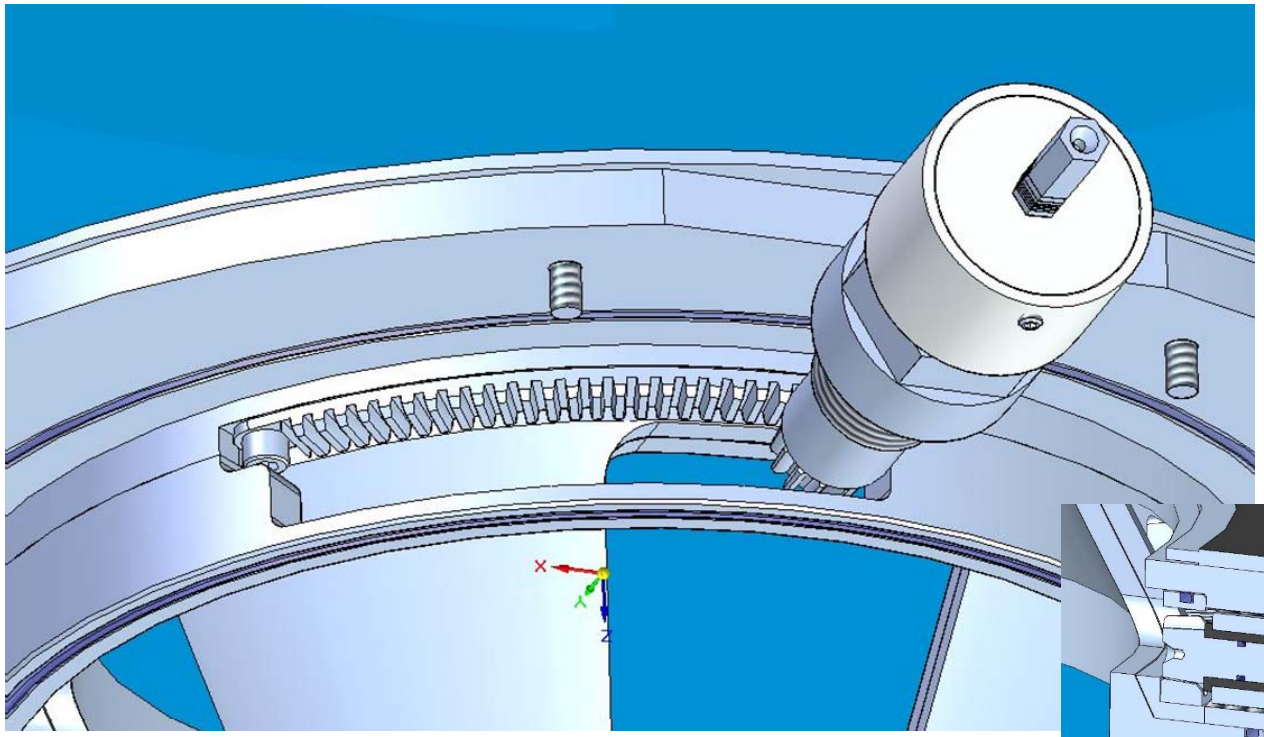
Pat Norwood
Sales Director – Oil & Gas
pnorwood@hotstart.com
281.600.3713

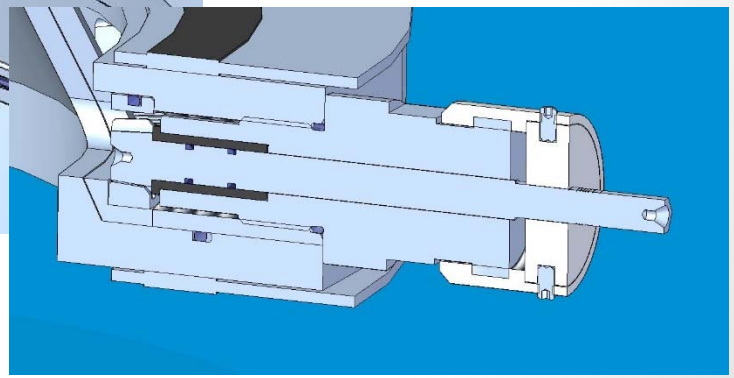
HOTSTART

Dynamic Variable Orifice (DVO)

for Adjustable Pulsation Dampening and System Blow-Down Rate Control

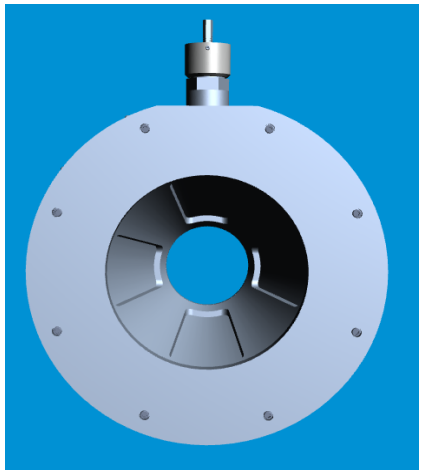
DVO – How Does it Work?



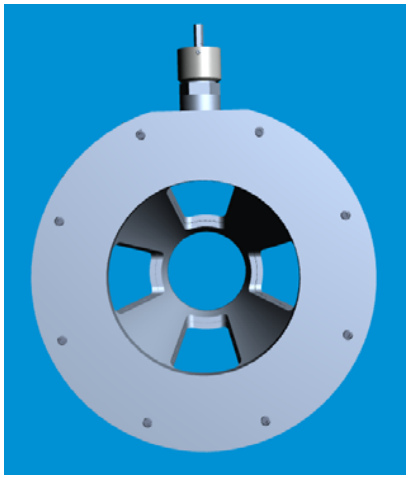


DVO – How Does it Work?

10” Conical DVO side view @ min beta setting.



10” Conical DVO end view @ minimum beta setting.



10” Conical DVO end view @ maximum beta setting.

- Range of beta ratios
- Round center passage determines minimum beta ratio
- Position of windowed passages adjusts beta ratio
- Flat, conical or hybrid configurations possible

DVO – Why?

- Change is a constant in our industry.
- Fixed pulsation control orifices may cause significant performance penalties.
- Swapping out standard orifice plates is very costly.

DVO – Applications

- Can be used anywhere you have a standard orifice plate to perform similar pulsation control
- Seasonal Condition Changes
- Ideal for packager/ fleet packages where a standard package will be used over many different operating conditions and scenarios
- Custom applications – liquid lines/pumps/screw compressors

DVO – Applications

- Optimization of Load Steps for flow, pulsation control
  - Via Automation of DVO, optimum Beta Ratio per Load Step
  - Use of pulsation study to determine orifice configuration in different operating conditions

- Controlled blowdown rate / operations
  - Greatly reduces damage to elastomeric seals
  - Possibly eliminate need for blowdown line silencer and 2-step blowdown
  - Better adherence to DOT 192 regulations

DVO – General Specifications

- Designed to fit between standard flanges
- 1500 psig MAWP standard
- 600 and 900# ANSI flanges standard – custom applications possible.
- 4” thru 24” dia. or larger
- Can adjust beta ratio while compressor pressurized & operating
- 0.4 to 0.7 for flat version
- 0.4 to 0.9 for conical version
- Manual or automatic control options

DVO – Automated Specifications

- Automation via Stepper Motor and Driver
- Hazardous Duty Class 1, Div 1 Stepper Motor
- 200 Steps per Rev, 1.8deg Step Angle
- EtherNet/IP and Modbus-TCP interfaces
- Receives signal from customer supplied PLC and sends pulse output to stepper motor. No PLC indexer required. No additional software required.
- 10:1 gear reduction gearbox to increase torque and improve position resolution.

DVO – Benefits

- Much broader operation range than with fixed orifices
- Pressure drop & horsepower loss can be optimized (minimized) as operating conditions change
- Increased capacity resulting in increased revenue
- With automation of the DVO, provides linked load steps or other operating parameters
- May allow less complicated pulsation bottles in some cases

Dynamic Variable Orifice (DVO) – Questions?

Please visit us at Booth #312

Dresser-Rand HSRC Product Improvements

MOS Cylinder Uprates

Bore Size (in.)	Previous MAWP (psig)	Uprated MAWP (psig)
4.75	1925	2750
5.75	1925	2575
7.00	1650	1885
8.00	1150	1430
9.00	750	1095
9.50	750	980
10.50	660	865
11.50	660	750
12.25	550	725
13.00	550	700
14.00	385	675
15.00	385	650
16.25	385	555
17.50	385	460
19.00	265	360

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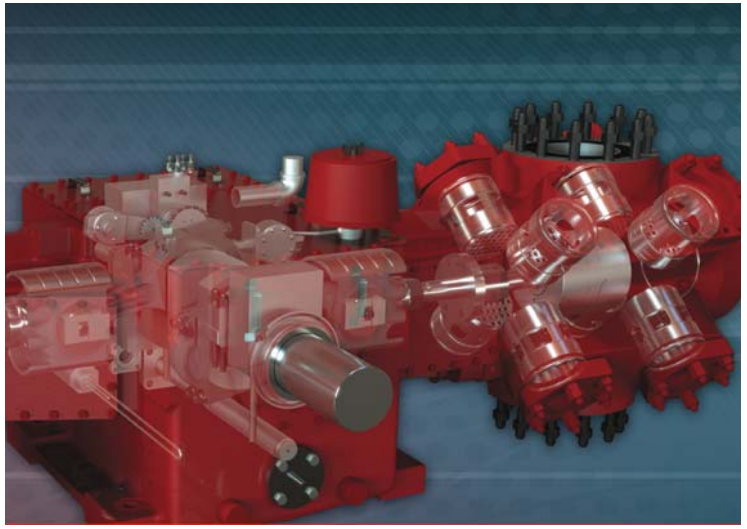
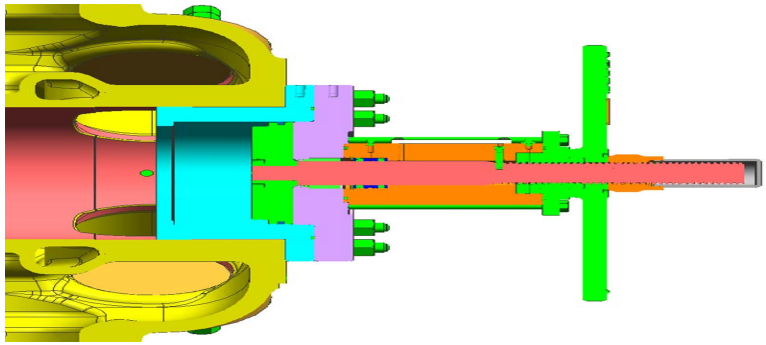


