IBM Asset Analytics for Rotational Equipment in Oil and Gas
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Solution Guide

IBM

Product Information

This document applies to IBM Asset Analytics for Rotational Equipment in Oil and Gas Version 1.0.1 and may also apply to subsequent releases.

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Contents

Introduction

The IBM Asset Analytics for Rotational Equipment in Oil and Gas solution gives you the information and insight that you need to provide proactive service to your customers.

Audience

This guide is intended for administrators and users of the Asset Analytics for Rotational Equipment in Oil and Gas solution. It provides information on installation, configuration, and use of the Asset Analytics for Rotational Equipment in Oil and Gas solution.

Finding information

To find product documentation on the web, including all translated documentation, access IBM® Knowledge Center (http://www.ibm.com/support/knowledgecenter).

Accessibility features

Accessibility features help users who have a physical disability, such as restricted mobility or limited vision, to use information technology products. Some of the components included in the Asset Analytics for Rotational Equipment in Oil and Gas have accessibility features. For more information, see Appendix A, "Accessibility features," on page 53.

Asset Analytics for Rotational Equipment in Oil and Gas HTML documentation has accessibility features. PDF documents are supplemental and, as such, include no added accessibility features.

Forward-looking statements

This documentation describes the current functionality of the product. References to items that are not currently available may be included. No implication of any future availability should be inferred. Any such references are not a commitment, promise, or legal obligation to deliver any material, code, or functionality. The development, release, and timing of features or functionality remain at the sole discretion of IBM.

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Chapter 1. Overview

IBM Asset Analytics for Rotational Equipment in Oil and Gas is a prepackaged solution that works with IBM Predictive Maintenance and Quality (PMQ).

Important: Before you install the solution, IBM Predictive Maintenance and Quality (PMQ) must be installed on your system.

IBM Asset Analytics for Rotational Equipment in Oil and Gas is a solution designed to help industries with operations that depend upon rotating assets such as pumps, motors, turbines, transmission devices, and auxiliary equipment.

The solution is used to provide real-time data on the performance of electric submersible pumps (ESPs), used in the oil and gas industry. This solution helps the oil and gas industry to:

- Enhance exploration and production
- Improve global operations
- Improve refining and manufacturing efficiency

What need does the solution address?

Modern technology has made previously inaccessible petroleum resources available. In the past, a single drill pad would typically be associated with a single well bore; that is, a single well. With the advent of directed and horizontal drilling techniques, a single well pad can now be the home to many well bores reaching a vast expanse of underground resources. Sophisticated new drilling equipment is also highly instrumented. Consequently, thousands of wells generate large volumes of real-time data that can be used to monitor and assess the overall performance, health, and productivity of a well.

Increased efficiencies, along with new technologies and methods, now require a production engineer to manage a large number of wells. In addition, the new extraction methods have added complexity. Producers must now contend with water waste that results from the fracturing process and the required separation of oil, gas, and water before it is pumped to the surface. Extraction of unconventional resources is less certain due to the additional complexity. However, performance data obtained from the well and extraction equipment can significantly help producers monitor operations, equipment, and the overall production process.

IBM Asset Analytics for Rotational Equipment in Oil and Gas provides production engineers and their supervisors with the ability to anticipate and quickly correct production shortfalls that can be attributed to extraction equipment. They will be able to predict when equipment is trending towards a complete shutdown and prevent the situation. This will lower operation costs, avoid lost productivity, and reduce expensive repairs.

What does the solution provide?

IBM Asset Analytics for Rotational Equipment in Oil and Gas can detect all performance modes of an electric submersible pump (ESP) using change point analysis. The solution's modes include low performance, high levels of pollution, and trending to failure.

The ESP is a long, vertical, inground piece of machinery at the center of a wellbore. The purpose of an ESP is to extract fluids from the wellbore and pump them to the surface. Failure of an ESP that brings the well to a halt and requires removal of the ESP will negatively impact production. This may cost days of nonproductive time and result in lost revenue and expensive repair.

The solution uses operational data obtained from the ESP to develop a predictive model of the ESP's performance. The solution captures a number of data sets related to the ESP operational data (historian, maintenance logs, production performance, and technical specifications), and generates an analysis related to ESP operational health. It monitors ESP performance in real time and determines if the ESP is in danger of failure.

If a potential failure is detected, the solution can recommend whether to repair, rehabilitate, or replace the ESP, based upon current asset health and maintenance models developed by the producer. Recommendations can also include tuning the pumps to improve performance towards higher yield and efficiency. Some of these recommendations can be integrated with Enterprise Asset Management (EAM) systems, such as SAP Plant Maintenance or IBM Maximo®, to accelerate repair time and to provide maintenance personnel with a detailed assessment of the problem.

How is the solution used by an organization?

The solution may be used by maintenance or operations organizations.

A maintenance organization uses the detailed performance data, assessment of the asset health and current conditions, and recommendations associated with a problematic electric submersible pump (ESP) to optimize the maintenance schedule with appropriate calibration and maintenance orders. The solution can rank problematic ESPs for priority attention based on fault analysis.

An operations organization uses the solution to assess the production impact related to the ESP performance. If an ESP is performing suboptimally or is in danger of failure, the solution will recognize this situation and assess the overall production efficiency impact. The operational team can develop production models based on the ESP's historical performance. The operations team can then modify or update business rules that generate recommendations based on insight provided by these models.

Chapter 2. Installation and configuration

The Asset Analytics for Rotational Equipment in Oil and Gas solution is for use with IBM Predictive Maintenance and Quality.

Planning the installation and configuration of the solution

Prepare a deployment plan to specify which part of the solution is to be deployed and on which computer node.

Note: Ensure that the system ports that will be used by this solution are not used by any other application.

Prerequisites

Before you install the Asset Analytics for Rotational Equipment in Oil and Gas solution, there are prerequisites that must be met.

The following conditions must be met before the solution can be installed:

- IBM Predictive Maintenance and Quality 2.5.1 is installed and configured.
- You have a Linux system that you can install to. The application installer works only on Linux.
- You understand your existing environment so that you can determine where you want the various components of the application to reside.
- You have administration rights and the ability to copy files between computers.

Installing R software

You must install R software RPMs on the Analytics node computer for the Asset Analytics for Rotational Equipment in Oil and Gas solution.

The RPMs must be installed in the following order:

Install this set first:
1. `libRmath-3.1.0-5.el6.x86_64`
   - Dependencies:
     yum install `libgomp-4.4.7-16.el6.x86_64`
2. `libRmath-devel-3.1.0-5.el6.x86_64`
3. `texinfo-4.13a-8.el6.x86_64`
4. `texinfo-tex-4.13a-8.el6.x86_64`
   - Dependencies:
     yum install tetex & yum install `texinfo-4.13a-8.el6.x86_64`
5. `R-java-devel-3.1.0-5.el6.x86_64` Force this with the --nodeps option (rpm -ivh R-java-devel-3.1.0-5.el6.x86_64.rpm --nodeps)

Install this set second:
1. `liblzma5-5.2.1-94.1.x86_64`
2. `libicu-devel-4.2.1-9.1.el6_2.x86_64`
   - Dependencies:

yum install libicu

yum install libicudata.so.42

yum install libicu-4.2.1-9.1.el6_2

If the installation still fails asking for `libicu-4.2.1-9.1.el6_2`, run with the `--nodeps` option (`rpm -ivh libicu-devel-4.2.1-9.1.el6_2.x86_64.rpm --nodeps`)

3. `lapack-3.2.1-4.el6.x86_64`
4. `xz-devel-5.2.1-94.1.x86_64`
5. `tcl-devel-8.5.7-6.el6.x86_64`
   - Dependency:

     yum install tcl
6. `tk-devel-8.5.7-5.el6.x86_64`
   - Dependencies:

     yum install `libX11-devel`

     yum install `libXft-devel`

     yum install `libtk8.5.so`

     yum install `tk-8.5.7-5.el6.x86_64`
7. `pcre-devel-7.8-6.el6.x86_64`
   - Dependency:

     Yum install `pcre`

     If `pcre-7.8-7.el6.x86_64` is already installed, go with the **–nodeps** option (`rpm -ivh pcre-devel-7.8-6.el6.x86_64.rpm --nodeps`)
8. `blas-devel-3.2.1-4.el6.x86_64`
   - Dependency

     yum install `blas*`

     If this is installed already and you receive a conflict error message, then ignore this installation.
9. `blas-3.2.1-4.el6.x86_64`

   If this is installed already and you receive a conflict error message, then ignore this installation.
10. `lapack-devel-3.2.1-4.el6.x86_64`

    This should be installed when the dependency for the first set is installed.

Install this set last:
1. `R-core-3.1.0-5.el6.x86_64`
   - Dependencies:

     yum install tex*

     yum install liblapack.so.3*
2. `R-java-3.1.0-5.el6.x86_64`
   - Dependency:

     yum install java-1.5.0-gcj
3. `R-core-devel-3.1.0-5.el6.x86_64`
   - Dependencies:

     yum install bzip2-devel

     yum install gcc-c++

     yum install lapack-devel*

4. `R-devel-3.1.0-5.el6.x86_64`
   - Dependency:
     Yum install R-core-devel

You can download the packages from a site such as rpm.pbone.net.

Procedure

1. Log on to the Analytics node computer as the **root** user or as a user with **sudo** permissions.
2. Install any package that is not already installed.

   You must download any missing package, and then install the downloaded package by typing the following command:

   `rpm -i` *`full_package_name`*`.rpm`

   For example, to install `libRmath-3.1.0-5.el6.x86_64`, type `rpm -i libRmath-3.1.0-5.el6.x86_64.rpm`.

   To install a package using `--nodeps` in the command, type `rpm -i --nodeps R-java-devel-3.1.0-5.el6.x86_64.rpm`.

Installing SPSS Modeler Essentials for R on the Analytics node computer

You must install IBM SPSS® Modeler Version 17 Essentials for R on the Analytics node computer.

For more information about R and Essentials for R software for IBM SPSS, see the IBM SPSS documentation (https://www.ibm.com/developerworks/community/wikis/home?lang=en#!/wiki/We70df3195ec8_4f95_9773_42e448fa9029/page/Downloads%20for%20IBM%C2%AE%20SPSS%C2%AE%20Statistics).

Procedure

1. Log in to the Analytics node computer as the **root** user or as a user with **sudo** permissions.
2. Check the installation path for R software by using the following command:

   `rpm –ql R-core-3.1.0-5.el6.x86_64 | more`
3. Check the location of the `pasw.stats` directory in the SPSS Modeler Server installation directory. The default path is `/usr/IBM/SPSS/ModelerServer/17.0/ext/bin`.
4. Download and install the IBM SPSS Modeler Version 17 Essentials for R software. You can download the installer from Tools for SPSS Products website (https://www.ibm.com/marketing/iwm/iwm/web/preLogin.do?source=swg-tspssp).
5. Go to the directory where you downloaded the installer.
6. Enter the following command:

   `chmod +x` *`filename`*
7. Run the `bin` file to install the software.

Installing R software packages

You must install additional R software packages on the IBM Predictive Maintenance and Quality Analytics node computer.

You must install the following R packages. Ensure that you install the versions in the following list. Some versions may not be the most current. These versions can be found on the **Old sources** link on the package page.

- zoo (version 1.7-11)
- changepoint (version 1.1.5)
- mclust (version 4.4)
- mAr (version 1.1-2)
- NORMT3 (version 1.0-3)
- Outliers (version 0.14)

Important: You must install the zoo package first.

Procedure

1. Log in to the Analytics node computer as the **root** user or as a user with **sudo** permissions.
2. Download the R software packages. You can download the installer from The Comprehensive R Archive Network (CRAN) website (http://cran.r-project.org/web/packages/available_packages_by_name.html).
3. Start the R console.

   For example, in a terminal windows, type R and press Enter.
4. Install each of the packages by using the following commands in the R console:

   ```
   install.packages("path/package",repos=NULL,type="source")
   ```

   For example, to install zoo version 1.7-11, enter the following command:

   ```
   install.packages("/home/zoo_1.7-11.tar.gz",repos=NULL,type="source")
   ```

   Install each package individually.

Downloading the solution

You must download the Asset Analytics for Rotational Equipment in Oil and Gas solution from IBM Passport Advantage®.

Before you begin

You must have a Passport Advantage account and be entitled to the package.

About this task

Passport Advantage contains package repositories. Instead of downloading the package from Passport Advantage and creating a repository locally, you access the repository on Passport Advantage.

Procedure

1. Set the Passport Advantage preference to connect to Passport Advantage.
2. Download the tar.gz file.
3. Move the tar file to the Linux node from which you want to run the installation.
4. Extract the contents of the tar file.

Contents of the download package

The Asset Analytics for Rotational Equipment in Oil and Gas solution package, which you download from Passport Advantage, contains several parts.

The following parts are included in the package:

- Analytics node artifacts—The IBM SPSS content is provided in a `.pes` file that you import into the IBM SPSS Collaboration and Deployment Services Content Repository. It consists of a training model and job, a scoring model and job, and the decision management rules stream.
- Data node artifacts—SQL files for creating the production data table in the **IBMPMQ** database and for importing data for those tables.
- Business Intelligence node artifacts—IBM Cognos® Business Intelligence dashboards, images that are used in the dashboards, a map specification, and the Framework Manager model.
- Integration Bus node artifacts—IBM Integration Bus solution bar files for custom flows to onboard data and trigger the analytics training and scoring jobs. It also includes WebSphere® MQ scripts, properties, and xml files that are required by the custom flows and for IBM Predictive Maintenance and Quality core components.

Modifying the sudoers file for the Linux user who runs the installation

To run the Asset Analytics for Rotational Equipment in Oil and Gas installation in a Linux environment, you must be either root user or have sudo permission on each node computer, and you must disable `requiretty` during the installation.

To install with sudo user permissions, you must add the user to the `sudoers` file.

Procedure

1. Log in as root user.
2. Enter the following command to open the `sudoers` file for editing:

   `visudo -f /etc/sudoers`
3. Locate the following line:

   `Defaults requiretty`
4. Press the I key to insert text.
5. Type a number sign (#) in front of `Defaults requiretty` to comment out the line. For example, the line will appears as `#Defaults requiretty`
6. If you run the installer as a user with sudo user permissions, go to the end of the file, and add the following line for your user:

   username `ALL=(ALL) NOPASSWD: ALL`
7. Press the Esc key, and enter `:wq` to save and close the file.
8. Repeat these steps on each computer on which you install a Asset Analytics for Rotational Equipment in Oil and Gas node.

Deploying the installation files on the nodes

You use the Solution Installer to deploy the installation files to the appropriate nodes.

Before you begin

Ensure that you know the following information for each of the nodes in your solution:

- Host name or IP address
- Password of the **root** user ID or a user ID and password that has **sudo** permissions

About this task

In this task, you create an installation configuration of your solution by dragging nodes onto a canvas, adding components to the nodes, and defining properties for the components.

Procedure

1. Log on to the computer where you downloaded the solution package.
2. Extract the contents of the solution package.
3. Go to the solution installer directory. For example:

   `cd IS_CSP_Customerinsight_1.0/SolutionInstaller/`
4. Enter the following command:

   `./firewall.sh`

   The ports that are used to transfer files to the nodes are opened on the server.
5. Enter the following command:

   `./setup.sh username first name last name email`

   The web server is started and the URL for the Solution Installer displays in the command line.
6. Start the Solution Installer by pasting the URL into a web browser.
7. Read the license agreement and click **Accept**.
8. Click **New Configuration** and then click **OK**.
9. Define the Business Intelligence node:

   a. Under **Mandatory Content List**, drag a **Node** onto the canvas.

   b. Under **Property Editor**, enter values for theBusiness Intelligence node.

   c. Drag **Cognos BI Content** onto the node. Do not change the values under **Property Editor**.

   d. Drag **Cognos BI Report Images** onto **Cognos BI Content**. Do not change the values under **Property Editor**.

   e. Drag **Rave Visualization Bundles** onto **Cognos BI Content**. Do not change the values under **Property Editor**.
10. Define the IBM Integration Bus node:

    a. Under **Mandatory Content List**, drag a **Node** onto the canvas.

    b. Under **Property Editor**, enter values for the IBM Integration Bus node.

    c. Drag **IBM Integration Bus Content** onto the node. Do not change the values under **Property Editor**.
11. If you want to save the configuration to use or refer to in the future, click **Save Configuration**.
12. Click **Validate**. The progress of the validation is displayed. If the validation fails, look at the log file to troubleshoot the problem.
13. Click **Run**.

Computer firewall settings required for the installation on Linux

The solution installer requires bidirectional communication with each node when you install a server component or server artifact component, and your firewall can interfere with this communication.

To ensure bidirectional communication, you must configure your firewall settings for the installation. Alternatively, you can temporarily disable your firewall during the installation.

A script is provided to open all necessary ports on the installation node. You can either use the `firewall.sh` script, open the ports manually, or disable the firewall settings.

In addition to opening ports on the installation node computer, you must open some ports on each computer to which content from the solution will be copied.

Configuring your firewall settings on the installation node computer by using the firewall script

You can run the firewall.sh script to open the ports on a Linux installation node.

About this task

The firewall.sh script opens the following ports on the solution installer node:
- 8080 incoming
- 443 incoming
- 9683 incoming
- 22 outgoing

Procedure

1. As the root user or as a user with sudo permissions, log on to the computer that contains the solution installer node.
2. Back up your existing firewall settings by typing the following command: `/etc/init.d/iptables save`.
3. Run the firewall.sh script.

Manually configuring firewall settings on the installation node

If you prefer not to disable your firewall settings or use the firewall.sh script, you can manually configure your firewall settings on the installation node.

