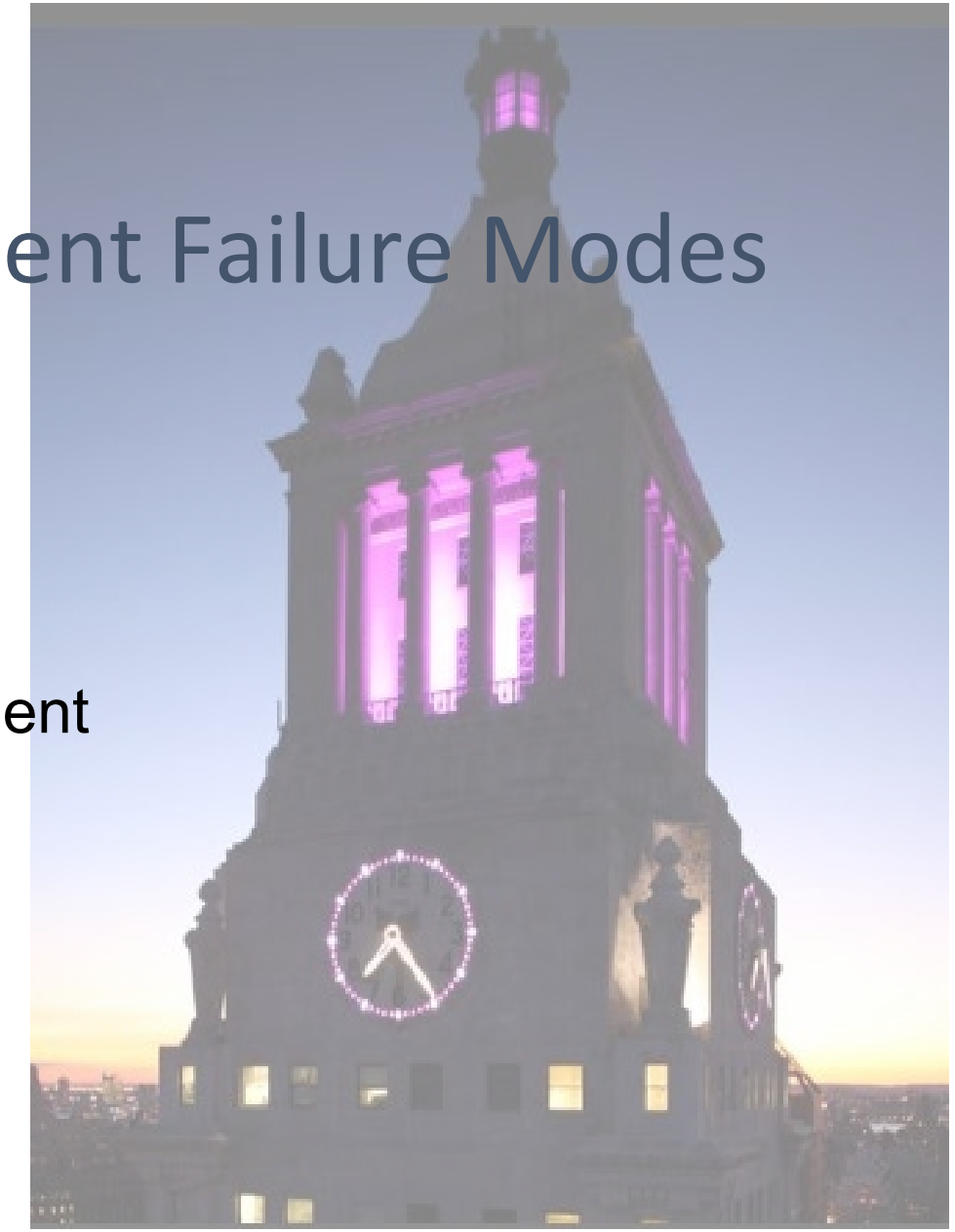
Documenting RCM and Equipment Failure Modes in Maximo



Mark Lozina
Asset Management and Technology Development
Consolidated Edison of New York Inc.

Jeff Tippett
Vice President
Maintenance Group Inc.

conEdison

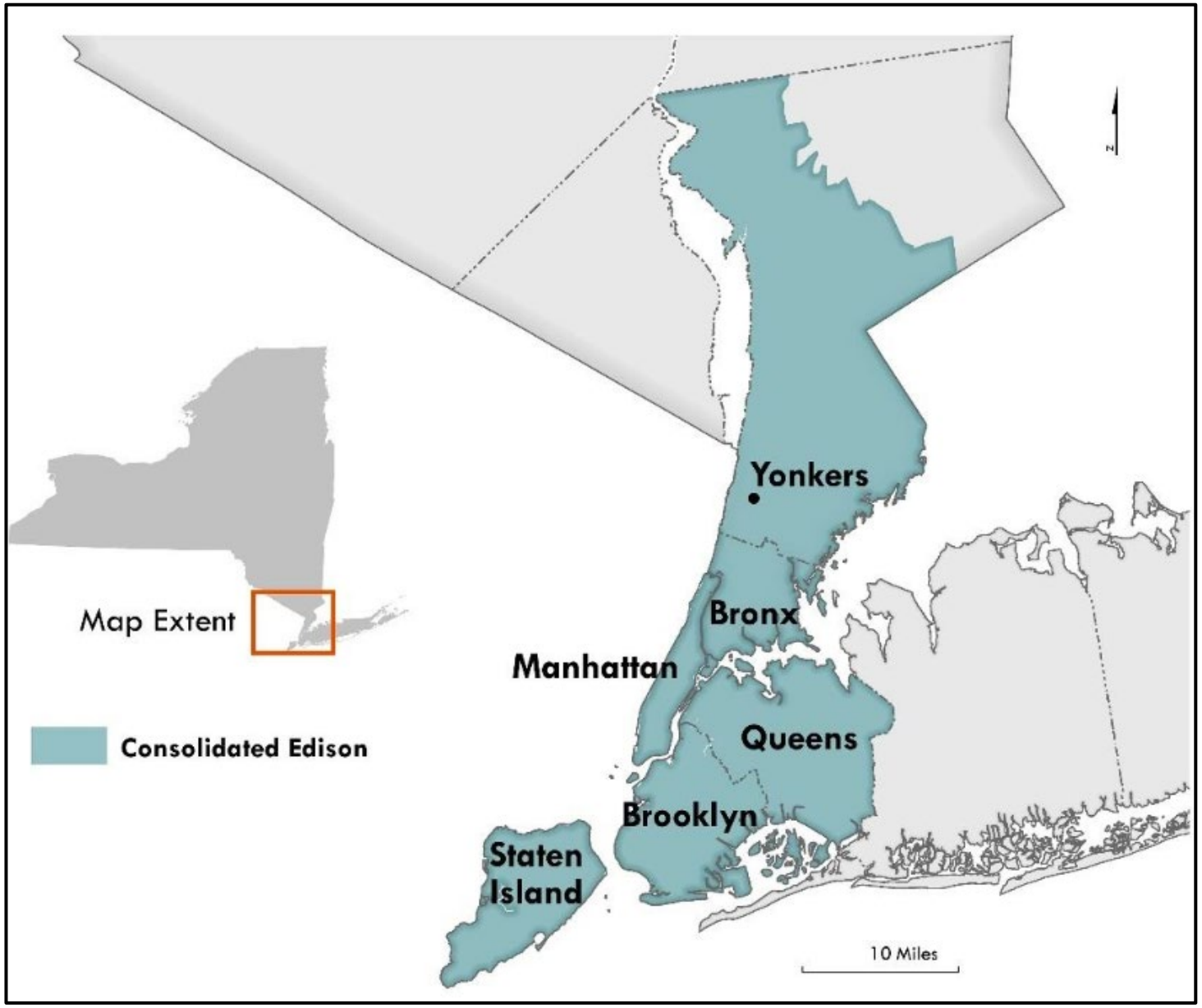
Commodities:
- Electric
- Gas
- Steam

Over 10 million customers

$62 billion in assets

$12 billion in annual revenue

Central Operations (Transmission, Substations, and Power Generation) implemented Maximo in 1998



If we could go back in time and implement Maximo again, these are the 2 things we would do differently:

1. Categorize Equipment
2. Utilize failure mode coding

Reliability Centered Maintenance (RCM):

Reliability Centered Maintenance is an engineering framework that enables the definition of a complete maintenance regimen. It regards maintenance as the means to maintain the functions a user may require of machinery in a defined operating context.

1. What is the item supposed to do and its associated performance standards?
2. In what ways can it fail to provide the required functions?
3. What are the events that cause each failure?
4. What happens when each failure occurs?
5. In what way does each failure matter?
6. What systematic task can be performed proactively to prevent, or to diminish to a satisfactory degree, the consequences of the failure?

