



EUR18_18 - PAS IEC 63131 System Control Diagram Tutorial

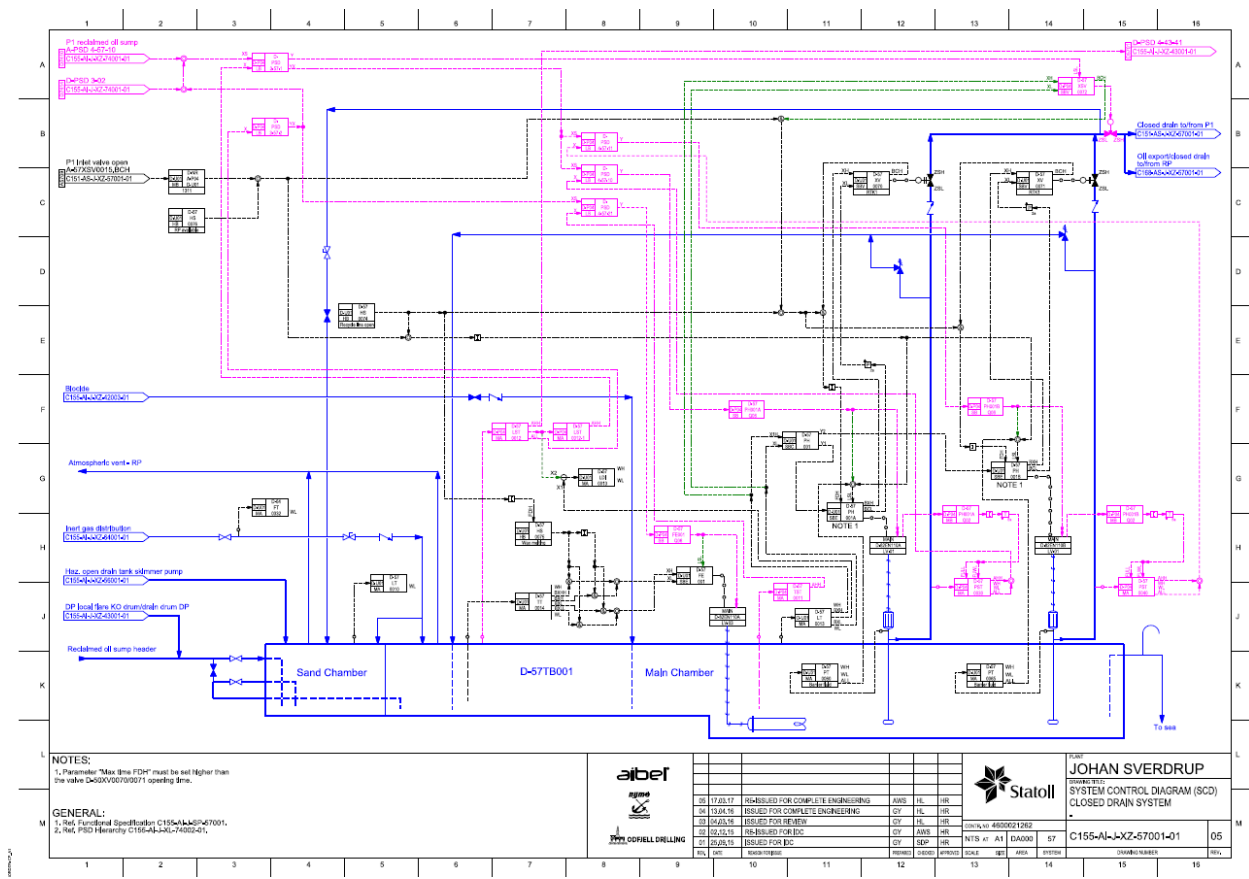
Idar Pe Ingebrigtsen, Equinor



- Introduction
- Background for the method
- The extend of usage so far
- The Standard
 - The Function blocks
 - The Diagram
 - The Method

Introduction

- The system control diagram is a logic diagram which starts where the P&ID ends.
- It uses the process as background.



