Functional Design Specification for Advanced Process Controller APC-J144_LIC_005C

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Executive Summary

This document is the Functional Design Specification (FDS) for the Advanced Process Controller (APC) that is being implemented. The document is structured into the following six sections:

Section 1 is a process background and description the process whereby the APC controller will be implemented. Based on the S88 standard, the process descriptions are covered.Also included are the stability and efficiency measures on the each unit which drive APC systems to align with Anglo American strategy.

Section 2 is an explanation of the basic control philosophy of the process unit.

Section 3 is a detailed explanation of the APC controller, including descriptions of the control, manipulated and disturbance variables as well as the controller objectives and key performance indicators (KPI's). This section also describes the logic for the detection of the four types of plant process state alarms which are; critical, high, low and default.

Section 4 (optional) is a description of the control technologies that will be used in the implementation of the APC controller. The control technologies are Fuzzy Control and Model Predictive Control (MPC).

Section 5 (optional) is a list of the heartbeats.

Section 6 (optional) is a list of all the tags that will be used in the implementation of the DMS Feed process unit APC controller.

Addendums (optional) is the final section of the document which is an explanation of the basic principles of operations for Process States, Fuzzy Control, Model Based Control and finally Model Predictive Control.

1) Process Background And Description

1.1) SIS-JIG (Site)

1.1.1) Background

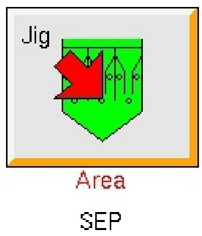


Fig 1: The members of the SIS-JIG Site - Highlighting the Jig-Area - SEP

1.2) SEP (Jig-Area)

1.2.1) Background

The jig plant at Sishen Iron Ore Mine consists of a primary, secondary and tertiary crushing circuit crushing the feed material to a -25 mm top size and longitudinally stacking it on two ROM (run of mine) feed beds. The ROM feed bed material is reclaimed by a bucket reclaimer and conveyed to eight feed bunkers.

After beneficiation the lumpy ore (-25 mm +8 mm) is conveyed and stacked on the blending beds while the fine material (-8 mm +1 mm) is conveyed to the dewatering bunkers and then stacked on the fine blending beds. The jig plant consist of eight modules with three jigs each, the coarse jig (-25 mm +8 mm), medium jig (-8 mm +3 mm) and fine jig (-3 mm +1 mm).

Jigging is a process of particle stratification in which the particle rearrangement results from an alternate expansion and compaction of a bed of particles by a pulsating fluid flow. The rearrangement results in layers of particles that are arranged by increasing density from top to bottom of the jig bed. The particles, in addition to the vertically expanded and compacted bed motion, move continuously and horizontally across the supporting jig screen helped by the feed material that is introduced at one end. The feed rate influences the retention time of the material in the jig and thus the number of pulses the material will receive. Following the particle stratification, the particle bed is physically cut at a desired horizontal particle density plane to separate the desired product from the less dense gangue material.

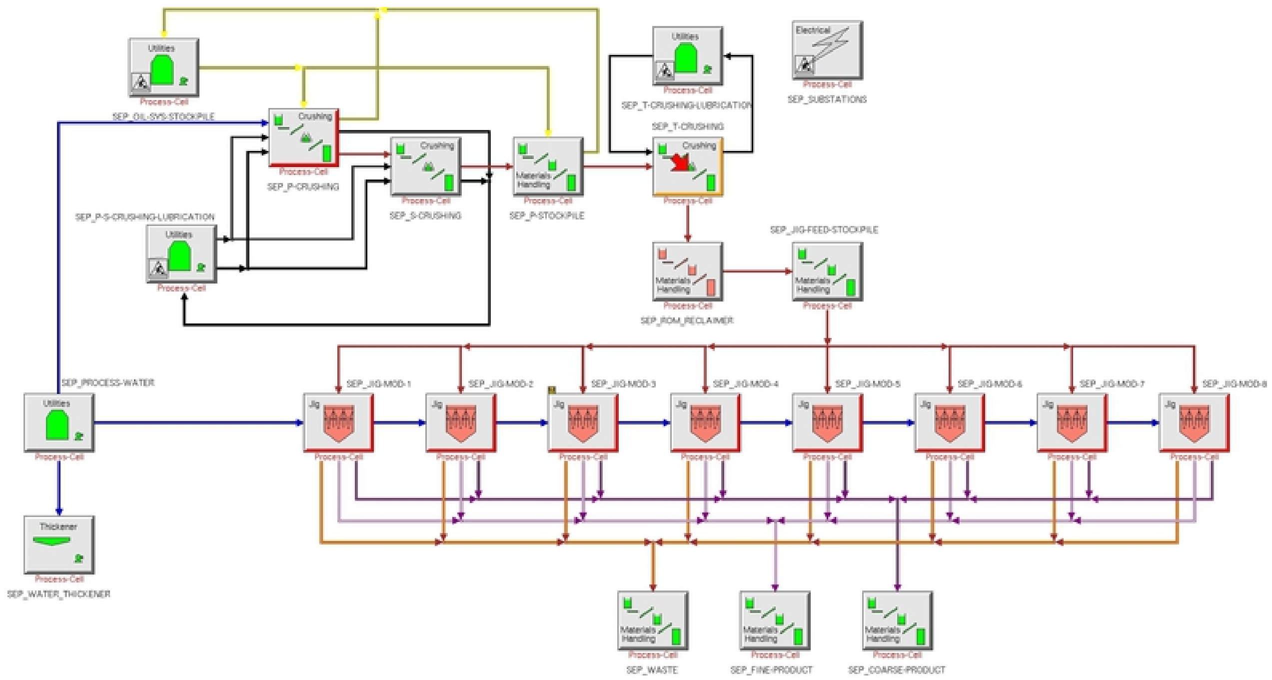


Fig 2: The members of the SEP Jig-Area - Highlighting the Crushing-Process-Cell - T-CRUSHING

1.3) T-CRUSHING (Crushing-Process-Cell)

1.3.1) Background

The tertiary crusher stage is fed from the primary stockpile, which contains the primary and secondary crusher product. The tertiary crushing plant consists of four tertiary cone crushers, each of which are fed at a controlled rate through a feed bin, two feeders per crusher. The tertiary crushing plant is in closed circuit and produces a -25mm which is conveyed to one of two pre-blending beds, these beds are fed to the beneficiation process (jigging).

1.3.2) Purpose

1.3.3) Theory

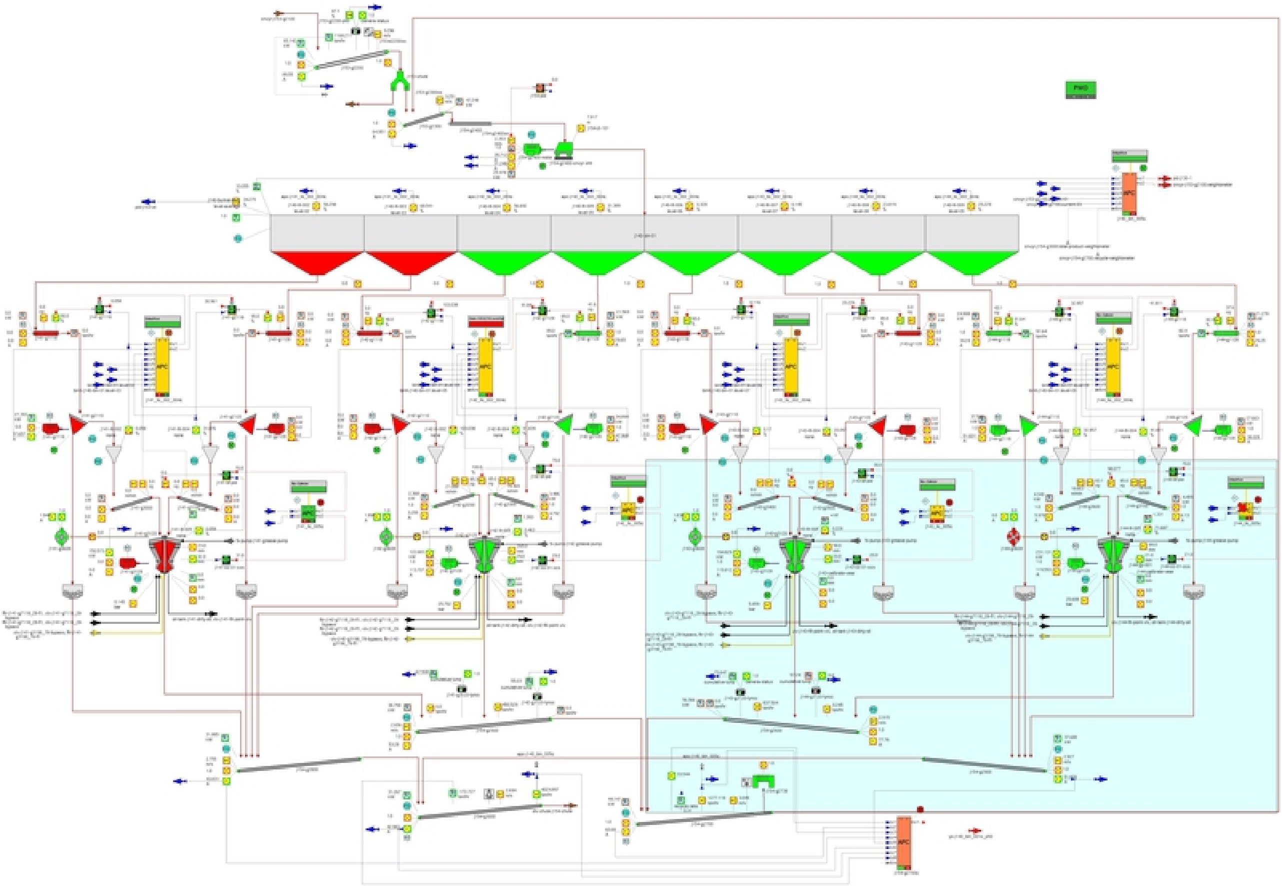


Fig 3: The members of the T-CRUSHER-PRODUCT unit which is a member of T-CRUSHING Crushing-Process-Cell - Highlighting J144_LIC_005C

1.4) T-CRUSHER-PRODUCT (Unit)

1.4.1) Background

The crusher product will be recycled back to the tertiary crusher feed bin where it will go through the screens and separated into +25mm and -25mm streams.

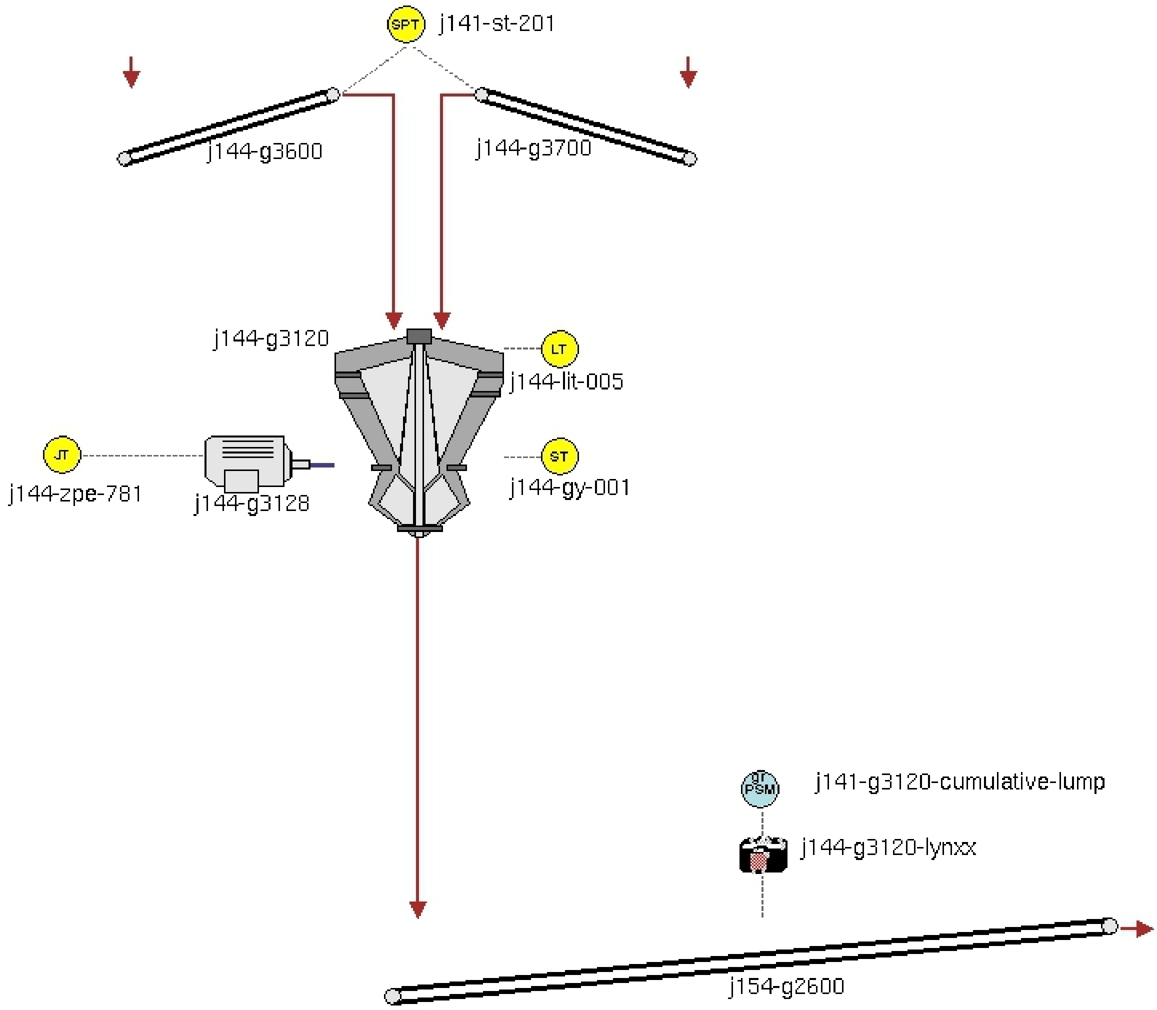


Fig 4: Relevant Circuit Schematic

1.4.2) Measures

2) Basic Control

2.1) Description

One base layer PID controller for the combined speed manipulation of the two conveyors (and J141-G3100) feeding the crusher (J141-G3120).
One logic controller manipulating the closed side setting (CSS) (J141-GY-001) of the crusher (J141-G3120).

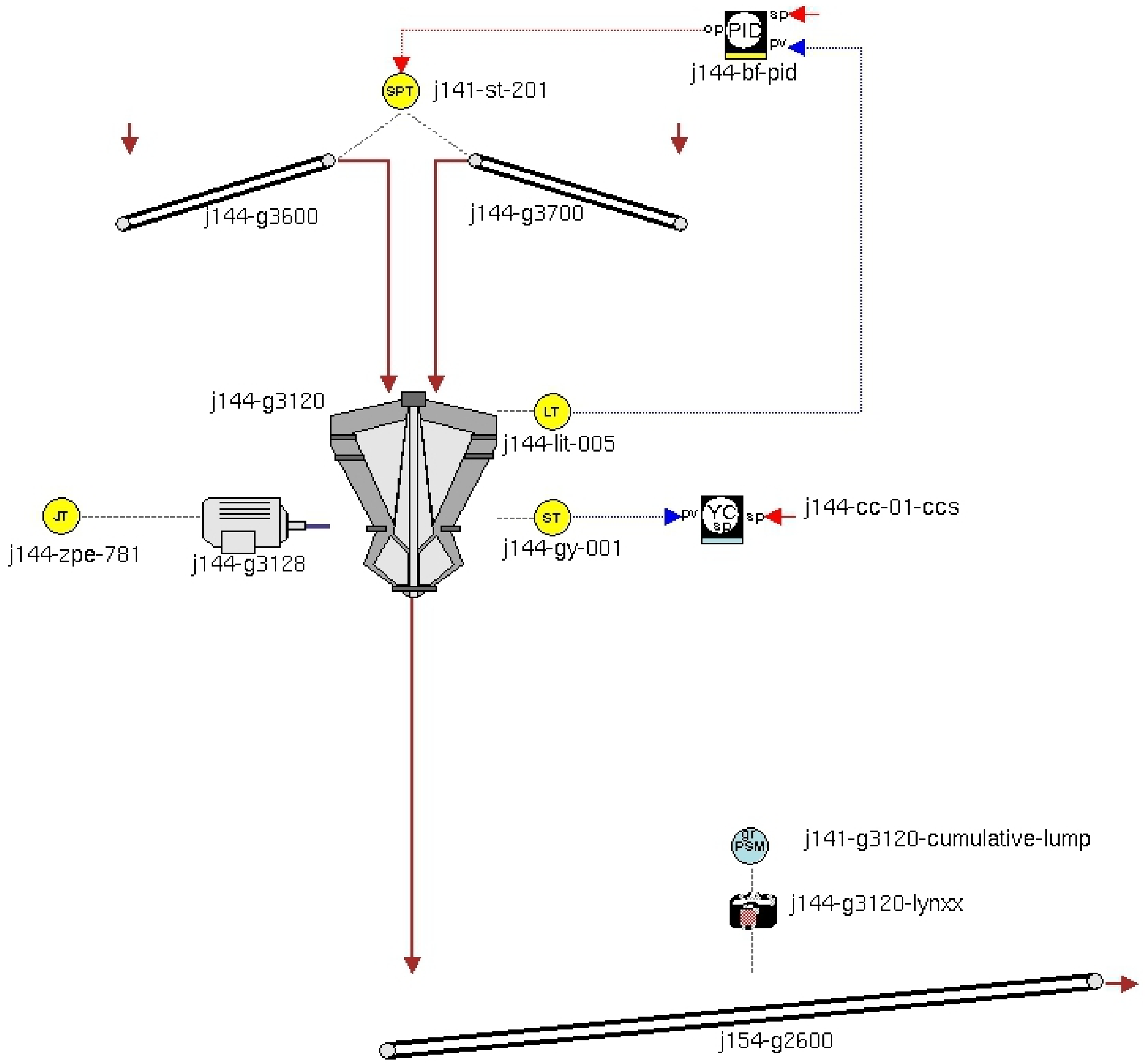


Fig 5: Circuit with Basic Control

2.2) PID Tuning Parameters

PID Tuning			
Controller ID	P	I	D
J144-BF-PID	0.26	88000.00	0.00

3) ADVANCED CONTROL

3.1) Description

The advanced control layer makes use of a fuzzy logic rule-based algorithm and model predictive controller that utilizes the tertiary crusher's cavity level (T-Crusher J144-G3120 Level PID-Controller J144-BF-PID), the tertiary crusher's closed-side setting (J144-GY-001) and potentially the tertiary crusher feeder speed (J141-ST-201) to control the crusher's product cumulative lump fraction (J141-G3120-CUMULATIVE-LUMP), crusher power consumption (J144-ZPE-781) and the crusher cavity level (J144-LIT-005).
The objective of the advanced process controller (J144_LIC_005C) is to maximize product cumulative lump while observing constraints on crusher power.

