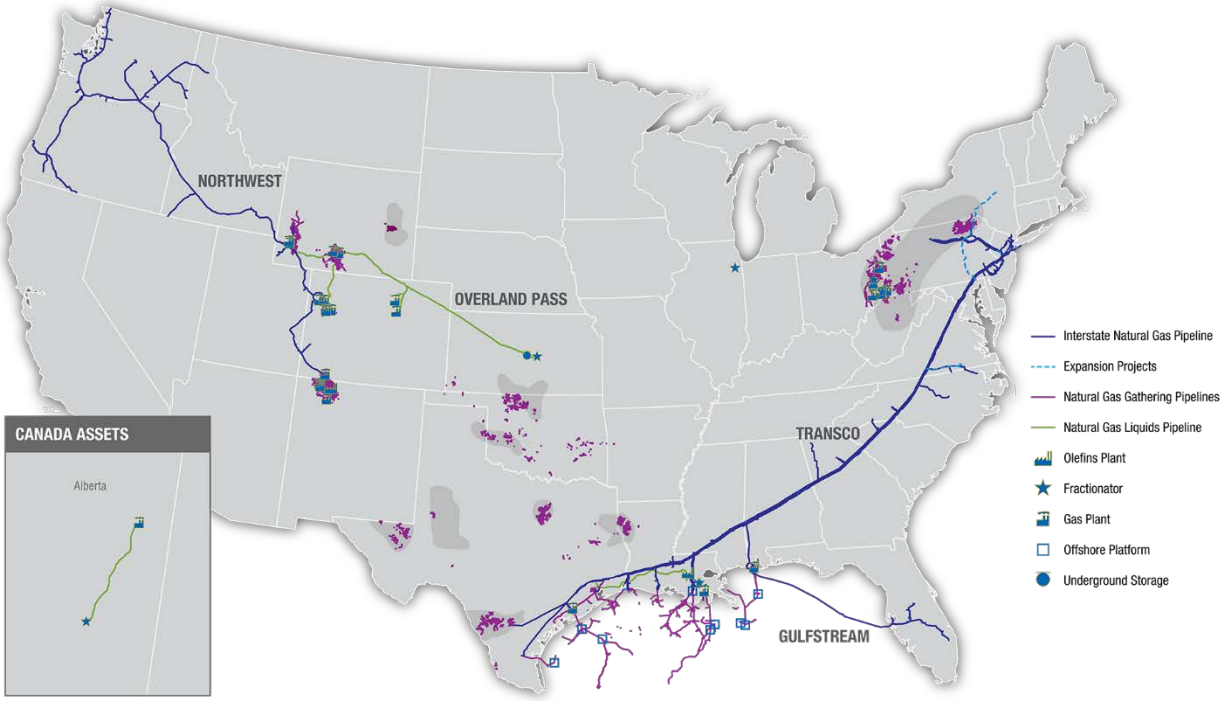
Gas Turbine Performance Monitoring
with the PI System

Presented by **Mark Warren**

About Williams



- Natural gas gathering, processing, and transportation company founded in 1908
- 5,000 Employees
- Transport 14% of U.S. natural gas consumption
- 11,200 miles of oil and gas gathering lines
- Gas processing capacity of approximately 7 bcf/d
- 1,400 miles of NGL and olefin transportation pipelines