RCM Analysis Compilation

- Asset RCM Group
- Asset functions and functional failure
- Failure modes that cause functional failures
  - Component
  - Component problem
  - Cause of component problem
- Consequence of functional failure (system effects)
- Maintenance task to prevent failure or mitigate consequences

Applying RCM Analysis to an RCM Group

- Identify all assets in RCM Group
- Classify all asset locations
  - Criticality (Critical/Non-Critical)
  - Duty Cycle (High/Low)
  - Service Condition (Severe/Mild)
- Set Maintenance Group that reflects the PM Basis

Template View Close Window

Circuit Breakers

Plant Type: **FOSSIL**
Category/SubCategory: **Electrical / Breakers**
SME: [redacted]
Backup SME: ,
Rev Number: **0**
Status: **Approved**
Approved By - Date: [redacted]

Boundary Definition | SME Summary | Comments | Implementation History | Revision History | Operating Experience | Commitments | Condition Definitions | File Attachments(0)

Task View | FMECA View

View Basis Text

Component Classification		CHS	CLS	CHM	CLM	NHS	NLS	NHM	NLM	_HS	_LS	_HM	_LM
Criticality	Critical	x	x	x	x								
	Non-Critical					x	x	x	x				
										x	x	x	x
Duty Cycle	High	x		x		x		x		x		x	
	Low		x		x		x		x		x		x
Service Condition	Severe	x	x			x	x			x	x		
	Mild			x	x			x	x			x	x
Time Directed													
COP - Calibrate protection relay(s)		4.00 Y	4.00 Y	4.00 Y	4.00 Y	4.00 Y	4.00 Y	4.00 Y	4.00 Y	N/A	N/A	N/A	N/A
Failure Mode													
		Man Hours Needed: 0.00Hours Unavailable: 0Sort Order: 0											
COP - Current Injection Testing (600V)		6.00 Y	6.00 Y	6.00 Y	6.00 Y	6.00 Y	6.00 Y	6.00 Y	6.00 Y	N/A	N/A	N/A	N/A
Failure Mode													
		Man Hours Needed: 0.00Hours Unavailable: 0Sort Order: 0											
COP - Inspection		3.00 Y	3.00 Y	3.00 Y	3.00 Y	3.00 Y	3.00 Y	3.00 Y	3.00 Y	N/A	N/A	N/A	N/A
Failure Mode													
		Man Hours Needed: 0.00Hours Unavailable: 0Sort Order: 0											
COP - Trip test protection relay(s)		4.00 Y	4.00 Y	4.00 Y	4.00 Y	4.00 Y	4.00 Y	4.00 Y	4.00 Y	N/A	N/A	N/A	N/A
Failure Mode													
		Man Hours Needed: 0.00Hours Unavailable: 0Sort Order: 0											

What is Preventive Maintenance Basis?

RCM

Failure modes and actions to prevent or mitigate them

- Functional failures
- Component that causes asset failure
- Component problem
- Cause of component problem

} Failure Mode

Regulatory Requirements

Engineering Specifications

Manufacturer Recommendations

Operational Experience

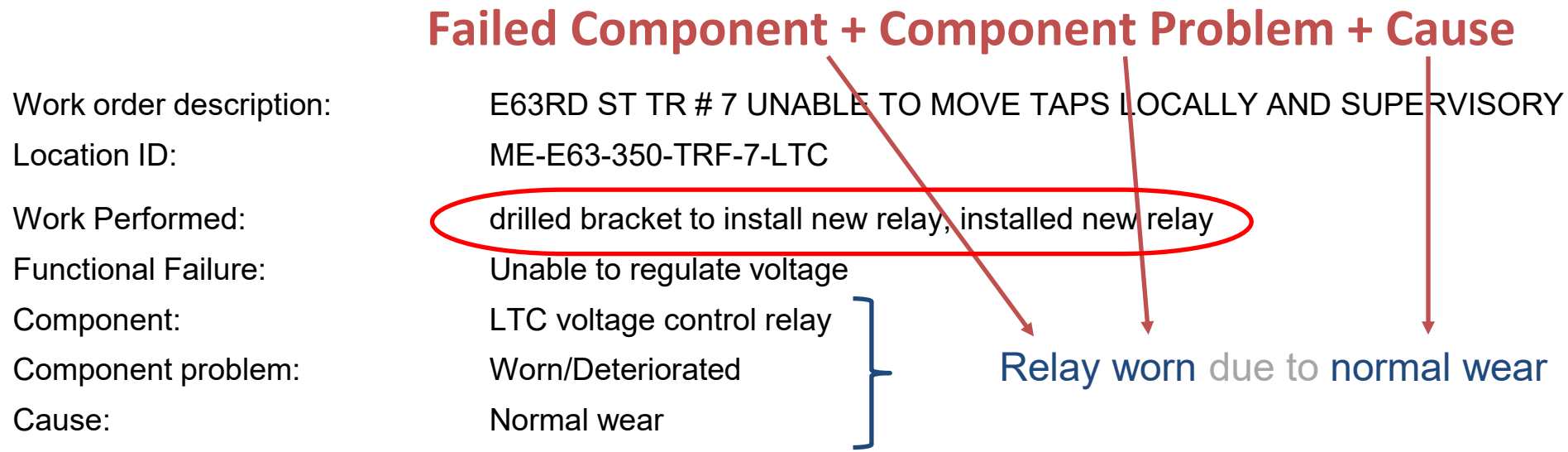
IBM MAXIMO

What is a Failure Mode?

The failure mode contains 3 distinct pieces of information:

- **Failed Component** (a part of the asset)
- **Component problem**
- **Cause**

All 3 pieces are then concatenated together on the work order at job completion.



Why is knowing Failure Mode so important?

Failure Mode: Relay worn due to normal wear

Asset: Load Tap Changer

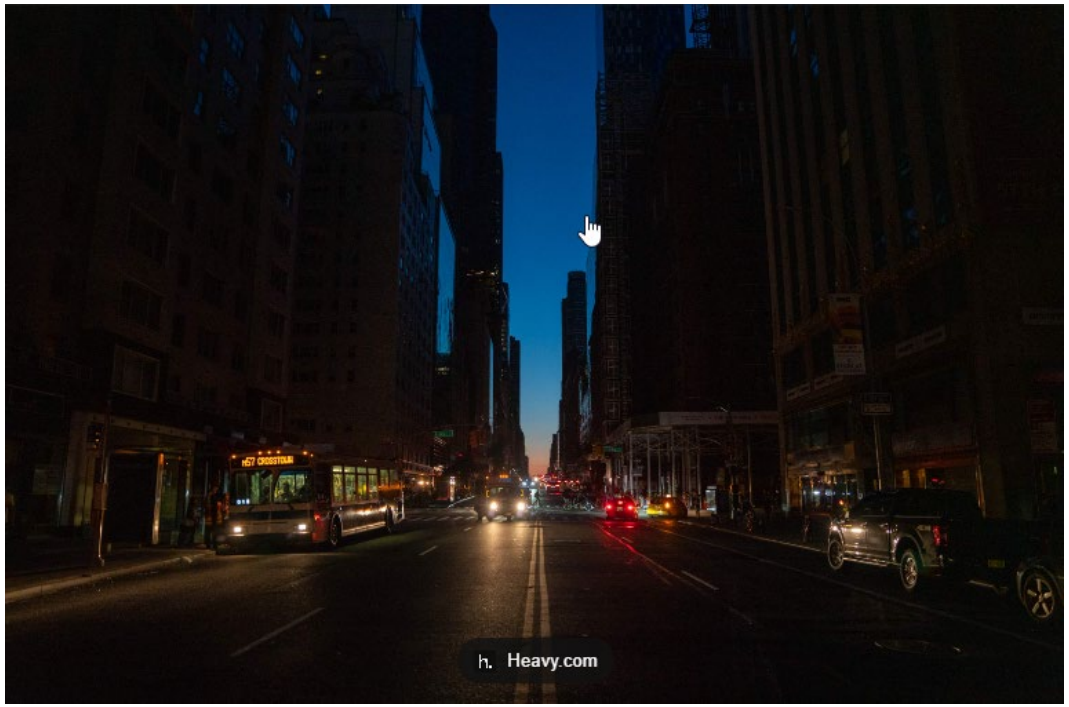
Maintenance strategy: Full PM 10 Years or 40,000 Operations

Is this a new failure mode?

How often do we see this failure mode?

Should we modify our maintenance strategy?

- Increase frequency of inspection?
- Modify scope of current PM?
- Create new PM?
- Maybe we need a relay that lasts longer?