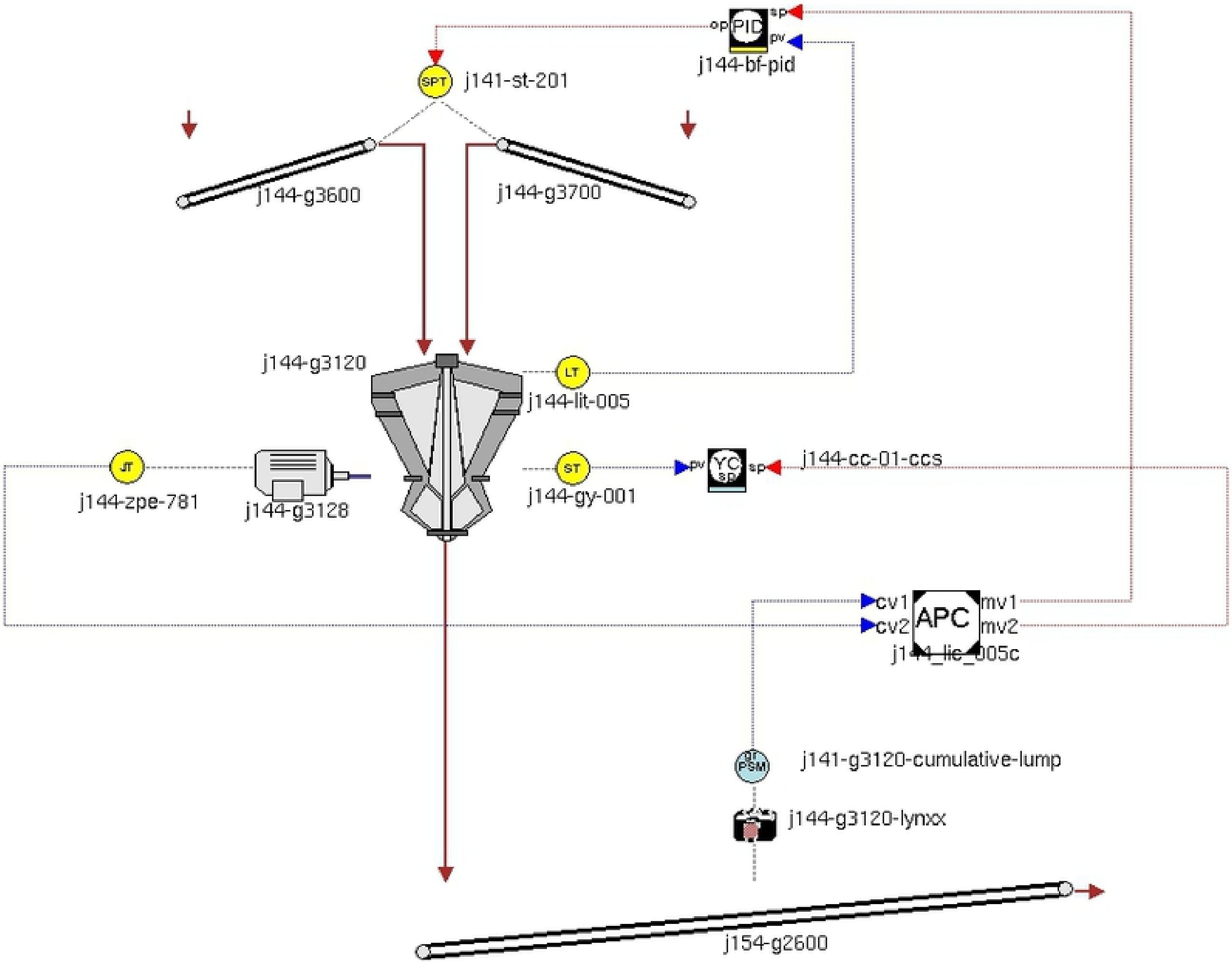


Fig 6: Circuit with Advanced Control

3.2) Controlled Variables

The first controlled variable is the tertiary crusher product p50 (J144-G3120-LYNXX). This p50 reading represents the size where 50% of particles would pass meassured by camera (J144-G3120-LYNXX).
In the event that the crusher product p50 reaches a high limit as entered on the SCADA faceplate:
1. The crushing rate of the tertiary crusher () must be increased be :
a. The tertiary crusher () closed side setting (T-Crusher J144-G3120 Css Logic-Controller-Sp-Only J144-CC-01-CCS) must be increased.
The inverse philosophy is also true when the p50 reaches a low limit.
The second controlled variable is the tertiary crusher motor power draw (J144-ZPE-781). The crusher motor power draw (J144-ZPE-781) is maintained above the low limit to ensure effective crushing and below the high limit to prevent motor trip. The tertiary crusher () closed side setting T-Crusher J144-G3120 Css Logic-Controller-Sp-Only J144-CC-01-CCS) is used to control this.
In the case where the motor power is too high, the tertiary crusher closed side setting (T-Crusher J144-G3120 Css Logic-Controller-Sp-Only J144-CC-01-CCS) will be increased by the controller. The reverse philosophy is used to

increase crusher motor power draw.
The third process variable is the crusher cavity level reading (). This level reading represents the current level of the tertiary crusher () cavity .
In the event that the cavity level reaches a high limit as entered on the SCADA faceplate:
The following actions will be taken:
1. The crusher closed-side setting will (T-Crusher J144-G3120 Css Logic-Controller-Sp-Only J144-CC-01-CCS) open:
a. Increasing the crusher gap will increase throughput through crusher and reduce cavity level.

The inverse philosophy is also true for increasing the crusher cavity.
Note - This is used as an override variable. CSS will only open when level is high and feeder cannot slow down constraining the system.

The following table lists the relevant controlled variables for this controller along with their engineering units and control limits. Note that these control limits can be adjusted from the SCADA faceplate

APC CVs for APC-J144_LIC_005C				
Description	ID	EU	Low	High
CV1:	J141-G3120-CUMULATIVE-LUMP	QUANTITY	40.00	80.00
CV2: T-Crusher-4 Motor J144-G3128 Power	J144-ZPE-781	kW	185.00	350.00

3.2.1) GED Encapsulator

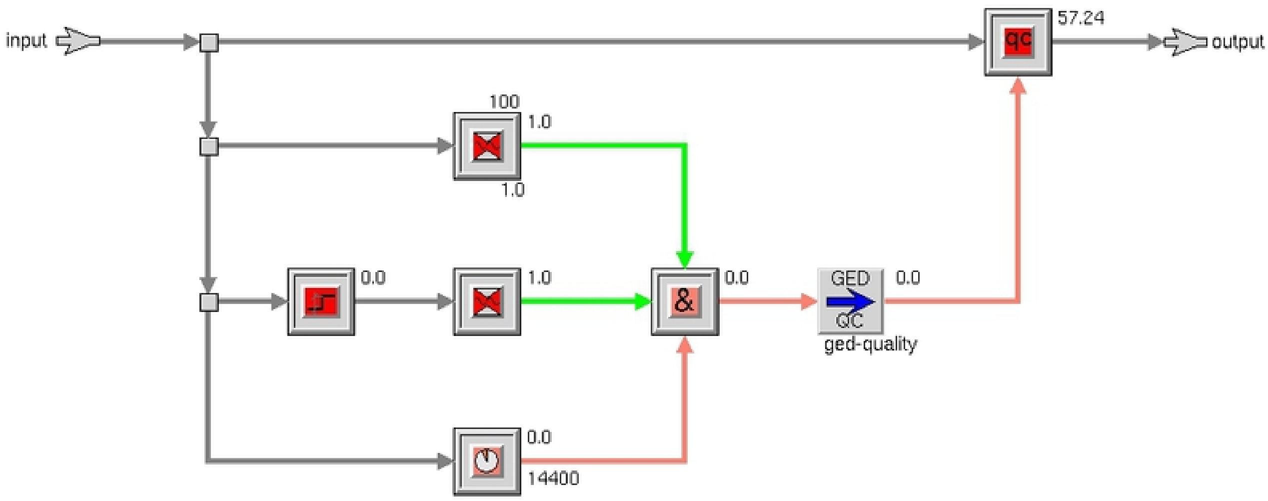


Fig 7: Subworkspace of GED Encapsulator (CAM-J144-G3120-LYNXX.CUMULATIVE-LUMP-02.GED) upon Cam-J144-G3120-Lynxx.cumulative-Lump-02

3.3) Manipulated Variables

The first controlled variable is the level controller (J144-BF-PID) setpoint which will write to the level PID (T-Crusher J144-G3120 Level PID-Controller J144-BF-PID) setpoint. This PID controller will manipulate the speed of the two conveyors (J144-G3600 and J144-G3700) feeding the tertiary crusher (J144-G3120).
The second controlled variable is the tertiary crusher (J144-G3120) CSS (J144-CC-01-CCS) setpoint which will write out to the CSS ratio controller (T-Crusher J144-G3120 Css Logic-Controller-Sp-Only J144-CC-01-CCS) setpoint. The CSS ratio controller will increase or decrease the CSS to increase the cumulative lump fraction produced by the tertiary crusher (J144-G3120) or to increase the through put through the tertiary crusher (J144-G3120).

The following table lists the relevant manipulated variables for this controller along with their engineering units and control limits. Note that these control limits can be adjusted from the SCADA faceplate

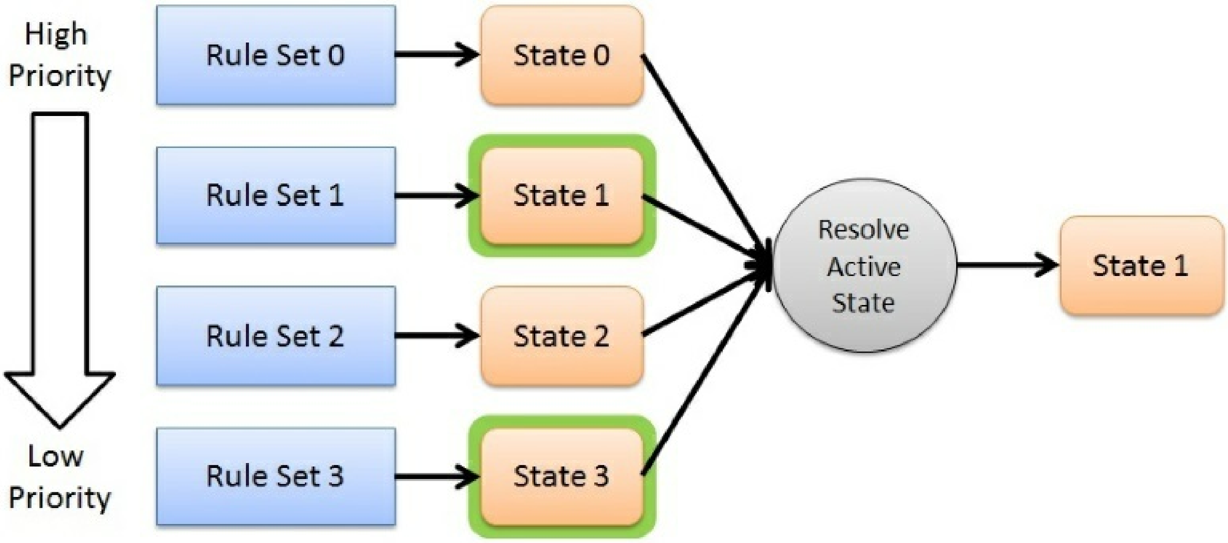
APC MVs for APC-J144_LIC_005C				
Description	ID	EU	Low	High
MV1: T-Crusher J144-G3120 Level PID-Controller J144-BF-PID	J144-BF-PID	%	30.00	70.00
MV2: T-Crusher J144-G3120 Css Logic-Controller-Sp-Only J144-CC-01-CCS	J144-CC-01-CCS	mm	16.00	35.00

3.4) Objectives and KPI's

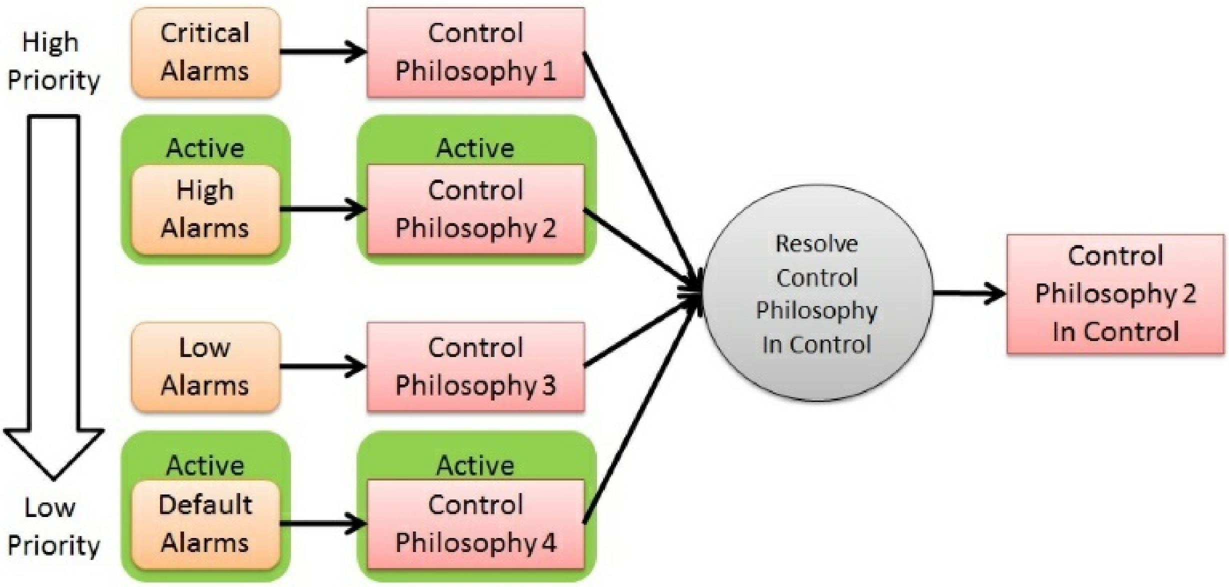
Objectives For Apc-J144_Lic_005c				
Measure	Goal	Owner	KPI	Weight

3.5) Process States

In APET, control philosophies are built around the state of the process. Different process conditions (broadly speaking) require different actions to be taken to achieve performance targets. In APET, process states are resolved through graphical rules and used in a hierarchical bidding system to determine the current process state. The governing state is then used in deciding which control scheme to implement.
These two steps are briefly described below.
1) Active State Resolution
Each state is determined by a set of rules. These are usually built up using graphical rules and may monitor any information available within the APET application. A state is considered active if all specified conditions are met. This means that it is possible the more than one state can be active at a time. To deal with this, states are ranked based on a priority, so that the active state with the highest priority becomes the in-control state.



Because it is also possible that no states are active, it is important to select a state that acts as the default state. The default state usually corresponds to the state with the lowest priority (default alarms).
2) Control Philosophy Resolution
Each state corresponds to a specific control philosophy that will be implemented. Once the active state has been determined, the corresponding control philosophy is activated.



