SmartConnect Use Case:

D19 – System Operator uses monitoring data for condition-based maintenance programs

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Document History

Revision History

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Approvals

This document requires following approvals.

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Contents

1. Use Case Description

1.1 Use Case Title

System Operator uses monitoring data for condition-based maintenance programs.

1.2 Use Case Summary

This use case describes how the use of remote sensor devices could enable SCE to proactively monitor equipment in the field to make maintenance decisions based on the current conditions of those assets. This is referred to as condition-based maintenance, and stands in contrast to "reactive" or traditional "preventive" maintenance strategies that prescribe maintenance based on when assets fail or on the calendar, respectively. Under a condition-based maintenance (CBM) approach remote sensors provide operational and non-operational data to SCE back office systems both periodically (e.g. every 10 minutes or every hour, depending on the asset or data), and upon an event occurring. Analyses are automatically performed on sensor data using rules and algorithms that identify assets potentially in need of repair or replacement. This approach to monitoring and maintaining assets would enable SCE to identify equipment needing repair or replacement prior to failure. It would also allow SCE to optimize asset utilization over their useful lives. The business value of condition-based monitoring includes improved system reliability, reduced costs, and increased customer benefits.

1.3 Use Case Detailed Narrative

Traditional approaches to maintaining electrical grid infrastructure are based on "preventive" or, in some cases, "reactive" methods. Under a preventive maintenance approach, assets are generally inspected using a calendar-based schedule. For example, certain assets are inspected every 5 years, while others are inspected every year, and so on. Under a reactive maintenance approach, assets are inspected and repaired only after they fail. Neither approach fully mitigates the risk that critical assets will fail while in service, in some cases resulting in catastrophic consequences.

Condition-based maintenance (CBM) reduces the risk of asset failure by performing maintenance activities on an "as needed" basis, prior to asset failure. Under this approach field assets are fitted with remote sensors that monitor, record and share data relevant to the condition of the assets. On a periodic basis, or upon the occurrence of an event, the remote devices transmit this sensor data to SCE back office systems for analysis. It is anticipated that data used for CBM will be comprised of a mix of operational and non-operational data. Operational data would be transmitted via existing SCADA systems, while non-operational data would be transmitted via a Non-Operational Data Downloader. Both types of data would

be received and archived by a common data historian (Historian) and other vendor-specific databases. The following is a partial list of sensors used in the industry today, or perceived to be available in the future:

- Self-reporting distribution transformers (health metric life odometer)
- Dissolved gas analysis sensors
- Partial discharge detectors
- Wireless mesh sensors
- Infrared thermographic imaging monitors
- Online frequency response sensors
- Acoustic emission defect sensors
- Moisture in oil sensors
- Load current measurement devices
- Backscatter sensors
- Weather monitoring devices (wind speed and direction, precipitation, relative humidity, barometric pressure, and solar intensity)

The Equipment Diagnostic Processor (EDP), an analytical program that interacts with other systems, would retrieve the sensor data from the Historian and analyze it using Asset Health Rules (AHR) and other asset-specific configuration data. Asset Health Rules consist of a set of rules, formulas and algorithms used to calculate a series metrics related to asset condition. The frequency of this analysis depends upon the asset and type of analysis. EDP might perform some analyses once per day, while others might occur once every 10 minutes. EDP would also perform analyses upon the occurrence of an event.

After calculating a series of asset health metrics using the AHRs, EDP then runs these asset health metrics against two secondary sets of notification rules. These notification rules determine the appropriate personnel to notify as well as any recommended actions.

The first set of notification rules is the “Immediate Action Rules”. EDP runs the metrics against this rule set to determine if immediate notification of the EMS Operator is required. If a notification threshold is met, EDP notifies the EMS Operator and provides a recommended course of action. Recommended actions might include clearing the bank, preparing to clear the bank, reduce load, etc. Prior to recommending a course of action, EDP will also perform contingency analysis. The results of the contingency analysis would accompany the recommended actions. For example, EDP might provide the EMS Operator with a list of prioritized options. The EMS Operator can then select from these options, involving operator-specific knowledge in the final decision making process.

A longer term goal is for EDP to automatically initiate the risk mitigation process without involvement of the EMS Operator. This goal will not be feasible until substantial research is performed to understand how to interpret the CBM data and other environmental factors, and whether these factors can reliably inform automated risk mitigation strategy decisions.

