

Node ID	2
Design Intent	To transfer outlet stream from R201 to S203 through V201. V201 reduces the pressure of the stream from 5 atm to 1 atm. To separate o-toluidine from unreacted o-nitrotoluene, by-products and methanol solvent in S203, operating at 1atm.

Row ID	Parameter	Deviation	Causes	Consequences	Existing Safeguards	Recommendations
Separator S201						
2.1	Flow	No flow through FCV-203	Blockage in FCV-203	C1: No flow into S201; column dries up; no column performance; delay in production of o-toluidine C2: Overheating of H204; fire risks	S1: FAL-212 will trigger low flow; notify operator S2: LAL-202 will trigger low level; notify operator S3: TAL-207 will trigger low temperature; notify operator S4: PAL-206 will trigger low pressure; notify operator	R1: Regular inspection of valve R2: Regular cleaning
2.2	Flow	No flow through FCV-203	FIC-209 gives lower setpoint for FCV-203 in error	Refer to 2.1 C1, C2	Refer to 2.1 S1, S2, S3, S4	R1: Regular testing of controller
2.3	Flow	No flow through FCV-203	FT-209 gives much higher reading in error	Refer to 2.1 C1, C2	Refer to 2.1 S1, S2, S3, S4	R1: Regular testing of transmitter
2.4	Flow	No flow through V201	Blockage in V-201	Refer to 2.1 C1, C2	Refer to 2.1 S1, S2, S3, S4	Refer to 2.1 R1, R2
2.5	Flow	No flow through V201	PIC-207 gives lower setpoint for V201 in error	Refer to 2.1 C1, C2	Refer to 2.1 S1, S2, S3, S4	Refer to 2.2 R1
2.6	Flow	No flow through V201	PT-207 gives much higher reading in error	Refer to 2.1 C1, C2	Refer to 2.1 S1, S2, S3, S4	Refer to 2.3 R1
2.7	Flow	Less flow through FCV-203	Fouling in FCV-203	C1: Less flow into S201; column runs with low capacity; lower column performance; delay in production of o-toluidine C2: Overheating of H204; fire risks	Refer to 2.1 S1, S2, S3, S4 S5: FIC209 will open FCV-203 more; flow into S201 increases	Refer to 2.1 R1, R2 R3: Change position of flow control valve (FCV-203) and pressure regulating valve (V-201)
2.8	Flow	Less flow through FCV-203	FIC-209 gives lower setpoint for FCV-203 in error	Refer to 2.7 C1, C2	Refer to 2.1 S1, S2, S3, S4	Refer to 2.2 R1 and 2.7 R3
2.9	Flow	Less flow through FCV-203	FT-209 gives higher reading in error	Refer to 2.7 C1, C2	Refer to 2.1 S1, S2, S3, S4	Refer to 2.3 R1 and 2.7 R3
2.10	Flow	Less flow through V201	Fouling in V201	Refer to 2.7 C1, C2	Refer to 2.1 S1, S2, S3, S4	Refer to 2.1 R1, R2 and 2.7 R3
2.11	Flow	Less flow through V201	PIC-207 gives lower setpoint for V201 in error	Refer to 2.7 C1, C2	Refer to 2.1 S1, S2, S3, S4	Refer to 2.2 R1 and 2.7 R3
2.12	Flow	Less flow through V201	PT-207 gives higher reading in error	Refer to 2.7 C1, C2	Refer to 2.1 S1, S2, S3, S4	Refer to 2.3 R1 and 2.7 R3

2.13	Flow	More flow through FCV-203	Breakage inside FCV-203	C1: More flow into S201; column is flooded; overpressure of S201; lower column performance; delay in production of o-toluidine C2: Backflow of liquid into H204 through gas inlet port; overflow in H204; overpressure of H204; liquid can leak out and damage personnel or fire risks C3: Increased risk of leakage	S1: FAH-212 will trigger high flow; notify operator S2: LAH-202 will trigger high level; notify operator S3: TAH-207 will trigger high temperature; notify operator S4: PAH-206 will trigger high pressure; notify operator S5: LAHH-206 will trigger high flow; I6 will trigger; SOV-206 will open and release contents in S201 S6: PRV-2 will open upon reaching its setpoint	Refer to 2.1 R1