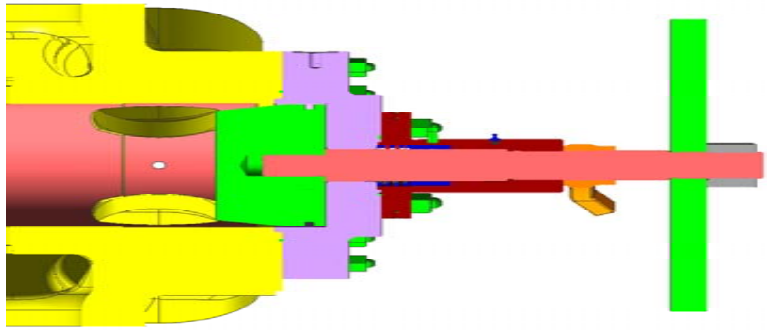
MOS VVCP Updated Design

- Full bore VVCP
- Eliminated sealing surface
- Switched from gaskets to O-rings
- Overall less number of parts
- Increase commonality of actuator parts & reduce production cycle time
  - Faster delivery
  - Better part availability
- Cylinder clearance remains unchanged

Previous VVCP



Updated VVCP



HOS/HOSS Compressor Cylinder
Highly Efficient/Reliable HammerHead Valve

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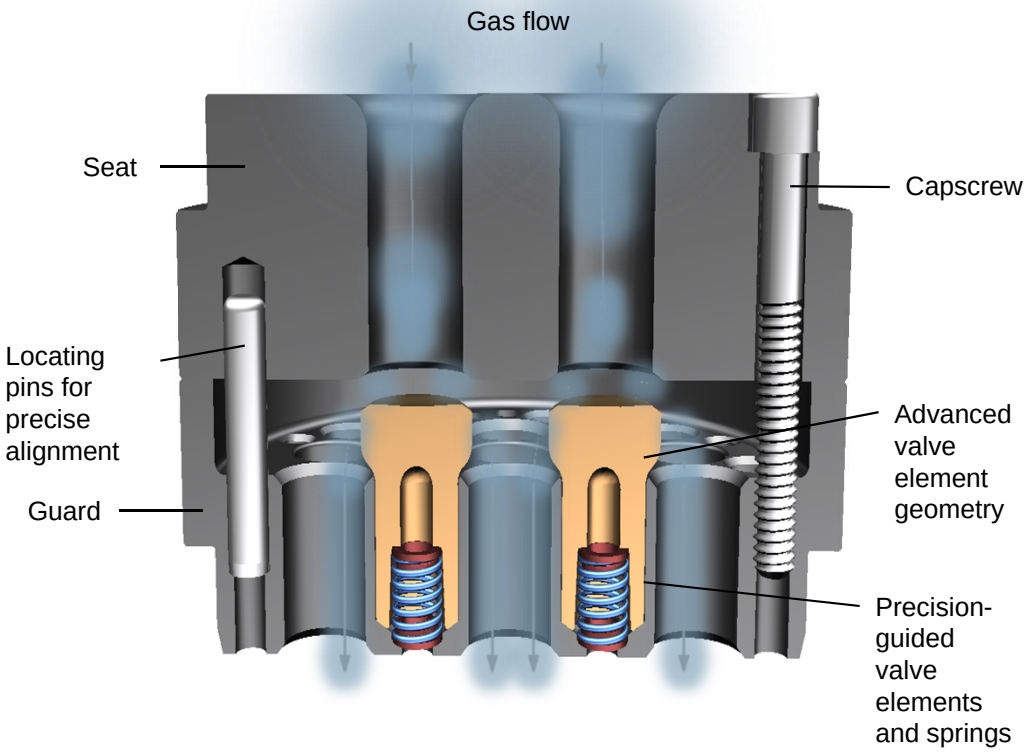
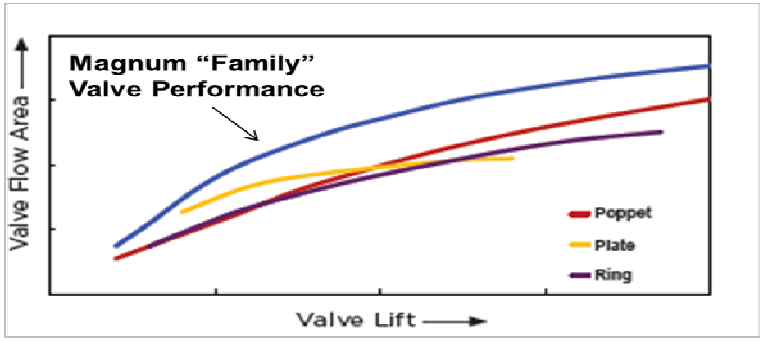
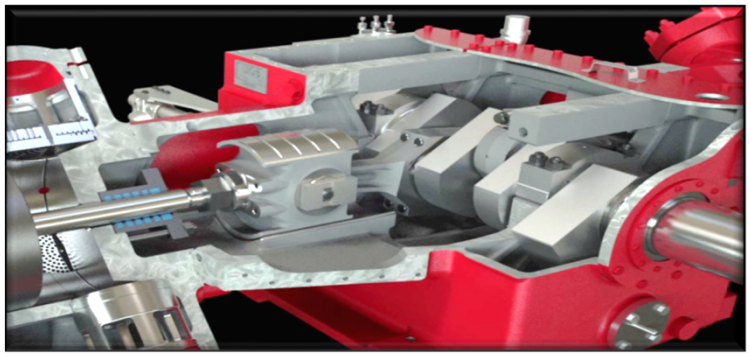


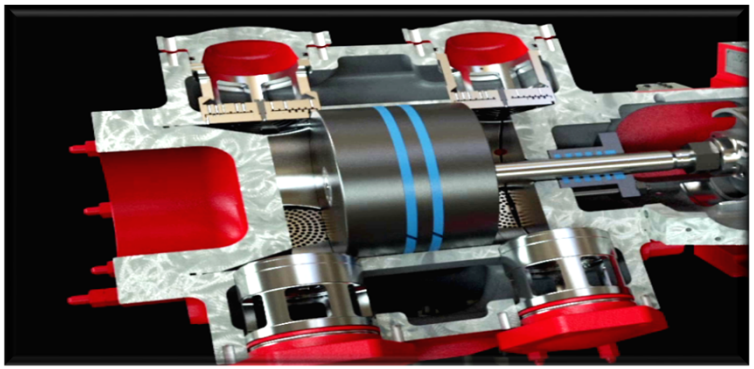


Opportunities for Improvement



Frame

- Service
- Simplification
- Safety



Cylinder

- Reliability
- Efficiency
- Service
- Safety

HOS Compressor Frame
Crosshead Access

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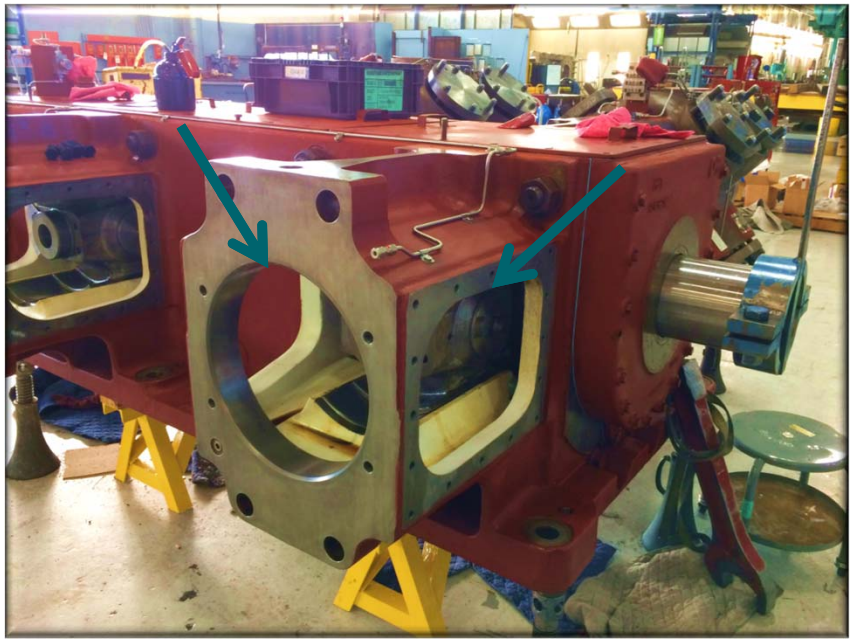
Before