EDP next runs the metrics against a second set of notification rules, the “Asset Management Engineer Notification Rules”. These rules have a lower threshold than the immediate action rules, and are used to alert the Asset Management Engineer (AME) to any asset abnormalities requiring

maintenance work or other any other action. Upon receiving a notification the AME would research the problem by evaluating the EDP metric information, running custom asset queries on the Enterprise Asset Management System, or by researching other data sources. One outcome of this step is that the AME could modify the AHR based on any new knowledge about the asset. Alternatively, the AME may generate a maintenance order (with appropriate priority) for the given asset.

For the "immediate action" case, the final step in this use case scenario consists of the EMS Operator receiving the notification and performing the recommended actions as directed by EDP.

The following is a list of substation-level SCE assets that are capable of being monitored under a condition-based maintenance approach, and the relevant sensors and data points corresponding to the assets.

Potential Substation Assets with Remote Sensor Devices		
Assets	*Sensors*	*Data Points*
Transformers	(1) Dissolved Gas Analysis (DGA) sensors (2) Bushing sensors (3) Temperature sensors (4) Bank cooling fan sensors	(1) DGA data (2) Current leakage (bushing) (3) Temperature a. top oil b. bottom oil c. hot spot (measured & calculated) d. core e. ambient (4) Phasor data (5) Loading a. Voltage b. Current c. Power d. Var (6) Moisture in oil (7) Partial discharge (8) Fan operating current

Potential Substation Assets with Remote Sensor Devices		
Assets	*Sensors*	*Data Points*
Circuit Breakers	(1) DGA sensors (oil circuit breakers) (2) Trip coil signature (3) Gas density sensor (SF6 circuit breakers) (4) Vacuum failure sensor (vacuum circuit breakers)	(1) DGA data (oil circuit breakers) (2) Trip coil signature data (3) Temperature a. Circuit breaker bus bar b. Ambient (4) Loading (5) Operating time (6) Gas density (7) Vacuum failure alarm
Disconnect Switches (manual switches)	(1) Infrared thermography camera (2) Operation counter (3) Current meter	(1) Infrared thermography data (2) # of operations (3) Current (4) Temperature
Distribution Switches (Remote Control Switches, etc.)	(1) Infrared thermography camera (2) Operation counter (3) Current meter	(1) Infrared thermography data (2) # of operations (3) Current (4) Temperature
Transmission Switches (Remote Control Switches, etc.)	(1) Infrared thermography camera (2) Operation counter (3) Current meter	(1) Infrared thermography data (2) # of operations (3) Current (4) Temperature
Capacitors	(1) Operation counter (2) Current meter	(1) Relay protection (2) # of operations
Reactors	(1) Operation counter	(3) Relay protection

Potential Substation Assets with Remote Sensor Devices		
Assets	*Sensors*	*Data Points*
	(2) Current meter	(4) # of operations
Load Tap Changers (LTC)	(1) Operation counters (2) Oil analysis device (3) Position indication	(1) # of operations (2) Oil analysis (3) Position
Voltage Transformer (VT) & Coupling Capacitor Voltage Transformer (CCVT)		(1) Open delta secondary monitoring
Insulators	(1) Corona sensor	(1) Current leakage (2) Current (3) Corona discharge
Digital Relays	(1) Integrated current oscillography sensor	(1) Loading (2) Sequence of events (3) Phasor data (4) Target information
Intelligent Electronic Devices (IED)	IED	I^2T

Business Value

The benefits of using condition-based monitoring data to determine asset maintenance needs include the following:

1. **Improved System Reliability**:
    a. Avoid Catastrophic Failures: Sensor devices alert SCE to impending asset failures, allowing the equipment to be repaired or replaced prior to failure.
    b. Avoid Service Interruptions: Monitoring asset conditions via remote sensors increases the likelihood that critical conditions will be identified prior to asset failure. These assets can be repaired or replaced prior to failure, increasing grid reliability.

c. Improved Power Quality: More effective asset monitoring and maintenance activities should improve power quality as assets are repaired or replaced when needed.