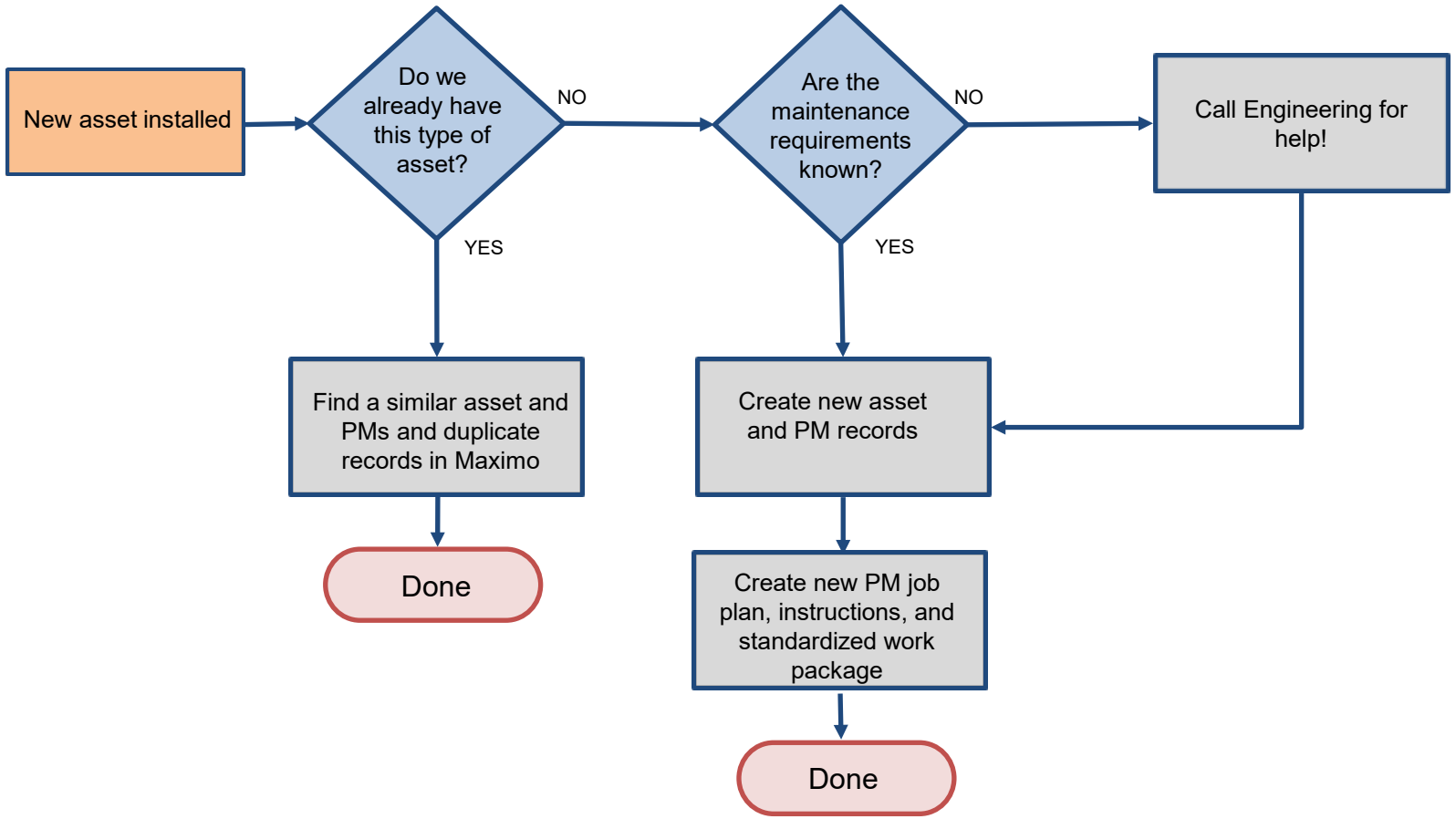


RCM and PM Basis Initiative

Changes:

- Assets will be categorized and classified
  - Equipment group – high level bundling used for budgeting
  - RCM group – assets that have the same functional failures and failure modes
  - Maintenance group – assets that have the same maintenance requirements
  - Criticality (critical, not critical)
  - Duty Cycle (high, low)
  - Environment (severe, mild)
- Master PMs created for all maintenance groups
  - Automatic notification of any missing PMs
- RCM documented for all major equipment types
  - Provides the following coding for CM work orders:
    - Functional failure/degraded condition
    - Component
    - Component problem
    - Cause
- PM changes processed in Maximo using Management of Change (MOC)
- Problem codes collected on CM work orders to categorize types of issues per RCM group
- Failure mode data collected on CM work orders for weekly review by Reliability Team
  - Cause codes will be added for all Functional Failures
- RCM module reports allow review of documented CM failure modes vs. RCM
- PowerBI reports utilized to standardize reliability team frequently used metrics

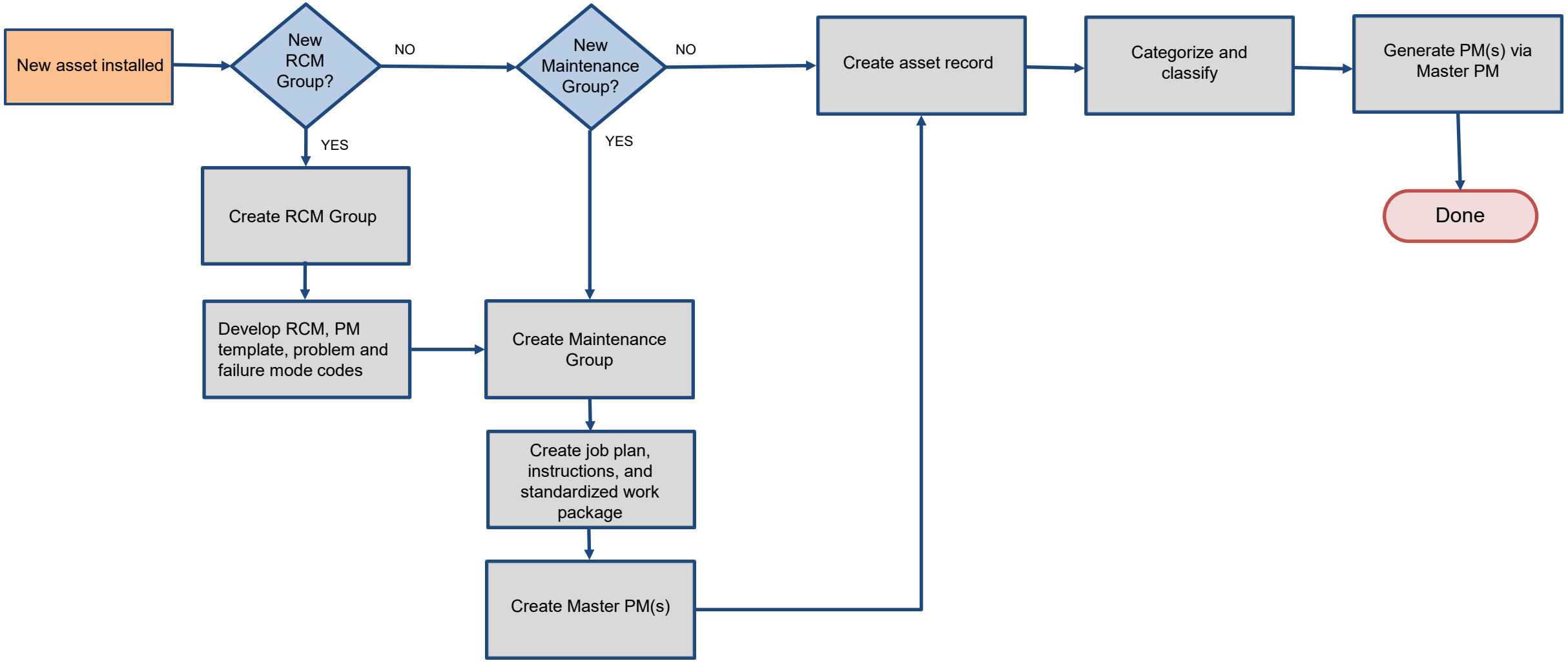
Asset On-boarding Process (Old)



Disadvantages:

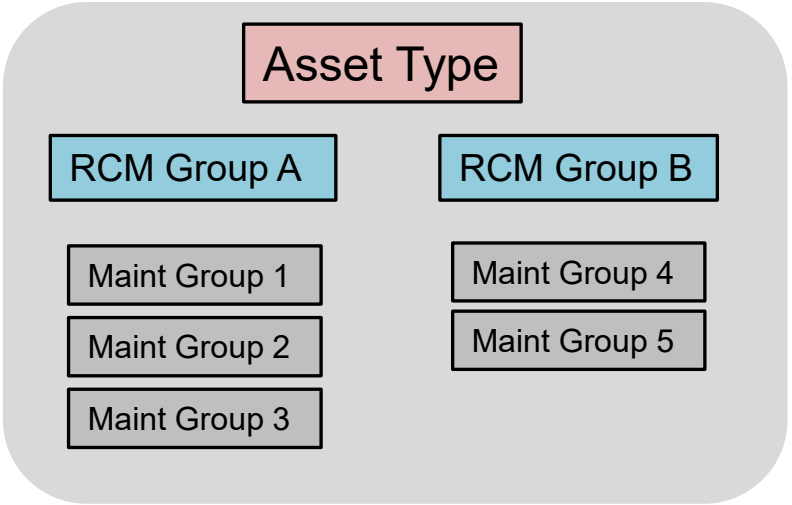
- Record quality highly dependent on Maximo administrator
- Asset “categorization” is haphazard – difficult to query with accurate results
- Engineering doesn’t understand Maximo so help is difficult to obtain
- Record duplication is error-prone

Asset On-boarding Process (New)



Use of RCM Group and Maintenance Group

RCM Group – Specific picklists for each of the following
- Functional failures
- Component that causes asset failure
- Component problem
- Cause of component problem