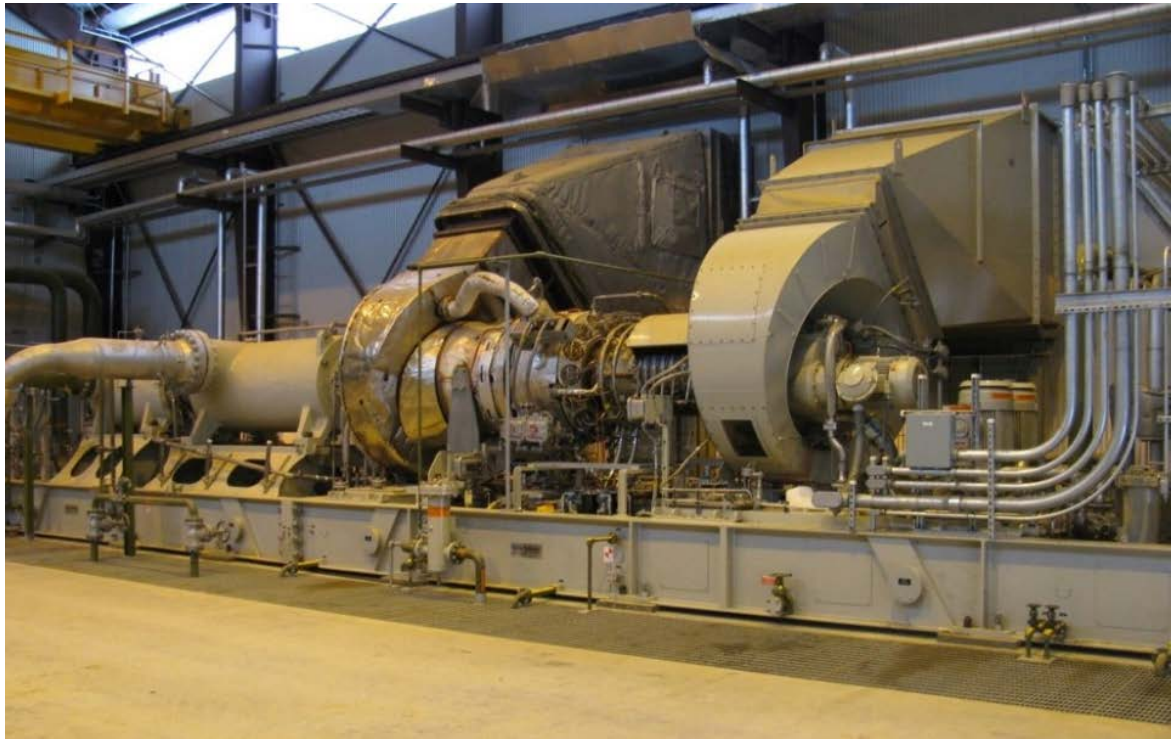
FORTUNE WORLD'S MOST ADMIRED COMPANIES 2015
#1 IN ENERGY: U.S.

Asset Performance & Benchmarking

- Charge
- Business-side
- Multi-discipline
- Bottom-up
- Center of excellence

Gas Turbines and Centrifugal Compressors

- Ringing the cash register
- Difference maker
- Economy of scale



Application: Turbines Dashboard

- At-a-glance operating status and metrics
- Parameters to control fields/metrics, models, operating areas
- Home base for tying to more detailed displays and reports

Unit	Equipment Number	Model	Run Status	Starts (30 Days)	Utilization % (30 Days)
FCA-Dogie: Unit 1	CG91001/CG91001	Centaur40	ON	1	99.9
FCA-Dogie: Unit 2	CG91003/CG91003	Centaur40	ON	0	99.9
FCA-Dogie: Unit 3	CG91004/CG91004	Centaur40	ON	0	100
FCA-El Cedro: Mars A	CG9101/CG9101	Mars90	ON	0	100
FCA-El Cedro: Mars B	CG9102/CG9102	Mars90	OFF	0	0
FCA-Ignacio: Inlet Mars	CG9301	Mars100	OFF	1	30.3
FCA-Ignacio: Inlet Taurus	CG9201	Taurus70	ON	2	99.9
FCA-Ignacio: Inlet Titan	CG9401	Titan130	ON	0	99.9
FCA-Ignacio: Recomp East/2	CG9601	Titan130	ON	1	99.7

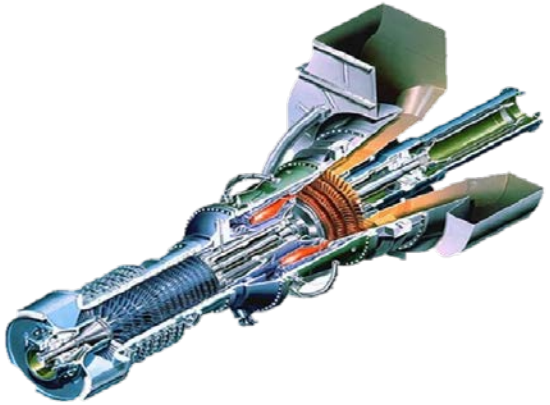
Application: Turbines Notifications

- Business need identified
- Exception-based reporting in real-time
- Business impact
  - Equipment expert awareness
  - Minimize downtime and repair cost
  - Proactive response
  - Manage known issues

