OCTOBER 25, 2023

Digitizing LNG Production Operations

Actionable Insights from the Cameron LNG Digital Journey

Franz Field

Cameron LNG

IT/Digital Manager

Agenda

1. Introduction : Cameron LNG
2. Business Context : Cameron LNG
3. Digital Value Drivers
4. Digital Value Case 1: Digitizing Field Activities
   - AVEVA™ Mobile Operator
5. Digital Value Case 2: Wireless Field Sensors / PI Analytics
   - AVEVA™ PI System™, PI Asset Framework, PI Vision, PI Connectors
6. Summary & Challenges
7. Questions

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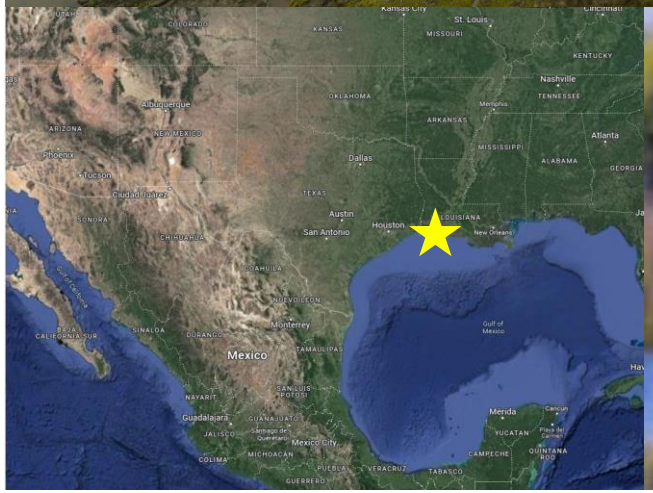
Cameron LNG

Local Roots with a Global Reach

- 1 x World Scale LNG Export Facility COMPANY
- 3 Trains x 4.5 MTPA = 13.5 MTPA nominal capacity
  Authorized export capacity of 14.95 MTPA (1.7 bcfd)
- Air Products APCI propane mixed refrigerant C3-MR
- GE/Baker Hughes Frame 7EA gas turbines
- Power supply = Entergy Louisiana Utility grid
- Tolling Agreement; no Upstream, No Trading, No Shipping

2014 AUG	Final Investment Decision
2019 MAY	Train 1 Commissioning
2020 AUG	Full Commercial Operations
2022 DEC	500th Cargo



SEMPRA INFRASTRUCTURE
TotalEnergies
MITSUI&CO.
Mitsubishi Corporation
NYK LINE NIPPON YUSEN KAISHA
AVEVA

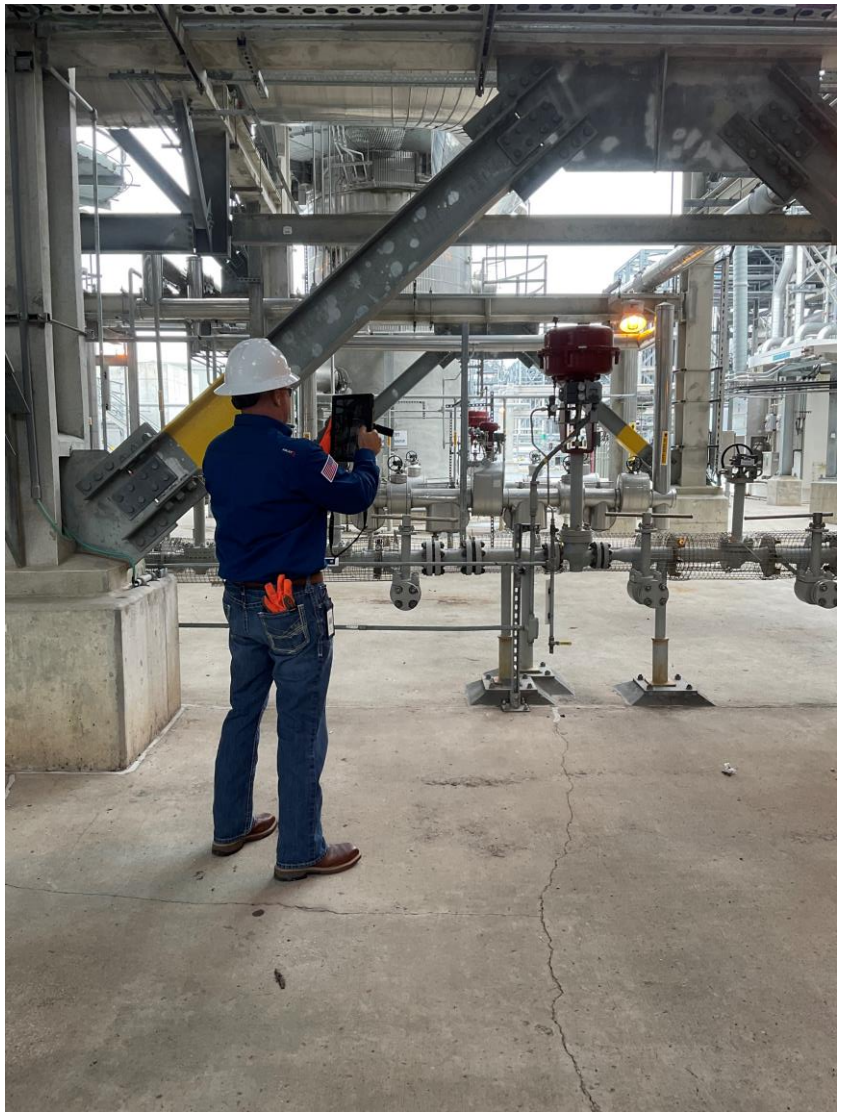
Cameron LNG – Digital / Business Context & Drivers

OPEX Business Model : POWER + PEOPLE + PRODUCTION

- Modern LNG Facility – **instrumented for control**
- Plant Fiber communications infrastructure; **fiber connection to internet**
- Pipeline **gas supply** – options and interconnectivity
- Reliable GRID **Power**
- Focused Business Model – Molecules from pipeline fence to loading arms. Controllable OPEX.

- **Skilled** / Small workforce
- Built by senior leaders with international LNG Project and Operations Experience
- Resilient / Open / Friendly **Culture**

- Single Tennant / Cloud-first Business & Production IT Systems Infrastructure
- Right-sized **proven** LNG/Oil & Gas core systems
  - SAP, Energy Components, UniSim, **PI System, Mobile Operator** (Intelatrac)
- 2D & 3D CAD Models for new facilities - SmartPlant Instrumentation, P&ID, PDS 3D



Strategic Digital Drivers

1	**Prove Small, Plan for Scale** ■ Early results – weeks not months ■ Demonstrate viable path forward	Execute affordable/achievable/scalable digital pilots to demonstrate technology capabilities, HSSE compliance, benefits, organizational impact, related opportunities, and supply chain readiness
2	**Material Upside, Low Regret** ■ One implementation unlocks multiple business case opportunities ■ Proving efficiency gains in one use case unlocks similar opportunities	Digital solutions and pilots where one implementation unlocks multiple improvement opportunities. Solutions with efficiency gains in one use case unlock insights to further efficiencies
3	**Build durable Digital Delivery Partnerships** ■ Technology Suppliers ■ Post Pilot Digital Delivery partners	Identify Digital technology vendors and service providers who wish to partner with Cameron LNG. Build digital delivery capability to scale digital transformation at Cameron LNG through pragmatic and strategic partnerships.
4	**Build Credibility Demonstrate Efficacy** ■ Data speed / coverage / plot plan ■ Consumer grade devices / Field use ■ Form factor x data entry	Through scaled implementation model, demonstrate digital technologies and services are fit for purpose for Cameron LNG business size, scale, and existing technologies already implemented.