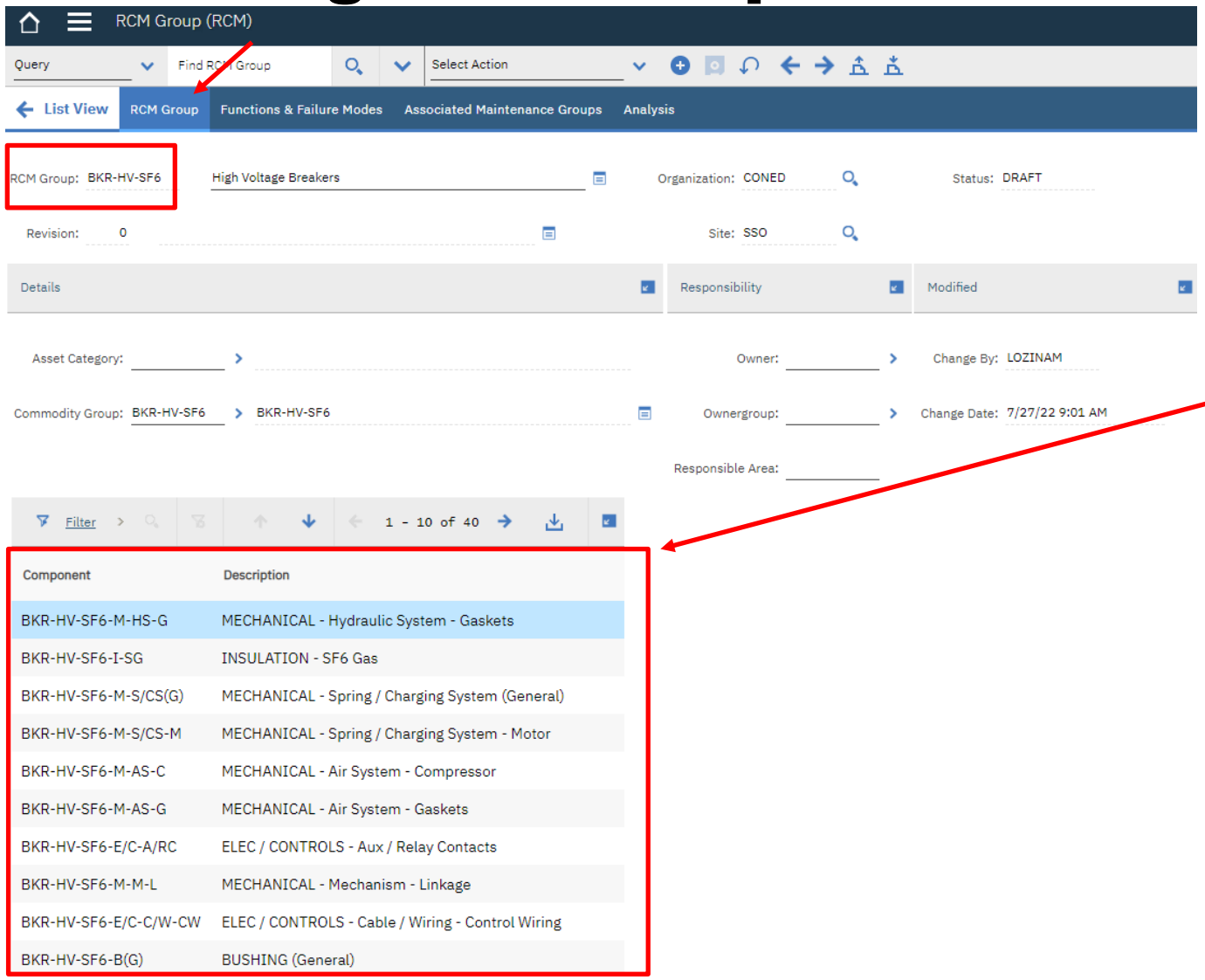


Maintenance Group
- Determines the applicable Master PM(s) for asset

An asset type can have one or multiple RCM Groups!

An RCM Group can have one or multiple Maintenance Groups!

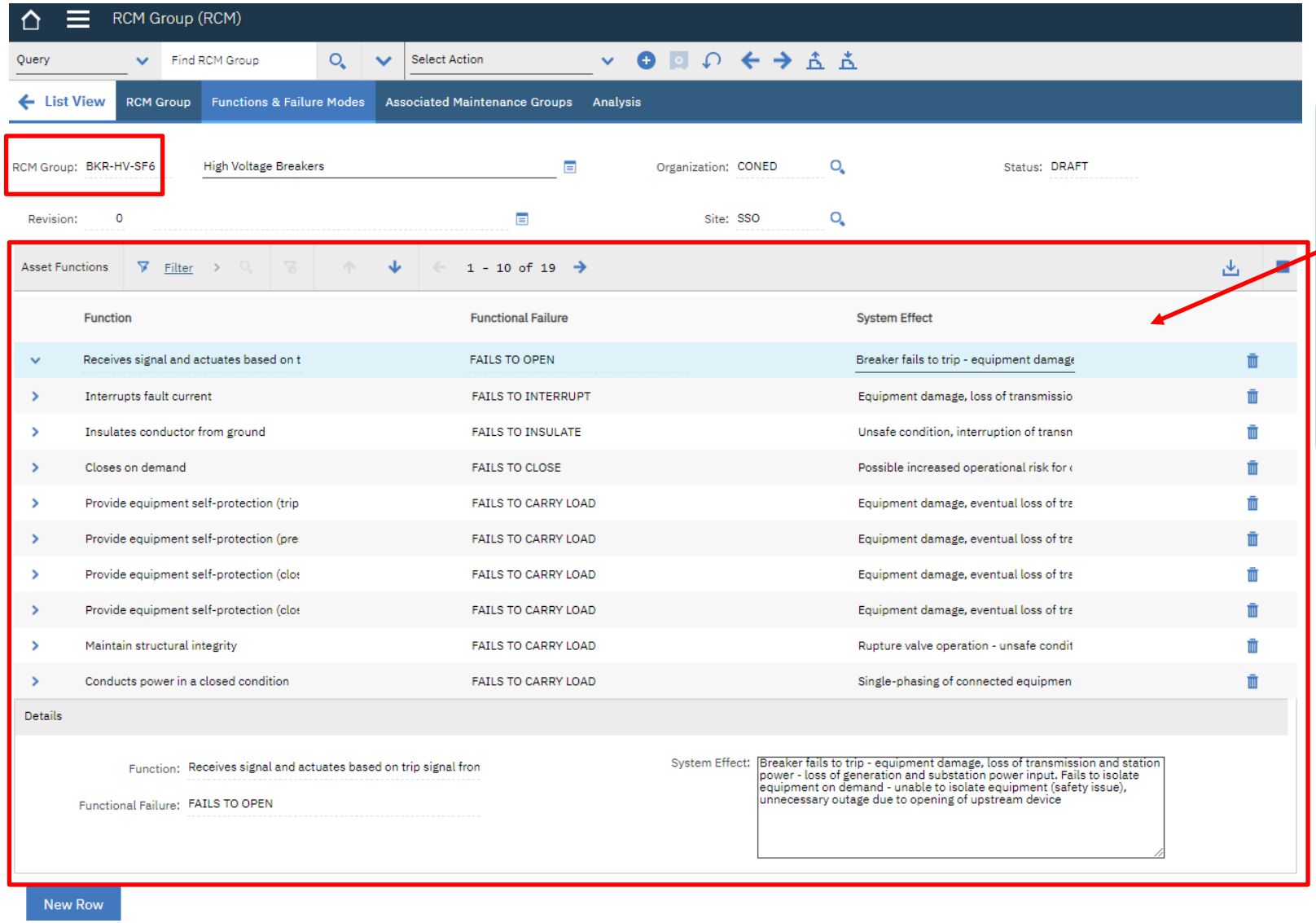
Viewing RCM Group



BKR-HV-SF6 High Voltage Breakers

Asset components to be used throughout application for failure mode reporting.

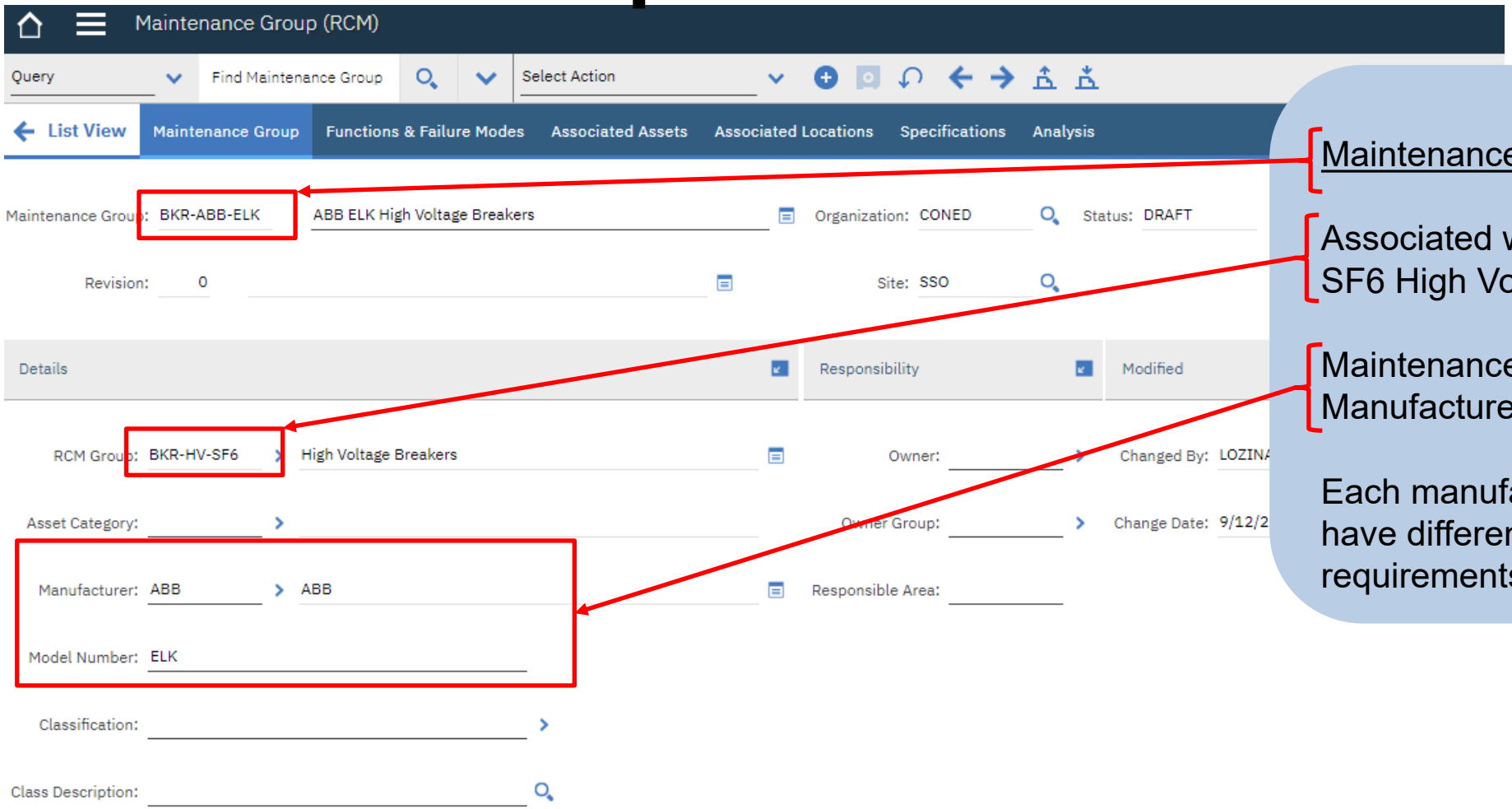
RCM Group – Defines Asset Functions



BKR-HV-SF6 High Voltage Breakers

Define all asset functions and functional failures, including system effects for the RCM Group.

