

DJ1 H2 supply to Delesto – Process control and safeguarding narrative

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Approved by HyCC

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Introduction

In this Design Intent the Djewels1 LP Hydrogen supply to the wet H2 system is described.

1. Purpose of design to wet H2 system (Scope of this document)

The function of the design is to reduce the pressure and supply appropriate flow to the Delesto boilers via the Nobian wet H2 line. The DJ1 LP H2 will be supplied in the following operating modes this line:

DJ1 H2 to Wet H2 network of MEB Operating modes

- 1) Normal operation: Dual supply of H2 to Delesto via wet H2 line by MEB and DJ1
- 2) DJ1 only Mode: DJ1 is sole supplier to Delesto
- 3) Single supply of MEB to LP wet H2 network (existing situation, not discussed in document)

Other operating modes (Not discussed further in this document)

DJ1 H2 to Nobian dry H2 network - Operating modes

- 1) Parallel supply of DJ1 H2 to wet H2 network and dry H2 network is not currently considered in the design but can be incorporated at a later stage if required with appropriate design modifications which are expected to be minimal.

2. Starting Points Process control

Normal Operation

- MEB H2 is burned at Delesto
- MEB H2 always has offtake priority vs DJ1 H2
- H2 demand at Delesto is linked to the steam production required by Delesto unit

Start Up

- The DJ1 H2 supply to Delesto can be started up when the MEB unit is operational and supplying H2 to Delesto
- The switching of H2 operation from dual supply mode (DJ1+MEB supply to Delesto) to DJ1 only mode (DJ1 supply only) requires stopping Djewels hydrogen supply followed by switching operating modes
- The switching of H2 operation from island mode to dual supply mode requires DJ1 to first stop supply

Intra day variations - MEB E-Flex

- In case the MEB unit reduces H2 supply to Delesto as it reduces capacity due to offering grid balancing services. DJ1 will have no obligation to ramp up H2 supply. Delesto will compensate for reduced H2 by increasing natural gas firing in the afterburners if required to maintain steam demand.
- In case the MEB unit increases H2 supply to Delesto as it increases capacity due to offering grid balancing services the flow setpoint to Djewels 1 will automatically decrease

Intra day variations – MEB customers trip

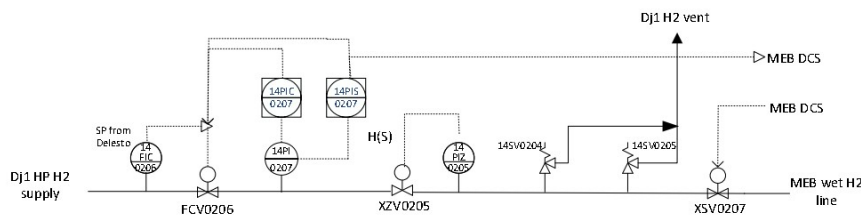
- In case the MEB unit is operating at full capacity with DJ1 supplying H2 in parallel and there is a trip of the MEB customers unit. DJ1 will have to reduce supply flowrate or stop supply in case the requested remaining H2 from Delesto is below DJ1 turndown.

3. Process control – Dual supply mode (Parallel supply MEB+DJ1 to Delesto)

Flow Control DJ1 H2 to Delesto

14FIC0206

Control scheme



Process description

The H2 flow supply from DJ1 to Delesto will be governed by Delesto. The Delesto station control algorithm will send a flow setpoint to Djewels station control continuously. Djewels station control will use the Delesto signal to send a feed forward signal to the Djewels electrolyzers (EPU control) to adjust production accordingly and will send a matching flow setpoint to 14FIC0206.