There are always 4 controller states for every APC controller in APET. These controller states are grouped together

as follows:
1. Critical Alarms
2. High Alarms
3. Low Alarms
4. Default Alarms
Each of these 4 controller states may containing at least one referencing state. For example, the Default Alarms container will contain the MPC optimizer and default states amongst others.
Based on the referenced states of each controller state, the State Index of the controller state may be:
0 if it is not active
1 active but not in-control
2 active AND in-control
All of the attributes of the controller states are display on the SCADA faceplate.

3.5.1) CRITICAL-ALARMS

The following CRITICAL-ALARMS are defined:

3.5.1.1) Crusher-Constrained

This process state determines whether the tertiary crusher is constrained, if the crusher cavity level is high. This process state represents the discrete state of the controller. When this process state is 0 then the discrete is active and when it is 1 discrete is off (controller can take action).

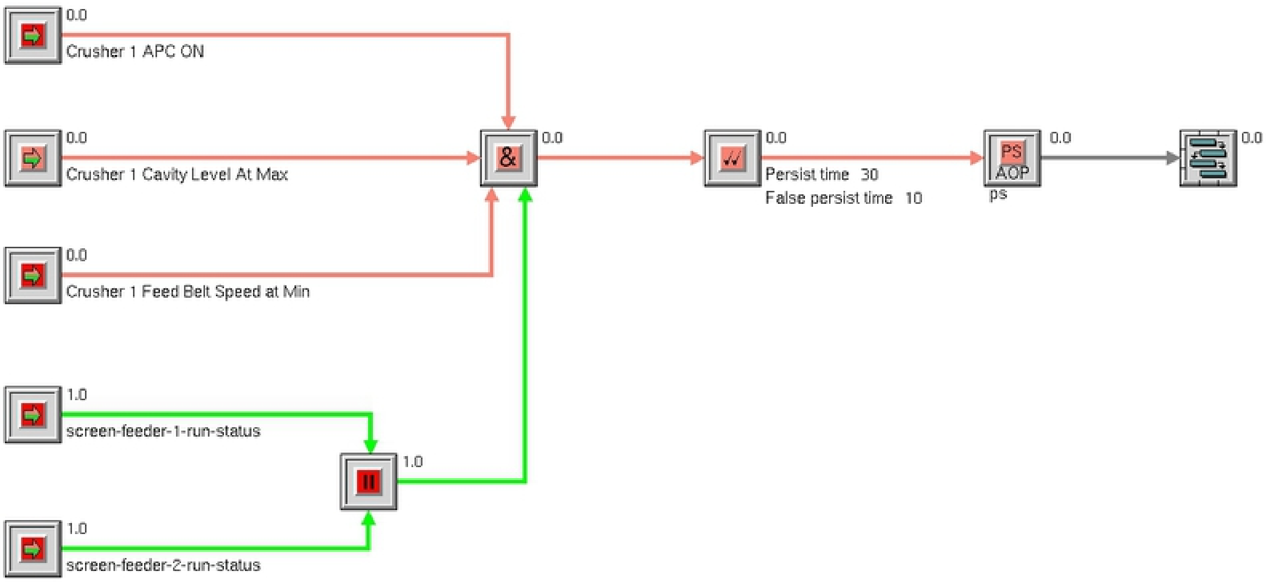


Fig 8: Determining Crusher-Constrained

3.5.2) HIGH-ALARMS

The following HIGH-ALARMS are defined:

3.5.2.1) Crusher-Stop

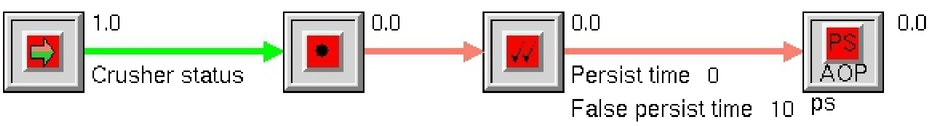


Fig 9: Determining Crusher-Stop

3.5.2.2) Conveyor-154-G2700-Constrained

This process state determines whether the tertiary crusher product conveyor (J154-G2700) current (J154-G2768) is constrained. This process state becomes true when the secondary crusher product conveyor current reaches a high limit as set on the SCADA face plate.
While this state is true the tertiary crusher closed side setting (J141-CC-01-CSS) must be decreased to reduce the current (J154-G2768) on the tertiary crusher product conveyor (J154-G2768).

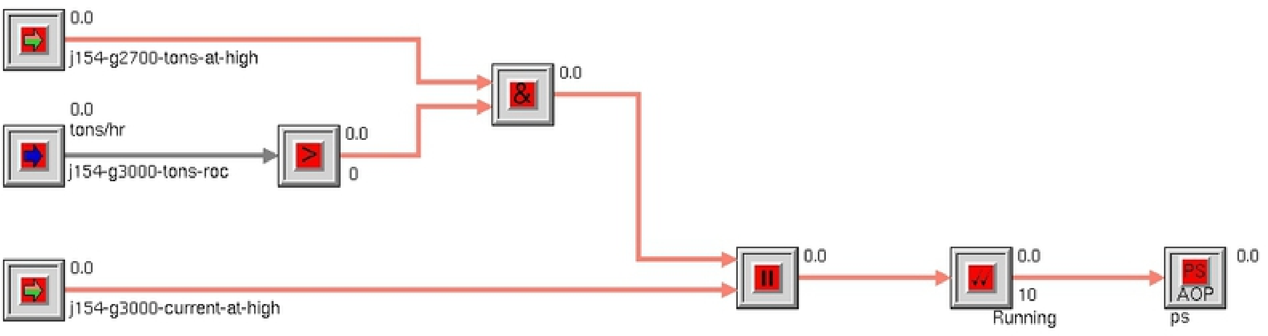


Fig 10: Determining Conveyor-154-G2700-Constrained

3.5.2.3) Conveyor-154-G2600-Constrained

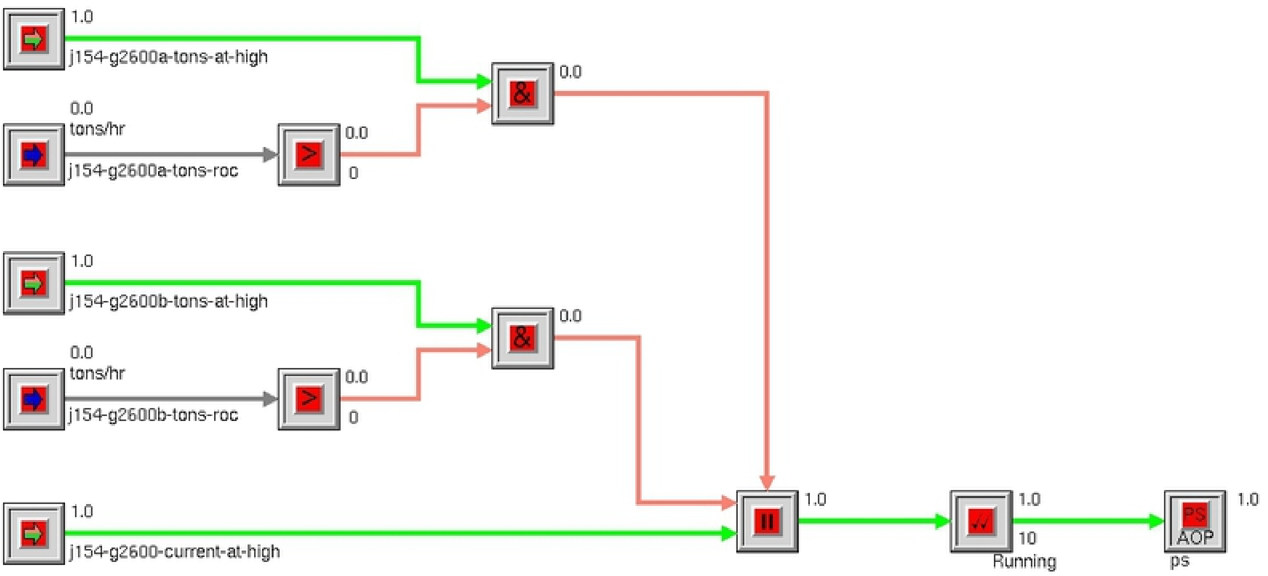


Fig 11: Determining Conveyor-154-G2600-Constrained

3.5.2.4) Cone-Crsh-J144-G3120.ps_Crusher-High-Power

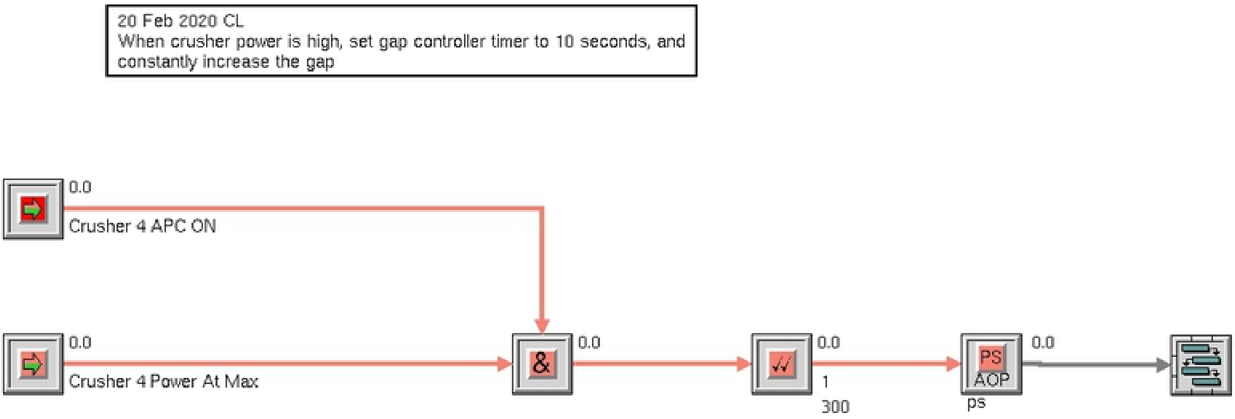


Fig 12: Determining Cone-Crsh-J144-G3120.ps_Crusher-High-Power

3.5.3) LOW-ALARMS

The following LOW-ALARMS are defined:

3.5.3.1) Css-Calibrate

When Tertiary Crusher 1 is calibrated, the CSS PV FB at metal-to-metal contact is captured as the off-set value and used as the new "Zero" and written to the CSS SP. This is done before the Crusher Feeder starts again and during the Crusher Calibration Sequence being executed. This off-set "zeroing" will ensure that when the crusher starts up, the current CSS SP FB will represent a true "Zero" (or closed) position.

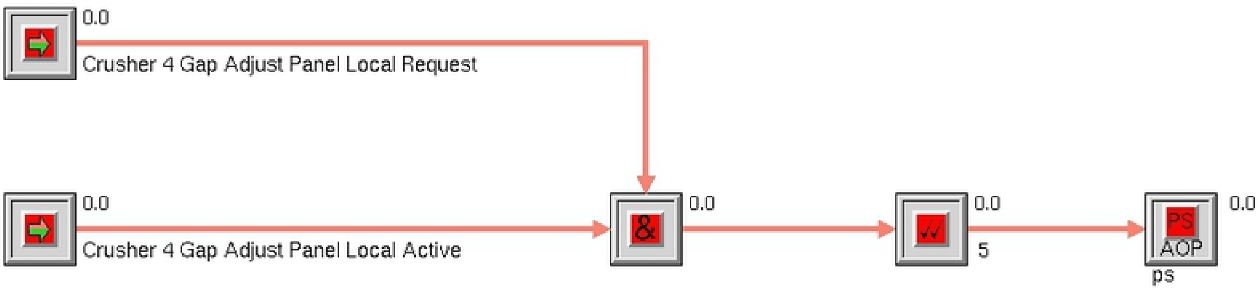


Fig 13: Determining Css-Calibrate

3.5.3.2) Css-Change-Imminent

This process state determines if a CSS SP change is expected soon by considering the time remaining until the next SP timer trigger and the current proposed SP change. While this state is true, reduce the feed bin high limit to ensure sufficent capacity during the CSS SP change that also introduces a temporary feeder stop.

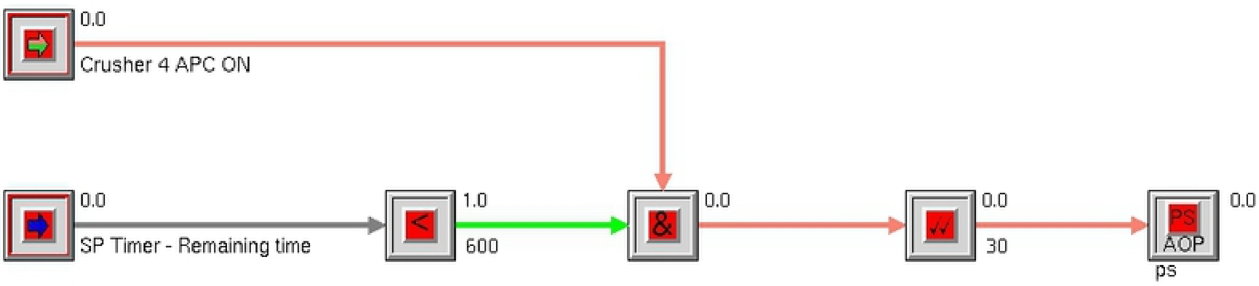


Fig 14: Determining Css-Change-Imminent

3.5.4) DEFAULT-ALARMS

The following DEFAULT-ALARMS are defined:

3.5.4.1) Mpc-Optimizer

Discrete logic ensuring that:
the operator request is ON;
the MPC controller is switched ON; and
the communications between the MPC and APET are OK (HB healty).
Note that the MPC optimizer state will be true (Active) if the logic above is true. The MPC optimizer will be In Control if none of the higher priority states are true.

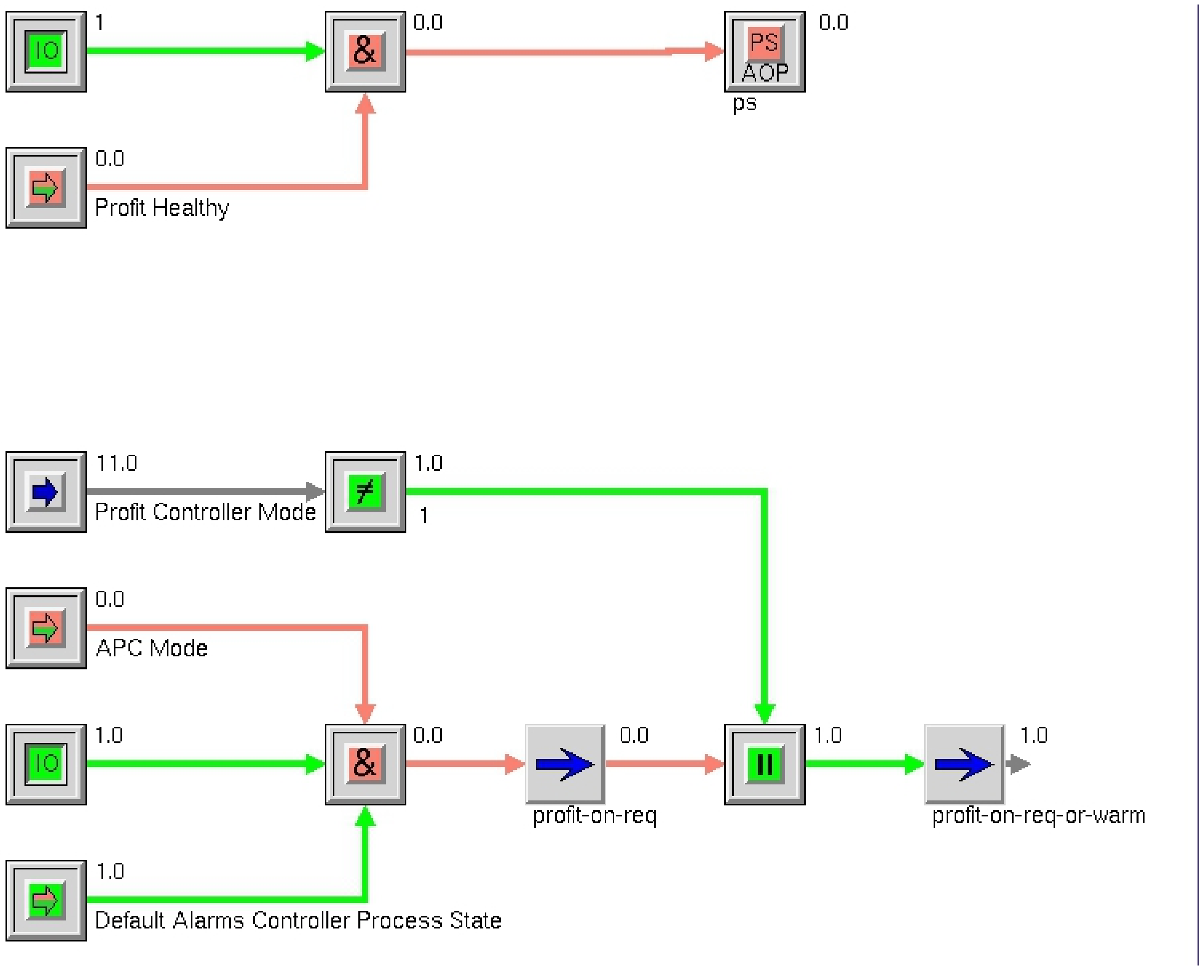


Fig 15: Determining Mpc-Optimizer

3.5.4.2) Default-Root

This state is the lowest in the hierarchy and should always be true (Active). The DEFAULT state represents the stable state.