Procedure

1. As the root user or as a user with sudo permissions, log on to the computer that contains the solution installer node .
2. Back up your existing firewall settings by typing the following command: `. /etc/init.d/iptables save`
3. On the computer that contains the solution installer node, add rules for the ports that are required by the installer by typing the following commands:

```
iptables -I INPUT -p tcp --dport 8080 -j ACCEPT
iptables -I OUTPUT -p tcp --sport 8080 -m state --state
RELATED,ESTABLISHED -j ACCEPT

iptables -I INPUT -p tcp --dport 443 -j ACCEPT
iptables -I OUTPUT -p tcp --sport 443 -m state --state
RELATED,ESTABLISHED -j ACCEPT

iptables -I INPUT -p tcp --dport 9683 -j ACCEPT
iptables -I OUTPUT -p tcp --sport 9683 -m state --state
RELATED,ESTABLISHED -j ACCEPT

iptables -I OUTPUT -p tcp --dport 22 -j ACCEPT
iptables -I INPUT -p tcp --sport 22 -m state --state
RELATED,ESTABLISHED -j ACCEPT
```

Configuring firewall settings on other computers that will contain content from the solution

On all node computers to which content from the solution will be copied, the ports 443, 9683, and 8080 must be opened for the installation process.

Procedure

1. On each of the computers to which content for the solution will be copied, add rules for the ports that are required by the installer by typing the following commands:

   ```
   iptables -I OUTPUT -p tcp --dport 443 -j ACCEPT
   iptables -I INPUT -p tcp --sport 443 -m state --state RELATED,ESTABLISHED -j ACCEPT

   iptables -I OUTPUT -p tcp --dport 9683 -j ACCEPT
   iptables -I INPUT -p tcp --sport 9683 -m state --state RELATED,ESTABLISHED -j ACCEPT

   iptables -I OUTPUT -p tcp --dport 8080 -j ACCEPT
   iptables -I INPUT -p tcp --sport 8080 -m state --state RELATED,ESTABLISHED -j ACCEPT
   ```

2. Type the following command to save your firewall settings:

   ```
    /etc/init.d/iptables save
   ```

3. Type the following command to restart your firewall:

   ```
   /etc/init.d/iptables restart
   ```

4. Verify that your changes are applied by using the following command:

   ```
   iptables -L
   ```

   The added port appears in the list.

5. Repeat these steps on each computer on which you will install an IBM Asset Analytics for Rotational Equipment in Oil and Gas node.

Disabling firewall settings during installation (optional)

If you choose to temporarily disable your computer's firewall during the installation of the IBM Asset Analytics for Rotational Equipment in Oil and Gas solution, ensure that you enable the firewall on each node after the installation is complete.

About this task

Important: If you disable your computer's firewall during the installation, you must still ensure that the required ports are opened on each node computer when you restart your firewall.

Procedure

1. Log on to the computer as the root user or as a user with sudo permissions.
2. Type the following command:

   ```
   /etc/init.d/iptables stop
   /etc/init.d/iptables save
   ```

3. Repeat these steps on each computer on which you install a node and on the server from which you are running the installation.

What to do next

After the installation is complete, on each node, type `/etc/init.d/iptables start` to restart your firewall.

Creating the database tables

Before you can use the IBM Asset Analytics for Rotational Equipment in Oil and Gas application, you must create the tables in the IBMPMQ database.

Procedure

1. Log on to the data node computer as root user.
2. On the data node computer, if the compressed file is not already extracted, then extract its contents.
3. Open a terminal window, and go to the directory where the content files were extracted.
4. Type the following command to change the permissions for the files: `chmod -R 755 *`
5. Open the `create_prod_table_ESP.sql` file in a text editor.
6. Ensure that you enter the correct user and password for the database instance owner.

   db2inst1 is the default **user** parameter. If you did not use the default database users, ensure that you enter the correct user name. Ensure that you enter the correct password in the **using** parameter.
7. Save and close the file.
8. Change to the database instance owner. For example:

   `su db2inst1`
9. Run `db2 -tvf ./create_prod_table_ESP.sql`.
10. Disconnect from the database.

What to do next

You must import data into the new **ESP_PROD_DATA** tables. These tables contain the data that is populated in the Oil Production Chart in the dashboards. The data must include a **Pump_ID** column that has a valid **Resource_ID** in the **MASTER_RESOURCE** table.

For more information about the data, see "Master data and metadata for the solution" on page 21.

Creating new directories on the Integration Bus node

Content must be loaded to the IBM Integration Bus server from specific directories. You must create the directories before the content can be loaded.

Procedure

1. Log in to the Integration Bus node computer as the **mqm** user.

   Important: The user must be the **mqm** user or a member of the **mqm** group. If you copy the files as another user, they might not be processed by the Integration Bus node components.
2. Go to the `/var/PMQ/MQSIFileInput` directory.
3. Create the following directories:
   - `espaggregatein`—The input folder for the aggregated data.
   - `esptriggersfolder`—The input folder for triggering batch jobs.
   - `maintenancedatain`—The input folder for the maintenance data.

- `welltestdatain`—The input folder for the well test data.
- `espsensordatain`—The input folder for the raw sensor data.
- `espstaticdatain`—The input folder for the design data

Moving properties, orchestration, and solution definition files

You must move the properties, orchestration, and solution definition files to the appropriate directories on your Integration Bus node computer.

Procedure

1. Log in to the Integration Bus node computer as the **mqm** user.

   Important: The user must be the **mqm** user or a member of the **mqm** group. If you copy the files as another user, they might not be processed by the Integration Bus node components.

2. Go to the directory where you installed the solution content files, and extract the `REOilGas_AssetAnalytics_IIBContent.zip` file. For example, type `unzip REOilGas_AssetAnalytics_IIBContent.zip`.

   The default path where the files are deployed is `/opt/IBM/IS_REOilGas_AssetAnalytics_1.0`.

3. Copy the following files from the `Scripts` directory to the `/var/mqsi/shared-classes` directory on the Integration Bus node computer.
   - `ESP_BatchScoring.properties`
   - `ESP_SensorData.properties`
   - `ESP_MaintenanceData.properties`
   - `ESP_WellTestData.properties`
   - `ESP_AggregateData.properties`
   - `PMQ_solution_definition.xml`
   - `ESP_StaticData.properties`

4. Copy the `PMQ_orchestration_definition_esp.xml` file from the `Scripts` directory to the `/var/mqsi/shared-classes/orchestrations` directory on the Integration Bus node computer.

5. Copy the `PMQ_orchestration_definition_batch.xml` file from the `Scripts` directory to the `/var/PMQ/MQSIFileInput/properties` directory on the Integration Bus node computer.

Configuring the orchestration files

You must update the orchestration files to include the server name and port number for your IBM SPSS Collaboration and Deployment Services server that is running on your IBM Predictive Maintenance and Quality Analytics node.

Procedure

1. On the Integration Bus node computer, go to the `/var/PMQ/MQSIFileInput/properties`, and open the `PMQ_orchestration_definition_batch.xml` file in a text editor.

2. In the `<ESPTrainingTrigger>` identifier section, do the following steps:

   a. In the `<webservice>` section, change the `<url>` value to the server name and port number for your IBM SPSS Collaboration and Deployment Services server.

   b. In the `<scheduler>` section, change the values to set a frequency for when the training job is to be run.

   c. Remove the comments from the `<scheduler>` to enable it.

3. In the `ESPScoringTrigger` identifier section, do the following steps:

   a. In the `<webservice>` section, change the `<url>` value to the server name and port number for your IBM SPSS Collaboration and Deployment Services server.

   b. In the `<scheduler>` section, change the values to set a frequency for when the scoring job is to be run.

   c. Remove the comments from the `<scheduler>` to enable it.

4. Save and close the file.

5. On the Integration Bus node computer, go to the `/var/mqsi/shared-classes/orchestrations`, and open the `PMQ_orchestration_definition_esp.xml` file in a text editor.

6. In the `pmq.espscoring` orchestration_cd section, do the following steps:

   a. Change the `<host_name>` value to the server name for your IBM SPSS Collaboration and Deployment Services server.

   b. Change the `<port_number>` value to the port number that IBM SPSS Collaboration and Deployment Services server is using.

7. Save and close the file.

Creating an execution group and queue

You must create an execution group on the IBM Maintenance and Quality Integration Bus node computer for the Asset Analytics for Rotational Equipment in Oil and Gas solution. You must also create the queue in IBM WebSphere MQ.

Procedure

1. On the Integration Bus node computer, in a terminal window, go to the `installation_location`/mqsi/9.0.0.1/bin directory. For example, if you installed to the default location, go to the `/opt/ibm/mqsi/9.0.0.1/bin` directory.

2. Change to the **mqm** user. For example, `su mqm`.

3. Enter the following command to load the profile that is needed for the **mqm** user, and press Enter:

   `. ~/.bash_profile`

4. Enter the following command to create an execution group:

   `mqsicreateexecutiongroup pmqbroker -e espcustomflows`

5. Type `runmqsc pmqmanager`, and press Enter.

6. Enter the following command to create the queue:

```
DEFINE QL(ESP.TR.TIMER.IN) REPLACE +
                MAXDEPTH(5000) +
                DESCR('Input Local Queue of ESP Training batch flow')
DEFINE QL(ESP.SCORE.TIMER.IN) REPLACE +
                MAXDEPTH(50000) +
                DESCR('Input Local Queue of ESP Scoring batch flow')
```

Deploying the broker archive files

You must deploy broker archive (`.bar`) files on the IBM Predictive Maintenance and Quality Integration Bus node computer for the Asset Analytics for Rotational Equipment in Oil and Gas solution.

The `.bar` files contain custom flows that are used to load Integration Bus data as events into the Predictive Maintenance and Quality data store. There are four flows, one each for aggregated data, well test data, maintenance data, and sensor data. The file also contains custom flows for running the training and scoring models in batch.

You must deploy 2 `.bar` files.

Procedure

1. Log on to the Integration Bus node computer as the **mqm** user.
2. Enter the following command:

   ```
   mqsideploy pmqbroker –e espcustomflows –a path/
   REOilGas_AssetAnalytics_CustomFlows.bar
   ```

   The default *path* where the `.bar` files are deployed is /opt/IBM/
   IS_REOilGas_AssetAnalytics_1.0/BAR.
3. Enter the following command:

   ```
   mqsideploy pmqbroker –e pmqgroup1 –a path/
   REOilGas_AssetAnalytics_EventLoad.bar
   ```

Importing IBM SPSS analytic content

You must load the IBM SPSS analytic content for the IBM Asset Analytics for Rotational Equipment in Oil and Gas application. You load the analytics content by using IBM SPSS Deployment Manager.

Procedure

1. Copy the .pes file from the location where you deployed the Asset Analytics for Rotational Equipment in Oil and Gas on the Analytics node computer to the computer where IBM SPSS Collaboration and Deployment Services Deployment Manager is installed.
2. In IBM SPSS Collaboration and Deployment Service Deployment Manager, right-click **Content Repository**, and click **Import**.
3. Browse to the `REOilGas_AssetAnalytics_CDS.pes` file
4. Select the following options:
   - Resolve conflicts globally
   - Add new version of target item or rename source item, Use labels from source.
   - Continue import even if some objects cannot be imported due to locking conflicts.
   - Resolve Invalid Version Conflicts, Import.
   - Resource Definitions, Recommended - Import if there are no Duplicate ID conflicts or Duplicate Name conflicts.
5. Click **OK**.

Results

Content folders and resource definitions are added to the repository alongside any existing content.

Setting up the analytic content in IBM SPSS Collaboration and Deployment Services

You must add user credential definitions in IBM SPSS Collaboration and Deployment Services Deployment Manager for the Asset Analytics for Rotational Equipment in Oil and Gas solution.

Procedure

1. On your Microsoft Windows computer, start IBM SPSS Collaboration and Deployment Services Deployment Manager. For example, click **Start** > **Deployment Manager**.
2. In Deployment Manager, click **Content Explorer**.
3. Expand **Resource Definitions** > **Credentials**.
4. Right-click **Credentials**, and click **New** > **Credentials Definition**.
   a. In the **Name** box, enter IBMPMQ, and click **Next**.
   b. In the **User ID** box, enter the database user name. For example, enter db2inst1
   c. In the **Password** box, enter the password for the database user.
   d. Leave **Security Provider** blank.
   e. Click **Finish**.
5. Right-click **Data sources**, and click **New** > **Data Source Definition**.
   a. In the **Name** box, enter IBMPMQ.
   b. In the **Type** box, select **ODBC Data Source**.
   c. Click **Next**.
   d. In the **DSN** box, enter IBMPMQ.
   e. Click **Finish**.

Configuring the training and scoring jobs

The training job is loaded as part of the REOilGas_AssetAnalytics_CDS.pes deployment file that you loaded into SPSS Modeler Deployment Manager. You must add the credentials and ODBC connection information for your IBMPMQ database to the **ODBC Data Sources** tab for the job.

Procedure

1. In SPSS Modeler Deployment Manager, expand **Content Repository** > **ESP**, and select **ESP_TRAIN_JOB**.
2. On the **ODBC Data Sources** tab, click each entry in the **ODBC DSN** column, and select the credentials for your IBMPMQ database.
3. Click **OK**.
4. Expand **Content Repository** > **ESP**, and select **ESP_SCORE_JOB**.
5. On the **ODBC Data Sources** tab, click each entry in the **ODBC DSN** column, and select the credentials for your IBMPMQ database.
6. Click **OK**.

Deploying the IBM Cognos content

For IBM Cognos Business Intelligence, you must catalog the database, create a data source connection, and then deploy the content files for the IBM Asset Analytics for Rotational Equipment in Oil and Gas solution.

Before you begin

Ensure that the IBM Predictive Maintenance and Quality data node is installed and configured and that the **IBMPMQ** database is present on the database server.

Connecting to the IBMPMQ database

You must create a database connection to the **IBMPMQ** database in IBM Cognos Business Intelligence. Before you can create the connection, you must catalog the database in the IBM DB2® client.

Procedure

1. Log on to the Business Intelligence node computer, and change to the db2inst1 user. For example, in a terminal window, type su db2inst1.
2. Enter the following command to catalog the database server:

   db2 "catalog tcpip node OP(*Nodename*) remote *DB2_server_name* server *DB2_port_number*"
3. Enter the following command to catalog the **IBMPMQ** database:

   db2 "catalog database **IBMPMQ** as **IBMPMQ** at node OP(*Nodename*)"
4. Enter the following command to ensure that the database was cataloged correctly:

   db2 list database directory

   IBMPMQ should appear in the list.

Creating a data source connection to the IBMPMQ database

You create a data source connection using IBM Cognos Administration.

Procedure

1. Open a web browser.
2. Go to the IBM Cognos BI portal URL. For example, go to http://binodename/ibmcognos/.
3. On the **Welcome** page, click **Administer IBM Cognos Content**.
4. Click the **Configuration** tab, and click **Data Source Connections**.
5. Click the **New Data Source** icon.
6. In the **Name** box, type IBMPMQ, and then click **Next**.
7. In the connection page, select **IBM DB2**, ensure that **Configure JDBC connection** is selected, and click **Next**.
8. In the **DB2 database name** field, type IBMPMQ.
9. Leave **DB2 connect string** blank.
10. Under **Signons**, select both **Password** and **Create a signon that the Everyone group can use**, and then type the user ID and password for the DB2 instance owner user that you used to create the database, and click **Next**. For example, enter db2inst1 and the appropriate password.

    Tip: To test whether the parameters are correct, click **Test the connection**. After you test the connection, click **OK** to return to the connection page.
11. In the **Server name** box, enter the name or IP address of your IBM DB2 server computer.
12. In the **Port number** box, enter the DB2 port number. The default is 50000.
13. In **Database name**, type IBMPMQ.

> **Tip:** To test whether the parameters are correct, click **Test the connection**. After you test the connection, click **OK** to return to the connection page.

14. Click **Finish**.

Moving the IBM Cognos content

You must copy the IBM Cognos content for the IBM Asset Analytics for Rotational Equipment in Oil and Gas application to the appropriate locations in your IBM Cognos installation to be able to deploy the content.

Procedure

1. Copy the IBM Cognos content from the computer where you deployed the Asset Analytics for Rotational Equipment in Oil and Gas Business Intelligence content to the `Cognos_Install_location\Deployment` folder on the Business Intelligence node computer.

   The Asset Analytics for Rotational Equipment in Oil and Gas IBM Cognos content file is named `REOilGas_AssetAnalytics_BIContent.zipChangeTheVarFileWithTheRightName`.

2. Copy the IBM Cognos report image file to the `Cognos_Install_location\webcontent\ReportImages` folder on the Business Intelligence node computer.

   You must create the `ReportImages` folder if it does not already exist.

   The report images file is named `REOilGas_AssetAnalytics_Images.zipChangeTheVarFileWithTheRightName`.

3. Extract the file.

4. Copy the following images from the `Cognos_Install_location\webcontent\ReportImages` folder to the `Cognos_Install_location\webcontent\samples\images` folder.

   You must create the `samples\images` folder if it does not already exist.

   Copy the following files:
   - `ibmLogo.png`
   - `IS_HamburgerMenu_Black0_32px.png`
   - `User.png`
   - `ESP_About_darkgrey.png`
   - `ESP_TopFactors_darkgrey.png`

5. Copy the IBM Cognos map specification file to the Business Intelligence node computer.

   The map specification file is named `REOilGas_AssetAnalytics_Map_Rave.zip`.

6. Extract the report image file in the `Cognos_Install_location\webcontent` folder.

   You should have a `Cognos_Install_location\webcontent` folder that contains the report image files.

7. Copy the IBM Cognos Framework Manager model file from the computer where you deployed the application to the computer where you installed IBM Cognos Framework Manager, and extract the file.

   The Framework Manager file is named `REOilGas_AssetAnalytics_FMProject.zip`.

8. If you want to edit the Framework Manager models, you must catalog the Asset Analytics for Rotational Equipment in Oil and Gas database on the computer where Framework Manager is installed.

Deploying the IBM Cognos reports

You must deploy the Asset Analytics for Rotational Equipment in Oil and Gas reports using IBM Cognos Administration.

