OCTOBER 24, 2023

Implementing condition monitoring using the AVEVA PI System to drive Condition-Based Maintenance

Meridian Energy at AVEVA World San Francisco

William Herewini and Saif Fawzi

Harapaki Wind Farm, Hawke's Bay

Presentation Agenda

Who are we?

Our business challenge

Our data pipeline

Use cases

Results and benefits

What's next?

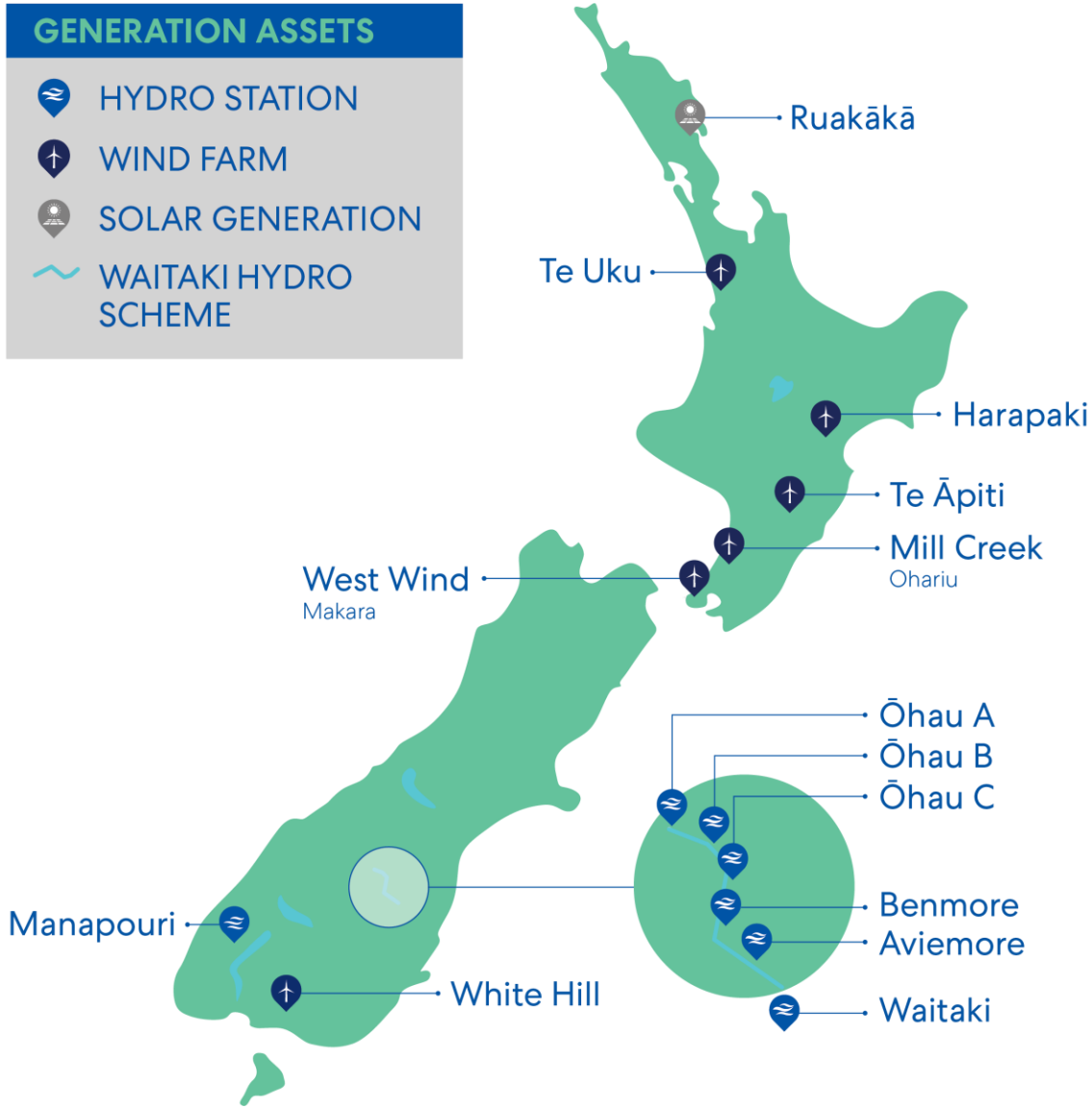
Who are we?

Aotearoa/New Zealand's largest energy generator with over 2800 MW of installed capacity equating to approx. 30% of the country's electricity

100% renewable generation – Wind, Water and Sun

- 7 hydro stations
- 5 wind farms with 2 new underway
- Grid-scale Battery Energy Storage Systems (BESS) and solar array underway

We retail electricity to more than 363,000 customers (or about 15% of household and business) across Aotearoa through our Meridian and Powershop brands.



Who are we?

Our purpose – Clean energy for a fairer and healthier world

More than just power – doing our bit to help drive sustainability for ourselves and our customers

- Fleet electrification
- Community Decarbonisation
- KidsCan
- Kākāpō Recovery
- Forever Forests

Who are we?

The power to make a difference through data

Improve processes from a routine-based maintenance approach to a data informed condition-based maintenance approach

Why?

Make life easier for our on-site teams to do their jobs effectively

Improve asset health

Do our bit to keep the lights on in Kiwi homes and Aotearoa/New Zealand powered through the cold winter months

Godley River Delta, Lake Tekapo


Aviemore Hydro Station, Waitaki Valley

Our Business Challenge

Problem

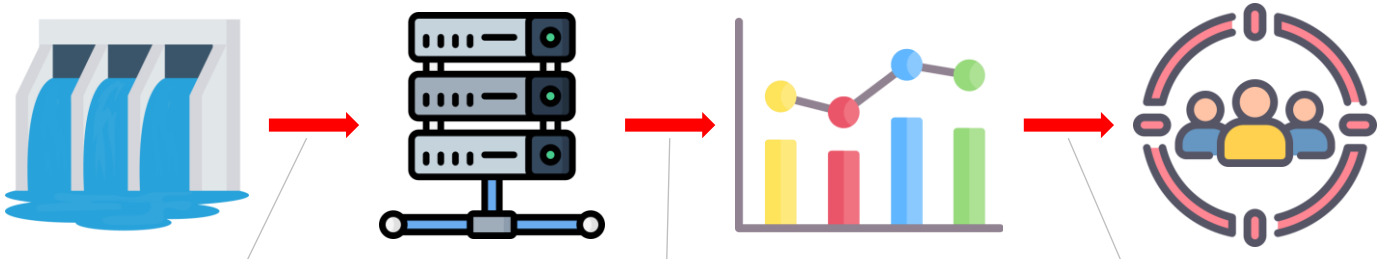
- Lack of visibility into our generating assets
- Requiring plant outages and routine maintenance to investigate the degradation of our generating assets
- Outage flexibility becoming less frequent due to constraints from market demand

Goal

- Meridian Energy would like to optimise resource usage through condition-based maintenance