Use Case: Exhaust Temperature Shift

COMPANY and GOAL

Williams gathers, processes and transports natural gas, and compression equipment availability is on the critical path



CHALLENGE

Known failure indicators found during inspection or based on performance degradation

- Downtime is expensive and can be extended if repair materials and labor are not coordinated in advance
- Failure to address known indicators carries additional liabilities

SOLUTION

PI AF-based solution for monitoring exhaust temperature shifts, relative to history

- PI OLEDB Enterprise aggregates historical norms, based on PI Asset Framework (AF) formula attributes
- Turbine Notifications continuously monitors actual versus historical for shifts that indicate further deterioration
- SMEs review and action

RESULTS

Operation continues under heightened supervision until planned repair outage opportunity

- Williams and repair vendor manage risk of subsequent damage with continuous monitoring
- Asset continues to operate
- Required downtime reduced as much as three-fold

Application: CentriPerf4PI

- Actual vs design equipment performance
- CentriPerf = Existing desktop application, developed by turbine SME
- Interfaced with real-time data via AFSDK
- Continuously store calculations in PI Tags
- Tags and Asset Framework (AF) structure expose data for use with visualization and reporting functionality

Tools for Solutions

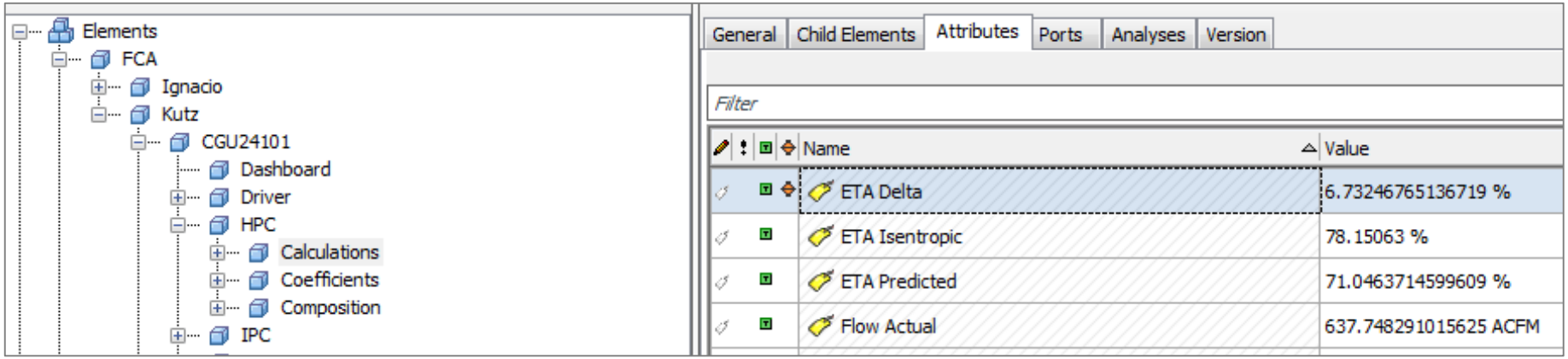
Using the PI System to drive equipment reliability

- PI Asset Framework
- PI Notifications
- PI OLEDB Enterprise
- PI Coresight
- PI AFSDK

"Do not let what you cannot do interfere with what you can do."