Procedure

1. Open a web browser.
2. Go to the IBM Cognos BI portal URL.
3. On the **Welcome** page, click **Administer IBM Cognos Content**.
4. On the **Configuration** tab, click **Content Administration**.
5. On the toolbar, click the **New Import** button.
6. In the **Deployment Archive** pane, select deployment archive, and click **Next**.
   The deployment archive is named
   REOilGas_AssetAnalytics_BIContent.zipChangeTheVarFileWithTheRightName.
7. In the **Specify a name and description** pane, accept the default or enter a new name, and click **Next**.
8. In the **Select the public folders and directory content** pane, select all of the packages in the table, leave the **Options** as default, and click **Next**.

   Note: Ensure that the **Disable after import** option is cleared.
9. In the **Specify the general options** pane, accept the defaults, and click **Next**.
10. On the **Review the summary** page, click **Next**.
11. On the **Select an action** page, select **Save and run once**, and click **Finish**.
12. On the **Run with options** page, accept the defaults, and click **Run**, and then click **OK**.
13. Select **View the details of this import after closing this dialog** and click **OK**.

Importing the map specification to IBM Cognos BI

The Asset Analytics for Rotational Equipment in Oil and Gas application includes a map specification for the Executive Dashboard. You must import the map specification into IBM Cognos Business Intelligence.

Procedure

1. Open a web browser.
2. Go to the IBM Cognos BI portal URL.
3. On the **Welcome** page, click **Administer IBM Cognos Content**.
4. On the **Library** tab, click **Import Visualization**.
5. Browse to and select the REOilGas_AssetAnalytics_Map_Rave.zip file.
6. Follow the steps in the wizard to import the file.

Opening the Framework Manager model

You can view the Asset Analytics for Rotational Equipment in Oil and Gas dashboard model in IBM Cognos Framework Manager. The Framework Manager project file (.cpf) for the Capacity Management Analytics model is included in the REOilGas_AssetAnalytics_FMProject.zip file.

Procedure

1. Start IBM Cognos Framework Manager.
2. From the **Welcome** page, click **Open a project**.

3. Navigate to the folder where you extracted the
   `REOilGas_AssetAnalytics_FMProject.zip` file, and select the `IBMPMQ_Model.cpf`
   file.
4. Click **Open**.
5. If you must republish the packages, you must update the **Tenant_Id** in the
   Tenant_lookup parameter in the model.
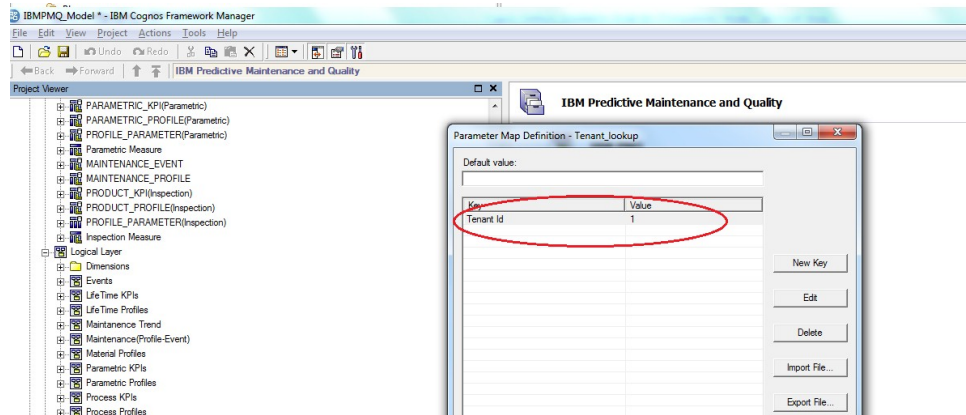
You can find the **Tenant_Id** in the **IBMPMQ** database by using the following
database query:

`Select Tenant_Id from pmqsch.tenant where Tenant_cd='ESP'`

6. After you have made changes to the model, you can republish the package.
   a. In the **Project Viewer** pane, expand **Packages**.
   b. Right-click the package, and click **Publish Package**.

   After publishing, the package should be available in **Public Folders** >
   REOilGas_AssetAnalytics in the IBM Cognos Business Intelligence portal.

Importing the Rave specification to IBM Cognos BI

The Asset Analytics for Rotational Equipment in Oil and Gas application includes
a Rave specification for the dashboard. You must import the Rave specification into
IBM Cognos Business Intelligence.

Procedure

1. Open a web browser.
2. Go to the IBM Cognos BI portal URL.
3. On the **Welcome** page, click **Administer IBM Cognos Content**.
4. On the **Library** tab, click **Import Visualization**.
5. Navigate to the folder where you saved the
   `REOilGas_AssetAnalytics_Map_Rave.zip` file.
6. Follow the steps in the wizard to import the file.

Importing images to IBM Cognos BI

The Asset Analytics for Rotational Equipment in Oil and Gas application includes
some images for the dashboard. You must import those images into IBM Cognos
Business Intelligence.

Procedure

1. Go to the IBM Cognos BI install location. For instance, `/opt/ibm/cognos/c10_64`.

2. Extract the images archive `REOilGas_AssetAnalytics_Images.zip` in the `<COGNOS_INSTALL_LOCATION>/webcontent/ReportImages`. For instance, `/opt/ibm/cognos/c10_64/webcontent/ReportImages`.

Onboard pump data

Custom flows are provided with the Asset Analytics for Rotational Equipment in Oil and Gas solution. You use the custom flows to onboard pump data and to trigger training and scoring models.

Master and metadata must be loaded into the IBM Predictive Maintenance and Quality database, and you must also load the event data before you can run the analytic training or the scoring models.

Asset Analytics for Rotational Equipment in Oil and Gas provides the following custom flows:

- `ESPAggregateFlow.msgflow`—Formats aggregated data as Predictive Maintenance and Quality events
- `ESPMaintenanceFlow.msgflow`—Formats maintenance data as Predictive Maintenance and Quality events
- `ESPScoringTrigger.msgflow`—Flow that triggers scoring model for each pump
- `ESPSensorRawDataFlow.msgflow`—Formats raw sensor data as Predictive Maintenance and Quality events
- `ESPTrainingTrigger.msgflow`—Flow that triggers the training model
- `ESPWellTestFlow.msgflow`—Formats well-test data as Predictive Maintenance and Quality events
- `ESPStaticDataFlow.msgflow`—Formats design data as Predictive Maintenance and Quality events

The data onboarding flows write event data files directly to IBM Integration Bus `eventdatain` folder.

The flows are provided in a file that is named `ESPCustomFlows_PI.zip`. The

The `ESPCustomFlows_PI.zip` file is deployed to `/opt/ibm/IS_REOilGas_AssetAnalytics_1.0/Source` by default.

Flow property files

Each `msgflow` file has a properties file that you can configure.

JDBCProperties
Includes properties for JDBC connection name and the schema name.

Header record
Holds the header record for the output event file.

Values for event fields
Properties for setting default values for Predictive Maintenance and Quality event attributes.

Measurement name mappings
For setting different measurement type names.

Master data and metadata for the solution

You must provide the master data and metadata for the Asset Analytics for Rotational Equipment in Oil and Gas solution. You must prepare the CSV files before you can load them into the environment.

The master data and metadata must be provided in the CSV files that are shown in the following list:

- `language_upsert.csv`
- `tenant_upsert.csv`
- `event_code_upsert.csv`
- `event_type_upsert.csv`
- `location_upsert.csv`
- `group_dim_upsert.csv`
- `measurement_type_upsert.csv`
- `production_batch_upsert.csv`
- `material_upsert.csv`
- `source_system_upsert.csv`
- `supplier_upsert.csv`
- `value_type_upsert.csv`
- `resource_type_upsert.csv`
- `product_upsert.csv`
- `process_upsert.csv`
- `material_type_upsert.csv`
- `resource_upsert.csv`

The following are examples of the contents that each of the CSV files that you must prepare must contain.

The files `group_dim_upsert.csv`, `location_upsert.csv`, and `resource_upsert.csv` should be based on the pump details, including its hierarchical relationship to other entities, such as wells and platforms, and organization relationships and suited to your environment.

language_upsert.csv - Notepad

```
language_cd,language_name,isdefault
EN,ENGLISH,1
FR,French,0
JA,Japanese,0
PT,Portuguese,0
SC,Simplified Chinese,0
TC,Traditional Chinese,0
```

tenant_upsert.csv - Notepad

```
tenant_cd,tenant_name,isdefault
ESP,ESP,0
```

event_code_upsert.csv - Notepad

```
event_code_set,event_code_set_name,event_code,language_cd,tenant_cd
-NA-,Non applicable,-NA-,EN,ESP
```

event_type_upsert.csv - Notepad

```
event_type_cd,event_type_name,Language,Tenant_CD
-NA-,Non applicable,EN,ESP
ESPAGGREGATE,ESPAGGREGATE,EN,ESP
ESPTRAINING,ESPTRAINING,EN,ESP
ESPSCORING,ESPSCORING,EN,ESP
ESPRECOMMENDED,ESPRECOMMENDED,EN,ESP
ESPMEASUREMENT,ESPMEASUREMENT,EN,ESP
ESPSTATIC,ESPSTATIC,EN,ESP
```

location_upsert.csv - Notepad

```
location_cd,location_name,region_cd,region_name,country_cd,country_name,state_province_cd
state_province_name,city_name,latitude,longitude,language_cd,tenant_cd,Isactive
-NA-,Not Applicable,,,,,,,,,,EN,ESP,1
Bagley,Bagley,USA,USA,USA,USA,TX,Texas,Borger Field,31.96859,-99.90181,EN,ESP,1
Gregg,Gregg,USA,USA,USA,USA,TX,Texas,Borger Field,32.48925,-96.64033,EN,ESP,1
Rusk,Rusk,USA,USA,USA,USA,TX,Texas,Borger Field,31.79600,-95.15022,EN,ESP,1
Upshur,Upshur,USA,USA,USA,USA,TX,Texas,Ranger Field,32.70997,-94.97665,EN,ESP,1
Smith,Smith,USA,USA,USA,USA,TX,Texas,Ranger Field,32.33525,-95.31025,EN,ESP,1
Cherokee,Cherokee,USA,USA,USA,USA,TX,Texas,Caddo Lake Field,30.98147,-98.70832,EN,ESP,1
```

group_dim_upsert.csv - Notepad

```
group_type_cd,group_type_name,group_member_cd,group_member_name,language_cd,tenant_cd
-NA-,Not Applicable,-NA-,Not Applicable,EN,ESP
Organization,Organization,GlobeEx Oil Corporation,GlobeEx Oil Corporation,EN,ESP
Site,Site,Borger Field,Borger Field,EN,ESP
Site,Site,Ranger Field,Ranger Field,EN,ESP
Site,Site,Caddo Lake Field,Caddo Lake Field,EN,ESP
```

measurement_type_upsert.csv - Notepad

```
measurement_type_cd,measurement_type_name,unit_of_measure,carry_forward_indicator,aggregation_type,
event_code_indicator,language_cd,tenant_cd
Motor_Temp,Motor_Temp,deg C,0,,0,EN,ESP
DH_Amps,DH_Amps,amps,0,,0,EN,ESP
Output_Freq,Output_Freq,,0,,0,EN,ESP
Pump_Intk_Pres,Pump_Intk_Pres,psi,0,,0,EN,ESP
PCM_System_Error,PCM_System_Error,,0,,0,EN,ESP
Status,Status,,0,,0,EN,ESP
TEST_TYPE,TEST_TYPE,,0,,0,EN,ESP
OIL_RATE,OIL_RATE,,0,,0,EN,ESP
GAS_RATE,GAS_RATE,,0,,0,EN,ESP
TUBING_PRESS,TUBING_PRESS,,0,,0,EN,ESP
ALLOCATABLE,ALLOCATABLE,,0,,0,EN,ESP
WATER_CUT,WATER_CUT,,0,,0,EN,ESP
PROD_HOURS,PROD_HOURS,,0,,0,EN,ESP
TEST_HOURS,TEST_HOURS,,0,,0,EN,ESP
DATE_MODIFIED,DATE_MODIFIED,,0,,0,EN,ESP
PRIMARY_REASON,PRIMARY_REASON,,0,,0,EN,ESP
JOB_COST_TOTAL,JOB_COST_TOTAL,,0,,0,EN,ESP
Changepoint_Time,Changepoint_Time,,0,,0,EN,ESP
Mode_StartTime,Mode_StartTime,,0,,0,EN,ESP
Stoppage_Prob,Stoppage_Prob,,0,,0,EN,ESP
Failure_Prob,Failure_Prob,,0,,0,EN,ESP
samplenumPIP,samplenumPIP,,0,,0,EN,ESP
PIPROC,PIPROC,,0,,0,EN,ESP
PIPAVG,PIPAVG,,0,,0,EN,ESP
PIPMAX,PIPMAX,,0,,0,EN,ESP
PIPMIN,PIPMIN,,0,,0,EN,ESP
flagPIP,flagPIP,,0,,0,EN,ESP
samplenumMTRT,samplenumMTRT,,0,,0,EN,ESP
MTRTROC,MTRTROC,,0,,0,EN,ESP
MTRAVG,MTRAVG,,0,,0,EN,ESP
MTRMAX,MTRMAX,,0,,0,EN,ESP
MTRMIN,MTRMIN,,0,,0,EN,ESP
flagMTRT,flagMTRT,,0,,0,EN,ESP
samplenumAmp,samplenumAmp,,0,,0,EN,ESP
AmpROC,AmpROC,,0,,0,EN,ESP
AmpAVG,AmpAVG,,0,,0,EN,ESP
AmpMAX,AmpMAX,,0,,0,EN,ESP
AmpMIN,AmpMIN,,0,,0,EN,ESP
flagAmp,flagAmp,,0,,0,EN,ESP
samplenumOutputFreq,samplenumOutputFreq,,0,,0,EN,ESP
OutputFreqROC,OutputFreqROC,,0,,0,EN,ESP
OutputFreqAVG,OutputFreqAVG,,0,,0,EN,ESP
OutputFreqMAX,OutputFreqMAX,,0,,0,EN,ESP
OutputFreqMIN,OutputFreqMIN,,0,,0,EN,ESP
flagOutputFreq,flagOutputFreq,,0,,0,EN,ESP
Bad,Bad,,0,,0,EN,ESP
StatusTime,StatusTime,,0,,0,EN,ESP
TotalRunTime,TotalRunTime,,0,,0,EN,ESP
AggrStatus,AggrStatus,,0,,0,EN,ESP
PCMSystemError,PCMSystemError,,0,,0,EN,ESP
JOB_NAME,JOB_NAME,,0,,0,EN,ESP
Mode,Mode,,0,,0,EN,ESP
ChangePointTime,ChangePointTime,,0,,0,EN,ESP
ESPRC,ESP Recommendation,,0,,0,EN,ESP
ESP_Downhole_Pres,ESP_Downhole_Pres,,0,,0,EN,ESP
ESP_Downhole_Temp,ESP_Downhole_Temp,,0,,0,EN,ESP
```

production_batch_upsert.csv - Notepad

```
production_batch_cd,production_batch_name,product_cd,product_type_cd,product_date,language
-NA-,Not Applicable,-NA-,-NA-,2015-01-01,EN,ESP
```

material_upsert.csv - Notepad

```
material_cd,material_name,material_type_cd,supplier_cd,language_cd,tenant_cd,Isactive
-NA-,Not Applicable,-NA-,-NA-,EN,ESP,1
```

```
source_system_upsert.csv - Notepad
File  Edit  Format  View  Help
source_system_cd,source_system_name,language_cd,tenant_cd,isactive
-NA-,Not Applicable,EN,ESP,1
RD,RawData,EN,ESP,1
WTD,WellTestData,EN,ESP,1
MD,MaintenanceData,EN,ESP,1
TR,Training,EN,ESP,1
SCOR,Scoring,EN,ESP,1
SD,StaticData,EN,ESP,1
```

```
supplier_upsert.csv - Notepad
File  Edit  Format  View  Help
supplier_cd,supplier_name,language_cd,tenant_cd,Isactive
-NA-,Not Applicable,EN,ESP,1
```

```
value_type_upsert.csv - Notepad
File  Edit  Format  View  Help
value_type_cd,value_type_name,Language,Tenant_CD
PLAN,Planned Value,EN,ESP
ACTUAL,Actual Measurement,EN,ESP
FORECAST,Forecast Value,EN,ESP
STATIC,Static Reference Value,EN,ESP
PREPROCESSED,Preprocessed Value,EN,ESP
```

```
resource_type_upsert.csv - Notepad
File  Edit  Format  View  Help
resource_type_name,resource_type_cd,language_cd,tenant_cd
ASSET,ASSET,EN,ESP
```

```
product_upsert.csv - Notepad
File  Edit  Format  View  Help
product_cd,product_name,product_type_cd,product_type_name,parent_product_cd,parent_product
-NA-,Not Applicable,-NA-,Not Applicable,,,EN,ESP,1
```

```
process_upsert.csv - Notepad
File  Edit  Format  View  Help
process_cd,process_name,parent_process_cd,language_cd,tenant_cd
-NA-,Not Applicable,,EN,ESP
```

```
material_type_upsert.csv - Notepad
File  Edit  Format  View  Help
material_type_cd,material_type_name,language_cd_tenant_cd
-NA-,Not Applicable,EN,ESP
```

The Asset Analytics for Rotational Equipment in Oil and Gas solution provides for defining multilevel resource hierarchies that are augmented by group dimensions. A number of associations and relationships between resources and attributes can be defined. Any number of pumps can be defined, and associations can be defined to group them by any dimension; for example, OEM or Vendor can be defined as a dimension and associated with a pump.