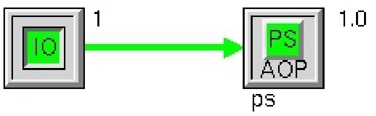


Fig 16: Determining Default-Root

3.6) Interlocks

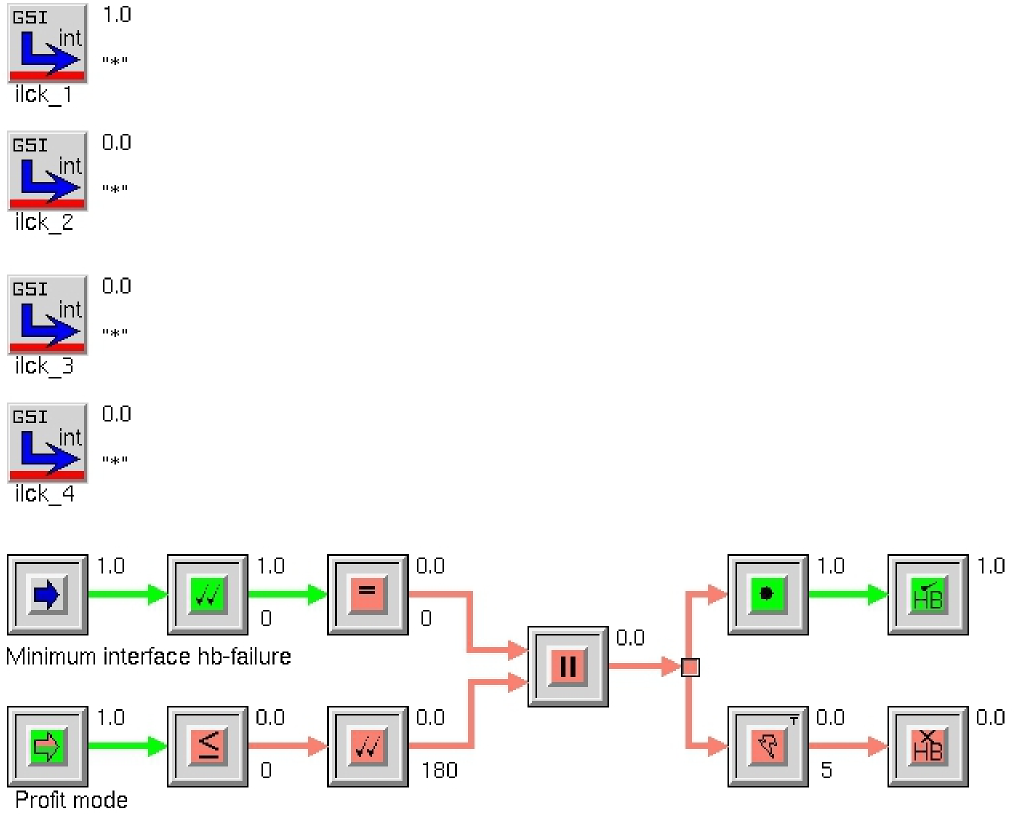


Fig 17: Interlocks: Apc-J144_Lic_005c.interlocks

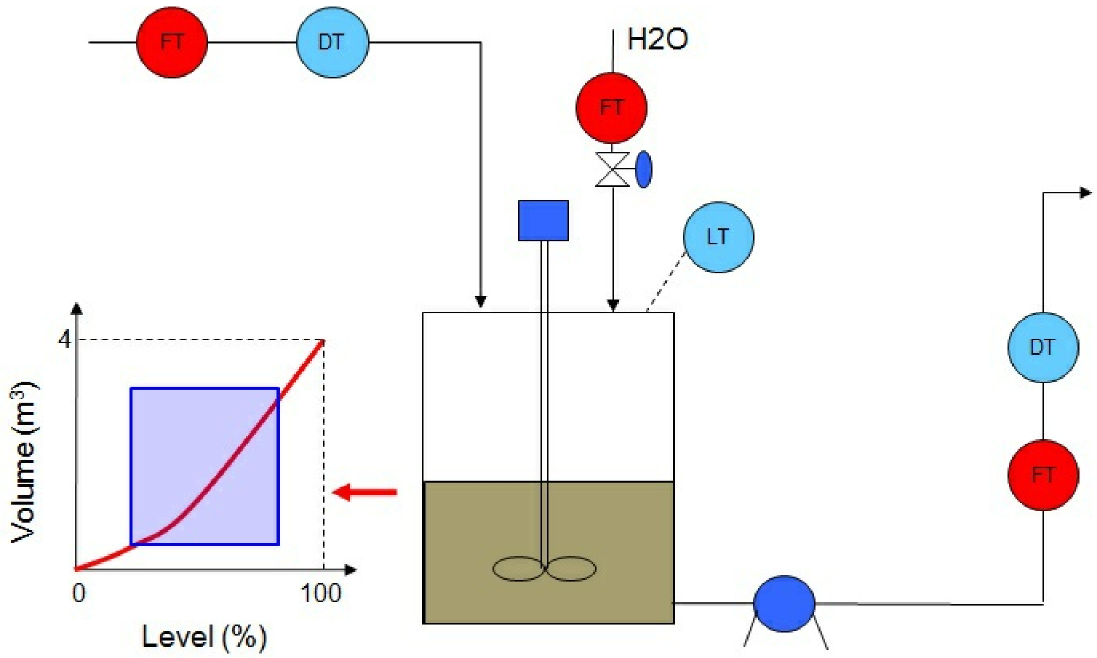
4) Control Technologies

Model predictive control (MPC) is an advanced method of process control that has been in use in the process industries in chemical plants and oil refineries since the 1980s. Model predictive controllers rely on dynamic models of the process, most often linear empirical models obtained by system identification. Dynamic process models describe how the process parameters will respond in the future for changes made to the process in the present time. These models can therefore predict process responses into the future. The main advantage of MPC is the fact that it allows for the current process conditions (current timeslot) to be optimized, while accounting for future process conditions (future timeslots) still to happen as a result of changes to the current process conditions. This is achieved by optimizing over a finite time-horizon (the future predictions), implementing the current timeslot actions and then relying on feedback to account for unmeasured disturbances and model/plant mismatches. This implies that the model prediction error that may exist (or develop over time) is also taken into account by the MPC algorithm. MPC models therefore do not have to be 100% accurate. As a result of this the MPC technology is very robust, and typically outperforms most other advanced process control techniques. The MPC further has the ability to anticipate/predict future events and can take control actions accordingly. An example of this is that the MPC can predict that the bin level will drop below the low level limit, which will result in the feeder being interlocked and stopped. The feeder stop will again cause the bin level to increase sharply. The MPC can take all of these future predictions into account and prevent this scenario from happening. PID controllers normally implemented as part of the base layer (PLC) control do not have this predictive ability. Therefore the PID controller in the base layer (PLC) control will not be able to prevent the above feeder interlock and stop.

The models used in MPC are generally intended to represent the behaviour of complex dynamic systems, which cannot be effectively controlled by base layer (PLC) controllers such as PID controllers. Dynamic characteristics that are difficult for PID controllers include large time delays, variable interaction and high-order dynamics.

MPC uses current and historical plant responses/measurements, the current dynamic state of the process, the MPC models, and the process variable targets and limits to calculate future changes in the dependent variables (the variables to be controlled, such as bin levels and product mass flowrates). These changes are calculated to hold the dependent variables close to target while honoring constraints on both independent (the levers that can be pulled by the MPC system, such as feeder speeds or PID setpoints) and dependent variables. The MPC typically sends out only the first setpoint change (of the sequence of calculated changes required going into the future) in each independent variable to be implemented, and repeats the calculation when the next change is required (by updating the sequence of calculated changes required going into the future).

Below is an image to illustrate the concepts:



In summary, Model Predictive Control (MPC) is a multivariable control algorithm that uses:

1. an internal dynamic model of the process
2. a history of past control moves and
3. an optimization cost function J over the receding prediction horizon,

to calculate the optimum control moves.

An example of a quadratic cost function for optimization is given by:

$$J = \sum_{i=1}^{N} w_{x_i}(r_i - x_i)^2 + \sum_{i=1}^{N} w_{u_i}\, \Delta u_i{}^2$$

With:

X_i = *i*-th controlled variable (e.g. measured bin level)

r_i = *i*-th reference variable (e.g. required bin level)

u_i = *i*-th manipulated variable (e.g. feeder speed)

w_{Xi} = weighting coefficient reflecting the relative importance of X_i

w_{ui} = weighting coefficient penalizing relative big changes in u_i

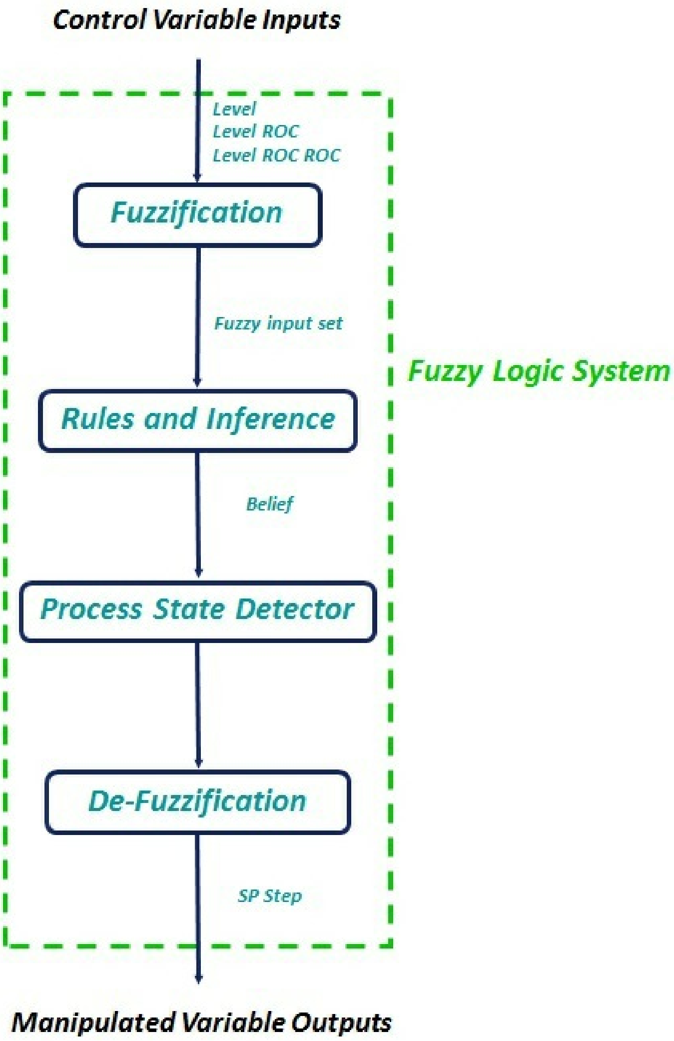
The figure below represents the model matrix for the secondary crusher model predictive controller, showing the dynamic step response between each controller input-output pair.

4.1) Expert Rule Based Control

4.2) Fuzzy Control

4.2.1) Fuzzy Sets

A fuzzy logic system (FLS) can be defined as the nonlinear mapping of an input data set to a scalar output data. A FLS consists of four main parts: fuzzifier, rules, inference engine, and defuzzifier. These components and the general architecture of a FLS is shown in the figure below.



The process of fuzzy logic is defined as follows: Firstly, a crisp set of input data are gathered and converted to a fuzzy set using fuzzy linguistic variables, fuzzy linguistic terms and membership functions. This step is known as fuzzification. Afterwards, an inference is made based on a set of rules. Lastly, the resulting fuzzy output is mapped to a crisp output using the membership functions, in the defuzzification step.

The fuzzy logic algorithm can be summarized as follows:

1. Define the linguistic variables and terms (initialization)
2. Construct the membership functions (initialization)
3. Construct the rule base (initialization)
4. Convert crisp input data to fuzzy values using the membership functions (fuzzification)
5. Evaluate the rules in the rule base (inference)
6. Combine the results of each rule (inference)
7. Convert the output data to non-fuzzy values (defuzzification)

Linguistic variables are the input or output variables of the system whose values are words or sentences from a natural language, instead of numerical values. A linguistic variable is generally decomposed into a set of linguistic terms. Example: Leven in a bin. Let level (LVL) be the linguistic variable which represents the amount of metarial in the bin. To qualify the level, terms such as high and low are used in real life. These are the linguistic values of the level. Then, LVL(t) = extremely low, low, ok, high, extremely high can be the set of decompositions for the linguistic variable level. Each member of this decomposition is called a linguistic term and can cover a portion of the overall values of the bin level.

Membership functions are used in the fuzzification and defuzzification steps of a FLS, to map the non-fuzzy input values to fuzzy linguistic terms and vice versa. A membership function is used to quantify a linguistic term. Note that, an important characteristic of fuzzy logic is that a numerical value does not have to be fuzzified using only one membership function. In other words, a value typically belongs to multiple sets at the same time. For example the bin level value can be considered as extremely low and low at the same time, with different degrees of memberships.

APET includes a powerful fuzzy controller toolset which includes a very flexible editing environment as well as a variety of membership functions to be used.

Each CV feeding into the controller is fuzzified (classified within a fuzzy membership function) by one or more FIS-INPUTS. For control variables (CV) there are typically three types of classification: proximity (this relates to the

normalised value), slope (rate of change) and slope rate of change (this implies acceleration).
For each of the fuzzy families, a specific input must be provided based on the value of the CV (and its recent history).
1. Proximity: this is a comparison of the normalised value of the CV
2. Slope: this represents the slope or rate of change of the CV over a defined period and is calculated within the APC system
3. Slope Rate of Change: this represents the rate of change of the slope of the CV and is calculated within the APC system

4.2.1.1) Fuzzy Sets For CAM-J144-G3120-LYNXX.CUMULATIVE-LUMP-02

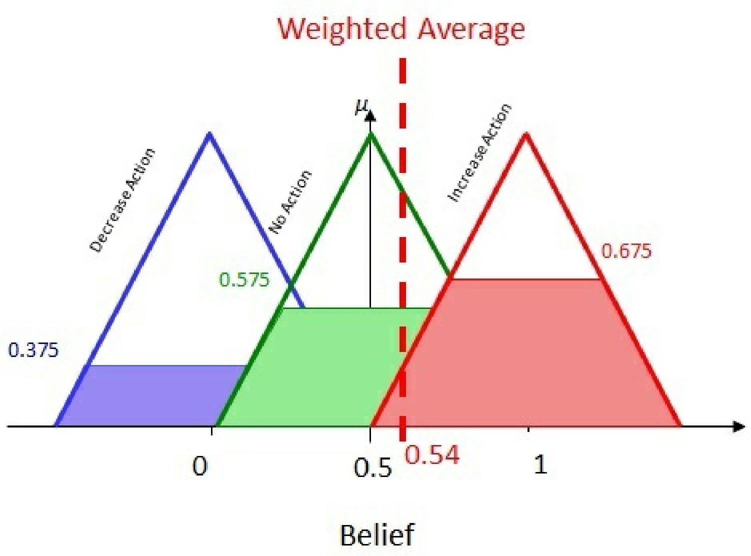
The advanced process controller (J144_LIC_005C) uses the data from the Lynxx camera (J142-G3120-LYNXX) to calculate the cumulative percentage based on the +8mm and -31.5mm produced by the tertiary crusher (J144-G3120) . The analog readings are processed and the following variable fuzzified and used as controller input:
1 . Tertiary Crusher Discharge Cumulative Lump PV (process variable value which is normalized based on limits entered on the SCADA faceplate)
This reading is also used by the model predictive controller as a control variable (CV).

4.2.1.2) Fuzzy Sets For MOTOR-J144-G3128.POWER

The advanced process controller (J144_LIC_005C) uses the crusher motor power draw (J144-ZPE-781) reading.

4.2.2) Defuzzy Function

After the inference step, the overall result is a fuzzy value. This result should be defuzzified based on the process state which is In Control to obtain a final crisp output. This is the purpose of the defuzzifier component of a FLS. Defuzzification is performed according to the membership function of the output variable. For instance, assume that we have the result in the figure below at the end of the inference. In this figure, the shaded areas all belong to the fuzzy result. The purpose is to obtain a crisp value, represented by the dotted line in the figure below, from this fuzzy result.



The crisp value (or belief) is then converted back to a setpoint change using the defuzzy function.

4.2.2.1) Defuzzy functions for PID-J144-BF-PID

The defuzzification of the belief for conveyors speed (J141-ST-201) PID controller (T-Crusher J144-G3120 Level PID-Controller J144-BF-PID) contains functions for Optimizer (for old prime controller, not in use), MPC-Optimizer (Psibyl controller) and Default.