Maintenance Group – Created from RCM Group



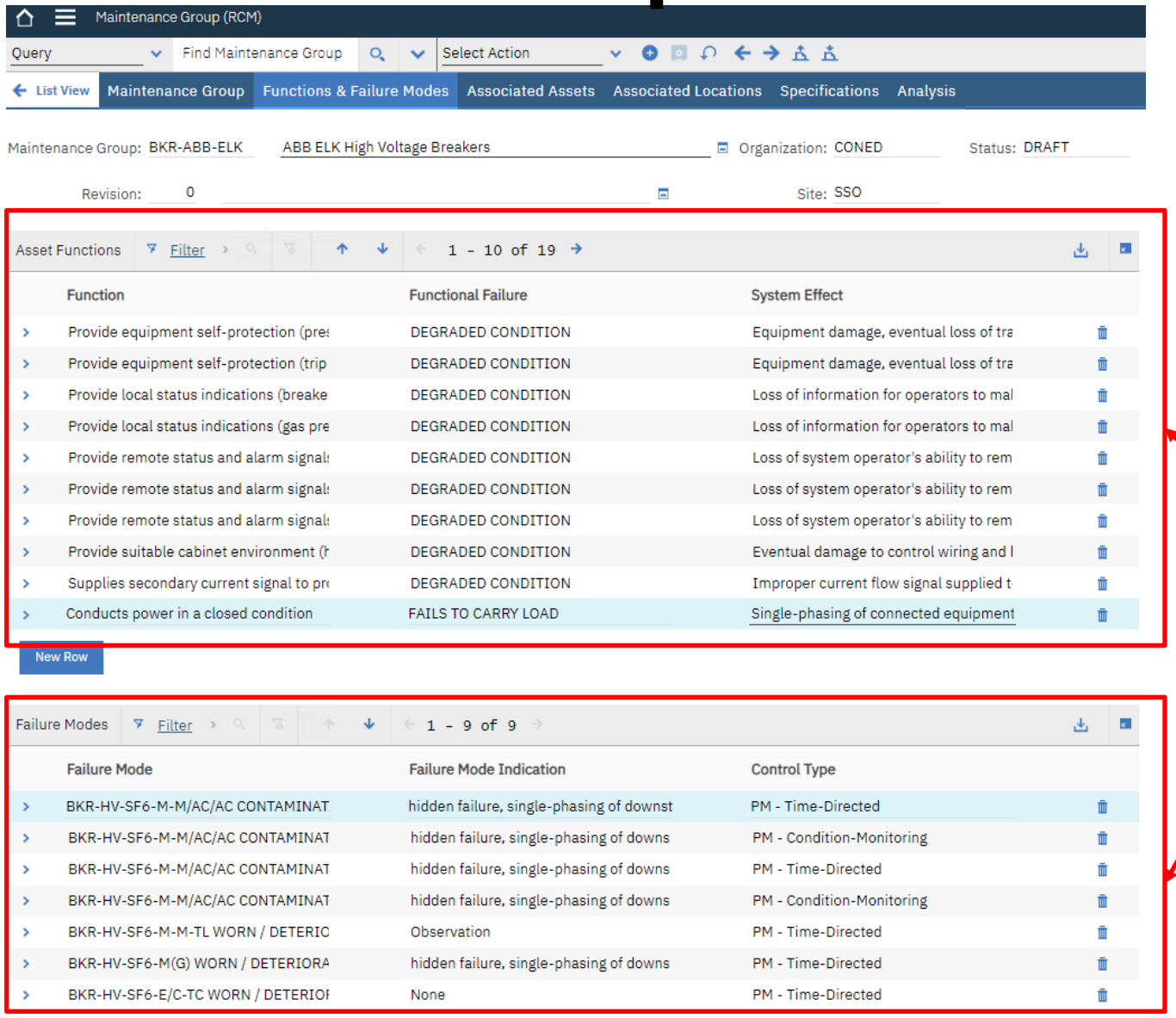
Maintenance Group: BKR-ABB-ELK

Associated with RCM Group BKR-HV-SF6 High Voltage Breakers

Maintenance Group can specify Manufacturer and Model Number as

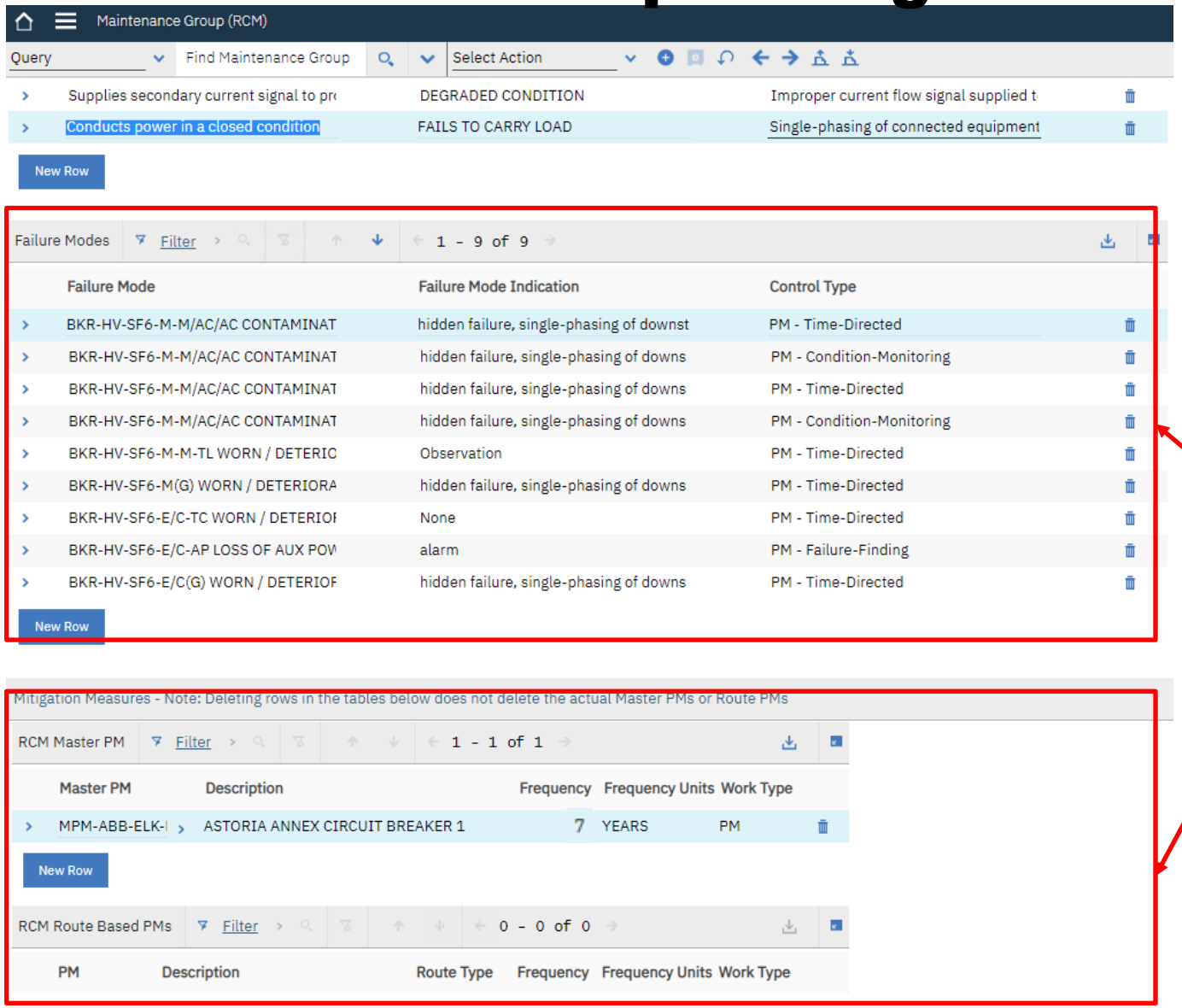
Each manufacturer or model could have different maintenance requirements

Maintenance Group – Functions & Failure Modes



Maintenance Group Asset Functions and Failure Modes are copied from the RCM Group and only editable in the RCM Group application.

