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TECHNICAL NOTE

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LabMET

EPAS n.v. Eco Process Assistance

SCK·CEN STUDIECENTRUM VOOR KERNENERGIE CENTRE D'ÉTUDE DE L'ÉNERGIE NUCLÉAIRE

TECHNICAL NOTE 80.421

Functional tests report Waste Preparation Unit

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1. Introduction

In BELISSIMA Phase 1, a Waste Preparation Unit (WPU) was constructed by Packo Inox NV. The functional test plan for the unit including P&ID and component description was described in TN80.311.

The tests were organized in three phases. A first phase aimed to check the absence of leaks and to check functionalities and responses of components. In a second phase, the accuracy of the level transmitter indicating the actual liquid level in the homogenization tank of the WPU was verified. In a last phase, the adequacy of controller actions under normal and abnormal operation was checked.

The test record sheets are assembled in this TN80.421.

2. Functional test record sheets

The completed test record sheets including the annotated test procedures can be found in Appendix 1.

3. Conclusions

All functional tests for the Waste Preparation Unit have been performed, as recorded in the test record sheets.
In TN80.431, the results of the functional tests will be presented and discussed.

Appendix 1 – Test record sheets Functional tests Waste Preparation Unit

MELISSA	**BELISSIMA Waste Preparation Unit**	vito vision on technol
	Test record sheet: Functional tests: absence of leaks, functionality check	Test code: T_001 Version: 01 Date: /2010 03/09 -02/10 Page: 1

Responsible person	H. Ehlandt
Applicable test plan and protocols	TN.80.311

Criterion	Tag	Description	Test performed (Y/N)	Test result (C/NC)	Comments/Deviation
Absence of liquid leakage	/	/			
	VSL2_0000_01	Main tank	Y	C	
	VSSL_0100_01	Cleaning tank	Y	C	
	SP_0002_01	Shear pump	Y	C	
	P_0102_01	Centrifugal pump with mechanical coupling	Y	C	
	LS_0004_01	Level switch (foam detection main tank)	Y	C	High level, tank half-full to full
	LS_0004_02	Level switch (main tank)	Y	C	
	LT_0004_01	Level transmitter	Y	C	
	LS_0102_01	Level switch (cleaning tank)	Y	C	
	HV_0000_01	Sanitary 2-way ball valve, drain buffer tank	Y	C	
	HV_0002_01	Sanitary 2-way ball valve, before shear pump	Y	C	
	HV_0002_02	Sanitary 2-way ball valve, after shear pump	Y	C	
	PV_0102_01	Powered 2-way diaphragm valve, after centrifugal pump	Y	C	
	PV_0006_01	Powered 2-way diaphragm valve, inlet water to main tank	Y	C	
	HV_0002_03	2-way diaphragm valve, valve to sample	Y	C	
	HV_0001_01	Sanitary 2-way ball valve, inlet double jacket	N		not connected
	HV_0001_02	Sanitary 2-way ball valve, outlet double jacket	N		not connected
	PV_0101_01	Powered 2-way diaphragm valve, inlet water to	Y	C	

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	Test record sheet: Functional tests: absence of leaks, functionality check	Test code: T_001 Version: 01 Date: /2010 30/09 -02/10 Page: 2

Criterion	Tag	Description	Test performed (Y/N)	Test result (C/NC)	Comments/Deviation
		sprayball			
	HV_0100_01	Sanitary 2-way ball valve, inlet water to cleaning tank	Y	C	
	HV_0102_01	Sanitary 2-way ball valve, drain after centrifugal pump	Y	C	
	HV_0002_04	Sanitary 2-way ball valve, drain after shear pump	Y	C	
		Connections			
Functionality check	BLE_0003_01	Mechanically coupled stirrer main tank	Y	C	
	NOZ_0005_01	Sprayball	Y	C	
	LS_0004_01	Level switch (foam detection main tank)	Y	C	
	LS_0004_02	Level switch (main tank)	Y	C	
	LT_0004_01	Level transmitter	Y	C	
	LS_0102_01	Level switch (cleaning tank)	Y	C	
	PV_0102_01	Powered 2-way diaphragm valve, after centrifugal pump	Y	C	
	PV_0006_01	Powered 2-way diaphragm valve, inlet water to main tank	Y	C	
	PV_0101_01	Powered 2-way diaphragm valve, inlet water to sprayball	Y	C	

Test result (pass/fail)		P	Number of deviations:		
Test executed by	H. Eblander	Date	02/10/'10	Signature	
Reviewed by	H. DeWever	Date	28/10/'10	Signature	

Deviation form

Deviation Number	Deviation:		Criticality
	Corrective action:	Responsible	Due date
	Corrective action performed and checked: Ref. of retests	Checked/ approved by	Closing date

MELISSA	**BELISSIMA Waste Preparation Unit**	vito vision on technol
	Test record sheet: Functional tests: Accuracy of level transmitter	Test code: T_002 Version: 01 Date: /2010 01/10 Page: 1