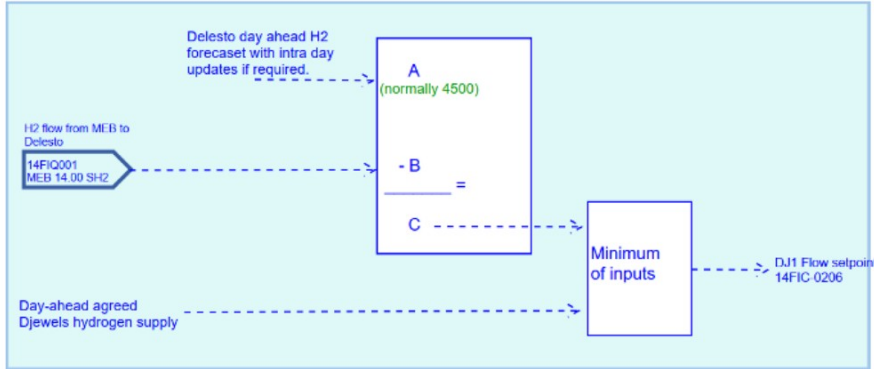
Process control

14FIC0206 controls the flowrate of H2 that is supplied to the wet H2 line by manipulating 14FCV0206A/B.

The 14FCV0206A is operational between the flow range of 0-500 Nm³/h and the B valve between 400 Nm³/h-4000 Nm³/h. During normal operations the A valve will operate in parallel mode to the B valve in flow control.

The day ahead agreed max allowable H2 supply from DJ1 to Delesto will be agreed between DJ1 and Delesto and be entered into the Delesto DCS. A calculator block in Delesto will continuously calculate the setpoint towards DJ1 using a calculator box with formula as seen in figure below.

Algorithm for calculating Flow setpoint for DJ1 flow controller 14FIC-0106



Setpoint

14FIC0206 receives its setpoint from DJ1 station control algorithm, which receives the setpoint from Delesto.

Table 1: H2 flow setpoint range from Delesto to DJ1 station command and 14FIC0206

Setpoint	Setpoint (Nm3/h)	lowrate
Normal Operation		
Min flow	800	
Max flow	4000	
Startup		
Min flow	0	
Max flow	500	

Commented [AR1]: Add table on the start up mode flows possible for DJ1

14PIC0102

In order to prevent imbalance between what is produced and what is supplied, the Djewels pressure controller 14PIC0102 adjusts the electrolyser setpoint to keep the pressure in the main hydrogen header at 30 barg¹.

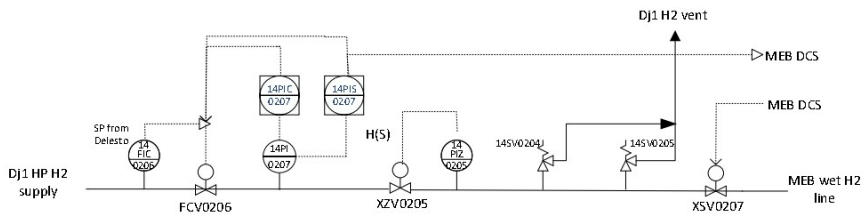
¹ Value to be finetuned during detailed design and CSU. Possibly requires a lower setpoint.



Wet H2 line pressure Control

14PIS0207 (HS)

Control scheme



Process description

H2 from the high pressure H2 header is fed to the wet H2 line after pressure reduction via 14FCV0206.

Control description

If the pressure reaches 1.6 barg the high level switch activates and closes 14XSV0207 and 14FCV0206. The main purpose of high pressure switch is to prevent too high a pressure due to DJ1 operation. The switch also ensures spurious lifting of 14SV0204/5 does not occur due to pressure peaks originating from a Teijin Aramid unit trip or from a rapid Delesto H2 burner shutdown.

Setpoint

Table 2: Pressure setpoints at 14PIS0207

	Final Element	Setpoint (barg)	Pressure
High switch	14XSV0207* and 14FCV0206	1.6	

*Runs via MEB DCS with a time delay



4. Process control – DJ1 only mode (DJ1 only supply to delesto)

Flow Control DJ1 H2 to Delesto

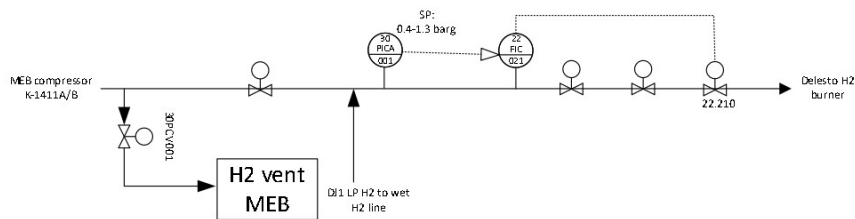
14FIC0206

The controller will function in an identical manner as described in section 3 above.