Digitizing Field Activities

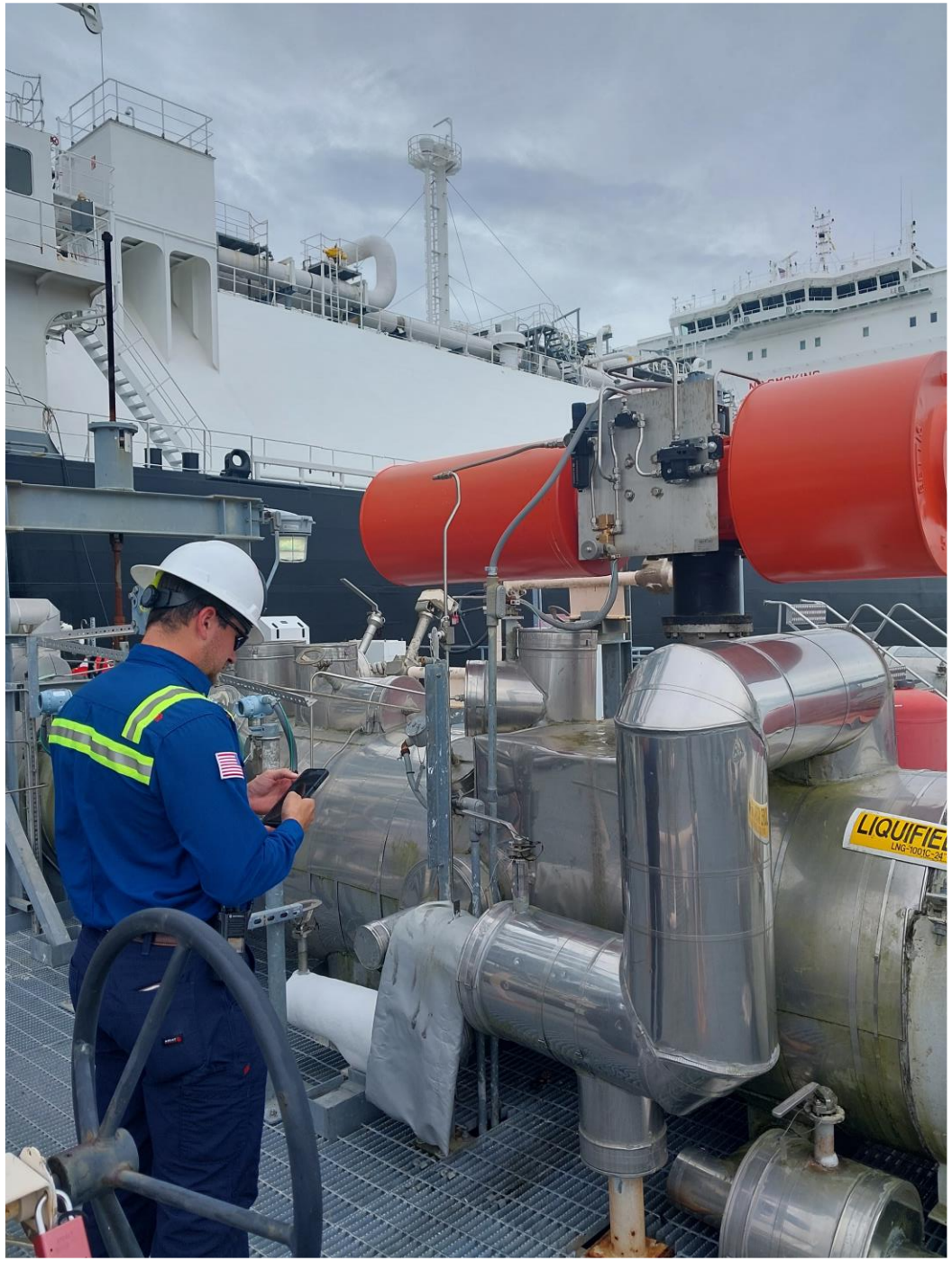
Field Wireless Data / Connected Worker

CONNECT the Connected Worker

Field Wireless Data

- Bring Data to the Field – access data systems in the Field. Reduce round trips to offices to access information.

- Bring Field Data to the Office – data entry from the Field, sensor data. Reduce manual entry and data errors



Challenge : Digital Technologies x Electrical Safety / Hazardous Locations

Digital Devices must be rated for use in Hazardous Zone – Class 1 Div 2 LNG Liquefaction Area

- LNG Equipment Areas – Primarily Class 1 DIV 2 – Electrical Safety
- Division 2 = Locations where ignitable concentrations of flammable gases, vapours or liquids are not likely to exist under normal operating conditions.
- Risk / Considerations
  - Sealed battery – waterproof, dust-proof
  - Time-based risk factors – how long is the device or equipment present in the hazardous location?
  - Device power

AVEVA™ Mobile Operator at Cameron LNG

Operator Rounds Management

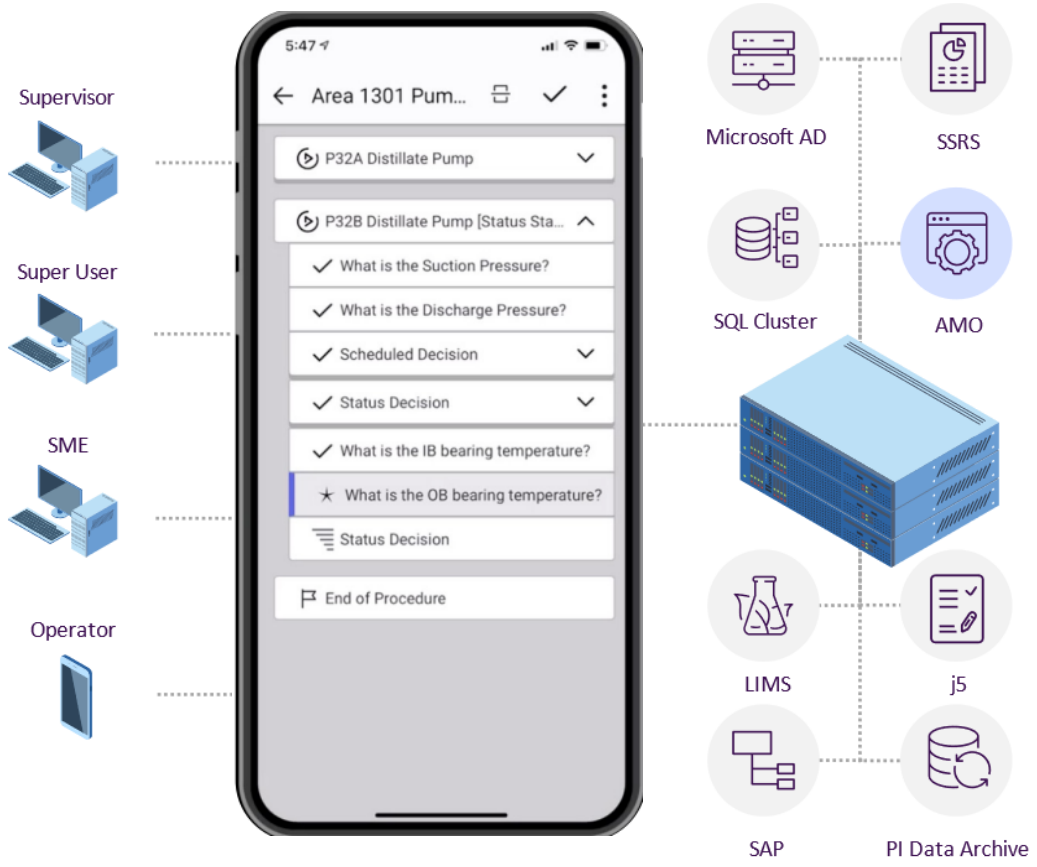
- Shift Operator Rounds – 3 shifts / day x 365 days
- Structured procedures to make Observations, Collect non-networked instrument data
- Write equipment maintenance requests if/when needed and sync directly to Maintenance System SAP
- Interfaces to SAP Preventative Maintenance, PI Historian, Shift Logbook, Lab Information System

