Functional Design Specification for Plant Wide Optimizer
PWO-SEP_T-CRUSHING

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APC-J144_LIC_005C: The plant status is: RUNNING and the Advanced Process Controller mode is: MANUAL
APC-J143_LIC_005C: The plant status is: STOPPED and the Advanced Process Controller mode is: MANUAL
APC-J142_LIC_005C: The plant status is: RUNNING and the Advanced Process Controller mode is: MANUAL
APC-J141_LIC_005C: The plant status is: STOPPED and the Advanced Process Controller mode is: AUTO
APC-J144_LIC_002_004C: The plant status is: RUNNING and the Advanced Process Controller mode is: MANUAL
APC-J143_LIC_002_004C: The plant status is: STOPPED and the Advanced Process Controller mode is: MANUAL
APC-J142_LIC_002_004C: The plant status is: RUNNING and the Advanced Process Controller mode is: MANUAL
APC-J141_LIC_002_004C: The plant status is: STOPPED and the Advanced Process Controller mode is: MANUAL
APC-J140_BIN_005C: The plant status is: RUNNING and the Advanced Process Controller mode is: MANUAL
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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

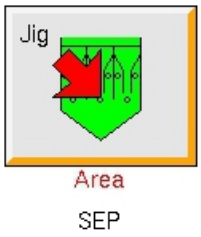

Fig 1: The members of the SIS-JIG Site - Highlighting the Jig-Area - SEP

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.

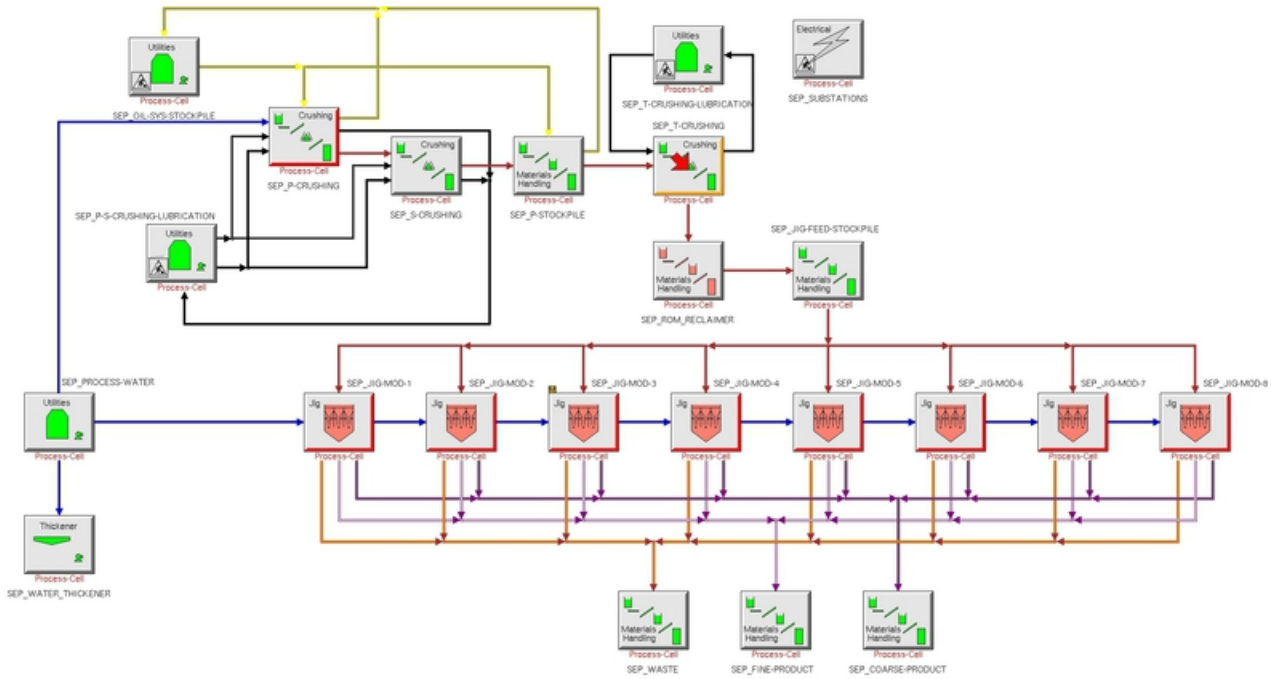

Fig 2: The members of the SEP Jig-Area - Highlighting the Crushing-Process-Cell - T-CRUSHING

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

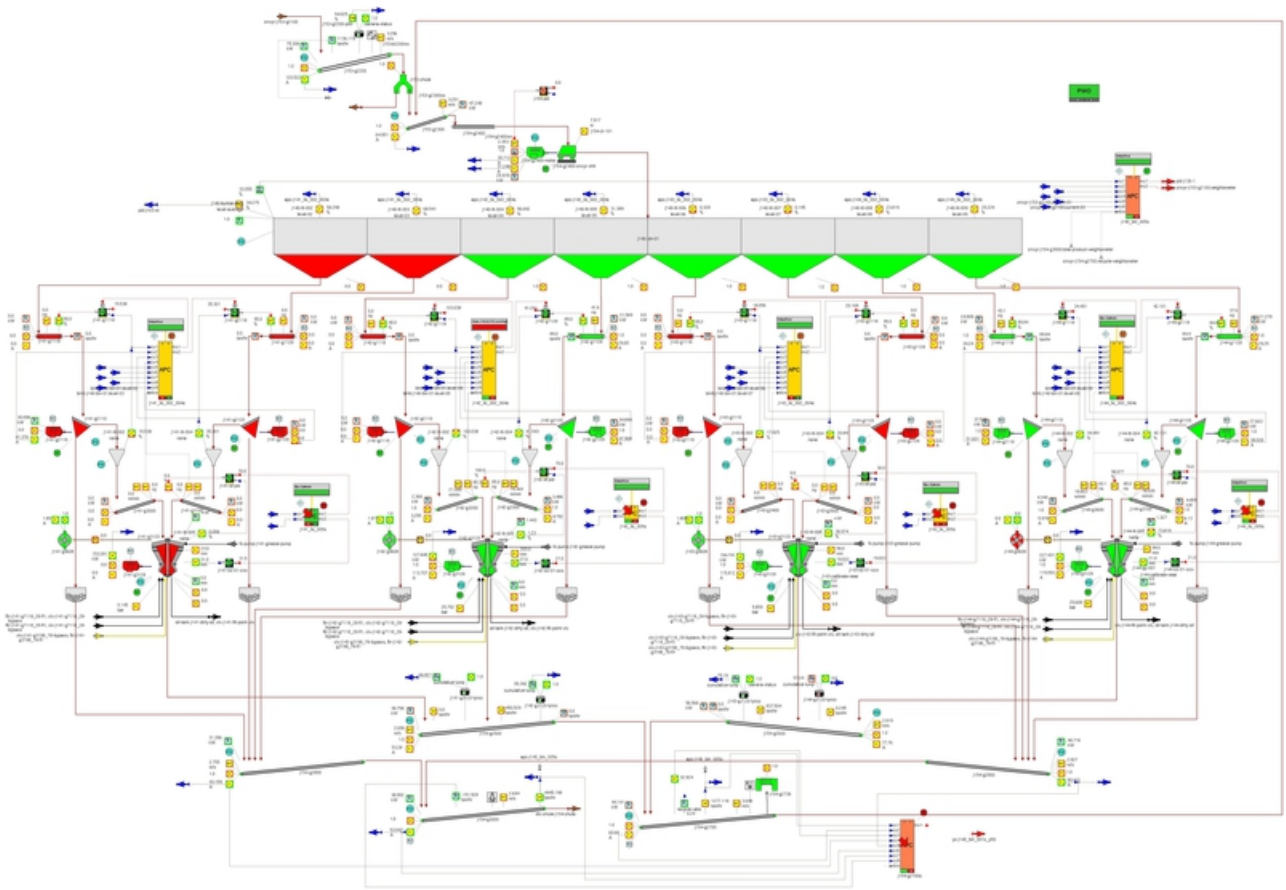

Fig 3: The members of the T-CRUSHER-PRODUCT unit which is a member of T-CRUSHING Crushing-Process-Cell - Highlighting J154-G2700C, J144_LIC_005C, J143_LIC_005C, J142_LIC_005C, J141_LIC_005C