2.14	Flow	More flow through FCV-203	FIC-209 gives higher setpoint for FCV-203 in error	Refer to 2.13 C1, C2	Refer to 2.13 S1, S2, S3, S4, S5, S6	Refer to 2.2 R1
2.15	Flow	More flow through FCV-203	FT-209 gives lower reading in error	Refer to 2.13 C1, C2	Refer to 2.13 S1, S2, S3, S4, S5, S6	Refer to 2.3 R1
2.16	Flow	More flow through V201	Breakage inside V201	Refer to 2.13 C1, C2	Refer to 2.13 S1, S2, S3, S4, S5, S6	Refer to 2.1 R1
2.17	Flow	More flow through V201	PIC-207 gives higher setpoint for V201 in error	Refer to 2.13 C1, C2	Refer to 2.13 S1, S2, S3, S4, S5, S6	Refer to 2.2 R1
2.18	Flow	More flow through V201	PT-207 gives lower reading in error	Refer to 2.13 C1, C2	Refer to 2.13 S1, S2, S3, S4, S5, S6	Refer to 2.3 R1
2.19	Level	Low level in S201	Less flow through FCV-203 (Refer to 'Flow' 2.1, 2.7-2.9)	Refer to 2.7 C1, C2	Refer to 2.1 S1, S2, S3, S4 and 2.7 S5	Refer to 2.7 R1, R2, R3
2.20	Level	Low level in S201	Less flow through V201 (Refer to 'Flow' 2.4, 2.10-2.12)	Refer to 2.7 C1, C2	Refer to 2.1 S1, S2, S3, S4	Refer to 2.10 R1, R2, R3
2.21	Level	Low level in S201	Faulty SOV-206 being in fully open position	Refer to 2.7 C1, C2	Refer to 2.1 S1, S2, S3, S4	Refer to 2.1 R1
2.22	Level	Low level in S201	Position of the three-way valve is wrongly set	C1: Less reflux into S201; column runs with low capacity; lower column performance; delay in production of o-toluidine	Refer to 2.1 S1, S2, S3, S4 S5: Operator is well trained and competent	R1: Have a detailed protocol of operation R2: Set standards and requirements for level of competence for operator
2.23	Level	High level in S201	More flow through FCV-203 (Refer to 'Flow' 2.13-2.15)	C1: More flow into S201; column is flooded; overpressure of S201; lower column performance; delay in production of o-toluidine C2: Backflow of liquid into H204 through gas inlet port; overflow in H204; overpressure of H204; liquid can leak out and damage personnel or fire risks C3: Increased risk of leakage	(Refer to 'Flow' 2.13-2.15)	R1: Install bunding around column
2.24	Level	High level in S201	More flow through V201 (Refer to 'Flow' 2.16-2.18)	Refer to 2.23 C1, C2, C3	Refer to 2.23	Refer to 2.23 R1

2.25	Level	High level in S201	Position of the three-way valve is wrongly set	C1: More reflux into S201; column floods; lower column performance; delay in production of o-toluidine	Refer to 2.1 S1, S2, S3, S4 S5: Operator is well trained and competent	R1: Have a detailed protocol of operation R2: Set standards and requirements for level of competence for operator
2.26	Temperature	High temperature in S201	TT207 reading too low in error	C1: Off specification performance in S201 C2: Pressure rise in S201	S1: TT209 triggers TZAHH S2: TAH207 triggered S3: AT205 triggers FCV-207	R1: Regular testing and maintenance of TT207
2.27	Temperature	High temperature in S201	FCV-207 mechanical failure	Refer to 2.27	S1: TT209 triggers TZAHH S2: TAH207 triggered	Refer to 2.1: R1, R2
2.28	Temperature	Low temperature in S201	TT207 reading too high in error	C1: Off specification performance in S201	S1: TAL207 triggered S2: AT205 triggers FCV-207	Refer to 2.26: R1, R2
2.29	Temperature	Low temperature in S201	FCV-207 mechanical failure	Refer to 2.28	S1: TAL207 triggered	R1: Additional flow transmitter to monitor the flowrate of the cold stream from H204