After



HOS Compressor Frame
Top and Side Cover Bolting

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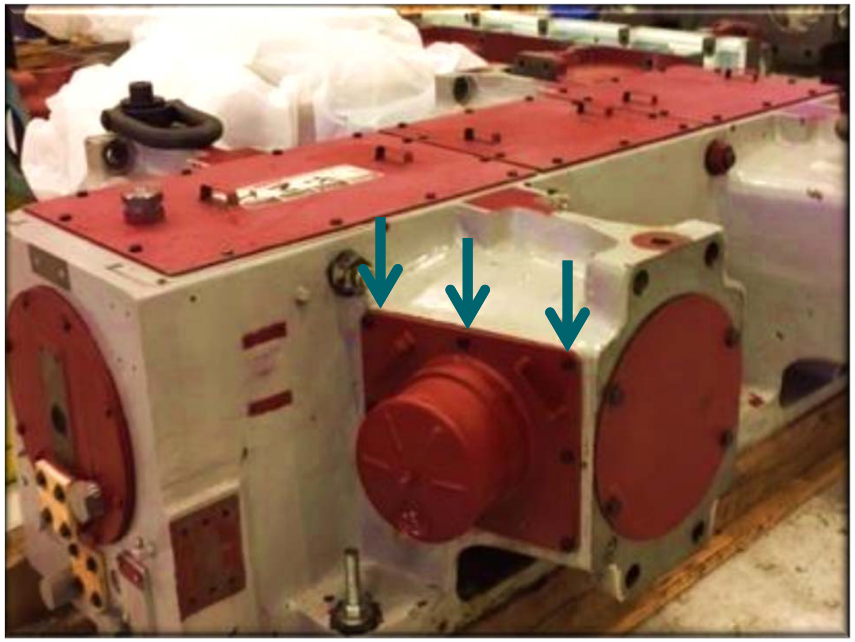
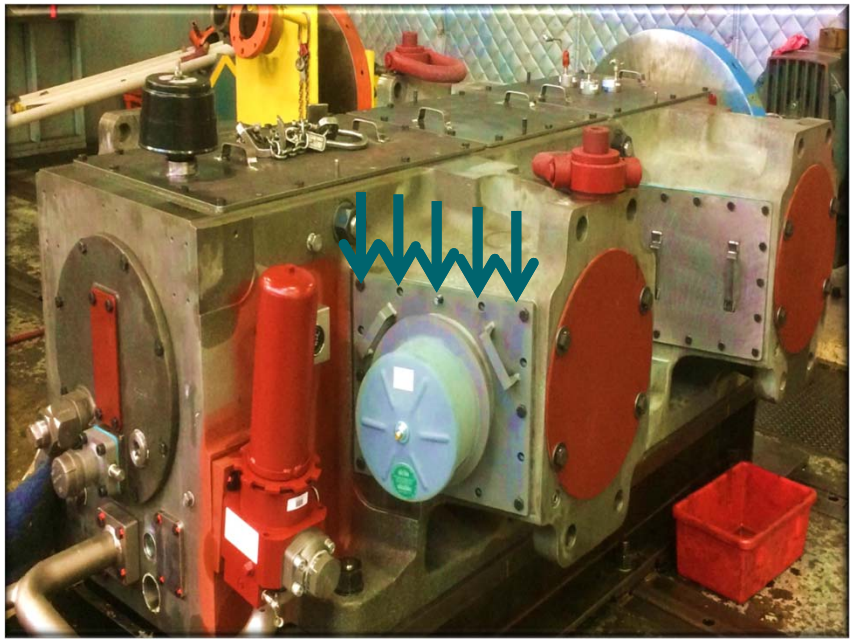
Before



After



HOS Compressor Frame
Simplified Oil System

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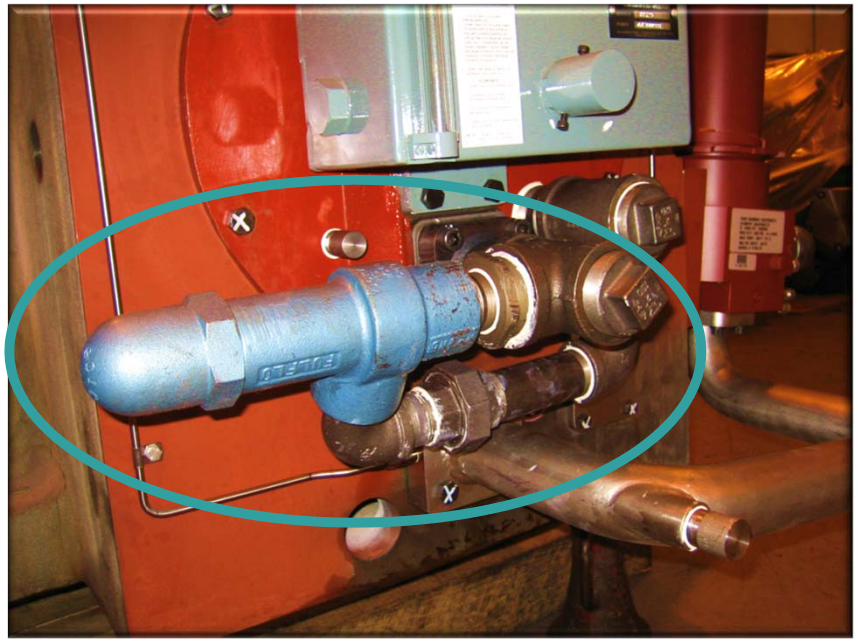
Before



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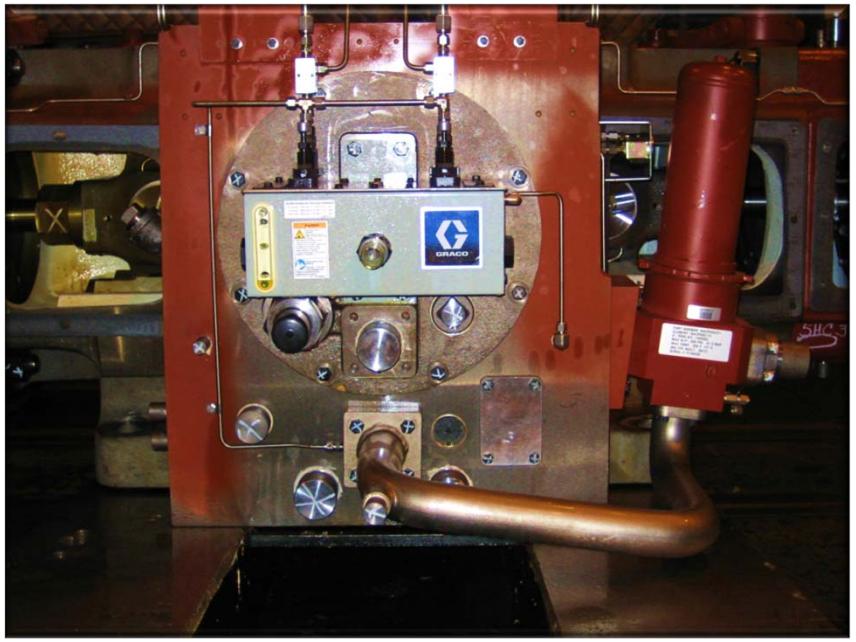

HOS/HOSS Compressor Cylinders
Simplified Assembly of Piston & Rod

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Before

After

HOS/HOSS Compressor Cylinders

Longer Life Less Leakage Packing ECR (Emission Control Ring)

SIEMENS
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Before

After

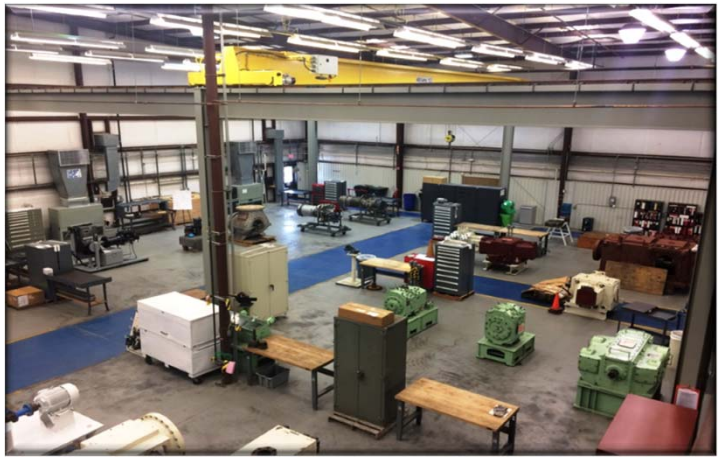
General Service Support

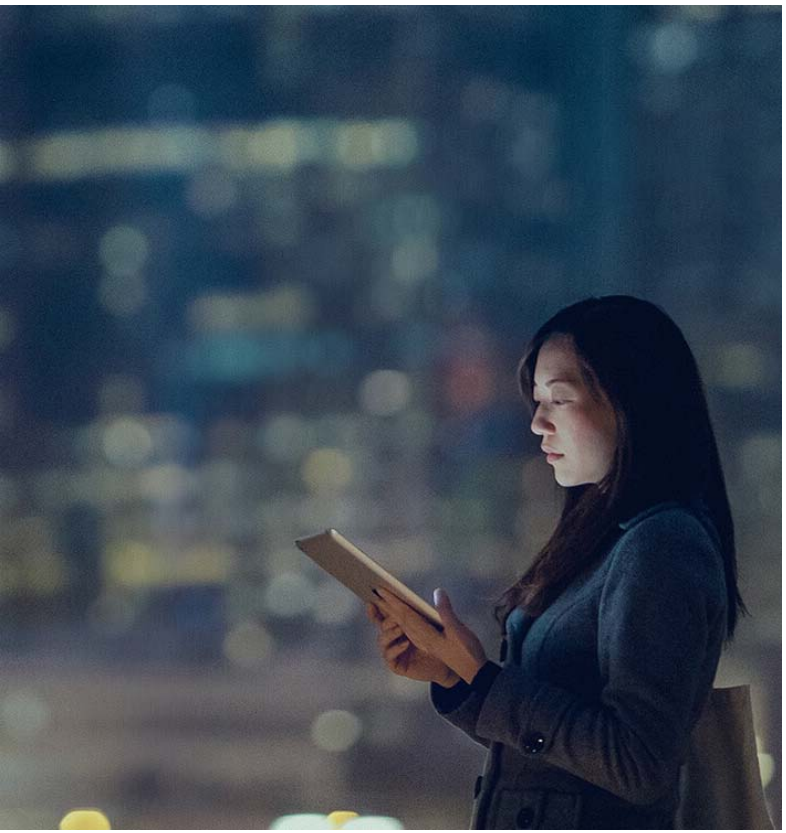
Parts Support – Houston Warehouse

Emergency Parts Hotline

716-904-2080

General Service Support
Training





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mlguo@siemens.com

siemens.com

DE-4000

Next-Generation Safety Shutdown and Control System for Gas Compression Packages and Other Critical Equipment