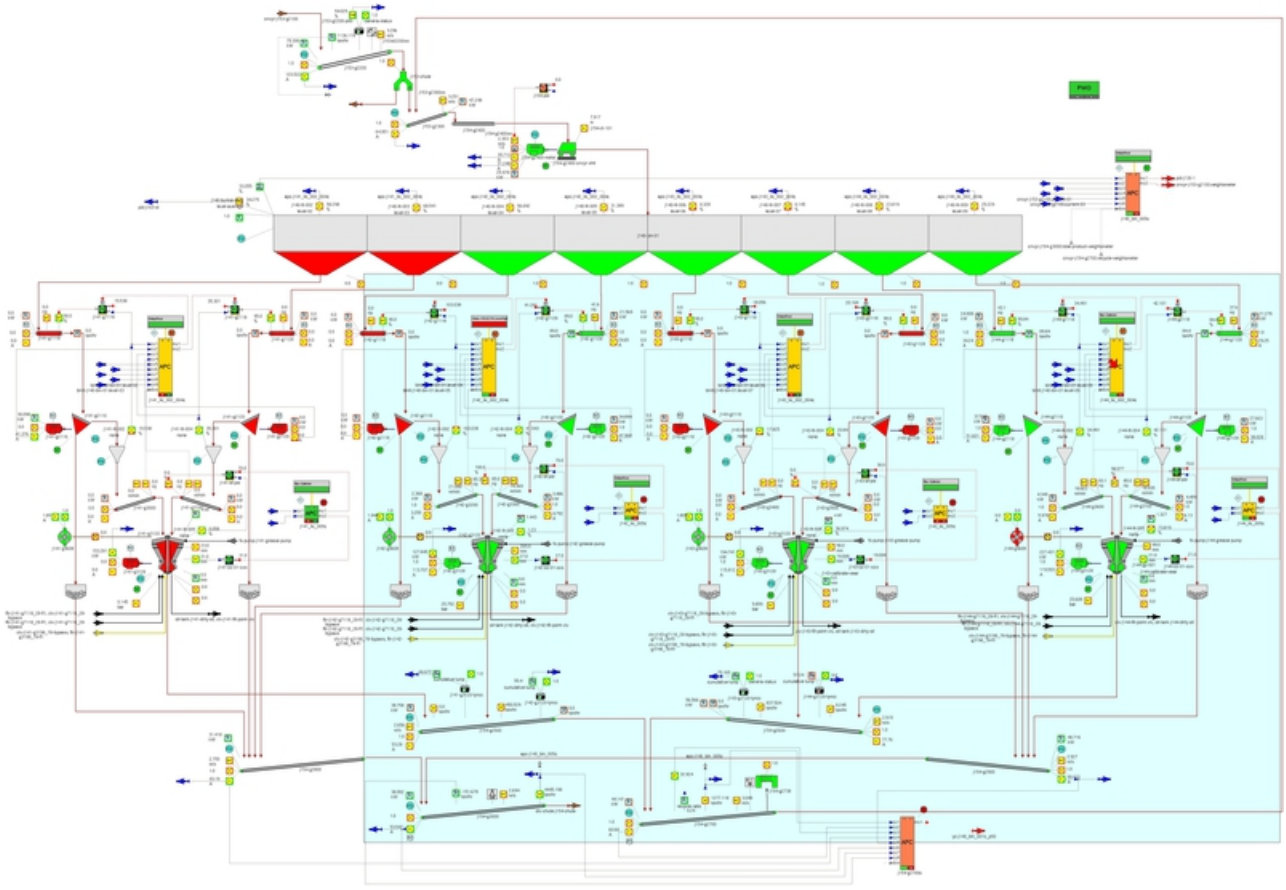

Fig 4: The members of the CRUSHER-04-FEED unit which is a member of T-CRUSHING Crushing-Process-Cell - Highlighting J144_LIC_002_004C

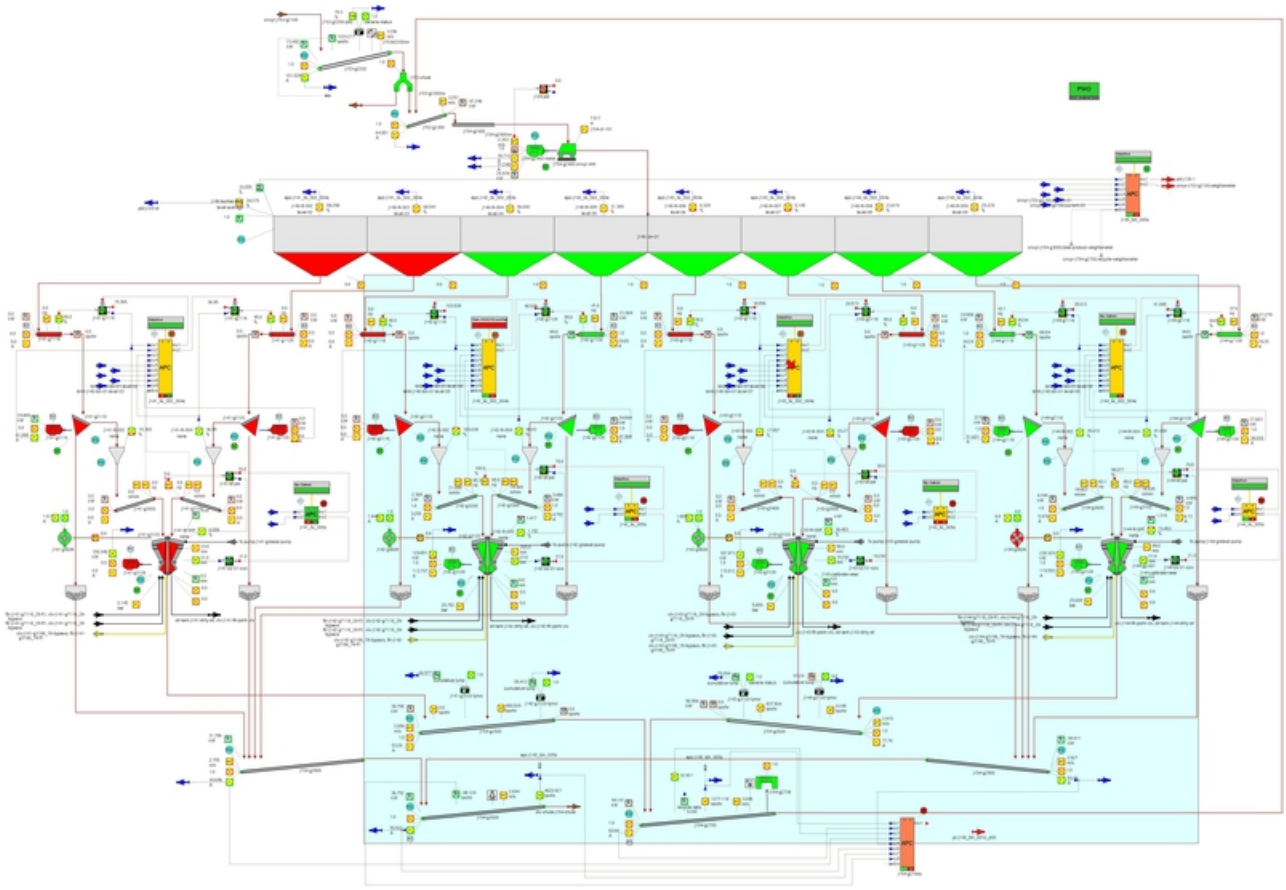

Fig 5: The members of the CRUSHER-03-FEED unit which is a member of T-CRUSHING Crushing-Process-Cell - Highlighting

J143_LIC_002_004C

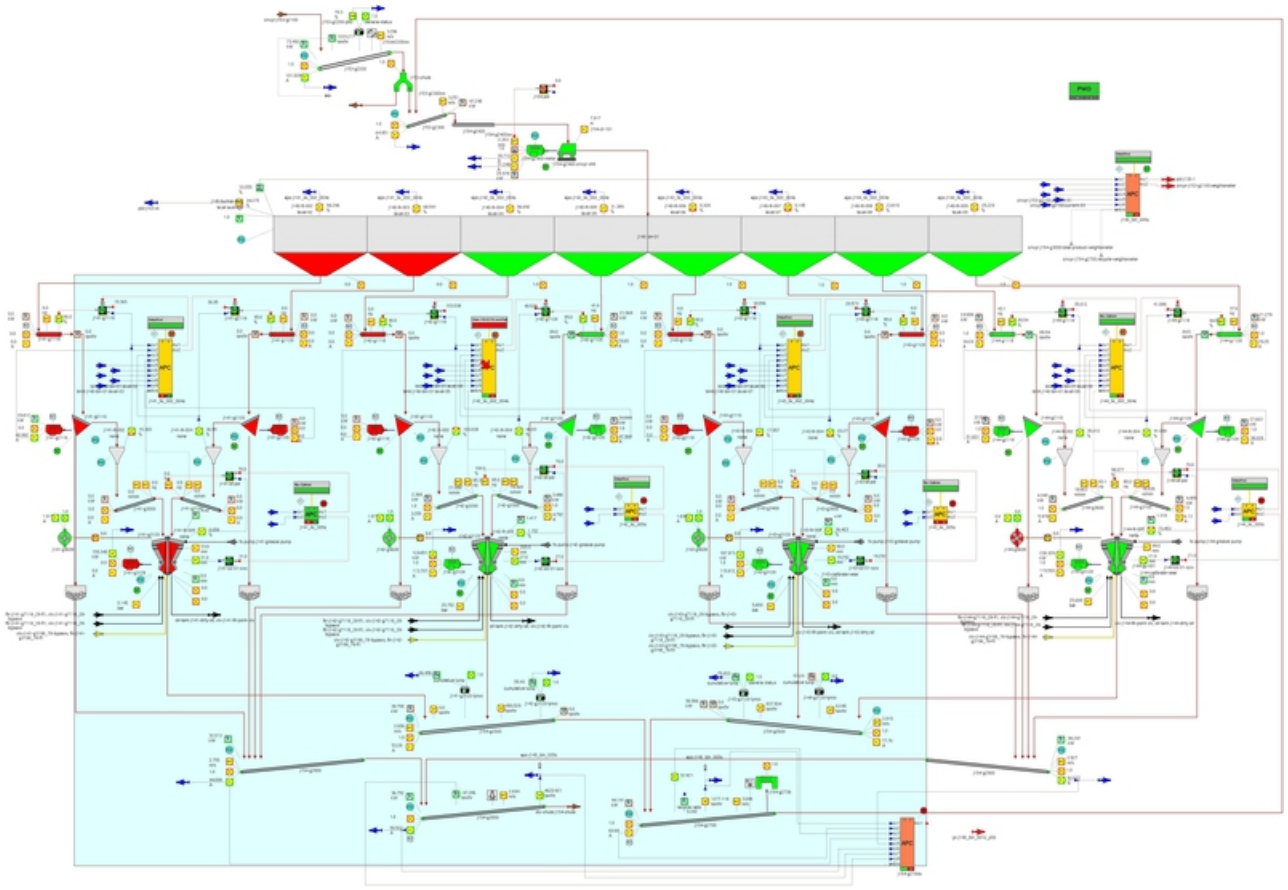

Fig 6: The members of the CRUSHER-02-FEED unit which is a member of T-CRUSHING Crushing-Process-Cell - Highlighting J142_LIC_002_004C