The examples contain a base level of data that can be used for a fictional resource that is named ESP501 of type ESP and a child of an ASSET that is named Well7. ESP is associated with the manufacturer specified by the attribute group_dim_member_cd_1 as AC. Irrespective of the resource hierarchy and group dimension associations that are defined, all electrical submersible pumps in this example content are associated with the resource type ESP.
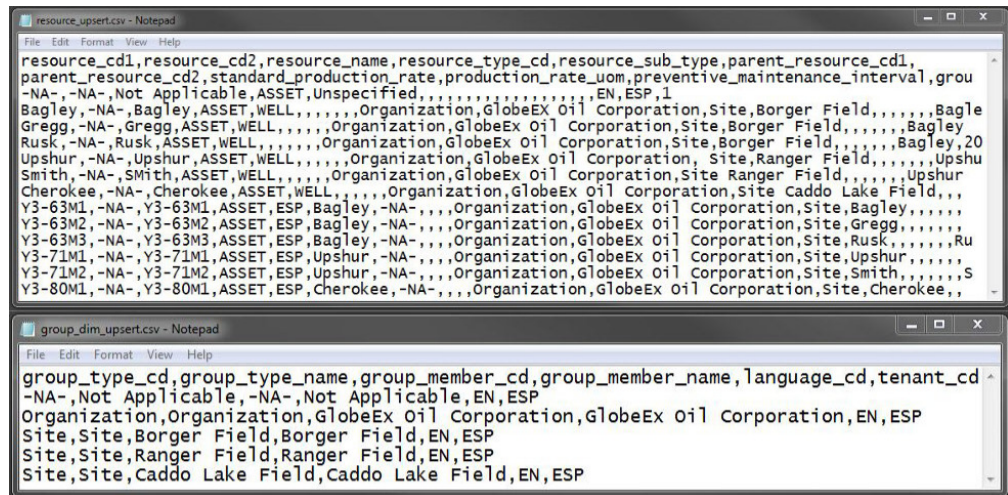
Loading the master data and metadata

You must load the master data and metadata for the Asset Analytics for Rotational Equipment in Oil and Gas solution in a specific order.

Procedure

1. Log in to the Integration Bus node computer as the `mqm` user.
2. Copy the files to the `/var/PMQ/MQSIFileInput/masterdatain` directory in the order that is shown in the following table:

Order	File name
1	language_upsert.csv
2	tenant_upsert.csv
3	event_code_upsert.csv
4	event_type_upsert.csv
5	group_dim_upsert.csv
6	location_upsert.csv This file should be based on the location of the equipment.
7	material_type_upsert.csv
8	measurement_type_upsert.csv
9	process_upsert.csv
10	product_upsert.csv
11	profile_calculation_upsert.csv
12	resource_type_upsert.csv
13	source_system_upsert.csv
14	supplier_upsert.csv
15	value_type_upsert.csv
16	material_upsert.csv
17	production_batch_upsert.csv
18	profile_variable_upsert.csv
19	resource_upsert.csv

Important: The files must be copied one at a time.

For more information about master and metadata for IBM Predictive Maintenance and Quality, see the following topics in IBM Knowledge Center under Predictive Maintenance and Quality 2.5.1:
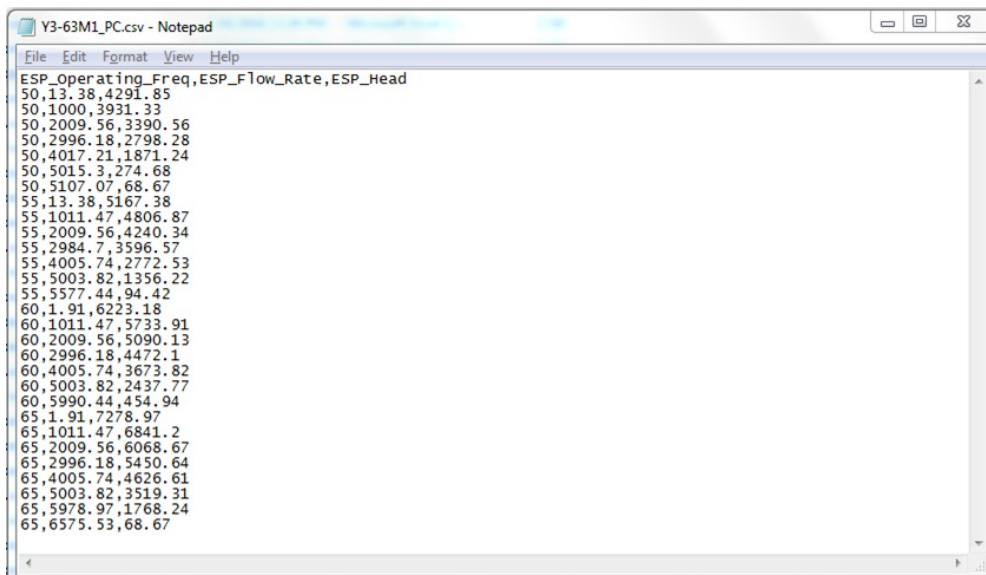
- Master data process
- File format and location
- The flat file API

Design data
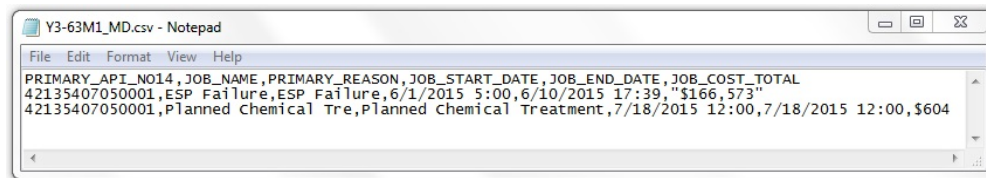
Design data must also be loaded for the Asset Analytics for Rotational Equipment in Oil and Gas solution.

Design data includes information such as pump curve data, well curve data, best efficiency point data, upthrust data, and downthrust data.

The following are examples of the contents that each of the CSV files that you must prepare must contain. The CSV files that you use should reflect your environment.

```
Y3-63M1_UT.csv - Notepad
File  Edit  Format  View  Help
ESP_Upthrust_Flow_Rate,ESP_Upthrust_Head
1848.95,3467.81
2032.5,4240.34
2204.59,4987.12
2376.67,5836.91
```



```
Y3-63M1_DT.csv - Notepad
File  Edit  Format  View  Help
ESP_Downthrust_Flow_Rate,ESP_Downthrust_Head
4900.57,3622.32
4510.52,3133.05
4177.82,2592.27
3799.24,2154.51
```

The example custom flows expect design data in the formats shown in the image.

When you create the design data, ensure that:

- A design file must have data for only a single pump.
- The names of the event data files should be prefixed with <SerialNo_>. For example, well test data for a pump with serial number of ESP401 should be named ESP401_***.csv. The custom flow looks up the location and model of the pump based on the Serial_Number of the pump in the file name.

Onboarding design data

You must load the design data for the Asset Analytics for Rotational Equipment in Oil and Gas solution.

Procedure

1. Log in to the Integration Bus node computer as the `mqm` user.
2. Copy the design data files that you created to the directory /var/PMQ/MQSIFileInput/espstaticdatain. Example file names are

   - Y3-63M1_PC.csv
   - Y3-63M1_MD.csv
   - Y3-63M1_BEP.csv
   - Y3-63M1_UT.csv
   - Y3-63M1_DT.csv

Event data

Event data must also be loaded for the Asset Analytics for Rotational Equipment in Oil and Gas solution.

Event data includes information such as maintenance data, well test data, and time variable data.

The following are examples of the contents that each of the CSV files that you must prepare must contain. The CSV files that you use should reflect your environment.

Y3-63M1_AGGR.csv - Notepad

File Edit Format View Help

```
start time,end time,samplenumPIP,4Hour_PIPROC,4Hour_PIPAVG,4Hour_PIPMAX,4Hour_PIPMIN,flagPIP,
samplenumMTRT,4Hour_MTRTROC,4Hour_MTRTAVG,4Hour_MTRTMAX,4Hour_MTRTMIN,flagMTRT,samplenumAmp,
4Hour_AmpROC,4Hour_AmpAVG,4Hour_AmpMAX,4Hour_AmpMIN,flagAmp,samplenumOutputFreq,4Hour_OutputFreqROC,
4Hour_OutputFreqAVG,4Hour_OutputFreqMAX,4Hour_OutputFreqMIN,flagOutputFreq,Bad,Status,StatusTime,
TotalRuntime,PCM_System_Error
03/10/2015 21:00,03/11/2015 01:00,2,0.200,178.350,178.400,178.300,,2,-0.603,150.650,150.800,150.500,
03/11/2015 01:00,03/11/2015 05:00,3,-0.417,178.300,178.500,178.100,,2,0.207,150.650,150.700,150.600,
03/11/2015 05:00,03/11/2015 09:00,2,-1.214,178.500,178.800,178.200,,3,-0.205,150.600,150.700,150.500
03/11/2015 09:00,03/11/2015 13:00,2,,178.400,178.600,178.200,,,,,,,,2,,28,28,28,,,,,,,,,,Stopped,03/1:
03/11/2015 13:00,03/11/2015 17:00,,,,,,4,2.039,148.325,150.700,146.100,,,,,,,,,,,,,,,,,,
03/11/2015 17:00,03/11/2015 21:00,2,,178.350,178.400,178.300,,,,,,,,2,,28,28,28,2,,62.900,62.900,62.
03/12/2015 01:00,03/12/2015 05:00,2,,177.400,177.400,177.400,,8,-1.955,148.988,150.800,146.100,,2,,2(
```

Y3-63M1_MD.csv - Notepad

File Edit Format View Help

```
PRIMARY_API_NO14,JOB_NAME,PRIMARY_REASON,JOB_START_DATE,JOB_END_DATE,JOB_COST_TOTAL
42135407050001,ESP Failure,ESP Failure,6/1/2015 5:00,6/10/2015 17:39,"$166,573"
42135407050001,Planned Chemical Tre,Planned Chemical Treatment,7/18/2015 12:00,7/18/2015 12:00,$604
```

Y3-63M1_WD.csv - Notepad

File Edit Format View Help

```
API_NO14,WELL_TEST_DATE,TEST_TYPE,OIL_RATE,GAS_RATE,WATER_RATE,GAS_OIL_RATIO,TUBING_PRESS,
ALLOCATABLE,WATER_CUT,PROD_HOURS,TEST_HOURS,COMMENTS,DATE_MODIFIED
42415307470000,01/01/2015 00:00,A        ,12.000,2294.920,1343.950,191250.000,0.000,Y,99.120,5,8,,0:
42415307470000,02/06/2015 00:00,A        ,30.000,1167.000,840.000,38900.000,0.000,Y,96.550,20,8,,02,
42415307470000,01/14/2015 00:00,B        ,0.000,1398.000,963.000,0.000,0.000,N,100.000,16,8,,01/14/
42415307470000,01/22/2015 00:00,A        ,24.000,1149.000,894.000,47875.000,0.000,Y,97.390,24,8,,01,
42415307470000,02/11/2015 00:00,A        ,27.000,1386.000,840.000,51333.330,0.000,Y,96.890,24,8,,02,
42415307470000,02/02/2015 00:00,A        ,21.000,1074.000,801.000,51142.860,0.000,Y,97.450,24,8,,02,
42415307470000,01/28/2015 00:00,A        ,21.000,1314.000,855.000,62571.430,0.000,Y,97.600,24,8,,01,
42415307470000,02/19/2015 00:00,A        ,30.000,1167.000,810.000,38900.000,412.780,Y,96.430,24,8,,(
42415307470000,02/15/2015 00:00,A        ,17.460,1210.790,771.300,69333.340,0.000,Y,97.790,24,8,,02,
42415307470000,03/06/2015 00:00,A        ,24.000,603.000,846.000,25125.000,385.420,Y,97.240,24,8,,0:
42415307470000,03/14/2015 00:00,A        ,30.000,660.000,810.000,22000.000,392.860,Y,96.430,24,8,,0:
42415307470000,03/18/2015 00:00,A        ,24.000,588.000,816.000,24500.000,388.280,Y,97.140,20,8,,0:
42415307470000,03/22/2015 00:00,A        ,24.000,615.000,780.000,25625.000,373.400,Y,97.010,23,8,,0:
42415307470000,03/01/2015 00:00,A        ,27.000,1254.000,759.000,46444.450,405.480,Y,96.560,24,8,,(
42415307470000,03/27/2015 00:00,A        ,18.000,591.000,759.000,32833.330,372.750,Y,97.680,24,8,,0:
42415307470000,04/05/2015 00:00,A        ,36.000,630.000,858.000,17500.000,383.010,Y,95.970,24,8,,04
```

Y3-63M1_RD.csv - Notepad

File Edit Format View Help

```
Site,Time,Measure,Value
Bagley,10-Mar-15 21:05:02,Pump_Intk_Pres,178.3000031
Bagley,10-Mar-15 23:05:01,Pump_Intk_Pres,178.4000092
Bagley,11-Mar-15 01:00:02,Pump_Intk_Pres,178.5
Bagley,11-Mar-15 02:50:16,Pump_Intk_Pres,178.3000031
Bagley,11-Mar-15 04:50:01,Pump_Intk_Pres,178.1000061
Bagley,11-Mar-15 06:41:25,Pump_Intk_Pres,178.8000031
Bagley,11-Mar-15 08:40:00,Pump_Intk_Pres,178.1999969
Bagley,11-Mar-15 08:42:02,Pump_Intk_Pres,Pt Created
Bagley,11-Mar-15 09:00:00,Pump_Intk_Pres,178.1999969
Bagley,11-Mar-15 09:07:57,Pump_Intk_Pres,178.6000061
Bagley,11-Mar-15 18:04:58,Pump_Intk_Pres,178.4000092
Bagley,11-Mar-15 18:14:50,Pump_Intk_Pres,178.3000031
Bagley,12-Mar-15 03:19:57,Pump_Intk_Pres,177.4000092
Bagley,12-Mar-15 03:29:57,Pump_Intk_Pres,177.4000092
Bagley,12-Mar-15 12:31:59,Pump_Intk_Pres,176.8000031
Bagley,12-Mar-15 12:44:55,Pump_Intk_Pres,176.8000031
Bagley,12-Mar-15 21:50:31,Pump_Intk_Pres,176.9000092
```

The example custom flows expect event and other supporting operational data in the formats shown in the image.

When you create the event data, ensure that:

- An event or operational data file must have data for only a single pump.
- The names of the event data files should be prefixed with <SerialNo_>. For example, well test data for a pump with serial number of ESP501 should be named ESP501_***.csv. The custom flow looks up the location and model of the pump based on the Serial_Number of the pump in the file name.

Onboarding event data

You must load the event data for the Asset Analytics for Rotational Equipment in Oil and Gas solution.

Procedure

1. Log in to the Integration Bus node computer as the **mqm** user.
2. Copy the event data files that you created to the following directories:

Example file name	Target input directory
Y3-63M1_AGGR_Sample.csv	/var/PMQ/MQSIFileInput/espaggregatein
Y3-63M1_MD.csv	/var/PMQ/MQSIFileInput/maintenancedatain
Y3-63M1_WD.csv	/var/PMQ/MQSIFileInput/welltestdatain
Y3-63M1_RD.csv	/var/PMQ/MQSIFileInput/espsensordatain

Configure and prime Maximo

If you are using IBM Maximo, you must create an enterprise service for the Asset Analytics for Rotational Equipment in Oil and Gas solution.

The work order creation service is called by an IBM Integration Bus flow in IBM Predictive Maintenance and Quality. You must configure the web service to receive work order creation requests from IBM Integration Bus.

For more information, see the Creating a work order service in IBM Maximo Asset Management topic in IBM Knowledge Center (www.ibm.com/support/knowledgecenter/SSTNNL_2.5.1/com.ibm.swg.ba.cognos.pmq_solution_guide.2.5.1.doc/t_create_work_order_maximo.html?lang=en).

After the web service is configured, the Maximo instance must be primed to map the master data in the Predictive Maintenance and Quality data mart. That is, you must map the resources and locations details in Maximo to enable it to receive, identify, and process work orders against these resources.

For more information, see the IBM Maximo Asset Management topic in IBM Knowledge Center (www.ibm.com/support/knowledgecenter/SSTNNL_2.5.1/com.ibm.swg.ba.cognos.pmq_solution_guide.2.5.1.doc/c_integ_maximo.html?lang=en).

Manually triggering batch training and scoring jobs

You can manually trigger a batch training or scoring job in your Asset Analytics for Rotational Equipment in Oil and Gas solution by copying a file to the esptriggersfolder directory.

Procedure

1. To trigger a training job:
   a. Log in to the Integration Bus node computer as the **mqm** user.
   b. Create a file that is named esptraining.txt. The file can be blank.
   c. Copy the file to the /var/PMQ/MQSIFileInput/esptriggersfolder directory.
2. To trigger a scoring job:
   a. Log in to the Integration Bus node computer as the **mqm** user.
   b. Create a file that is named espscoring.txt. The file can be blank.
   c. Copy the file to the /var/PMQ/MQSIFileInput/esptriggersfolder directory.

Verifying your installation

You can verify your installation by accessing the Asset Analytics for Rotational Equipment in Oil and Gas dashboards in IBM Cognos Business Intelligence.