Responsible person	H. Eblander
Applicable test plan and protocols	TM. 80.311

Action	Expected result	Remarks	Result (C/NC)	Deviation
After proper calibration of LT_0004_01, 40 l of water is added manually to the homogenization tank 9 points calibration	The outgoing signal of LT_0004_01 corresponds with the measured value	—	C	
	LT_0004_01 indicates a water volume of 40 ±4 l	—	C	
	LT_0004_01 shows a stable measurement	see lab book 2010-SCT-08-035	C	
After emptying the tank, 10 l of water is added manually to the homogenization tank	The outgoing signal of LT_0004_01 corresponds with the measured value	—	C	
	LT_0004_01 indicates a water volume of 10 ±1.0 l	—	C	
	LT_0004_01 shows a stable measurement	see lab book 2010-SCT-08-035	C	

Test result (pass/fail)		P	Number of deviations:		
Test executed by	H. Eblander	Date	01/10/10	Signature	
Reviewed by	A. De Wever	Date	25/10/10	Signature	

Deviation Number	Deviation:		Criticality
	Corrective action:	Responsible	Due date
	Corrective action performed and checked: Ref. of retests	Checked/ approved by	Closing date

MELISSA	**BELISSIMA Waste Preparation Unit**	vito vision on technol
	Test record sheet: Functional tests: Adequacy of controller actions under normal and abnormal operation	Test code: T_003 Version: 01 Date: /2010 01-02/10 Page: 1

Responsible person	H. Ebbander
Applicable test plan and protocols	TH. 80.311

Action	Expected result	Remarks	Result (C/NC)	Deviation
Normal operation				
'Start filling CO-04'	Valve PV_0101_01 opens Water added to tank VSL2_0000_01 through nozzle NOZ_0005_01	—	C	
'Stop filling CO-04'	Valve PV_0101_01 closes	—	C	
'Start shear pump'	Pump SP_0002_01 starts pumping water	—	C	
'Stop shear pump'	Pump SP_0002_01 stops	—	C	
'Speed shear pump' changed	Pump speed increases when position changed from 3. to 6.. Pump speed decreases when position changed from 6. to 3.	—	C	
'Start mixer'	Agitator BLE_0003_01 starts	—	C	
'Stop mixer'	Agitator BLE_0003_01 stops	—	C	
'Speed mixer' changed	Agitator speed increases when position changed from 3. to 6.. Agitator speed decreases when position changes from 6. to 3..	—	C	
'Start filling CO-03'	Valve PV_0006_01 opens	—	C	
'Stop filling CO-03'	Valve PV_0006_01 closes	—	C	
'Extra filling CO-03'	Valve PV_0006_01 opens	—	C	
'Start cleaning pump'	Pump P_0102_01 starts pumping water	—	C	
	Valve PV_0102_01 opens	—	C	
'Stop cleaning pump'	Pump P_0102_01 stops	—	C	
	Valve PV_0102_01 closes	—	C	
Volume of 10 l is entered in controller display. Button 'Start filling CO-04' is pushed	10 l of water is added to tank VSL2_0000_01	— weight recorded in lab book 2010-SCT-013-035	C	
Volume of 40 l is entered in controller display. Button 'Start filling CO-04' is pushed	40 l of water is added to tank VSL2_0000_01	— id	C	

MELISSA	**BELISSIMA Waste Preparation Unit**	vito vision on technol
	Test record sheet: Functional tests: Adequacy of controller actions under normal and abnormal operation	Test code: T_003 Version: 01 Date: /2010 01-02/10 Page: 2

Entered volume is first 15 l and the button 'Start filling CO-03'. Then the entered volume is set to ~~32~~ 3 l and the button '~~Extra~~ Start filling CO-03' pushed.	Total added water volume to tank VSL2_0000_01 is ~~37~~ 3 l	— id.	C	
Abnormal operation				
Empty homogenization tank until LS_0004_01 indicates low level	Pump SP_0002_01 stops running	—	C	
Empty cleaning tank until LS_0102_01 indicates low level	Pump P_0102_01 stops running	—	C	
Manhole MH_0009_01 is open and button 'start mixer' is pushed	Agitator BLE_0003_01 does not start	—	C	
Agitator BLE_0003_01 and pump SP_0002_01 are running, then manhole MH_0009_01 is opened	Agitator BLE_0003_01 and pump SP_0002_01 stop running	—	C	
Press 'Emergency stop'	No automatic restart when power supply is renewed	—	C	
Simulate power failure and manually restart	No automatic restart when power supply is renewed	—	C	

Test result (pass/fail)		P	Number of deviations:		
Test executed by	H. Eblander	Date	02/10/'10	Signature	
Reviewed by	H. De Wever	Date	28/10/10	Signature	

Deviation form

Deviation Number	Deviation:		Criticality
	Corrective action:	Responsible	Due date
	Corrective action performed and checked: Ref. of retests	Checked/ approved by	Closing date