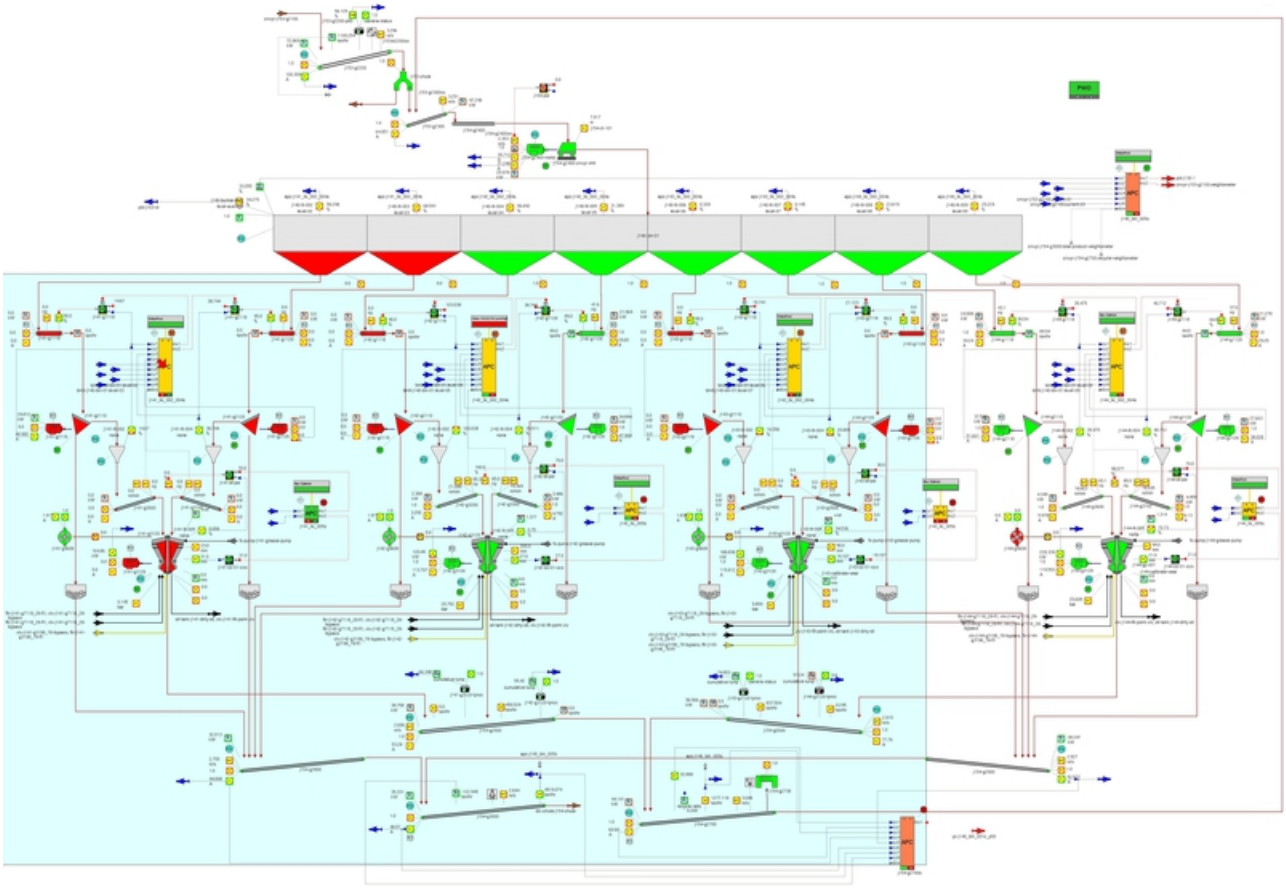

Fig 7: The members of the CRUSHER-01-FEED unit which is a member of T-CRUSHING Crushing-Process-Cell - Highlighting J141_LIC_002_004C

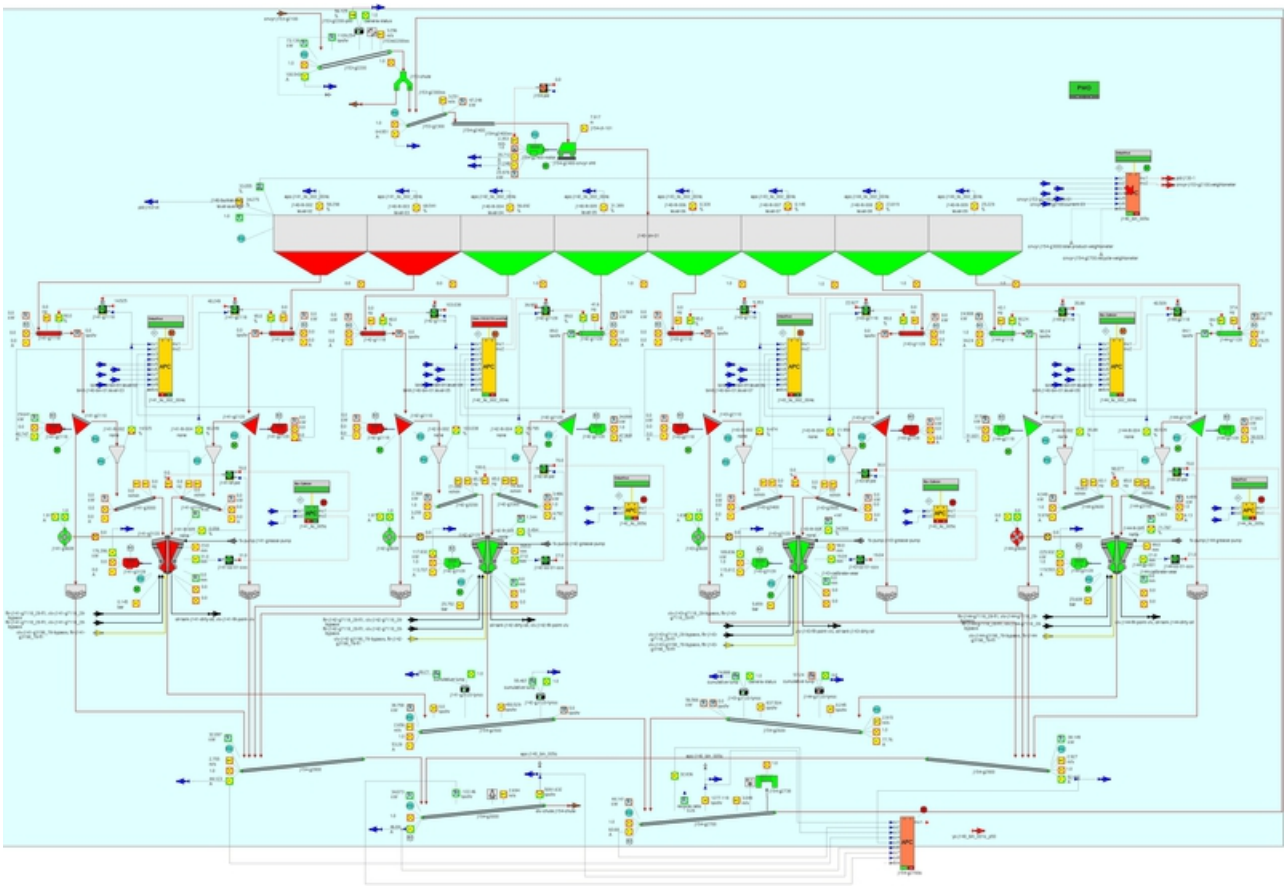

Fig 8: The members of the BIN-FEED unit which is a member of T-CRUSHING Crushing-Process-Cell - Highlighting J140_BIN_005C

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.