- Intelatrac in use for many years at Cameron LNG

  2022: Added Field Wireless Data / CBRS network to Site

  2023: Mobile Operator 2020 R2 on Ecom Ex-Cover 6 Pro D2

  2024: Moving from shared / shift device to dedicated mobile handheld for each Operator



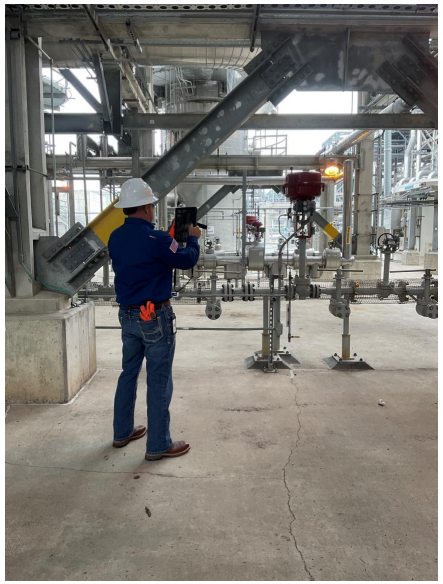
Field Wireless High-Speed Data

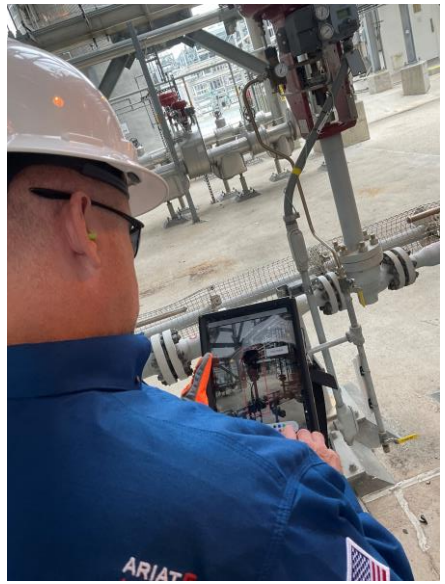
Private 4G LTE Band 48 (CBRS) Installation

- Cost-effective addition of high speed wireless data to Field Operations
- Support business processes in the Field
  - Not for process control
  - Not connected to control systems network
- High Security – SIM card required for access
- Not dependent on Public Carrier Network
- 1-2 LTE Cellular Radios cover 1 mile x 3 mile site
- CBRS / LTE Band 48 ease of use, no spectrum licensing
- LTE Band 48 Support in most all modern mobile devices – Apple & Android

Mobile Devices for Field Use

- Electrical Safety : Class 1 DIV 2
  - Apple iOS - Industrial cases; UL-certified
  - Android – Pepperl+Fuchs eCOM
- 4G LTE Band 48 (CBRS) for High-Speed data in the field





Ecom Ex-Cover Pro

Ecom Tab-Ex Model

Apple iPhone

Apple iPad

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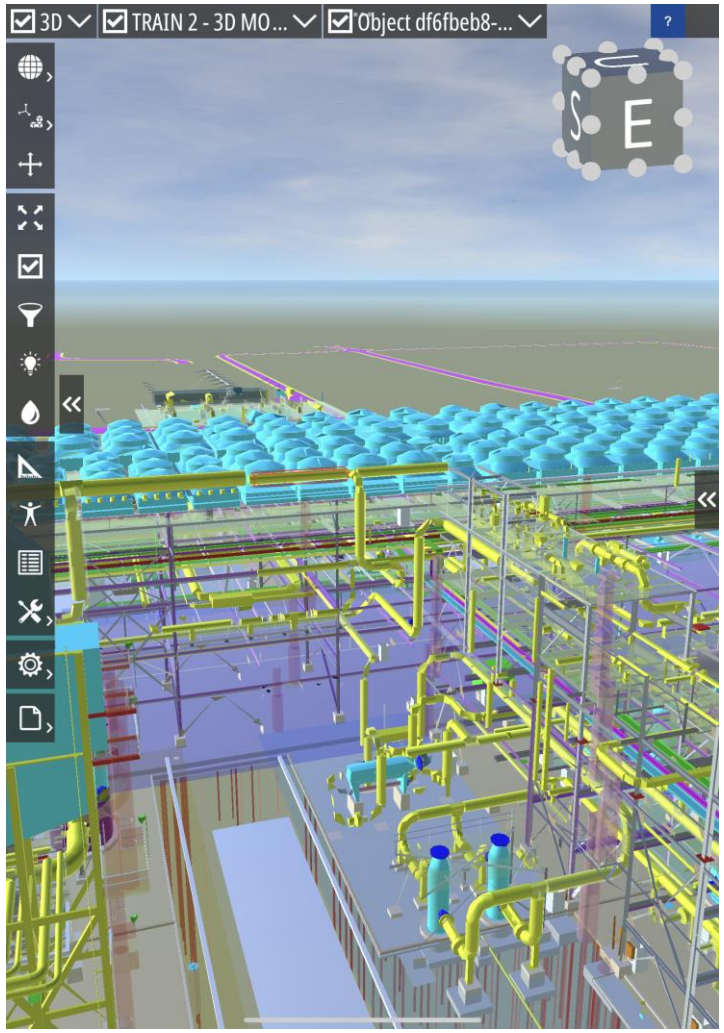
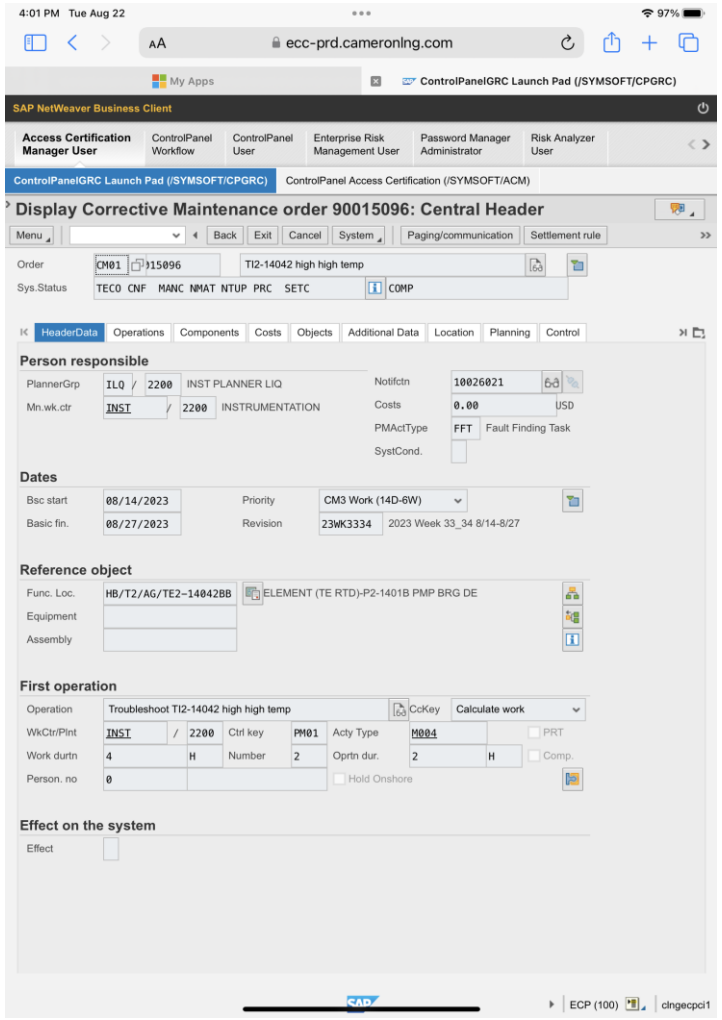
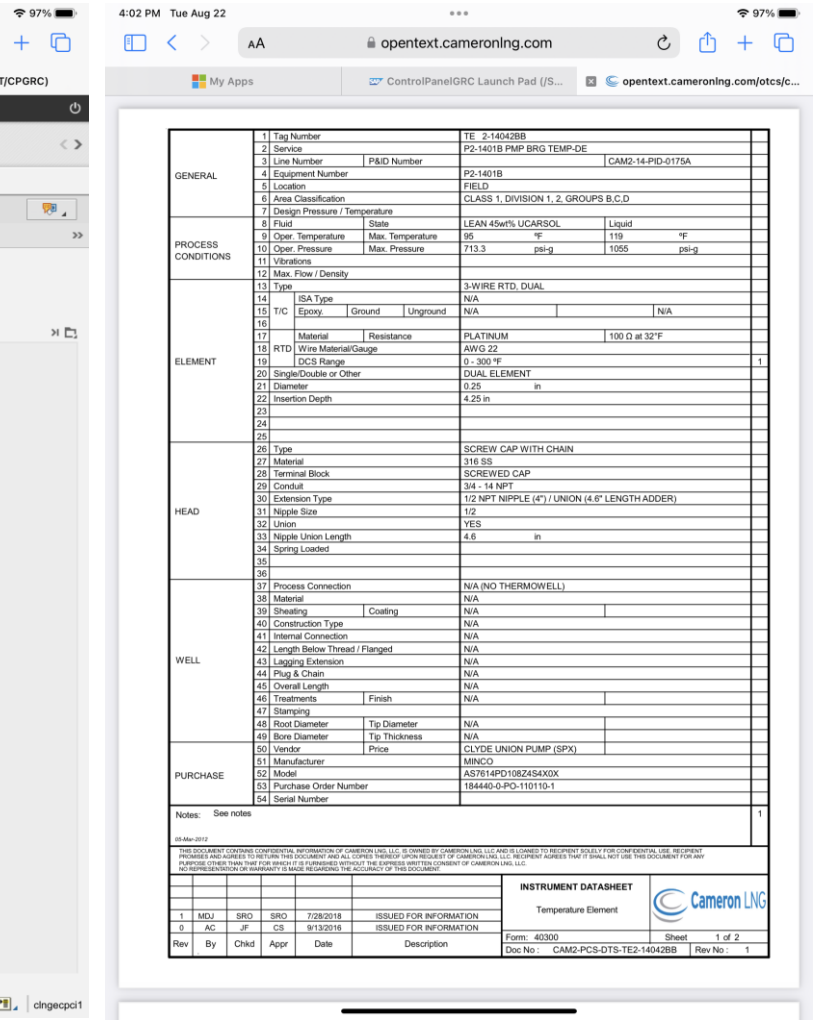
Digital Field Operations