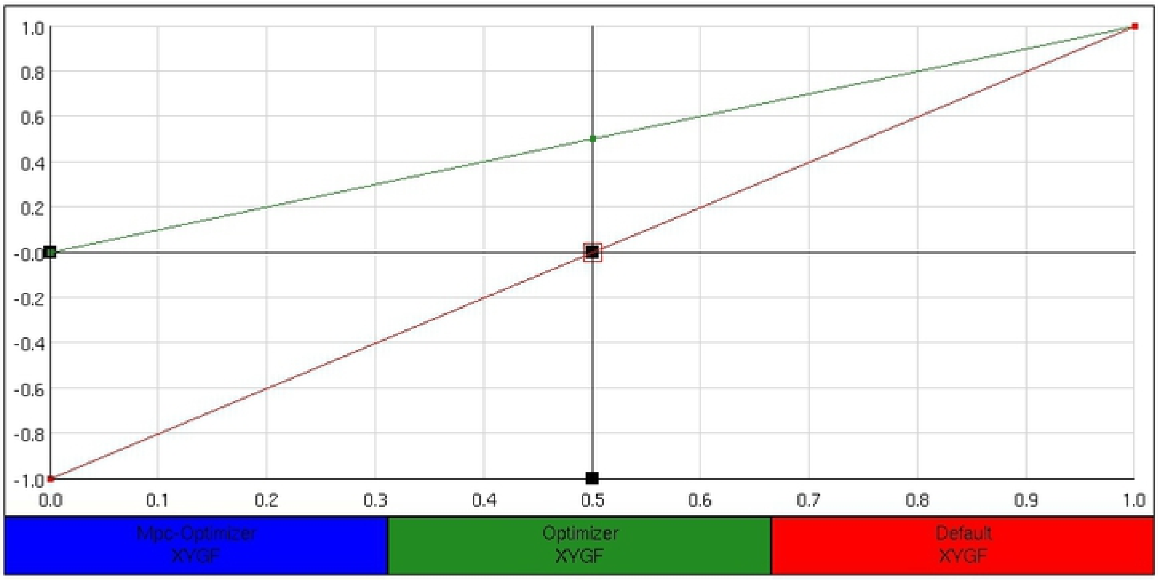


Fig 18: The defuzzy function for PID-J144-BF-PID.SP-STEP.FIS

4.2.2.2) Defuzzy functions for YC-J144-CC-01-CCS

The defuzzification of the belief for crusher CSS (J144-CC-01-CCS) ratio controller (T-Crusher J144-G3120 Css Logic-Controller-Sp-Only J144-CC-01-CCS) contains functions for Optimizer (for old prime controller, not in use), MPC-Optimizer (Psibyl controller) and Default.
On the sub workspace of CSS controller (J144-CC-01-CCS) the logic was built in to allow for the implementation of the gap changes as well as to prevent PV drifting by limiting the changes to a maximum of 2 mm.

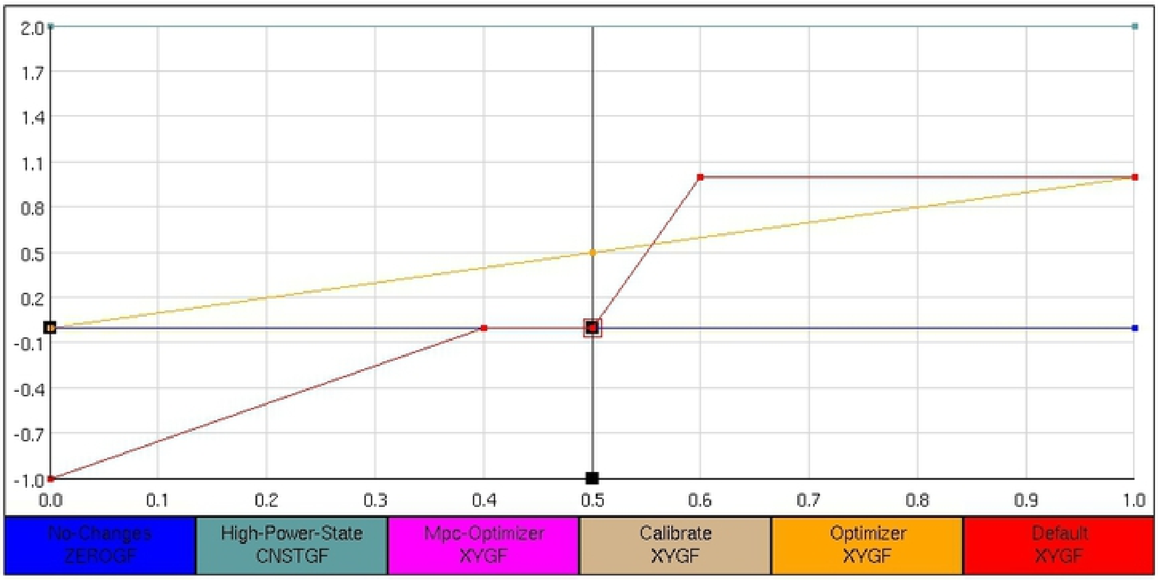


Fig 19: The defuzzy function for YC-J144-CC-01-CCS.SP-STEP.FIS

4.3) Model Based Control

4.4) Model Predictive Control (MPC)

4.4.1) Model Matrix: PROFIT-CONTROLLER - J144-LIC-005c

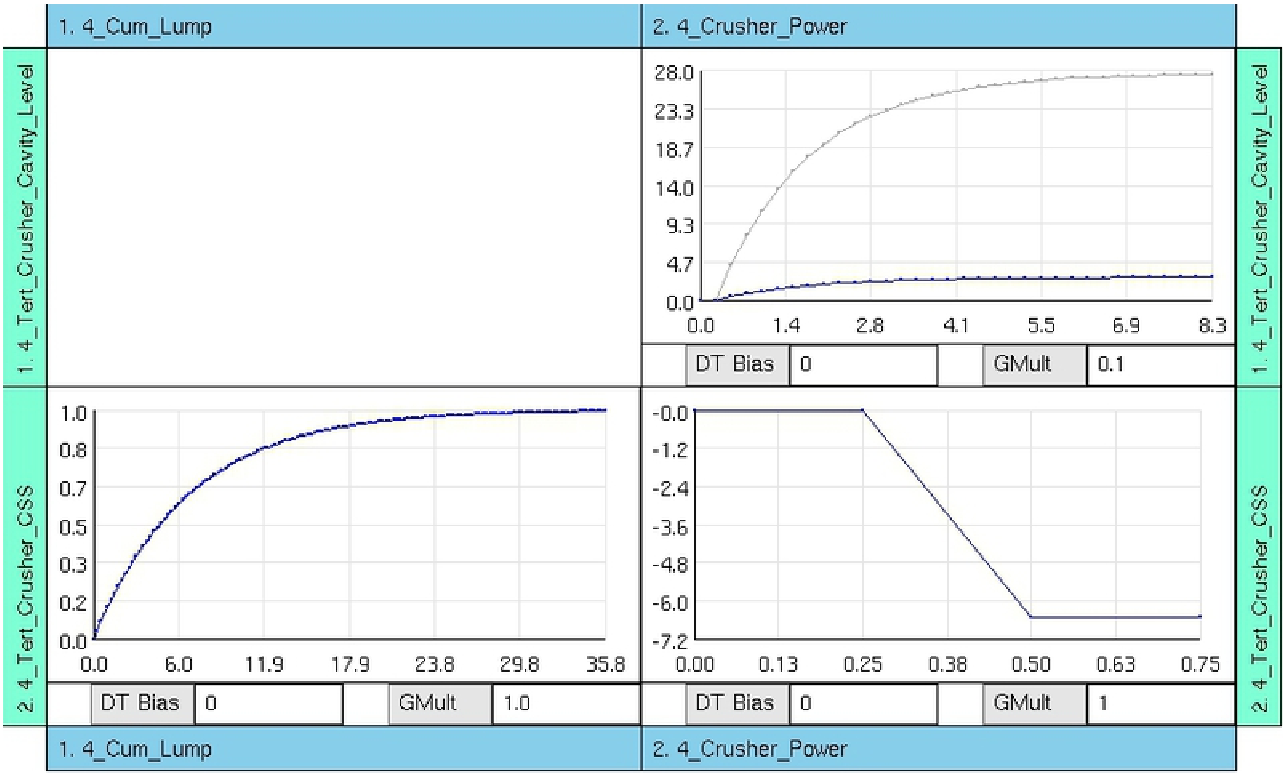
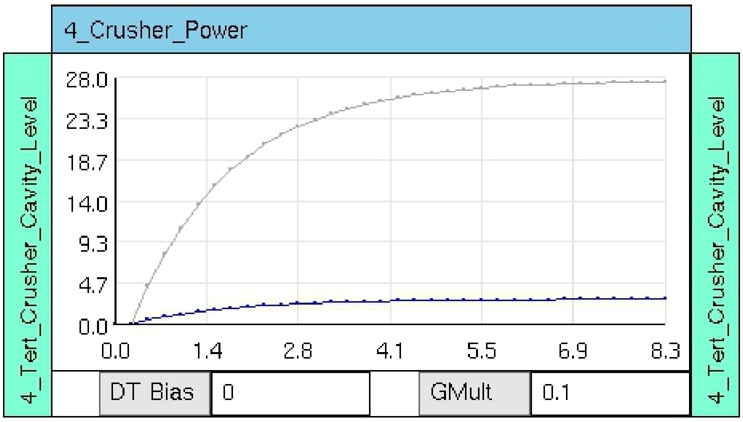
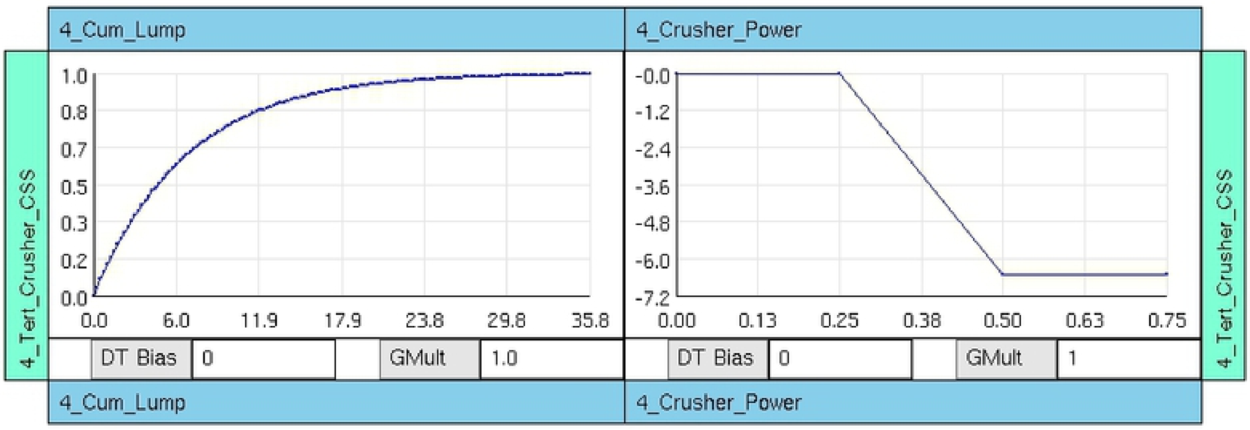


Fig 20: Model Matrix: PROFIT-CONTROLLER - J144-LIC-005c





5) HEARTBEATS

Heartbeats			
Name	Type	Parameter	Update Interval
SIS-JIG.SEP.APC-J144_LIC_005C.HB-IN	TIMED-TOGGLE	TIMEOUT:45	15
SIS-JIG.SEP.APC-J144_LIC_005C.HB-OUT	TOGGLE	MIN:0; MAX:1	15

6) Tag Listing

6.1) APC Tags

6.1.1) GSI Interface: IDX_COMMON

Tag	OPC Tag
SIS-JIG.SEP.APC-J144_LIC_005C.OBJECTIVE	
SIS-JIG.SEP.APC-J144_LIC_005C.OBJECTIVE-BEST-PERF	
SIS-JIG.SEP.APC-J144_LIC_005C.PROCESS-RUN-SIGNAL	

6.1.2) GSI Interface: IDX_SIS_EXPERT_22583_JIG_T_CRUSHING

Tag	OPC Tag
SIS-JIG.SEP.APC-J144_LIC_005C.AUTO-MANUAL-MODE	JIG_Galaxy.J144LIC005C_MVC.QON

6.2) CV1 Tags

6.2.1) GSI Interface: IDX_SIS_EXPERT_22583_JIG_T_CRUSHING

Tag	OPC Tag
SIS-JIG.SEP.CAM-J144-G3120-LYNXX.CUMULATIVE-LUMP-02.HH	G02M100.G02M100.DB929;REAL678
SIS-JIG.SEP.CAM-J144-G3120-LYNXX.CUMULATIVE-LUMP-02.INT-HI	JIG_Galaxy.J144LIC005C_MVC.PV3_H
SIS-JIG.SEP.CAM-J144-G3120-LYNXX.CUMULATIVE-LUMP-02.INT-LO	JIG_Galaxy.J144LIC005C_MVC.PV3_L
SIS-JIG.SEP.CAM-J144-G3120-LYNXX.CUMULATIVE-LUMP-02.LL	G02M100.G02M100.DB929;REAL686
SIS-JIG.SEP.CAM-J144-G3120-LYNXX.CUMULATIVE-LUMP-02.READING	G02M100.G02M100.DB929;REAL18

6.3) CV2 Tags

6.3.1) GSI Interface: IDX_SIS_EXPERT_22583_JIG_T_CRUSHING

Tag	OPC Tag
SIS-JIG.SEP.MOTOR-J144-G3128.POWER.HH	G02M100.G02M100.DB929;REAL690
SIS-JIG.SEP.MOTOR-J144-G3128.POWER.INT-HI	JIG_Galaxy.J144LIC005C_MVC.PV2_H
SIS-JIG.SEP.MOTOR-J144-G3128.POWER.INT-LO	JIG_Galaxy.J144LIC005C_MVC.PV2_L
SIS-JIG.SEP.MOTOR-J144-G3128.POWER.LL	G02M100.G02M100.DB929;REAL698
SIS-JIG.SEP.MOTOR-J144-G3128.POWER.PV	G02M100.G02M100.DB929;REAL44

6.4) MV1 Tags

6.4.1) GSI Interface: IDX_SIS_EXPERT_22583_JIG_T_CRUSHING

Tag	OPC Tag
SIS-JIG.SEP.CNVYR-J144-G3700.SPEED.HH	JIG_Galaxy.J144LIC005C_MVC.C3_SPHH_OP
SIS-JIG.SEP.CNVYR-J144-G3700.SPEED.INT-HI	JIG_Galaxy.J144LIC005C_MVC.C3_SP_H
SIS-JIG.SEP.CNVYR-J144-G3700.SPEED.INT-LO	JIG_Galaxy.J144LIC005C_MVC.C3_SP_L
SIS-JIG.SEP.CNVYR-J144-G3700.SPEED.LL	JIG_Galaxy.J144LIC005C_MVC.C3_SPLL_OP
SIS-JIG.SEP.CNVYR-J144-G3700.SPEED.PV	JIG_Galaxy.J144BFPID_T22.C_ManipulatedValue
SIS-JIG.SEP.CONE-CRSH-J144-G3120.LEVEL.HH	G02M100.G02M100.DB929;REAL726
SIS-JIG.SEP.CONE-CRSH-J144-G3120.LEVEL.INT-HI	JIG_Galaxy.J144LIC005C_MVC.C1_SP_H
SIS-JIG.SEP.CONE-CRSH-J144-G3120.LEVEL.INT-LO	JIG_Galaxy.J144LIC005C_MVC.C1_SP_L
SIS-JIG.SEP.CONE-CRSH-J144-G3120.LEVEL.LL	G02M100.G02M100.DB929;REAL734
SIS-JIG.SEP.CONE-CRSH-J144-G3120.LEVEL.PV	G02M100.G02M100.DB24;REAL1176
SIS-JIG.SEP.PID-J144-BF-PID.ACTUAL-SP	G02M100.G02M100.DB929;REAL488
SIS-JIG.SEP.PID-J144-BF-PID.APC-SP	G02M100.G02M100.DB929;REAL396
SIS-JIG.SEP.PID-J144-BF-PID.AUTO-MANUAL-MODE	JIG_Galaxy.J144BFPID_T22.C_ManualOn_Off

6.5) MV2 Tags

6.5.1) GSI Interface: IDX_SIS_EXPERT_22583_JIG_T_CRUSHING

Tag	OPC Tag
SIS-JIG.SEP.CONE-CRSH-J144-G3120.CSS.HH	G02M100.G02M100.DB929;REAL746
SIS-JIG.SEP.CONE-CRSH-J144-G3120.CSS.INT-HI	JIG_Galaxy.J144LIC005C_MVC.C2_SP_H
SIS-JIG.SEP.CONE-CRSH-J144-G3120.CSS.INT-LO	JIG_Galaxy.J144LIC005C_MVC.C2_SP_L
SIS-JIG.SEP.CONE-CRSH-J144-G3120.CSS.LL	G02M100.G02M100.DB929;REAL186
SIS-JIG.SEP.CONE-CRSH-J144-G3120.CSS.PV	G02M100.G02M100.DB929;REAL172
SIS-JIG.SEP.YC-J144-CC-01-CCS.ACTUAL-SP	G02M100.G02M100.DB929;REAL178
SIS-JIG.SEP.YC-J144-CC-01-CCS.APC-SP	G02M100.G02M100.DB929;REAL406
SIS-JIG.SEP.YC-J144-CC-01-CCS.AUTO-GAP-ON	G02M100.G02M100.DB23.DBX3436.1
SIS-JIG.SEP.YC-J144-CC-01-CCS.AUTO-MANUAL-MODE	G02M100.G02M100.DB23.DBX3436.1
SIS-JIG.SEP.YC-J144-CC-01-CCS.MODE-TOGGLE	JIG_Galaxy.J144_GY001.S_bGapAdjPanelLocReq