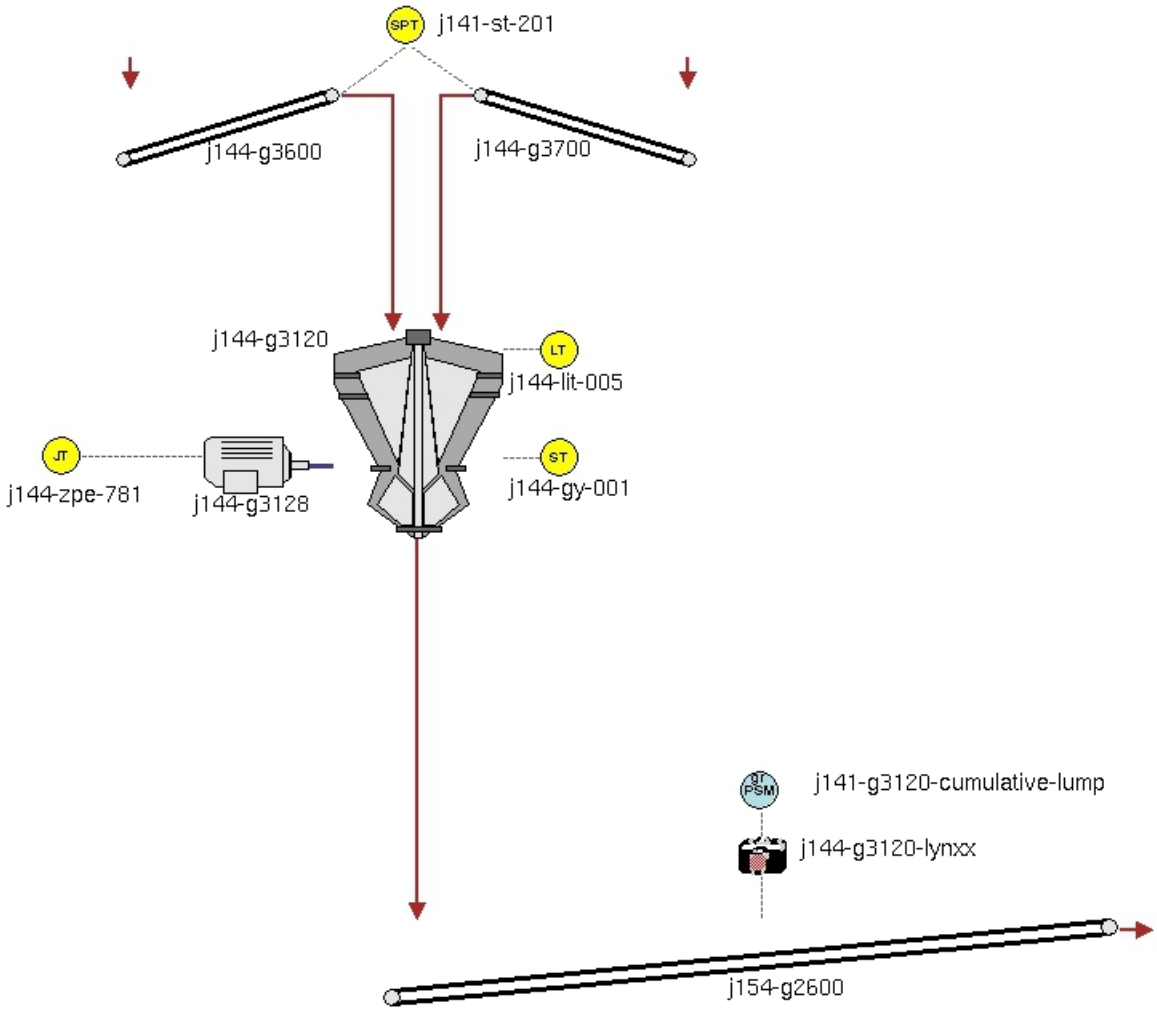

Fig 9: Relevant Circuit Schematic

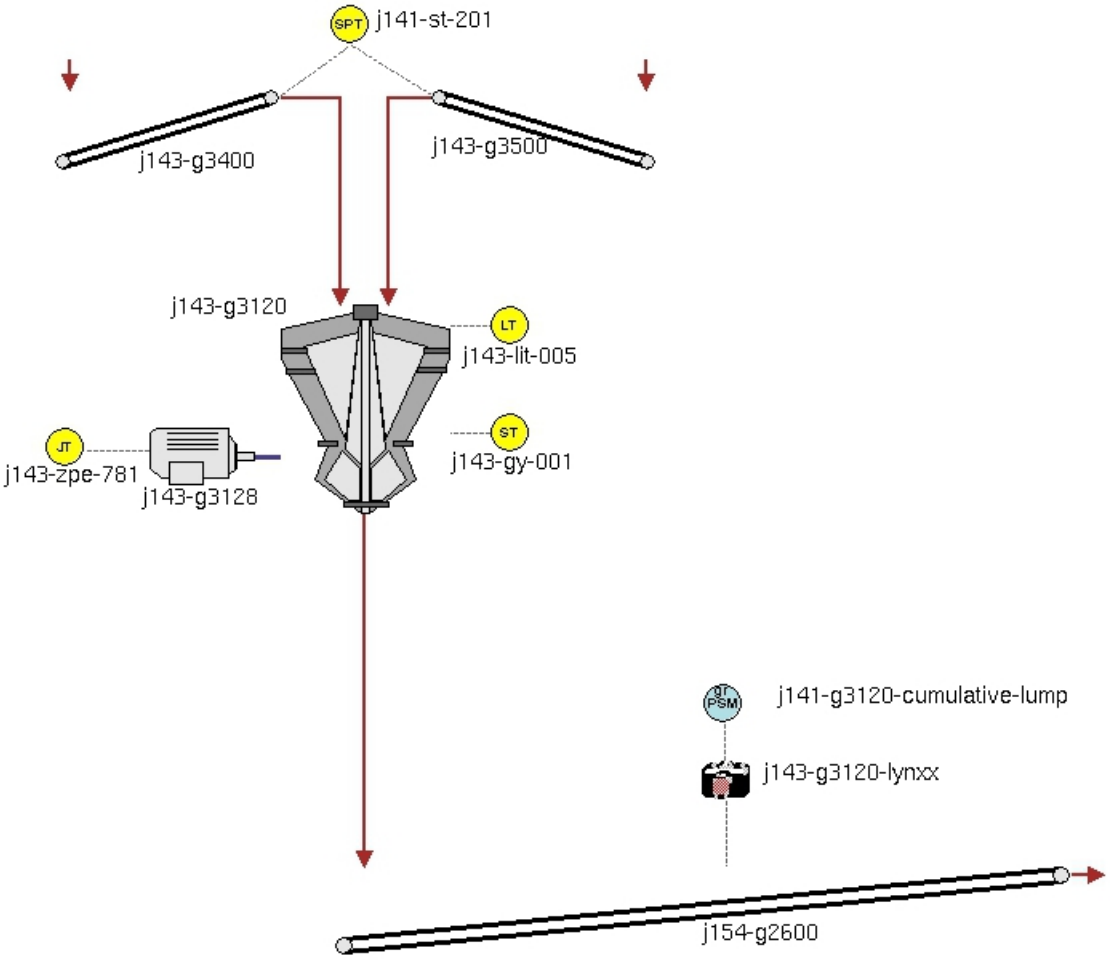

Fig 10: Relevant Circuit Schematic

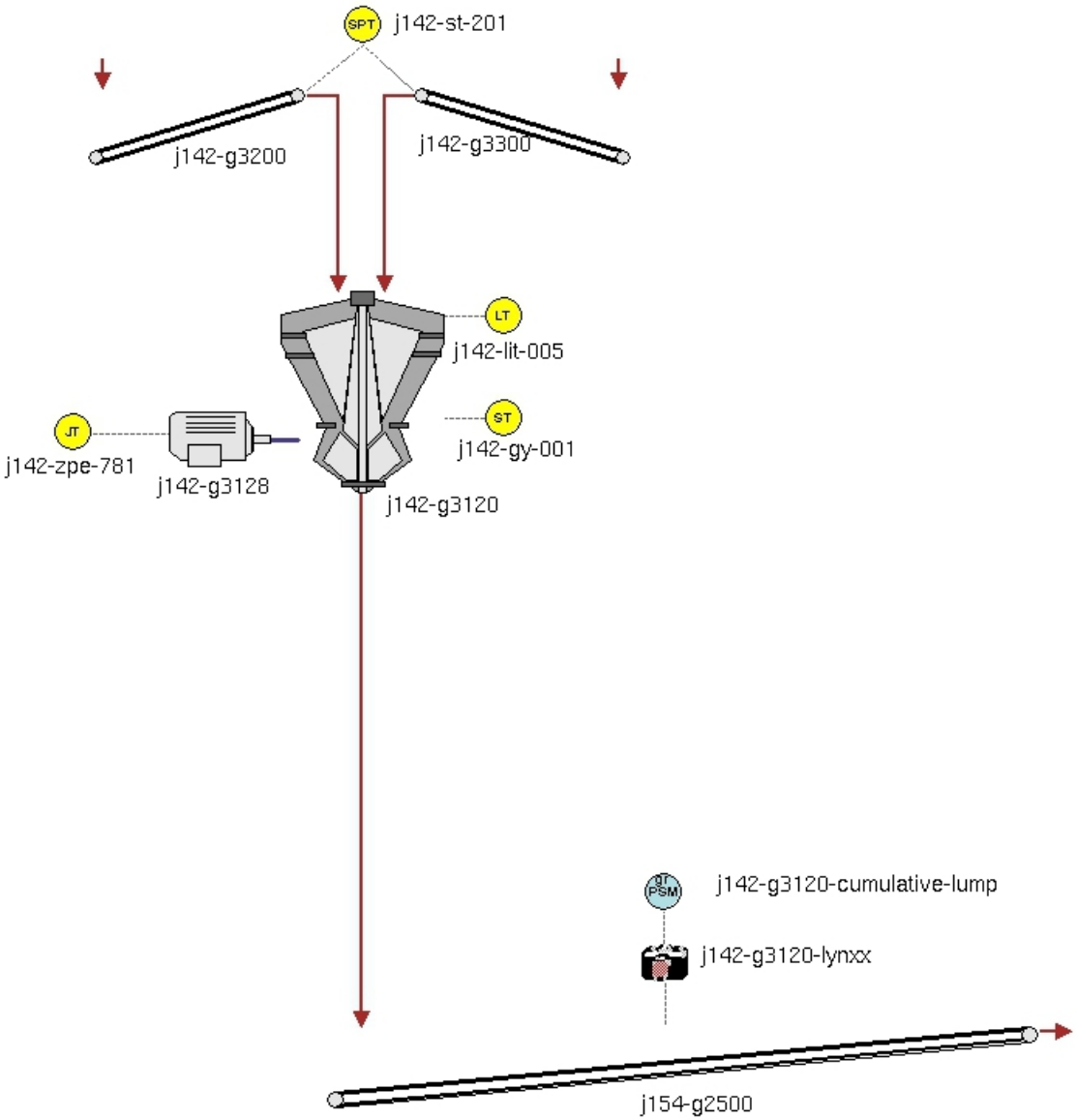

Fig 11: Relevant Circuit Schematic

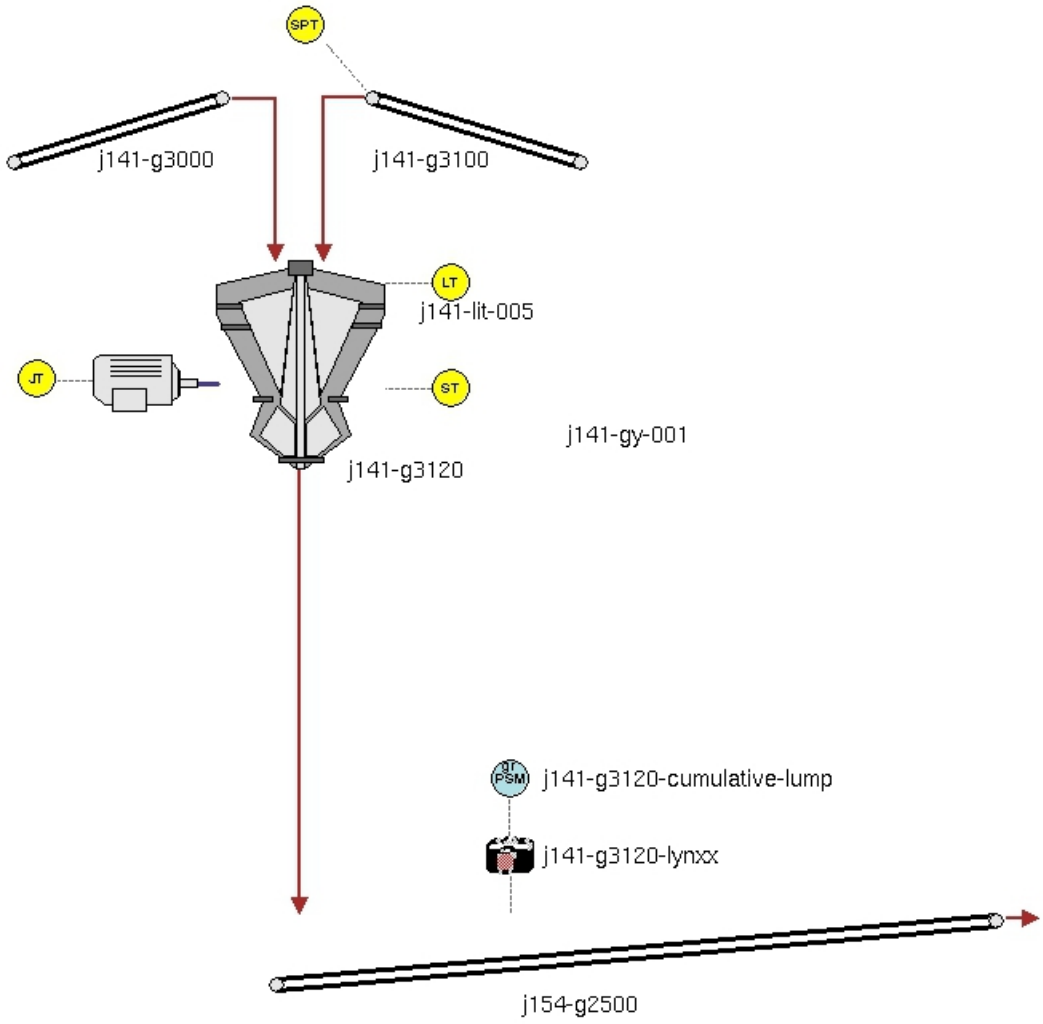

Fig 12: Relevant Circuit Schematic

1.4.2) Measures

1.5) CRUSHER-04-FEED (Unit)

1.5.1) Background

The secondary crusher (J120-G3100) output reports to the primary stockpile (J130-ST-01) which reports to the tertiary crusher feed bin (J140-BIN-01) via the tertiary crusher feed bin conveyor (J153-G2100). For each crusher unit there are two variable speed vibrating feeders (J144-G1118 and J144-G1128) withdrawing material from the tertiary crusher feed bin (J140-BIN-01). These feeders feed screens (J144-G2110 and J144-G2120) which separates the oversize from the undersize. The -25mm reports to J154-G3000 which will feed the JIG feed stockpile. The +25mm ore reports to chutes (J144-G2110-CHUTE and J144-G2120-CHUTE) which in turns feed the tertiary crusher (J144-G3120) via two variable speed conveyors (J144-G3600 and J144-G3700).

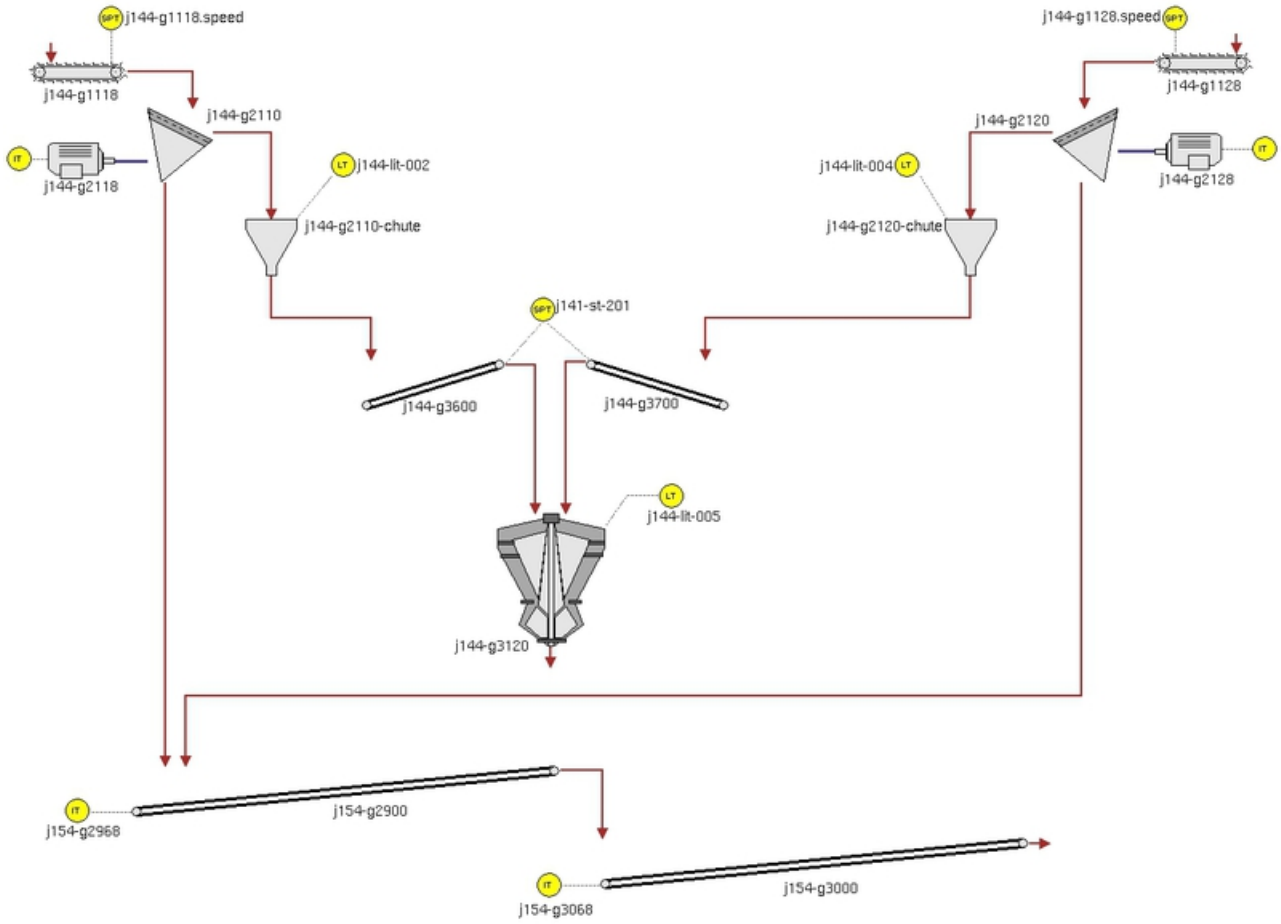

Fig 13: Relevant Circuit Schematic

1.5.1.1) Scrn-J144-G2110: Measure: Nr-Starts

Nr-Starts Measure							