Major Turnaround Maintenance Planning



Mobile Access to SAP Maintenance System Records





Wireless Field Sensors / PI Analytics

Electrically Safe : Class 1 DIV 2

Low Cost

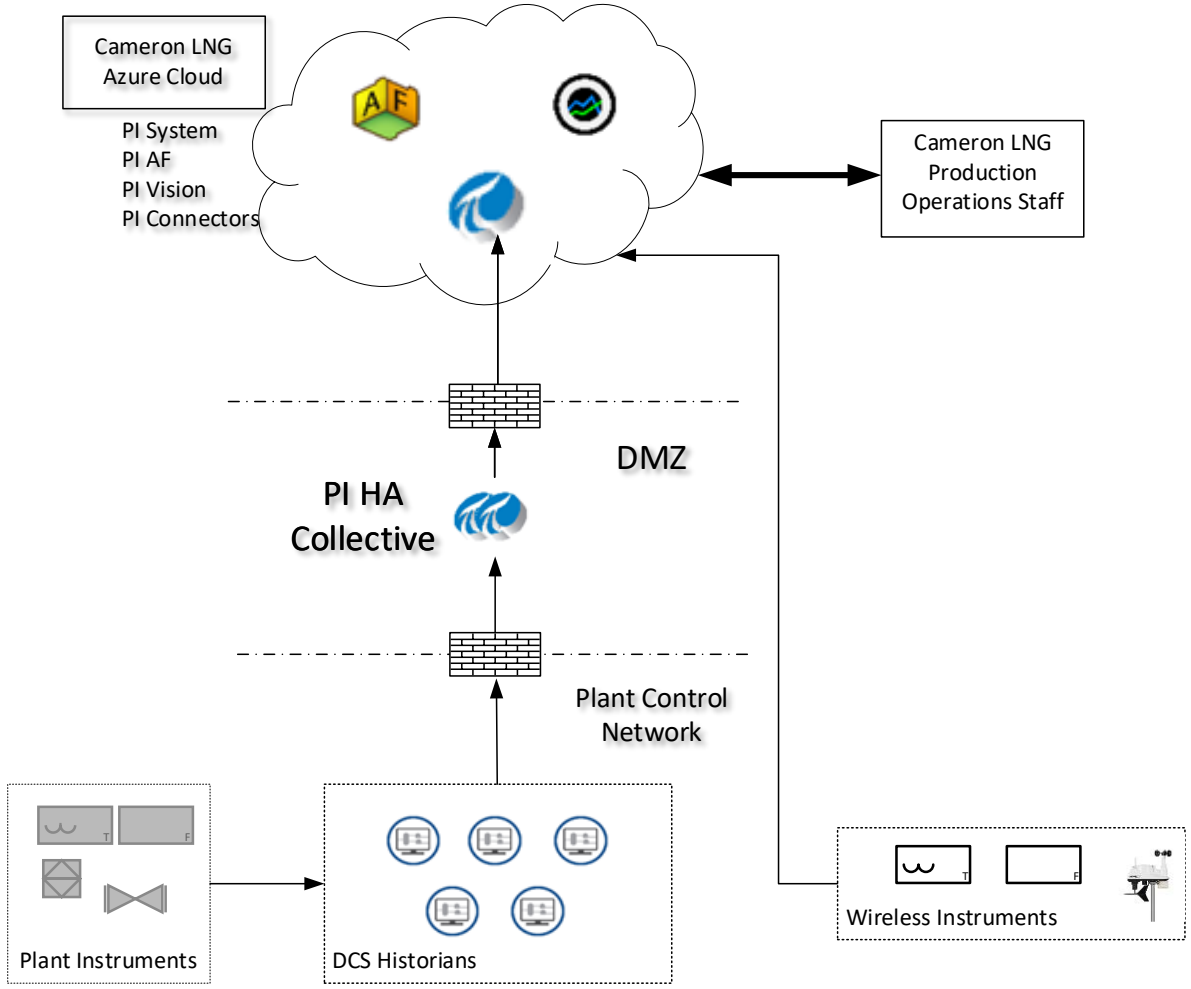
AVEVA™ PI System™ at Cameron LNG

Democratize plant data across the Enterprise

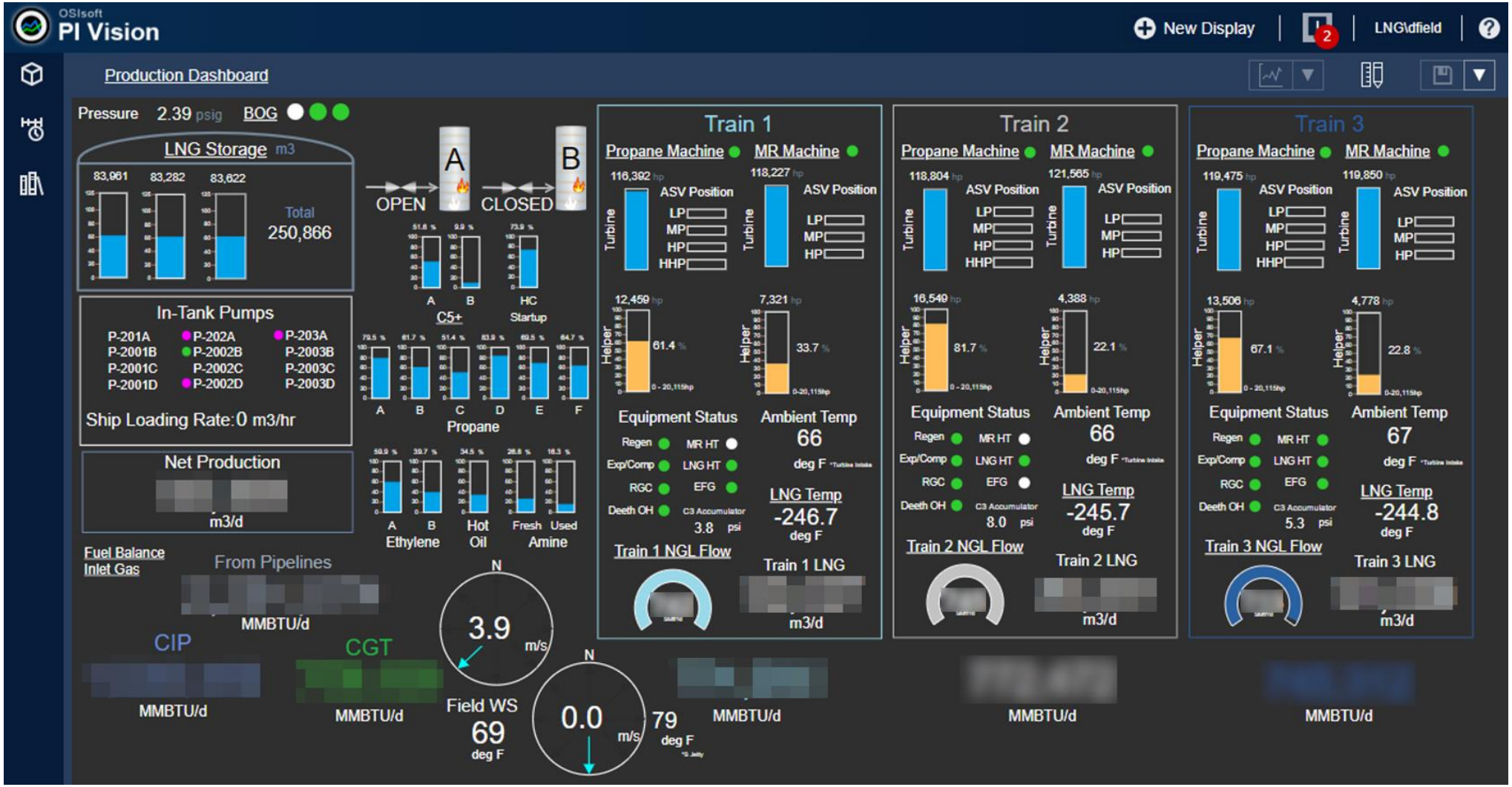
- All/Majority of all Control System / DCS data is available in PI System : ~70,000 PI tags
- PI Vision to democratize DCS graphics and frequently used graphics to understand current plant conditions