Procedure

1. Open a web browser.
2. Go to the IBM Cognos BI portal URL. For example, go to `http://bi_node_name/ibmcognos/`
3. Click **IBM Cognos Content**.
4. In the **REOilGas_AssetAnalytics** folder, click **REOilGas_AssetAnalytics** to view the landing page.
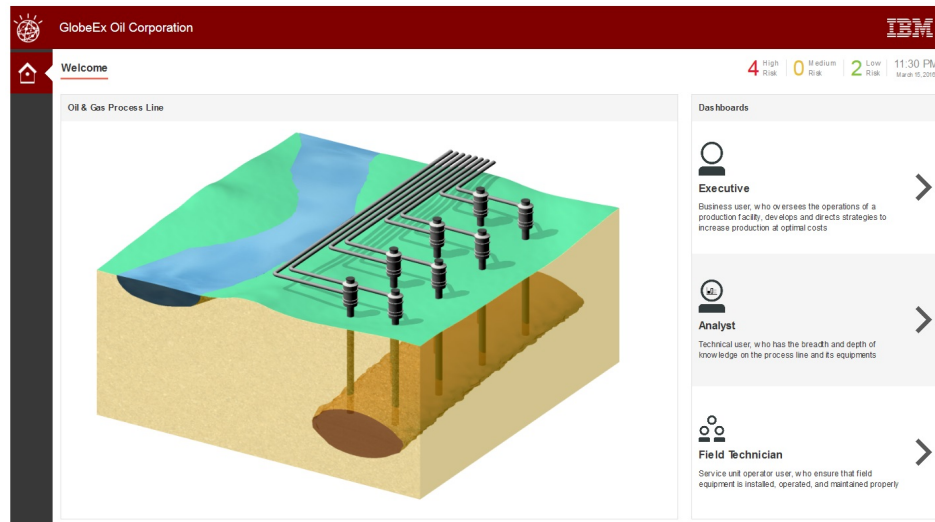
5. On the landing page, click the **Executive** persona on the **Dashboards** panel to view the **Executive Dashboard**.
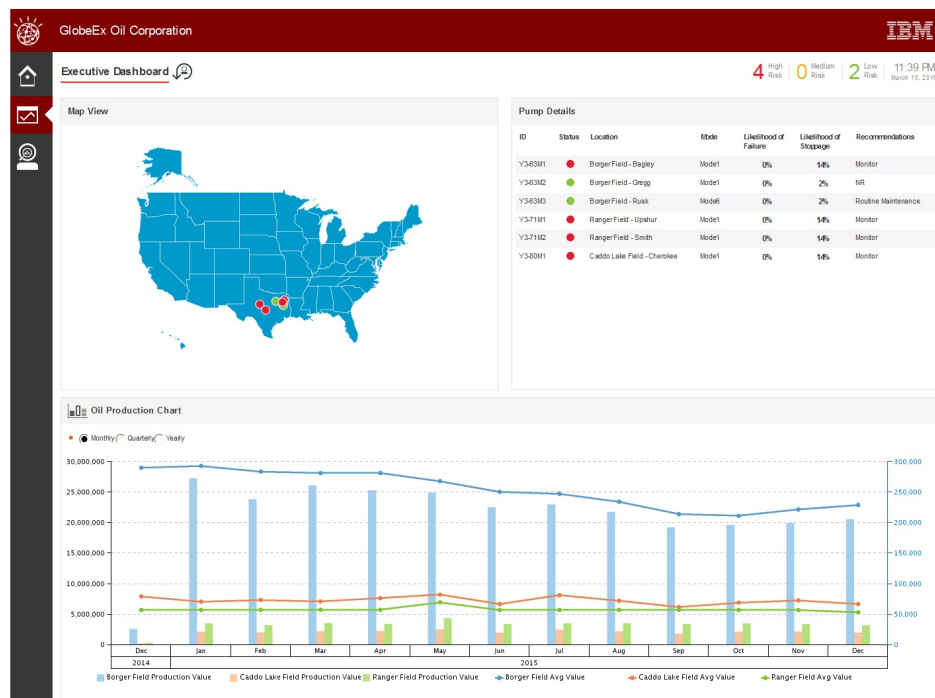
6. On the landing page, click the **Analyst** persona on the **Dashboards** panel to view the **Analyst Dashboard**.
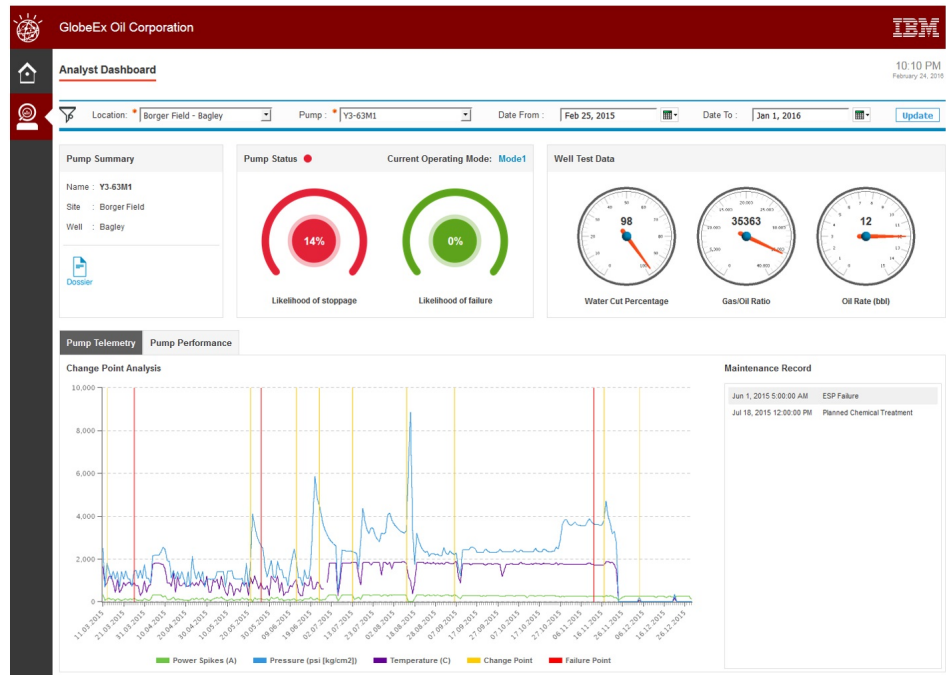
Chapter 3. Overview of the analytics model

Asset Analytics for Rotational Equipment in Oil and Gas is designed for critical equipment that is used in the oil and gas industry.

The analytics model adopts a unique method of pattern detection and recognition on equipment sensor information and correlates it with stoppage and failure events. This method provides information about the current state of the equipment and pump that can be used for preemptive maintenance.

The analytics model also consists of a performance curve that shows the variable speed operation which is widely used in the oil and gas industry. This provides a graphical solution for monitoring the clustering of well data points (flow rate versus pressure head) around the point where the system curve (well curve) intersects the pump curve for a given frequency. Also, a time series model is used to forecast the well operating data for up to four days. The output of this model provides additional information for preemptive maintenance.

Data sources

The analytics models work on the following data sources:

Aggregated sensor data
Sensor data values are aggregated over a predefined period. The default period is 4 hours. The data values include telemetry, such as pump intake pressure, motor temperature, amperage, and motor frequency. Over the aggregated window, average and rate of change (ROC) values are used by the model. The **STATUS** field indicates whether the equipment is running or stopped.

Well test data
Data that contains information from periodic well tests that are conducted on the wells that are associated with the critical asset. This data contains measurements such as oil rate, gas rate, water cut, gas oil ratio, and water rate. Measurements with **TEST_TYPE** = "A" are considered.

Maintenance data
Data that contains information on maintenance events, including failures. For failure events, the **PRIMARY_REASON** field is assumed to have text that contains "failure".

Functional description

The analytics models segregate the operation of the asset into modes of operation. The segregation over the operating life of the equipment (for which data is available) is achieved by looking at sensor data from the master sensor. The following terms are relevant from a context perspective:

BEP   The best efficiency point of a pump.

Changepoint time
The time at which a mode transition happens.

Down thrust
The downward force on the shaft impeller assembly during pump operation.

Flow rate (B/D)
> The volume of fluid that passes per unit time.

Forecast data
> The preprocessed data used to develop a time series model that predicts the trend of future observations.

Master sensor
> A sensor that contains information or exhibits variability that is related to equipment behavior, especially in terms of equipment failure and stoppage. The default is pump intake pressure value average. The master sensor is used to detect equipment mode changes.

Missing values
> A condition that occurs when no data value is stored for the variables (such as *Oil_rate* or *Water_rate*) in an observation.

Mode A phase of operation that is associated with certain equipment behavior and specific propensities for failure and stoppage. These modes are deduced by the model.

Performance curve
> A combination of pump curves and a system curve (well curve), plotted as flow rate versus pressure head.

Pressure head (ft.)
> The total equivalent height that the fluid is to be pumped.

Pump curve
> A characteristic curve of a pump, plotted as flow rate versus pressure head.

Simulated data
> Data that is generated through a neural network model that is trained using existing historic data (such as **Observation_TimeStamp**, **Oil_rate**, **Water_rate**, and **PumpID**) and later scored against the time stamp corresponding to the missing value observation.

System curve
> See "well curve."

Upward thrust
> The upward force on the shaft impeller assembly during pump operation.

Well curve
> A characteristic curve of a well, plotted as flow rate versus pressure head. Also known as system curve.

Minimum data requirements

For the minimum sensor (aggregated) data, at least one aggregated data point is required for the following measurement types for each item of equipment or pump:

- PIPAVG
- PIPROC
- MTRTAVG
- MTRTROC
- OutputFreq_AVG
- OutputFreq_ROC
- AmpAVG

- AmpROC

For the minimum well test data, at least one data point is required for the following measurement types for each item of equipment or pump:
- OIL_RATE
- GAS_RATE
- WATER_RATE
- GAS_OIL_RATIO
- WATER_CUT

For the performance curve model, at least 40 observations are required for the well test data. This data is loaded initially for the measurement types previously listed for each pump. Furthermore, for the subsequent job schedules, at least one observation from each measurement type is required for every pump.

For equipment to be considered for profiling and mode detection in the training model, at least 24 non-null sensor (aggregated) data points must be available. At least one data point for well test (**Test_Type** = "A") with a time stamp before the time window available for sensor data must also be available. These criteria ensure reliability in the generated model. Under these conditions, at least one mode is outputted by the training model and a valid model file is generated.

A valid model file is required for scoring to be started successfully for an item of equipment. The scoring model waits for at least six sensor data points to accumulate after the last changepoint (or six data points overall if no changepoints are present) before it attempts to detect the new mode of the equipment.

Scheduling the job

To create a new schedule, in the **Content Explorer** of IBM SPSS Collaboration and Deployment Services Deployment Manager, right-click the ESP_PERFORMANCE job and then select **New schedule > Time-Based**. For time-based schedules, the **Schedule Time** and **Recurrence** page of the **Schedule** wizard defines the time of day and frequency at which the job runs, as well as the duration of the schedule. Select a **Start Time** of 12:00 AM and set the **Recurrence Pattern** to run the job on every alternate day in a week, except Saturday and Sunday, starting on Monday.

Interpretations of results

The following list explains how to interpret the results:

Mode naming
> Each mode is assigned a number in a sequence that starts from 1, such as Mode 1, Mode 2, and so on. The numbers are identifiers that distinguish between the modes. No ordinality is associated with the naming of modes.

Probabilities for stoppage and failure
> The stoppage and failure probabilities that are generated reflect the propensity to fail or stop within the current aggregate window. For example, if the data is aggregated over a four-hour window, the propensities reflect the probability to fail or stop within those 4 hours. However, these values are constant for a specific mode of the equipment. If the equipment enters a mode with a high failure or stoppage propensity, remedial action can be recommended.

Recommendations

The recommendations are generated based on a rules engine that is configured in IBM SPSS Decision Management. These recommendations translate to work orders that are created in IBM Maximo. For more information, see the section on SPSS decision management rule customization.

Mode 0 interpretation

The appearance of Mode 0 is a special case in which the model is waiting for sufficient data to accumulate, after the last determined changepoint for the equipment, to reliably classify the sensor pattern. Over time, with more data in the database, a pattern emerges. When this situation occurs, Mode 0 is replaced with one of the modes (ID >= 1) detected during the model training. However, if Mode 0 persists after the equipment changes to a new mode, the model detects a new pattern. The model must be retrained and rescored for this new pattern to be assimilated by the system.

Guidelines and recommended action

Guidelines for interpreting the graphical results and corresponding recommended actions are provided in the analyst dashboard.

Training model

The training model makes use of all available historical Maintenance and Operational data for slurry pumps to train an analytical model which can be used for scoring the Time-To-Failure.

About this task

You can configure the following parameters for the model:

IPAVG

Pump intake pressure (average).

MTRTAVG

Motor temperature (average).

AMPAVG

Pump amperage (average).

FREQAVG

Pump frequency control output (average).

aggrwindowsecs

The number of seconds over which the data is aggregated to calculate metrics, such as average and rate of change (ROC).

mastsensor

The master sensor based on which mode changes are detected.

tenantcd

The default tenant code that is used to store data for this solution is **ESP**. Use this code to specify a different value (a new tenant code string).

Important:

If parameters are modified, ensure that they are modified for both the training and scoring model. The values of these parameters must be consistent between the training and scoring models.

Do not edit any other model parameters. Editing the other parameters can cause the models to stop functioning.

Perform the following steps to configure the analytics model training and scoring.

Procedure

1. Open **ESP_TRAIN_JOB** from the analytics content.
2. Click the stream.
3. Configure the training model. Go to the **Parameters** tab and edit the parameters for the **ESP_TRAIN_JOB** job.

   The following image shows the **Parameters** for the **ESP_TRAIN_JOB** job:
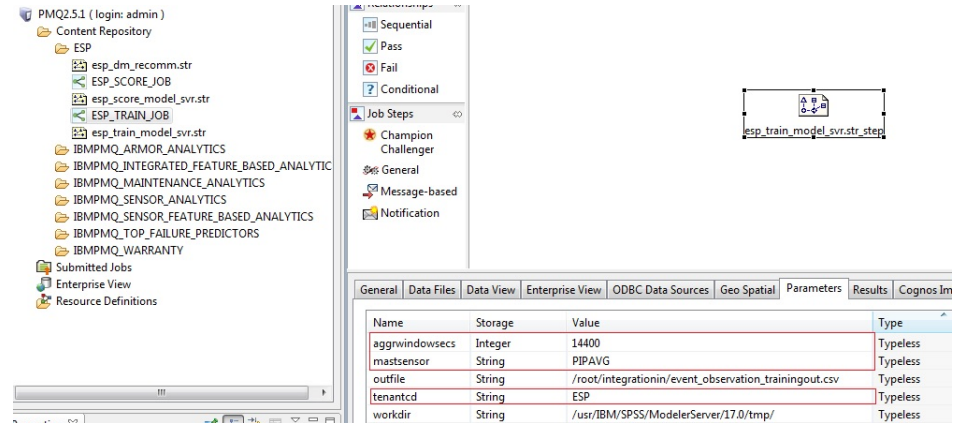
4. Save the job.
5. Configure the scoring model. Open the **ESP_SCORE_JOB** job and repeat the steps. The following image shows the parameters for the **ESP_SCORE_JOB** job:
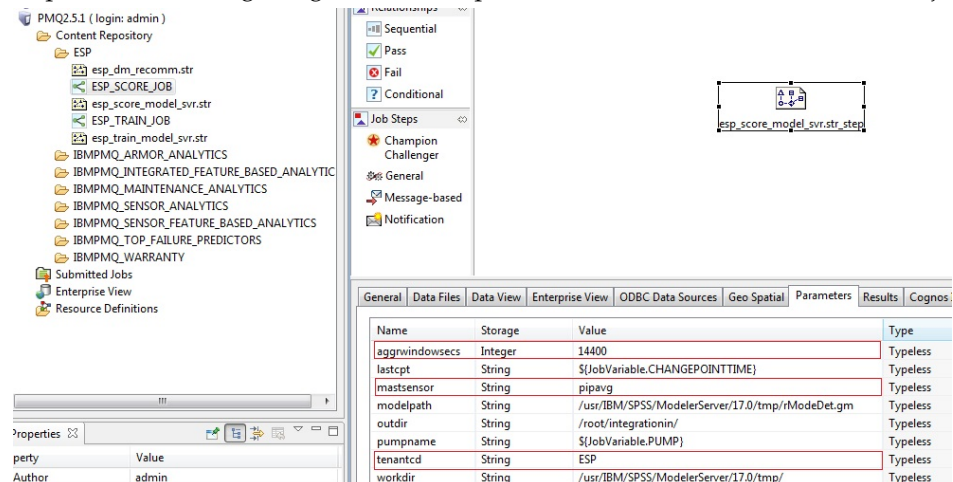
6. Configure the performance curve model. Open the **ESP_PERFORMANCE** job.
7. Click **esp_performance_forecasting.str_step** and configure the ODBC data sources. The following image shows the database table needed for scoring in

the **ESP_PERFORMANCE** job:
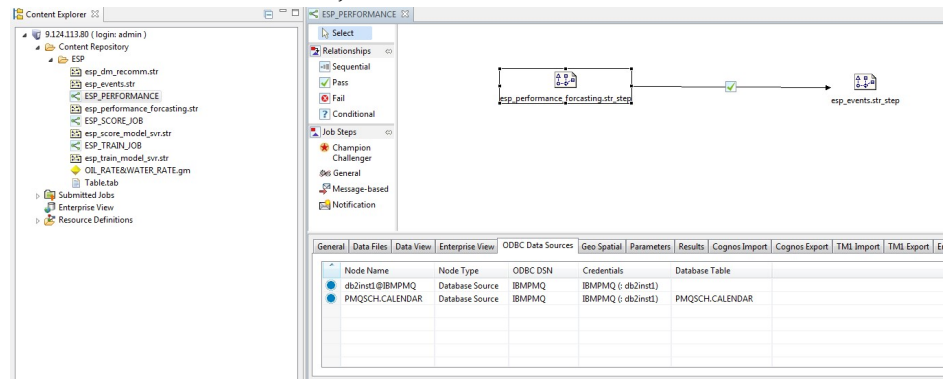
8. Click **esp_events.str_step** and configure the ODBC data sources. The following image shows the database tables needed to convert the modeler output to a PMQ DB2 format:
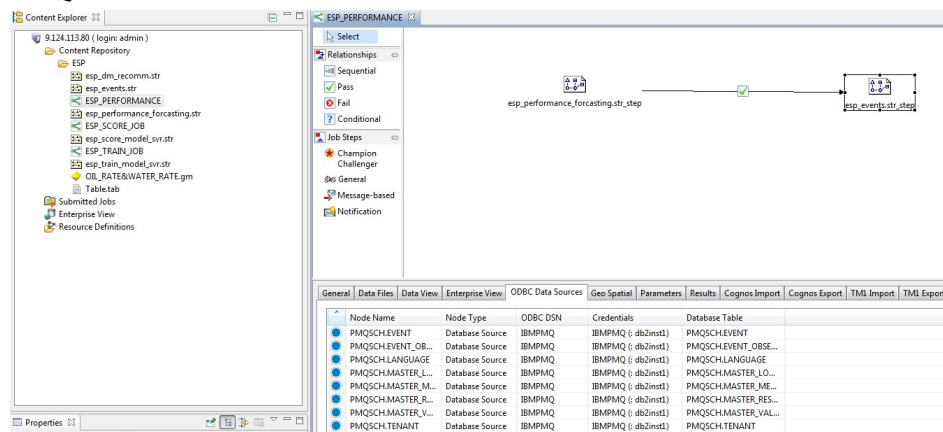
Scoring

SPSS decision management rules may be customized to determine the recommendations made by the model for every item of equipment.