Measure	Goal	EU	Owner	Key Performance Indicator (KPI)?	Lower Control Limit (LCL)	Target Value	Upper Control Limit (UCL)
NR-STARTS	MINIMIZE		APC-CUSTODIAN	false	0	0	10

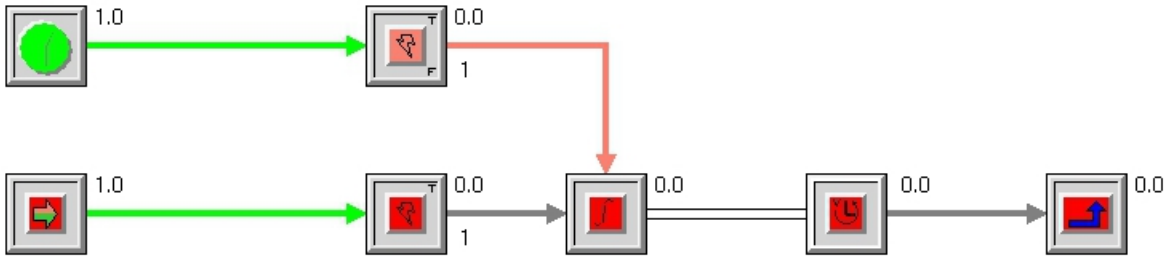

Fig 14: Determining Nr-Starts

1.5.1.2) Scrn-J144-G2120: Measure: Nr-Starts

Nr-Starts Measure

Measure	Goal	EU	Owner	Key Performance Indicator (KPI)?	Lower Control Limit (LCL)	Target Value	Upper Control Limit (UCL)
NR-STARTS	MINIMIZE		APC-CUSTODIAN	false	0	0	10

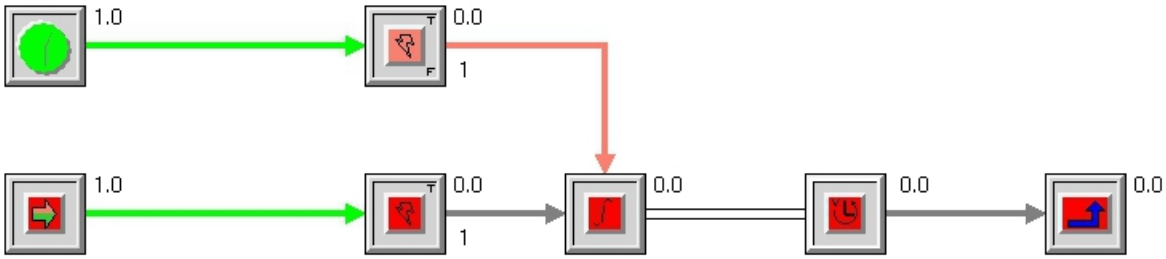

Fig 15: Determining Nr-Starts

1.6) CRUSHER-03-FEED (Unit)

1.6.1) Background

The secondary crusher (J120-G3100) output reports to the primary stockpile (J130-ST-01) which reports to the tertiary crusher feed bin (J140-BIN-01) via the tertiary crusher feed bin conveyor (J153-G2100). For each crusher unit there are two variable speed vibrating feeders (J143-G1118 and J143-G1128) withdrawing material from the tertiary crusher feed bin (J140-BIN-01). These feeders feed screens (J143-G2110 and J143-G2120) which separates the oversize from the undersize. The -25mm reports to J154-G3000 which will feed the JIG feed stockpile. The +25mm ore reports to chutes (J143-G2110-CHUTE and J143-G2120-CHUTE) which in turns feed the tertiary crusher (J143-G3120) via two variable speed conveyors (J143-G3400 and J143-G3500).