-John Wooden

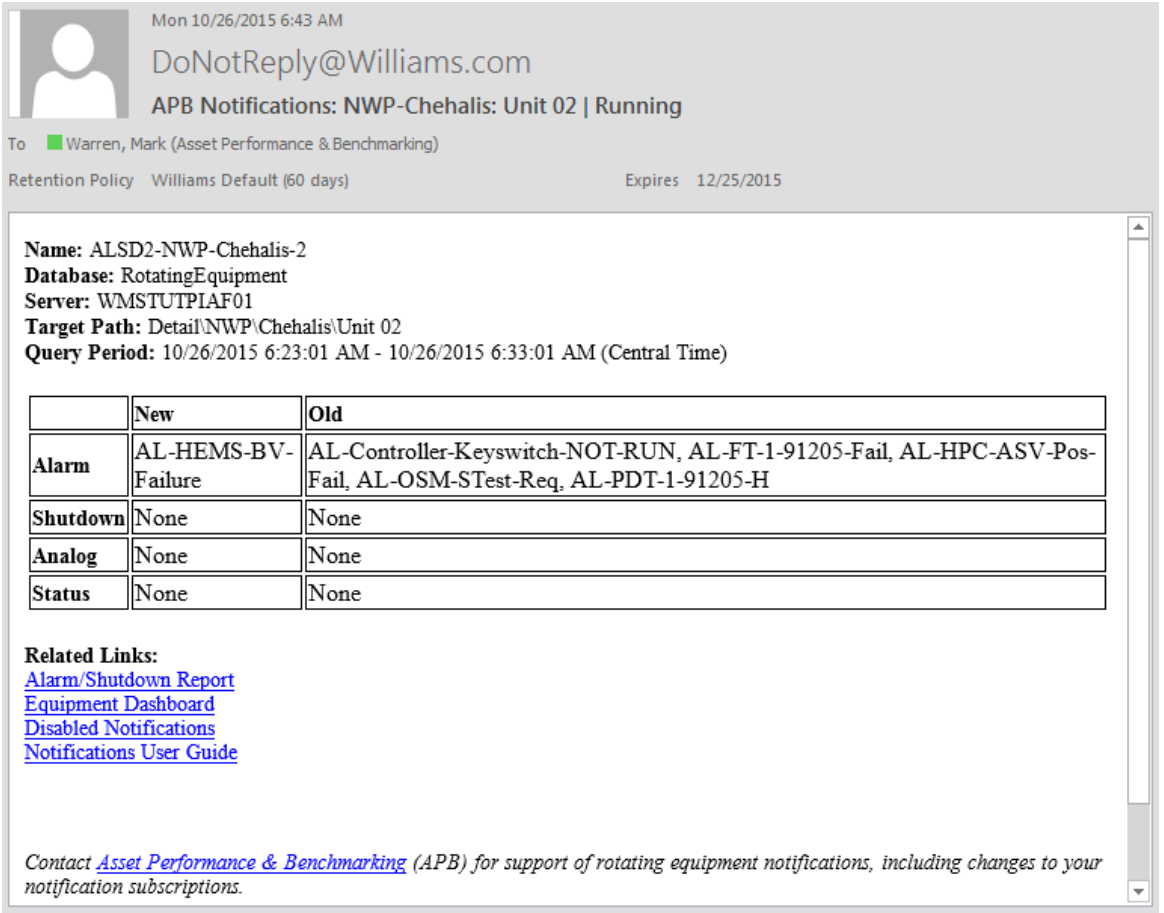
PI Asset Framework



- Structures real-time operational data from PI Tags
- Pair real-time with metadata and calculations needed for business decisions
- Models developed can be scaled out to similar and related assets

PI Notifications

- Excursions are brought to the attention of equipment SMEs using PI Notifications
- Notification contains links to additional turbine data



Mon 10/26/2015 6:43 AM

DoNotReply@Williams.com

APB Notifications: NWP-Chehalis: Unit 02 | Running

To Warren, Mark (Asset Performance & Benchmarking)

Retention Policy Williams Default (60 days) Expires 12/25/2015

Name: ALSD2-NWP-Chehalis-2
Database: RotatingEquipment
Server: WMSTUTPIAF01
Target Path: Detail\NWP\Chehalis\Unit 02
Query Period: 10/26/2015 6:23:01 AM - 10/26/2015 6:33:01 AM (Central Time)

	New	Old
Alarm	AL-HEMS-BV-Failure	AL-Controller-Keyswitch-NOT-RUN, AL-FT-1-91205-Fail, AL-HPC-ASV-Pos-Fail, AL-OSM-STest-Req, AL-PDT-1-91205-H
Shutdown	None	None
Analog	None	None
Status	None	None

Related Links:
Alarm/Shutdown Report
Equipment Dashboard
Disabled Notifications
Notifications User Guide

Contact Asset Performance & Benchmarking (APB) for support of rotating equipment notifications, including changes to your notification subscriptions.