Annex: Test strategy as from TN80.311

Phase 1

- Checking absence of leaks
  - The tanks are filled halfway with water
  - Components under liquid level are checked for the absence of leakages
  - A recheck is performed after 24 h
  - If a leak is observed, connections have to be tightened, the component better aligned or gaskets replaced
  - The shear pump is activated and the appropriate valves opened to fill the piping with water
  - All components in the piping are visually checked for absence of leaks
  - The centrifugal pump is activated and the appropriate valves opened to fill the piping with water
  - All components in the piping are checked for absence of leaks
- Checking functionalities and responses of components
  - All valves are opened and closed to check their operability
  - All electrical instruments are switched on and checked one by one for their operation
  - The tanks and pipes are filled with water till high level
  - The response of the high level switch in the homogenizing tank is checked
  - The stirrer is switched on and off
  - Mixing of and turbulence in the water volume is checked visually
  - The nozzle is activated and the spreading of water checked visually against the tank walls and top
  - The shear pump is switched on and off, while the flow of water into the homogenizing tank is checked visually
  - The cleaning pump is switched on and off and the flow of water into the homogenizing tank checked visually
  - The homogenizing tank is emptied and the response of the low level switch checked
  - The cleaning tank is emptied and the response of the low level switch checked

Phase 2: Checking the level transmitter accuracy

- The level transmitter is calibrated according to the manufacturer's instructions, choosing an appropriate calibration procedure which should take into account the non-linear increase in water volume with the height of the tank (round-bottomed tank and the presence of recirculation pipe) 9-points calibration ⇒ linearisation

- The homogenizing tank is filled manually with a known amount of water between 40 and 50 l which will be the typical values used for waste preparation
- The correspondence between the outgoing signal of the level transmitter and the measured value is checked
- If they are different, connections and settings are checked and adapted
- The correspondence between the measured value and the actually added water volume is checked
- If this is different, the level transmitter is recalibrated or a different more-point calibration procedure is used
- This procedure is repeated until measured value and actually added water volume differ less than 10%
- The stability of the signal is monitored every 2 min for at least 30 min while simultaneously the stability of the water surface is checked
- Then a different volume of water is added in the lower range (10-20 l) and the procedure repeated

Phase 3

- Executing controller action and checking adequacy of answer under normal operation
  - The homogenization tank is filled with water to half the total volume by pushing the buttons 'Start filling CO-03' and 'Stop filling CO-03'. The opening and closing of the appropriate valve is checked.
  - The shear pump is switched on
  - The flow of water into the homogenizing tank and the opening of the associated valve is checked visually. The actual flow of the pump is not measured as not the flow but rather the mixing capacity is important and this will be verified during the demonstration tests
  - The frequency of the shear pump is varied by varying the position of the button 'speed shear pump'
  - The flow of water into the homogenizing tank is checked visually
  - The shear pump is switched off. The flow of water and closing of the associated valve is checked visually.
  - The stirrer is switched on and the response checked visually
  - Its stirring speed is varied through the button 'speed mixer' and the response checked visually
  - The stirrer is switched off
  - The cleaning tank is filled with water to half the total volume by ~~pushing the buttons 'Start filling CO-03' and 'Stop filling CO-03'. The opening and closing of the appropriate valve is checked~~. opening the Hand Valve HV_0100_01
  - Extra water is added to the cleaning tank by ~~pushing button 'Extra filling CO-03'. The response is checked visually~~. opening HV_0100_01
  - The cleaning pump is switched on and off
  - The flow of water into the homogenizing tank and the opening/closing of the associated valve is checked visually.

- The homogenization tank and piping is completely emptied. The water tap is opened halfway to avoid too high water flows into the system. A predefined volume below 20 l is entered in the controller display and the button 'start filling CO-03' pushed. The amount of water entered is measured by completely emptying the tank. This procedure is repeated 3 times for the same volume, and then again 3 times for a predefined volume between 40 and 50 l.
- The homogenization tank is first filled to a predefined level of 15 l. Then an additional volume of 17 l is added by pushing the button. The total volume is measured by weighing. By mishake we increased the level to 12l

- Executing controller action and checking adequacy of answer under abnormal operation
  - The homogenization tank is filled with water. The shear pump is running. The homogenization tank is emptied by opening the drain until the low level switch switches. The shear pump should then stop running.
  - The cleaning tank is filled with water. The cleaning pump is running and pumping the water to the homogenization tank. When the low level switch in the cleaning tank switches, the cleaning pump should stop running.
  - The stirrer is switched off. The manhole is opened. The stirrer is then activated through the control unit. It should not be possible to activate it.
  - The homogenization tank is filled with water. The manhole is closed and the stirrer and shear pump activated. When the manhole is opened, both compounds should stop running.
  - The manhole is closed again. The stirrer is activated. When 'Emergency stop' is pushed, the stirrer should not automatically restart after renewed power supply.
  - The system is reset. The stirrer is activated. When the power supply is interrupted and a manual restart performed, the stirrer should not automatically restart.