2. **Reduced Costs:**

a. Capital Efficiency Improvements:

i. Lengthen Asset Life Span: Use of remote sensors can extend the operating lives of field equipment, which increases the return on the initial capital investment in that equipment. Useful lives can be extended by performing maintenance activities when they are needed, rather than on a preventive or reactive basis.

ii. Increase Capacity Utilization: Use of remote sensors allows SCE to increase equipment capacity utilization without significant reductions in the useful lives or safe operating levels of the equipment.

b. Operations Improvements:

i. Increased Maintenance Effectiveness: Frequent monitoring of transformers improves SCE's diagnostic capabilities and, thus, the appropriateness of maintenance activities for these assets.

ii. Penalty Reduction: If out of compliance with NERC reliability requirements, a utility may be charged $1 million per occurrence per day. These penalties can be charged retroactively.

iii. Trend Analyses: Condition-based monitoring sensors provide a greater number of data points which can be used to perform trend and causality analyses to identify "bad actors" (by asset types, families, voltage classes, manufacturer, etc.).

iv. Improve Compliance Reporting: Some remote sensors are used on higher voltage transmission lines that have ISO and NERC compliance reporting requirements. These devices would supply the necessary data to SCE for use in compliance reporting.

v. Post Mortem Analyses: Remote sensor data provides an opportunity to understand, post mortem, the conditions of an asset prior to failure. This knowledge can be used by the Enterprise Asset Management System to improve its ability to identify problems prior to asset failure, improve its ability to predict the timing of asset failures, and optimize its retirement and replacement planning process.

vi. Test Resource Optimization: Assets that are able to self-monitor their condition obviate the need for manual calendar-based testing. Rather, testing and maintenance is performed when needed (as identified through condition-based monitoring). While field operations workload could be made more efficient, this could also lead to an increase in engineering staff required to manage and analyze this new data set.

vii. Equipment Specifications: Condition-based monitoring information shall allow SCE to better analyze the performance of specific assets throughout their lifecycles. This information will better inform the development of equipment specifications based on SCE's unique operating and environmental conditions.

viii. Procurement Strategy: SCE can use historical data to more accurately forecast equipment needs. For example, SCE could more accurately estimate the remaining useful lives of assets, and incorporate this into asset replacement planning.

SCE could also establish purchasing triggers that activate when inventory (e.g. equipment or spare parts) reaches pre-specified levels. SCE would be able to use this data to make stronger arguments for capital spending in general rate case filings.

ix. Optimize Allocation of Resources: Transitioning to a condition-based approach would result in an optimization of maintenance activities in which resources are assigned to activities and locations where they are most needed.

x. Reduce Overtime Pay: To the extent SCE can reduce unplanned outages, there may be a reduction in associated overtime pay.

xi. Workforce Effectiveness: Condition-based monitoring data would be available to field personnel via a handheld Consolidated Mobile Solution device, equipping them with more relevant and timely information, and improving their effectiveness.

3. **Increased Customer Benefits**:

   a. Avoid Collateral Damage: A reduction in catastrophic failures reduces potential collateral damage. Collateral damage includes customer interruption and economic loss, declines in customer satisfaction, loss of capital assets, loss of revenue, and loss of productivity during service restoration periods.

   b. Customer Satisfaction: Increased reliability would result in increased customer satisfaction.

1.4 Business Rules and Assumptions

- Although the principles of condition-based maintenance can be applied to a multitude of asset types across the enterprise, this use case covers transmission substation assets. Use case D17, which introduces the concept of the Smart Grid Centralized Command and Control Center, discusses the broad categories of Smart Grid devices, the types of data they produce, and the management of this data. Condition-based maintenance is one of several applications included in use case D17.
- SCE currently performs monitoring of wind speed and direction, precipitation, temperature, relative humidity, barometric pressure, and solar intensity. All of this data is sent to the Energy Management System.

2. Actors

Describe the primary and secondary actors involved in the use case. This might include all the people (their job), systems, databases, organizations, and devices involved in or affected by the Function (e.g. operators, system administrators, customer, end users, service personnel, executives, meter, real-time database, ISO, power system). Actors listed for this use case should be copied from the global actors list to ensure consistency across all use cases.

Actor Name	***Actor Type (person, device, system etc.)***	***Actor Description***
Asset Health Rules (AHR)	Rules	Asset Health Rules are used by the Equipment Diagnostic Processor to create a series of metrics about a particular asset using all available inputs including historical and current data. AHR shall be flexible and configurable by asset-type, specific assets, vendor, vintage, etc. They may be modified by the Asset Management Engineer using a relatively simple interface (which does not require a programmer to write code).
Asset Management Engineer (AME)	Person	The Asset Management Engineer is responsible for paying attention to all the assets. SCE might even have a more specialize role for the person who only monitors transformers (e.g. a Transformer Asset Management Engineer). The AME configures Asset Health Rules for submission to the Equipment Diagnostic Processor.
Energy Management System (EMS)	System	The Energy Management System is a system of tools used by system operators to monitor, control, and optimize the performance of the transmission system. The monitor and control functions are performed through the SCADA network. Optimization is performed through various EMS applications.
EMS Operator	Person	The EMS Operator monitors the EMS systems, takes immediate action when necessary (from EDP), alerts the Asset Management Engineer (AME) to critical EMS alarms, and assists the AME by implementing the AME's mitigation processes.
Enterprise Asset Management System (EAMS)	System	This represents the module of the Enterprise Resource Planning system concerned with storing and updating information regarding utility assets. This keeps track of every asset in the enterprise including all trouble reports, installation information, manufacturer, information gathered by field personnel, etc. This is used to establish baselines on individual assets and classes of assets, and to track these assets to compare against the baselines. This system also contains a suite of analysis tools, decision support functions, dashboard, etc.