Wet H2 line pressure Control

30PICA001

Control scheme



Process description

DJ1 supplies H2 to the wet H2 line which goes to the Delesto afterburners. The pressure in the wet H2 line is kept at the setpoint by 30PICA001.

Control description

Pressure in the wet H2 line will be controlled by 30PICA001. In this mode of operation as the MEB is shut down, the controller will only have the control signal to 22(/23)FIC0201 active. The signal to 30PCV001 will not be actuated upon.

Setpoint

The controller has a variable pressure set point dependent on the flow to the H2 burners. This is required to ensure that at low flows the valves of Delesto are able to operate with sufficient stability as they were not originally designed for such low turndown flows.

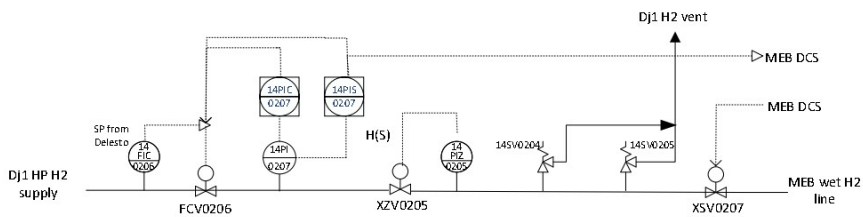
Numerous parameters influence the hydrogen pressure setpoint in the wet H2 line with steam demand being the leading cause and also influence by natural gas and hydrogen flowrate to burner.

Table 3: Hydrogen pressure setpoints to the Delesto burner varies as below

Setpoint (barg)	Pressure
0,4	
1,3*	

* The setpoint of 1.3 barg occurs when delesto is at its design limit firing both max H2 flowrate in the after burner and maximum natural gas flowrate.

14PIS0207 (HS)
Control scheme



Process description

H2 from the high pressure H2 header is fed to the wet H2 line after pressure reduction via 14FCV0206.

Control description

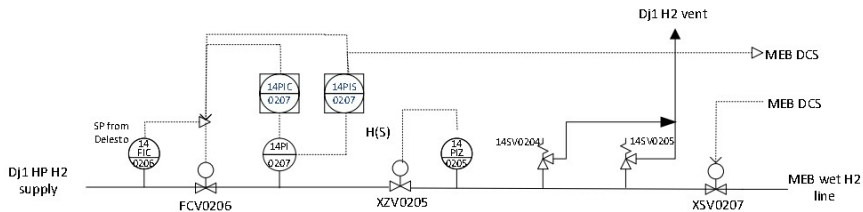
If the pressure reaches 1.6 barg the high level switch activates and closes 14FCV0206 and sends a signal to close 14XSV0207 via the MEB DCS. The main purpose of high pressure switch is to prevent high pressure in the wet H2 line. The controller also ensure no spurious lifting of 14SV0204/5 due to pressure peaks originating from a rapid Delesto H2 burner shutdown.

Setpoint

Table 4: Pressure setpoints at 14PIS0206

	Final Element	Setpoint (barg)	Pressure
High switch	14XSV0207 14FCV0206	and 1.6	

14PIC0207 (Start up only)
Control Scheme



Process description

During start up the Delesto unit requires both pressure and flow control in the wet H2 line. 14PIC0207 enables start up of the Delesto H2 auxiliary burners by controlling the pressure in the line. During start up 14FIC0206 is de-activated.

Control description

14PIC0207 is active only during the start up of the Delesto H2 auxiliary burner. At start up a Delesto operator needs to activate the controller. 14PIC0207 will then control the pressure in the wet H2 line during the startup, while the Delesto operator will manually ramp up the Delesto flow control 22/23FIC021. Once the Delesto unit has reached a stable acceptable H2 firing in the auxiliary burner the operator will switch the controls to flow control by activating 14FIC0206.