PI OLEDB Enterprise

Turbine Alarms and Shutdowns

Last Refreshed at: 10/26/2015 1:02:19 PM

- Below tables show active alarm/shutdown events at the End Time selected and archived alarm/shutdown events during the time range selected
- Values are archived upon value changes and once every eight (8) hours, if the value remains constant
- Click on the a specific alarm/shutdown item to view a historical trend
- Time can be intered in MM/DD/YYYY HH:MM:SS AM/PM or PI time (*=now, t=today, y=yesterday, h=hour, m=minute, s=second)

NWP-Chehalis: Unit 02 - Active at End Time
AL-Controller-Keyswitch-NOT-RUN
AL-FT-1-91205-Fail
AL-HEMS-BV-Failure
AL-HPC-ASV-Pos-Fail
AL-OSM-STest-Req
AL-PDT-1-91205-H

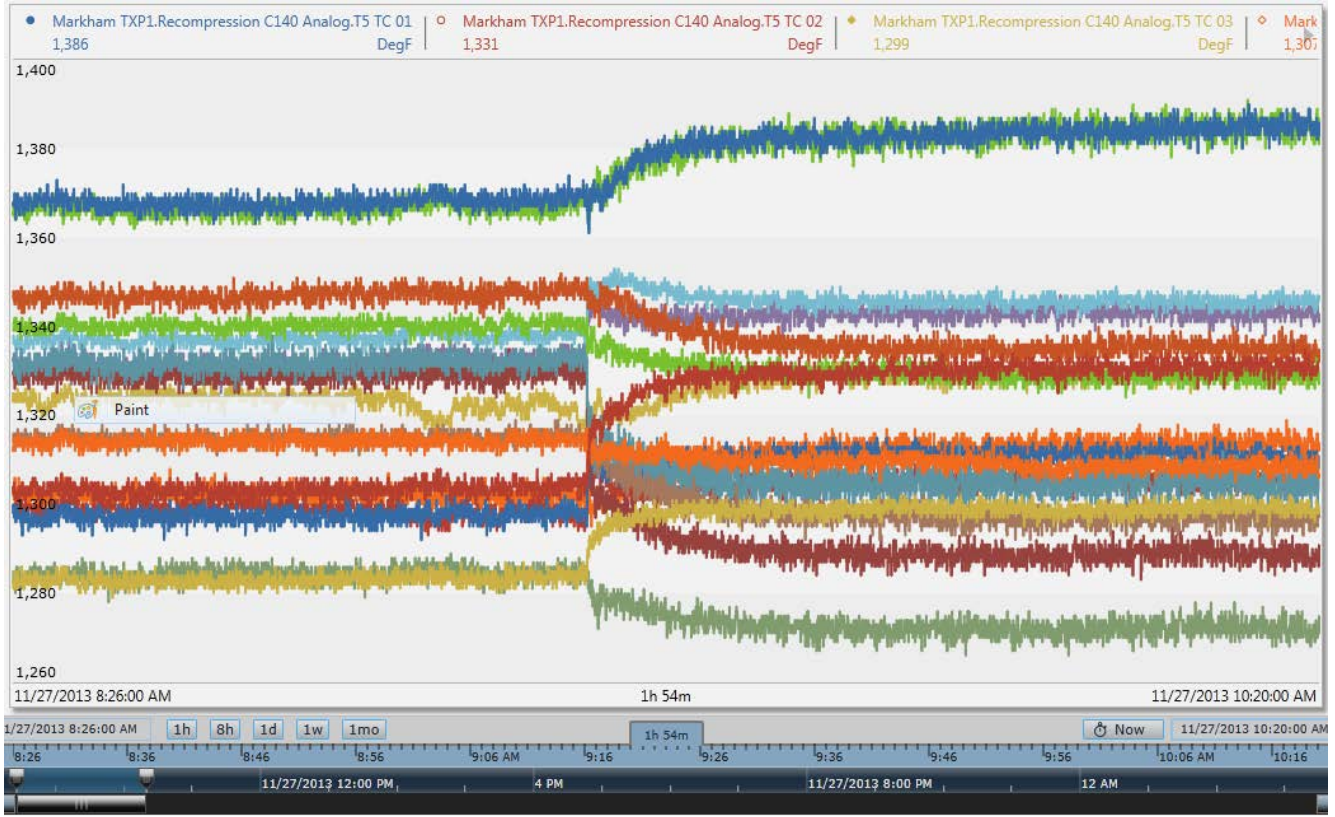
NWP-Chehalis: Unit 02 - Archived between Start and End Times	Date/Time
AL-Controller-Keyswitch-NOT-RUN	10/26/2015 06:42:00
AL-FT-1-91205-Fail	10/26/2015 06:42:00
AL-HEMS-BV-Failure	10/26/2015 06:32:33
AL-HPC-ASV-Pos-Fail	10/26/2015 06:42:00
AL-OSM-STest-Req	10/26/2015 06:42:00