The AVEVA PI System ecosystem was crucial for this

Our Data Pipeline

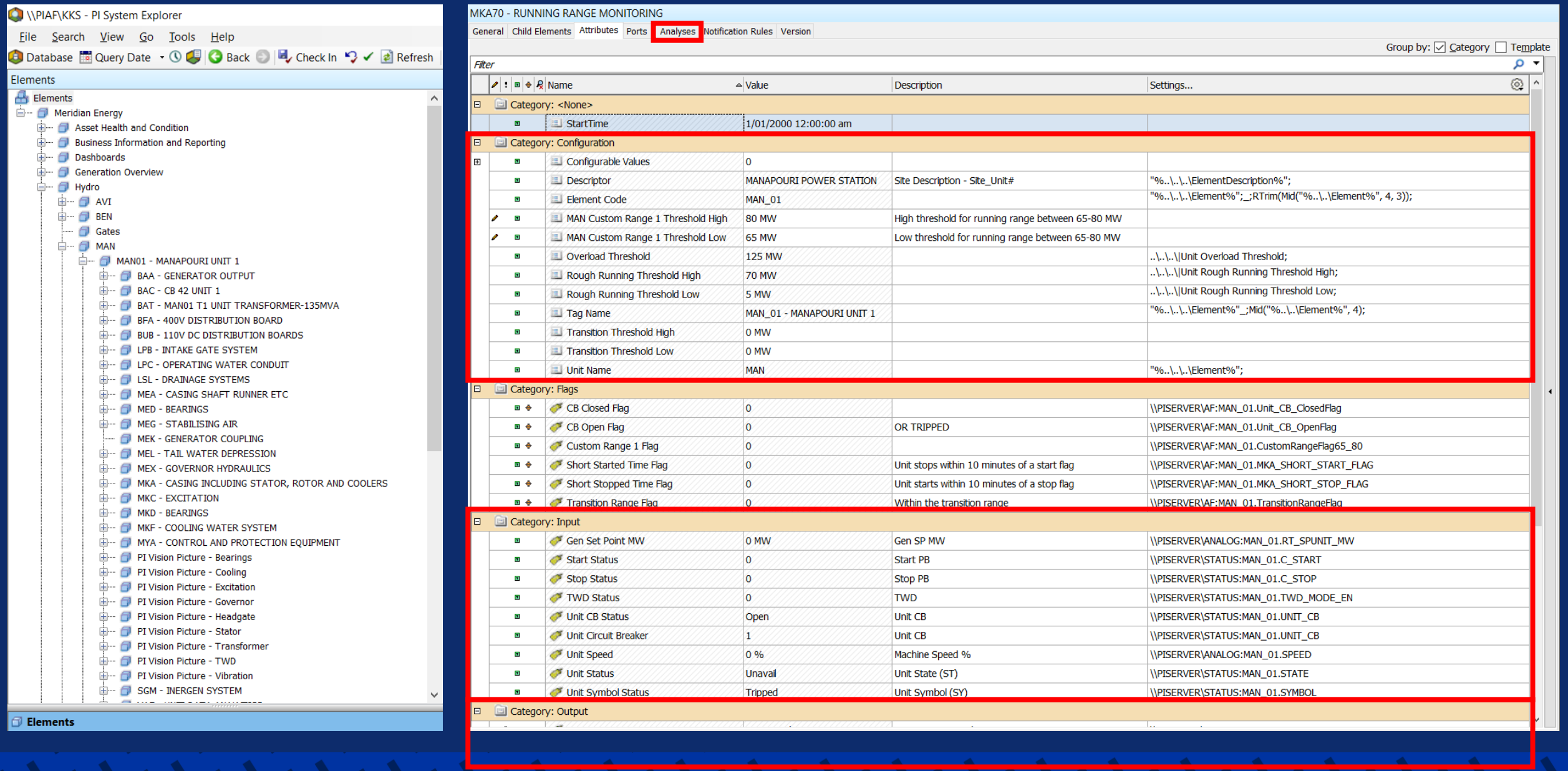


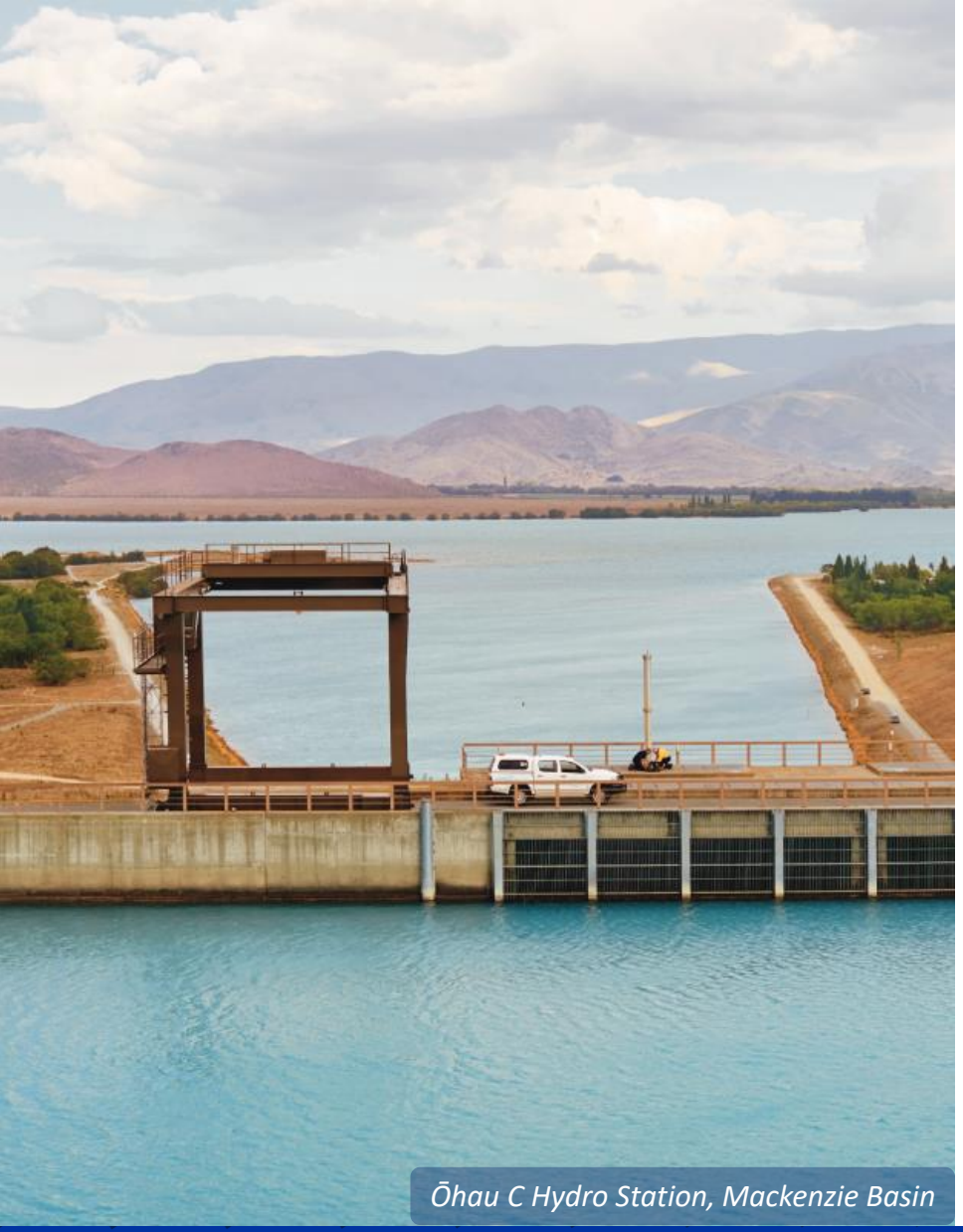
AVEVA PI System collects data points from our assets and stores them within our **PI Data Archive**

AVEVA PI Asset Framework builds analytical models to format and contextualise data

AVEVA PI Vision and **Dimension Software's Asset Intellect** constructs platform to collate and present relevant information from various data sources

White Hill Wind Farm, Southland


\\PIAF\KKS - PI System Explorer
File Search View Go Tools Help
Database Query Date Back Check In Refresh
Elements
Elements
Meridian Energy
Asset Health and Condition
Business Information and Reporting
Dashboards
Generation Overview
Hydro
AVI
BEN
Gates
MAN
MAN01 - MANAPOURI UNIT 1
BAA - GENERATOR OUTPUT
BAC - CB 42 UNIT 1
BAT - MAN01 T1 UNIT TRANSFORMER-135MVA
BFA - 400V DISTRIBUTION BOARD
BUB - 110V DC DISTRIBUTION BOARDS
LPB - INTAKE GATE SYSTEM
LPC - OPERATING WATER CONDUIT
LSL - DRAINAGE SYSTEMS
MEA - CASING SHAFT RUNNER ETC
MED - BEARINGS
MEG - STABILISING AIR
MEK - GENERATOR COUPLING
MEL - TAIL WATER DEPRESSION
MEX - GOVERNOR HYDRAULICS
MKA - CASING INCLUDING STATOR, ROTOR AND COOLERS
MKC - EXCITATION
MKD - BEARINGS
MKF - COOLING WATER SYSTEM
MYA - CONTROL AND PROTECTION EQUIPMENT
PI Vision Picture - Bearings
PI Vision Picture - Cooling
PI Vision Picture - Excitation
PI Vision Picture - Governor
PI Vision Picture - Headgate
PI Vision Picture - Stator
PI Vision Picture - Transformer
PI Vision Picture - TWD
PI Vision Picture - Vibration
SGM - INERGEN SYSTEM
Elements
MKA70 - RUNNING RANGE MONITORING
General Child Elements Attributes Ports Analyses Notification Rules Version
Group by: Category Template
Filter
Name Value Description Settings...
Category: <None>
StartTime 1/01/2000 12:00:00 am
Category: Configuration
Configurable Values 0
Descriptor MANAPOURI POWER STATION Site Description - Site_Unit# "%..\..\..\ElementDescription%";
Element Code MAN_01 "%..\..\..\Element%";_;RTrim(Mid("%..\..\Element%", 4, 3));
MAN Custom Range 1 Threshold High 80 MW High threshold for running range between 65-80 MW
MAN Custom Range 1 Threshold Low 65 MW Low threshold for running range between 65-80 MW
Overload Threshold 125 MW ..\..\..\|Unit Overload Threshold;
Rough Running Threshold High 70 MW ..\..\..\|Unit Rough Running Threshold High;
Rough Running Threshold Low 5 MW ..\..\..\|Unit Rough Running Threshold Low;
Tag Name MAN_01 - MANAPOURI UNIT 1 "%..\..\..\Element%"_;Mid("%..\..\Element%", 4);
Transition Threshold High 0 MW
Transition Threshold Low 0 MW
Unit Name MAN "%..\..\..\Element%";
Category: Flags
CB Closed Flag 0 \\PISERVER\AF:MAN_01.Unit_CB_ClosedFlag
CB Open Flag 0 OR TRIPPED \\PISERVER\AF:MAN_01.Unit_CB_OpenFlag
Custom Range 1 Flag 0 \\PISERVER\AF:MAN_01.CustomRangeFlag65_80
Short Started Time Flag 0 Unit stops within 10 minutes of a start flag \\PISERVER\AF:MAN_01.MKA_SHORT_START_FLAG
Short Stopped Time Flag 0 Unit starts within 10 minutes of a stop flag \\PISERVER\AF:MAN_01.MKA_SHORT_STOP_FLAG
Transition Range Flag 0 Within the transition range \\PISERVER\AF:MAN_01.TransitionRangeFlag
Category: Input
Gen Set Point MW 0 MW Gen SP MW \\PISERVER\ANALOG:MAN_01.RT_SPUNIT_MW
Start Status 0 Start PB \\PISERVER\STATUS:MAN_01.C_START
Stop Status 0 Stop PB \\PISERVER\STATUS:MAN_01.C_STOP
TWD Status 0 TWD \\PISERVER\STATUS:MAN_01.TWD_MODE_EN
Unit CB Status Open Unit CB \\PISERVER\STATUS:MAN_01.UNIT_CB
Unit Circuit Breaker 1 Unit CB \\PISERVER\STATUS:MAN_01.UNIT_CB
Unit Speed 0 % Machine Speed % \\PISERVER\ANALOG:MAN_01.SPEED
Unit Status Unavail Unit State (ST) \\PISERVER\STATUS:MAN_01.STATE
Unit Symbol Status Tripped Unit Symbol (SY) \\PISERVER\STATUS:MAN_01.SYMBOL
Category: Output