Actor Name	***Actor Type (person, device, system etc.)***	***Actor Description***
Equipment Diagnostic Processor (EDP)	System	The Equipment Diagnostic Processor is an application that evaluates current asset condition data with respect to historical baseline data and, based on a series of factors, provides diagnoses and identifies probable "bad actors".
Historian	System	The Historian is a common data repository for all operational and non-operational data. Operational data is fed to this system via SCADA, while non-operational data is transmitted via the Non-Operational Data Downloader. The historian function is currently performed by eDNA at SCE.
Non-Operational Data Downloader (NODD)	System	The Non-Operational Data Downloader is an application that gathers non-operational data from field sensors, translates the data into a format suitable for storage and archive, and transmits this converted data to both SCE's common data historian and to other vendor-specific databases.

3. Step by Step analysis of each Scenario

Describe steps that implement the scenario. The first scenario should be classified as either a "Primary" Scenario or an "Alternate" Scenario by starting the title of the scenario with either the work "Primary" or "Alternate". A scenario that successfully completes without exception or relying heavily on steps from another scenario should be classified as Primary; all other scenarios should be classified as "Alternate". If there is more than one scenario (set of steps) that is relevant, make a copy of the following section (all of 3.1, including 3.1.1 and tables) and fill out the additional scenarios.

3.1 Primary Scenario: System Operator determines level of severity / risk of impending asset failure and takes corrective action

This scenario describes how SCE monitors the condition of assets using remote sensor devices. These devices provide both operational and non-operational data to SCE's Equipment Diagnostic Processor (EDP) for analysis on a period basis (or upon the occurrence of an event). EDP evaluates the data using a series of asset-specific Asset Health Rules and algorithms, and calculates a series of metrics. These metrics are then run against two secondary sets of rules. The metrics are run against "Immediate Action Rules" to determine whether the EMS Operator needs to be notified of the asset condition and, if so, what action he needs to take. The EDP also simultaneously runs the Contingency Analysis application to identify potential contingencies. The contingency analysis results, together with any recommended course of action, are communicated to the EMS Operator. The EDP analysis metrics are also run against "Asset Management Engineer Notification Rules" which alert the Asset Management Engineer (AME) to conditions of lesser criticality. The AME would use this EDP data in conjunction with other data sets from the Enterprise Asset Management System to determine whether maintenance orders or other actions are required.

Triggering Event	***Primary Actor***	***Pre-Condition***	***Post-Condition***
(Identify the name of the event that start the scenario)	*(Identify the actor whose point-of-view is primarily used to describe the steps)*	*(Identify any pre-conditions or actor states necessary for the scenario to start)*	*(Identify the post-conditions or significant results required to consider the scenario complete)*
SCE back office systems gather operational and non-operational data from remote sensor devices.	Energy Management System & Non-Operational Data Downloader	Asset Health Rules have been configured and alarm levels established.	EMS Operator takes corrective action.

3.1.1 Steps for this scenario

Describe the normal sequence of events that is required to complete the scenario.

Step #	*Actor*	*Description of the Step*	*Additional Notes*
#	*What actor, either primary or secondary is responsible for the activity in this step?*	*Describe the actions that take place in this step. The step should be described in active, present tense.*	*Elaborate on any additional description or value of the step to help support the descriptions. Short notes on architecture challenges, etc. may also be noted in this column.*
1	Energy Management System (EMS)	EMS gathers operational data from field sensors and stores it in a common data historian (Historian).	Operational data is gathered by EMS via SCADA systems. This is approximately 50% of the data that would be evaluated in a condition-based monitoring (CBM) environment. This data includes DGA data, operations counters, temperature, and loadings. Although it is not included as a separate step, this data would likely be transmitted from the field sensors to EMS via substation data concentrators.
2	Non-Operational Data Downloader (NODD)	NODD gathers non-operational data from field sensors and stores it in a Historian and other databases.	There are two types of non-operational data: (1) periodically sampled point data, and (2) vendor specific data. Non-operational data includes circuit breaker trip coil signatures, protective relay targets and oscillography, fault records, digital fault recorder oscillography, etc. This data currently goes into separate systems. In the future, SCE