14FCV0206A is fast acting to control the pressure during start up. The A valve is operational between the flow range of 0-500 Nm³/h and the B valve between 400 Nm³/h-4000 Nm³/h. During normal operations the A valve will operate in parallel mode to the B valve in flow control.

Commented [AR2]: Turndown ratio for DJ1 during supply.

Setpoint

Table 5: Pressure setpoints startup to Delesto burner

Setpoint (barg)	Pressure
1	

* Operator determines the appropriate setpoint required at start up between 0.4barg-1.3barg.

5. Safeguarding – Normal mode + DJ1 only mode

14PIZ0205 will trip the DJ1 system in case the pressure rises above 1.7 barg.

PSV 14SV-0204 protects against over pressure of the LP distribution system and downstream users at a set pressure of 2 barg (plus max 10% accumulation).

PSV 14SV-0205 protects against over pressure of the LP distribution system and downstream users at a set pressure of 2.2 barg (plus max 10% accumulation).

30GBZ001 will trip the DJ1 plant when the valve has been opened more than 10%

The 2 relief valves in parallel offer a risk reduction factor of 1000 when in clean operation which is the case for dry H2 supply to Delsto from DJewles 1.

Relief scenarios taken into account are:

- Fail open control valve 14FCV0206. In dual supply mode (MEB+DJ1 supply) + DJ1 only mode.
- 30PCV-001 fails closed while controlled to be open. In normal mode (parallel supply) and during Delesto shutdown
- Blocked outlet to Delesto, and failure of 14FIC0206. In DJ1 only mode and parallel mode.

Table 6: Pressure setpoints

Setpoint	Pressure (barg)
DJ1 trip	1.7
Safety valve 14SV0204	2
Safety valve 14SV0205	2, 2



DJ1 Operating mode selector

Mode selector: The MEB is in control of selecting the operating mode of DJ1 H2 supply to Delesto whether this is DJ1 only mode (DJ1 only supplying H2 to Delesto) or whether it is in dual supply mode (both MEB and DJ1 are supplying H2 in parallel to Delesto). Delesto also sends an input signal on the operating mode of DJ1 to the MEB (DJ1 mode selector). When both modes are matching a signal on the appropriate operating mode is sent to DJ1.

DJ1 release signal from MEB

MEB logic solver: A logic solver as shown below in the MEB plant will evaluate all MEB SIS signals, MEB DCS release signal and Delesto DCS signals. In case any of the signals are in "trip" the logic solver will remove the release signal HZ0205 from DJ1 and close 14XZV0205. The logic solver will also close 14XSV0207 with a time delay after closing of 14XZV0205.

MEB manual release: The manual release signal 14HS0201 from an MEB operator via the DCS is sent to the MEB logic solver which will take away the release signal from DJ1 through 14HZ0205 (In DJ1 plant).

MEB unit trip: In case the MEB unit is entering a trip the DJ1 unit also needs to be tripped. In the situation that all 4 TG units in the MEB unit have a trip signal, the release signal 14HZ0205 will be taken away and the DJ1 valve 14XZV0205 will be closed. The logic solver will also close 14XSV0207 with a time delay. Upon the safe shutdown of the MEB unit and removal of all trip signals from the MEB plant and positive isolation of the MEB unit, the DJ1 operation can be switched to operate in DJ1 only mode through the MEB and Delesto selector switch.

MEB electrolyser H2 side low pressure: A low pressure trip signal from 81PIZ1302A in the MEB hydrogen line towards compressors will be (at a dedicated setpoint) sent to the MEB logic solver. This logic solver will take away release signal 14HZ0205 which will stop hydrogen supply by closing 14XZV0105. The logic solver will also close 14XSV0207 with a time delay. Upon the safe shutdown of the MEB unit, removal of all trip signals from the MEB plant and positive isolation of the MEB unit from the DJ1 plant, the DJ1 operation can be switched to operate in DJ1 only mode through the MEB selector switch.

H2 to MEB vent stack: 30GBZ001 opened more than 10%, a new position indicator on 30 PCV001 will take away release signal HZ0205 and as a result XZV0205 will close the hydrogen supply, this will ensure a very minimal amount of DJ1 H2 will be vented to the MEB waterlock in case of upset operations.