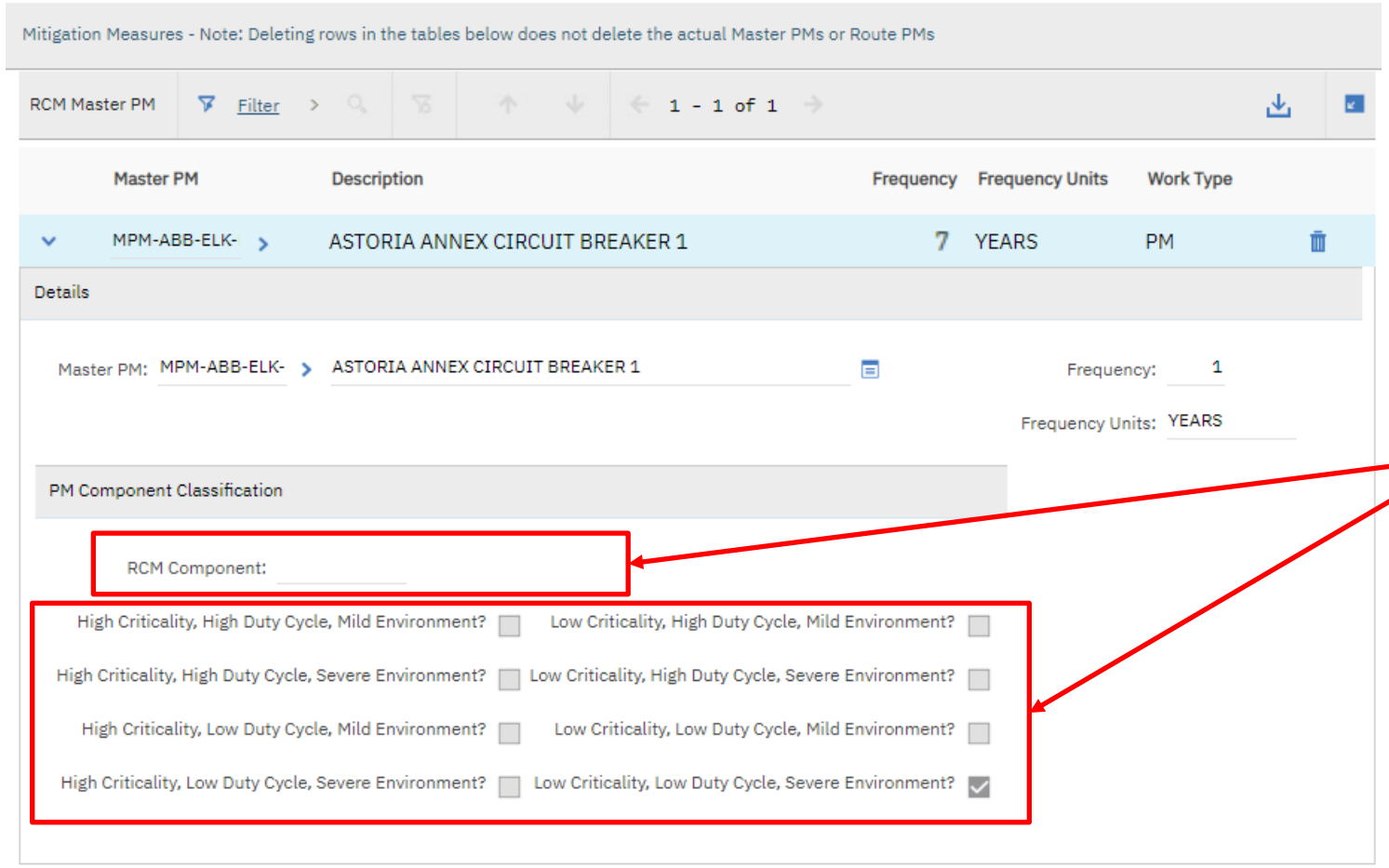
Maintenance Group – Mitigation Measures



For each Failure Mode a mitigating Master PM(s) or Route Base PM(s) can be assigned.

The PM's for these Mitigation Measures define the maintenance strategy of the Maintenance Group to prevent the asset functional failures from occurring.

Maintenance Group – Mitigation Measures (cont'd)

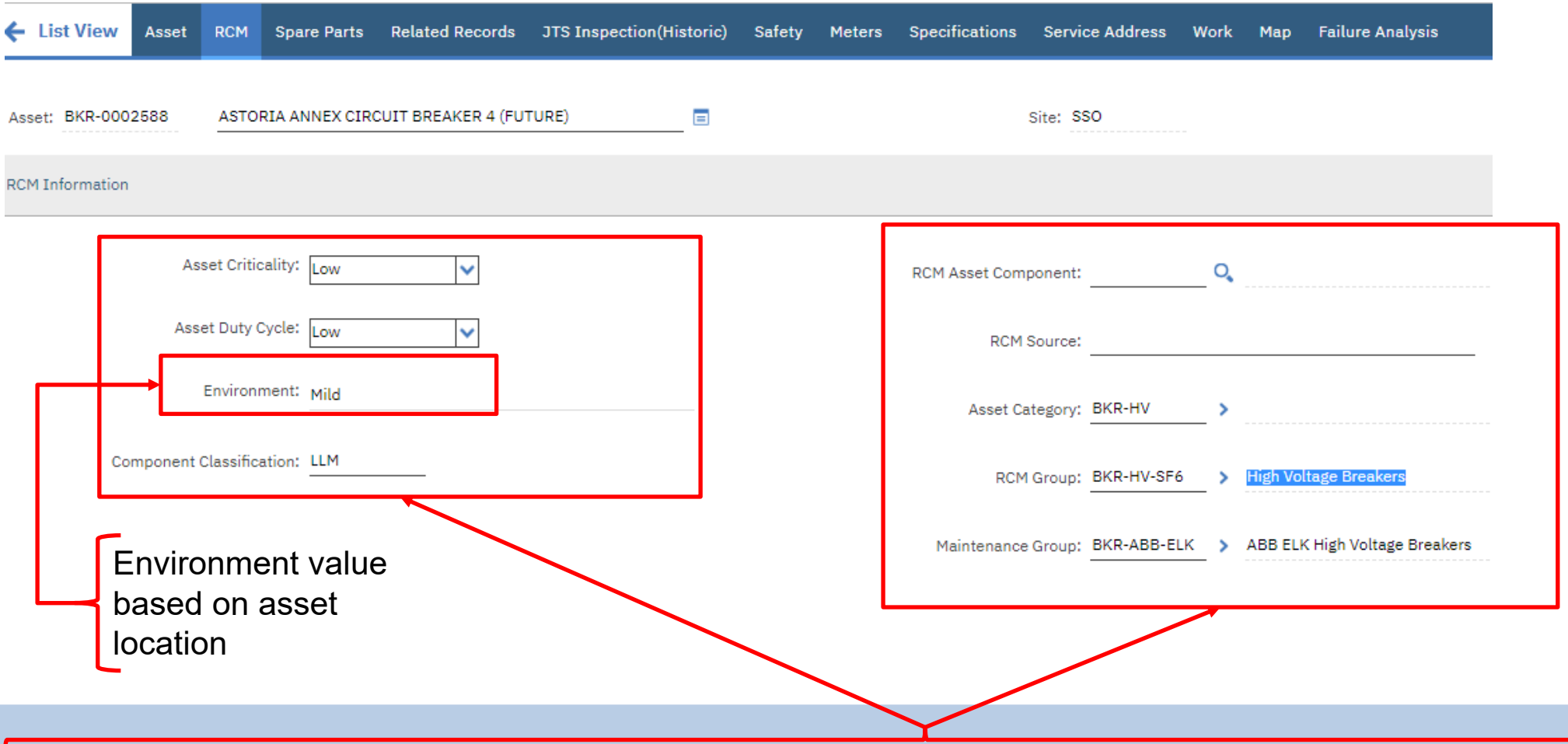


Each Master PM will be assigned any combination of Asset Component Classification

Optionally an RCM Component value may also be assigned.

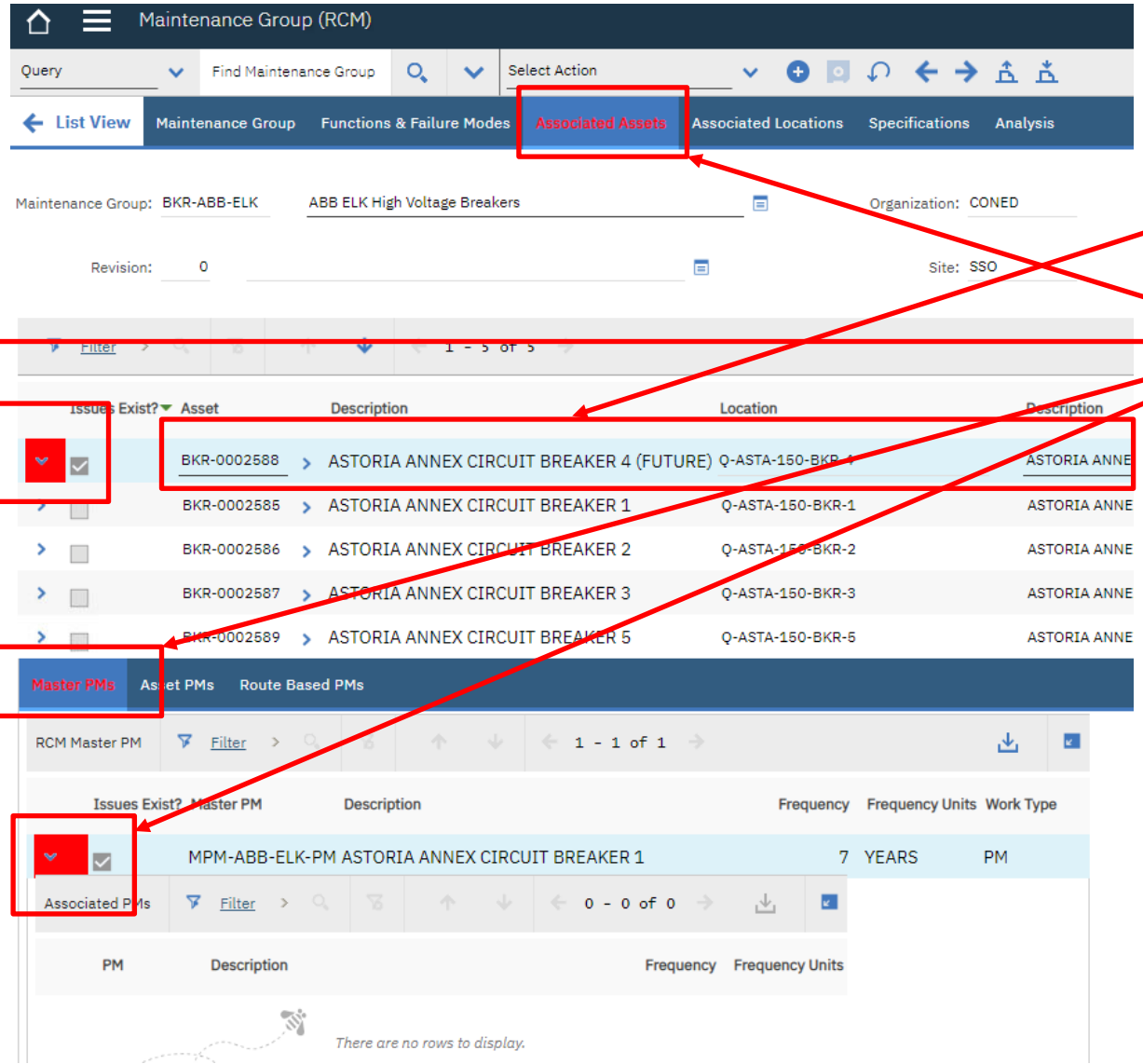
The system automatically associates all Maintenance Group Master PMs to associated assets based on matching this criteria.