Step #	Actor	Description of the Step	Additional Notes
			would collect and translate this data for storage in a common data Historian. This data would also continue to be stored in vendor-specific databases. Although it is not included as a separate step, this data would likely be transmitted from the field sensors to EMS via substation data concentrators.
3	Equipment Diagnostic Processor (EDP)	EDP applies Asset Health Rules (AHR), based on asset-specific configuration data, to historical CBM data to generate asset health metrics.	Having accessed the operational and non-operational sensor data from the Historian and other databases (e.g. vendor databases), EDP analyzes this data using the AHRs and algorithms, and calculates a series of asset health metrics. EDP performs this analysis on a periodic basis that varies by asset and analysis type. EDP also performs this analysis upon the occurrence of an event. These metrics are then run against secondary sets of notification rules as described in step 4.
4	EDP	EDP runs asset health metrics against "Immediate Action Rules."	This consists of applying the first of two secondary rule sets against the EDP-generated asset health metrics to decide whether an asset condition warrants immediate notification of the EMS Operator. If a critical threshold is not met, no further action is taken. If a critical threshold is met, this process continues to step 5. Steps 4, 5 & 6 all occur simultaneously.

Step #	Actor	Description of the Step	Additional Notes
5	EDP	EDP determines a recommended course of action.	The recommended course of action could include clearing the bank unconditionally, reducing load, preparing to clear the bank, calling someone, etc. The recommended course of action is intended to maintain a safe working environment and to continue operation of the system.
6	EDP	EDP runs the Contingency Analysis application to identify potential contingencies.	Information about potential contingencies would be communicated to the EMS Operator along with the recommended course of action (determined in step 5).
7	EDP	EDP notifies the EMS Operator of the asset condition (e.g. level of criticality), provides a recommended course of action, and identifies any potential contingencies.	The AME receives the same notification as the EMS Operator, although only the EMS Operator would be expected to take immediate action.
8	EMS Operator	EMS Operator receives notification and takes action.	
9	EDP	EDP runs asset health metrics against "Asset Management Engineer Notification Rules".	This consists of applying the second of two secondary rule sets against the EDP-generated asset health metrics to decide whether an asset condition warrants notification of the Asset Management Engineer (AME). These rules have a lower threshold than the "Immediate Action Rules" and, in general, identify abnormalities with lower levels of criticality.
10	EDP	EDP notifies the AME of the asset condition.	
11	AME	The AME performs customized queries to decide whether to issue maintenance orders or take other actions.	The AME would perform customized queries of data sets utilizing the

Step #	Actor	Description of the Step	Additional Notes
			Enterprise Asset Management System (EAMS) and other sources. EAMS consists of a dashboard (a screen that displays key equipment parameters), a decision support module, and rules to calculate key metrics. EAMS also has the ability to query and extract information about equipment pedigree, maintenance history, previous test data, etc. The AME uses this system to investigate what happened to the equipment, and to determine what steps should be taken to address the problem.
12	AME	The AME modifies the AHRs, if necessary.	If the AME determines that the AHRs require modification, based the AME's general or specific knowledge of the asset or alarm, they would be able to modify the AHR. For audit purposes, a log would be maintained to document any such changes.
13	AME	The AME generates a maintenance order, if necessary.	The maintenance order would be generated with an appropriate priority level based on the condition of the asset and the asset type.

4. Requirements

Detail the Functional, Non-functional and Business Requirements generated from the workshop in the tables below. If applicable list the associated use case scenario and step.

4.1 Functional Requirements

Req. ID	Functional Requirements	Associated Scenario # (if applicable)	Associated Step # (if applicable)
1	The Energy Management System (EMS) shall retrieve operational data from field devices (via SCADA).	1	1
2	EMS shall store operational data in a common data historian (Historian).	1	1
3	Operational data shall be accurately time-stamped.	1	1
4	The Non-Operational Data Downloader (NODD) shall retrieve non-operational data from field devices.	1	2
5	NODD shall convert non-operational data into a format suitable for storage in the Historian, if possible.	1	2
6	Non-operational data shall be accurately time-stamped.	1	2
7	NODD shall store non-operational data in the Historian and other vendor-specific databases.	1	2
8	Historian shall store asset operational and non-operational data based on CIM.	1	1 & 2
9	Substation data concentrators shall support multiple communications channels (e.g. for	1	1 & 2