- PI Asset Framework (AF) for calculated values, e.g. environmental reporting : ~5000 AF assets
- PI data feeds Commercial, Operations Shift Logbook and generates LNG Cargo Certificate of Quality
- Critical systems for Analysis, Production Planning and Optimization

  2023: Seeq rollout – *Engineering Data Workbench*

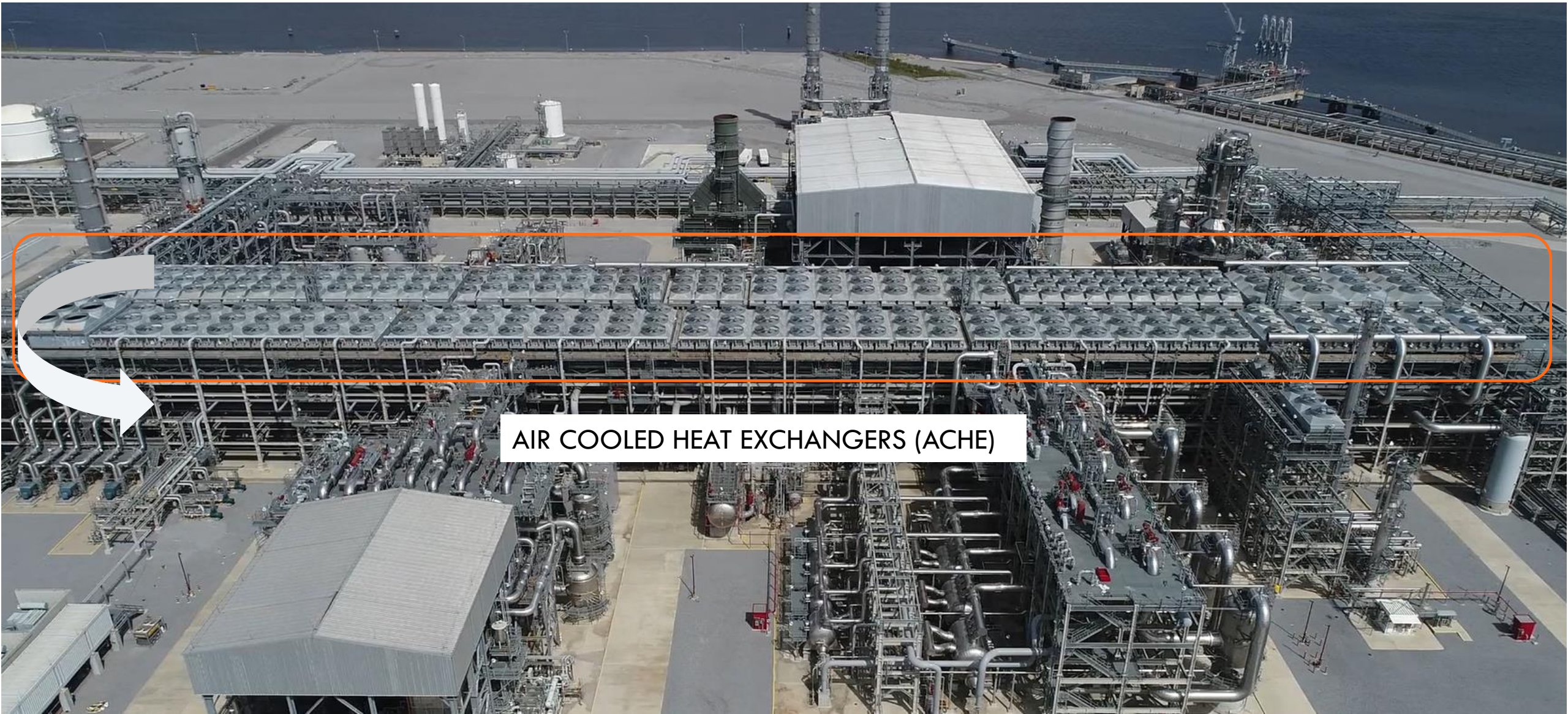
  2024: Wireless Field Sensors – additional data sources to PI using PI Connectors