2.30	Temperature	Low temperature in S201	SOV-205 mechanical failure	Refer to 2.28	Refer to 2.29	Refer to 2.29, R1
2.31	Temperature	Low temperature in S201	SOV-205 human error	Refer to 2.28	Refer to 2.29	Refer to 2.29, R1
2.32	Pressure	High Pressure in S201	PT207 reading is too low	C1: Overpressure leading to vessel rupture or explosion C2: Loss of o-toluidine production C3: Loss of o-toluidine purity	S1: PT206 (with its respective alarms) will monitor if pressure deviates from its set point and alert the operator S2: PT208 will monitor if pressure deviates from the set point and activate the emergency interlock I1 S3: PRV-2 will open if the pressure exceeds the set pressure S4: FIC-209 will activate if flow in the inlet stream to S201 deviates from its setpoint	R1: Regular testing of PT206 and PT208 R2: Add a bursting disc device to S201 R3: Add a blowdown valve to S201
2.33	Pressure	High pressure in S201	Malfunction in FCV-203 leading to it opening too much	Refer to 2.32: C1, C2	Refer to 2.32: S1, S2, S3, S4	Refer to 2.32: R2, R3 R3: Bypass around FCV-203
2.34	Pressure	High pressure in S201	PIC207 set point is too high	Refer to 2.32: C1, C2	Refer to 2.32: S1, S2, S3, S4	R1: Regular testing of PIC207 Refer to 2.32: R2, R3
2.35	Pressure	High pressure in S201	Failure of SOV-206	Refer to 2.32: C1, C2	Refer to 2.32: S1, S2, S3, S4	Refer to 2.32: R2, R3
2.36	Pressure	High pressure in S201	Failure of SOV-207	Refer to 2.32: C1, C2	Refer to 2.32: S1, S2, S3, S4	Refer to 2.32: R2, R3
2.37	Pressure	Low pressure in S201	Leakage from S201	C1: Increase chance of vessel implosion Refer to 2.32: C2, C3	Refer to 2.32: S1, S2, S4	R1: UV testing of vessel to check for cracks R2: Add a low-pressure and low-low pressure alarm with an interlock
2.38	Pressure	Low pressure in S201	PT207 reading is too high	Refer to 2.37: consequences	Refer to 2.32: S1, S2, S4	R1: Regular testing of PT207

2.39	Pressure	Low pressure in S201	Malfunction in FCV-203 leading to it closing too much	Refer to 2.37: consequences	Refer to 2.32: S1, S2, S4	R1: Add a bypass around FCV-203
2.40	Pressure	Low pressure in S201	Blockage of FCV-203	Refer to 2.37: consequences	Refer to 2.32: S1, S2, S4	Refer to 2.39: R1
2.41	Pressure	Low pressure in S201	PIC207 set point is too low	Refer to 2.37: consequences	Refer to 2.32: S1, S2, S4	R1: Regular testing of PIC-207
2.42	Pressure	Low pressure in S201	Failure of SOV-206	Refer to 2.37: consequences	Refer to 2.32: S1, S2, S4	R1: Regular testing of SOV-206
2.43	Pressure	Low pressure in S201	Failure of SOV-207	Refer to 2.37: consequences	Refer to 2.32: S1, S2, S4	R1: Regular testing of SOV-207
Reflux drum, S204						
2.44	Flow	No vapour product flow exiting S204	FCV-205 fails shut	C1: Pressure increased in S204 C2: Off specification performance in S201 due to increase in vapour fraction	S1: SOV-209 to be opened by operator	R1: Install pressure transmitter and control system to regulate pressure in S204 R2: Install pressure alarms on S204 R3: Install PRV on S204
2.45	Flow	No liquid flow exiting S204	Gate valve (V210) blockage	C1: Level in S204 increased C2: No flow rate in top stream from S204 C3: No flowrate into S201 from S204 which causes off specification performance in S201	S1: LT204 triggers LZAHH 204 and interlock I5. S2: SOV-208 to be opened by operator	None