Req. ID	Functional Requirements	Associated Scenario # (if applicable)	Associated Step # (if applicable)
	both operational and non-operational data).		
10	All data points in the Historian shall be mapped to specific assets in the Enterprise Asset Management System (EAMS)[1]. EAMS is necessary since it houses basic asset information such as manufacturer, vintage, how many times the device has had problems before, etc.	1	1 & 2
11	The Equipment Diagnostic Processor (EDP) shall utilize data from multiple data sources, including the common data Historian, vendor databases, and EAMS to run the Asset Health Rules (AHRs).	1	3
12	EDP analysis of CBM data against AHRs shall be triggered by events (e.g. faults, abnormal oscillography, etc).	1	3
13	EDP analysis of CBM data against AHRs shall be triggered by periodic, scheduled analysis for various asset types.	1	3
14	AHRs shall be customizable by vendor.	1	3
15	AHRs shall be customizable by model.	1	3
16	AHRs shall be customizable by individual asset.	1	3
17	AHR algorithms shall calculate asset health metrics that are asset class-specific.	1	3
18	AHRs shall indicate which asset health metrics are calculated for a given asset class.	1	3
19	EDP analysis output shall include asset health metrics.	1	3
20	AHRs shall be customizable by asset type.	1	3
21	EDP shall query asset data based on CIM structures and attributes.	1	3

[1] Mapping data points to specific assets is necessary to facilitate the development of applications such as the Equipment Diagnostic Processor (EDP). Application developers would need to be aware of the universe of available data in order to write queries. The industry term for this mapping is Common Information Model (CIM). CIM is an international standard for representing the relevant data for specific assets within an enterprise. The CIM is the "Rosetta Stone" that maps all data points to a specific asset. Applications such as EDP would use the CIM to determine where to find information for things such as an EMS dashboard.

Req. ID	Functional Requirements	Associated Scenario # (if applicable)	Associated Step # (if applicable)
22	EDP shall support variable analysis process frequencies based on asset and analysis types.	1	3
23	EDP shall contain a set of "Immediate Action Rules". These rules are used by EDP to determine when an asset condition shall be communicated to the EMS Operator.	1	4
24	EDP shall compare output of AHR execution (asset health metrics) to "Immediate Action Rule" thresholds for that asset class and health metric.	1	4
25	EDP shall compare the asset health metrics against "Immediate Action Rules" to determine whether the EMS Operator should be notified, as dictated by the AHRs.	1	4
26	EDP shall generate a prioritized list of recommended actions.	1	5
27	EDP shall be able to run the Contingency Analysis application.	1	6
28	If asset health metrics exceed "Immediate Action Rule" thresholds, EDP initiates the Contingency Analysis application, which assumes the loss of the given asset under current system conditions.	1	6
29	If asset health metrics exceed "Immediate Action Rule" thresholds, EDP shall notify the EMS Operator with prioritized actions, based on Contingency Analysis.	1	7
30	EDP shall be able to send the EMS Operator notification of the asset condition.	1	7
31	EDP shall be able to send the EMS Operator a recommended, prioritized course of action.	1	7
32	EDP shall be able to notify the EMS Operator of potential contingencies.	1	7
33	EDP shall support notification to multiple types of users. For example, in addition to the EMS Operator and Asset Management Engineer (AME), there may be others that could subscribe to these reports or data (e.g. procurement or field personnel).	1	7 & 10
34	EDP shall be made available to GIS. This would facilitate providing visualization to operations personnel.	1	7
35	The AME shall receive the same notification as the EMS Operator.	1	7
36	EDP shall log all "Immediate Action Rule" notifications.	1	7

Req. ID	Functional Requirements	Associated Scenario # (if applicable)	Associated Step # (if applicable)
37	EDP shall contain a set of "Asset Management Engineer Notification Rules". These rules are used by EDP to determine when an asset condition shall be communicated to the AME.	1	9
38	If asset health metrics exceed "Asset Management Engineer Notification Rule" thresholds, EDP shall notify the AME of the asset condition.	1	10
39	EDP shall be able to send the AME notification of the asset condition.	1	10
40	EDP shall log all "Asset Management Engineer Notification Rule" notifications.	1	10
41	The AME shall be able to test EDP algorithms and AHRs against historical data stored in the Enterprise Asset Management System (EAMS). This will allow SCE to validate AHRs.	1	11
42	EAMS shall have a record of static / nameplate data for each asset included in the Historian.	1	11
43	EAMS shall store asset static / nameplate data in compliance with CIM.	1	11
44	EAMS shall have a dashboard that displays key equipment parameters.	1	11
45	EAMS shall have a decision support module that supports queries of historical asset data.	1	11
46	AHRs shall be able to be modified by AMEs.	1	12
47	AHRs shall be able to be modified via a user interface that allows the AME to add or edit AHRs.	1	12
48	AME modifications to AHRs shall be logged for traceability (i.e. audit trail).	1	12
49	AHRs shall include a change history log for traceability.	1	12
50	EDP shall allow the AME to test AHRs, "Immediate Action Rules" and "Asset Management Engineer Notification Rules" against historical data. This will allow the AME to validate these rules, or to provide a basis for modifying them.	1	12
51	EDP shall make all notification logs and asset health metrics available to the Smart Grid Centralized Control Center (SGCC).	1	All