Report is generated using Microsoft SSRS interfaced to PI Asset Framework using PI OLEDB Enterprise

This report contains links to Coresight trends

PI Coresight

Example of a feature that we look for in the exhaust temperature shift analysis noted earlier



PI AFSDK

- Used to create custom Data Reference to turns static performance calculations into real-time, historized data sets
- Supplemental to the native analytical capabilities of AF, the AFSDK allow for programmatic solutions that can still leverage the structure and scalability of AF


```
using OSIsoft.AF;
using OSIsoft.AF.Asset;
using OSIsoft.AF.Time;
using OSIsoft.AF.UnitsOfMeasure;
```

Data Reference: CentriPerf4PI

Use Case: Failing I/O Module

Overall PI System Experience and Future

- Currently running over 15 applications based on PI System data
- Enterprise is recognizing the value being brought by the system
- Grass-roots efforts with operations have become visible at top levels
- Continuing to expand both applications and asset reach

Contact Information

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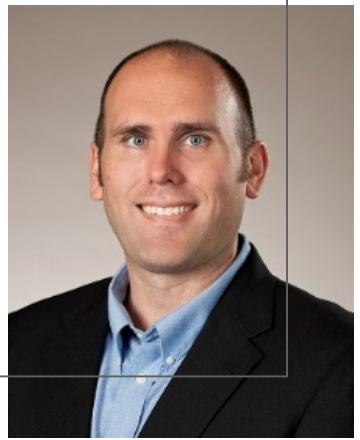
Williams



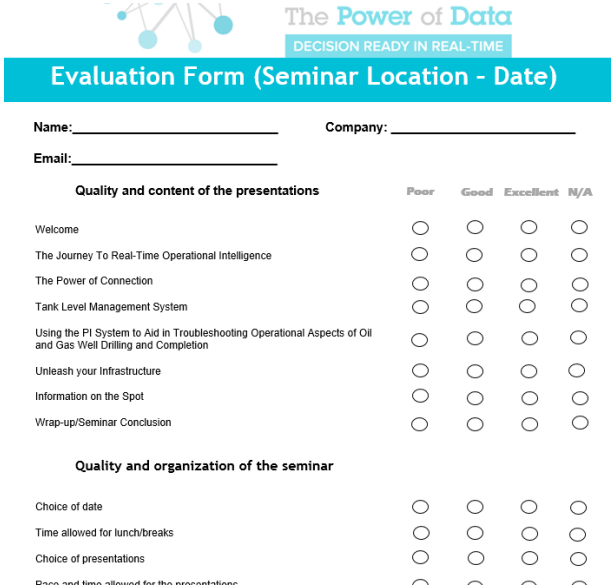
Questions

Please wait for the **microphone** before asking your questions

State your **name & company**

Please don't forget to…

Complete the Survey for this session


The Power of Data
DECISION READY IN REAL-TIME

Evaluation Form (Seminar Location - Date)

Name:_____ Company: _____

Email:_____

Quality and content of the presentations	Poor	Good	Excellent	N/A
Welcome	○	○	○	○
The Journey To Real-Time Operational Intelligence	○	○	○	○
The Power of Connection	○	○	○	○
Tank Level Management System	○	○	○	○
Using the PI System to Aid in Troubleshooting Operational Aspects of Oil and Gas Well Drilling and Completion	○	○	○	○
Unleash your Infrastructure	○	○	○	○
Information on the Spot	○	○	○	○
Wrap-up/Seminar Conclusion	○	○	○	○

Quality and organization of the seminar				
Choice of date	○	○	○	○
Time allowed for lunch/breaks	○	○	○	○
Choice of presentations	○	○	○	○
Pace and time allowed for the presentations	○	○	○	○

감사합니다

谢谢

Danke

Gracias

Merci

Thank You

ありがとう

Спасибо

Obrigado