Maintenance Group – Associating A New Asset



On the asset record RCM tab, assign the Asset Criticality, Asset Duty Cycle, RCM Asset Component (optional) and the RCM Group and Maintenance Group. This will automatically associate the asset with the selected Maintenance Group.

Maintenance Group – Associating New Asset (Cont'd)



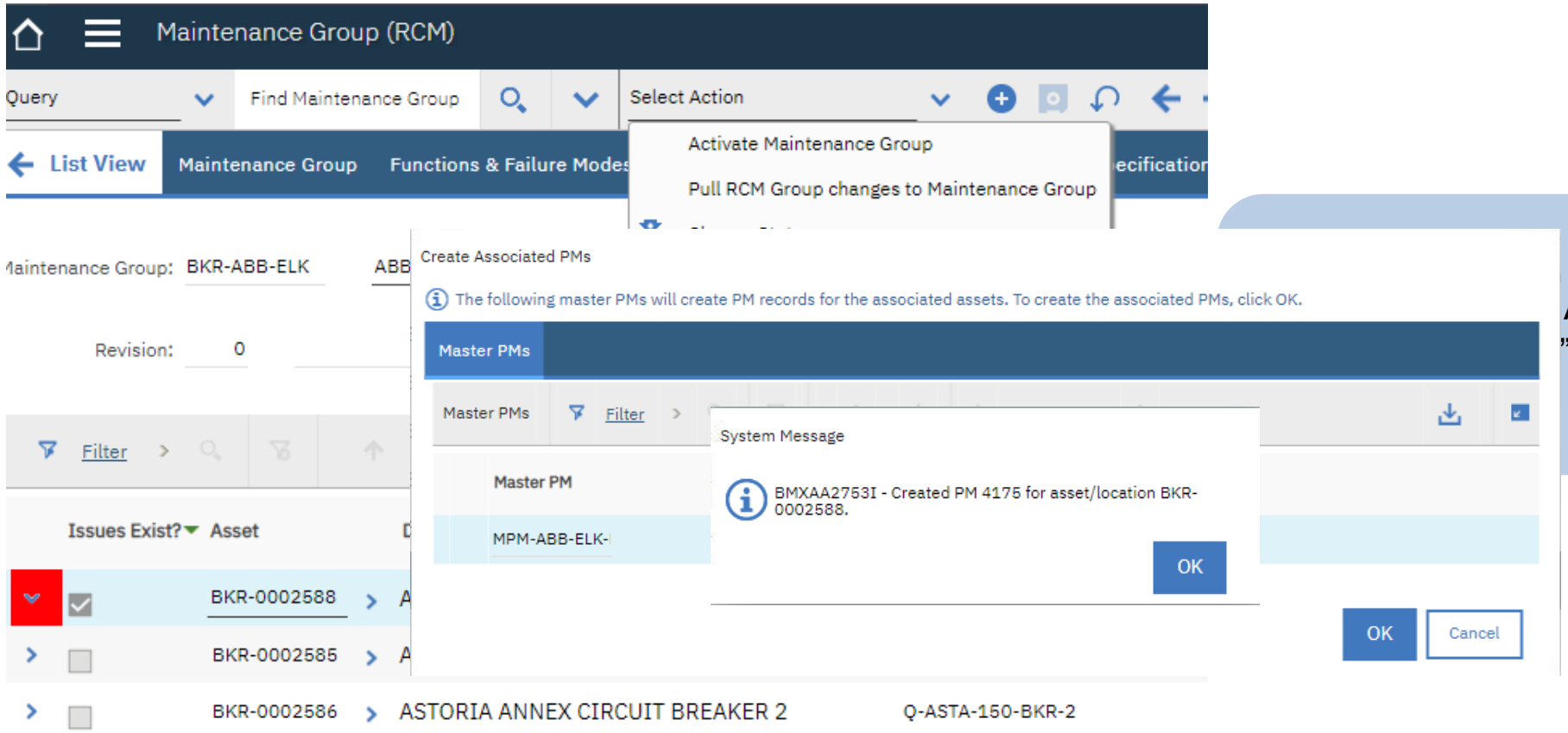
The new asset is automatically associated with the Maintenance Group.

"Bread crumbs" indicate that there are issues with the asset record.

The Master PM was automatically associated with the new asset, however there is no associated PM.

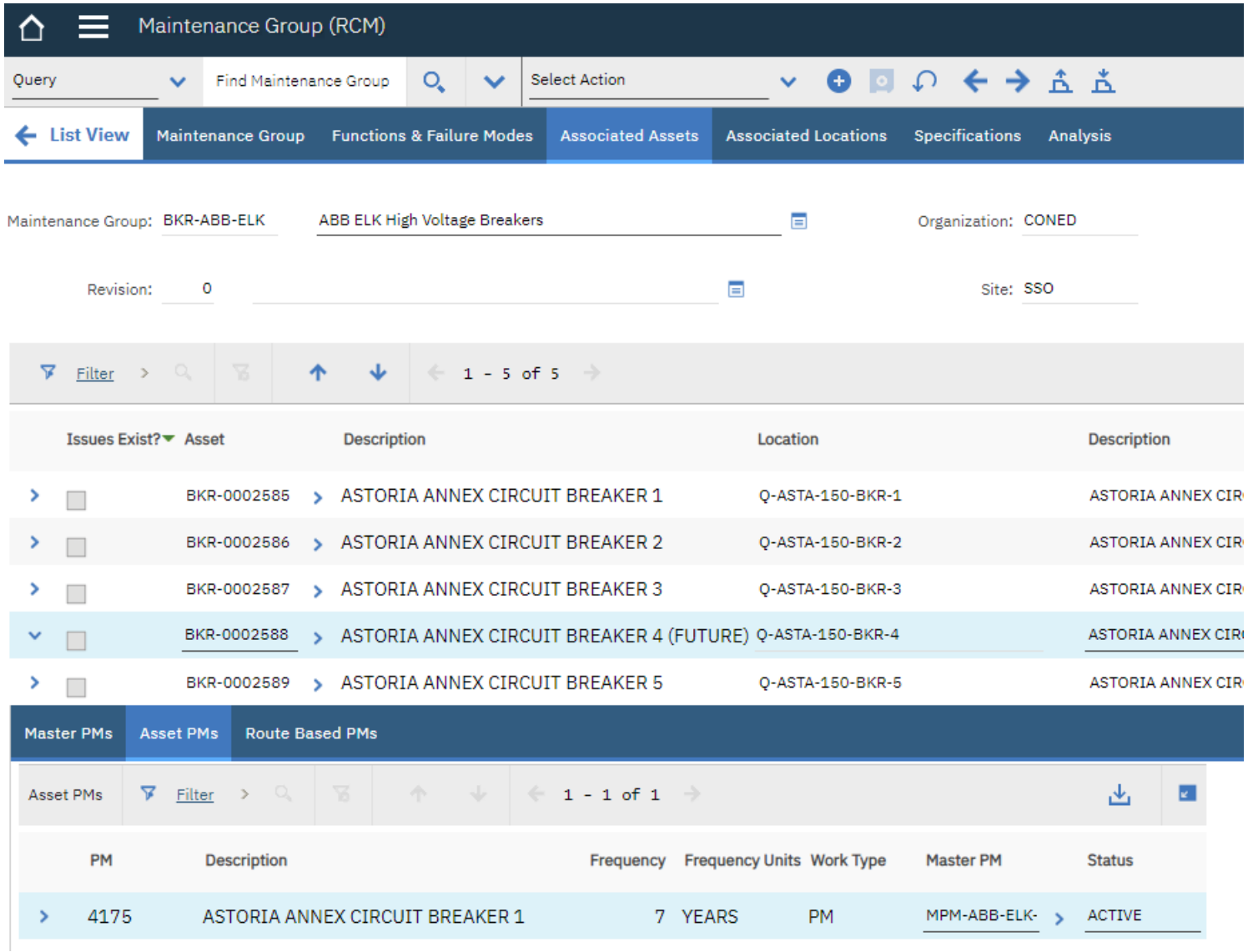
User must generate the associated PM for the Master PM – Asset combination.