Req. ID	***Functional Requirements***	***Associated Scenario #*** *(if applicable)*	***Associated Step #*** *(if applicable)*
52	The SGCC shall be able to review all EDP reporting. See use case D17 for a discussion of the SGCC.	1	All

4.2 Non-functional Requirements

Req. ID	Non-Functional Requirements	Associated Scenario # (if applicable)	Associated Step # (if applicable)
1	Data shall be obtained from SCE's current 10-15K digital relays. This data is not collected today, but it would be useful for NERC compliance and asset management.	1	1 & 2
2	The Non-Operational Data Downloader (NODD) shall support approximately the same number of data points as the operational data channel (SCADA).	1	2
3	The NODD will report non-operational on an exception basis (except for oscillography data which shall be reported by event). In other words, only changes in the data points will be reported. For example, temperature changes are reported, but consecutive 4-second temperature readings are not reported (unless the temperature changes).	1	2
4	The NODD shall support high bandwidth bursts of data of arbitrary length. This is primarily event-driven oscillography data.	1	2
5	The NODD shall retrieve oscillography data within 1 minute of record creation, or at least as often as the Equipment Diagnostic Processor (EDP) processor runs.	1	2
6	Certain analyses may require performance every hour; while others may require performance every 10 minutes.	1	3
7	EDP shall transmit "Immediate Action Rule" notifications to EMS Operators without delay upon running the asset health metrics against the "Immediate Action Rules".	1	7
8	AME notifications shall be transmitted by the next day through batch processing.	1	10

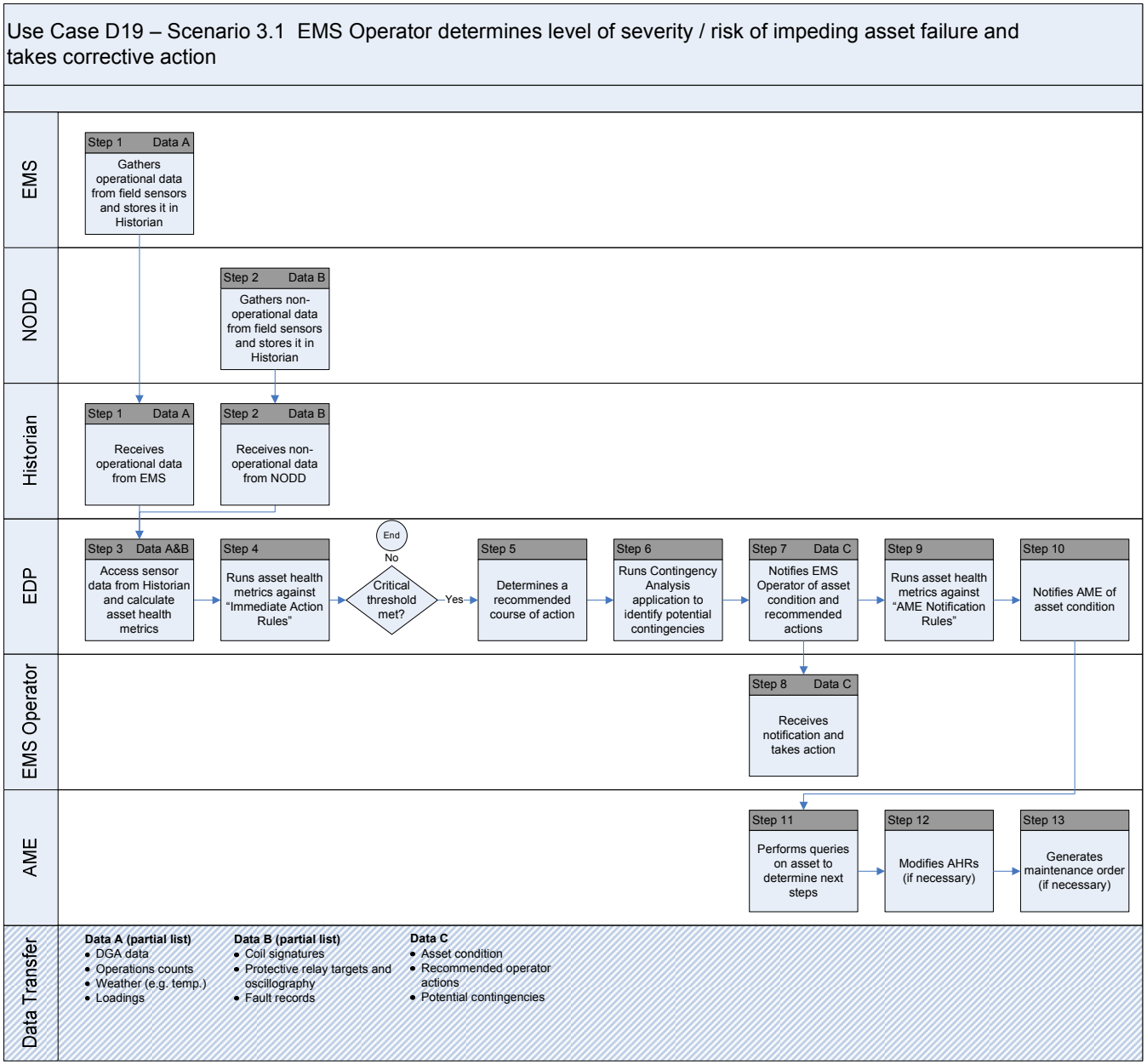
5. Use Case Models (optional)