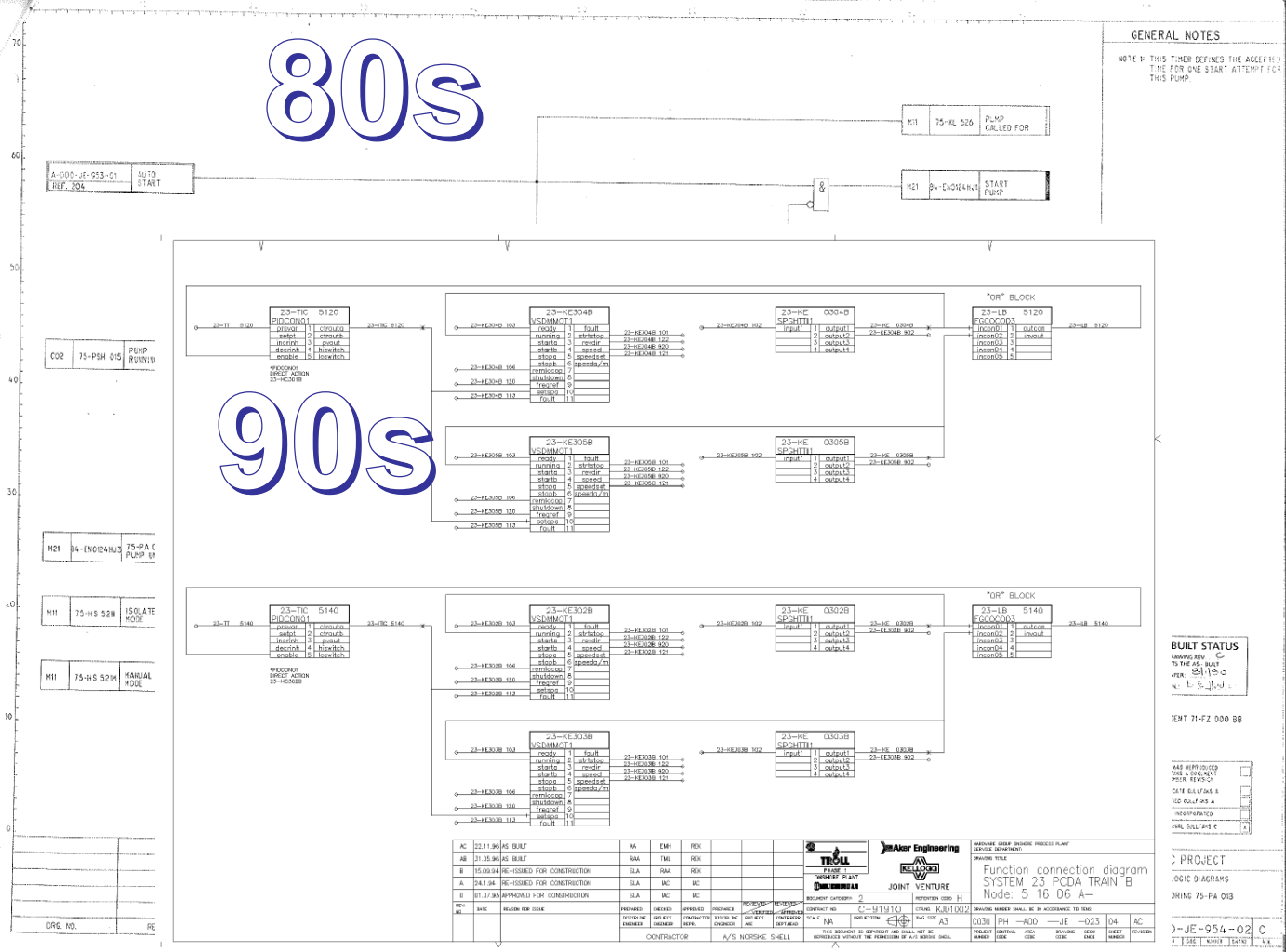
Background

- The challenge - to create the ICSS application for an offshore oil and gas platform on the Continental Norwegian Shelf.
- Some of the Framework
 - An offshore oil and gas platform covers 40 wells giving 200.000 barells of oil each day , produces it's own power, water, heat and may have a LQ with 200 beds.
 - The process medium is higly flammable and explosive, hence process safety is vital.
 - Process safety systems are integrated with process control on the operator station. Focus on no commen failure mode. Process safety actions is automatic and independant of process control in the application on controller level.
 - Process safety and Process control application to be developed in a systematic manner.
 - F&G system , Emergency shutdown, Process shutdown and process control.