Ōhau C Hydro Station, Mackenzie Basin

Use Cases

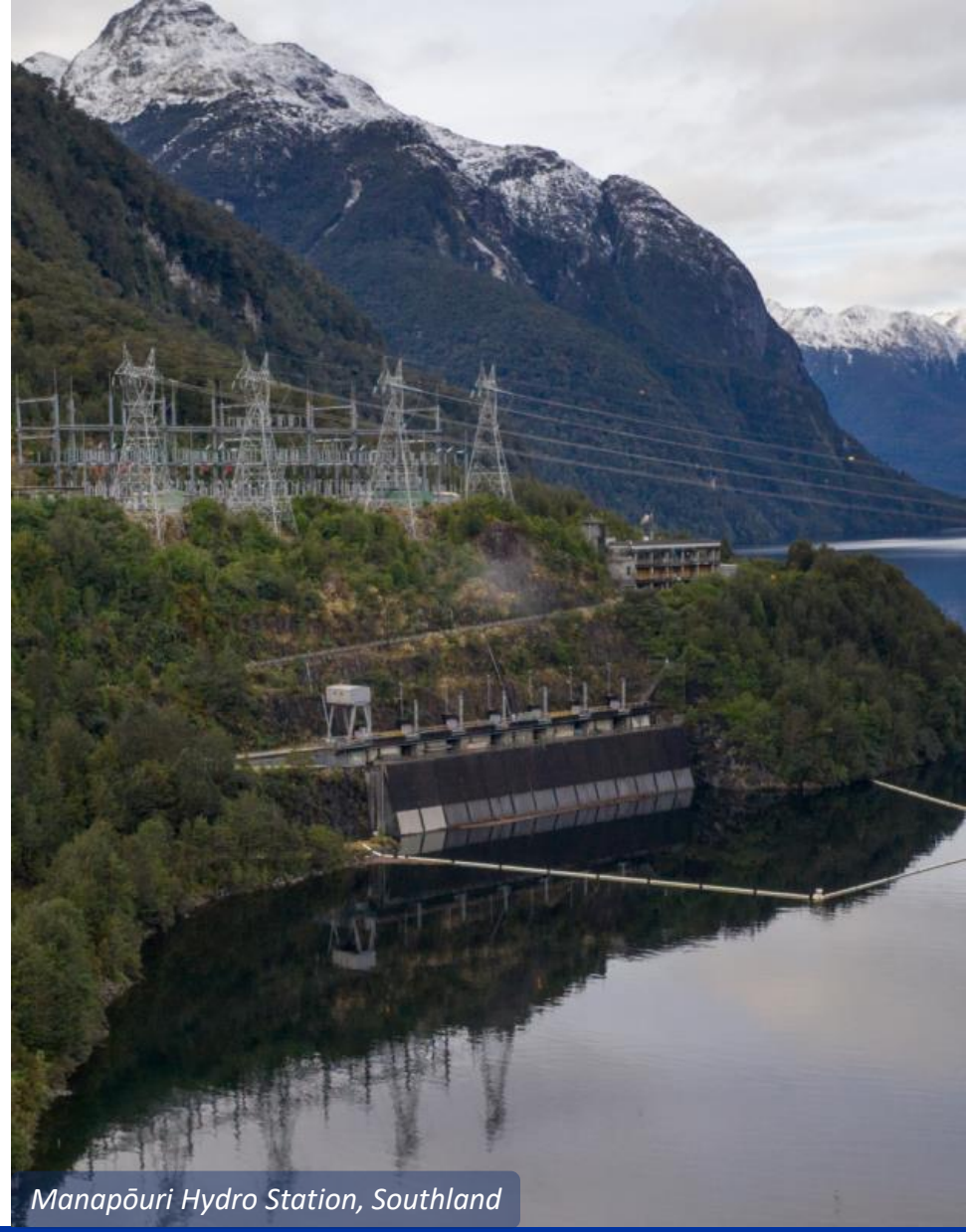
Hydro Unit Stopping Sequence Analysis

Hydro Unit Fatigue Monitoring

Hydro Unit Stopping Sequence Analysis

Problem

- Hydro generation units not stopping as expected leading to forced outages
- Loss of potential generation during outage period
- Uncertainty of root cause
  - Wicket gate failure
  - Degrading brake pads

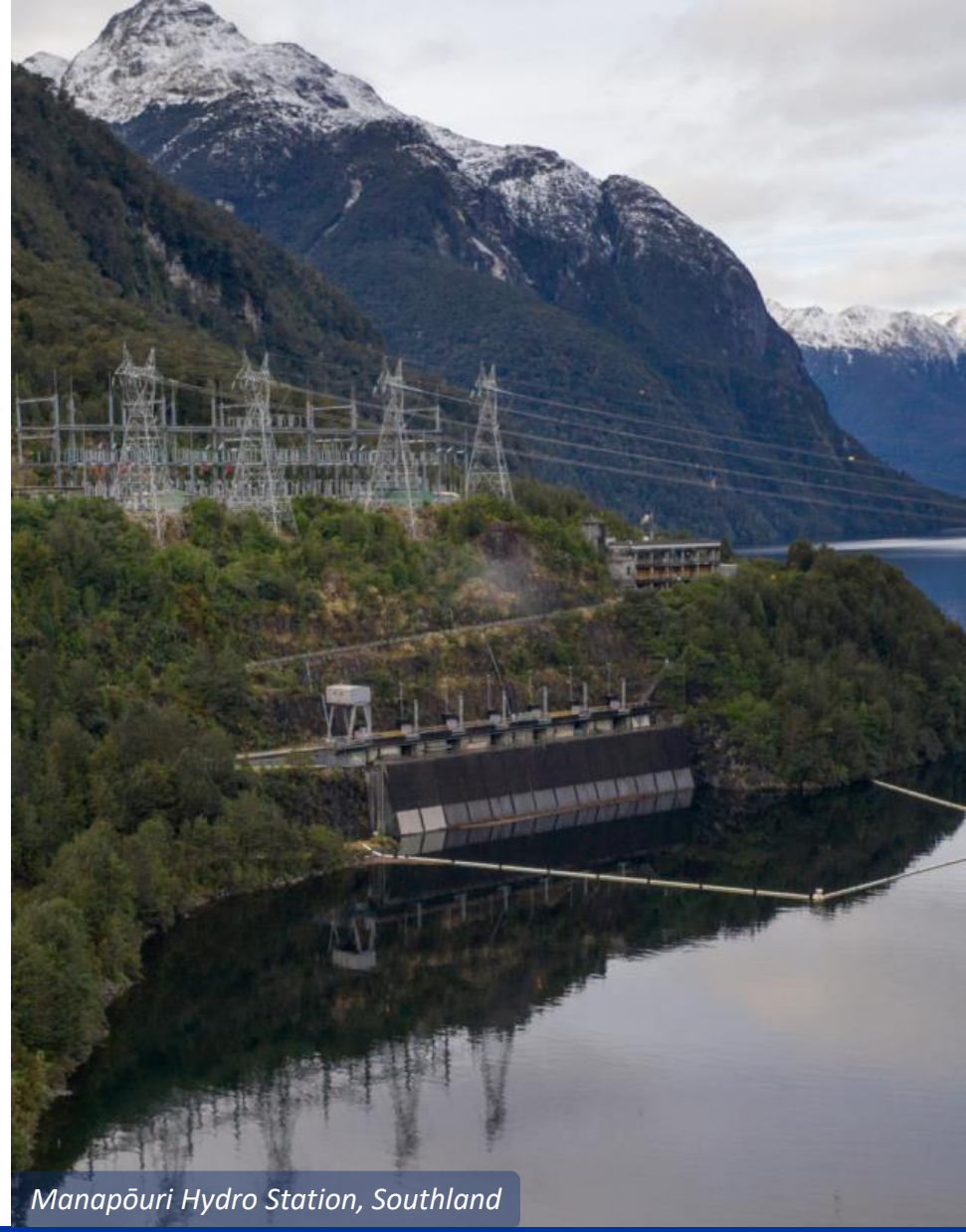


Manapōuri Hydro Station, Southland

Hydro Unit Stopping Sequence Analysis

Approach

- Use time-series data collected via AVEVA's PI system with PI Asset Framework and PI Vision
- Create event frames for each unit's stopping sequence
- Perform analytics on raw data to generate contextualised information
- Present information using PI Vision