Gas Compressor Association
March 2018

HOERBIGER

altronic
HOERBIGER Engine Division

Product Description

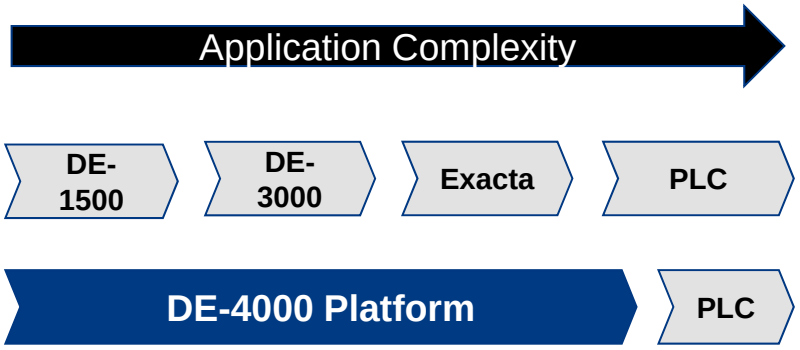
DE-4000 Next-Generation Safety Shutdown and Control System for Gas Compression Packages

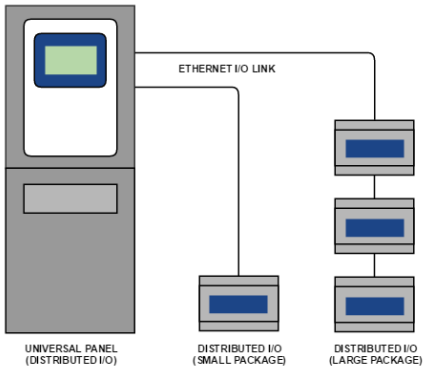
State-of-the-art engine and process control system

- **Innovative design** brings together configurability with unique customization and application engineering capability
- Built on **advanced ARM processors and System-On Module (SOM)** technology for long-term system support and upgrades
- **Highly scalable** – Standard system for small to larger horsepower, modest complexity to PLC-class applications
- **Suitable for internal support by user**
- **Embedded communications flexibility and optimized for remote monitoring**

Suitable for use in Class I, Division 2, Group C and D hazardous areas

Scalable, Flexible Nature





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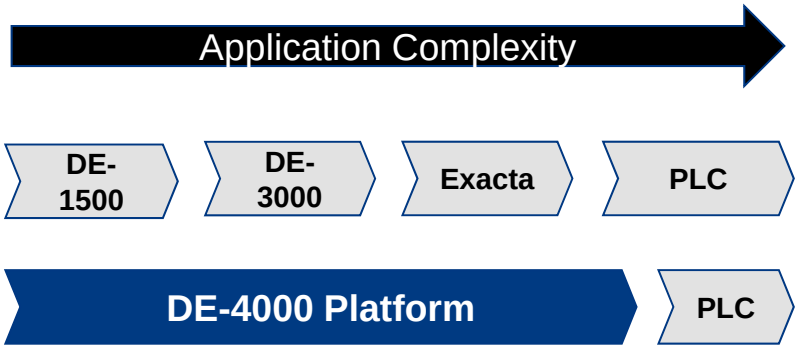
Product Description

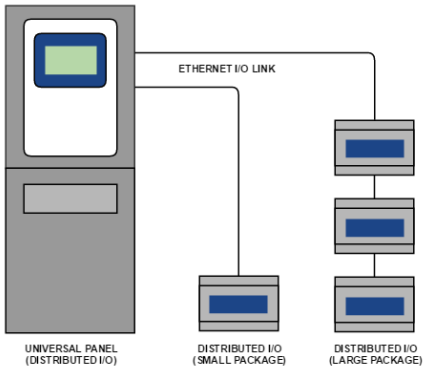
DE-4000 Next-Generation Safety Shutdown and Control System for Gas Compression Packages

Benefits of Operation and Service

- **System can be configured and supported by the user at any desired level** – Out-of-the box configuration, fully customized, and/or all requirements in between
- **Scalability drives a common control platform** across a fleet and all benefits associated with spares stocking and training – A more **UNIVERSAL PANEL**
- **Cost-effective vs. competitive solutions** – Moderate hardware and panel integration costs, plus reduced cost of installation with locally-mounted I/O
- **Supports IoT integration and local/remote system monitoring and control via smart phones, tablets, and PCs**

Scalable, Flexible Nature





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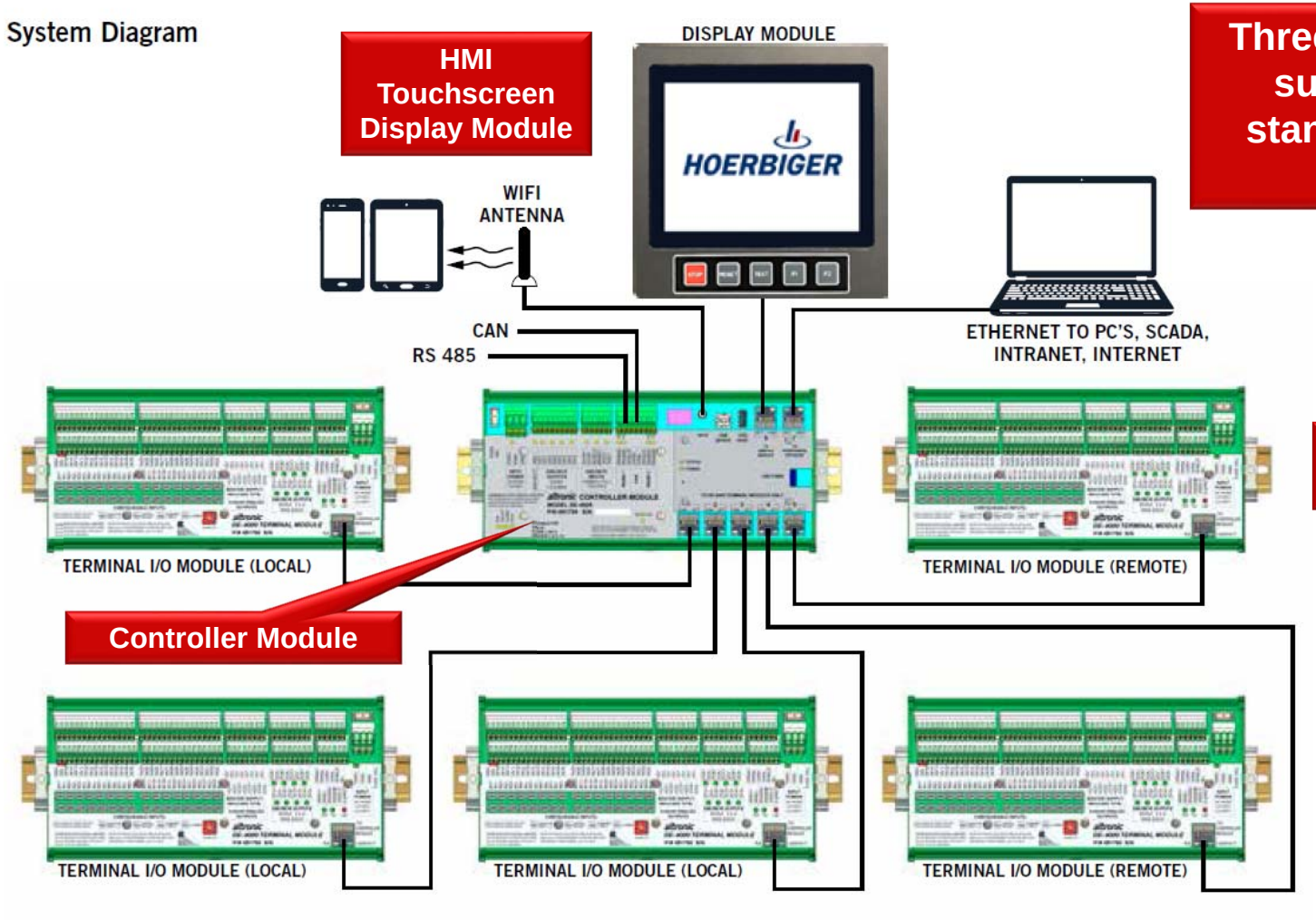
Product Description

DE-4000 Next-Generation Safety Shutdown and Control System for Gas Compression Packages