6.6) PROCESS-STATES Tags

6.6.1) GSI Interface: IDX_COMMON

Tag	OPC Tag
SIS-JIG.SEP.APC-J144_LIC_005C.CONE-CRSH-J144-G3120.CRUSHER-HIGH-POWER.STATE-BELIEF	
SIS-JIG.SEP.APC-J144_LIC_005C.CONE-CRSH-J144-G3120.CRUSHER-HIGH-POWER.STATE-INDEX	
SIS-JIG.SEP.APC-J144_LIC_005C.CONVEYOR-154-G2600-CONSTRAINED.STATE-BELIEF	
SIS-JIG.SEP.APC-J144_LIC_005C.CONVEYOR-154-G2600-CONSTRAINED.STATE-INDEX	
SIS-JIG.SEP.APC-J144_LIC_005C.CONVEYOR-154-G2700-CONSTRAINED.STATE-BELIEF	
SIS-JIG.SEP.APC-J144_LIC_005C.CONVEYOR-154-G2700-CONSTRAINED.STATE-INDEX	
SIS-JIG.SEP.APC-J144_LIC_005C.CRUSHER-CONSTRAINED.STATE-BELIEF	
SIS-JIG.SEP.APC-J144_LIC_005C.CRUSHER-CONSTRAINED.STATE-INDEX	
SIS-JIG.SEP.APC-J144_LIC_005C.CRUSHER-STOP.STATE-BELIEF	
SIS-JIG.SEP.APC-J144_LIC_005C.CRUSHER-STOP.STATE-INDEX	
SIS-JIG.SEP.APC-J144_LIC_005C.CSS-CALIBRATE.STATE-BELIEF	
SIS-JIG.SEP.APC-J144_LIC_005C.CSS-CALIBRATE.STATE-INDEX	
SIS-JIG.SEP.APC-J144_LIC_005C.CSS-CHANGE-IMMINENT.STATE-BELIEF	
SIS-JIG.SEP.APC-J144_LIC_005C.CSS-CHANGE-IMMINENT.STATE-INDEX	
SIS-JIG.SEP.APC-J144_LIC_005C.DEF-ROOT.STATE-BELIEF	
SIS-JIG.SEP.APC-J144_LIC_005C.DEF-ROOT.STATE-INDEX	
SIS-JIG.SEP.APC-J144_LIC_005C.MPC-OPTIMIZER.STATE-BELIEF	
SIS-JIG.SEP.APC-J144_LIC_005C.MPC-OPTIMIZER.STATE-INDEX	
SIS-JIG.SEP.APC-J144_LIC_005C.STATE-INDEX	

6.6.2) GSI Interface: IDX_SIS_EXPERT_22583_JIG_T_CRUSHING

Tag	OPC Tag
SIS-JIG.SEP.APC-J144_LIC_005C.CRIT-ALARMS.CMNTS	JIG_Galaxy.J144LIC005C_MVC.S1_CMNT
SIS-JIG.SEP.APC-J144_LIC_005C.CRIT-ALARMS.DESC	JIG_Galaxy.J144LIC005C_MVC.S1_DESCR
SIS-JIG.SEP.APC-J144_LIC_005C.CRIT-ALARMS.STATE-BELIEF	JIG_Galaxy.J144LIC005C_MVC.S1_WEIGHT
SIS-JIG.SEP.APC-J144_LIC_005C.CRIT-ALARMS.STATE-INDEX	JIG_Galaxy.J144LIC005C_MVC.S1_STATE
SIS-JIG.SEP.APC-J144_LIC_005C.DEF-ALARMS.CMNTS	JIG_Galaxy.J144LIC005C_MVC.S4_CMNT
SIS-JIG.SEP.APC-J144_LIC_005C.DEF-ALARMS.DESC	JIG_Galaxy.J144LIC005C_MVC.S4_DESCR
SIS-JIG.SEP.APC-J144_LIC_005C.DEF-ALARMS.STATE-BELIEF	JIG_Galaxy.J144LIC005C_MVC.S4_WEIGHT
SIS-JIG.SEP.APC-J144_LIC_005C.DEF-ALARMS.STATE-INDEX	JIG_Galaxy.J144LIC005C_MVC.S4_STATE
SIS-JIG.SEP.APC-J144_LIC_005C.HIGH-ALARMS.CMNTS	JIG_Galaxy.J144LIC005C_MVC.S2_CMNT
SIS-JIG.SEP.APC-J144_LIC_005C.HIGH-ALARMS.DESC	JIG_Galaxy.J144LIC005C_MVC.S2_DESCR

SIS-JIG.SEP.APC-J144_LIC_005C.HIGH-ALARMS.STATE-BELIEF	JIG_Galaxy.J144LIC005C_MVC.S2_WEIGHT
SIS-JIG.SEP.APC-J144_LIC_005C.HIGH-ALARMS.STATE-INDEX	JIG_Galaxy.J144LIC005C_MVC.S2_STATE
SIS-JIG.SEP.APC-J144_LIC_005C.LOW-ALARMS.CMNTS	JIG_Galaxy.J144LIC005C_MVC.S3_CMNT
SIS-JIG.SEP.APC-J144_LIC_005C.LOW-ALARMS.DESC	JIG_Galaxy.J144LIC005C_MVC.S3_DESCR
SIS-JIG.SEP.APC-J144_LIC_005C.LOW-ALARMS.STATE-BELIEF	JIG_Galaxy.J144LIC005C_MVC.S3_WEIGHT
SIS-JIG.SEP.APC-J144_LIC_005C.LOW-ALARMS.STATE-INDEX	JIG_Galaxy.J144LIC005C_MVC.S3_STATE

6.7) MESSAGES Tags

6.7.1) GSI Interface: IDX_SIS_EXPERT_22583_JIG_T_CRUSHING

Tag	OPC Tag
SIS-JIG.SEP.APC-J144_LIC_005C.BODY1	JIG_Galaxy.J144LIC005C_MVC.M1_DESCR
SIS-JIG.SEP.APC-J144_LIC_005C.BODY2	JIG_Galaxy.J144LIC005C_MVC.M2_DESCR
SIS-JIG.SEP.APC-J144_LIC_005C.BODY3	JIG_Galaxy.J144LIC005C_MVC.M3_DESCR
SIS-JIG.SEP.APC-J144_LIC_005C.BODY4	JIG_Galaxy.J144LIC005C_MVC.M4_DESCR
SIS-JIG.SEP.APC-J144_LIC_005C.BODY5	JIG_Galaxy.J144LIC005C_MVC.M5_DESCR
SIS-JIG.SEP.APC-J144_LIC_005C.ID1	JIG_Galaxy.J144LIC005C_MVC.M1_LOGIC
SIS-JIG.SEP.APC-J144_LIC_005C.ID2	JIG_Galaxy.J144LIC005C_MVC.M2_LOGIC
SIS-JIG.SEP.APC-J144_LIC_005C.ID3	JIG_Galaxy.J144LIC005C_MVC.M3_LOGIC
SIS-JIG.SEP.APC-J144_LIC_005C.ID4	JIG_Galaxy.J144LIC005C_MVC.M4_LOGIC
SIS-JIG.SEP.APC-J144_LIC_005C.ID5	JIG_Galaxy.J144LIC005C_MVC.M5_LOGIC
SIS-JIG.SEP.APC-J144_LIC_005C.SP-ACTION1	JIG_Galaxy.J144LIC005C_MVC.M1_ACTION
SIS-JIG.SEP.APC-J144_LIC_005C.SP-ACTION2	JIG_Galaxy.J144LIC005C_MVC.M2_ACTION
SIS-JIG.SEP.APC-J144_LIC_005C.SP-ACTION3	JIG_Galaxy.J144LIC005C_MVC.M3_ACTION
SIS-JIG.SEP.APC-J144_LIC_005C.SP-ACTION4	JIG_Galaxy.J144LIC005C_MVC.M4_ACTION
SIS-JIG.SEP.APC-J144_LIC_005C.SP-ACTION5	JIG_Galaxy.J144LIC005C_MVC.M5_ACTION
SIS-JIG.SEP.APC-J144_LIC_005C.SP-CHANGE1	JIG_Galaxy.J144LIC005C_MVC.M1_CHANGE
SIS-JIG.SEP.APC-J144_LIC_005C.SP-CHANGE2	JIG_Galaxy.J144LIC005C_MVC.M2_CHANGE
SIS-JIG.SEP.APC-J144_LIC_005C.SP-CHANGE3	JIG_Galaxy.J144LIC005C_MVC.M3_CHANGE
SIS-JIG.SEP.APC-J144_LIC_005C.SP-CHANGE4	JIG_Galaxy.J144LIC005C_MVC.M4_CHANGE
SIS-JIG.SEP.APC-J144_LIC_005C.SP-CHANGE5	JIG_Galaxy.J144LIC005C_MVC.M5_CHANGE
SIS-JIG.SEP.APC-J144_LIC_005C.TIME1	JIG_Galaxy.J144LIC005C_MVC.M1_TIMESTAMP
SIS-JIG.SEP.APC-J144_LIC_005C.TIME2	JIG_Galaxy.J144LIC005C_MVC.M2_TIMESTAMP
SIS-JIG.SEP.APC-J144_LIC_005C.TIME3	JIG_Galaxy.J144LIC005C_MVC.M3_TIMESTAMP
SIS-JIG.SEP.APC-J144_LIC_005C.TIME4	JIG_Galaxy.J144LIC005C_MVC.M4_TIMESTAMP
SIS-JIG.SEP.APC-J144_LIC_005C.TIME5	JIG_Galaxy.J144LIC005C_MVC.M5_TIMESTAMP

6.8) INTERLOCKS Tags

6.8.1) GSI Interface: IDX_SIS_EXPERT_22583_JIG_T_CRUSHING

Tag	OPC Tag
SIS-JIG.SEP.APC-J144_LIC_005C.INTERLOCKS.ILCK_1	JIG_Galaxy.J144LIC005C_MVC_FU.STA_IL_WordA.08
SIS-JIG.SEP.APC-J144_LIC_005C.INTERLOCKS.ILCK_1-DESC	JIG_Galaxy.J144LIC005C_MVC_FU.STA_FaultTable[1]
SIS-JIG.SEP.APC-J144_LIC_005C.INTERLOCKS.ILCK_2	JIG_Galaxy.J144LIC005C_MVC_FU.STA_IL_WordA.09
SIS-JIG.SEP.APC-J144_LIC_005C.INTERLOCKS.ILCK_2-DESC	JIG_Galaxy.J144LIC005C_MVC_FU.STA_FaultTable[2]
SIS-JIG.SEP.APC-J144_LIC_005C.INTERLOCKS.ILCK_3	JIG_Galaxy.J144LIC005C_MVC_FU.STA_IL_WordA.10
SIS-JIG.SEP.APC-J144_LIC_005C.INTERLOCKS.ILCK_3-DESC	JIG_Galaxy.J144LIC005C_MVC_FU.STA_FaultTable[3]
SIS-JIG.SEP.APC-J144_LIC_005C.INTERLOCKS.ILCK_4	JIG_Galaxy.J144LIC005C_MVC_FU.STA_IL_WordA.11
SIS-JIG.SEP.APC-J144_LIC_005C.INTERLOCKS.ILCK_4-DESC	JIG_Galaxy.J144LIC005C_MVC_FU.STA_FaultTable[4]

6.9) PROFIT-CONTROLLER Tags

6.9.1) GSI Interface: IDX_SIS_MPC_26583_JIG_T_CRUSHING_HONEYWELL

Tag	OPC Tag
	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-

SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT.CONTROL-RESTART	005c/ProfCon/Control Restart.InternalValue
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT.DEMAND	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/urtDemand.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT.HB	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/urtIntervalCount.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT.URT-COUNTDOWN	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/urtCountdown.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT.URT-EXEC-STATE	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/urtExecState.InternalValue
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_CTRL-MODE	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/Controller Mode.InternalValue
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_DISPLAY-STATUS	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/Displayed Status.InternalValue
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_MPC-STATE	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MPC_State.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_ON-OFF-TOGGLE	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/Turn ON OFF.InternalValue
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_OPT-ACC-TOL	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/Opt Acceleration Tol.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_OPT-SPEED-FACTOR	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/Optimizer Speed Factor.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_READ-MODEL-FLAG	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/Read Model Flag.InternalValue

6.10) PROFIT-CONTROLLER-CV1 Tags

6.10.1) GSI Interface: IDX_SIS_MPC_26583_JIG_T_CRUSHING_HONEYWELL

Tag	OPC Tag
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CUM_LUMP.BALANCE-FACTOR	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/CV/4_Cum_Lump/Balance Factor Value.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CUM_LUMP.CLOSED-LOOP-RESP-TIME	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/CV/4_Cum_Lump/Closed Loop Resp Time.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CUM_LUMP.ENABLED	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/CV/4_Cum_Lump/Control This CV.InternalValue
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CUM_LUMP.FF-TO-FB-PERF-RATIO	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/CV/4_Cum_Lump/FF to FB Perf Ratio.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CUM_LUMP.FUTURE-VALUE	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/CV/4_Cum_Lump/Future Value.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CUM_LUMP.HIGH-LIMIT-DELTA	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/CV/4_Cum_Lump/Delta Soft High Limit.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CUM_LUMP.HIGH-LIMIT-SLOT	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/CV/4_Cum_Lump/High Limit.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CUM_LUMP.HIGH-LIMIT-WEIGHT	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/CV/4_Cum_Lump/High Limit Error Weight.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CUM_LUMP.INTEGRATING	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/CV/4_Cum_Lump/Model type.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CUM_LUMP.LIMIT-VIOLATION	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/CV/4_Cum_Lump/Read Value.Color
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CUM_LUMP.LINEAR-COEFF	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/CV/4_Cum_Lump/Linear Coeff.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CUM_LUMP.LOW-LIMIT-DELTA	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/CV/4_Cum_Lump/Delta Soft Low Limit.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CUM_LUMP.LOW-LIMIT-SLOT	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/CV/4_Cum_Lump/Low Limit.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CUM_LUMP.LOW-LIMIT-WEIGHT	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/CV/4_Cum_Lump/Low Limit Error Weight.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CUM_LUMP.MV2.DTBIAS	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/Dead Time Bias.Value[0]
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CUM_LUMP.MV2.GMULT	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/Gain Multiplier.Value[0]
	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-

SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CUM_LUMP.NUMBER-OF-BLOCKS	005c/ProfCon/CV/4_Cum_Lump/Number of Blocks.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CUM_LUMP.PERF-RATIO	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/CV/4_Cum_Lump/Perf Ratio.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CUM_LUMP.PV	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/CV/4_Cum_Lump/Read Value DCS.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CUM_LUMP.SS-VALUE	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/CV/4_Cum_Lump/SS Value.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CUM_LUMP.STATE-ESTIMATION	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/CV/4_Cum_Lump/State Estimation.InternalValue
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CUM_LUMP.TARGET	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/CV/4_Cum_Lump/Desired Value.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CUM_LUMP.TARGET-WEIGHT	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/CV/4_Cum_Lump/Quadratic Coeff.Value

6.11) PROFIT-CONTROLLER-CV2 Tags

6.11.1) GSI Interface: IDX_SIS_MPC_26583_JIG_T_CRUSHING_HONEYWELL

Tag	OPC Tag
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CRUSHER_POWER.BALANCE-FACTOR	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/CV/4_Crusher_Power/Balance Factor Value.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CRUSHER_POWER.CLOSED-LOOP-RESP-TIME	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/CV/4_Crusher_Power/Closed Loop Resp Time.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CRUSHER_POWER.ENABLED	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/CV/4_Crusher_Power/Control This CV.InternalValue
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CRUSHER_POWER.FF-TO-FB-PERF-RATIO	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/CV/4_Crusher_Power/FF to FB Perf Ratio.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CRUSHER_POWER.FUTURE-VALUE	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/CV/4_Crusher_Power/Future Value.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CRUSHER_POWER.HIGH-LIMIT-DELTA	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/CV/4_Crusher_Power/Delta Soft High Limit.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CRUSHER_POWER.HIGH-LIMIT-SLOT	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/CV/4_Crusher_Power/High Limit.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CRUSHER_POWER.HIGH-LIMIT-WEIGHT	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/CV/4_Crusher_Power/High Limit Error Weight.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CRUSHER_POWER.INTEGRATING	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/CV/4_Crusher_Power/Model type.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CRUSHER_POWER.LIMIT-VIOLATION	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/CV/4_Crusher_Power/Read Value.Color
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CRUSHER_POWER.LINEAR-COEFF	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/CV/4_Crusher_Power/Linear Coeff.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CRUSHER_POWER.LOW-LIMIT-DELTA	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/CV/4_Crusher_Power/Delta Soft Low Limit.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CRUSHER_POWER.LOW-LIMIT-SLOT	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/CV/4_Crusher_Power/Low Limit.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CRUSHER_POWER.LOW-LIMIT-WEIGHT	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/CV/4_Crusher_Power/Low Limit Error Weight.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CRUSHER_POWER.MV1.DTBIAS	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/Dead Time Bias.Value[1]
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CRUSHER_POWER.MV1.GMULT	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/Gain Multiplier.Value[1]
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CRUSHER_POWER.MV2.DTBIAS	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/Dead Time Bias.Value[2]
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CRUSHER_POWER.MV2.GMULT	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/Gain Multiplier.Value[2]
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CRUSHER_POWER.NUMBER-OF-BLOCKS	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/CV/4_Crusher_Power/Number of Blocks.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CRUSHER_POWER.PERF-RATIO	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-