Manapōuri Hydro Station, Southland

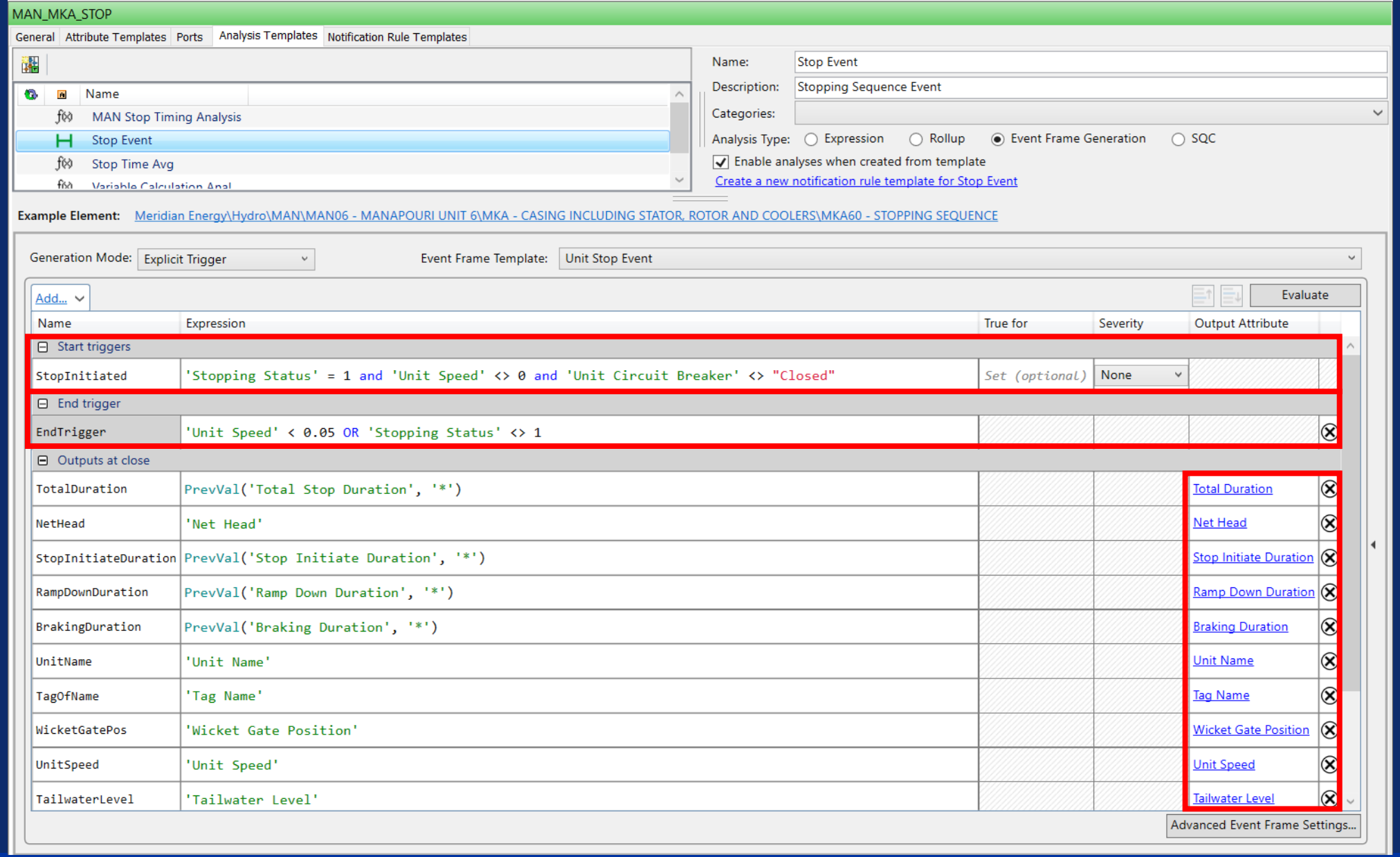
MAN_MKA_STOP

General | Attribute Templates | Ports | Analysis Templates | Notification Rule Templates

Group by: ☑ Category ☐ Template

Filter

Name	Description	Default Value	Settings...
Category: Configuration			
Unit Ramp Down Start Sp...	Threshold where ramp down se...	95 %	
Category: Input			
Braking Status		0	\\%Server%\STATUS:%@Element Code%.MKA50G0310ON
Headwater Level		0 m	\\PISERVER\ANALOG:MAN_SS.STN_HWL
Rotate Status		0	\\%Server%\STATUS:%@Element Code%.ROTATE
Stopped Status		0	\\%Server%\STATUS:%@Element Code%.STOPPED
Stopping Status		0	\\%Server%\STATUS:%@Element Code%.STOPPING
Tailwater Level		0 m	\\%Server%\ANALOG:MAN_SS2.LQB10L1100GE
Tripped Status	(SY) Tripped		\\PISERVER\STATUS:%@Element Code%.TRIPPED
Unit Circuit Breaker			\\PISERVER\STATUS:%@Element Code%.UNIT_CB
Unit Speed		0 %	\\%Server%\ANALOG:%@Element Code%.SPEED
Category: Output			
Brake Status Flag		0	\\%Server%\AF:%@Element Code%.MKA_BRAKE_FLAG
Braking Duration		0.00 s	\\%Server%\AF:%@Element Code%.MKA_BRAKE_DUR
Net Head		0 m	\\%Server%\AF:%@Element Code%.MKA_NET_HWL
Ramp Down Duration		0.00 s	\\%Server%\AF:%@Element Code%.MKA_RAMP_DWN_DUR
Stop Initiate Duration		0.00 s	\\%Server%\AF:%@Element Code%.MKA_STOP_INITIATE_DUR
Total Stop Duration		0 s	\\%Server%\AF:%@Element Code%.MKA_TOT_STOP_DUR
Wicket Gate Position		0	\\PISERVER\ANALOG:%@Element Code%.WICKET_GT_GP
Category: Statistics			
AvgBraking3mo		0.00 s	\\%Server%\AF:%@Element Code%.MKA_BRAKE_DUR_3MO_AVG
AvgRampDown3mo		0 s	\\%Server%\AF:%@Element Code%.MKA_RAMP_DWN_DUR_3MO_AVG
AvgStopInitiate3mo		0.00 s	\\%Server%\AF:%@Element Code%.MKA_STOP_INITIATE_DUR_MEDIAN
Braking50Percentile3mo		0.00 s	\\%Server%\AF:%@Element Code%.MKA_BRAKE_DUR_3MO_MEDIAN
RampDown50Percentile3mo		0.00 s	\\%Server%\AF:%@Element Code%.MKA_RAMP_DWN_DUR_3MO_MEDIAN
StopInitiate50Percentile3mo		0.00 s	\\%Server%\AF:%@Element Code%.MKA_STOP_INITIATE_DUR_MEDIAN

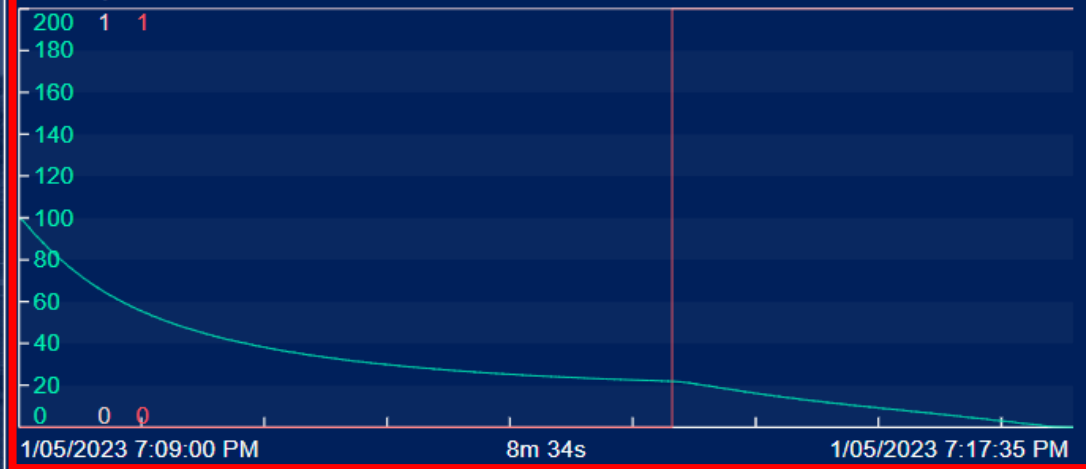

MAN_MKA_STOP
General
Attribute Templates
Ports
Analysis Templates
Notification Rule Templates
Name
MAN Stop Timing Analysis
Stop Event
Stop Time Avg
Name: Stop Event
Description: Stopping Sequence Event
Categories:
Analysis Type: Expression Rollup Event Frame Generation SQC
Enable analyses when created from template
Create a new notification rule template for Stop Event
Example Element: Meridian Energy\Hydro\MAN\MAN06 - MANAPOURI UNIT 6\MKA - CASING INCLUDING STATOR, ROTOR AND COOLERS\MKA60 - STOPPING SEQUENCE
Generation Mode: Explicit Trigger
Event Frame Template: Unit Stop Event
Add...
Evaluate
Name
Expression
True for
Severity
Output Attribute
Start triggers
StopInitiated
'Stopping Status' = 1 and 'Unit Speed' <> 0 and 'Unit Circuit Breaker' <> "Closed"
Set (optional)
None
End trigger
EndTrigger
'Unit Speed' < 0.05 OR 'Stopping Status' <> 1
Outputs at close
TotalDuration
PrevVal('Total Stop Duration', '*')
Total Duration
NetHead
'Net Head'
Net Head
StopInitiateDuration
PrevVal('Stop Initiate Duration', '*')
Stop Initiate Duration
RampDownDuration
PrevVal('Ramp Down Duration', '*')
Ramp Down Duration
BrakingDuration
PrevVal('Braking Duration', '*')
Braking Duration
UnitName
'Unit Name'
Unit Name
TagOfName
'Tag Name'
Tag Name
WicketGatePos
'Wicket Gate Position'
Wicket Gate Position
UnitSpeed
'Unit Speed'
Unit Speed
TailwaterLevel
'Tailwater Level'
Tailwater Level
Advanced Event Frame Settings...