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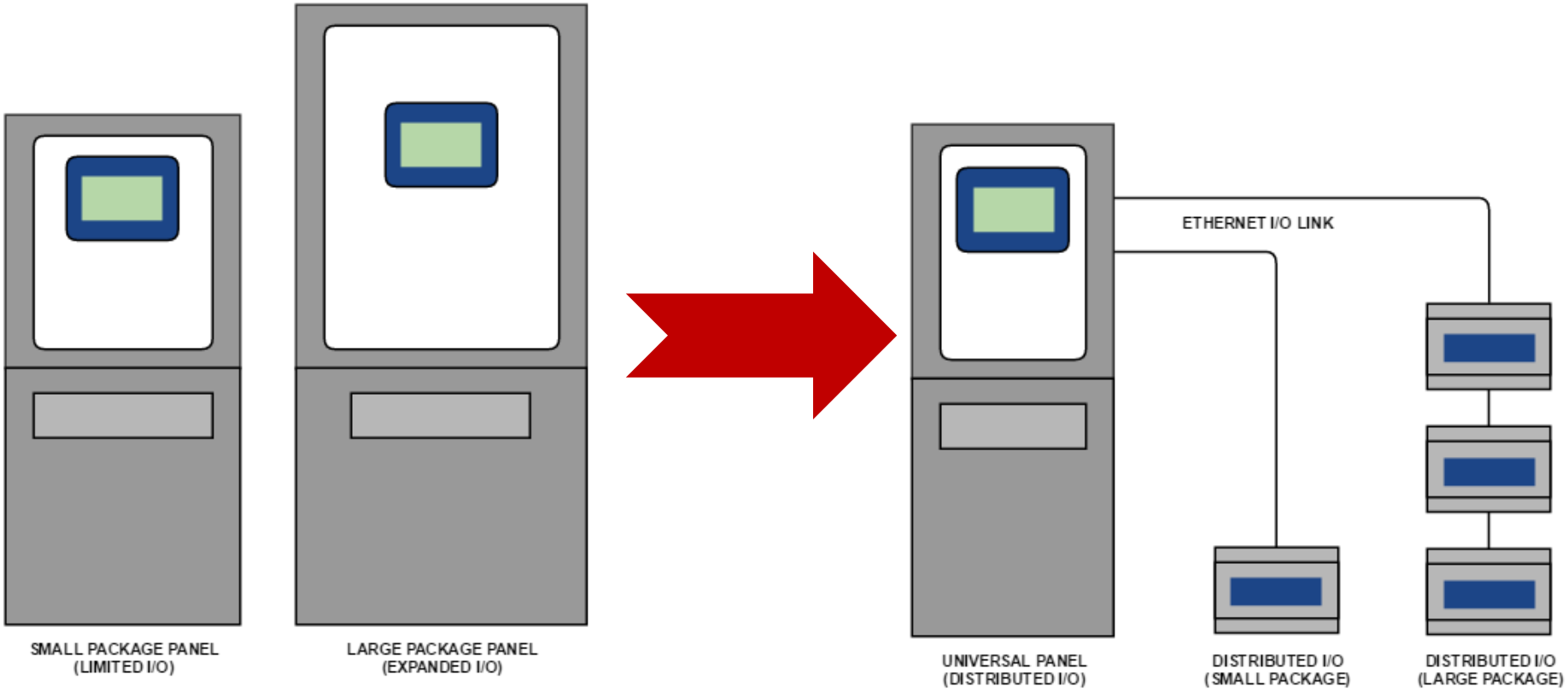
Product Description

DE-4000 Next-Generation Safety Shutdown and Control System for Gas Compression Packages



Distributed architecture allows for scalability across packages without the need for different control panels

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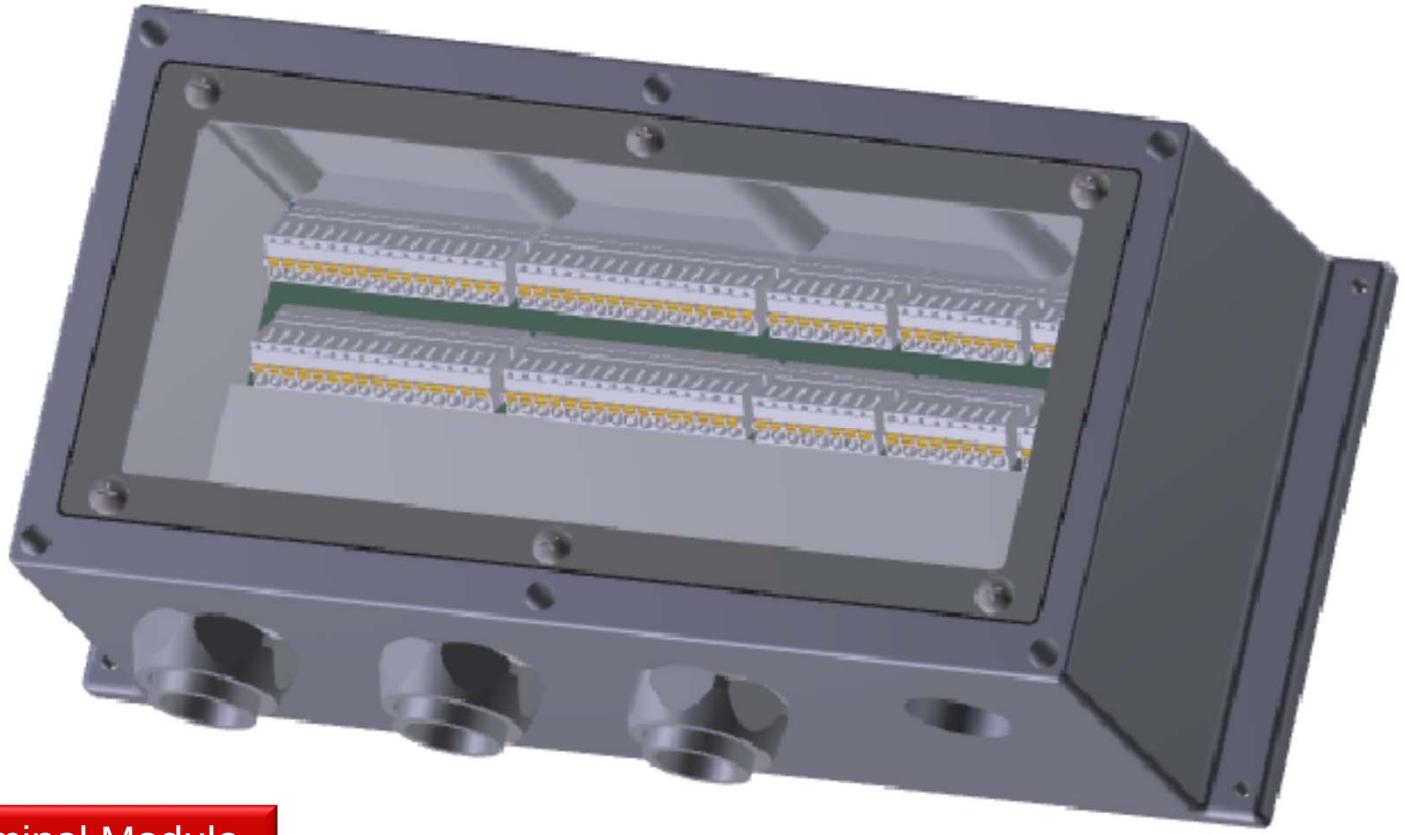
Technical Review

DE-4000 Configurable Safety Shutdown and Control System for Gas Compression Packages



Terminal Module

Remote Mounting Enclosure allows for distributed I/O structure

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Application Discussion

DE-4000 Next-Generation Safety Shutdown and Control System for Gas Compression Packages

DE-4000 is built on simple, but comprehensive system configuration

Can be easily configured using a standard, DE-3000-style configuration capability

Multiple layers of application configuration are available for customization and user-created logic

- Examples: Valve control, fuel flow, rod-load calculations, IoT, load control, etc.

All programming done directly on the device – No terminal program or licensing required

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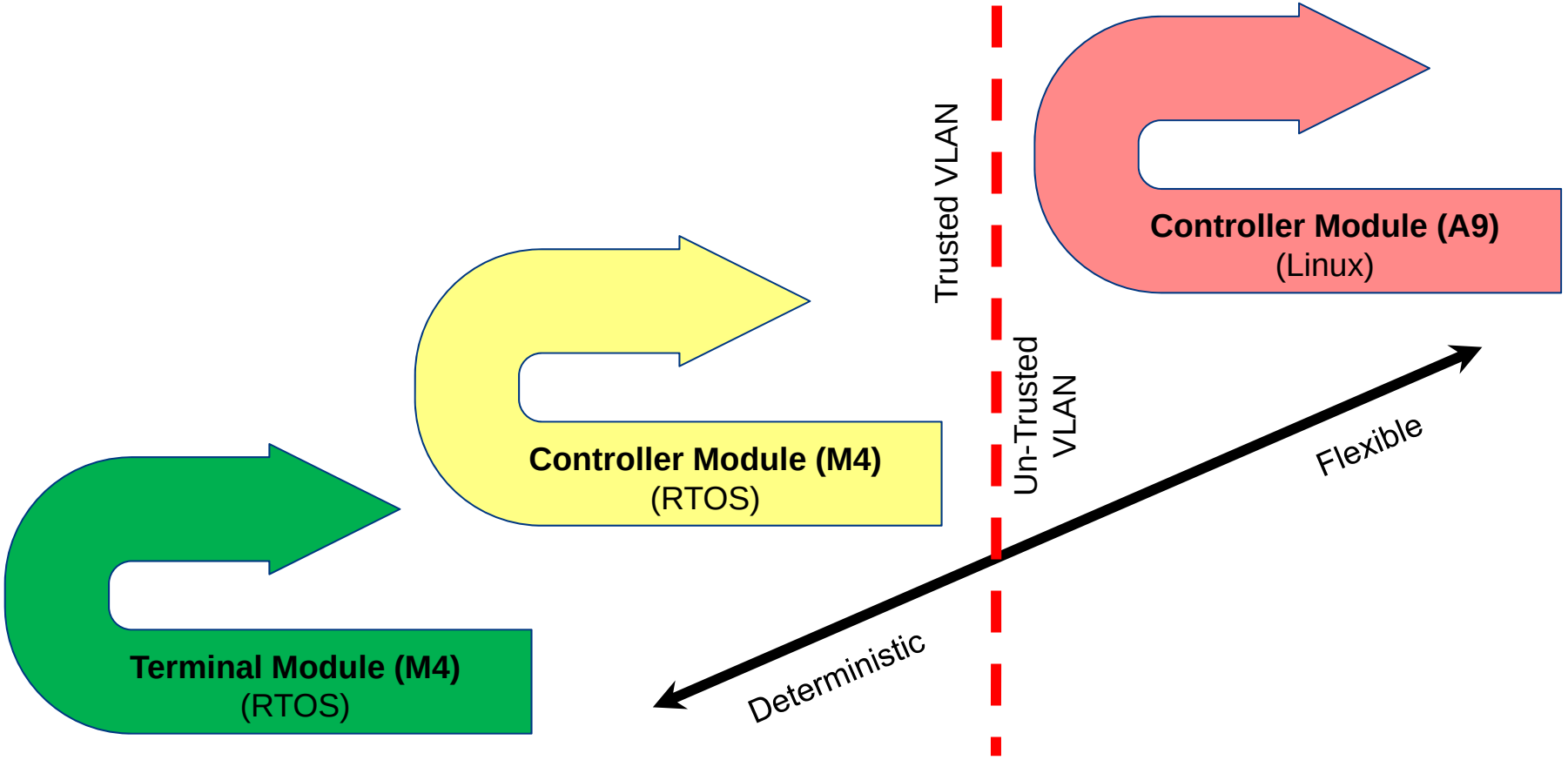
Application Discussion