Background -The history of logic diagrams - Statoil

- During 80thies use of Logic diagrams , elementary function blocks
- Norsk Hydro did Oseberg field development 1985 – 1989 and the need

- Stat Con
- Norsk
- Norsk
- Stat (Co
- IFE/ take
- NOR



ction

S

Usage - SCD referance list the first 10 years.

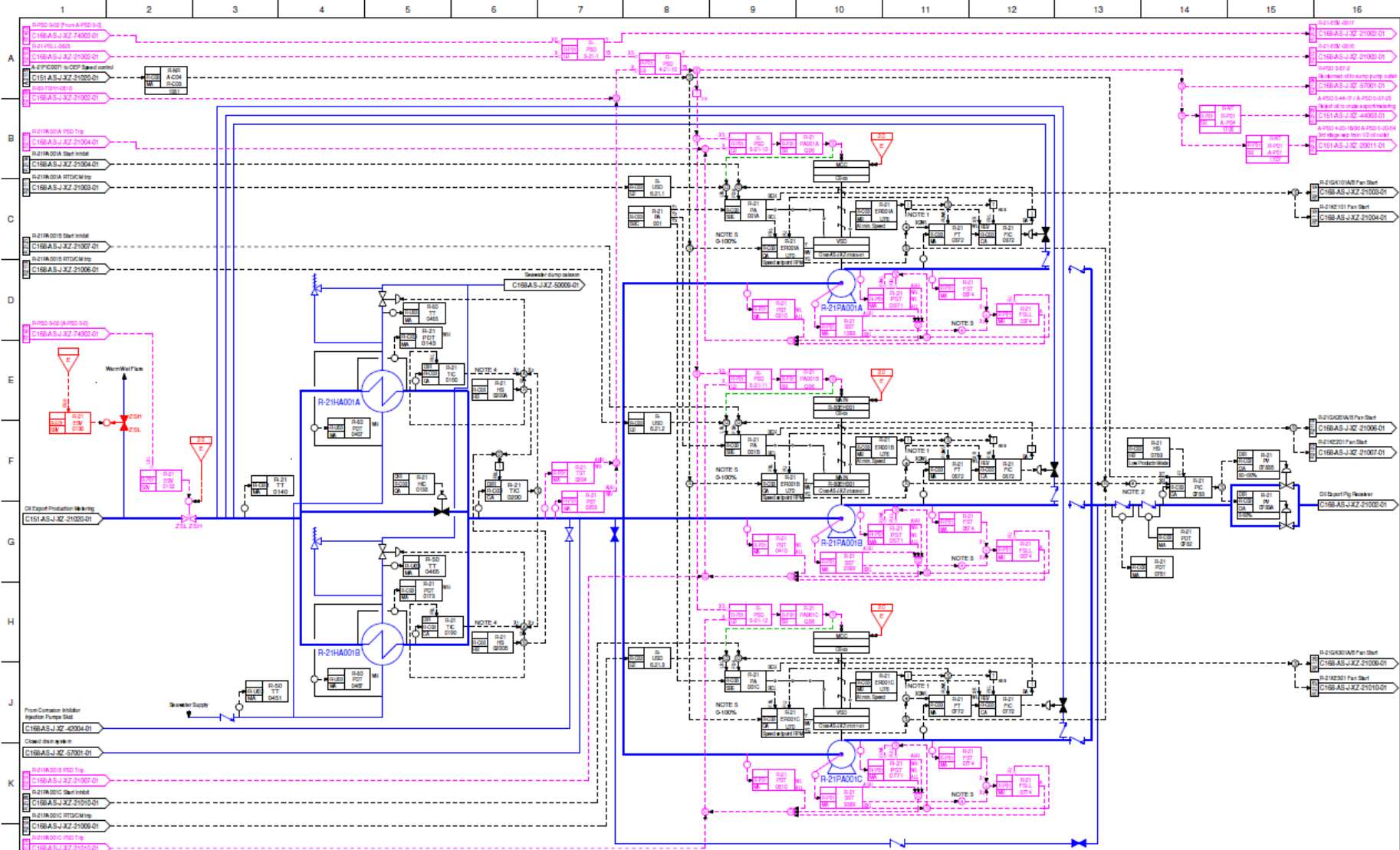
Project	Year	Operator	Supplier	Eng. Contr.
Brage	1994	Norsk Hydro	Siemens	Kværner
Troll B	1995	Norsk Hydro	Honeywell	Aker
Heidrun	1995	Conoco/Statoil	Simrad	Kværner
Sleipner Vest	1996	Statoil	ABB	Kværner
Njord	1997	Norsk Hydro	Siemens	Aker
Norne	1997	Statoil	Simrad	Kværner
Ekofisk	1998	Phillips	ABB	Kværner
Troll C	1998	Norsk Hydro	Siemens	Umoe
Jotun	1999	Esso	Honeywell	Kværner
Visund	1999	Norsk Hydro	Siemens	Umoe
Oseberg Øst	1999	Norsk Hydro	Siemens	Kværner
Oseberg Sør	2000	Norsk Hydro	Siemens	Aker
Oseberg Gass	2000	Norsk Hydro	Siemens	Aker
Snorre B	2001	Norsk Hydro	Siemens	Kværner
Kvitebjørn	2003	Statoil	Honeywell	ABB
Grane	2003	Norsk Hydro	ABB	Kværner

