INDUSTRY X.0

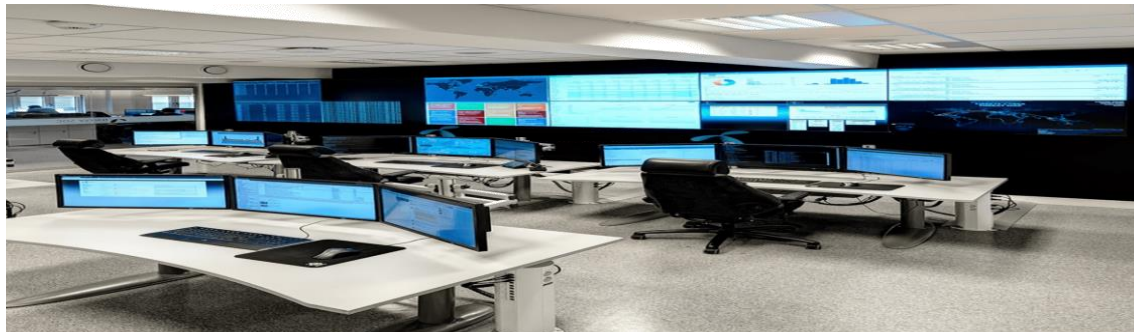
accenture

CENTROS INTEGRADOS DE CONTROLE

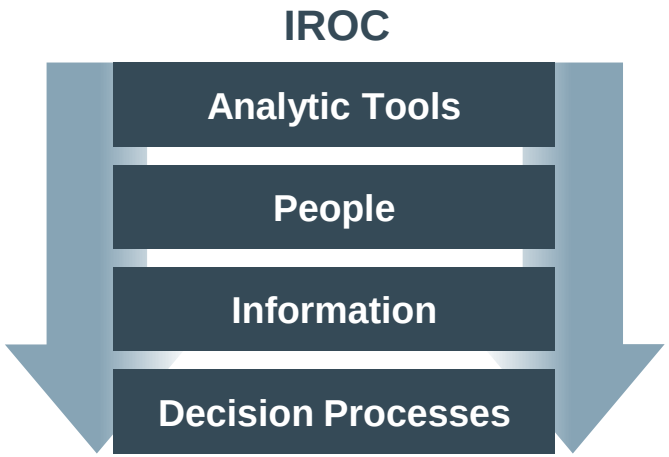
01

IROC CONCEPTS

INTEGRATED REMOTE OPERATIONS CENTER



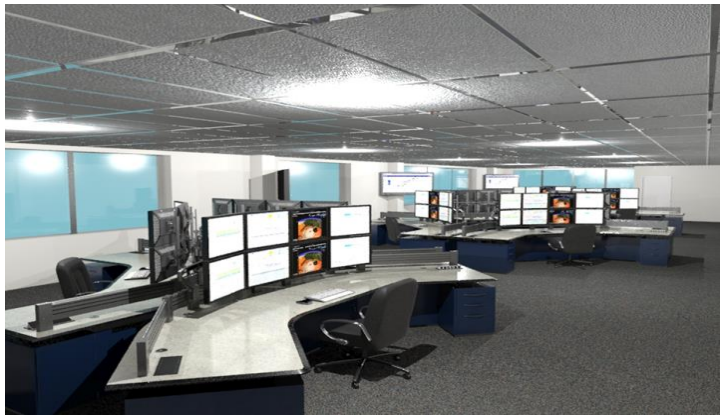
An Integrated Remote Operations Centre (IROC) is a collaborative environment organized to gather all necessary resources for decision making targeting operational improvements.



The value of an IROC lies in broadening the scope beyond the operations room and into strategic and tactical management. The IROC also includes data analytics and decision making. IROC is adopted to all types of industries.

INTELLIGENT REMOTE OPERATING CENTER IS A MATURE CONCEPT

MINING

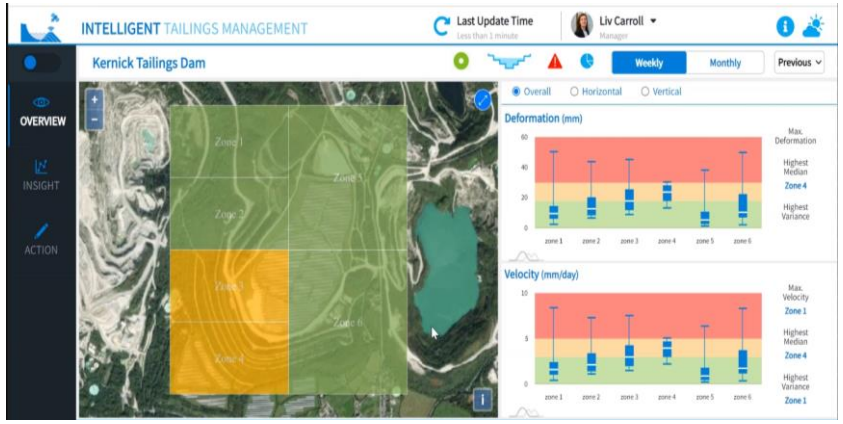


AÇUCAR E ÁLCCOL

OIL UPSTREAM

POWER GENERATION AND DISTRIBUTION

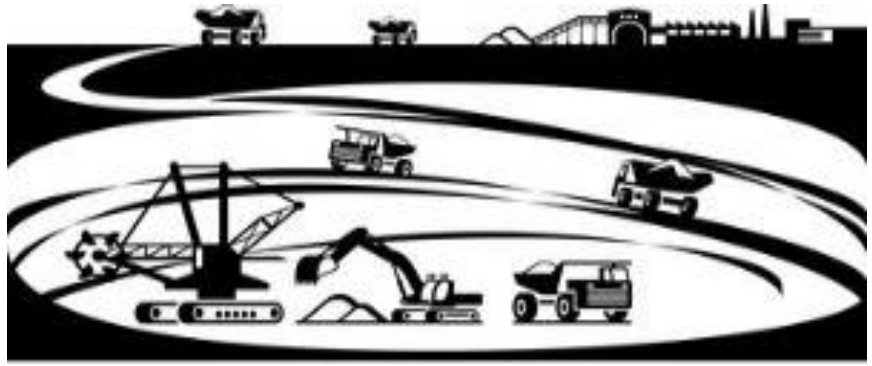
GEOTECHNICAL MONITORING



DOWNSTREAM LOGISTICS

IROC ENABLING PROGRAMS AND TECHNOLOGIES

- Collaboration Tools
- Change Management
- Simulation & Digital Twin
- Digital Worker
- Operations Performance Management
- Predictive Asset Management
- Worker Location
- Ergonomics & UI/UX design
- Compliance Management
- Knowledge Management
- Autonomous Operations
- IT/OT Security
- Platform Integration
- Water Management
- Energy Management
- Smart Mine Smart Plant Smart Logistics
- Precision Mining
- Overall Risk Management
- Data Reconciliation & Production Accounting
- Electronic Documentation
- Electronic Work Permit