2.46	Flow	No top stream flow from S204	FCV-206 mechanically fails shut	C1: Increase liquid flowrate entering S201 which causes off specification performance in S201	N/A	R1: Install flow transmitter on tops stream R2: Install flow alarm on tops stream
2.47	Flow	No top stream flow from S204	LIC203 set point too low in error	Refer to 2.46	Refer to 2.46	Refer to 2.46: R1, R2
2.48	Flow	No top stream flow from S204	LT203 reading too low in error	Refer to 2.46	Refer to 2.46	Refer to 2.46: R1, R2
2.49	Flow	Less vapour product flow exiting S204	PIC206 set point too high in error	C1: Pressure increased in S204 C2: Off specification performance in S201 due to increase in vapour fraction	S1: SOV-209 to be opened by operator	R1: Install pressure transmitter and control system to regulate pressure in S204 R2: Install pressure alarms on S204 R3: Install PRV on S204
2.50	Flow	Less vapour product flow exiting S204	PT206 reading too high in error	Refer to 2.49: C1, C2	Refer to 2.49: S1	Refer to 2.49: R1, R2, R3
2.51	Flow	Less vapour product flow exiting S204	FCV-205 mechanical failure	Refer to 2.49: C1, C2	Refer to 2.49: S1	Refer to 2.49: R1, R2, R3
2.52	Flow	Less top stream flow S204	FCV-206 failure	Refer to 2.46	Refer to 2.46	Refer to 2.46
2.53	Flow	More flow in top stream from S204	FCV-206 mechanical failure	C1: Level in S204 decreases C2: Off specification performance in S201 due to less flowrate from S204	N/A	Refer to 2.46

2.54	Flow	More flow in top stream from S204	LT203 reading too high in error	Refer to 2.53	N/A	Refer to 2.46
2.55	Flow	More flow in top stream from S204	LIC203 set point too high in error	Refer to 2.53	N/A	Refer to 2.46
2.56	Level	Low level in S204	More flow through FCV-206 (Refer to Flow Row 2.53)	C1: Low pressure gradient causes less reflux into S201; column runs with low capacity; lower column performance	S1: LAL-203 will trigger; notify operator	R1: Install flow transmitter and alarm downstream of FCV-206
2.57	Level	Low level in S204	Condenser duty in H203 is too low	Refer to 2.56: C1	Refer to 2.56: S1 S2: FIC-208 and TIC-208 controls the cooling water flow rate S3: FAL-208 will trigger when low cooling water rate S4: TAH-208 will trigger when high cooling water temperature	R1: Install temperature transmitters and alarms for H203 and the heated cooling water stream R2: Install temperature transmitter and alarm and flow transmitter and alarm between H203 and S204
2.58	Level	High level in S204	Less flow through FCV-206 (Refer to Flow Row 2.52)	C1: Liquid can enter gas outlet, creating disturbances for downstream separation and storage C2: Reduced capacity for gas storage, pressure in tank rises; overpressurisation C3: Increased risk of leakage	S1: LAH-203 will trigger; notify operator	R1: Install flow transmitter and alarm downstream of FCV-206
2.59	Level	High level in S204	Blockage in three way valve	Refer to 2.58: C1, C2	Refer to 2.58: S1	Refer to 2.58: R1
2.60	Level	High level in S204	Condenser duty in H203 is too high	Refer to 2.58: C1	Refer to 2.58: S1,	R1: Install temperature transmitters and alarms for H203 and the heated cooling water stream R2: Install temperature transmitter and alarm and flow transmitter and alarm between H203 and S204
2.61	Temperature	High temperature in S204	SOV-205 mechanical failure	C1: Off specification performance in S204 C2: Pressure rise in S204	S1: TT209 triggers TZAHH S2: TAH207 triggered S3: AT205 triggers FCV-207	R1: Additional flow transmitter to monitor the flowrate of the cold stream from H204