DE-4000 Next-Generation Safety Shutdown and Control System for Gas Compression Packages



Staged Software Structure Enables Flexibility and Reliability

- Balance of deterministic vs. flexible nature at different software levels
- Managed Ethernet switch at heart of system robustness

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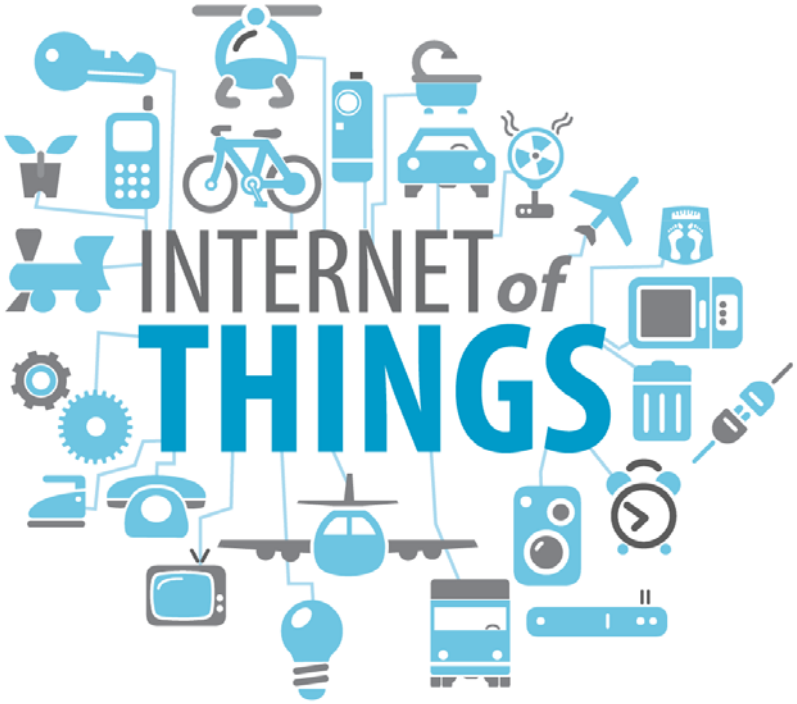
Application Discussion

DE-4000 Next-Generation Safety Shutdown and Control System for Gas Compression Packages

DE-4000 is designed for simple IoT integration – Internet of Things - and is 100% "Cloud Compatible"

- Linux-based Operating System - the same as two-thirds of all servers on the Internet
- Delivers the ability to do the computing where it makes the most sense: on-device or on external servers
- Provides security at all levels
- Simplifies integration of tablets, smart phones, and PCs, as well as larger supervisory systems



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FW MURPHY PRODUCTION CONTROLS

EICS ENGINE INTEGRATED CONTROL SYSTEM

In-Field Diagnostic Capabilities of the EICS Control System

2018 GCA Expo and Conference

Chad Stovell

March, 2018

Introduction

- Downward forcing emissions compliance of internal combustion engine based drive systems require every increasing levels of technology
  - Days of the “standard/simple” piston driven engine platform are long-gone!!!
  - Most engines resemble miniaturized chemical processing plants due to aftertreatment management
  - Increased number of sensor based control subsystems invite opportunities for failure points to disable the entire drivetrain
- In-field technical issues associated with advanced technology control systems require a very detailed understanding of the associated failure mode in order to efficiently resolve the issue
  - Usually accompanied by a technician bringing an oscilloscope, voltmeter, high tension lead current clamp, the kitchen sink, ……. out to the engine sight to begin troubleshooting
  - Hopes and prayers are usually welcomed at this point!!!
- *EICS* provides a number of key befits to help expedite troubleshooting steps necessary to get the engine running again, quickly

EICS Diagnostics

1. Fault Messaging Display
   - Currently occurring faults as well as previous historic faults
2. System State Snapshots
   - Collected at time of fault
3. Library of OBD Descriptions
   - Provided in easy to understand description format
   - Associated troubleshooting steps provided for each fault
4. On-Site Diagnostic Tools
   - Compression Test
   - Spark Firing Test
   - Running Spark Disable Test
     - Manual
     - Automated

Fault Messaging Display

- **SPN/FMI Fault Designations**
- **Fault Occurrence Counter**
- **Basic, Clear to Understand Diagnostic Messages**

Fault Snap Shot

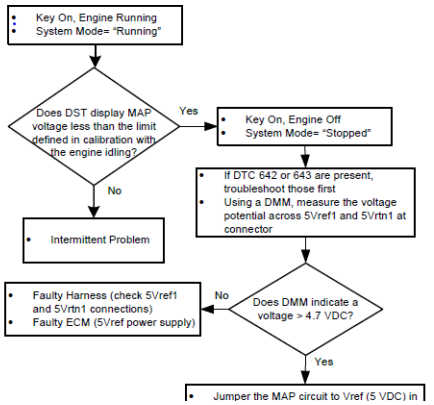
- **Recounts Key Operating Parameters for Each Fault**
- **Aides in Understanding Operating State for First Fault Occurrence**
- **Numerous Faults Also Available with Flight Data Recorder Data Log**

Fault Identification and Suggested Correction Steps

- **Detailed Description of Each Fault**
  - **Provided in *EICS* user manual**
  - **Explanation of how/why fault may have been triggered**
  - **Highlights possible causes of fault situation**
  - **Offers numerous troubleshooting steps to help rectify fault state**

DTC	SPN	FMI	Combined Messages	Trigger Condition	System Action	Likely causes	Troubleshooting Detail
1164	4237	1	The base calibration is adjusted for less fueling than expected from adaptive learn	Adaptive Learn has exceeded -35% correction	• Warning only	• Damaged mixer diaphragm. • Fuel pressure to D-EPR very high. • Fuel properties entered into base engine setup are incorrect.	1.) At engine idle, check that the fuel pressure entering the D-EPR is between 15 inH2O and 16.5 inH2O. Correct if needed. 2.) Open mixer top cover, remove and inspect diaphragm for holes or tears. Replace if needed. 3.) Check that the fuel properties entered in the engine setup are accurate. Correct as necessary.

DTC 107 – MAP Low Voltage



- **Decision Tree Representation of Troubleshooting**
  - **Helps establish a systematic approach to rectifying the root cause of fault**
  - **Provides direction to technicians who may not be overly familiar with certain engine sub-systems**

On-Site Diagnostic Tools

- **Compression Check Test**
  - Disables fuel system and ignition system during cranking
  - Allows compression test to be done without having to alter hardware

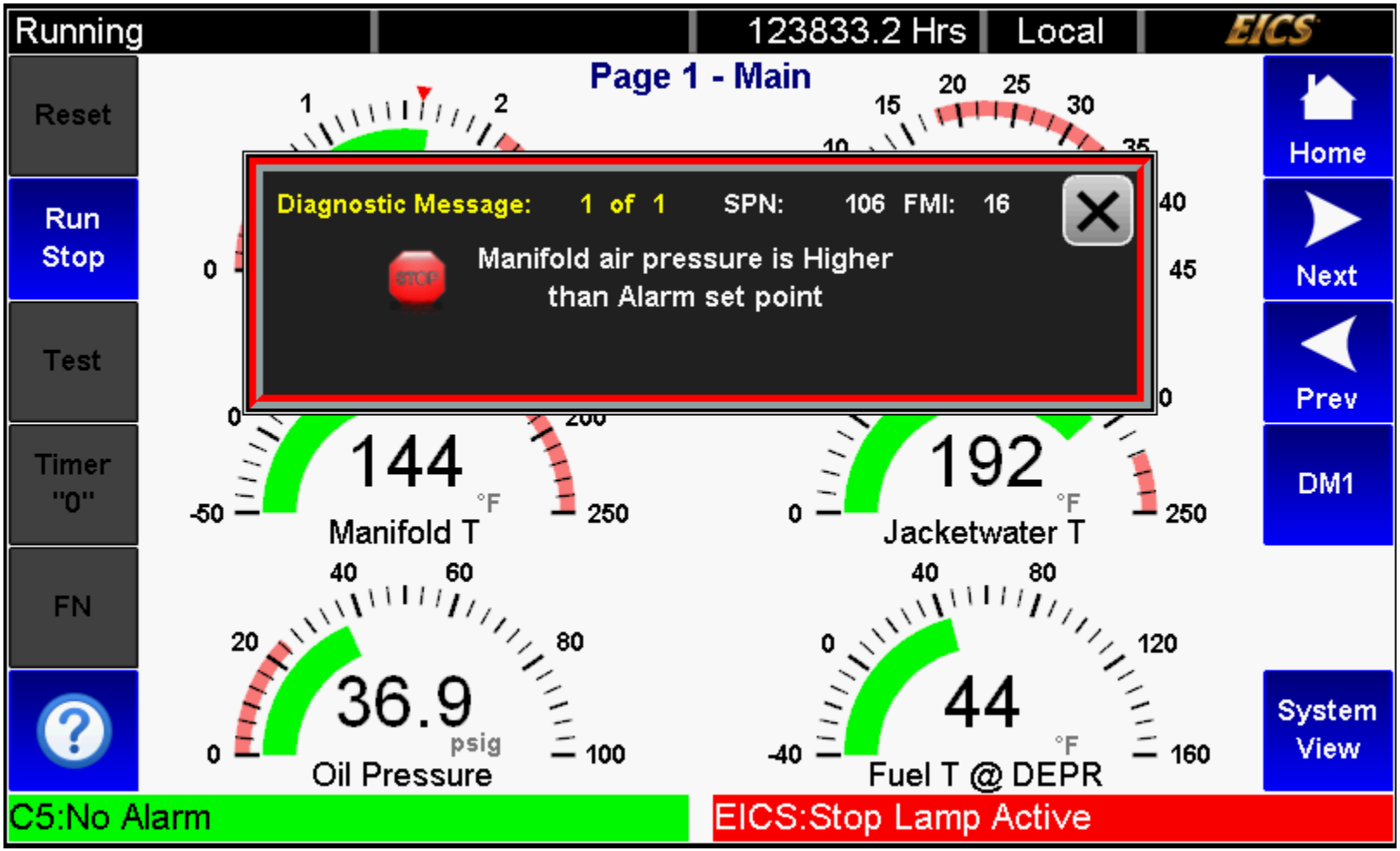
- **Spark Fire Test**
  - Able to test fire individual spark plugs while the engine is not running
  - Provides kV feedback to help identify faulty coils, wires or plugs