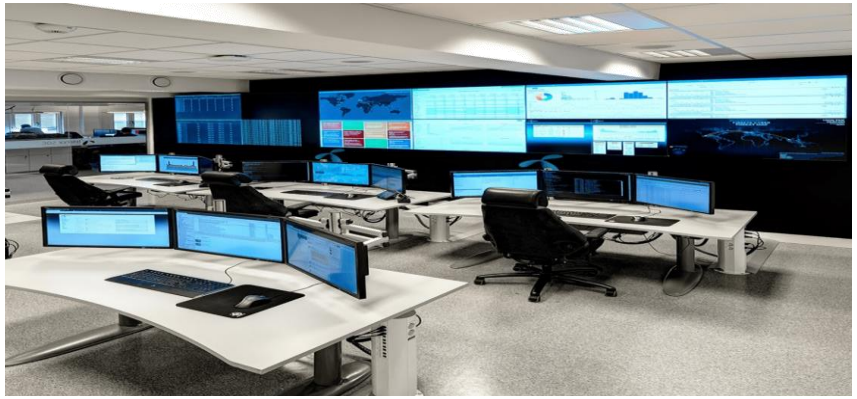
IROC ENABLING PROGRAMS AND TECHNOLOGIES

Collaboration Tools

Change Management

Simulation & Digital Twin

Digital Worker



Operations Performance Management

Predictive Asset Management

Worker Location

Ergonomics & UI/UX design

Compliance Management

Knowledge Management

Autonomous Operations

IT/OT Security

Platform Integration

Water Management

Energy Management

Smart Factory
Smart Warehouse
Smart Logistics

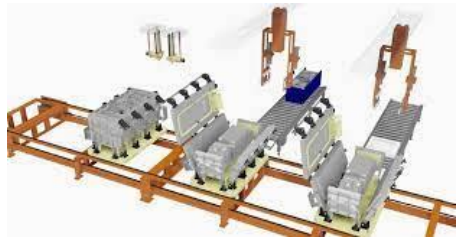
Connected Factory

Overall Risk Management

Production Planning & Execution

Electronic Documentation

Electronic Work Permit



MOTIVATORS

Production Optimization	The best practices are built, documented, and adopted to all production units. The rollout of best practices is automatic. **Process standardization and continuous improvement** assures the evolution of production processes and eliminates, “dialects” inside company.
Cost Reduction SME Sharing	The best specialists are available to all production units and not to just one plant
Performance Improvement	**Reducing process variability** like recovery in flotations brings immediate results. The more interactive is the plant the best the improvements are.
Cost Reduction Condition Based Maintenance	Moving the paradigm from “run to failure” to predictive reduces maintenance costs, reduce downtime and repair time.
Simplify Governance	Companies face difficulty to promote horizontal synchronization, because human organizations are vertical in nature. IROC offers a model for horizontal synchronization.
Optimize Production Chain	Look for the global optimum, not the local one.

MOTIVATORS

Improve Safety

IROC allows the reduction of human footprint in the plants, reducing the chance of accidents in the production areas and in the way (transportation) to the sites.

Reduce Infrastructure costs

Building housing and complementary urban infrastructure in remote places is expensive and difficult to sustain. Fly In / Fly Out schemas are expensive and reduce people ownership and engagement.

Attract and retain talents

It is difficult to motivate people to live in remote places. New generations prefer to raise their families in places with good urban infrastructure: schools, hospitals, access to continuous educations, etc. Young people want to work with advanced technologies like they use in their day to day lives.

Foster Collaboration

To promote horizontal collaboration eliminating operational silos. Optimizing promotes collaboration between planning and execution and across the production value chain phases.

Reduce people dependency

Operating desks in a IROC are process oriented. All interactions between them are formally defined, or “choreographed”. It is less dependent on people and on talent and uniform among shifts and crews.

IROC MATURITY CURVE

Maturity Level

I

Control Centers

Fusion of traditional control rooms

- Archipelago of WS doing traditional control room activities
- Low WS interaction
- Provides **Visualization** and basic operations
- Good technical infrastructure for data, image and voice to communicate with plant floor

II

Integrated Operating Centers

Focus on integration of all unitary processes

- Process based activities organization
- Includes Planning x Execution Consolidation
- Includes vertical programs like Energy/Water Management, Autonomous Plant, Production Accounting, etc.
- KPIs Management & Dashboarding
- Basic Data Analytics
- Worker security programs: worker and contractor tracking, etc.

III

Smart Operating Centers

Focus on supporting decision making with Data Analytics

- High data analytics contents to support decision making
- Consolidated Knowledge Management
- **Digital Worker** program makes perfect link between center and the field
- Decision Making Traceability
- Optimization tools for some processes: APC, control loops, corrosion management, leak control, etc.

IV

Production Chain Integrated Center

Focus on Overall Production Chain Optimization

- Focus in holistic source to destination optimization programs
- High-end optimization programs: Zero Harm, Zero Loss, Zero Waste Monitoring, Product blending, etc.
- Strong digital twins contents
- 3D visualization and AR/VR interaction
- Value Realization Office

Visibility — **Process Integration** — **Data Analytics** — **Overall Optimization**

THE SEVERAL FLAVORS OF IROC

- Production short term planning
- Plant Operations: Control Room integration
- Equipment dispatching
- Production Chain visualization
- Horizontal decision making
- Process KM and optimization

Operations

- Maintenance planning
- Maintenance dispatching
- Automation Assets Monitoring
- Control Loop Management
- Condition Based Monitoring
- Predictive Maintenance
- Over the shoulder Coaching

Asset Management

- Regulatory Control
- APC - Advanced Process Control
- RTO – Real Time Optimization
- Historians
- Dashboards
- Data Reconciliation

Expertise Center

- Energy: electricity / fuels
- Water management
- Utilities: O2, N2, CO2, compressed air, Ar, BFG, COG
- Carbon Footprint
- Renewables Energy
- Effluents, Emissions, Dust
- Communities' relationship

ESG

- Local Inbound/Outbound
- Train / Ship Logistics
- Product tracking / blockchain
- Reception / Shipping Yard management
- Delivery Scheduling

Logistics

- Overall Process and Production visibility
- KPIs Management using dashboards
- Integrated Production Planning
- Inventory Management
- Production Accounting
- Planned x Executed
- Bottleneck Management
- What If Analysis

Intelligence

IROC AND IRIC ARE DIFFERENT CONCEPTS

iROC

1) Focus on remote operations, controlling all mine and plant unitary processes remotely
2) Begins focusing a single production chain: mine + processing plant + logistics
3) Smart systems are postponed to wave 3. Operate remotely is the first objective.
4) Move operators to a central location, improving safety
5) Real time interaction, short time range analysis
6) Operational Focus
7) Foster sustainability of horizontal mining programs
8) More complex to implement
9) Big Bang