Values of Selected Stop

MAN_01

Stop Initiate Duration	Ramp Down Duration	Braking Duration	Total Stop Duration	Tailwater Level	Net Head
5.98 s	319.04 s	195.90 s	514.88 s	3.9222 m	No Data m
1/05/2023 7:17:35 PM	1/05/2023 7:17:35 PM	1/05/2023 7:17:35 PM	1/05/2023 7:17:35 PM	1/05/2023 7:17:35 PM	1/05/2023 7:17:35 PM

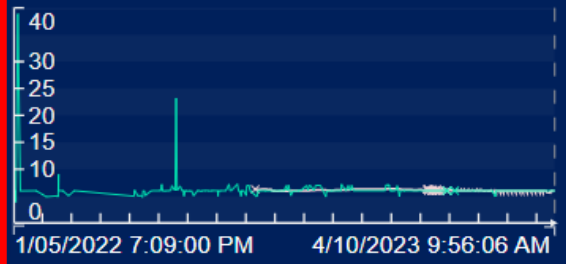
Unit Speed at Time of Event



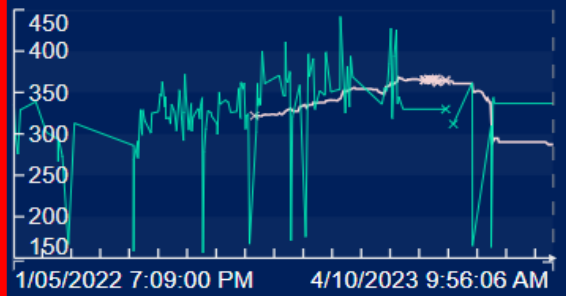
Unit Speed
0 %
Stopping Status
1
Braking Status
1

Event Name	Start Time	End Time	Duration
Stop Event 2023-05-02 20:40:22.052	2/05/2023 8:40:22 pm	2/05/2023 8:49:28 pm	9m 6s
Stop Event 2023-05-01 19:09:00.245	1/05/2023 7:09:00 pm	1/05/2023 7:17:35 pm	8m 34s
Stop Event 2023-04-30 17:08:45.101	30/04/2023 5:08:45 pm	30/04/2023 5:19:37 pm	10m 52s

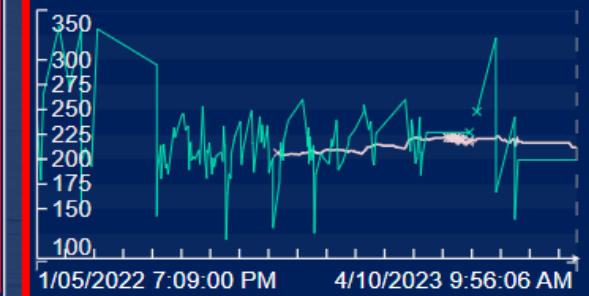
12-Month Trends of Rolling Averages



Stop Initiate Duration
6.00 s
AvgStopInitiate3mo
6.00 s



Ramp Down Duration
336.94 s
AvgRampDown3mo
287.21 s



Braking Duration
199.14 s
AvgBraking3mo
211.91 s

Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7

Values of Last Stop

Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7
Stop Initiate Duration 6.00 s 8/08/2023 2:17:49 PM	Stop Initiate Duration Shutdown s 22/06/2023 7:35:39 PM	Stop Initiate Duration 5.99 s 17/07/2023 9:05:43 PM	Stop Initiate Duration 6.02 s 21/09/2023 11:56:28 AM	Stop Initiate Duration 5.02 s 22/09/2023 6:13:51 AM	Stop Initiate Duration 12.95 s 30/08/2023 3:53:18 PM	Stop Initiate Duration 4.98 s 16/08/2023 11:11:59 AM
Ramp Down Duration 336.94 s 8/08/2023 2:23:20 PM	Ramp Down Duration 181.14 s 16/07/2023 8:06:06 AM	Ramp Down Duration 169.83 s 30/08/2023 7:23:32 AM	Ramp Down Duration 315.96 s 21/09/2023 12:01:38 PM	Ramp Down Duration 257.81 s 22/09/2023 6:18:04 AM	Ramp Down Duration 293.12 s 30/08/2023 4:13:13 PM	Ramp Down Duration 868.01 s 16/08/2023 11:26:22 AM
Braking Duration 199.14 s 8/08/2023 2:26:39 PM	Braking Duration 166.02 s 16/07/2023 8:08:52 AM	Braking Duration 192.11 s 30/08/2023 7:26:44 AM	Braking Duration 206.88 s 21/09/2023 12:05:05 PM	Braking Duration 232.19 s 22/09/2023 6:21:56 AM	Braking Duration 126.09 s 30/08/2023 4:15:19 PM	Braking Duration 357.98 s 16/08/2023 11:32:20 AM

3 Month Averages

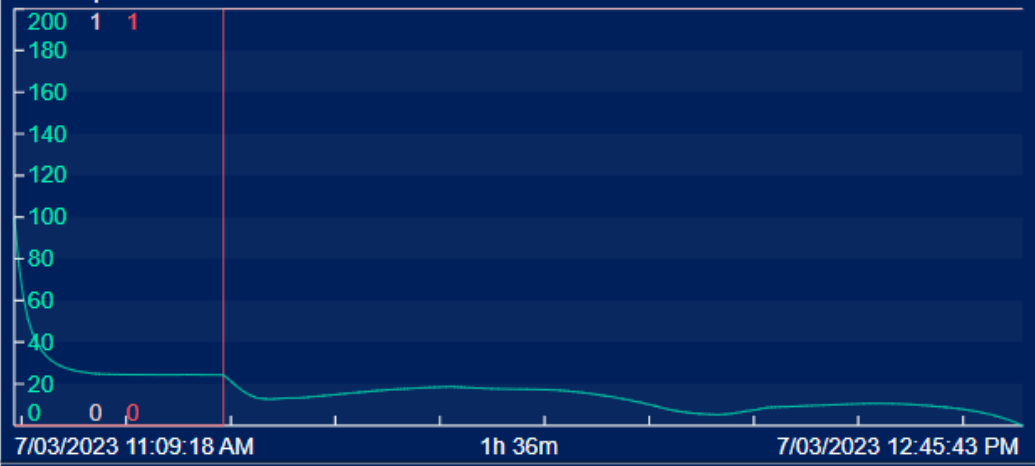
Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7
AvgStopInitiate3mo 6.00 s 4/10/2023 12:00:00 AM	AvgStopInitiate3mo Calc Failed s 22/09/2023 12:00:00 AM	AvgStopInitiate3mo 6.00 s 4/10/2023 12:00:00 AM	AvgStopInitiate3mo 26.90 s 4/10/2023 12:00:00 AM	AvgStopInitiate3mo 6.00 s 4/10/2023 12:00:00 AM	AvgStopInitiate3mo 8.25 s 4/10/2023 12:00:00 AM	AvgStopInitiate3mo 4.98 s 4/10/2023 12:00:00 AM
AvgRampDown3mo 287.21 s 4/10/2023 12:00:00 AM	AvgRampDown3mo 173.42 s 4/10/2023 12:00:00 AM	AvgRampDown3mo 307.26 s 4/10/2023 12:00:00 AM	AvgRampDown3mo 196.48 s 4/10/2023 12:00:00 AM	AvgRampDown3mo 261.73 s 4/10/2023 12:00:00 AM	AvgRampDown3mo 451.91 s 4/10/2023 12:00:00 AM	AvgRampDown3mo 519.52 s 4/10/2023 12:00:00 AM
AvgBraking3mo 211.91 s 4/10/2023 12:00:00 AM	AvgBraking3mo 172.69 s 4/10/2023 12:00:00 AM	AvgBraking3mo 207.16 s 4/10/2023 12:00:00 AM	AvgBraking3mo 167.94 s 4/10/2023 12:00:00 AM	AvgBraking3mo 196.75 s 4/10/2023 12:00:00 AM	AvgBraking3mo 206.88 s 4/10/2023 12:00:00 AM	AvgBraking3mo 256.48 s 4/10/2023 12:00:00 AM

Values of Selected Stop

MAN_02

Stop Initiate Duration	Ramp Down Duration	Braking Duration	Total Stop Duration	Tailwater Level	Net Head
7.15 s	1,199.1 s	4,586.01 s	5,785.1 s	3.7715 m	No Data m
7/03/2023 12:45:43 PM	7/03/2023 12:45:43 PM	7/03/2023 12:45:43 PM	7/03/2023 12:45:43 PM	7/03/2023 12:45:43 PM	7/03/2023 12:45:43 PM

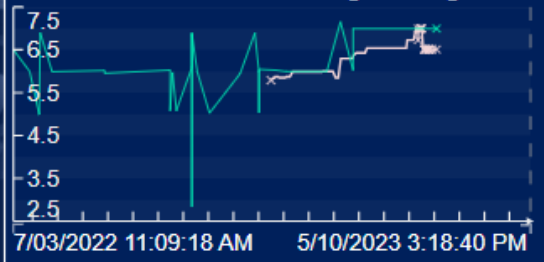
Unit Speed at Time of Event



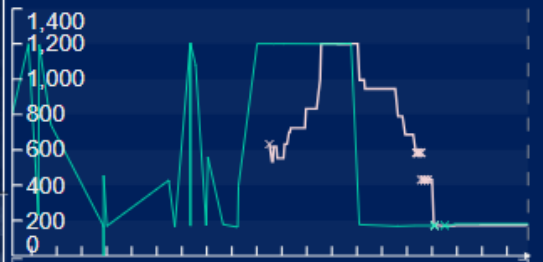
Unit Speed
0 %
Stopping Status
1
Braking Status
1