On-Site Diagnostic Tools (continued)

- **Spark Disable Test**
  - **Manual**
    - Specify individual cylinders to momentarily disable
  - **Automated**
    - Deactivates individual cylinders systematically
    - Evaluates health of power cylinder based upon change in manifold air pressure from operational state to disabled state
    - Effective for not only finding ignition system problems but also identifying failing power contributing cylinders

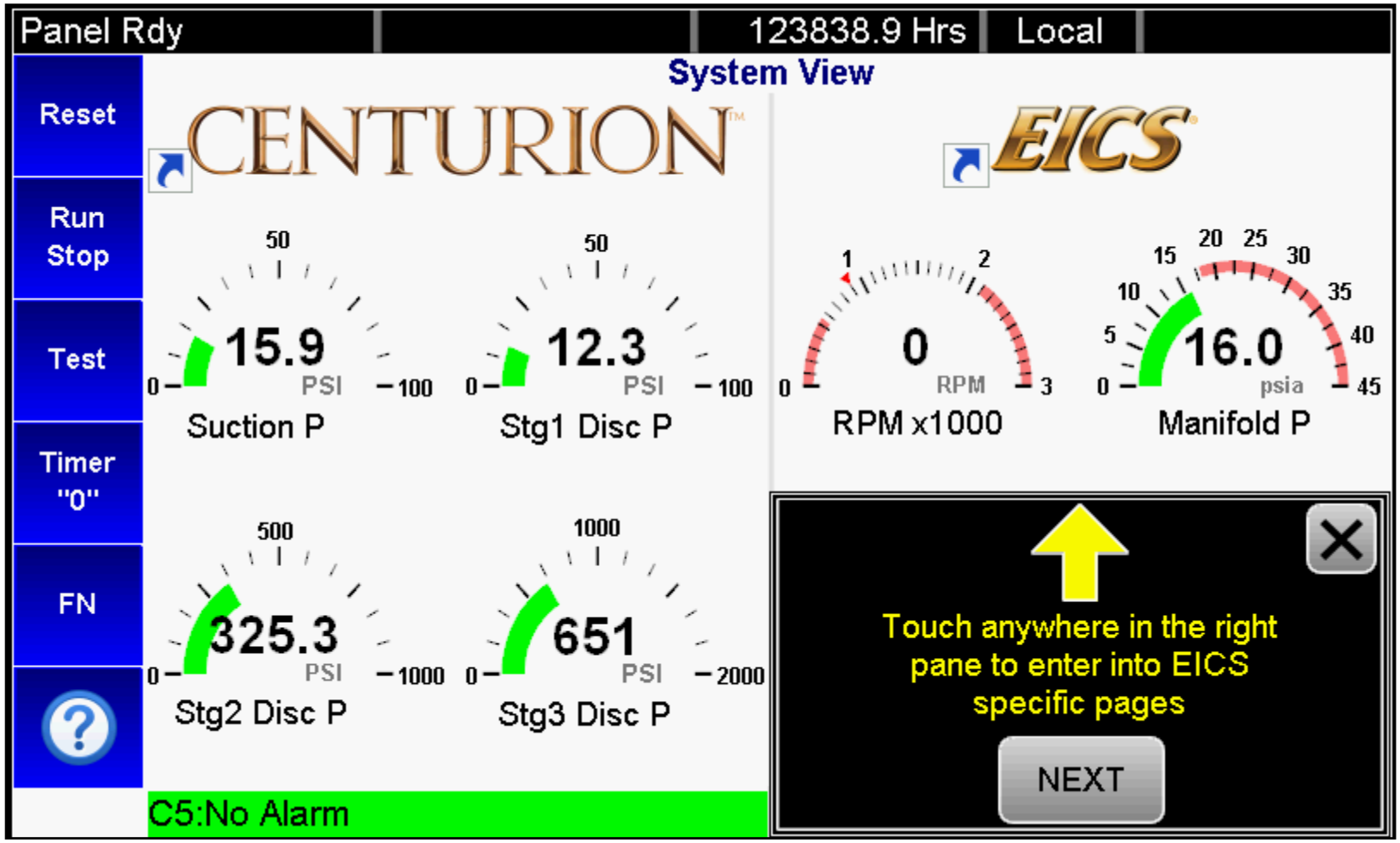
0.0 psia ✔	A cylinder that passes the test
0.0 psia ?	A cylinder that is marginal
0.0 psia ✘	A cylinder that fails the test

EICS Improved Screen Option



- New *EICS* system option for 2018 – Increased Size Display
- Additional fault information available through display

EICS and Centurion Unified Display



- **New display presents users with both *EICS* and Centurion compressor controller operating states and error messages**

EICS Fault Diagnostic System Coupled with On-Site Diagnostic Tools Efficiently Return Engine to a Running State

- Clear Fault Identification and Description
- Fault State Context Captured by Snapshots
- Potential Troubleshooting Steps Outlined
- Easy to Use Diagnostic Modes to Evaluate Engine Performance

DH1

mCore® SDR

powered by: eRCM Express™

Presented by:
Doyle Taylor, President & CEO of Monico
&
Chad Brahler, President of ACI Services, Inc.

What is mCore® SDR ?

mCore® is a:

- Protocol Translator
- Secure Edge Device Gateway
- Condition Monitoring Platform

mCore® is Monico's Next Generation platform for remote monitoring, telematics applications, and edge analytics. The vision for this device incorporates three original design goals:

(1) Industrial Cybersecurity

(2) a Rugged Package for Hazardous Locations

(3) Maximum Computing Power, Speed, and Efficiency

monico™
SIMPLE SOLUTIONS. POWERFUL MONITORING.

Hardware Specifications

- 8-48 VDC Power Supply
- -40 - 70 °C Operating Temperature up to 28VDC
- -40 - 65 °C Operating Temperature up to 48VDC
- IP67 rated for Temporary Water Immersion
- IP66 rated for High Volume Wash Down
- Vibration tested from 2-200 Hz at 5 G's Acceleration
- Shock Tested to 25 G's
- Class I Division II Groups A-D Surface Temp T5A

mCore® SDR

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Cyber Security Features

- NXP Chipset with Built-in Secure Storage Locations for Security Certificates
- x.509 Security Certificates for Bi-Directional Authentication
- SSL/TLS Encryption Sockets
- High Assurance Boot (HAB)
- Enterprise Level Linux Operating System
- Basic Firewall

mCore® SOR

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Additional Features

- LED Indicators for Power and all Communications Ports
- Data Logging
- 2GB of RAM and 4GB of Onboard Non-Volatile Storage
- Quad Core 1GHz Processor with Five Math Coprocessors DH5
- Basic Web Server User Interface
- Reverse Polarity Protected Power Supply
- Utilizes OSIsoft®'s Pi Connector Technology

mCore® SDR

monico™ SIMPLE SOLUTIONS. POWERFUL MONITORING.

Unparalleled Partnership

ACI Services, Inc.

monico
SIMPLE SOLUTIONS. POWERFUL MONITORING.™

mCore® SDR

created by:

MONICO
SIMPLE SOLUTIONS. POWERFUL MONITORING.™

=

Express™

eated by:

ACI Services, Inc.

eRCM Express™ Technology

- Provides OEM-Compatible Modeling
- Models Single and Multi-Stage Units
- Predicts S[DH3 / DH6]erformance Across Unit's Full Operating Map
- Calculates Full Rod Loads and Pin Reversals Per Throw
- Empowers UCP with Dynamic Speed and Pressure Safety Limits
- Help End-users Improve Capacity and Reduce Costs
- Minimizes PLC coding (saves programming costs)

ACI Services, Inc.

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DH4

Compared to previous eRCM Express™ Models...

mCore®

- More Robust
- Smaller Footprint
- More Communication Protocols
- Linux-Based – no more Port Locking and OS Failures
- Rated for Class I / Div II Locations
- Handles Electrical Spikes and Surges
- Wider Temperature Range
- Industrial and Ruggedized Package
- Empowered to Provide Local Condition Monitoring
- Quicker and More Consistent Installation

ACI Services, Inc.