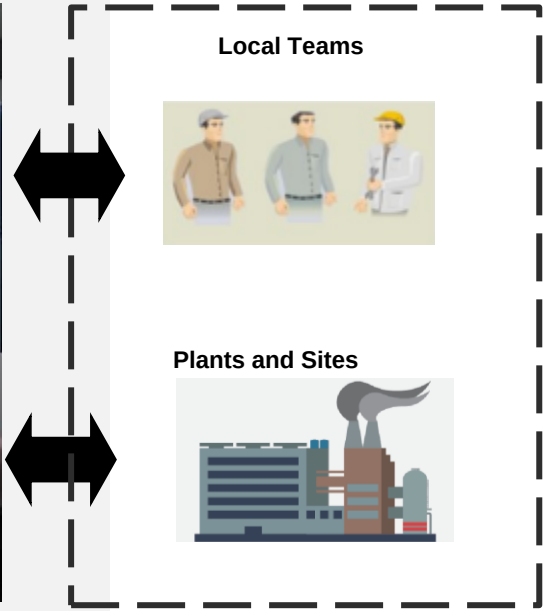
iRIC

1) Focus on overall visualization and data analytics
2) Can focus the full production ecosystem (holistic view) from the beginning
3) Captures overall synchronization opportunities across processes using unified production planning and variability control
4) Data analytics unveils actionable information for optimization
5) Near real time, short, medium and long-time range analysis
6) Tactical and Strategic Focus
7) KPIs and dashboarding
8) Foster Best Practices
9) Foster Internal Benchmarks
10) Manage Risk Management
11) Foster standardization
12) Easier to implement
13) Evolutive

iEC – Integrated Expertise Center

Process Control Optimization

iECs share specialists in advanced topics across the organization.



iEC – Process Control Center is a ground-breaking collaborative environment focused on maximizing and sustaining assets performance

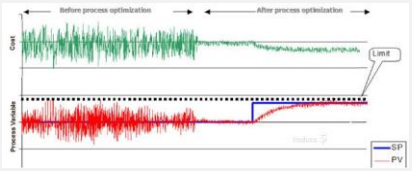
It can be seen as a shared services bureau for technical subjects, providing immediate first line of action and support and developing internal standards, best practices and knowledge repositories.

What kind of programs can be performed in those expertise Centers?

- Advanced Process Control, Control Loop Optimization, Expert systems for process optimization
- Robotics, OT Assets monitoring and management, Asset Management, including predictive maintenance, Technical architecture definition and management, including cybersecurity
- MSM - Multivariate statistics management, Dashboarding – managing all KPIs related to OT
- Services help desk

Some centers are specialized in managing the technical, HPGPS and other services.

There are cases were iEC became an independent company



iEC can be used to ensure control program sustainability, using advanced performance monitoring tools.

IROC IMPLEMENTATION JOURNEY FOCUSES ON SIX WORKSTREAMS

PROJECT MANAGEMENT APPROACH WILL DEPEND ON START POINT AND SCOPE

The start position & current baseline / maturity, as well as the overall end goal will often help determine the appropriate project management approach to take (this may also be influenced by industry standard).

Agile project management methodology can often be used when the IROC concept is being incrementally improved or expanded. Whereas **Waterfall** is more often used when an IROC vision is being stood up for the first time; starting with a Blueprint.

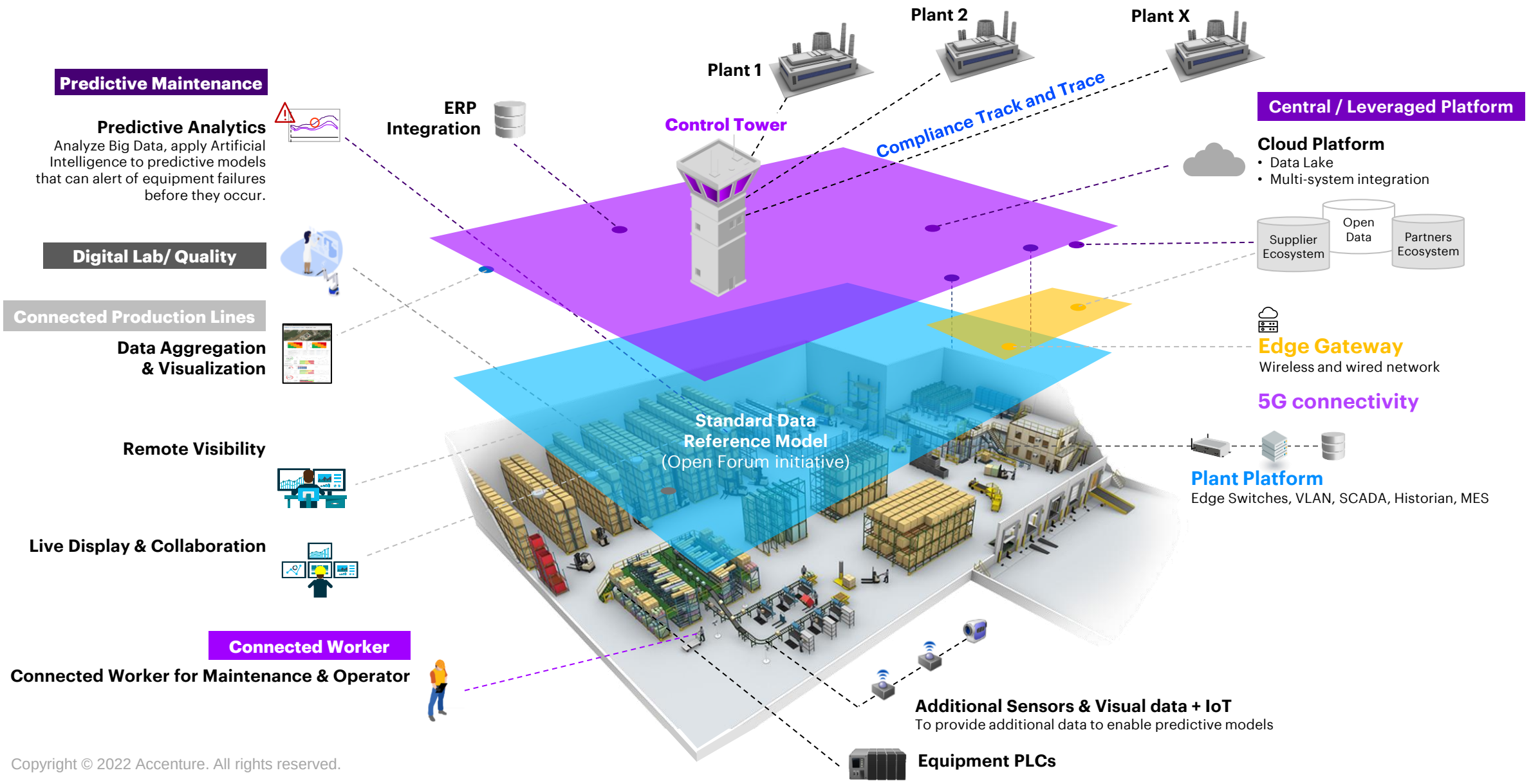
IROC will have an ongoing Sustain period either adapting to real process changes on site or driving the change e.g. due to new technology introduction or benchmarking/standardization across sites (equalize & optimize processes).