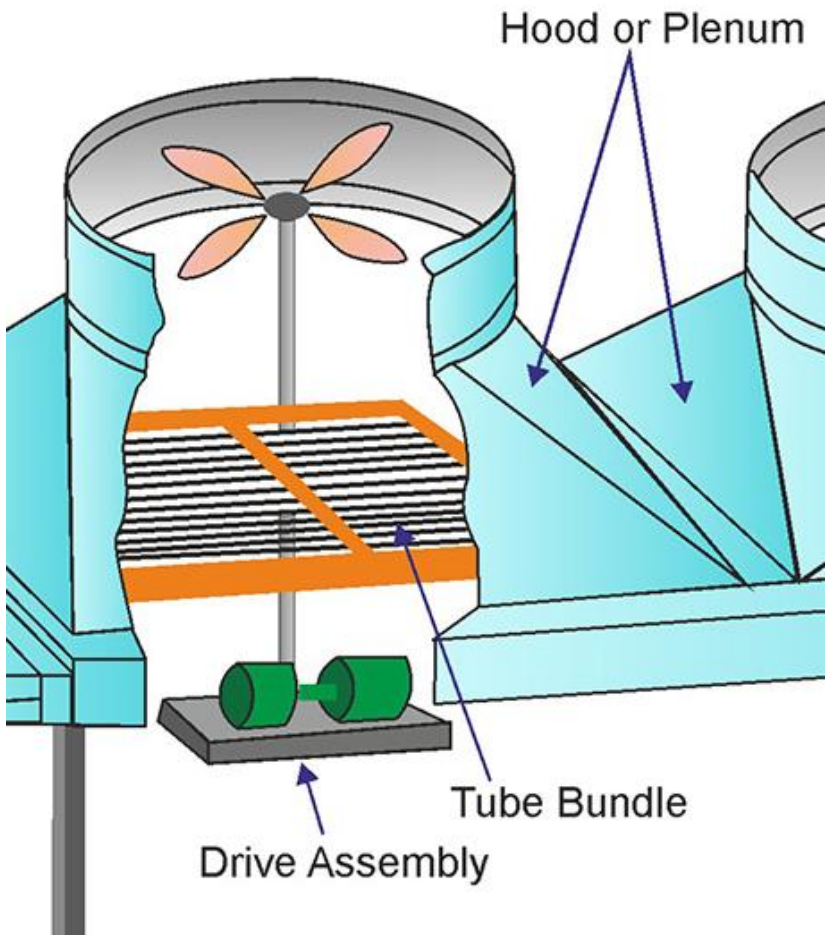
Production Operations Dashboard with PI Vision



Challenge : Hot Air Recirculation (HAR) effect on ACHE



Hot Air Recirculation (HAR) to Air-Cooled Heat Exchangers



LNG Industry Challenge : HAR impacts LNG Production

Understand / Correlate temperature profile across banks Air-Cooled Heat Exchangers

Understand / Correlate ambient temperature across site under different weather and wind conditions to Heat Exchanger Performance and resulting Production