Event Name	Start Time	End Time	Duration
3:18.088	21/03/2023 1:33:18 pm	21/03/2023 1:57:06 pm	23m 48s
Stop Event 2023-03-07 11:0 9:18.042	7/03/2023 11:09:18 am	7/03/2023 12:45:43 pm	1h 36m
Stop Event 2023-02-20 05:0 6:58.193	20/02/2023 5:06:58 am	20/02/2023 5:50:38 am	43m 40s
Stop Event 2023-01-05 18:2 2:51.280	5/01/2023 6:22:51 pm	5/01/2023 6:53:09 pm	30m 17s

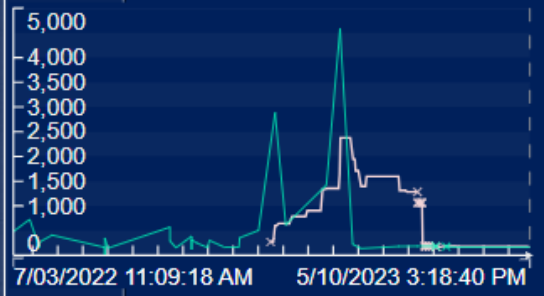
12-Month Trends of Rolling Averages



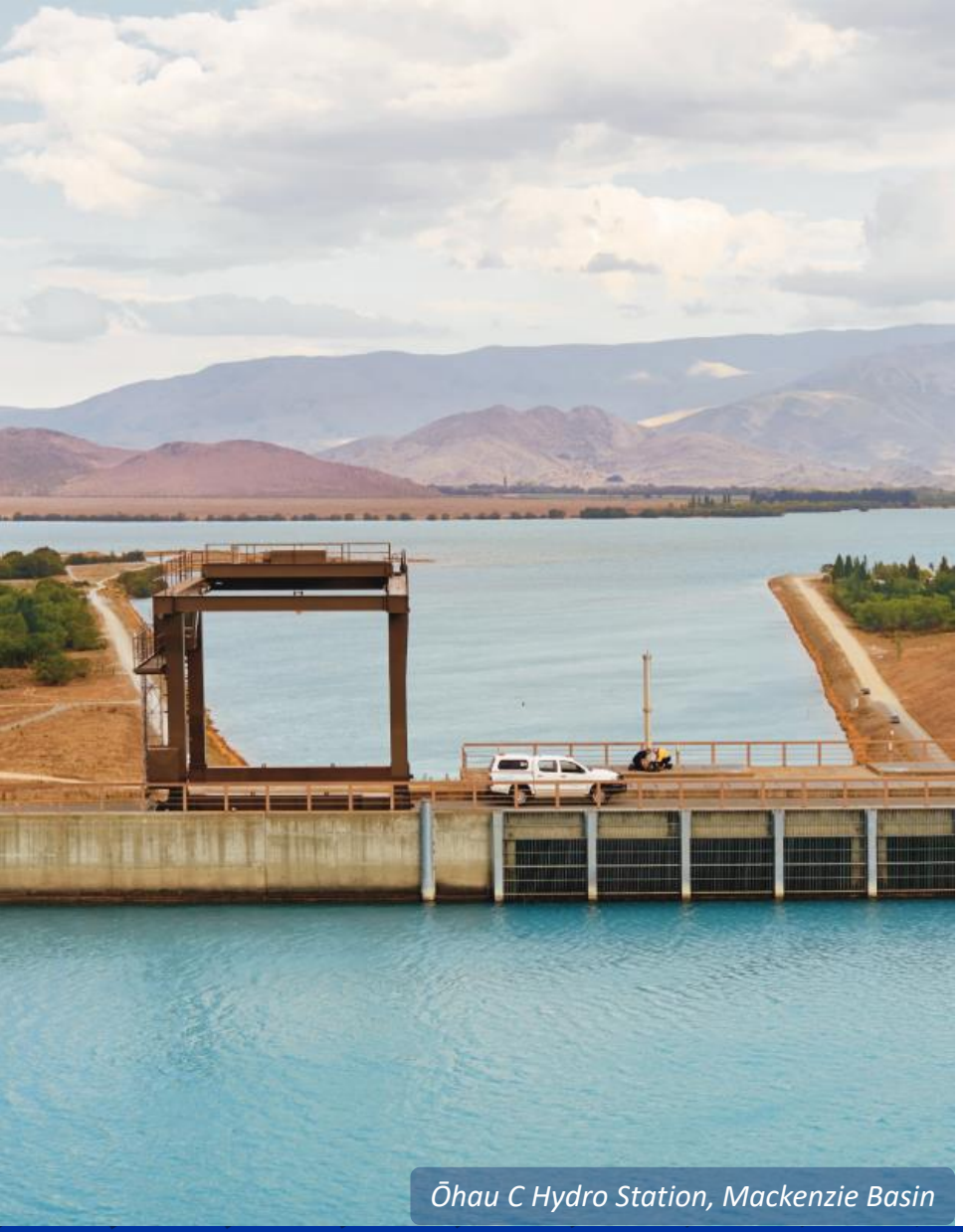
Stop Initiate Duration
Shutdown s
AvgStopInitiate3mo
Calc Failed s



Ramp Down Duration
181.14 s
AvgRampDown3mo
174.1 s



Braking Duration
166.02 s
AvgBraking3mo
170.03 s



Ōhau C Hydro Station, Mackenzie Basin

Use Cases

Hydro Unit Stopping Sequence Analysis

Hydro Unit Fatigue Monitoring

Hydro Unit Fatigue Monitoring

Problem

- Meridian Energy has no indication of unit fatigue correlating to raw, real-time data
- Lack of visibility into hydro operating metrics
- Insufficient data to drive condition-based maintenance decisions

Benmore Hydro Station, Waitaki Valley

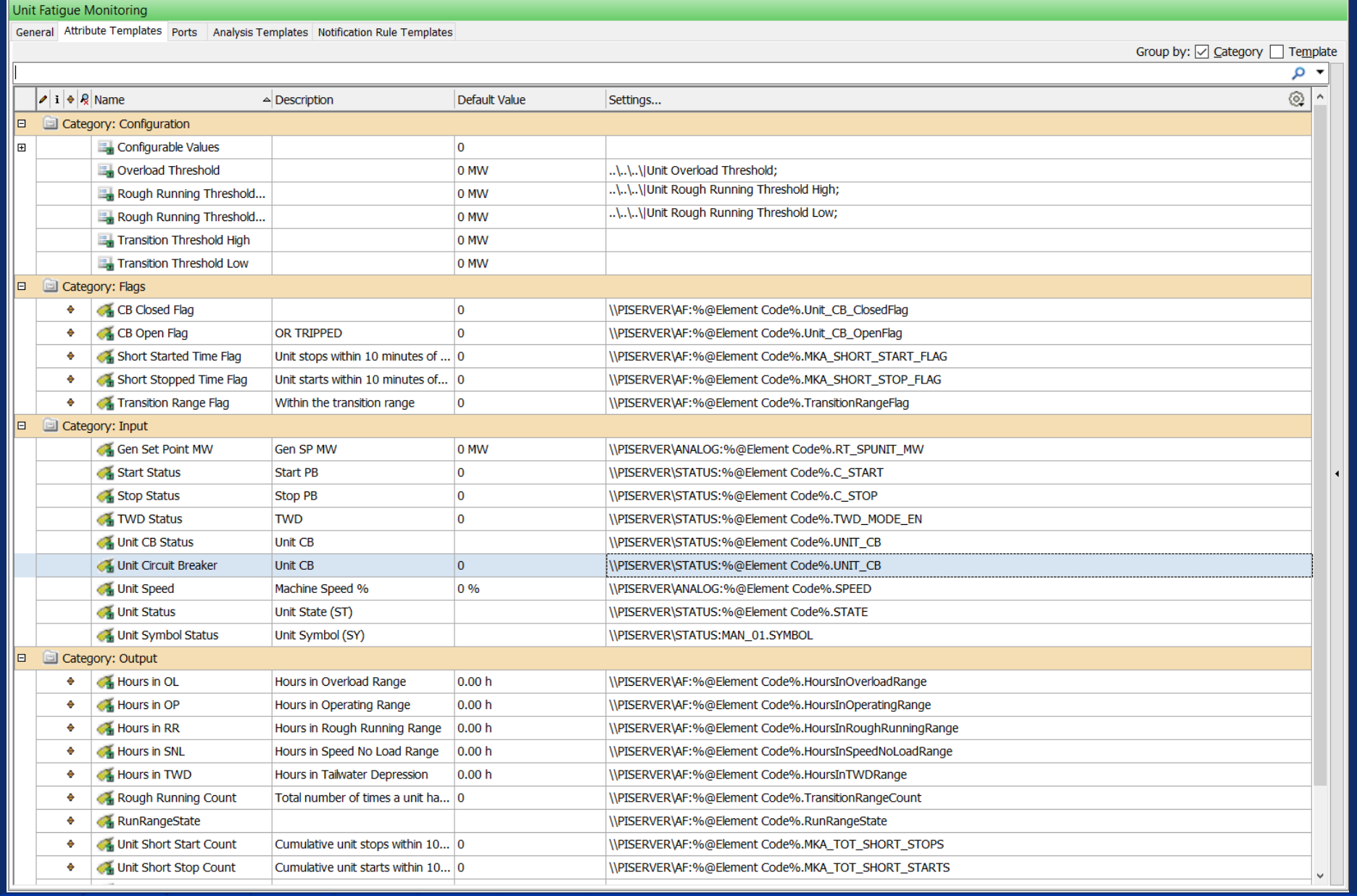
Hydro Unit Fatigue Monitoring

Approach

- Use time-series data from AVEVA's PI system with PI Asset Framework and PI Vision