02

MANUFACTURING CONTROL TOWER

INDUSTRY X

INTEGRATION BETWEEN LAYERS



INDUSTRY X

MANUFACTURING CONTROL TOWER

Possible **Manufacturing Control Tower** Functions:

- Production Planning
- Execution Management
- KPIs Management & Dashboads. Ex: OEE, OTIF, FPY, etc.
- Inefficiencies Management: Losses, Rework, Waste
- Energy Management, Utilities Management: electrical energy, fuel, water, compressed air, etc.
- Inbound, Outbound Logistics
- ESG Management
- Digital Twin, line simulation, what-if analysis
- Bottleneck Detection
- Maintenance dispatching
- Variability analysis
- Raw material, product inventory control, WIP management
- Communication with In-Field supervisors
- Circular economy management

INDUSTRY X

PLANT OF THE FUTURE

3 YEARS

Safety
For our employees and Clients

Quality
Of our products and services

Productivity
To invest more in the future with increased profitability

People engagement
To be the best we can be

Clients satisfaction
To earn client trust and loyalty

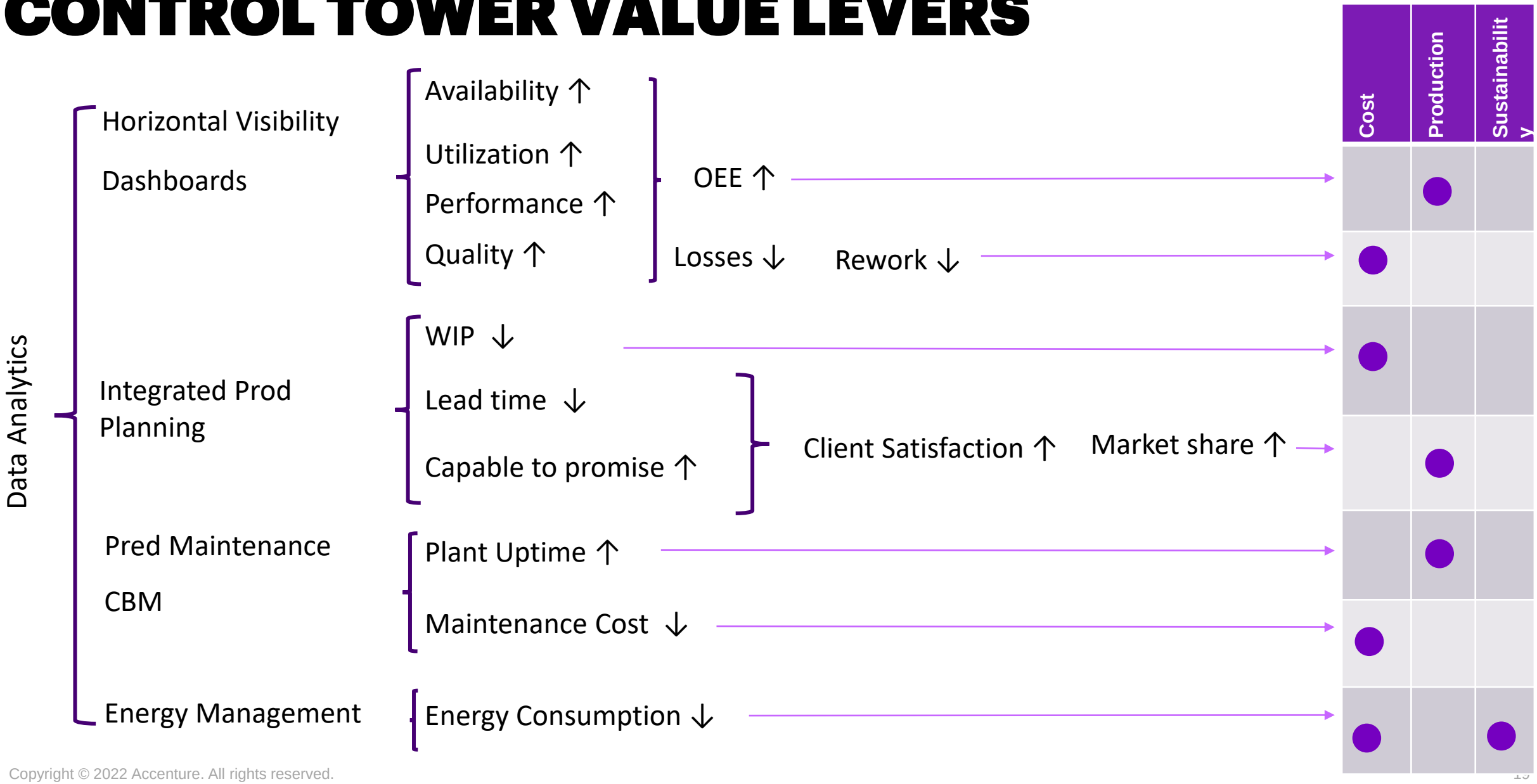
BASE Technologies

- Digital Twin
- Computer-integrated manufacturing
- Internet of Things
- Database & Cybersecurity

ENABLING Technologies

- Predictive Maintenance
- Augmented Reality
- Virtual reality
- Motion Capture
- 3D printing
- Adaptives AGVs
- Collaborative Robots
- Exoskeleton
- Intelligent Communication
- Radio frequency identification

CONTROL TOWER VALUE LEVERS



USE OF VR/AR

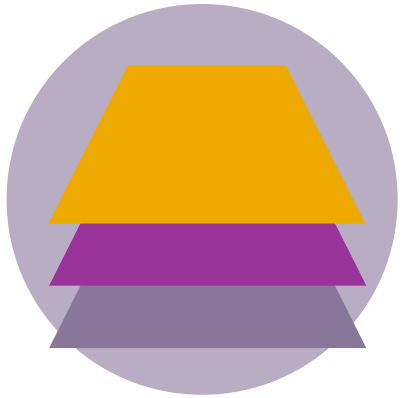
OVER THE SHOULDER COACHING THE SPECIALIST IS IN THE CONTROL TOWER (OR HOME)

INDUSTRY X

INTELLIGENT SUPPLY CHAIN CONTROL TOWER

OVERVIEW

Intelligent supply chain control towers and/or centers of excellence (CoE) drive **cross-functional collaboration** and **decision making**



3 layers of capabilities across the **entire supply chain**

DRIVE

1

An integrated framework providing **real-time visibility**, root cause analytics enabling rapid response and continuously improving process execution

2

A set of capabilities that seek to **combat rising volatility, complexity and uncertainty**

3

An **integration of supply chain processes** and tools across silos (enhanced collaboration)

4

A focused approach to **deliver a specific set of business outcomes – targeting improvements** in costs, inventory, quality, customer service and assets utilization