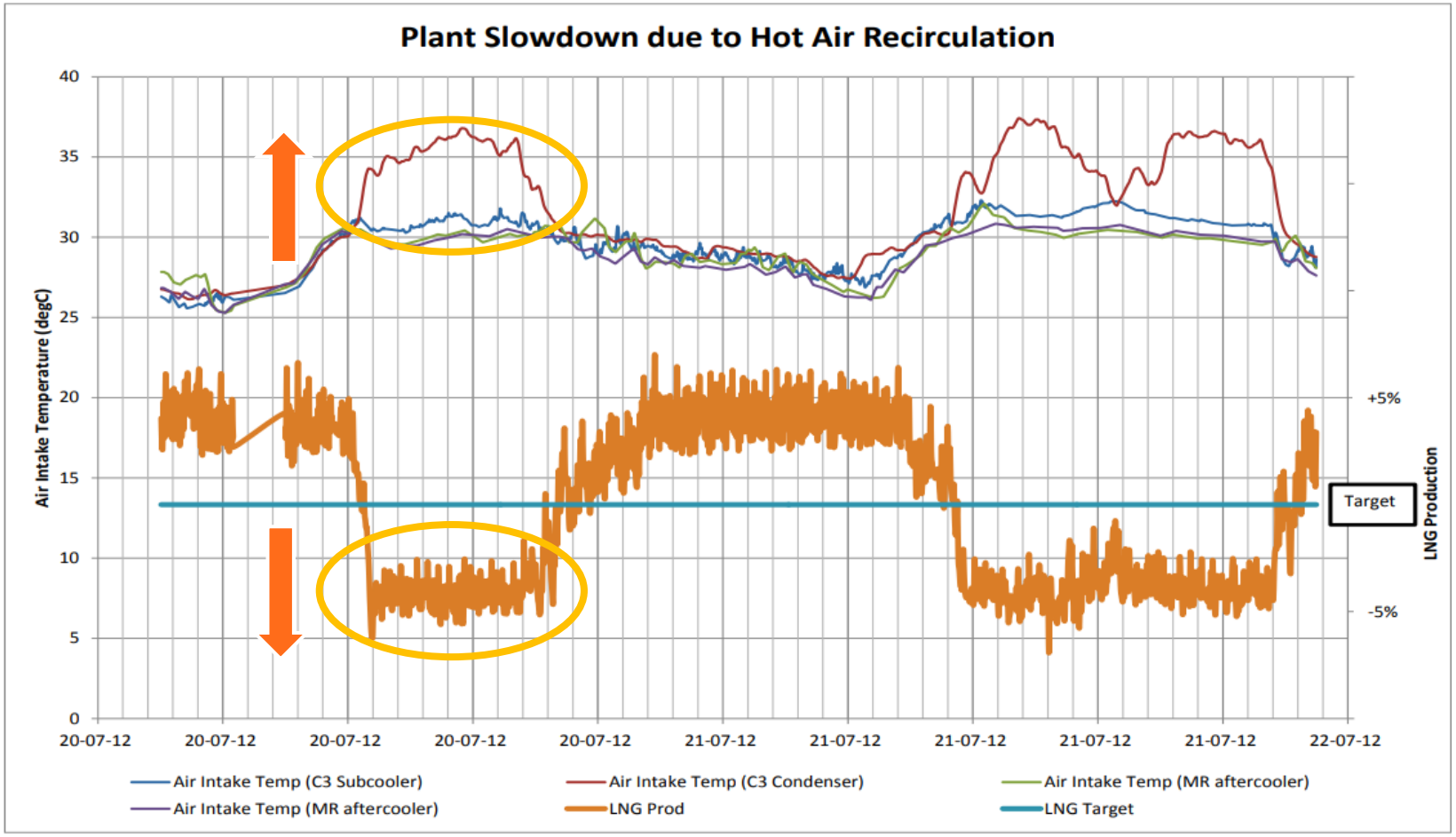
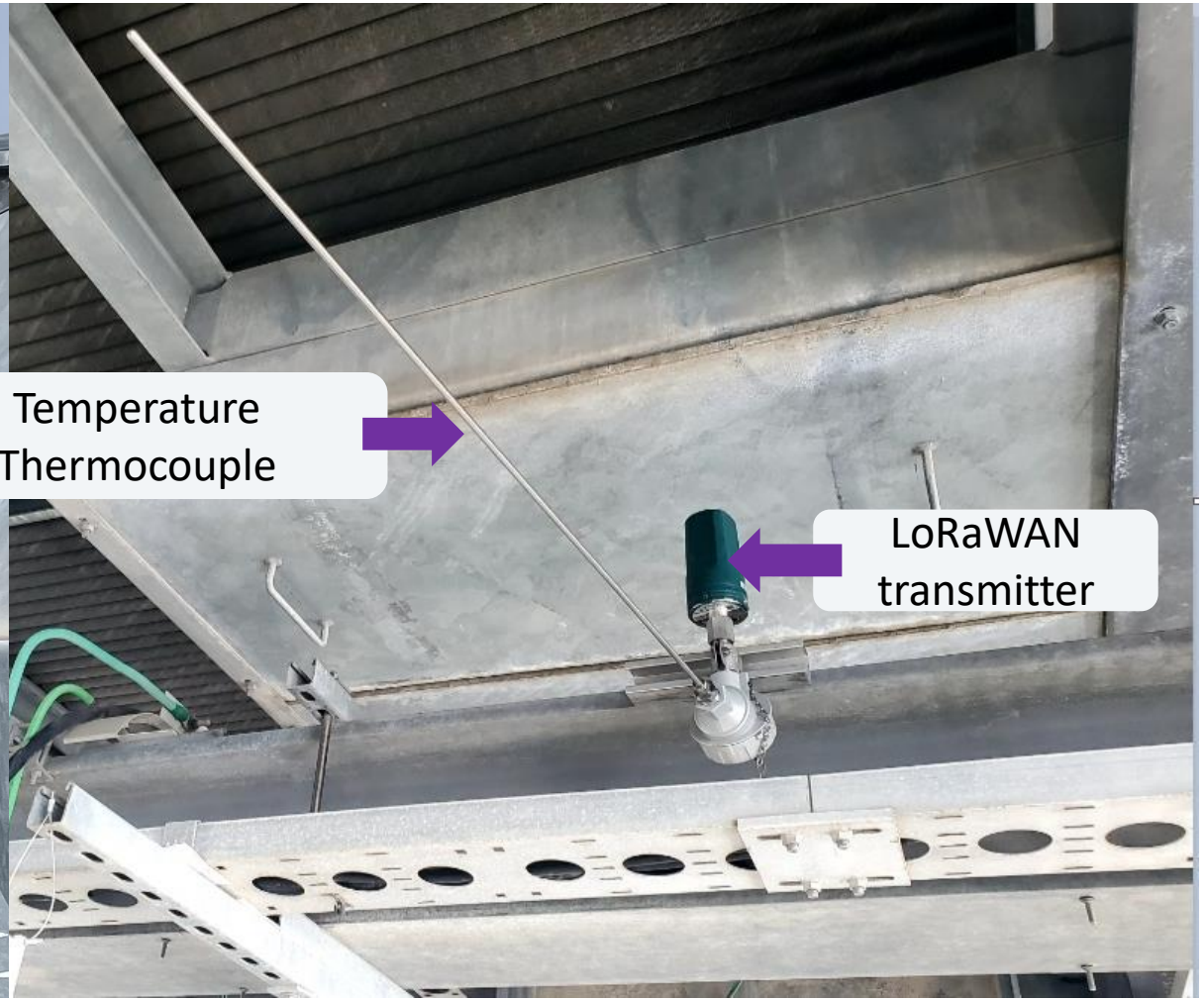


Figure 4. Plant Slowdown Due To HAR for MLNG Tiga

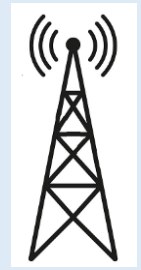
Wireless LoRaWAN Ambient Temperature Sensors to PI System



Wireless Weather Stations – Ambient Temperature to PI System

Wireless Sensor Pilot - LoRaWAN / PI Architecture

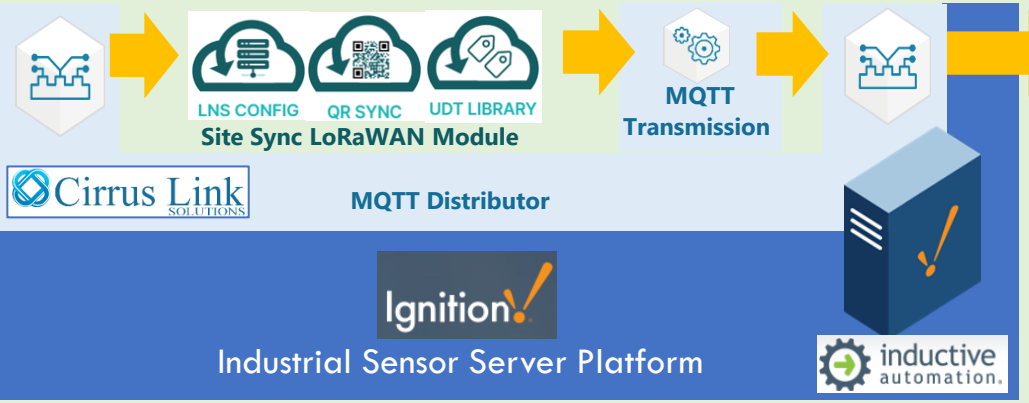
Long Range + Low Power + Class 1 DIV 2 Wireless Sensors



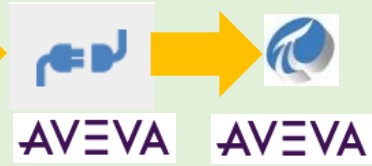
Antenna Tower

MultiTech Conduit 300 Gateway
Field Systems Rack

Ignition IIOT
Industrial Automation / Data Services



PI System



LoRaWAN Sensors	LoRaWAN RF 902-928 MHz Antenna	LoRaWAN Gateway, Network Server & Join Server	MQTT Broker Sparkplug B Server/Broker	Ignition with Site Sync Module Functioning as LoRaWAN Enablement	MQTT Transmission Sparkplug B Publisher	MQTT Broker Sparkplug B Server/Broker	MQTT Client PI MQTT Sparkplug B Connector	AVEVA PI Server
Send LoRaWAN Sensor Data via LoRa RF	Receive LoRaWAN Sensor Data via LoRa RF	Demodulate LoRa RF LoRaWAN Sensor Payloads and Publish MQTT over IP	**MQTT Distributor**: Publishers Deposit Data and Subscribers Consume Data	**SiteSync Module**: Decode LoRaWAN Payload. Build Sensor Data Tag structure. Configure Connection LoRaWan Network Server	**MQTT Transmission**: Publish Decoded LoRaWAN Data Tags to the MQTT Distributor		MQTT Subscriber of Decoded LoRaWAN data. PI Tag Creation	PI Tags / AF Structure