2.62	Temperature	High temperature in S204	SOV-205 human error	Refer to 2.61: C1, C2	Refer to 2.61: S1, S2, S3	R1: Additional flow transmitter to monitor the flowrate of the cold stream from H204

2.63	Pressure	High pressure in S204	Malfunction in FCV-205 leading to it closing too much	C1: Overpressure in S204 leading to rupture or explosion C2: Off specification performance in S204 C3: Increased temperature within S204	N/A	R1: Install pressure transmitter and control system to regulate pressure in S204 R2: Install pressure relief system on S204 R3: Install pressure alarms on S204 R4: Bypass around FCV-205
2.64	Pressure	High pressure in S204	Blockage in FCV-205	Refer to 2.63: C1, C2, C3	N/A	Refer to 2.63: R1, R2, R3, R4
2.65	Pressure	High pressure in S204	PIC206 set point is too low	Refer to 2.63: C1, C2, C3	N/A	Refer to 2.63: R1, R2, R3 R4: Regular testing of PIC206
2.66	Pressure	High pressure in S204	PT206 reading is too low	Refer to 2.63: C1, C2, C3	N/A	Refer to 2.63: R1, R2, R3 R4: Regular testing of PT206
2.67	Pressure	High pressure in S204	Blockage in gate valve downstream of S204	Refer to 2.63: C1, C2, C3	N/A	Refer to 2.63: R1, R2, R3 R4: Maintenance of gate-valve R5: Alternate parallel bypass route to gate-valve
2.68	Pressure	High pressure in S204	Blockage in FCV-206	Refer to 2.63: C1, C2, C3	N/A	Refer to 2.63: R1, R2, R3 R4: Bypass around FCV-206
2.69	Pressure	High pressure in S204	Malfunction of FCV-206	Refer to 2.63: C1, C2, C3	N/A	Refer to 2.63: R1, R2, R3 Refer to 2.68: R4
2.70	Pressure	High pressure in S204	Failure of SOV-208	Refer to 2.63: C1, C2, C3	N/A	Refer to 2.63: R1, R2, R3
2.71	Pressure	High pressure in S204	Failure of SOV-209	Refer to 2.63: C1, C2, C3	N/A	Refer to 2.63: R1, R2, R3
2.72	Pressure	High pressure in S204	Higher than expected flow in S204 from S201	Refer to 2.63: C1, C2, C4	N/A	R1: Installation of a flow control valve to regulate inlet into S204 from S201
2.73	Pressure	Low pressure in S204	Malfunction in FCV-205 leading to it opening too much	C1: Sub-optimal pressure leads to inefficient performance of H203	N/A	Refer to 2.63: R1, R2, R3, R4
2.74	Pressure	Low pressure in S204	PIC206 set point is too high	Refer to 2.73: C1	N/A	Refer to 2.63: R1, R2, R3, R4
2.75	Pressure	Low pressure in S204	PT206 reading is too high	Refer to 2.73: C1	N/A	Refer to 2.63: R1, R2, R3, R4
2.76	Pressure	Low pressure in S204	Malfunction of FCV-206	Refer to 2.73: C1	N/A	Refer to 2.63: R1, R2, R3, R4
2.77	Pressure	Low pressure in S204	Failure of SOV-208	Refer to 2.73: C1	N/A	R1: Regular maintenance and inspection of SOV-208
2.78	Pressure	Low pressure in S204	Failure of SOV-209	Refer to 2.73: C1	N/A	R1: Regular maintenance and inspection of SOV-209

2.79	Pressure	Low pressure in S204	Lower than expected flow in S204 due to pipeline leakage	Refer to 2.73: C1	N/A	R1: Regular inspection and maintenance of pipelines
Condenser, H203						
2.80	Flow	No flow in cooling water to H203	FCV-204 mechanically fails shut	C1: No liquid exiting H203 leading to less/no liquid flowrate in S204 C2: Less/no flowrate in top stream from S204 C3: Off specification performance in S201 due to increase in vapour fraction	S1: FT210 indicates no flow which triggers FZALL210 and interlock I1 to shutdown S201. S2: FT 208 triggers FAL208	R1: Level transmitter at S204 with a low level alarm.