Visibility, Planning & Execution

TODAY'S ORGANIZATIONS NEED TO RAPIDLY SENSE AND RESPOND TO CHANGES IMPACTING THE SUPPLY CHAIN

Abnormal Demand Patterns

Lack of Operational Visibility

Supply Disruptions

Imbalances in Capacity

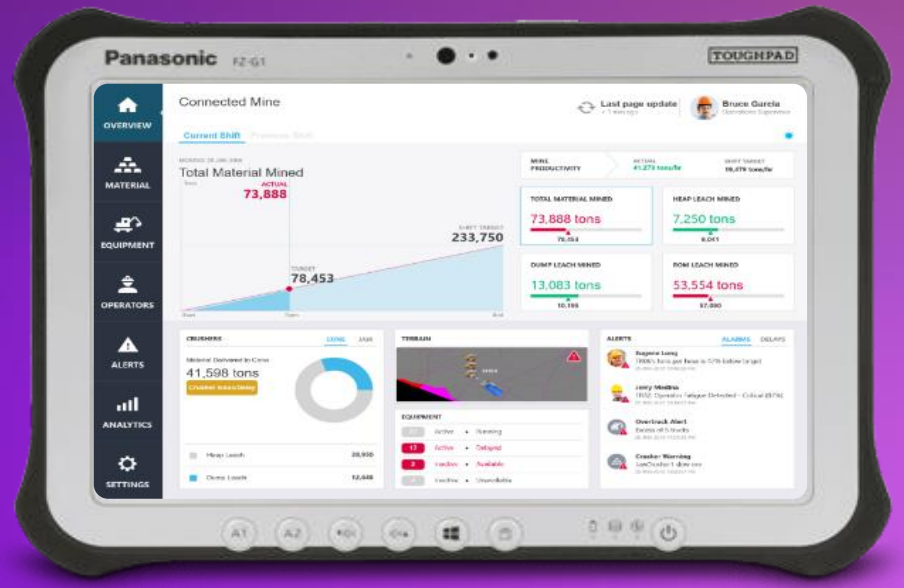
Unplanned Events – Natural Disasters, Pandemics

Geopolitical Challenges and Disruption

THERE ARE MANY DIFFERENT PERCEPTIONS ON WHAT A “CONTROL TOWER” IS…

- Logistics Platform
- Scenario Modeling
- Planning Tool
- Decision Engine
- Real-Time Supply Chain Visibility
- Data Visualization and Dashboard
- Centralized Command Center
- Workflow Management

03



INFORMATION SHOULD BE AVAILABLE EVERYWHERE

Connected Mine

OVERVIEW
MATERIAL
EQUIPMENT
OPERATORS
ALERTS
ANALYTICS
SETTINGS

Last page update
Up to date

Bruce Garcia
Operations Supervisor

Current Shift | Previous Shift

MONDAY, 31-OCT-2016

Total Material Mined

MINE PRODUCTIVITY	ACTUAL	SHIFT TARGET
	39,170 tons/hr	19,479 tons/hr

TOTAL MATERIAL MINED
147,894 tons
143,573

HEAP LEACH MINED
13,860 tons
11,056

DUMP LEACH MINED
14,551 tons
18,657

ROM LEACH MINED
119,483 tons
104,478

CRUSHERS

CONE | JAW

Material Delivered to Cone
33,908 tons
Long Queue Time

Heap Leach	24,144
Dump Leach	9,764

TERRAIN

EQUIPMENT

20	Active	▸	Running
17	Active	▸	Delayed
2	Inactive	▸	Available
11	Inactive	▸	Unavailable

ALERTS

ALARMS | DELAYS

Kaycee Tolman
TR18's tons per hour is 75% below target
31-OCT-2016 10:20:11 AM

Jerry Medina
TR32: Jerry Medina - Fatigue Detected : Critical (88%)
31-OCT-2016 10:19:22 AM

Overtruck Alert
Excess of 5 trucks
31-OCT-2016 10:21:47 AM

Crusher Warning
ConeCrusher1 has a long queue time
31-OCT-2016 10:21:35 AM

OVERVIEW
MATERIAL
EQUIPMENT
OPERATORS
ALERTS
ANALYTICS
SETTINGS

TR02 Earl Roberts EQUIPMENT / TRUCKS / ACTIVE-RUNNING

TR02

REASON
Production

LOCATION
S12

LAST SHOVEL
SH01 >

OPERATOR
Earl Roberts >

TIME IN STATE
03:10:24

Truck Productivity (tons/hour)	860
Average Payload (tons)	251
Tons Hauled (tons)	2,048

NUMBER OF DUMPS

TOTAL 27

12
Number of dumps at crusher

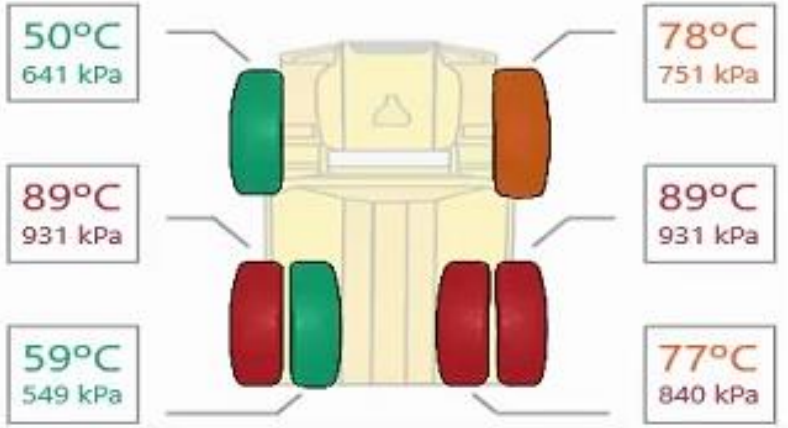
15
Number of dumps at stockpile

PREDICTIVE MAINTENANCE ALARMS

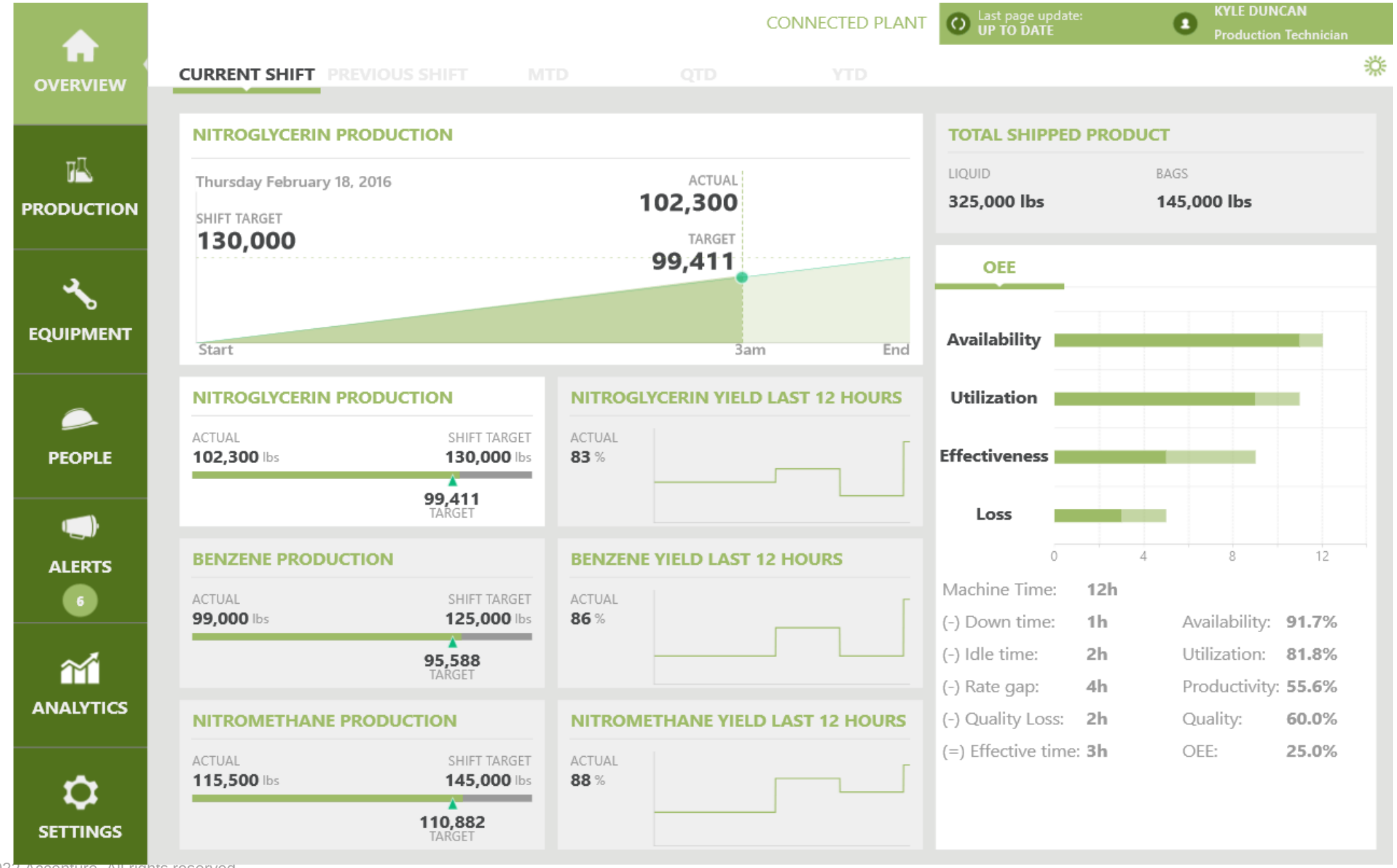
ALARM NAME	TTF	URGENCY
Indication of low oil pressure	10 days	Moderate
Engine Vacuum leak	15 days	Urgent