- Perform expression analysis to gain insights into operating metrics such as:
  - Unit starts/stops
  - Tailwater Depression (TWD) operations
  - Station loading
  - Time within various generation ranges

Benmore Hydro Station, Waitaki Valley

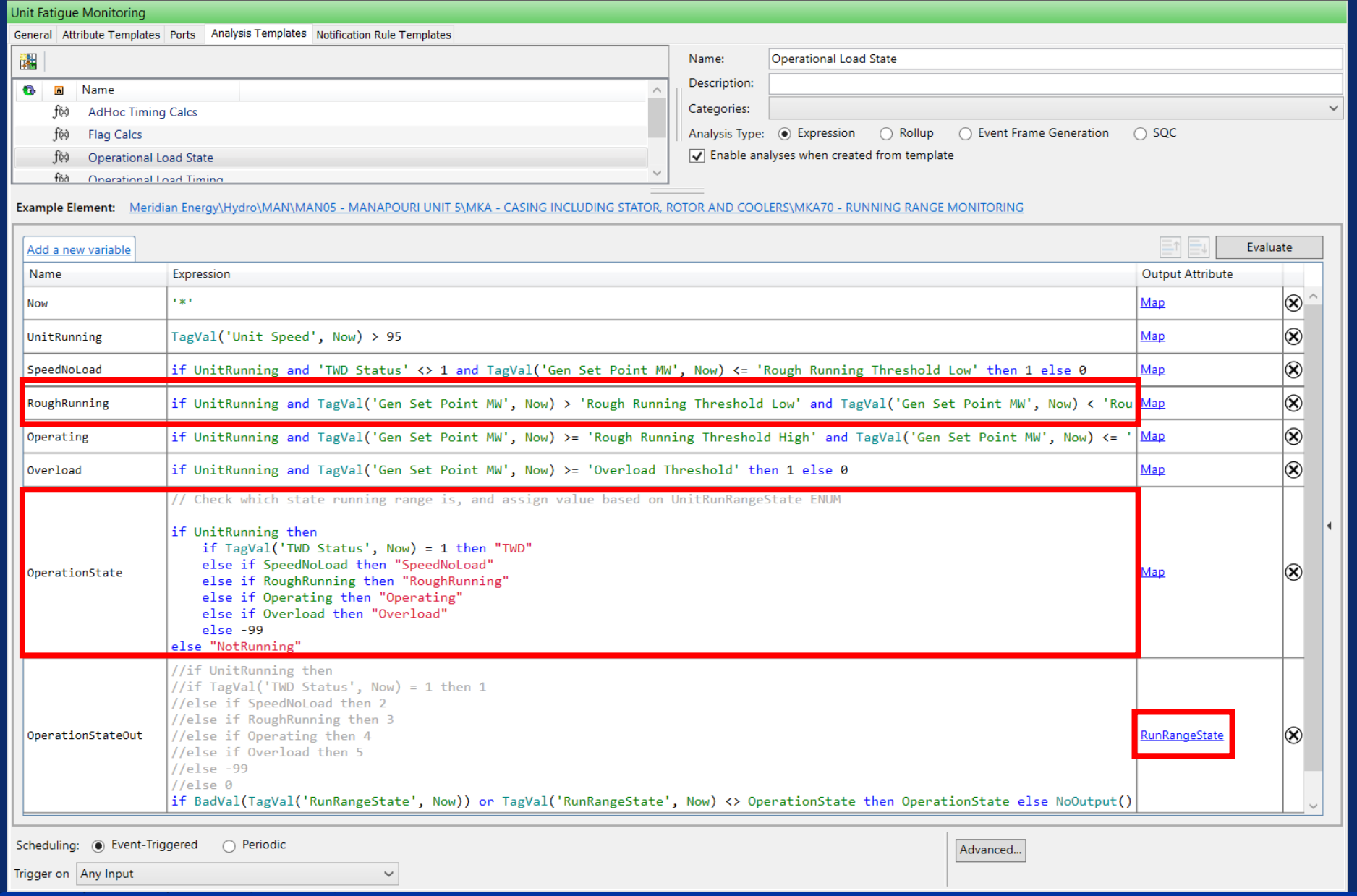


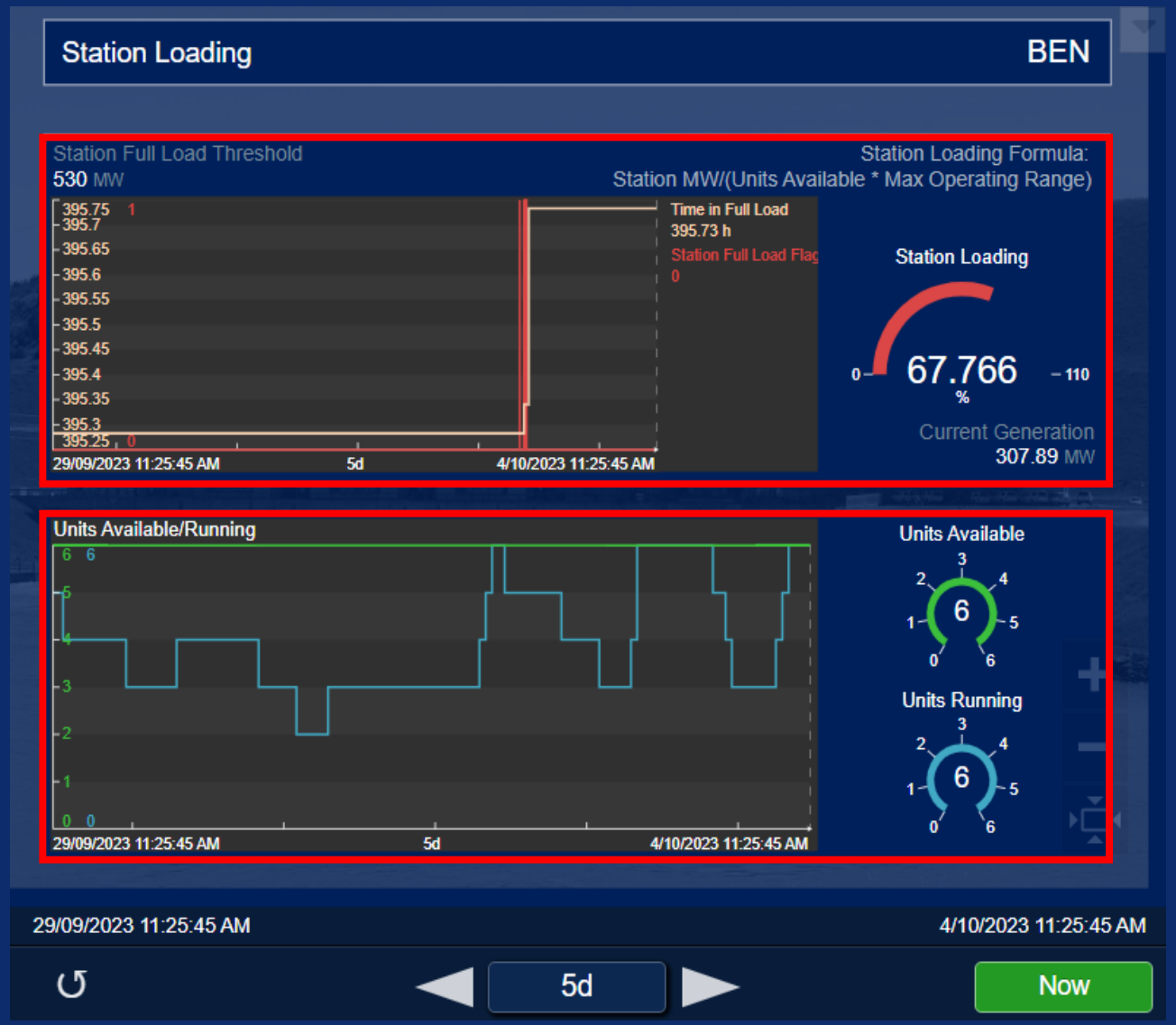
Unit Fatigue Monitoring

General | Attribute Templates | Ports | Analysis Templates | Notification Rule Templates