Maintenance Group – Create Associated PMs (Cont'd)



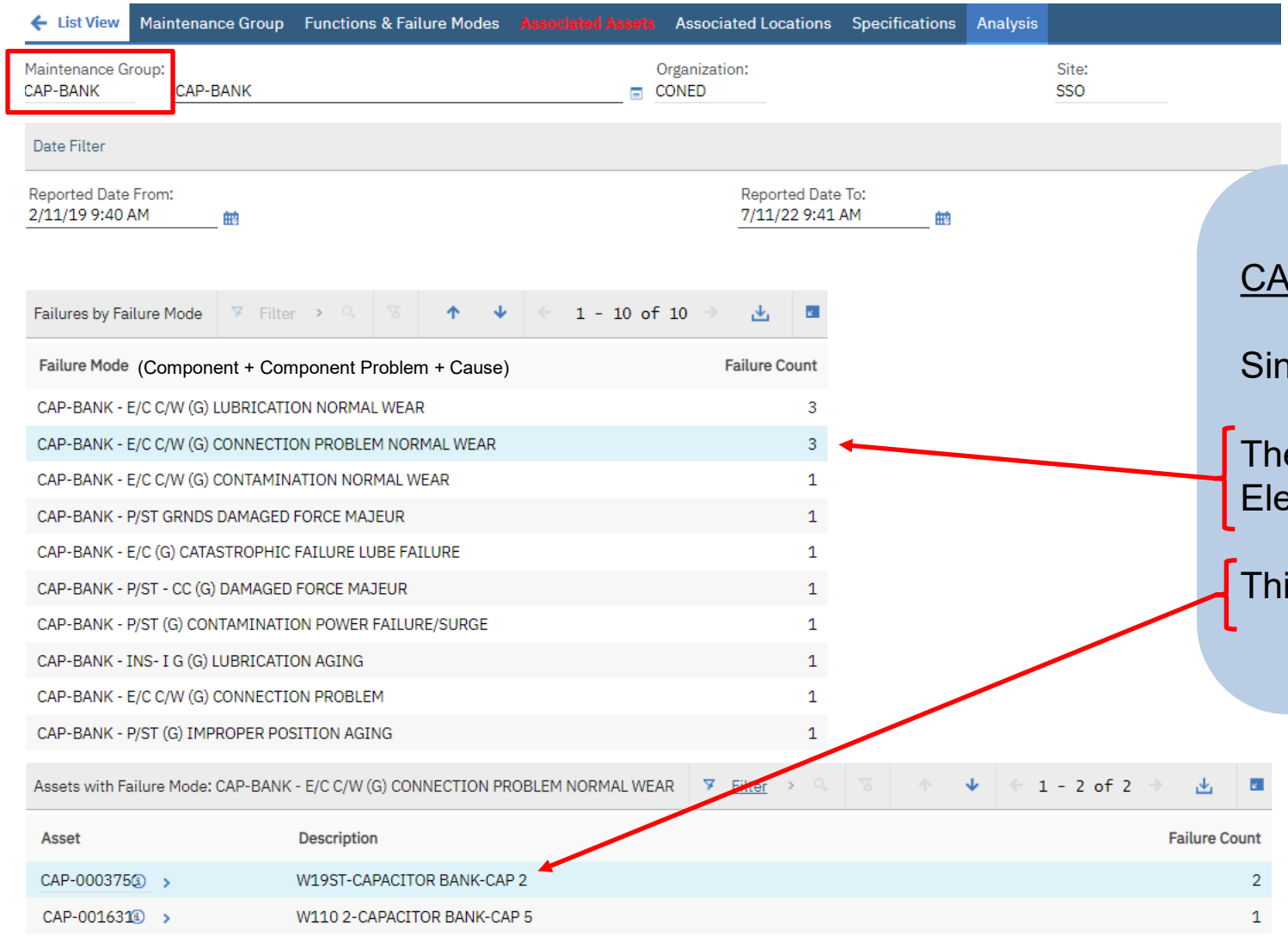
Action menu, choose "Create
".

Maintenance Group – Asset Associated



Once the PM is reviewed, assigned a start date and activated, the Maintenance Group will report there are no issues with the associated asset. Completing the asset association.

Maintenance Group - Analysis Tab



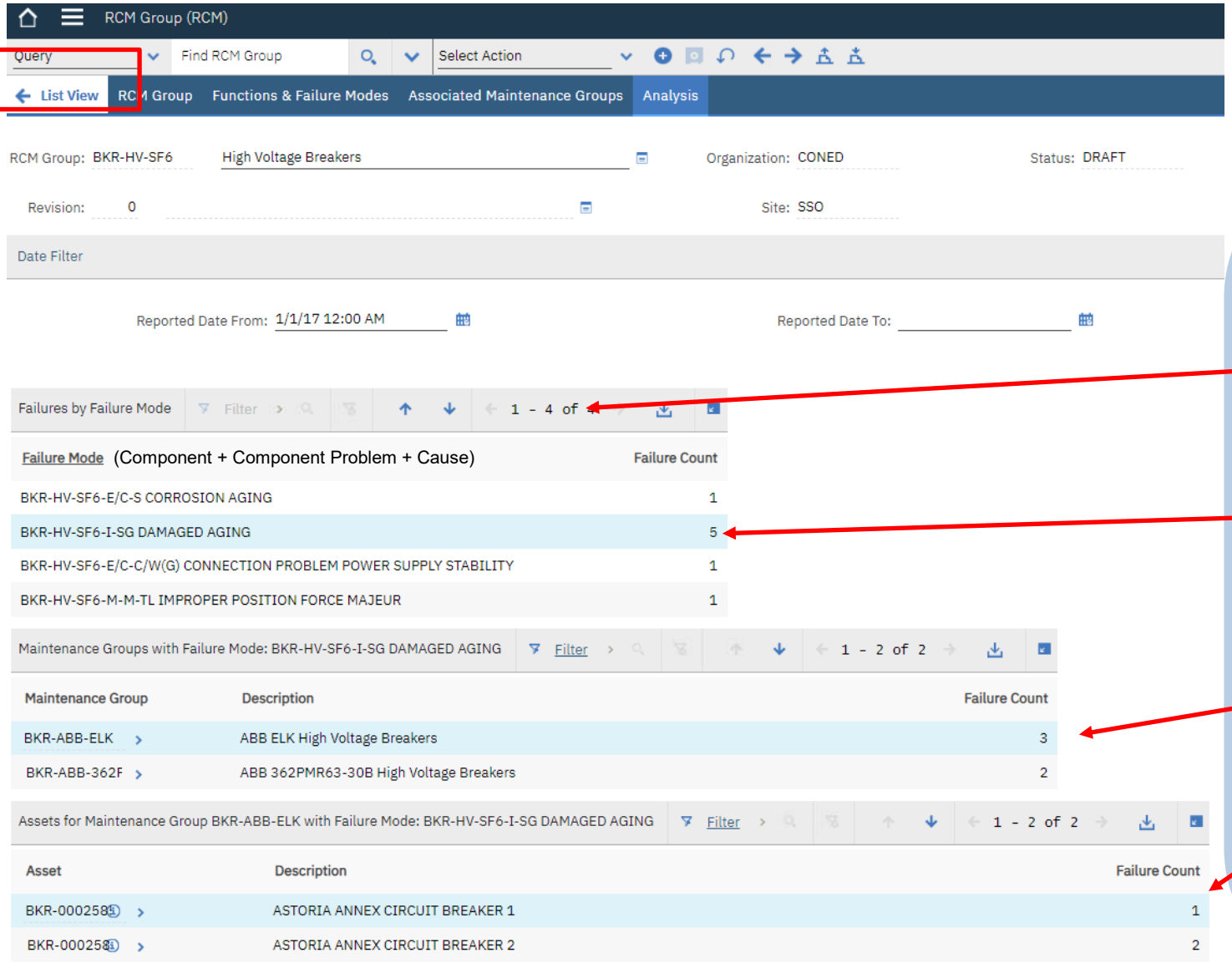
CAP-BANK maintenance group analysis

Since 2019, 10 different failure modes have occurred

The highlighted example shows 3 similar failures:
Electrical Control – Control Wiring – Normal Wear

This type of failure occurred twice on the same asset.

RCM Group - Analysis Tab



BKR-HV-SF6 RCM Group analysis

Since 2017, 4 different failure modes have occurred

The highlighted example shows 5 of the same failure has occurred:
Insulation – SF6 Gas – Damaged Aging

This failure occurred 3 times in Maintenance Group BKR-ABB-ELK and 2 times in Maintenance Group BKR-ABB-362P.

For Maintenance Group BKR-ABB-ELK this failure occurred once on one asset and twice on another.

CM Work Order Process (for Maintenance Group assets)

CM Work Order → Datasplice CM Job Plan Completed → Reliability Team Review

Field documentation
Captured in Datasplice and written back to Maximo work order

- As-found
- Work performed
- Problem code – what is issue with asset?
- Functional Failure or Degraded Condition
- Component(s)
- Component problem

Reliability team review
Captured in Engage and archived to Engage Metrics Database

- Accuracy/correction of work order coding
- Cause coding of functional failures

Benefits of this approach

- Eliminates need for 3rd party solutions to house RCM, and maintenance strategy
  - Supports a “living” PM program
  - Ease of access to maintenance strategy
  - Captures evolution of maintenance strategy
- Continuous validation that all required PMs are in Maximo
- Consistency in asset and PM records
- Global PM change capability
- Significantly improved ability to analyze and trend equipment performance
- Data analytics to justify maintenance strategy changes

Mark Lozina
lozinam@coned.com
917-992-9304

Jeff Tippett
jeff_tippett@maintenancegroup.com
709-682-4806

Special thanks to John Reeve!
planschd@outlook.com
253-328-3586
CRL, CMM, Author, CMMS champion
U.S. Patent 7,421,372 Maintenance Scheduling, Order of Fire

Books

Failure Modes to Failure Codes

Demanding Excellence from your Asset Management System