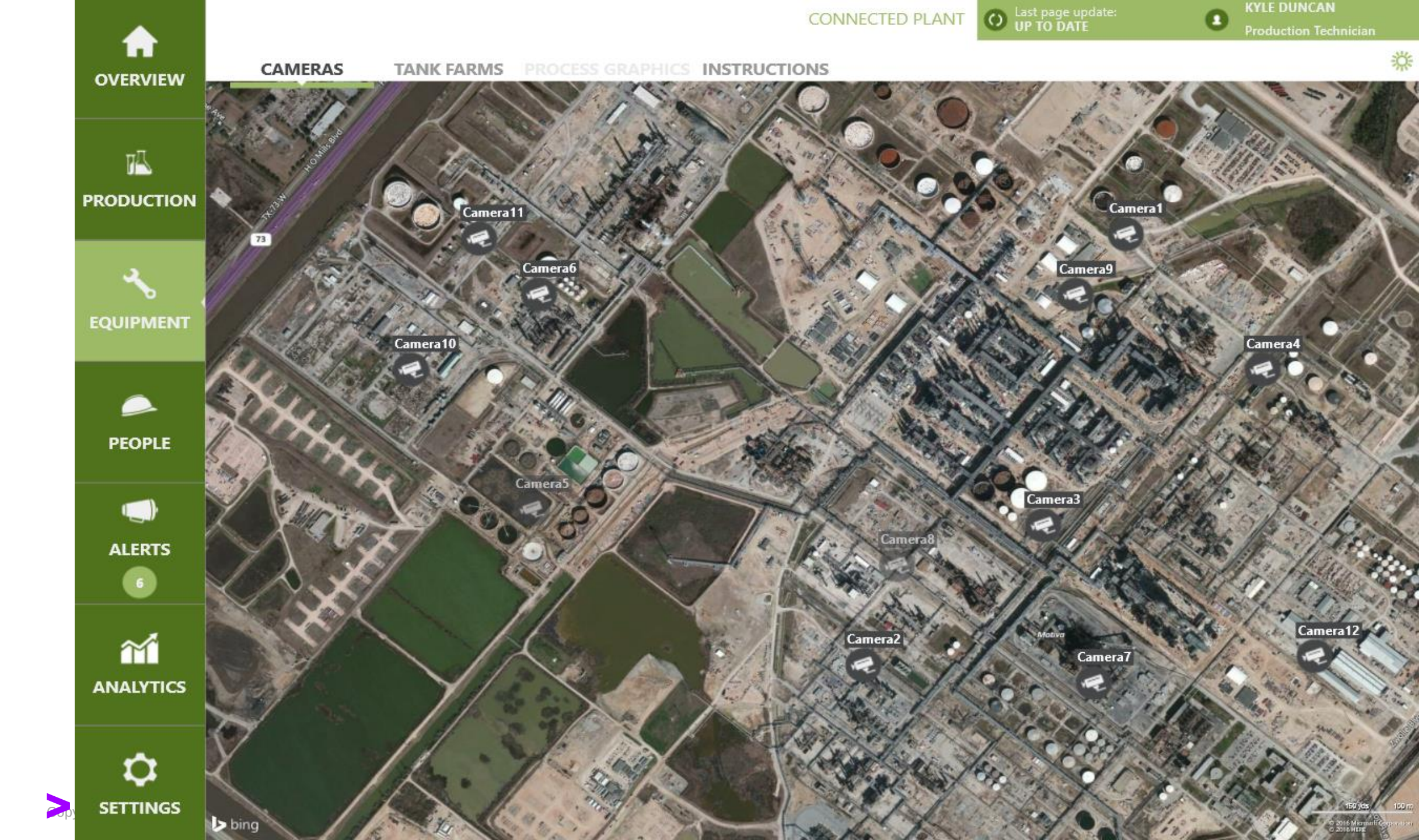
INDICATION OF LOW OIL PRESSURE

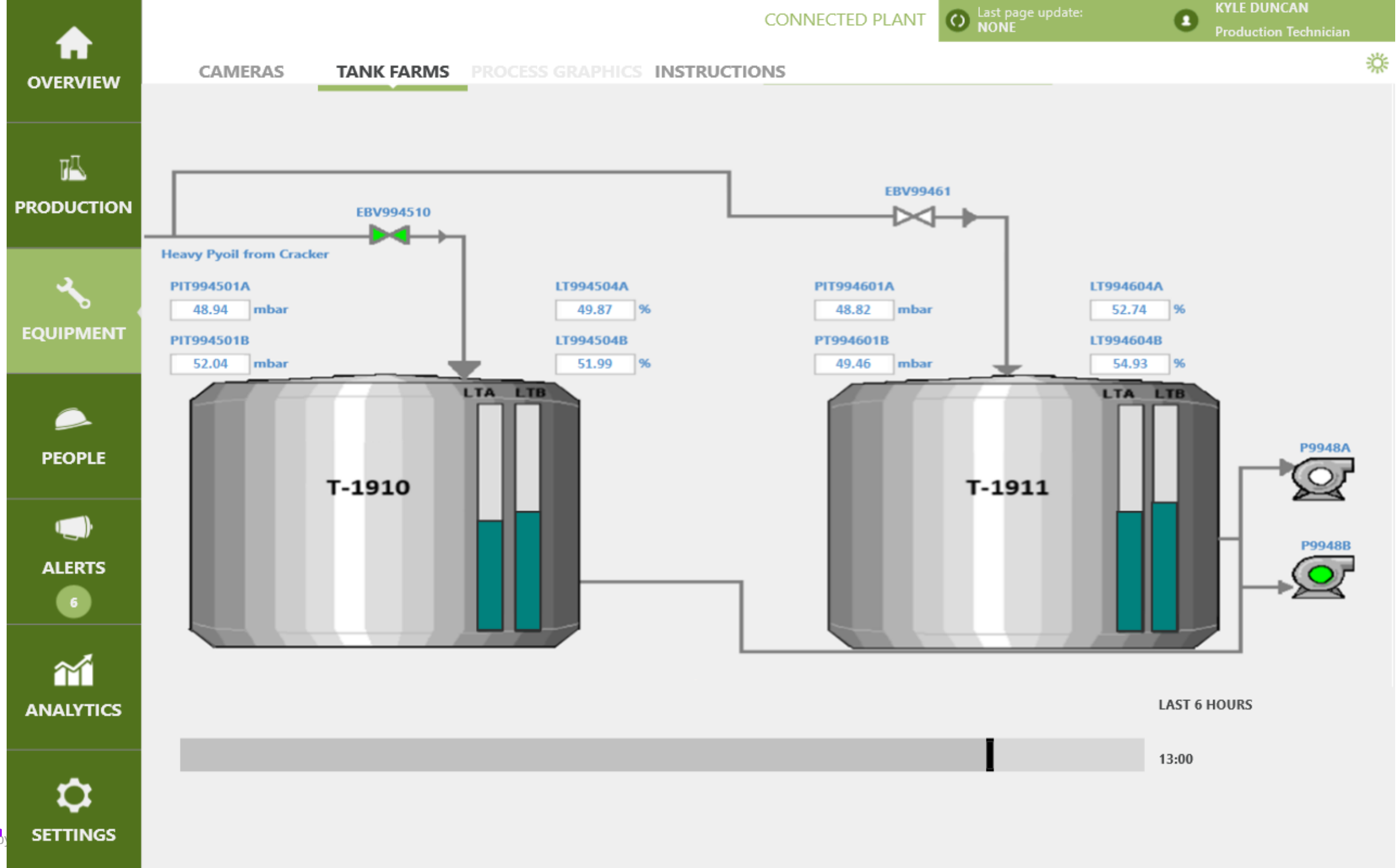
TIRE STATUS




Connected Mine
Last page update
None
Bruce Garcia
Operations Supervisor
OVERVIEW
MATERIAL
EQUIPMENT
OPERATORS
ALERTS
ANALYTICS
SETTINGS
Terrain Visualization
Material Flow
Crusher Matrix Visualization
Mine Planning Documents
FULL VIEW
DRILL01
DOZER1
Show daily cuts
On
Show dozers
On
Show trucks
On
Show drills
On
Show drill holes
On
TR03
TR13
SH03
DOZER8
SH11
A24
TR01
DOZER6
SH03 >
COMPLIANCE TO PLAN
N/A
AVG QUEUE TIME
1.75 mins