This section is used by the architecture team to detail information exchange, actor interactions and sequence diagrams

5.1 Information Exchange

For each scenario detail the information exchanged in each step

5.2 Diagrams



6. Use Case Issues

Capture any issues with the use case. Specifically, these are issues that are not resolved and help the use case reader understand the constraints or unresolved factors that have an impact of the use case scenarios and their realization.

Issue
Describe the issue as well as any potential impacts to the use case.
1. Condition-based monitoring may result in an increase in the amount of maintenance work.

7. Glossary

Insert the terms and definitions relevant to this use case. Please ensure that any glossary item added to this list should be included in the global glossary to ensure consistency between use cases.

Glossary	
Term	**Definition**
Common Information Model (CIM)	CIM is an international standard for representing the data for specific assets within an enterprise (or electrical system). The CIM is the "Rosetta Stone" that maps all data points to a specific asset. Having a common and clear taxonomy of all data elements for all assets within an enterprise is critical for application development.
Contingency Analysis (CA)	The Contingency Analysis (CA) is an Energy Management System (EMS) application that, on a pre-contingency event basis, performs a series of hypothetical scenario analyses on the system. It also generates alternative mitigation strategies for each of the hypothetical scenarios. To perform its analysis, CA first receives the current state of every bus on the system from the State Estimator. Using this information as its baseline, the CA then performs a series of analyses whereby it takes different equipment out of service (e.g. a line or transformer), and observes how the system adjusts. For each scenario, CA also determines whether the system adjustment would violate any of the line ratings. For each scenario, the CA also evaluates each line to determine the available current-carrying capacity that could be used if there is a contingency event. For example, suppose there are three parallel lines, Line A, Line B and Line C. Line A begins operating above its line rating and causes DLRS to generate an alarm. Meanwhile, Line B and Line C are both operating beneath their line ratings. The CA would evaluate how much capacity is available on Lines B and C based on the current dynamic ratings and current system loading conditions. It would then inform the EMS Operator how much capacity is available on Lines B and C, in case he needs to shift load from Line A to Lines B and C. CA runs this series of hypothetical analyses approximately once every 15 minutes, or upon demand.
North American Electric Reliability Corporation (NERC)	The North American Electric Reliability Corporation is a non-governmental organization that develops and enforces reliability standards for bulk power systems.
SCADA	SCADA refers to the system that coordinates and communicates operational processes in real time (every 4 seconds).
Smart Grid Control Center (SGCC)	The SGCC operates and controls transmission grid operations in SCE's service territory through the EMS, SCADA, DCMS, and other future systems.

8. References

Reference any prior work (intellectual property of companies or individuals) used in the preparation of this use case

9. Bibliography (optional)

Provide a list of related reading, standards, etc. that the use case reader may find helpful.

1. 2009 SCE GRC Testimony of Predictive Maintenance System.