2.81	Flow	No flow in cooling water to H203	FT208 reading too high in error	Refer to 2.80	Refer to 2.80	Refer to 2.80
2.82	Flow	No flow in cooling water to H203	FIC208 set point too low in error	Refer to 2.80	Refer to 2.80	Refer to 2.80
2.83	Flow	No vapour product flow exiting H203	High cooling duty in H203	C1: Off specification performance in S201 due to increase liquid flowrate C2: Level in S204 increased	S1: LT204 triggers LZAHH 204 and interlock I5. S2: SOV-208 to be opened by operator	R1: Temperature transmitter on the stream from H203 to S204
2.84	Flow	No liquid flow exiting H203	Low cooling duty in H203	C1: off specification performance in S201 due to increase vapour fraction C2: No top stream flowrate from S204	None	Refer to 2.83
2.85	Flow	Less flow in cooling water to H203	FCV-204 mechanical failure	C1: Less liquid exiting H203 leading to less/no liquid flowrate in S204 C2: Less/no flowrate in top stream from S204 C3: Off specification performance in S201 due to increase in vapour fraction	Refer to 2.80	Refer to 2.80
2.86	Flow	Less flow in cooling water to H203	FIC208 set point too low in error	Refer to 2.85	Refer to 2.80	Refer to 2.80
2.87	Flow	Less flow in cooling water to H203	FT208 reading too high in error	Refer to 2.85	Refer to 2.80	Refer to 2.80
2.88	Flow	More flow from cooling water to H203	FCV-204 mechanical failure	C1: Higher liquid fraction from H203 to S204 which causes the liquid level to rise. C2: Less vapour product C3: Off specification performance in S201 due to decrease in vapour fraction	S1: FT 208 triggers FAL208	R1: Additional flow transmitter with a high level alarm on the cooling water stream
2.89	Flow	More flow from cooling water to H203	FIC208 set point too high in error	Refer to 3.9	Refer to 2.88: S1	Refer to 2.88: R1
2.90	Flow	More flow from cooling water to H203	FT208 reading too low in error	Refer to 3.9	Refer to 2.88: S1	Refer to 2.88: R1

2.91	Temperature	High temperature in cooling water stream to H203	Temperature disturbance in water supply	C1: Low cooling duty in H203 C2: Off specification performance in S201 C3: Low flowrate in top stream C4: High flowrate in vapour product stream	S1: TT210 triggers to TZAHH210 alarm S2: TT208 triggers to TAH208 alarm	R1: Install back-up cooling equipment
2.92	Pressure	High pressure in H203	FT208 reading is too low	C1: Overpressure leading to rupture or explosion of H203 C2: Deviation from optimal pressure leading to inefficient performance of H203	N/A	R1: Installation of pressure transmitter and control system for cooling water into H203 R2: Installation of a high pressure alarm to notify operator of any increase from set point pressure
2.93	Pressure	High pressure in H203	FIC208 set point is too high	Refer to 2.92: C1, C2	N/A	Refer to 2.92: R1, R2
2.94	Pressure	High pressure in H203	Malfunction in FCV-204 leading to it opening too much	Refer to 2.92: C1, C2	N/A	Refer to 2.92: R2
2.95	Pressure	Low pressure in H203	FT208 reading is too high	Refer to 2.92: C2	N/A	Refer to 2.92: R1 R2: Installation of a low pressure alarm to notify operator of any increase from set point pressure
2.96	Pressure	Low pressure in H203	FIC208 set point is too low	Refer to 2.92: C2	N/A	Refer to 2.92: R1 Refer to 2.95: R2
2.97	Pressure	Low pressure in H203	Malfunction in FCV-204 leading to it closing too much	Refer to 2.92: C2	N/A	Refer to 2.95: R2
Reboiler, H204						
2.98	Flow	No flow of saturated steam into H204	FCV-207 fails shut	C1: Loss of function of H204 for separation due to loss of heat source C2: Build-up of material in H204 leading to overpressure C3: Loss of purity of o-toluidine	N/A	R1: Installation of a by-pass around FCV-207 R2: Installation of a low-flow alarm upstream of saturated steam source