TONS PER HOUR
704
SPOT TIME
0.25 mins
CURRENT STATUS
Active-Delayed
OF TRUCKS WAITING
0
IDLE TIME
2.27 mins
ELEVATION
4106.85 ft
LAST MATERIAL MINED
High Grade
SH01
SH02
SH03
SH04
SH05
SH06
SH07
SH08
SH09
SH10
SH11
SH12

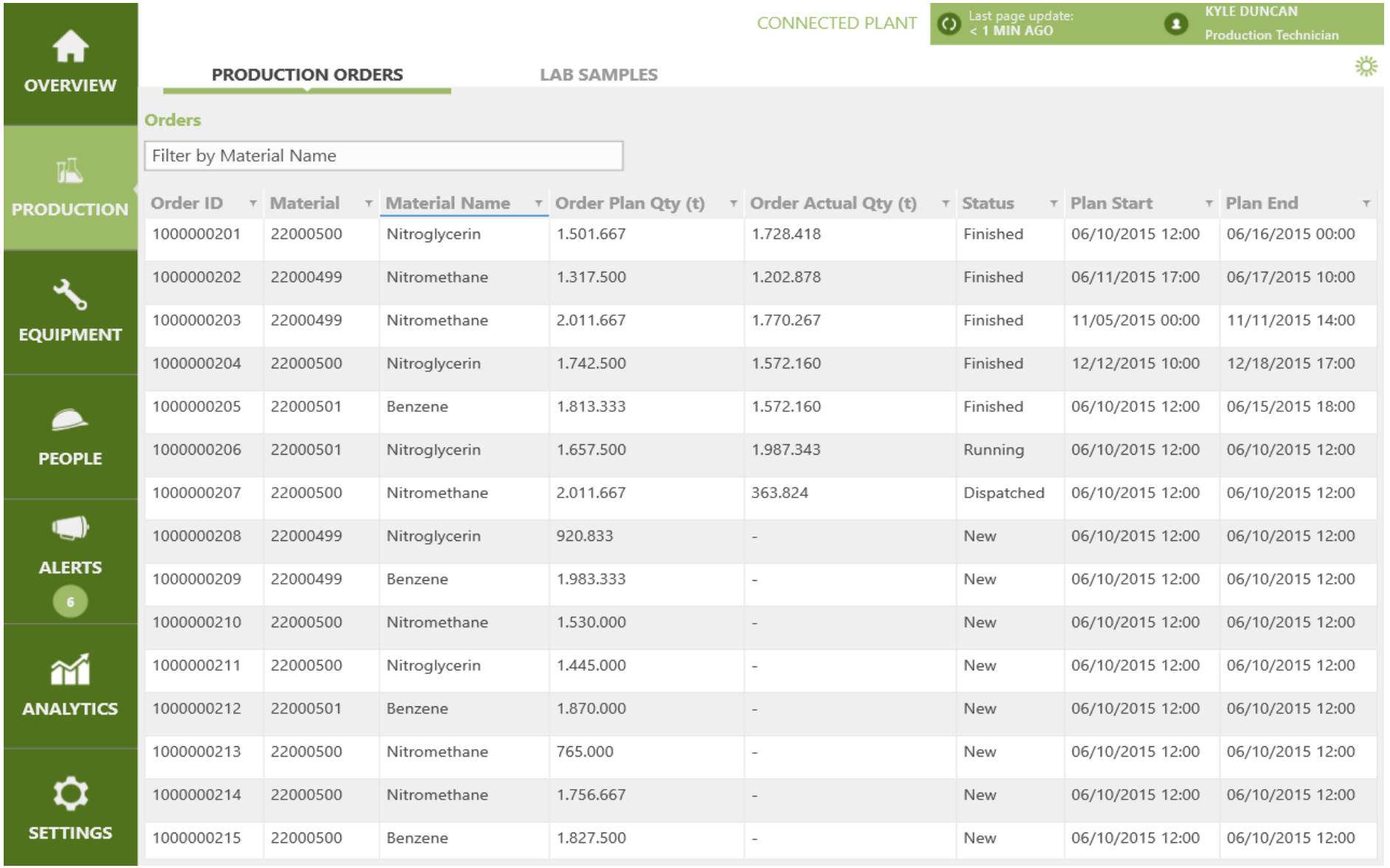



CONNECTED PLANT
Last page update:
UP TO DATE
KYLE DUNCAN
Production Technician
CAMERAS
TANK FARMS
PROCESS GRAPHICS
INSTRUCTIONS
OVERVIEW
PRODUCTION
EQUIPMENT
PEOPLE
ALERTS
6
ANALYTICS
SETTINGS
Camera11
Camera6
Camera10
Camera5
Camera1
Camera9
Camera4
Camera3
Camera8
Camera2
Camera7
Camera12
bing