Group by: Category Template

Name	Description	Default Value	Settings...
Category: Configuration			
Configurable Values		0	
Overload Threshold		0 MW	..\..\..|Unit Overload Threshold;
Rough Running Threshold...		0 MW	..\..\..|Unit Rough Running Threshold High;
Rough Running Threshold...		0 MW	..\..\..|Unit Rough Running Threshold Low;
Transition Threshold High		0 MW	
Transition Threshold Low		0 MW	
Category: Flags			
CB Closed Flag		0	\\PISERVER\AF:%@Element Code%.Unit_CB_ClosedFlag
CB Open Flag	OR TRIPPED	0	\\PISERVER\AF:%@Element Code%.Unit_CB_OpenFlag
Short Started Time Flag	Unit stops within 10 minutes of ...	0	\\PISERVER\AF:%@Element Code%.MKA_SHORT_START_FLAG
Short Stopped Time Flag	Unit starts within 10 minutes of...	0	\\PISERVER\AF:%@Element Code%.MKA_SHORT_STOP_FLAG
Transition Range Flag	Within the transition range	0	\\PISERVER\AF:%@Element Code%.TransitionRangeFlag
Category: Input			
Gen Set Point MW	Gen SP MW	0 MW	\\PISERVER\ANALOG:%@Element Code%.RT_SPUNIT_MW
Start Status	Start PB	0	\\PISERVER\STATUS:%@Element Code%.C_START
Stop Status	Stop PB	0	\\PISERVER\STATUS:%@Element Code%.C_STOP
TWD Status	TWD	0	\\PISERVER\STATUS:%@Element Code%.TWD_MODE_EN
Unit CB Status	Unit CB		\\PISERVER\STATUS:%@Element Code%.UNIT_CB
Unit Circuit Breaker	Unit CB	0	\\PISERVER\STATUS:%@Element Code%.UNIT_CB
Unit Speed	Machine Speed %	0 %	\\PISERVER\ANALOG:%@Element Code%.SPEED
Unit Status	Unit State (ST)		\\PISERVER\STATUS:%@Element Code%.STATE
Unit Symbol Status	Unit Symbol (SY)		\\PISERVER\STATUS:MAN_01.SYMBOL
Category: Output			
Hours in OL	Hours in Overload Range	0.00 h	\\PISERVER\AF:%@Element Code%.HoursInOverloadRange
Hours in OP	Hours in Operating Range	0.00 h	\\PISERVER\AF:%@Element Code%.HoursInOperatingRange
Hours in RR	Hours in Rough Running Range	0.00 h	\\PISERVER\AF:%@Element Code%.HoursInRoughRunningRange
Hours in SNL	Hours in Speed No Load Range	0.00 h	\\PISERVER\AF:%@Element Code%.HoursInSpeedNoLoadRange
Hours in TWD	Hours in Tailwater Depression	0.00 h	\\PISERVER\AF:%@Element Code%.HoursInTWDRange
Rough Running Count	Total number of times a unit ha...	0	\\PISERVER\AF:%@Element Code%.TransitionRangeCount
RunRangeState			\\PISERVER\AF:%@Element Code%.RunRangeState
Unit Short Start Count	Cumulative unit stops within 10...	0	\\PISERVER\AF:%@Element Code%.MKA_TOT_SHORT_STOPS
Unit Short Stop Count	Cumulative unit starts within 10...	0	\\PISERVER\AF:%@Element Code%.MKA_TOT_SHORT_STARTS


Unit Fatigue Monitoring
General
Attribute Templates
Ports
Analysis Templates
Notification Rule Templates
Name
AdHoc Timing Calcs
Flag Calcs
Operational Load State
Name: Operational Load State
Description:
Categories:
Analysis Type: Expression Rollup Event Frame Generation SQC
Enable analyses when created from template
Example Element: Meridian Energy\Hydro\MAN\MAN05 - MANAPOURI UNIT 5\MKA - CASING INCLUDING STATOR, ROTOR AND COOLERS\MKA70 - RUNNING RANGE MONITORING
Add a new variable
Evaluate
Name
Expression
Output Attribute
Now
'*'
Map
UnitRunning
TagVal('Unit Speed', Now) > 95
Map
SpeedNoLoad
if UnitRunning and 'TWD Status' <> 1 and TagVal('Gen Set Point MW', Now) <= 'Rough Running Threshold Low' then 1 else 0
Map
RoughRunning
if UnitRunning and TagVal('Gen Set Point MW', Now) > 'Rough Running Threshold Low' and TagVal('Gen Set Point MW', Now) < 'Rou
Map
Operating
if UnitRunning and TagVal('Gen Set Point MW', Now) >= 'Rough Running Threshold High' and TagVal('Gen Set Point MW', Now) <= '
Map
Overload
if UnitRunning and TagVal('Gen Set Point MW', Now) >= 'Overload Threshold' then 1 else 0
Map
OperationState
// Check which state running range is, and assign value based on UnitRunRangeState ENUM
if UnitRunning then
if TagVal('TWD Status', Now) = 1 then "TWD"
else if SpeedNoLoad then "SpeedNoLoad"
else if RoughRunning then "RoughRunning"
else if Operating then "Operating"
else if Overload then "Overload"
else -99
else "NotRunning"
Map
OperationStateOut
//if UnitRunning then
//if TagVal('TWD Status', Now) = 1 then 1
//else if SpeedNoLoad then 2
//else if RoughRunning then 3
//else if Operating then 4
//else if Overload then 5
//else -99
//else 0
if BadVal(TagVal('RunRangeState', Now)) or TagVal('RunRangeState', Now) <> OperationState then OperationState else NoOutput()
RunRangeState
Scheduling: Event-Triggered Periodic
Trigger on Any Input
Advanced...


Station Loading
BEN
Station Full Load Threshold
530 MW
Station Loading Formula:
Station MW/(Units Available * Max Operating Range)
395.75
395.7
395.65
395.6
395.55
395.5
395.45
395.4
395.35
395.3
395.25
Time in Full Load
395.73 h
Station Full Load Flag
0
29/09/2023 11:25:45 AM
5d
4/10/2023 11:25:45 AM
Station Loading
0
67.766
%
110
Current Generation
307.89 MW
Units Available/Running
6
5
4
3
2
1
0
29/09/2023 11:25:45 AM
5d
4/10/2023 11:25:45 AM
Units Available
Units Running
29/09/2023 11:25:45 AM
4/10/2023 11:25:45 AM
5d
Now


Running Range State Timings
BEN - BENMORE POWER STATION
Start Time
1/03/2023 12:00:00 AM
End Time
24/08/2023 12:00:00 AM
BEN01 - BENMORE UNIT 1
Hours Not Running
1,116.26 h
Hours in TWD
408.36 h
Hours in Speed No Load
13.55 h
Hours in Rough Running
9.06 h
Hours in Operating
2,635.76 h
Hours in Overload
38.10 h
BEN_02 - BENMORE UNIT 2
Hours Not Running
2,892.99 h
Hours in TWD
202.51 h
Hours in Speed No Load
16.76 h
Hours in Rough Running
3.57 h
Hours in Operating
1,106.11 h
Hours in Overload
1.50 h
BEN_03 - BENMORE UNIT 3
Hours Not Running
569.84 h
Hours in TWD
182.07 h
Hours in Speed No Load
9.40 h
Hours in Rough Running
4.95 h
Hours in Operating
3,380.91 h
Hours in Overload
74.43 h
BEN_04 - BENMORE UNIT 4
Hours Not Running
476.68 h
Hours in TWD
46.72 h
Hours in Speed No Load
10.94 h
Hours in Rough Running
5.29 h
Hours in Operating
3,603.93 h
Hours in Overload
79.64 h
BEN_05 - BENMORE UNIT 5
Hours Not Running
39.08 h
Hours in TWD
259.71 h
Hours in Speed No Load
8.25 h
Hours in Rough Running
4.33 h
Hours in Operating
3,850.89 h
Hours in Overload
60.82 h
BEN_06 - BENMORE UNIT 6
Hours Not Running
1,319.62 h
Hours in TWD
593.54 h
Hours in Speed No Load
19.10 h
Hours in Rough Running
9.39 h
Hours in Operating
2,203.81 h
Hours in Overload
75.64 h

Future Work Examples

- Overload Analysis
  - Revenue
  - Maintenance frequency
- Operational Vibration Analysis
  - Monitoring and Alarming
- Component condition heat map
  - Simple colour-coded condition visual
  - Single metric to describe unit fatigue
  - Similar degradation rates


West Wind, Mākara

Results and Benefits

Hydro unit stopping sequence analysis

- Provided data points and visuals of all prior stopping sequences to provide insights into component-level conditions
- Created trends of unit stopping times to monitor degradation of generating asset components over time

Hydro unit fatigue monitoring

- Highlights the way we operate our generating assets
- Provides foundation for future, complex analytics


West Wind, Mākara

Results and Benefits

AVEVA's PI System

- Provided foundation to build up a hierarchy of virtual assets increasing accessibility to critical plant information

PI Asset Framework

- Contextualise and format data for various business units
- Monitor events using start and end triggers whilst capturing relevant data
- Notify the right people at the right time when the plants are performing unexpectedly

PI Vision

- Integrate analytical data into graphs and displays to show only what is required

Meridian Energy has reduced the need for plant outages to perform analytics by increasing asset transparency with AVEVA's PI System

Challenge

- Lack of visibility into our generating assets
- Requiring plant outages and routine maintenance to investigate the degradation of our generating assets
- outage flexibility becoming less frequent due to constraints from market demand

Solution

- Integration of AVEVA's PI System, PI Asset Framework, and PI Vision to collect, analyse, and contextualise critical metrics within our generating assets

Results

- Created processes to collect and contextualise information and deliver it to various business units in relevant formats
- Developed a centralised platform to present data at different depths to accommodate all levels of interest

Ōhau A Hydro Station, Mackenzie Basin

Looking Ahead

Building more foundational models and expanding on these with more complex analytics

Integrate bi-directional channel between PI System and work management system

Manage alarms and notifications through Asset Framework

Integrate PI Web API into our pipeline

Waitaki Power Station, Lake Waitaki

Te Āpiti wind farm, Manawatū

Questions?

Please wait for the microphone.

State your name and company.

Please remember to…

Navigate to this session in the mobile app to complete the survey.

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