2.99	Flow	No flow from S201 (bottoms stream) into H204	Pipeline blockage	C1: Overheating of H204, which may result in a fire C2: Loss of o-toluidine production C3: Build-up of material in S201, which may result in overpressure and possible flooding	S1: LT205, LT206 and LT207 (with their respective alarms) will monitor if flow deviates from its set point and alert the operator due to lower than expected level S2: Executive alarm (LAZLL 207) connected to Interlock I7, triggering an automatic response	R1: Regular cleaning, maintenance and inspection of pipelines R2: Installation of flow indicator and transmitter on bottoms outlet stream of S201
2.100	Flow	No flow from H204 (top stream) to S201	Pipeline blockage	C1: Loss of o-toluidine production C2: Build-up of material in H204, which may result in overpressure	Refer to 2.99: S1, S2	Refer to 2.99: R1, R2
2.101	Flow	No bottoms stream from from H204	FCV-208 fails shut	Refer to 2.100: C1, C2	Refer to 2.99: S1 S2: Executive alarm (LAZHH 207) connected to Interlock I7, triggering an automatic response	R1: Installation of flow indicator and transmitter on bottoms stream from H204
2.102	Flow	No cooling stream flow from H204	Pipeline blockage	C1: May lead to build up in pressure in H204	N/A	Refer to 2.99: R1

2.103	Flow	No bottoms stream from H204	LIC-202 set point is too low	Refer to 2.100: C1, C2	Refer to 2.99: S2	R1: Regular testing and maintenance of LIC-202
2.104	Flow	No bottoms stream from H204	LT-202 reading is too low	Refer to 2.100: C1, C2	Refer to 2.99: S2	R1: Regular testing and maintenance of LIC-202
2.105	Flow	Less flow of saturated steam into H204	Pipeline leakage	Refer to 2.98: C1, C2, C3	N/A	Refer to 2.99: R1
2.106	Flow	Less flow from S201 into H204	Pipeline leakage	Refer to 2.99: C1, C2, C3	Refer to 2.99: S1, S2,	Refer to 2.99: R1, R2
2.107	Flow	Less flow from H204 (top stream) to S201	Failure in H204 due to stress corrosion and fracture	Refer to 2.100: C1, C2	Refer to 2.99: S1, S2	R1: Regular maintenance of H204, with appropriate cleaning R2: Regular inspection of H204 for any cracks or fractures Refer to 2.99: R2
2.108	Flow	Less flow from H204 (top stream) to S201	Pipeline leakage	Refer to 2.100: C1, C2	Refer to 2.99: S1, S2	Refer to 2.99: R1, R2
2.109	Flow	Less bottoms stream flow from H204	Refer to 2.103 and 2.104: Error in level control system (LIC-202 and LT202)	Refer to 2.100: C1	Refer to 2.99: S2	Refer to 2.103: C1 Refer to 2.104: C1
2.110	Flow	Less cooling stream flow from H204	Pipeline Leakage	Refer to 2.102: C1	N/A	Refer to 2.99: R1
2.111	Flow	More flow of saturated steam into H204	TT207 reading is too low in error	Refer to 2.98: C2 Refer to 2.99: C1	N/A	R1: Installation of a high flow alarm upstream of saturated steam source
2.112	Flow	More flow of saturated steam into H204	TIC207 set point is too low in error	Refer to 2.98: C2 Refer to 2.99: C1	N/A	Refer to 2.111: R1
2.113	Flow	More bottoms stream from H204	LIC202 set point is too low in error	C1: Overflow of o-toluidine storage vessel	S1: LAL-207 will trigger; notify operator if level in H204 is below set point Refer to 2.99: S2	R1: Installation of a flow indicator and transmitter on the bottoms outlet of H204 R2: Regular testing of LIC202
2.114	Flow	More bottoms stream from H204	LT202 reading is too high in error	Refer to 2.113: C1	Refer to 2.113: S1 Refer to 2.99: S2	Refer to 2.113: C1 R2: Regular testing of LT202
2.115	Level	High level in H204	More flow from S201	C1: Flooding of reboiler, leading to mechanical stress, risk of leakage C2: Vapour flowrate to column decreases; decreased column performance	S1: LALH-207 will trigger; notify operator S2: I7 will trigger S3: LAH-205 will trigger; notify operator S4: AIC-205 will control TIC-207 to lower saturated steam flow rate S5: LAH-202 will trigger; notify operator	R1: Install temperature transmitter and alarm in H204

2.116	Level	High level in H204	Reboiler duty too low	Refer to 2.115: C1, C2	Refer to 2.115: S1, S2, S3, S4, S5 S6: TIC-207 will control the saturated steam flow rate S7: TAL-207 will trigger; notify operator	Refer to 2.115
2.117	Level	High level in H204	Less flow through FCV-208 (Refer to Row 2.101)	Refer to 2.116	Refer to 2.116: S1, S2, S3, S4, S5	R1: Install flow transmitter and alarm after FCV-208