	005c/ProfCon/CV/4_Crusher_Power/Perf Ratio.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CRUSHER_POWER.PV	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/CV/4_Crusher_Power/Read Value DCS.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CRUSHER_POWER.SS-VALUE	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/CV/4_Crusher_Power/SS Value.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CRUSHER_POWER.STATE-ESTIMATION	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/CV/4_Crusher_Power/State Estimation.InternalValue
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CRUSHER_POWER.TARGET	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/CV/4_Crusher_Power/Desired Value.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_CRUSHER_POWER.TARGET-WEIGHT	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/CV/4_Crusher_Power/Quadratic Coeff.Value

6.12) PROFIT-CONTROLLER-MV1 Tags

6.12.1) GSI Interface: IDX_SIS_MPC_26583_JIG_T_CRUSHING_HONEYWELL

Tag	OPC Tag
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CAVITY_LEVEL.APC-SP	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_Cavity_Level/Sent Value.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CAVITY_LEVEL.CONSTRAINT-TYPE	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_Cavity_Level/Constraint Type.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CAVITY_LEVEL.DELTA-SOFT-HIGH-LIMIT	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_Cavity_Level/Delta Soft High Limit.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CAVITY_LEVEL.DELTA-SOFT-LOW-LIMIT	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_Cavity_Level/Delta Soft Low Limit.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CAVITY_LEVEL.ENABLED	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_Cavity_Level/Use This MV.InternalValue
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CAVITY_LEVEL.HIGH-LIMIT	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_Cavity_Level/High Limit.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CAVITY_LEVEL.LIMIT-VIOLATION	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_Cavity_Level/Read Value.Color
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CAVITY_LEVEL.LINEAR-COEFF	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_Cavity_Level/Linear Coeff.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CAVITY_LEVEL.LOW-LIMIT	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_Cavity_Level/Low Limit.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CAVITY_LEVEL.MAIN-CV	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_Cavity_Level/SSMove Main CV.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CAVITY_LEVEL.MAX-MOVE-DOWN	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_Cavity_Level/Max Move Down.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CAVITY_LEVEL.MAX-MOVE-UP	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_Cavity_Level/Max Move Up.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CAVITY_LEVEL.MV-MAN-ACTION	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_Cavity_Level/MV Man Action.InternalValue
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CAVITY_LEVEL.NUMBER-OF-BLOCKS	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_Cavity_Level/Number of Blocks.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CAVITY_LEVEL.OP	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_Cavity_Level/Read OP Value.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CAVITY_LEVEL.OP-HIGH	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_Cavity_Level/OP High Windup.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CAVITY_LEVEL.OP-HIGH-TRANSITION	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_Cavity_Level/OP High Transition.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CAVITY_LEVEL.OP-LOW	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_Cavity_Level/OP Low

	Windup.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CAVITY_LEVEL.OP-LOW-TRANSITION	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_Cavity_Level/OP Low Transition.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CAVITY_LEVEL.OP-TO-PV-GAIN	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_Cavity_Level/OP to PV Gain.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CAVITY_LEVEL.PB-ANTIWINDUP-RATIO	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_Cavity_Level/PB AntiWindup Ratio.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CAVITY_LEVEL.PV	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_Cavity_Level/Read Process Value.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CAVITY_LEVEL.QUADRATIC-COEFF	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_Cavity_Level/Quadratic Coeff.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CAVITY_LEVEL.RESOLUTION	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_Cavity_Level/Resolution.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CAVITY_LEVEL.SP	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_Cavity_Level/Read Value.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CAVITY_LEVEL.STATUS	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_Cavity_Level/Status.InternalValue
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CAVITY_LEVEL.TARGET	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_Cavity_Level/Desired Value.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CAVITY_LEVEL.USE-ARCH-LIMIT	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_Cavity_Level/Use Ach Limit.InternalValue
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CAVITY_LEVEL.WEIGHT	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_Cavity_Level/Weight.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CAVITY_LEVEL.WINDUP-SLOT	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_Cavity_Level/Windup Status.InternalValue

6.13) PROFIT-CONTROLLER-MV2 Tags

6.13.1) GSI Interface: IDX_SIS_MPC_26583_JIG_T_CRUSHING_HONEYWELL

Tag	OPC Tag
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CSS.APC-SP	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_CSS/Sent Value.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CSS.CONSTRAINT-TYPE	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_CSS/Constraint Type.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CSS.DELTA-SOFT-HIGH-LIMIT	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_CSS/Delta Soft High Limit.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CSS.DELTA-SOFT-LOW-LIMIT	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_CSS/Delta Soft Low Limit.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CSS.ENABLED	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_CSS/Use This MV.InternalValue
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CSS.HIGH-LIMIT	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_CSS/High Limit.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CSS.LIMIT-VIOLATION	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_CSS/Read Value.Color
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CSS.LINEAR-COEFF	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_CSS/Linear Coeff.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CSS.LOW-LIMIT	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_CSS/Low Limit.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CSS.MAIN-CV	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_CSS/SSMove Main CV.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CSS.MAX-MOVE-DOWN	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_CSS/Max Move Down.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CSS.MAX-MOVE-UP	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_CSS/Max Move Up.Value
	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-

SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CSS.MV-MAN-ACTION	005c/ProfCon/MV/4_Tert_Crusher_CSS/MV Man Action.InternalValue
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CSS.NUMBER-OF-BLOCKS	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_CSS/Number of Blocks.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CSS.OP	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_CSS/Read OP Value.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CSS.OP-HIGH	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_CSS/OP High Windup.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CSS.OP-HIGH-TRANSITION	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_CSS/OP High Transition.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CSS.OP-LOW	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_CSS/OP Low Windup.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CSS.OP-LOW-TRANSITION	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_CSS/OP Low Transition.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CSS.OP-TO-PV-GAIN	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_CSS/OP to PV Gain.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CSS.PB-ANTIWINDUP-RATIO	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_CSS/PB AntiWindup Ratio.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CSS.PV	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_CSS/Read Process Value.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CSS.QUADRATIC-COEFF	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_CSS/Quadratic Coeff.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CSS.RESOLUTION	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_CSS/Resolution.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CSS.SP	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_CSS/Read Value.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CSS.STATUS	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_CSS/Status.InternalValue
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CSS.TARGET	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_CSS/Desired Value.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CSS.USE-ARCH-LIMIT	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_CSS/Use Ach Limit.InternalValue
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CSS.WEIGHT	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_CSS/Weight.Value
SIS-JIG.SEP.APC-J144_LIC_005C.PROFIT_4_TERT_CRUSHER_CSS.WINDUP-SLOT	(J144-LIC-005c)/$J144-LIC-005c/J144-LIC-005c/ProfCon/MV/4_Tert_Crusher_CSS/Windup Status.InternalValue

6.14) OTHER Tags

6.14.1) GSI Interface: IDX_SIS_EXPERT_22583_JIG_T_CRUSHING

Tag	OPC Tag
SIS-JIG.SEP.APC-J144_LIC_005C.HB-IN	G02M100.G02M100.DB929;INT664
SIS-JIG.SEP.APC-J144_LIC_005C.HB-OUT	G02M100.G02M100.DB929;INT14
SIS-JIG.SEP.CNVYR-J144-G3700.STATUS.PV	JIG_Galaxy.J144G3768_T12.S_Running
SIS-JIG.SEP.CNVYR-J154-G2600.CURRENT.PV	JIG_Galaxy.J154G2668_T1.S_Current
SIS-JIG.SEP.CNVYR-J154-G2600.WEIGHTOMETER-01.PV	JIG_Galaxy.J154G2600B_T4.S_ProcessValue
SIS-JIG.SEP.CNVYR-J154-G2600.WEIGHTOMETER-02.PV	JIG_Galaxy.J154G2600A_T4.S_ProcessValue
SIS-JIG.SEP.CNVYR-J154-G2700.CURRENT.HH	G02M100.G02M100.DB942;REAL436
SIS-JIG.SEP.CNVYR-J154-G2700.CURRENT.PV	JIG_Galaxy.J154G2768_T25.S_Current
SIS-JIG.SEP.CNVYR-J154-G2700.RECYCLE-WEIGHTOMETER.HH	G02M100.G02M100.DB940;REAL460
SIS-JIG.SEP.CNVYR-J154-G2700.RECYCLE-WEIGHTOMETER.PV	JIG_Galaxy.J140_DIAG01.TC_RECIRC_RATE
SIS-JIG.SEP.CONE-CRSH-J144-G3120.GAP-ADJUSTMENT-PANEL-LOCAL-ACTIVE.PV	JIG_Galaxy.J144_GY001.S_bGapAdjPanelLocActive
SIS-JIG.SEP.CONE-CRSH-J144-G3120.GAP-ADJUSTMENT-PANEL-LOCAL-REQUEST.PV	JIG_Galaxy.J144_GY001.S_bGapAdjPanelLocReq
SIS-JIG.SEP.FDR-J144-G1118.STATUS.PV	JIG_Galaxy.J144G1118_T12.S_Running
SIS-JIG.SEP.FDR-J144-G1128.STATUS.PV	JIG_Galaxy.J144G1128_T12.S_Running
SIS-JIG.SEP.MOTOR-J144-G3128.STATUS.PV	JIG_Galaxy.J144G3128_T25.S_Running

6.14.2) GSI Interface: IDX_SIS_EXPERT_30581_JIG_LYNXX

Tag	OPC Tag
SIS-JIG.SEP.CAM-J144-G3120-LYNXX.CAMERA-STATUS.PV	J144_PSA_all_ok
SIS-JIG.SEP.CAM-J144-G3120-LYNXX.PASSING-31.5MM.PV	J144_PSA_sfcp12
SIS-JIG.SEP.CAM-J144-G3120-LYNXX.PASSING-8MM.PV	J144_PSA_sfcp6

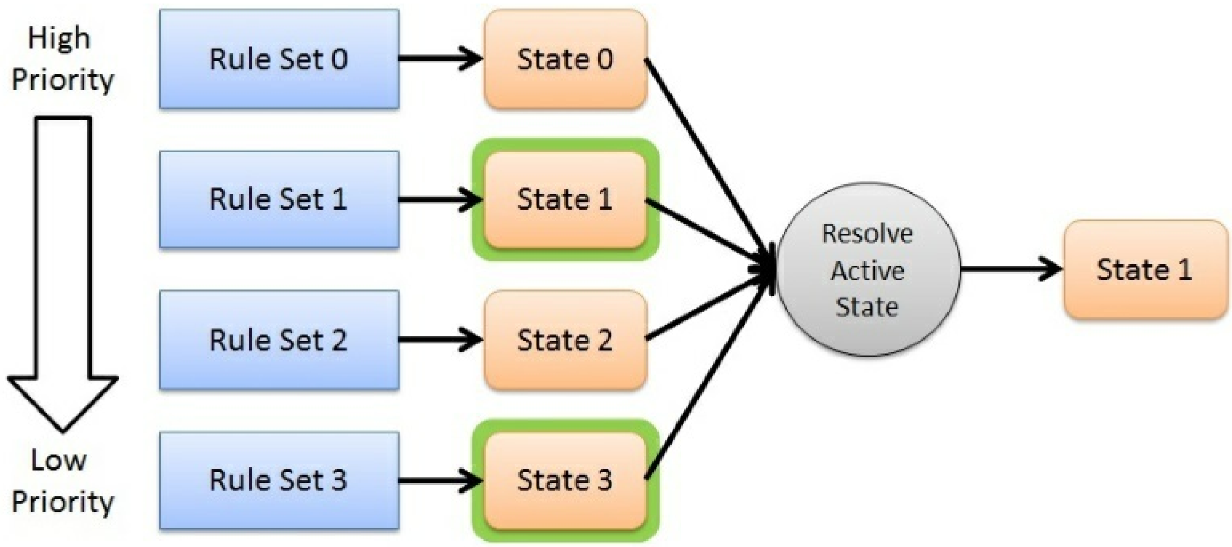
ADDENDUMS

A1 - Basic Principles of Process States

In APET, control philosophies are built around the state of the process. Different process conditions (broadly speaking) require different actions to be taken to achieve performance targets. In APET, process states are resolved through graphical rules and used in a hierarchical bidding system to determine the current process state. The governing state is then used in deciding which control scheme to implement.

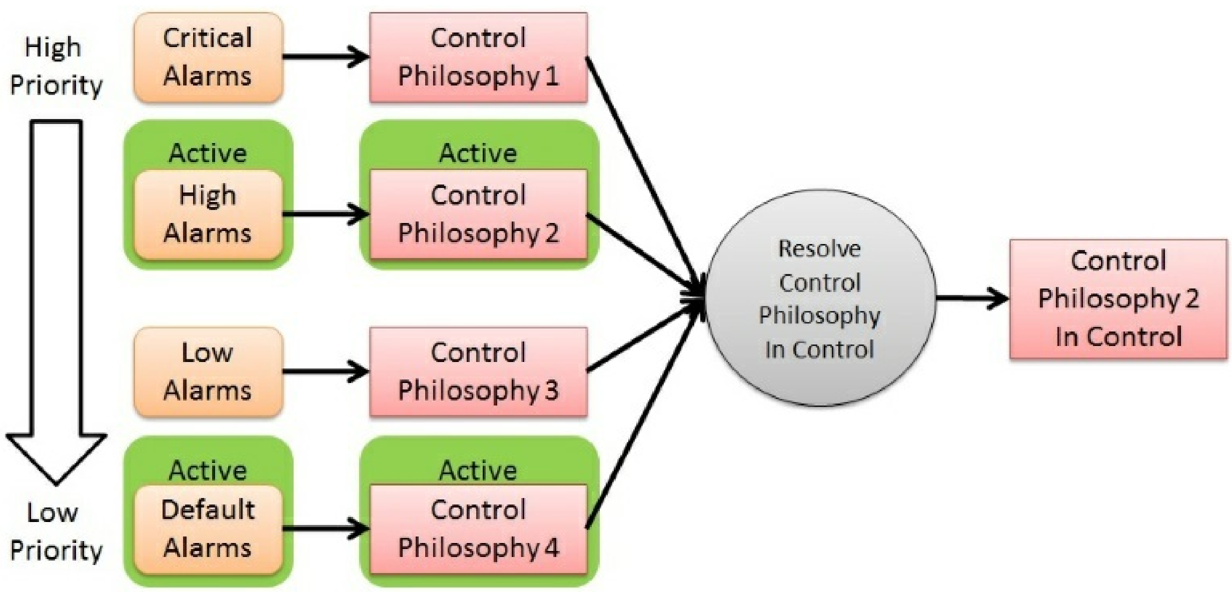
These two steps are briefly described below.

1) Active State Resolution
Each state is determined by a set of rules. These are usually built up using graphical rules and may monitor any information available within the APET application. A state is considered active if all specified conditions are met. This means that it is possible the more than one state can be active at a time. To deal with this, states are ranked based on a priority, so that the active state with the highest priority becomes the in-control state.



Because it is also possible that no states are active, it is important to select a state that acts as the default state. The default state usually corresponds to the state with the lowest priority (default alarms).

2) Control Philosophy Resolution
Each state corresponds to a specific control philosophy that will be implemented. Once the active state has been determined, the corresponding control philosophy is activated.



There are always 4 controller states for every APC controller in APET. These controller states are grouped together as follows:
1. Critical Alarms
2. High Alarms
3. Low Alarms
4. Default Alarms

Each of these 4 controller states may containing at least one referencing state. For example, the Default Alarms container will contain the MPC optimizer and default states amongst others.