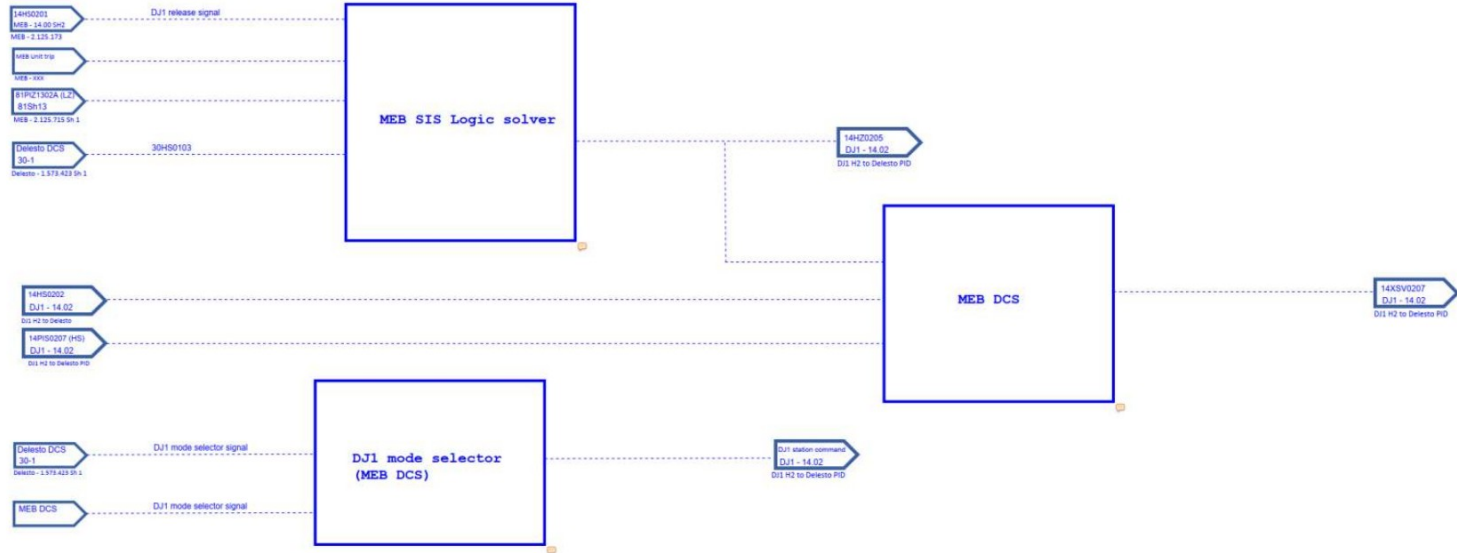


Delesto

Auxiliary firing trip: In case the supplementary firing in Delesto trips the Delesto SIS trip signal 22/23XZ182A is sent to the MEB logic solver which then takes away the release signal from HZ0205 in the DJ1 plant.

H2 firing in auxiliary boiler trip: In case the H2 firing in Delesto trips the Delesto SIS trip signal 22/23UZ342 is sent to the MEB logic solver which then takes away the release signal from HZ0205 in the DJ1 plant.

Delesto manual release: The manual release signal comes from an operator who can trip the DJ1 plant using HS0102.





Appendix 1: Existing MEB/Delesto wet H2 network pressure control

Productie waterstof (nat + droog)

waterstofproductie electrolyse	Nm3/t Cl2	320
chloorproductie	t/h	14
Waterstofproductie 2 barg	Nm3/h	4480
Afname droge waterstof	Nm3/h	2466
Beschikbaar (natte waterstof)	Nm3/h	2014

Productie en afname droge waterstof

Max. droog capaciteit	Nm3/h	2640
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Afnames droge waterstof

Teijin	Nm3/h	1256
Teijin reserve (future)	Nm3/h	250
MCA	Nm3/h	300
H2 busstation (Pitpoint)*	Nm3/h	100
Netstack*	Nm3/h	40
Netstack (future)*	Nm3/h	60
HyEnergy*	Nm3/h	460
Delesto	Nm3/h	
Huidige totaal afname	Nm3/h	2466