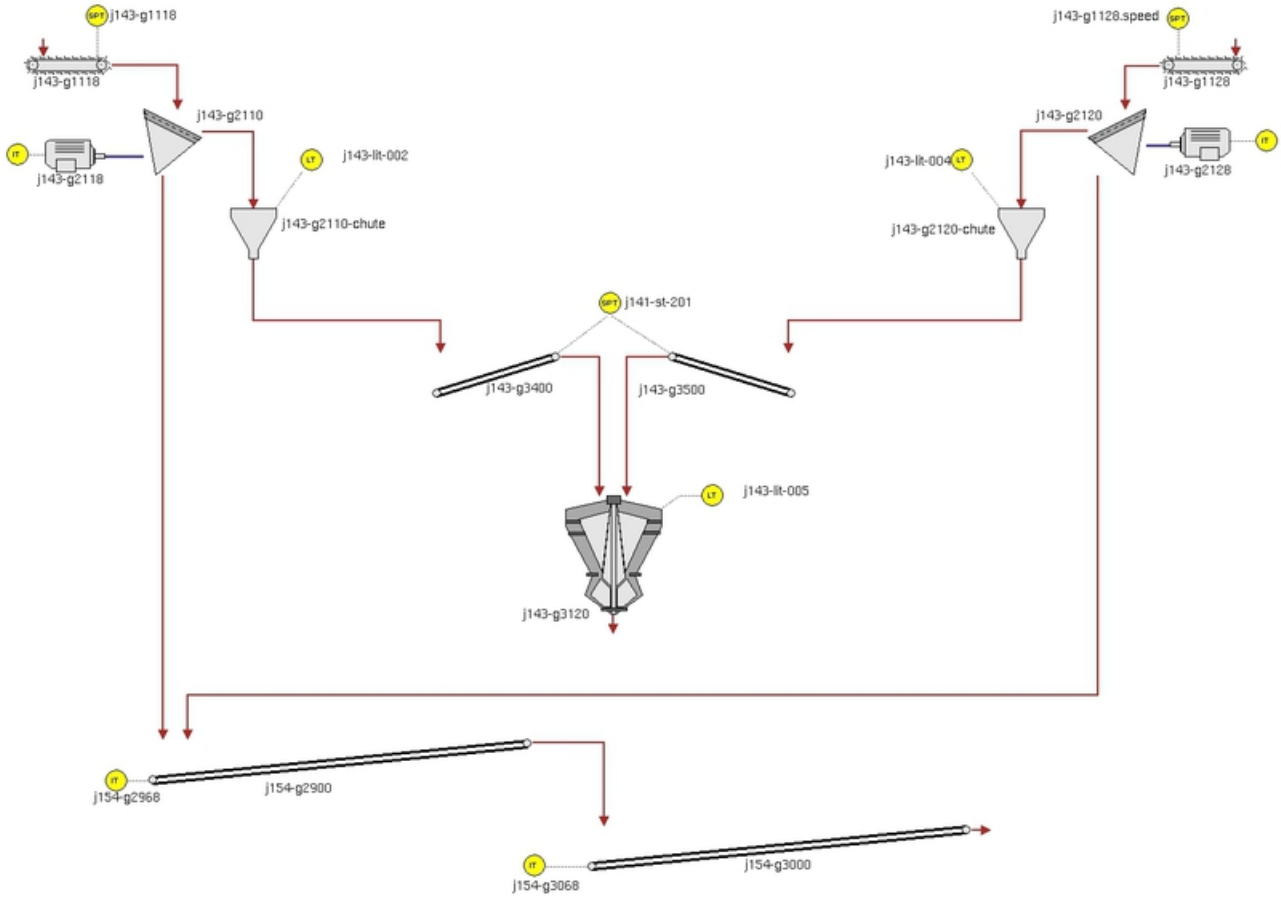

Fig 16: Relevant Circuit Schematic

1.6.1.1) Scrn-J143-G2110: Measure: Nr-Starts

Nr-Starts Measure							
Measure	Goal	EU	Owner	Key Performance Indicator (KPI)?	Lower Control Limit (LCL)	Target Value	Upper Control Limit (UCL)
NR-STARTS	MINIMIZE		APC-CUSTODIAN	false	0	0	10

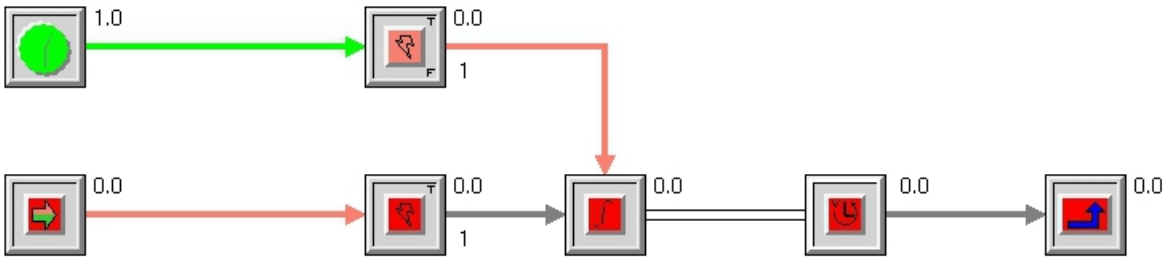

Fig 17: Determining Nr-Starts

1.6.1.2) Scrn-J143-G2120: Measure: Nr-Starts

Nr-Starts Measure							
Measure	Goal	EU	Owner	Key Performance Indicator (KPI)?	Lower Control Limit (LCL)	Target Value	Upper Control Limit (UCL)
NR-STARTS	MINIMIZE		APC-CUSTODIAN	false	0	0	10

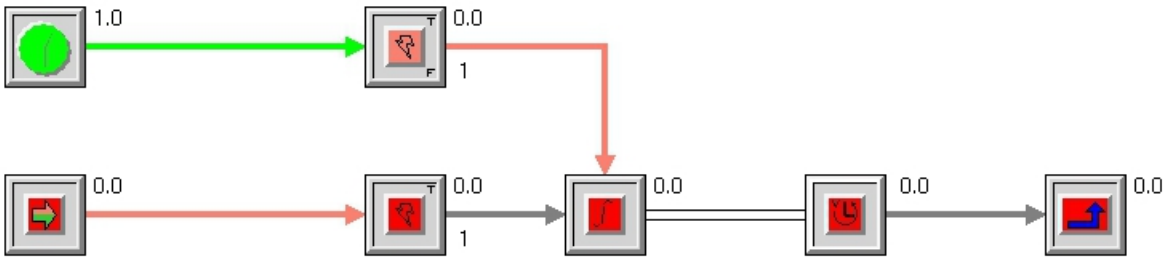

Fig 18: Determining Nr-Starts

1.7) CRUSHER-02-FEED (Unit)

1.7.1) Background

The secondary crusher (J120-G3100) output reports to the primary stockpile (J130-ST-01) which reports to the tertiary crusher feed bin (J140-BIN-01) via the tertiary crusher feed bin conveyor (J153-G2100). For each crusher unit there are two variable speed vibrating feeders (J142-G1118 and J142-G1128) withdrawing material from the tertiary crusher feed bin (J140-BIN-01). These feeders feed screens (J142-G2110 and J142-G2120) which separates the oversize from the undersize. The -25mm reports to J154-G3000 which will feed the JIG feed stockpile. The +25mm ore reports to chutes (J142-G2110-CHUTE and J142-G2120-CHUTE) which in turns feed the tertiary crusher (J142-G3120) via two variable speed conveyors (J142-G3200 and J142-G3300).