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Thank you!

Questions?

WellCaddie

Measure | Analyze | Predict

Thompson Speir
Sales Manager, WellCaddie

What to monitor

Suction Pressure

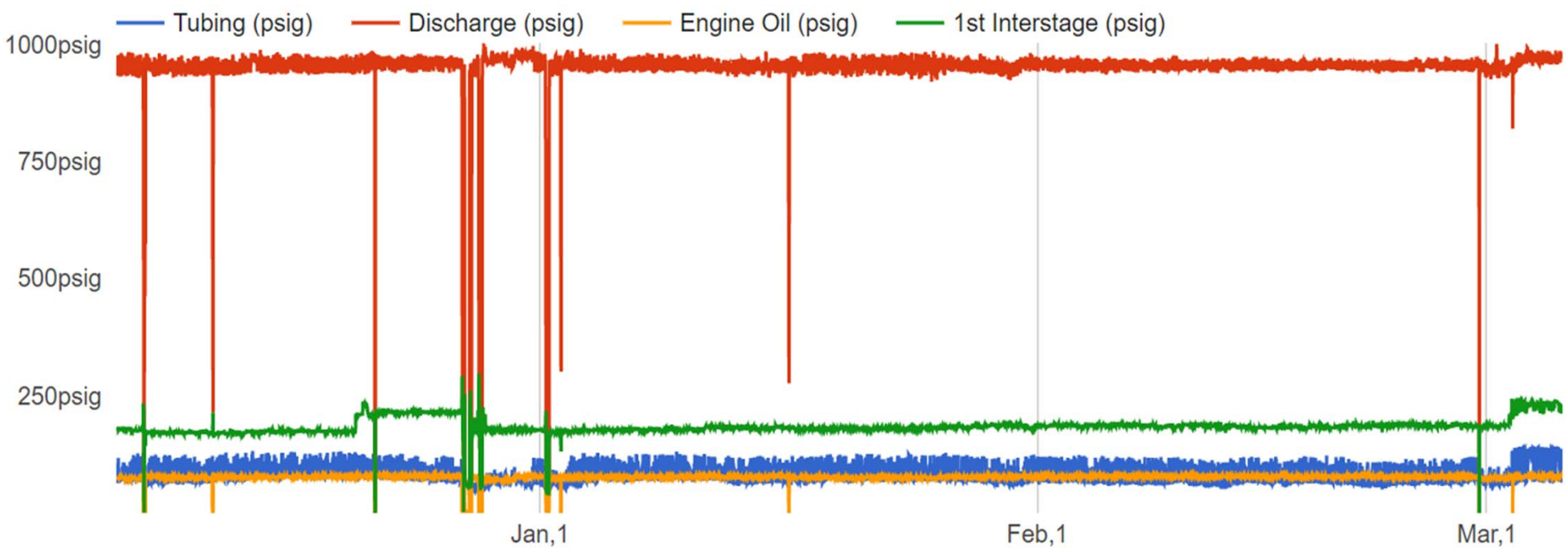
Discharge Pressure

Interstage Pressure

Engine Manifold Pressure

A timeline of pressures can help reveal when a compressor is off and ultimately show why it went off. Freezing, open valves, and loss of power are common issues solved faster with monitoring.

“99%” Uptime



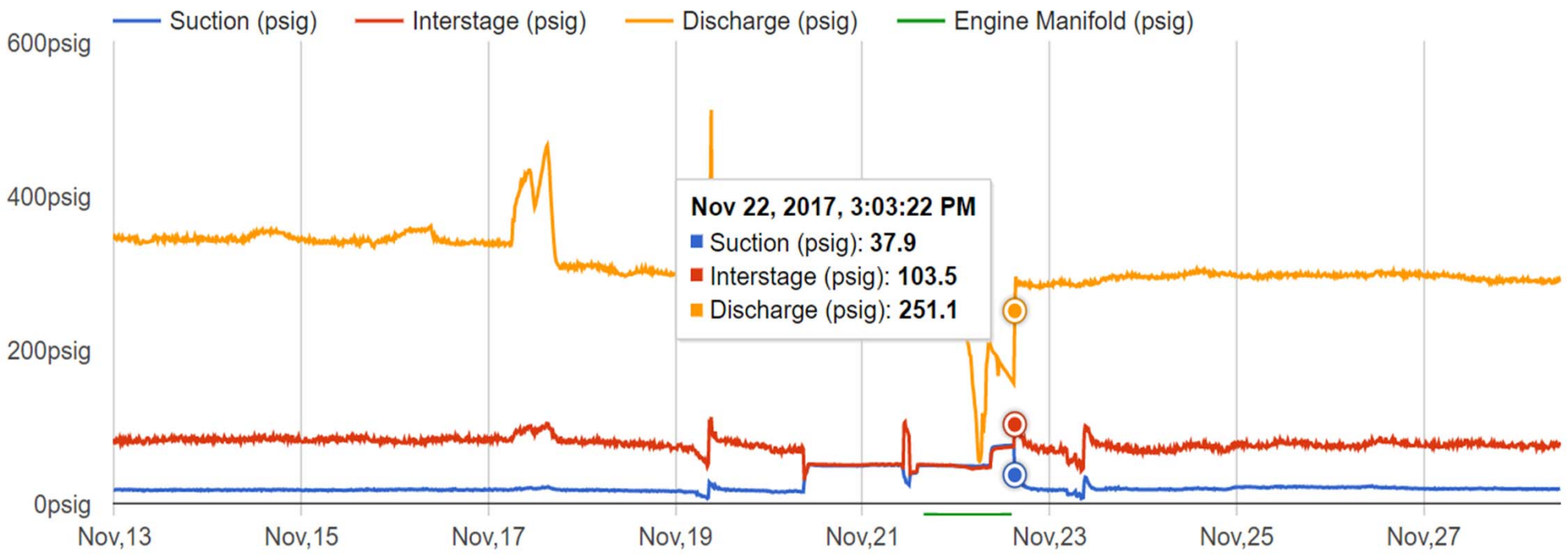
Even the best performing compressors will go down.

What to monitor

Annunciator Monitoring/Controls

The annunciator can tell when the compressor is down and has error codes. Knowing you can receive a notification as soon as a compressor goes down can save you time and money. Additionally, monitoring can tell you instantly when the annunciator receives an error instead of hours/days later by a person.

Thanksgiving Week



Compressor problem is found and fixed, an opened valve was leaking gas!

Easy to View Dashboard

Easy to view dashboard works on:

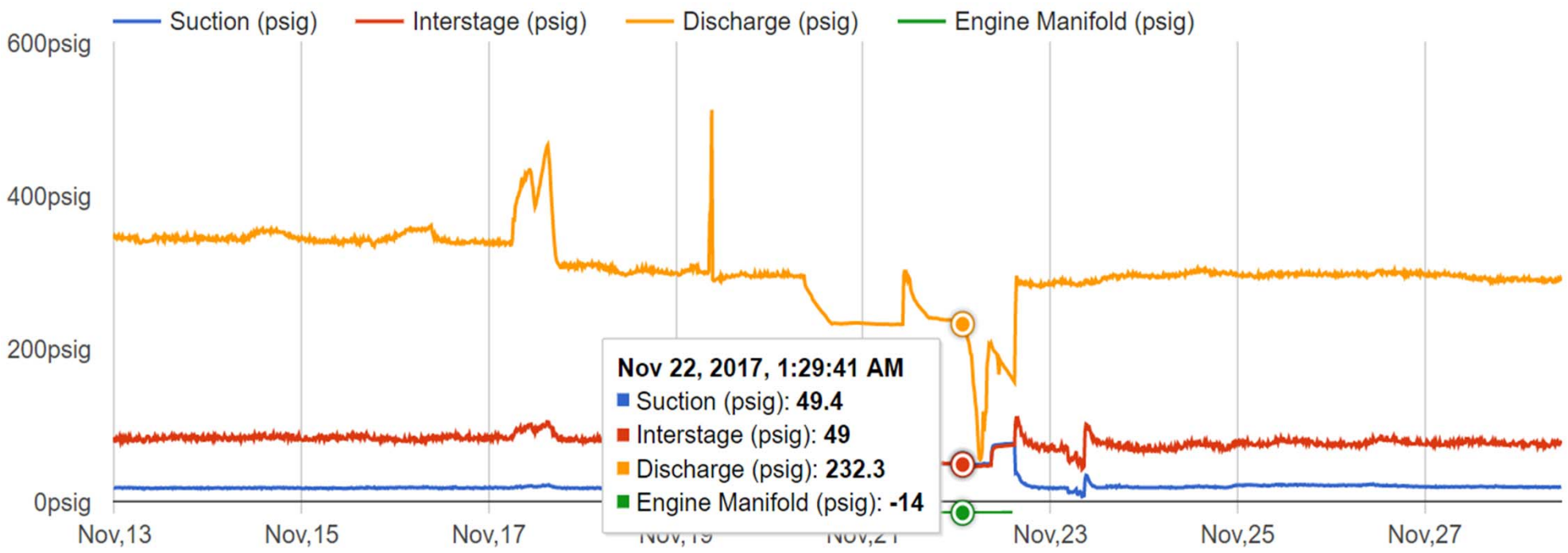
Desktop

Tablets

Smart Phones

Download data of the last 7 days, 90 days, or ALL previous days to Excel with one click.

Thanksgiving Week



Loss of discharge pressure. Compressor had been acting up with no known cause.

Minimize Downtime

Too much information can be as detrimental as no information.

Information should be shown in a manner that will make problems obvious.

Operators will often miss problems when too much information is shown.

Whether your an operator or a leasing company, run-time is king.

Down-time is lost time that cannot be made up.

Questions?

Thompson Speir

Sales Manager, WellCaddie

Booth 107/108

Live demo at wellcaddie.com