About this task

The recommendations determined by the SPSS decision management rules are based on two variables:

- stoppage probability (STOP_PROB)
- failure probability (FAIL_PROB)

Stoppage and failure probabilities for equipment are automatically calculated by the analytics model. The decision management rules allow flexibility in choosing the conditions for generating different recommendations, which are ultimately used to create work orders.

Procedure

1. Open IBM Analytical Decision Management.

2. In the following image, replace*<ip address>* and *<port>* with the IP address and port for accessing the SPSS modeler server node.
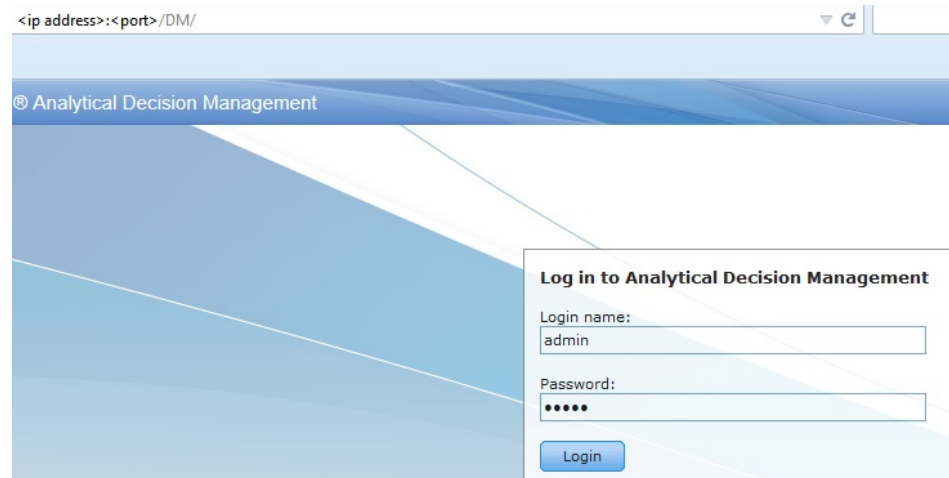
3. Log in with the credentials needed for accessing SPSS Decision Management.
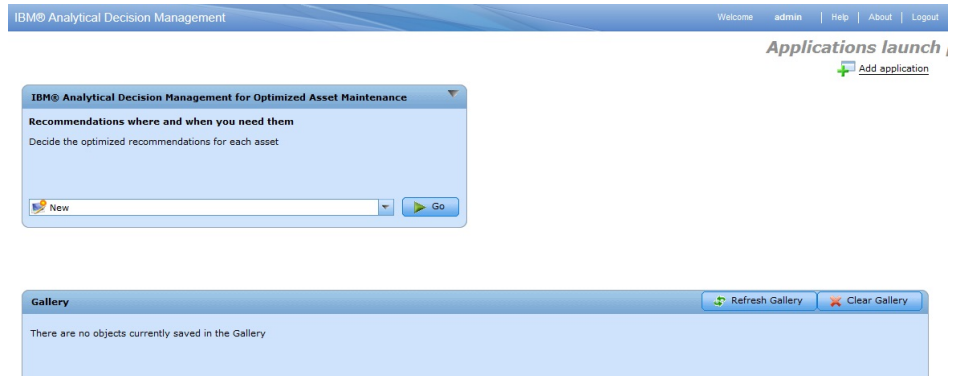
4. If the box labelled **IBM Analytical Decision Management for Optimized Asset Maintenance** is not displayed, click **Add application** and click **IBM Analytical Decision Management for Optimized Asset Maintenance** to add

the application.
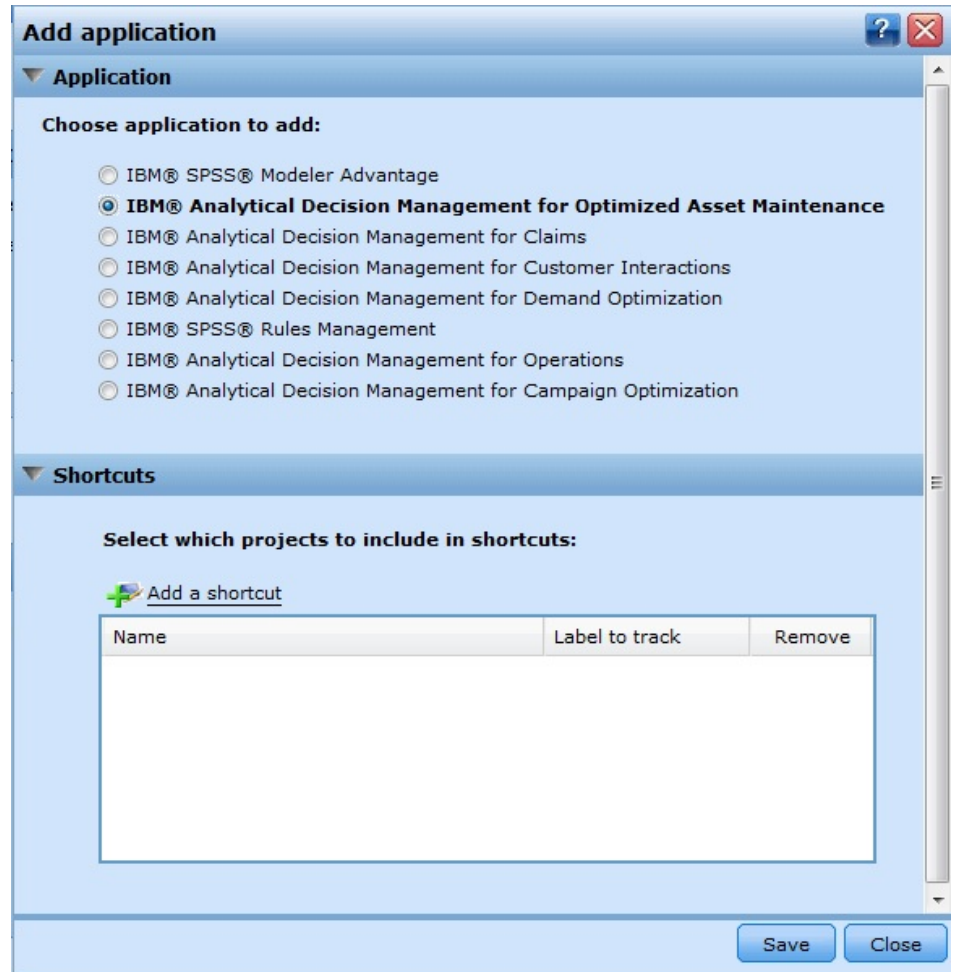
5. Click **Save**.

6. Save the job.

7. In the application drop-down menu, if **esp_dm_recomm.str** is displayed, select the file and click **Go**.
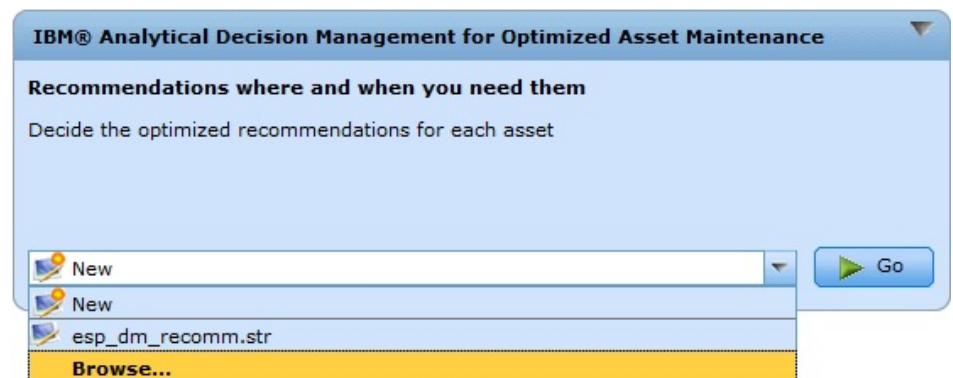
8. If **esp_dm_recomm.str** is not displayed, select **Browse** and navigate to the **ESP** folder in the **Content Repository**. Then select **esp_dm_recomm.str** and

click **Open**.
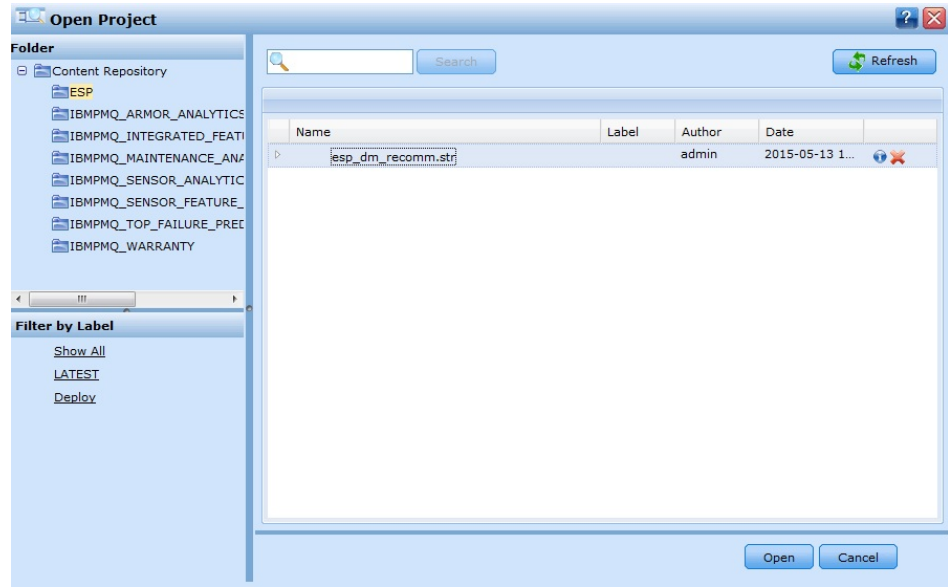
9. Select the **Define** step in the project flow.
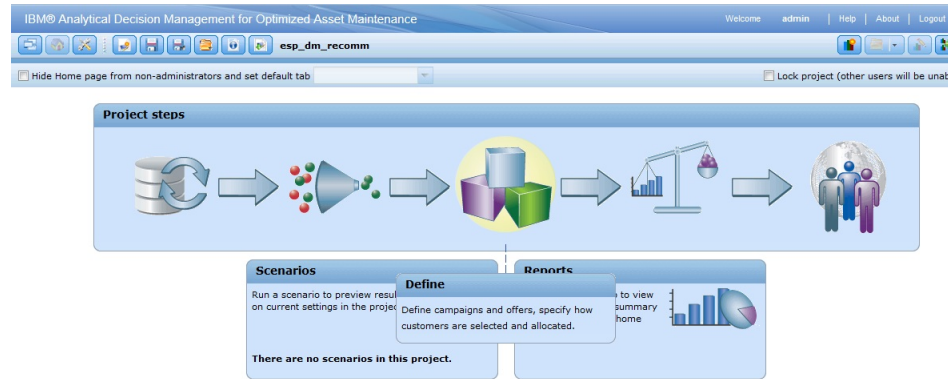
10. The user interface is displayed for the **Define** step, showing the rules configured by default and the associated recommendations under the **Allocate to** column of the **Segment Rules** table.

11. Expand the **My Campaign** list to display the configured list of recommendations. Right-click **My Campaign** to add a new recommendation