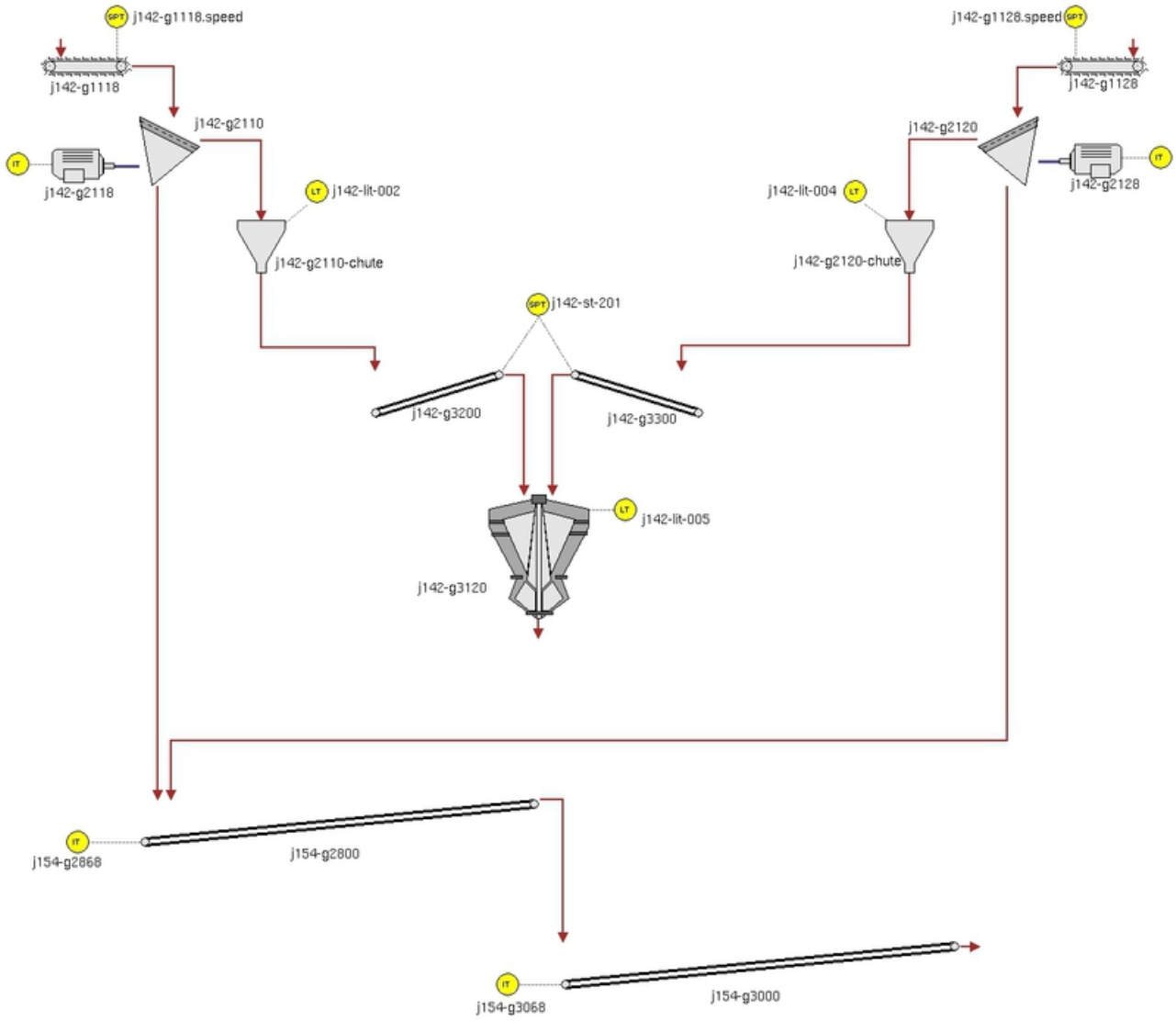

Fig 19: Relevant Circuit Schematic

1.7.1.1) Scrn-J142-G2110: Measure: Nr-Starts

Nr-Starts Measure							
Measure	Goal	EU	Owner	Key Performance Indicator (KPI)?	Lower Control Limit (LCL)	Target Value	Upper Control Limit (UCL)
NR-STARTS	MINIMIZE		APC-CUSTODIAN	false	0	0	10

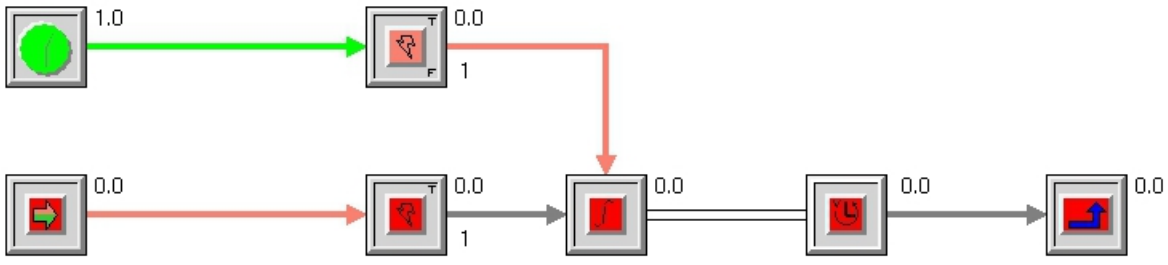

Fig 20: Determining Nr-Starts

1.7.1.2) Scrn-J142-G2120: Measure: Nr-Starts

Nr-Starts Measure							
Measure	Goal	EU	Owner	Key Performance Indicator (KPI)?	Lower Control Limit (LCL)	Target Value	Upper Control Limit (UCL)
NR-STARTS	MINIMIZE		APC-CUSTODIAN	false	0	0	10

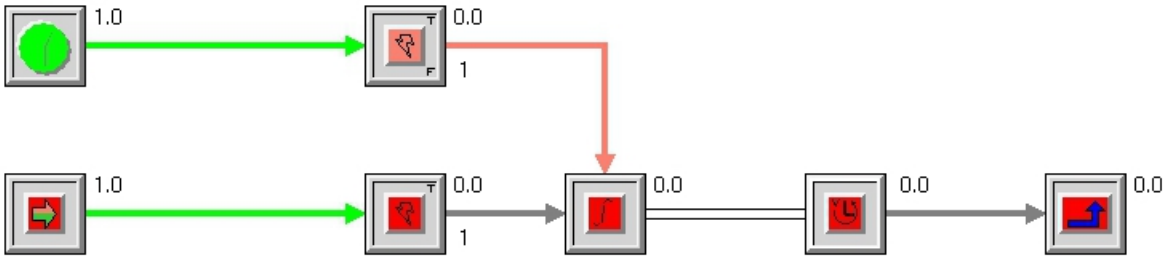

Fig 21: Determining Nr-Starts

1.8) CRUSHER-01-FEED (Unit)

1.8.1) Background

The secondary crusher (J120-G3100) output reports to the primary stockpile (J130-ST-01) which reports to the tertiary crusher feed bin (J140-BIN-01) via the tertiary crusher feed bin conveyor (J153-G2100). For each crusher unit there are two variable speed vibrating feeders (J141-G1118 and J141-G1128) withdrawing material from the tertiary crusher feed bin (J140-BIN-01). These feeders feed screens (J141-G2110 and J141-G2120) which separates the oversize from the undersize. The -25mm reports to J154-G3000 which will feed the JIG feed stockpile. The +25mm ore reports to chutes (J141-G2110-CHUTE and J141-G2120-CHUTE) which in turns feed the tertiary crusher (J141-G3120) via two variable speed conveyors (J141-G3000 and J141-G3100).

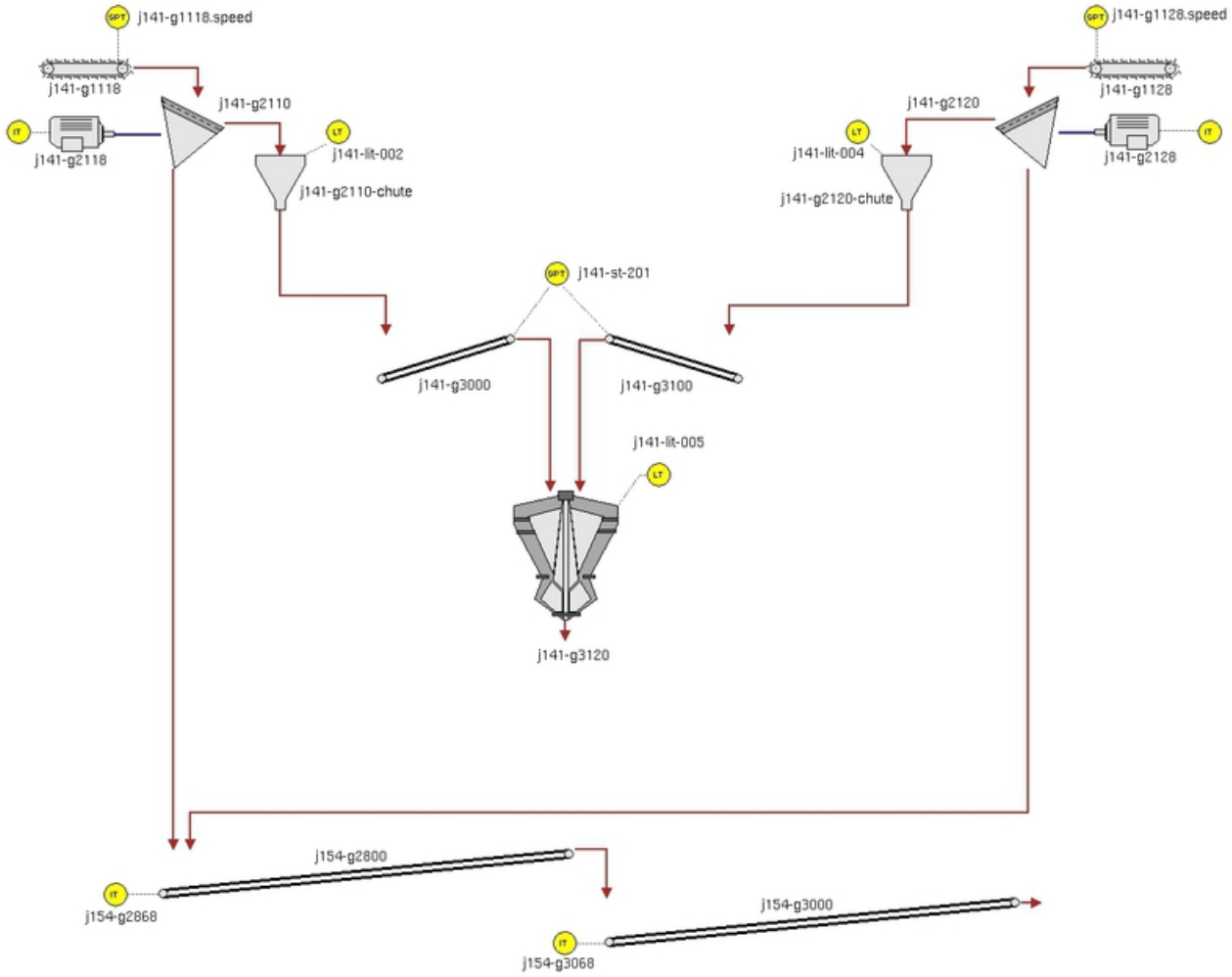

Fig 22: Relevant Circuit Schematic

1.8.1.1) Scrn-J141-G2110: Measure: Nr-Starts

Nr-Starts Measure							
Measure	Goal	EU	Owner	Key Performance Indicator (KPI)?	Lower Control Limit (LCL)	Target Value	Upper Control Limit (UCL)
NR-STARTS	MINIMIZE		APC-CUSTODIAN	false	0	0	10