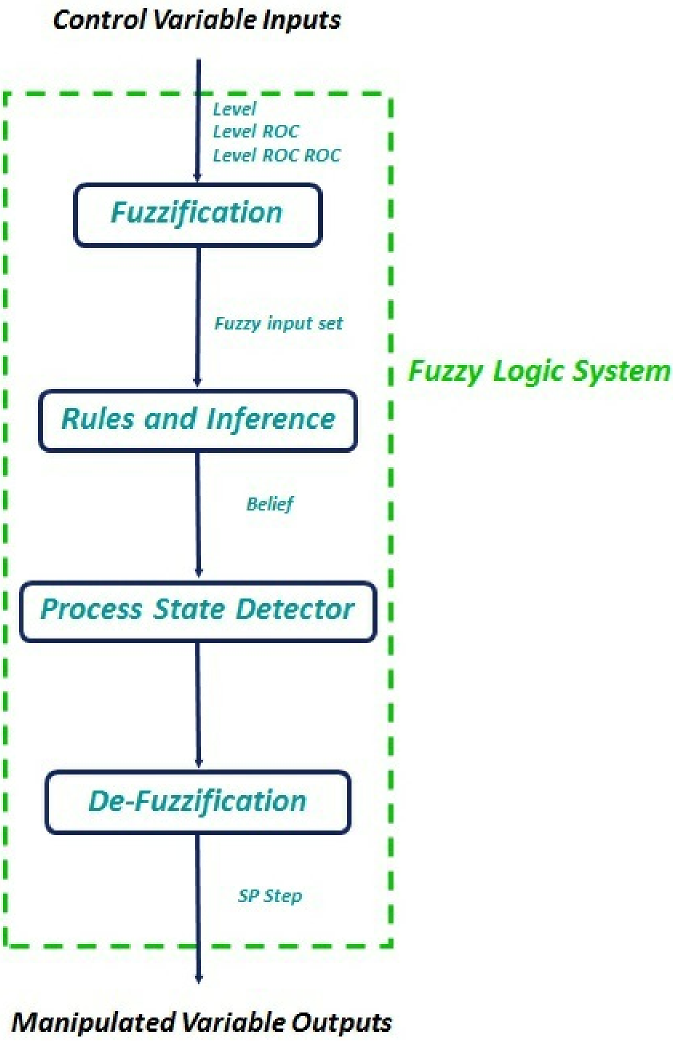
Based on the referenced states of each controller state, the State Index of the controller state may be:
0 if it is not active
1 active but not in-control
2 active AND in-control

All of the attributes of the controller states are display on the SCADA faceplate.

If the controller has detected a certain process state scenario, it will take corrective actions in an attempt to resolve this scenario. The corresponding BELIEF value displayed next to a PROCESS STATE is an indication of how true this state is. The belief value of each state will determine the size of the control actions implemented. If the PROCESS STATE belief state is 65.0% true, than less aggressive control actions will be implemented to resolve this condition compared to a scenario where the belief value is 90.0% true. This approach implies that the controller will never wait for any process state (excluding the DEFAULT state, which represents the stable state) to reach a value of 100.0% before implementing any control actions to resolve the state. All of the PROCESS STATES other than the DEFAULT state are less desirable state conditions and the controller will attempt to keep their belief values as low as possible.

A2 - Basic principles of Fuzzy Control

A fuzzy logic system (FLS) can be defined as the nonlinear mapping of an input data set to a scalar output data. A FLS consists of four main parts: fuzzifier, rules, inference engine, and defuzzifier. These components and the general architecture of a FLS is shown in the figure below.



The process of fuzzy logic is defined as follows: Firstly, a crisp set of input data are gathered and converted to a fuzzy set using fuzzy linguistic variables, fuzzy linguistic terms and membership functions. This step is known as fuzzification. Afterwards, an inference is made based on a set of rules. Lastly, the resulting fuzzy output is mapped to a crisp output using the membership functions, in the defuzzification step.

The fuzzy logic algorithm can be summarized as follows:

1. Define the linguistic variables and terms (initialization)
2. Construct the membership functions (initialization)
3. Construct the rule base (initialization)
4. Convert crisp input data to fuzzy values using the membership functions (fuzzification)
5. Evaluate the rules in the rule base (inference)
6. Combine the results of each rule (inference)
7. Convert the output data to non-fuzzy values (defuzzification)

Linguistic variables are the input or output variables of the system whose values are words or sentences from a natural language, instead of numerical values. A linguistic variable is generally decomposed into a set of linguistic terms. Example: Leven in a bin. Let level (LVL) be the linguistic variable which represents the amount of material in the bin. To qualify the level, terms such as high and low are used in real life. These are the linguistic values of the level. Then, LVL(t) = extremely low, low, ok, high, extremely high can be the set of decompositions for the linguistic variable level. Each member of this decomposition is called a linguistic term and can cover a portion of the overall values of the bin level.

Membership functions are used in the fuzzification and defuzzification steps of a FLS, to map the non-fuzzy input values to fuzzy linguistic terms and vice versa. A membership function is used to quantify a linguistic term. Note that, an important characteristic of fuzzy logic is that a numerical value does not have to be fuzzified using only one membership function. In other words, a value typically belongs to multiple sets at the same time. For example the bin level value can be considered as extremely low and low at the same time, with different degrees of memberships.

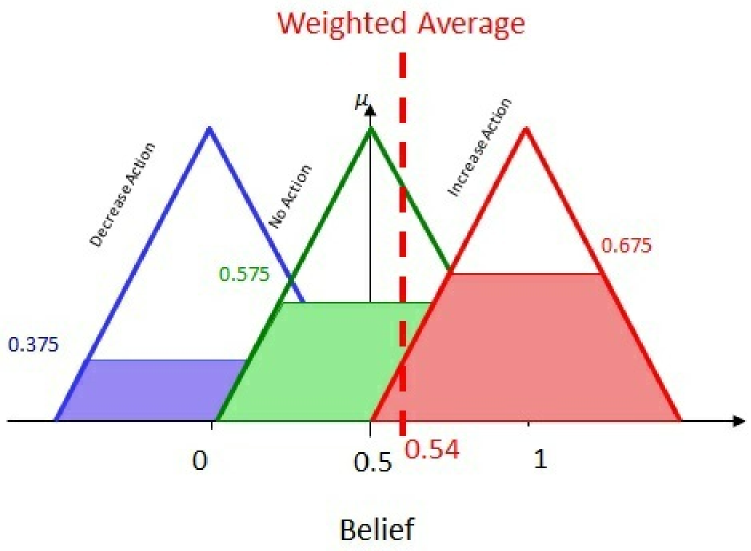
APET includes a powerful fuzzy controller toolset which includes a very flexible editing environment as well as a variety of membership functions to be used.

Each CV feeding into the controller is fuzzified (classified within a fuzzy membership function) by one or more FIS-INPUTS. For control variables (CV) there are typically three types of classification: proximity (this relates to the normalized value), slope (rate of change) and slope rate of change (this implies acceleration).

For each of the fuzzy families, a specific input must be provided based on the value of the CV (and its recent history).

1. Proximity: this is a comparison of the normalized value of the CV
2. Slope: this represents the slope or rate of change of the CV over a defined period and is calculated within the APC system
3. Slope Rate of Change: this represents the rate of change of the slope of the CV and is calculated within the APC system

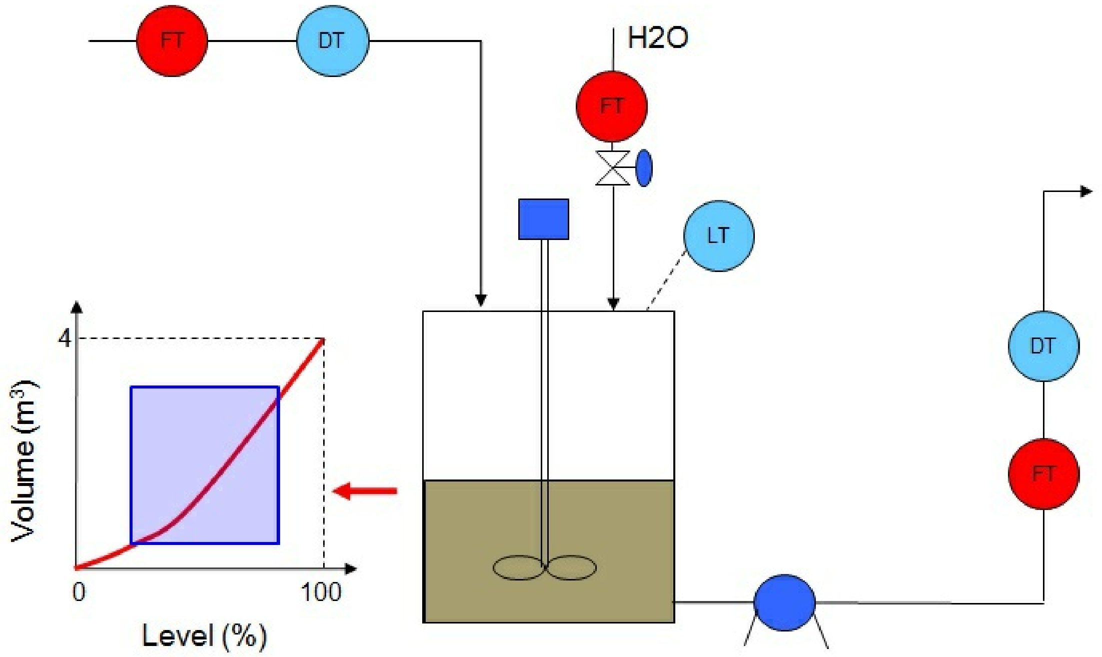
After the inference step, the overall result is a fuzzy value. This result should be defuzzified based on the process state which is In Control to obtain a final crisp output. This is the purpose of the defuzzifier component of a FLS. Defuzzification is performed according to the membership function of the output variable. For instance, assume that we have the result in the figure below at the end of the inference. In this figure, the shaded areas all belong to the fuzzy result. The purpose is to obtain a crisp value, represented by the dotted line in the figure below, from this fuzzy result.



The crisp value (or belief) is then converted back to a setpoint change using the defuzzy function.

A3 - Basic Principles of Model Based Control (MBC)

Sumps and surge tanks form a buffer between processes, and can be used to reject large disturbances and thereby improve stability in downstream operations. They typically resemble the diagram below, with multiple input lines (some possibly unmeasured) and a single discharge.



Fundamentally, the change in sump volume (dV/dt) is equal to the net flow into the sump, or:

$$\frac{dV(t)}{dt} = F_{in}(t) - F_{out}(t)$$

Where: F_{in} and F_{out} = respective flow measured in m^3/s

Integrating to get the current sump volume:

$$V(t) = \int_0^t F_{in}(\tau) - F_{out}(\tau)d\tau = \int_0^t \Delta F(\tau)d\tau$$

This is the principle on which all derivations are done The sump tank is a pure integrating process, where the model based control aims to minimize flow out deviation by modifying the sump level via its derivative DeltaF(t).

To minimize the discharge flowrate variation, there are two basic approaches the model based controller can take:
1. Delay control action until it is really necessary, or
2. Perform minimal control action now in the event that it will stave off drastic changes later.

Principle: There exists a time Tc such that if we ramp Fout(t) at a rate of Mout then we will be at capacity at Tc, with a net flowrate of zero, given that Fin(t) remains constant.

This implies that we begin the ramp now, and depending on the volume between the capacity and our current level, we will reach the capacity limit at Tc. Therefore if there is a large DeltaV (effectively - capacity available), the ramp will have an extremely slow rate and the flow out will hardly be affected, whereas if we are at capacity (DeltaV), the flow out will track the flow in. It is possible to even allow for discharge flow overshoot if we are over capacity.

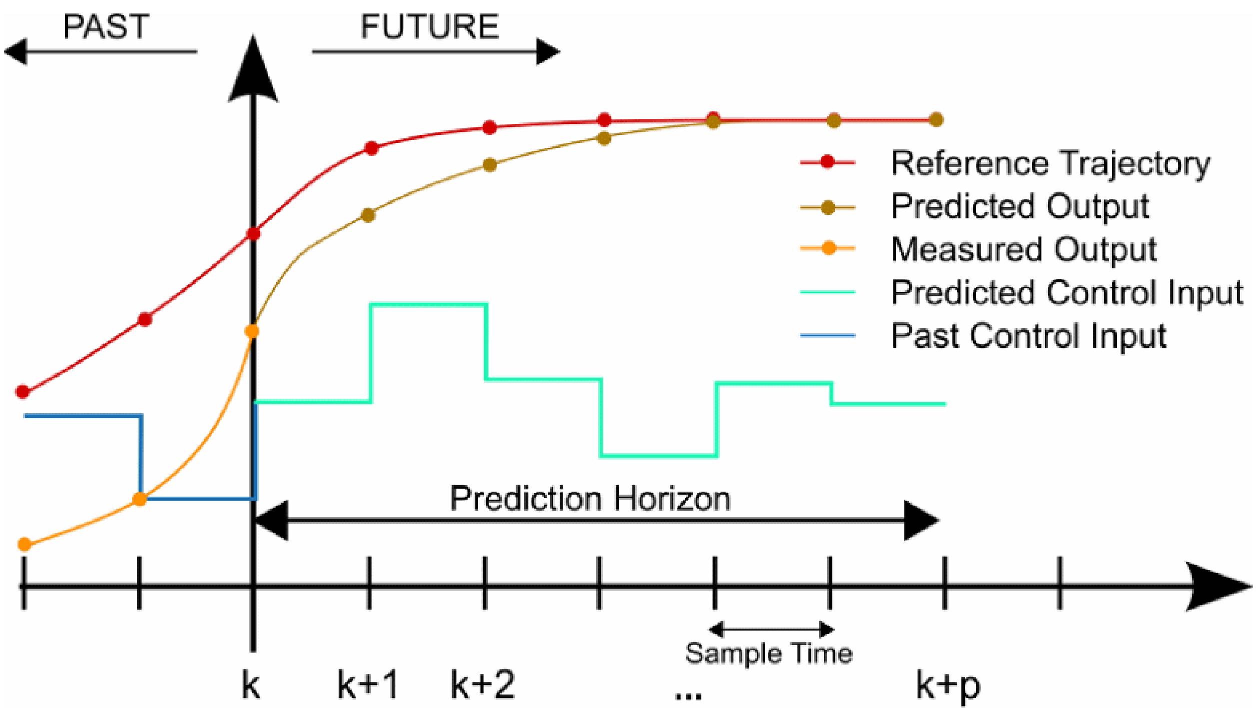
A4 - Basic Principles of Model Predictive Control (MPC)

Model predictive control (MPC) is an advanced method of process control that has been in use in the process industries in chemical plants and oil refineries since the 1980s. Model predictive controllers rely on dynamic models of the process, most often linear empirical models obtained by system identification. Dynamic process models describe how the process parameters will respond in the future for changes made to the process in the present time. These models can therefore predict process responses into the future. The main advantage of MPC is the fact that it allows for the current process conditions (current timeslot) to be optimized, while accounting for future process conditions (future timeslots) still to happen as a result of changes to the current process conditions. This is achieved by optimizing over a finite time-horizon (the future predictions), implementing the current timeslot actions and then relying on feedback to account for unmeasured disturbances and model/plant mismatches. This implies that the model prediction error that may exist (or develop over time) is also taken into account by the MPC algorithm. MPC models therefore do not have to be 100% accurate. As a result of this the MPC technology is very robust, and typically outperforms most other advanced process control techniques. The MPC further has the ability to anticipate/predict future events and can take control actions accordingly. An example of this is that the MPC can predict that the bin level will drop below the low level limit, which will result in the feeder being interlocked and stopped. The feeder stop will again cause the bin level to increase sharply. The MPC can take all of these future predictions into account and prevent this scenario from happening. PID controllers normally implemented as part of the base layer (PLC) control do not have this predictive ability. Therefore the PID controller in the base layer (PLC) control will not be able to prevent the above feeder interlock and stop.

The models used in MPC are generally intended to represent the behaviour of complex dynamic systems, which cannot be effectively controlled by base layer (PLC) controllers such as PID controllers. Dynamic characteristics that are difficult for PID controllers include large time delays, variable interaction and high-order dynamics.

MPC uses current and historical plant responses/measurements, the current dynamic state of the process, the MPC models, and the process variable targets and limits to calculate future changes in the dependent variables (the variables to be controlled, such as bin levels and product mass flowrates). These changes are calculated to hold the dependent variables close to target while honoring constraints on both independent (the levers that can be pulled by the MPC system, such as feeder speeds or PID setpoints) and dependent variables. The MPC typically sends out only the first setpoint change (of the sequence of calculated changes required going into the future) in each independent variable to be implemented, and repeats the calculation when the next change is required (by updating the sequence of calculated changes required going into the future).

Below is an image to illustrate the concepts:



In summary, Model Predictive Control (MPC) is a multivariable control algorithm that uses:
1. an internal dynamic model of the process
2. a history of past control moves and
3. an optimization cost function J over the receding prediction horizon,
to calculate the optimum control moves.

An example of a quadratic cost function for optimization is given by:

$$J = \sum_{i=1}^{N} w_{x_i}(r_i - x_i)^2 + \sum_{i=1}^{N} w_{u_i}\,\Delta u_i^{\,2}$$

With:

X_i = *i*-th controlled variable (e.g. measured bin level)

r_i = *i*-th reference variable (e.g. required bin level)

u_i = *i*-th manipulated variable (e.g. feeder speed)

w_{Xi} = weighting coefficient reflecting the relative importance of X_i

w_{ui} = weighting coefficient penalizing relative big changes in u_i