(offer) as needed.
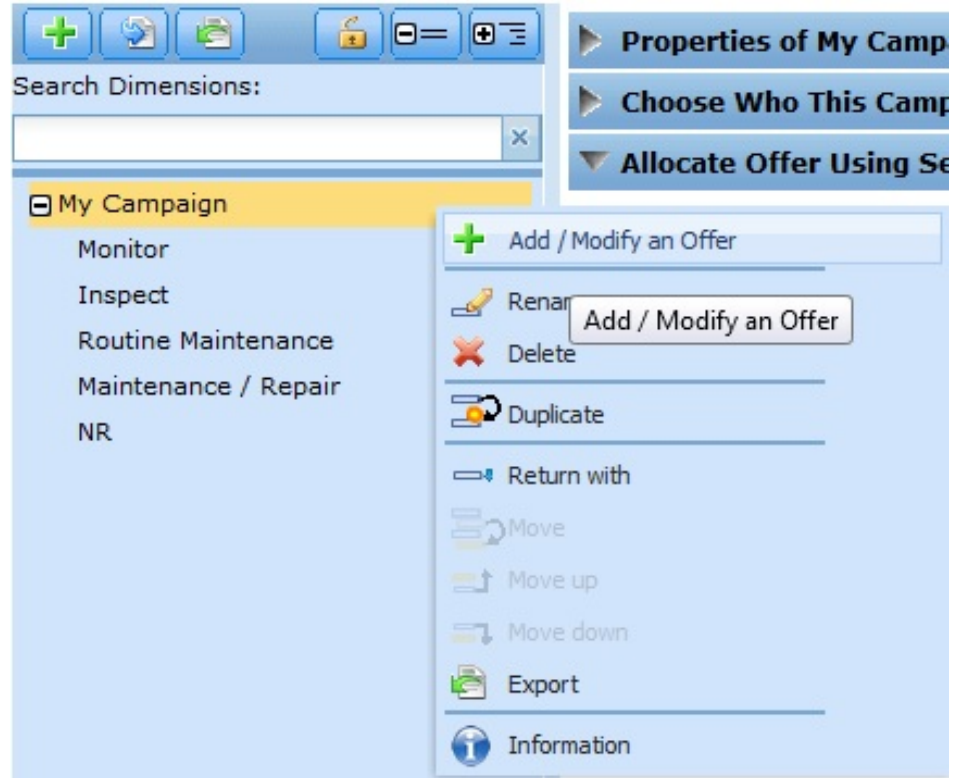
12. Right-click on names to delete or rename existing recommendations.
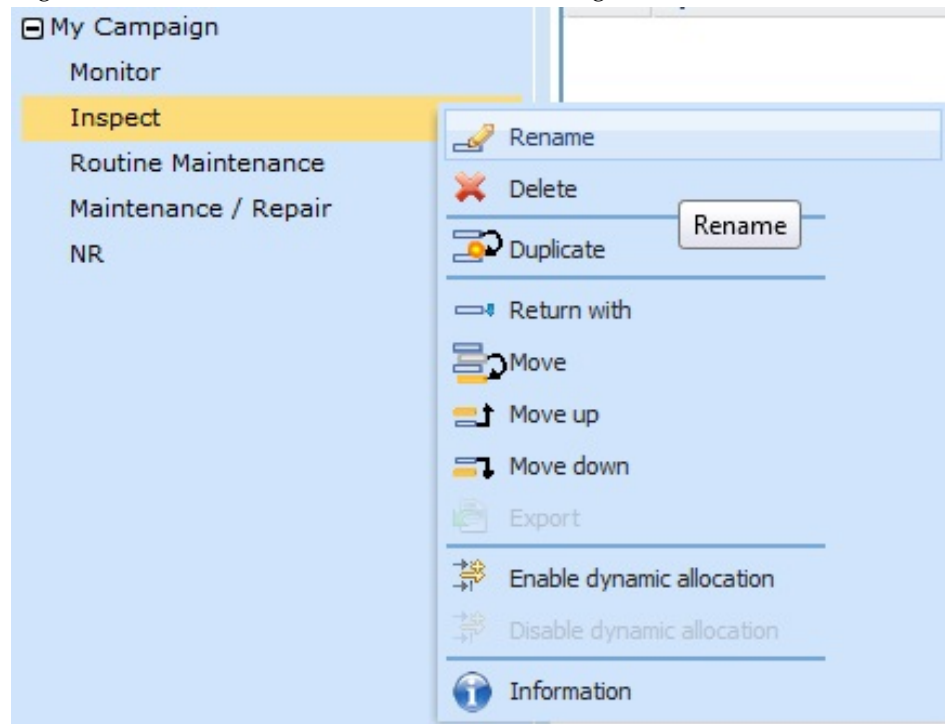
13. Click **My Campaign** again to see all segment rules.
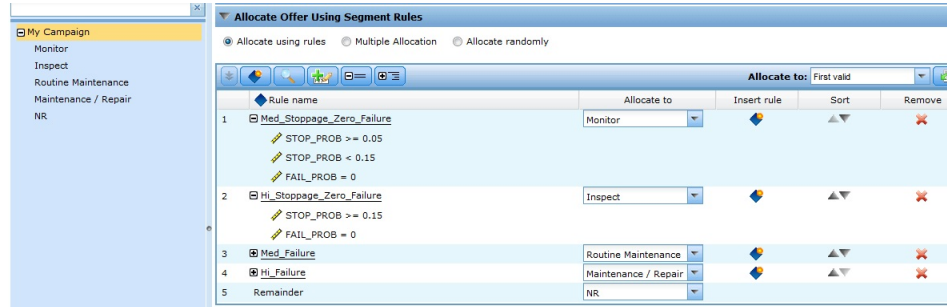
14. Click the diamond icon in the **Insert Rule** column to create a new rule, or click **X** to remove existing rules.
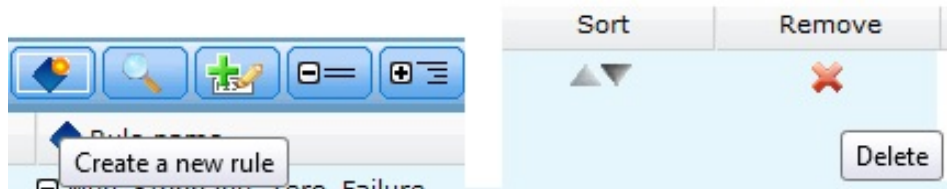
15. Click the rule name to edit any rule.
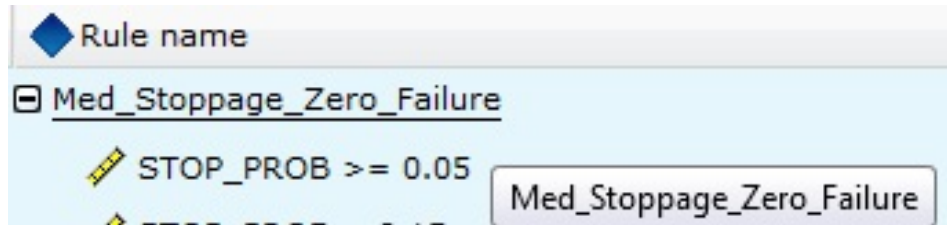
16. Using the **Edit Rule** box, modify the conditions to create a true rule. Click **X** to delete existing expressions. Add new expressions by entering the variable name and values in the last row of edit boxes. Use the expression drop-down menus to select one of the prelisted expressions that relate the variable to the value. The only permissible variables are STOP_PROB and FAIL_PROB. By default, all expressions are related with an AND condition.
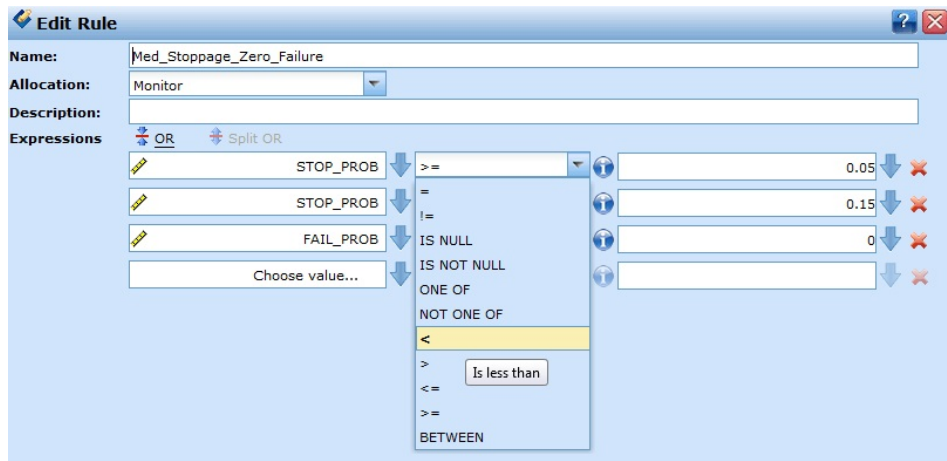
17. If two expressions need to be related with an `OR` condition, click **OR**, and select the expressions which require this condition. Then, click **Combine**.
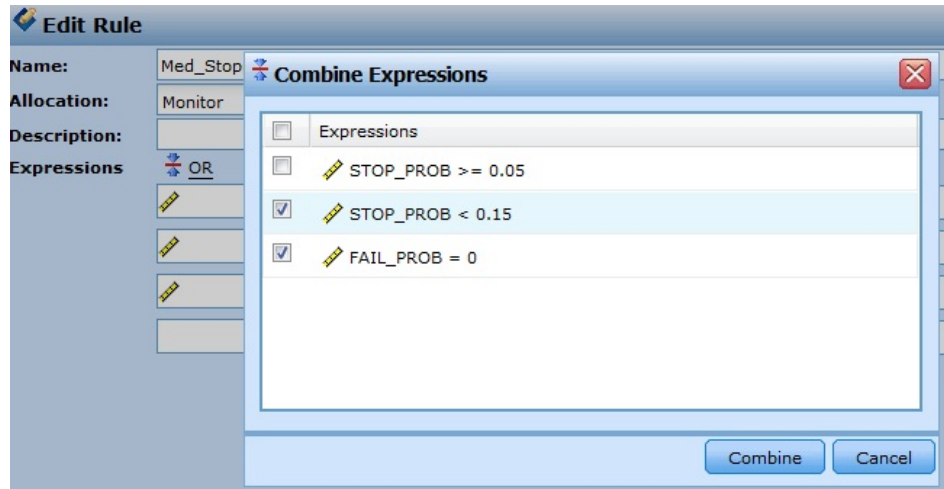
18. After the rule expressions have been edited, click **OK**.
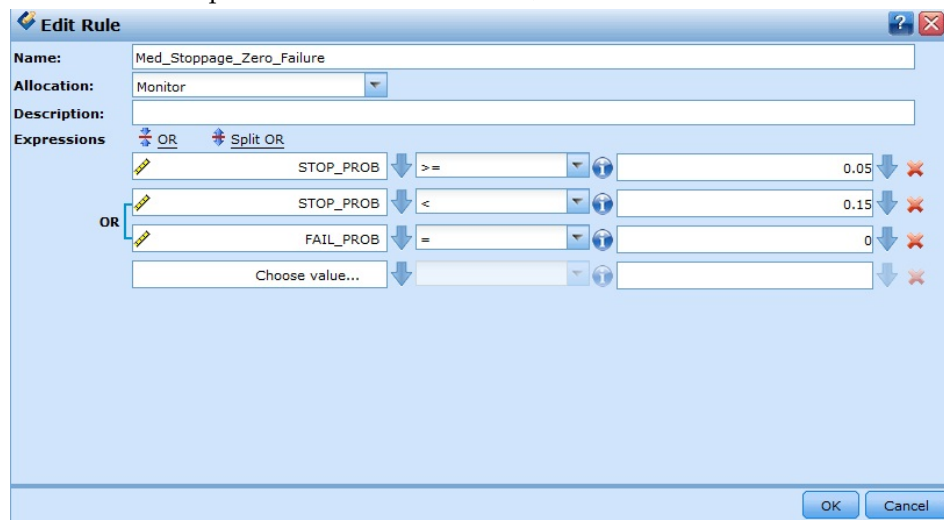
19. For each rule, choose the corresponding recommendation using the **Allocate to** drop-down menu.

Important: Ensure that different recommendations are generated under mutually exclusive rule sets. No more than one recommendation should be generated under any combination of `STOP_PROB` and `FAIL_PROB`

20. After editing all the rules, click **Save**.

21. To deploy, click the **Deploy** tab. In the **Deploy** pull-down menu, select **Deploy**, and click **Apply Label**.

22. Click the **Logout** link to log out of SPSS Decision Management.

Chapter 4. Using Asset Analytics for Rotational Equipment in Oil and Gas

This section describes two typical use cases that show how to use the IBM Asset Analytics for Rotational Equipment in Oil and Gas solution to predict pump failures.

Asset Analytics for Rotational Equipment in Oil and Gas provides dashboards that are designed to organize and categorize information for the various performance of modes of an electric submersible pump (ESP), as well as highlight the current mode of the ESP. The dashboards also highlight overall high, medium, and low risk ESPs.

The dashboards are designed for two personas: an executive and an analyst.

Workflow and user roles

This workflow shows how the solution can be used to thoroughly evaluate a potentially faulty pump with a high likelihood of failure. For this example, two primary users have been identified: an executive and an analyst. A typical process workflow is described.

Using the executive dashboard

Executives are one of the two primary users of the Asset Analytics for Rotational Equipment in Oil and Gas solution.

About this task

This task describes how a typical executive using the solution would identify a potentially faulty pump for further investigation. The screen captures shown are for example purposes and will vary depending on your particular implementation.

Procedure

1. Log on to the executive dashboard to scan for issues that need attention. Some of the pumps are in a critical state.

2. The **Map View** displays the geographical location and status of the pump.

Map View
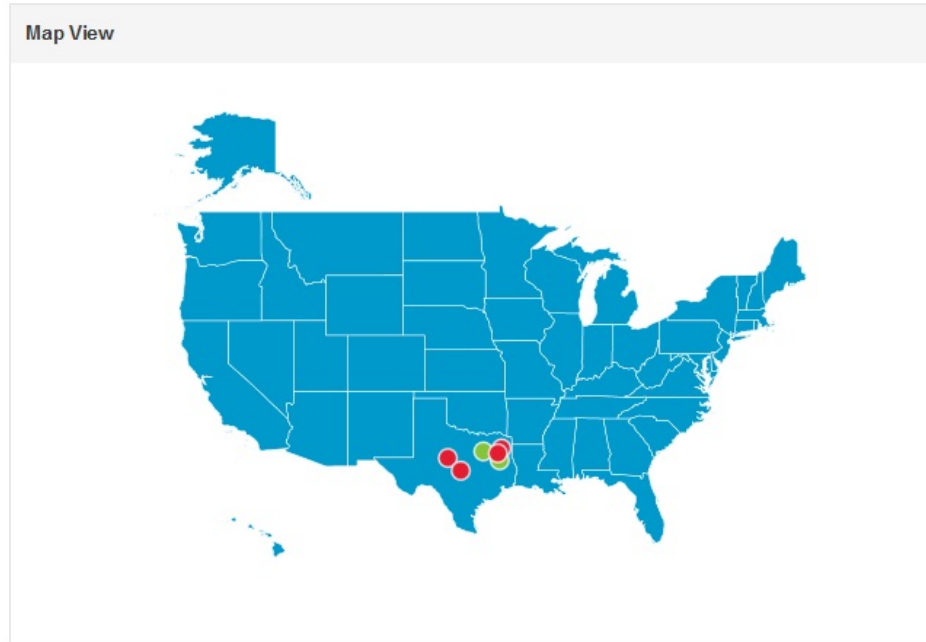
The individual panes on the dashboard provide further information about the pumps. The number of pumps at high, medium, and low is defined by the a calculation based on the probability of failure or stoppage of the pump.

4 High Risk | **0** Medium Risk | **2** Low Risk

The **Pump Details** Pane provides the pump's status, current mode, probability of failure, and probability of stoppage, and recommendations.

Pump Details

ID	Status	Location	Mode	Likelihood of Failure	Likelihood of Stoppage	Recommendations
Y3-63M1	●	Borger Field - Bagley	Mode1	0%	14%	Monitor
Y3-63M2	●	Borger Field - Gregg	Mode1	0%	2%	NR
Y3-63M3	●	Borger Field - Rusk	Mode6	0%	2%	Routine Maintenance
Y3-71M1	●	Ranger Field - Upshur	Mode1	0%	14%	Monitor
Y3-71M2	●	Ranger Field - Smith	Mode1	0%	14%	Monitor
Y3-80M1	●	Caddo Lake Field - Cherokee	Mode1	0%	14%	Monitor

Finally, an executive can view the oil production chart for the last two years, providing yearly, monthly, and quarterly production and average production chart date for various locations. Use the radio button on the chart to switch

between yearly, monthly, and quarterly views.
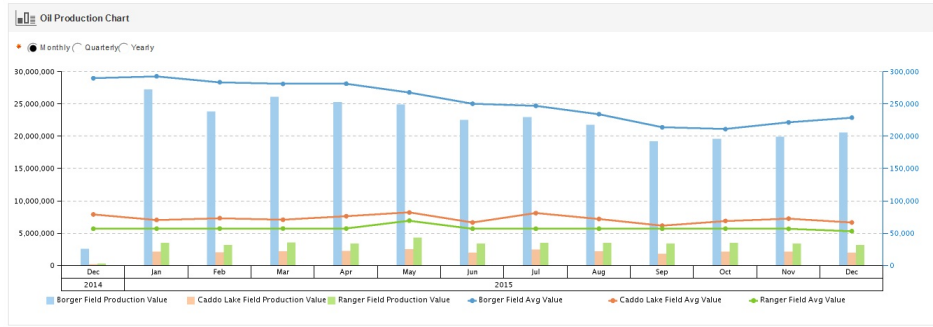
Using the analyst dashboard

Analysts are one of the two primary users of the Asset Analytics for Rotational Equipment in Oil and Gas solution.

About this task

This task describes how a typical analyst using the solution would identify a potentially faulty pump for further investigation. In addition, the performance curve model will help the analyst to understand and visualize the pump; well interactions through the measured well test variables. The following screen captures are for example purposes and will vary depending on your particular implementation.

Procedure

1. Log on to the**Analyst Dashboard** for a detailed an analysis of a specific pump.
2. In the **Filter** pane, enter the location, pump name, and dates to view the dashboard for a specific pump.
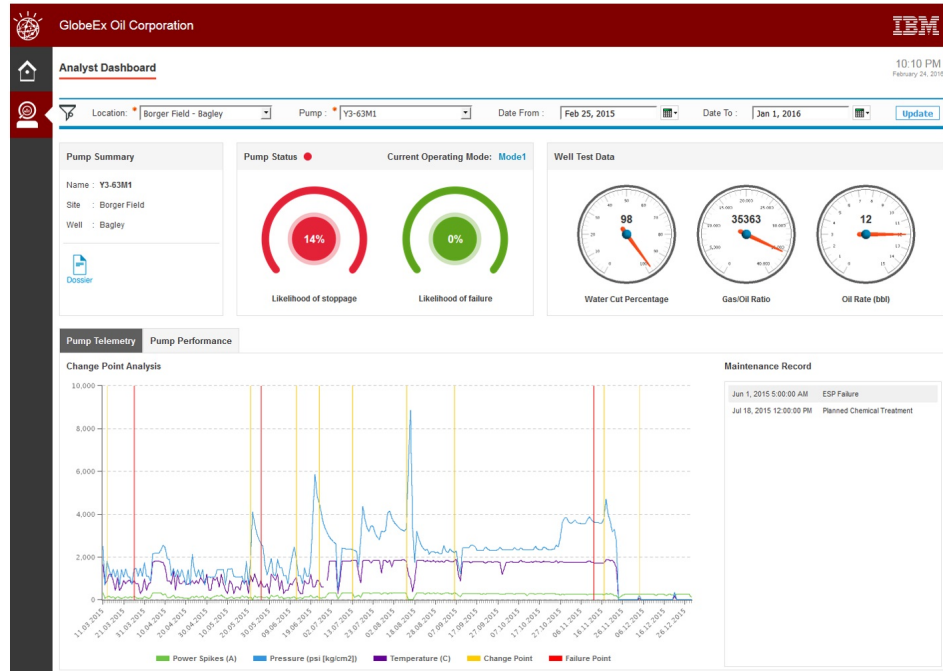
The individual panes provide key functionality or information. The **Filter** pane is used to filter pumps based on location, pump name, and date filters.

The **Pump Summary** pane displays the details of the selected pump such as name, site, and well.
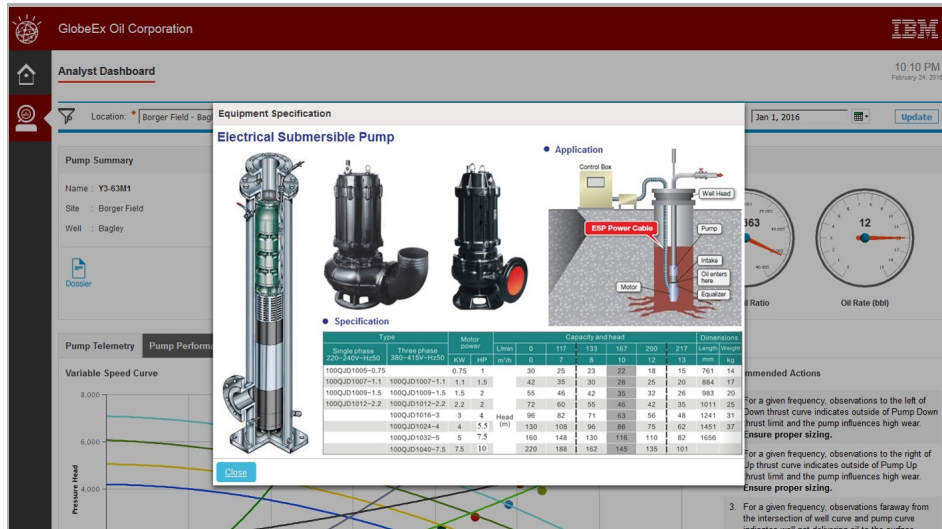
The **Pump Summary** pane has a Dossier feature, which will display the equipment specification.