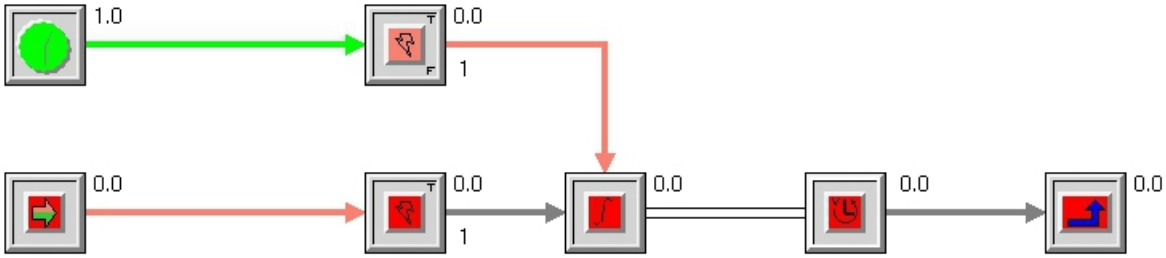

Fig 23: Determining Nr-Starts

1.8.1.2) Scrn-J141-G2120: Measure: Nr-Starts

Nr-Starts Measure

Measure	Goal	EU	Owner	Key Performance Indicator (KPI)?	Lower Control Limit (LCL)	Target Value	Upper Control Limit (UCL)
NR-STARTS	MINIMIZE		APC-CUSTODIAN	false	0	0	10

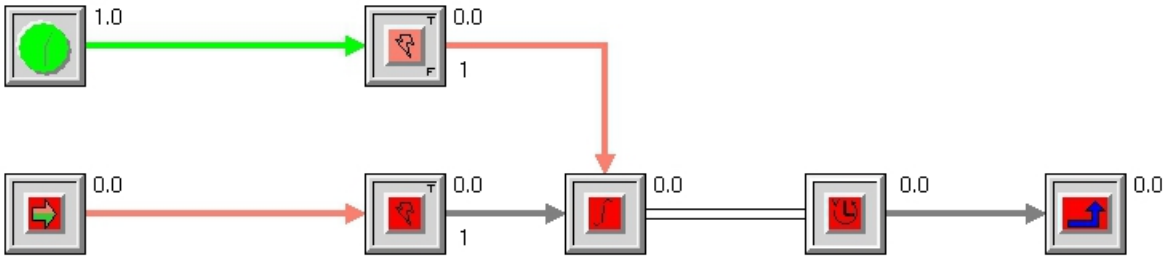

Fig 24: Determining Nr-Starts

1.9) BIN-FEED (Unit)

1.9.1) Background

Material from the primary stockpile (J130-ST-01) is discharged via up to four vibrating feeders (J130-G4100/200/300/400) onto a conveyor (J153-G2100) which transports the material onto another conveyor (J153-G2200). The fresh feed along with the recycle stream from recycle conveyor (J154-G2700) reports to the T-Crusher Shuttle Feed Conveyor (J154-G2400) which reports directly into T-Crusher Feed Bin (J140-BIN-01).
The T-Crusher Feed Bin is divided into eight smaller bins which are arranged in two rows of four bins above four tertiary crushers. Bins 1 and 2 discharge to T-Crusher J141-G3000, 3 and 4 to T-Crusher J142-G3000, 5 and 6 to T-Crusher J-143-G3000 and 7 and 8 to t-Crusher J144-G3000.
Each tertiary crusher module therefore consists of two bins, each discharging via an apron feeder onto a single deck vibrating screen. The undersize of the vibrating screen reports to a rock box and then onto the circuit product conveyors. The oversize reports to a chute from where it is extracted via conveyor to the crusher. Crusher product is discharged onto the crusher product conveyors and then onto the recycle conveyors where it is transported to T-Crusher Feed Bin (J140-BIN-01).

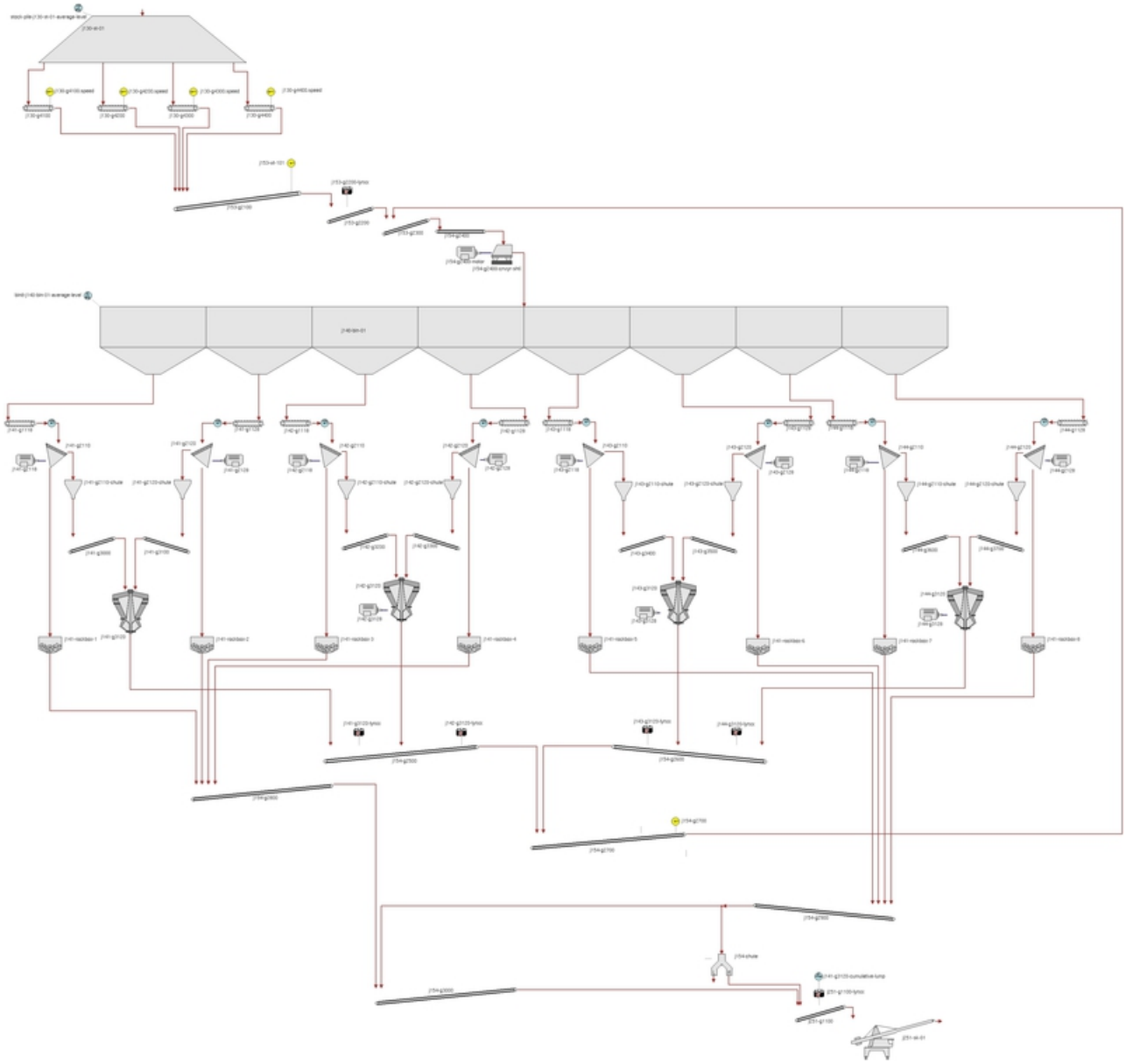

Fig 25: Relevant Circuit Schematic

1.9.1.1) Cnvyr-Shtl-J154-G2400-Cnvyr-Shtl: Measure: Nr-Starts

Nr-Starts Measure							
Measure	Goal	EU	Owner	Key Performance Indicator (KPI)?	Lower Control Limit (LCL)	Target Value	Upper Control Limit (UCL)
NR-STARTS	MINIMIZE		APC-CUSTODIAN	false	0	0	10

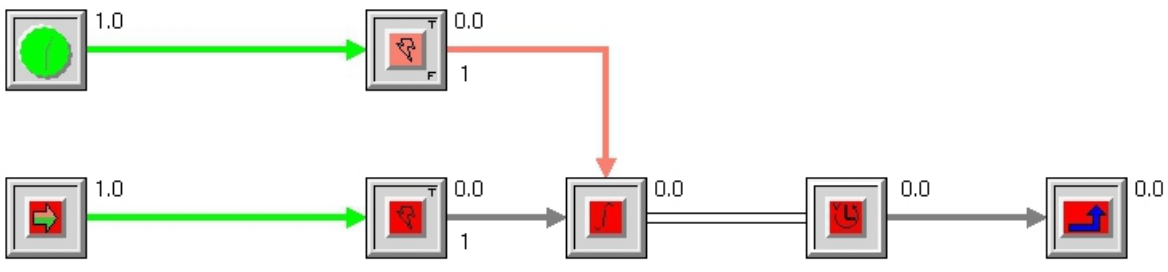

Fig 26: Determining Nr-Starts

Fig 20. Determining NV-Starts

2) Plant Wide Optimizer Description

3) Detail FDS Documentation

3.1) Detail FDS DocumentationAPC-J154-G2700C

3.2) Detail FDS DocumentationAPC-J144_LIC_005C

3.3) Detail FDS DocumentationAPC-J143_LIC_005C

3.4) Detail FDS DocumentationAPC-J142_LIC_005C

3.5) Detail FDS DocumentationAPC-J141_LIC_005C

3.6) Detail FDS DocumentationAPC-J144_LIC_002_004C

3.7) Detail FDS DocumentationAPC-J143_LIC_002_004C

3.8) Detail FDS DocumentationAPC-J142_LIC_002_004C

3.9) Detail FDS DocumentationAPC-J141_LIC_002_004C

3.10) Detail FDS DocumentationAPC-J140_BIN_005C