CONNECTED PLANT
Last page update:
NONE
KYLE DUNCAN
Production Technician
OVERVIEW
PRODUCTION
EQUIPMENT
PEOPLE
ALERTS
6
ANALYTICS
SETTINGS
CAMERAS
TANK FARMS
PROCESS GRAPHICS
INSTRUCTIONS
EBV994510
EBV99461
Heavy Pyoil from Cracker
PIT994501A
48.94
mbar
PIT994501B
52.04
mbar
LT994504A
49.87
%
LT994504B
51.99
%
PIT994601A
48.82
mbar
PT994601B
49.46
mbar
LT994604A
52.74
%
LT994604B
54.93
%
LTA
LTB
T-1910
T-1911
P9948A
P9948B
LAST 6 HOURS
13:00

PRODUCTION ORDERS

INDUSTRY X



Order ID	Material	Material Name	Order Plan Qty (t)	Order Actual Qty (t)	Status	Plan Start	Plan End
1000000201	22000500	Nitroglycerin	1.501.667	1.728.418	Finished	06/10/2015 12:00	06/16/2015 00:00
1000000202	22000499	Nitromethane	1.317.500	1.202.878	Finished	06/11/2015 17:00	06/17/2015 10:00
1000000203	22000499	Nitromethane	2.011.667	1.770.267	Finished	11/05/2015 00:00	11/11/2015 14:00
1000000204	22000500	Nitroglycerin	1.742.500	1.572.160	Finished	12/12/2015 10:00	12/18/2015 17:00
1000000205	22000501	Benzene	1.813.333	1.572.160	Finished	06/10/2015 12:00	06/15/2015 18:00
1000000206	22000501	Nitroglycerin	1.657.500	1.987.343	Running	06/10/2015 12:00	06/10/2015 12:00
1000000207	22000500	Nitromethane	2.011.667	363.824	Dispatched	06/10/2015 12:00	06/10/2015 12:00
1000000208	22000499	Nitroglycerin	920.833	-	New	06/10/2015 12:00	06/10/2015 12:00
1000000209	22000499	Benzene	1.983.333	-	New	06/10/2015 12:00	06/10/2015 12:00
1000000210	22000500	Nitromethane	1.530.000	-	New	06/10/2015 12:00	06/10/2015 12:00
1000000211	22000500	Nitroglycerin	1.445.000	-	New	06/10/2015 12:00	06/10/2015 12:00
1000000212	22000501	Benzene	1.870.000	-	New	06/10/2015 12:00	06/10/2015 12:00
1000000213	22000500	Nitromethane	765.000	-	New	06/10/2015 12:00	06/10/2015 12:00
1000000214	22000500	Nitromethane	1.756.667	-	New	06/10/2015 12:00	06/10/2015 12:00
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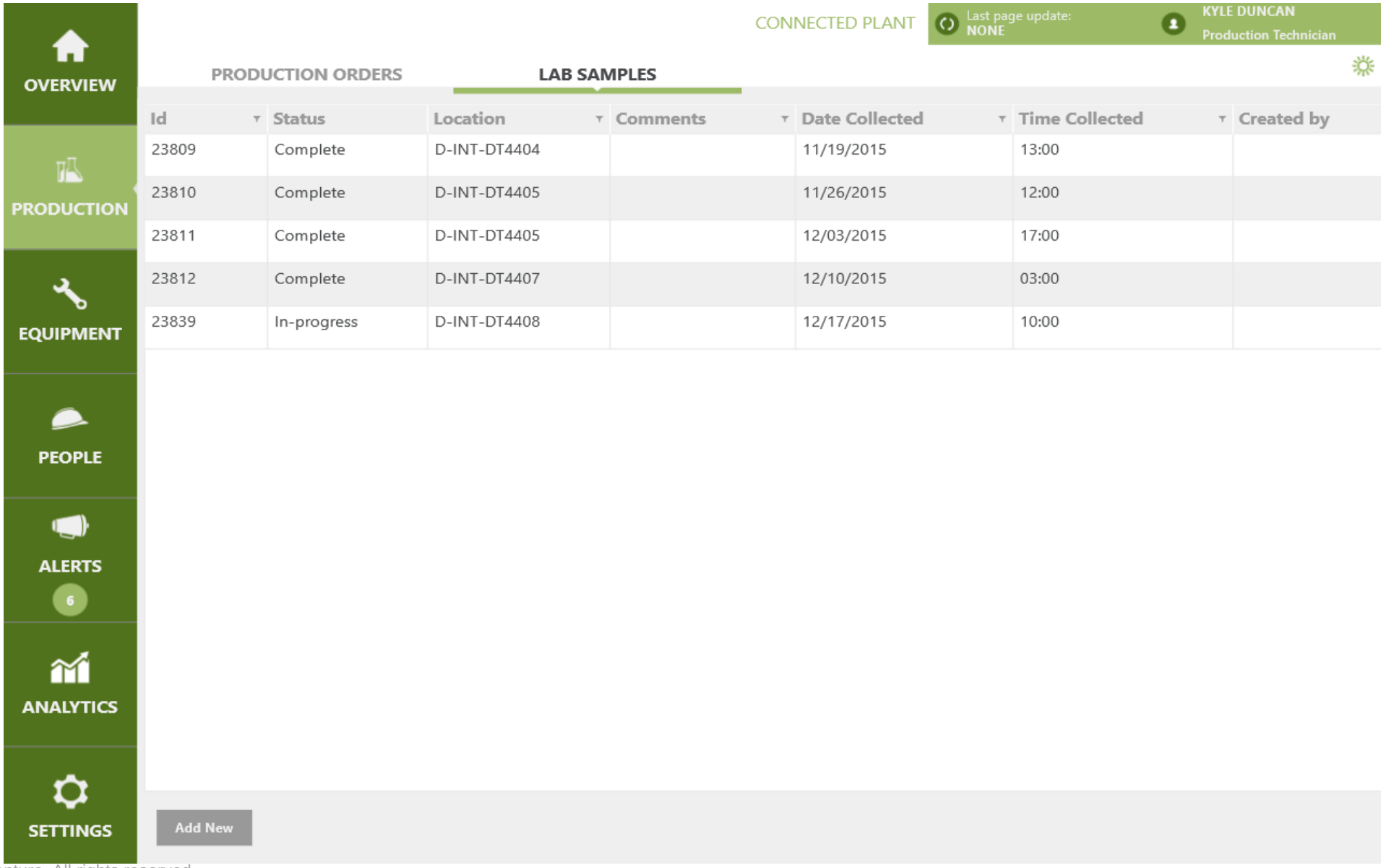
QUALITY
INDUSTRY X



QUESTIONS ?

Constantino Seixas Filho
Managing Director – Manufacturing & Engineering

Industry X – Latam

constantino.seixas@accenture.com