The **Pump Status** pane displays the status, current operating mode, likelihood of failure, and stoppage.
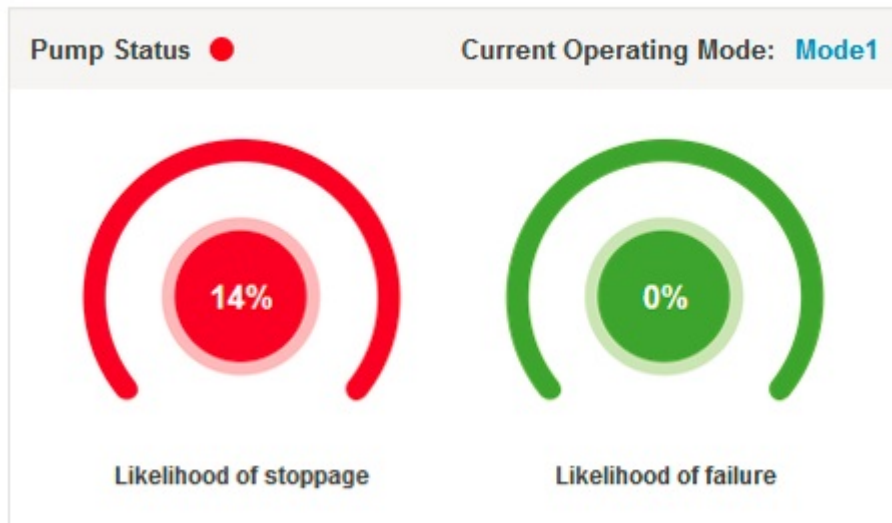
The dial charts present well test data for water cut percentage, gas and oil ration, and oil rate.
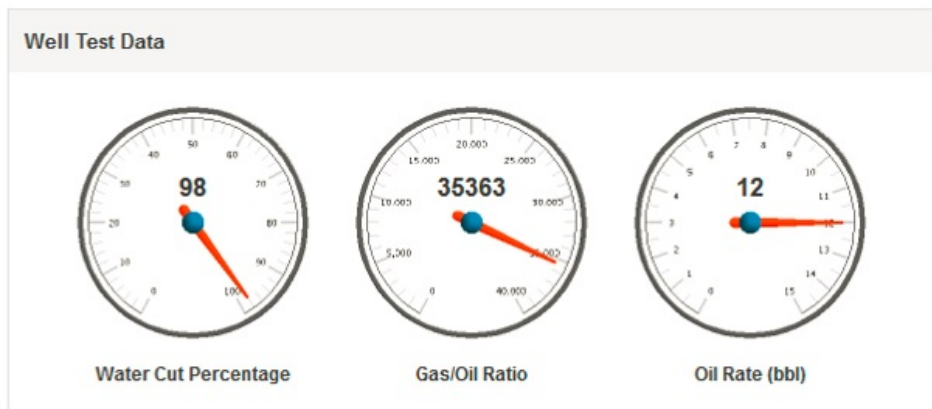
The **Change Point Analysis** chart displays the trends for temperature, pressure, and amperage sensors. Bars highlight the change points of the pump's performance. The **Maintenance Summary** pane includes a short description of the maintenance updates.
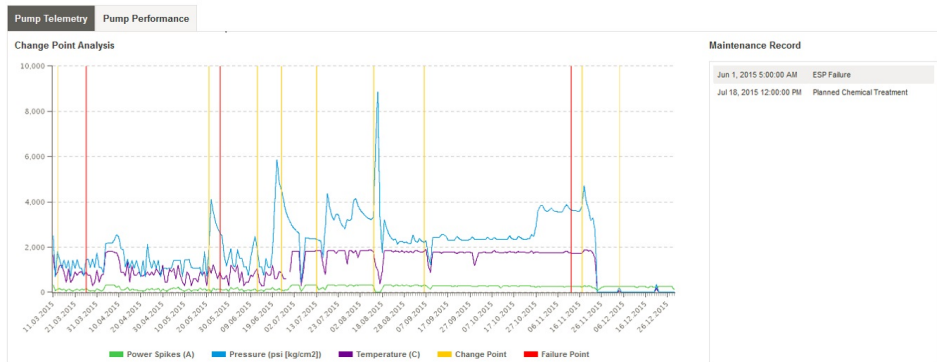
3. Click the **Pump Performance** tab on the report. The **Variable Speed Pump Performance Curve** depicts the interaction between the pump and the well, including plots of actual and forecast performance data. The preprocessed data shows the past four days performance at 65 Hz, with the default forecast data

plots showing one day. Forecast data is shown for 50-65 Hz.
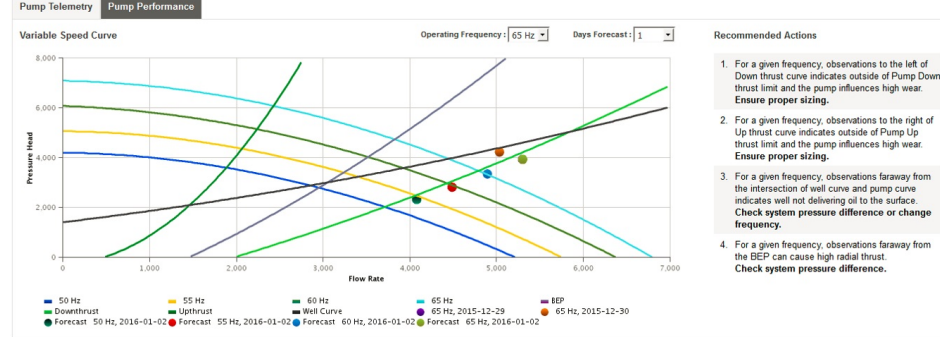
4. Open the **Operating Frequency** drop-down menu and select **55 Hz**. A frequency between 50-65 Hz can be selected.

5. Open the **Days Forecast** drop-down menu and select **2**. Up to four days can be selected on this menu. The chart will be updated with the new parameters and on the legend. The preprocessed data shows the past four days performance at 55 Hz, with the forecast data plots now showing two days.

6. Review the guidance for **Recommended Actions**, which is provided in the **Recommended Actions** pane.

Usage scenario

Asset Analytics for Rotational Equipment in Oil and Gassolution provides powerful predictive capabilities.

A typical process of extraction may take place from widely distributed oil and gas wells. In a given scenario, there could be thousands of wells and ESPs generating large volumes of real-time data.

For such a scenario, a predictive model could be built using data metrics for one year, such as intake and discharge pressure, drive amperage, and temperature. This data could be obtained from the historian, a database that logs time-based process data, as well as the Enterprise Asset Management database.

A small number of metrics could be used to characterize the performance of the ESPs, focusing on the optimal discharge pressure and key factors contributing to failures. This use case could then be used to provide real-time predictive scoring of ESP performance.

Appendix A. Accessibility features

Accessibility features help users who have a physical disability, such as restricted mobility or limited vision, to use information technology products.

For information about the commitment that IBM has to accessibility, see the IBM Accessibility Center (www.ibm.com/able).

IBM Cognos HTML documentation has accessibility features. PDF documents are supplemental and, as such, include no added accessibility features.

Report output

In IBM Cognos Administration, you can enable system-wide settings to create accessible report output. For more information, see the *IBM Cognos Business Intelligence Administration and Security Guide*. In IBM Cognos Report Studio, you can enable settings to create accessible output for individual reports. For more information, see the *IBM Cognos Report Studio User Guide*. You can access the previously mentioned documents at IBM Knowledge Center (http://www.ibm.com/support/knowledgecenter).

Appendix B. Troubleshooting

This section contains troubleshooting information for the Asset Analytics for Rotational Equipment in Oil and Gas installation.

Troubleshooting resources

Troubleshooting resources are sources of information that can help you resolve a problem that you are having with an IBM product.

Support Portal

The IBM Support Portal is a unified, centralized view of all technical support tools and information for all IBM systems, software, and services.

The IBM Support Portal lets you access all the IBM support resources from one place. You can tailor the pages to focus on the information and resources that you need for problem prevention and faster problem resolution. Familiarize yourself with the IBM Support Portal by viewing the demo videos (https://www.ibm.com/blogs/SPNA/entry/the_ibm_support_portal_videos).

Find the content that you need by selecting your products from the IBM Support Portal (http://www.ibm.com/support/entry/portal).

Before contacting IBM Support, you will need to collect diagnostic data (system information, symptoms, log files, traces, and so on) that is required to resolve a problem. Gathering this information will help to familiarize you with the troubleshooting process and save you time.

Service request

Service requests are also known as Problem Management Reports (PMRs). Several methods exist to submit diagnostic information to IBM Software Technical Support.

To open a PMR or to exchange information with technical support, view the IBM Software Support Exchanging information with Technical Support page (http://www.ibm.com/software/support/exchangeinfo.html).

Fix Central

Fix Central provides fixes and updates for your system's software, hardware, and operating system.

Use the pull-down menu to navigate to your product fixes on Fix Central (http://www.ibm.com/systems/support/fixes/en/fixcentral/help/getstarted.html). You may also want to view Fix Central help.

IBM developerWorks®

IBM developerWorks provides verified technical information in specific technology environments.

As a troubleshooting resource, developerWorks provides easy access to the most popular practices, in addition to videos and other information: developerWorks (http://www.ibm.com/developerworks).

IBM Redbooks®

IBM Redbooks are developed and published by the IBM International Technical Support Organization, the ITSO.

IBM Redbooks (http://www.redbooks.ibm.com) provide in-depth guidance about such topics as installation and configuration and solution implementation.

Software support and RSS feeds

IBM Software Support RSS feeds are a quick, easy, and lightweight format for monitoring new content added to websites.

After you download an RSS reader or browser plug-in, you can subscribe to IBM product feeds at IBM Software Support RSS feeds (https://www.ibm.com/software/support/rss).

Log files

Log files can help you troubleshoot problems by recording the activities that take place when you work with a product.

Error messages

The first indication of a problem is often an error message. Error messages contain information that can be helpful in determining the cause of a problem.

Troubleshooting a problem

Troubleshooting is a systematic approach to solving a problem. The goal of troubleshooting is to determine why something does not work as expected and how to resolve the problem.

Review the following table to help you or customer support resolve a problem.

Table 1. Troubleshooting actions and descriptions

Actions	Description
A product fix might be available to resolve your problem.	Apply all known fix packs, or service levels, or program temporary fixes (PTF).
Look up error messages by selecting the product from the IBM Support Portal, and then typing the error message code into the **Search support** box (http://www.ibm.com/support/entry/portal/).	Error messages give important information to help you identify the component that is causing the problem.
Reproduce the problem to ensure that it is not just a simple error.	If samples are available with the product, you might try to reproduce the problem by using the sample data.

Table 1. Troubleshooting actions and descriptions (continued)

Actions	Description
Ensure that the installation successfully finished.	The installation location must contain the appropriate file structure and the file permissions. For example, if the product requires write access to log files, ensure that the directory has the correct permission.
Review all relevant documentation, including release notes, technotes, and proven practices documentation.	Search the IBM Knowledge Center to determine whether your problem is known, has a workaround, or if it is already resolved and documented.
Review recent changes in your computing environment.	Sometimes installing new software might cause compatibility issues.

If the items in the table did not guide you to a resolution, you might need to collect diagnostic data. This data is necessary for an IBM technical-support representative to effectively troubleshoot and assist you in resolving the problem.

Troubleshooting known errors

There are solutions for known errors that you may encounter in IBM Asset Analytics for Rotational Equipment in Oil and Gas.

Table 2. Solutions to errors or problems in the executive dashboards in IBM Asset Analytics for Rotational Equipment in Oil and Gas..

Error or problem	Action
Model or package does not exist. This error occurs with this message: The model or package /content/folder[@name='REOilGas_AssetAnalytics'] /package[@name='IBMPMQ']/model[@name='2015-06- 16T05:18:25.171Z'] does not exist or you are not allowed to use it because of security settings.	Ensure IBMPMQ Mode is published on the Cognos server in **Public Folders** > **REOilGas_AssetAnalytics**.
Dashboards display "No Data Available" even if there is data available in the IBMPMQ database.	Ensure the Tenant ID is updated in the IBMPMQ model parameter, and the package is published.

Table 3. Solutions to errors or problems in IBM Cognos dashboards in IBM Asset Analytics for Rotational Equipment in Oil and Gas..

Error or problem	Action
Electrical submersibile pump (ESP) locations are plotted outside the map.	Map lenders locations are based on the latitude and longitude values for a location. The longitude value should have a -ve value stored in the Master_Location.Longitude column.
The map does not show all the ESPs .	If multiple pumps have the same latitude and longitude values, the ESPs data points will overlap and only one ESP will be plotted on the map.
The ESP's location name is not available when pointing to the circles on the map.	If the map is not showing the location name for the pump when you point to a circle on the map, view the **Location Name** in the **Pump Details** pane.
The **Pump Details** column headers disappear when there is scroll bar in the pane.	The **Pump Details** column headers scroll up or down with the list.
Oil production data is not available for entire data set stored in the ESP_PROD_DATA table.	Oil production data shows only the last two years of the ESP_PROD_DATA table. For example, if data is stored for 2011 through 2014, the dashboard will show only the 2013 and 2014 years.
The **Oil Production Chart** is not available on the dashboard	Ensure the data is populated in the ESP_PROD_DATA table.

Table 4. Solutions to errors or problems in the analyst dashboards in IBM Asset Analytics for Rotational Equipment in Oil and Gas..

Error or problem	Action
Change points do not appear in the **Change Point Analysis** chart.	This chart shows data based on an observation time stamp. The change point for a pump will be available only if any one of the three sensors (temperature, pressure, or amperage) has data on the selected date.
Red color bars appear in the **Change Point Analysis** chart.	Change points are highlighted using orange color bars in the chart. Red bars are for high severity mode. In the solution, mode 2 has red bars.

Table 4. Solutions to errors or problems in the analyst dashboards in IBM Asset Analytics for Rotational Equipment in Oil and Gas. (continued).

Error or problem	Action
Pump Name selections cause unexpected location and pump filter behavior.	The **Pump Name** filter is cascaded based on location. When a location is selected, the pump list is refreshed and the first pump in that location is selected. Please click on the **Update** button to refresh the dashboard.

Troubleshooting SPSS

If your SPSS job fails, there are some troubleshooting steps you can follow to resolve the issue. Troubleshooting the execution of SPSS jobs requires IBM SPSS Collaboration and Deployment Services Deployment Manager 7.0 to be installed on the workstation from which the server connection is to be established.

Procedure

1. Start IBM SPSS Collaboration and Deployment Services Deployment Manager 7.0.
2. Go to **File > New > Content Server Connection**.
3. Enter the **Connection name** and **Server URL** in the **Connection Information** dialog box, where *<server_ip_address>* is the IP address of the SPSS server node and *<port>* is the port number configured for the server connection.
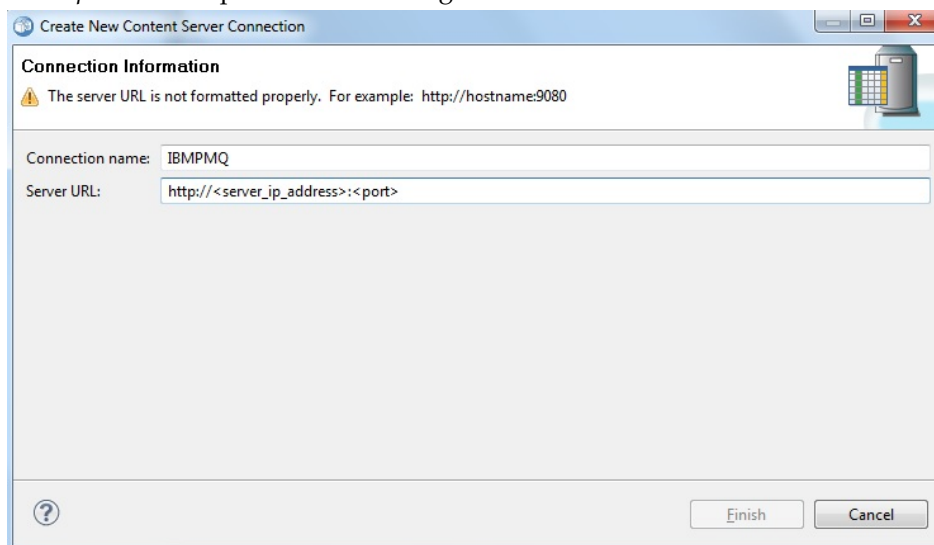
4. Expand the new **Content Server Connection** and provide the authentication details for the server.

5. Expand the ESP folder in the Content Repository for the two job files: ESP_TRAIN_JOB, for model training, and ESP_SCORE_JOB, for model scoring.
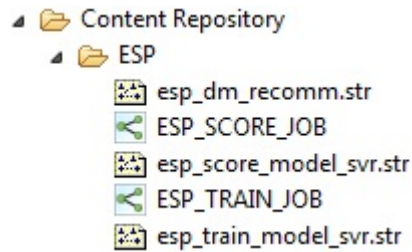
6. Right-click on the job that you are troubleshooting and click **Show Job History** in the pull-down menu.
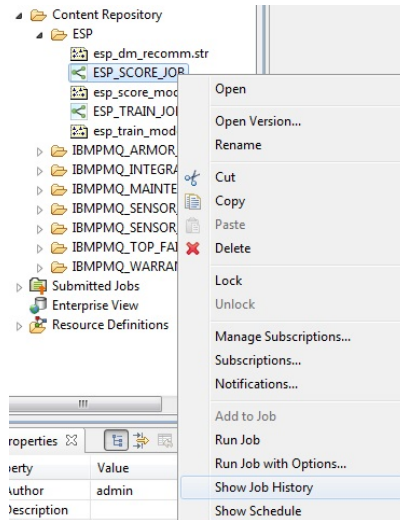
7. Two logs will be visible for each job. The first log shows information related to the job itself, such as the parameters used for running the job. The second log shows information related to the stream contained within the job.

8. To find the source of the failure, scroll to the error information provided near the end of the log file. Use this for problem rectification and further debugging.

Troubleshooting IIB

There are solutions for known errors that you may encounter while loading data. Errors will be logged in the folder `/var/PMQ/MQSIFileInput/error`.

Table 5. Solutions to errors or problems while loading data.

Error or problem	Action
`Resource doesn't exist or location is not specified for the resource, please check serial number in the file name/master_resource table`	Ensure that the `SerialNo` in the master_resource table and data file name are the same.
`Invalid measurement value in the input file`	Ensure that the values provided for design data are all numbers.

Table 5. Solutions to errors or problems while loading data. (continued)

Error or problem	Action
`Please check the input file name, file name should have a prefix of <SerialNo>_`	Ensure that the names of the data files are prefixed with `<SerialNo_>`.

After the solution installer is run, Chef processes are still running after the cleanup.sh script is executed

After the cleanup.sh script is run on the solution installer node, all Chef processes should be terminated. However, in some cases Chef processes are still running.

If you try to run the solution installer setup.sh file again, you might receive a message that required ports are in use, or creation of the chef user might fail.

The solution to this issue is to reboot the installation node after you run the "cleanup.sh" script.

Note: This information applies only to the solution installer node and not the client/target nodes.

Attention: The solution installer runs on the latest versions of Chrome and Firefox. It is not tested on Safari and does not run on Internet Explorer.

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