Cameron LNG

ACHE Wireless Temperature Sensor Trial – Rain/Storm Event

10/3 12:16p

10/4 11:42a

Digital Solutions Summary

Business Opportunity	Digital Solutions

• Digitize LNG Operations business processes
  ○ Reduce manual effort in data entry
  ○ Gain access and insight to data ‘trapped’ on paper
• Digital technologies enable field access to Operations systems and data in usable formats to maximize ‘wrench time’ and minimize office data entry/data visualization
	Consumer-grade Mobile Tablets and Smartphones rated for use in Hydrocarbon hazardous areas with high-speed wireless data network
	
	Private 4G LTE/CBRS : Wide-area high speed data with high security. Cost-effective to implement and support
	
	Mobile Digital Applications for Industrial Business – Aveva Mobile Operator, Shift Logbook, SAP PM, Electronic Work Permits, 3D Review Model

• Add additional data monitoring instrumentation capabilities for different parts of LNG Production	Low Cost Wireless Sensors – Temperature, Vibration, Position LoRaWAN wireless data infrastructure to PI System

Challenges

- Technology Industry has been slow to deliver cost-effective, modern digital devices for safe use in Hydrocarbon Operations environment
- Historical lag to bring latest consumer technologies to industrial environment at affordable price point is getting better but still lacking
- Ex/Electrically Safe solutions needed for:
  - Handheld computers
  - Wireless Sensors
  - Wireless Communications
- Energy Industry needs to collaborate effectively with Technology Industry to accelerate solutions and time to value

AVEVA

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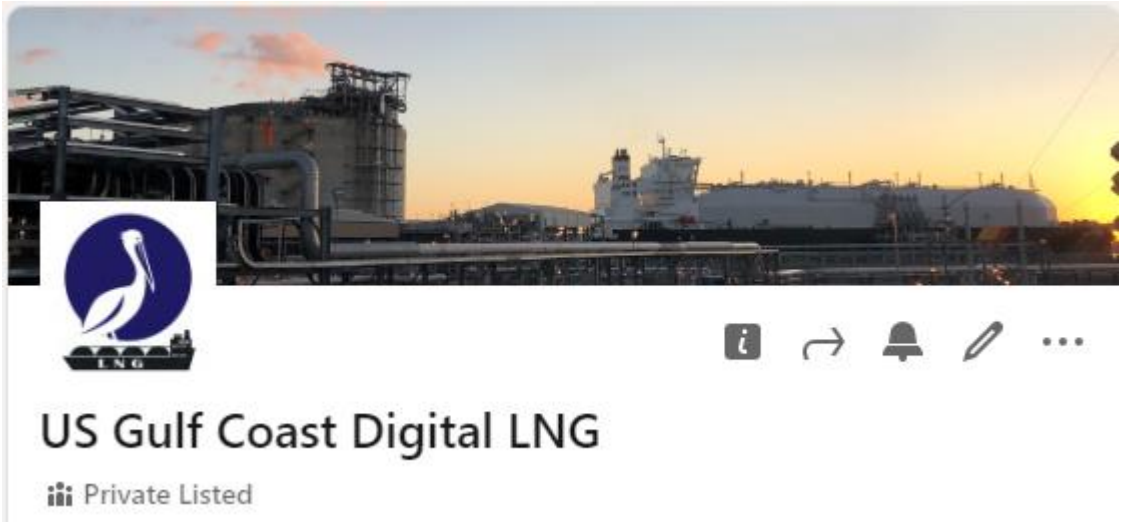

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Questions?

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State your name and company.

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Navigate to this session in the mobile app to complete the survey.

Thank you!

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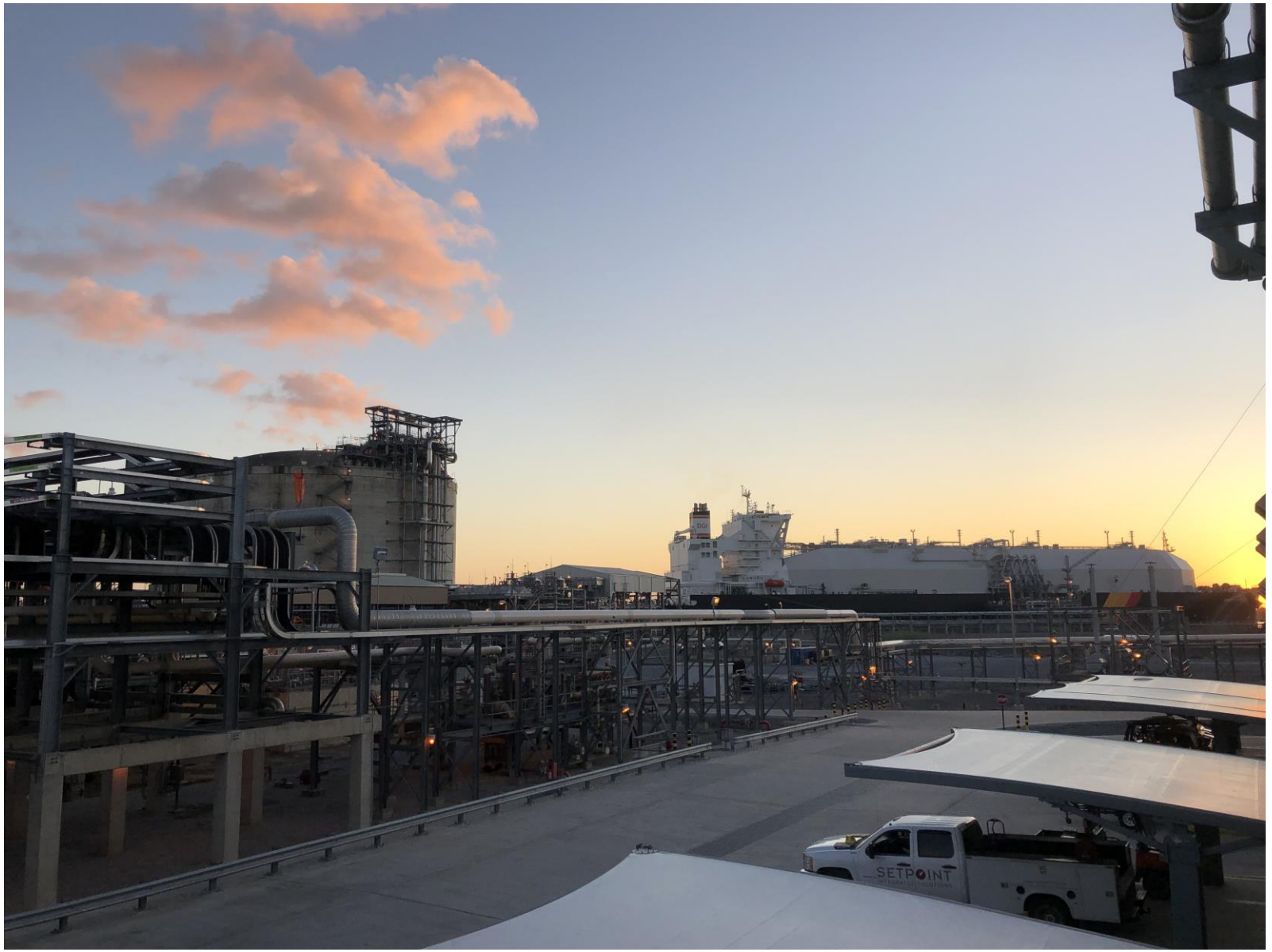

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