2.118	Pressure	High pressure in H204	Higher than expected flow of saturated steam into H204	C1: Overpressure in H204 may lead to an explosion Refer to 2.100: C1	S1: Flow restricted by FCV-207	R1: Installation of a pressure indicator and control system R2: Installation of a high pressure alarm to notify operator of any increase from set point pressure
2.119	Pressure	High pressure in H204	LT202 reading is too low	Refer to 2.118: C1 Refer to 2.100: C1	S1: LT205 will trigger alarm should level increase due to pressure rising S2: Executive LAZHH will trigger automatic response should experience high increase (due to pressure rise)	Refer to 2.118: R1, R2 R3: Regular inspection and testing of LT202
2.120	Pressure	High pressure in H204	LIC202 set point is too high	Refer to 2.118: C1 Refer to 2.100: C1	Refer to 2.119: S1, S2	Refer to 2.118: R1, R2 R3: Regular inspection and testing of LIC202
2.121	Pressure	High pressure in H204	Mechanical failure of FCV-207	Refer to 2.118: C1 Refer to 2.100: C1	N/A	Refer to 2.118: R1, R2 R3: Regular inspection of FCV-207
2.122	Pressure	High pressure in H204	Blockage in FCV-207	Refer to 2.118: C1 Refer to 2.100: C1	N/A	Refer to 2.118: R1, R2 R3: Regular cleaning and maintenance of FCV-207 R4: Ensure operator checks for blockage in FCV-207

2.123	Pressure	High pressure in H204	Mechanical failure of FCV-208	Refer to 2.118: C1 Refer to 2.100: C1	Refer to 2.119: S1, S2	Refer to 2.118: R1, R2 R3: Regular inspection of FCV-208
2.124	Pressure	High pressure in H204	Blockage in FCV-208	Refer to 2.118: C1 Refer to 2.100: C1	Refer to 2.119: S1, S2	Refer to 2.118: R1, R2 R3: Regular cleaning and maintenance of FCV-208 R4: Ensure operator checks for blockage in FCV-208
2.125	Pressure	Low pressure in H204	LT202 reading is too high	C1: Operation at sub-optimal pressure may lead to inefficient o-toluidine purification, resulting in economic loss C2: may lead to cavitation	Refer to 2.119: S1, S2	Refer to 2.118: R1 R2: Installation of a low pressure alarm to notify operator of any increase from set point pressure Refer to 2.119: R3
2.126	Pressure	Low pressure in H204	LIC202 set point is too low	Refer to 2.125: C1, C2	Refer to 2.119: S1, S2	Refer to 2.118: R1 Refer to 2.125: R2 Refer to 2.120: R3
2.127	Pressure	Low pressure in H204	Mechanical failure of FCV-207	Refer to 2.125: C1, C2	N/A	Refer to 2.118: R1 Refer to 2.125: R2 Refer to 2.121: R3
2.128	Pressure	Low pressure in H204	Mechanical failure of FCV-208	Refer to 2.125: C1, C2	Refer to 2.119: S1, S2	Refer to 2.118: R1 Refer to 2.125: R2 Refer to 2.123: R3
2.129	Composition	Other than setpoint in bottoms stream	AT205 reads erroneous value	C1: Bottoms stream to further purification steps is off spec, so o-toluidine product quality is compromised	N/A	R1: Consider installing an additional transmitter and controller, and programme an alert in the control panel if the two transmitters are reading different values
2.130	Composition	Other than setpoint in bottoms stream	AIC205 set point incorrect	Refer to 2.130: C1	N/A	Refer to 2.130: R1
2.131	Composition	Less (o-toluidine) than setpoint in bottoms stream	Decreased reboiler duty	C1: Flooding of reboiler, leading to mechanical stress, risk of leakage C2: Vapour flowrate to column decreases; decreased column performance	Refer to 2.115: S1, S2, S3, S4, S5 Refer to 2.116: S6, S7	R1: Install temperature transmitter and alarm in H204

2.132	Composition	More (o-toluidine) than setpoint in bottoms stream	Increased reboiler duty	<p>C1: Heat removal from steam is reduced; temperature of vapour in reboiler increases; pressure increases and increased risk of explosion</p> <p>C2: Bottoms stream can run dry, reducing o-toluidine production rate</p>	<p>S1: LALL-207 will trigger; notify operator</p> <p>S2: LAL-205 will trigger; notify operator</p> <p>S3: LAL-202 will trigger; notify operator</p> <p>S4: TAH-207 will trigger; notify operator</p> <p>Refer to 2.115: S2, S4, S6</p>	Refer to 2.131: R1
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