Usage - SCD Usage recent projects

Project	Year	SAS	Eng.Contr. /SCD	Operatør	Proj type
Gudrun	2014	ABB	Aibel	Statoil	Greenfield
Eldfisk	2015	Siemens	Aker Solutions	ConocoPhillips	Brownfield Greenfield
Tyrihans	2009	Kongsberg	FMC	Statoil	Tie-in Kristin
Morvin	2010	Kongsberg	AK subsea	Statoil	Tie-in Åsgard B
O2		Siemens	Siemens	Statoil	Tie-in
Kårstø NGL Meetering		ABB	MWKellog	Statoil	Upgrade
Valomon	2016	Honeywell	Samsung/ Technip KL	Statoil	Greenfield
Goliat	2017	ABB	Hyundai/ABB	ENI	Greenfield
Ekofisk Z	2013	ABB	Aker Solutions	ConocoPhillips	Greenfield
Jordbær		ABB	Samsung/ABB	TeeKay	Greenfield
Mariner	2018	Kongsberg	DSME / CB&I London	Statoil	Greenfield
Aasta Hansteen	2017	ABB	Hyundai / CB&I Haag	Statoil	Greenfield
Gina Krogh	2017	Emerson	Daewoo / Akersol. KL	Statoil	Greenfield
Edvard Grieg	2016	Honeywell	Akersolutions	Lundin	Greenfield
Johan Sverdrup	2019	Kongsberg	AkerSolutions / Aibel / KBR	Statoil	Greenfield

Usage - within Statoil





NOTES
 1. Minimum Flow Control setpoint and Alarm formula varies with RPM speed, see Automation Functional Specification for System 21 C168-AS-J-SP-21001, S.1.2.1. Zero Speed shall produce Zero setpoint to force valve closed.
 2. Back pressure Control setpoint formula which varies with maximum RPM speed, see Automation Functional Specification for System 21 C168-AS-J-SP-21001, S.1.2.2.
 3. Discharge Flow Trip setpoint formula which varies with RPM speed, see Automation Functional Specification for System 21 C168-AS-J-SP-21001, S.1.2.2.
 4. Software minimum stop set normally at 13%.
 5. X input to LFD CA block is ranged 0-100%. Y output is ranged to scale X to 0-2077 RPM in Phase 1 and 0-3395 RPM in Phase 2, but shall have permanently minimum value of 1620 RPM. XIG & YG are in RPM



03	21.04.2016	ISSUED FOR DETAIL ENGINEERING / DETAIL DESIGN	JMYH	MS	KP	CONTR NO	4503126105				
02	07.03.2016	ISSUED FOR REVIEW	JMYH	MS	KP	NA	AT1 RA000 21				
01	10.06.2015	ISSUED FOR INFORMATION	JMYH	MS	KP						
REV	DATE	REASON FOR ISSUE	MADE BY	CHECKED	APPROVED	SCALE	SZL	AREA	SYSTEM	DSG-WING NUMBER	REV

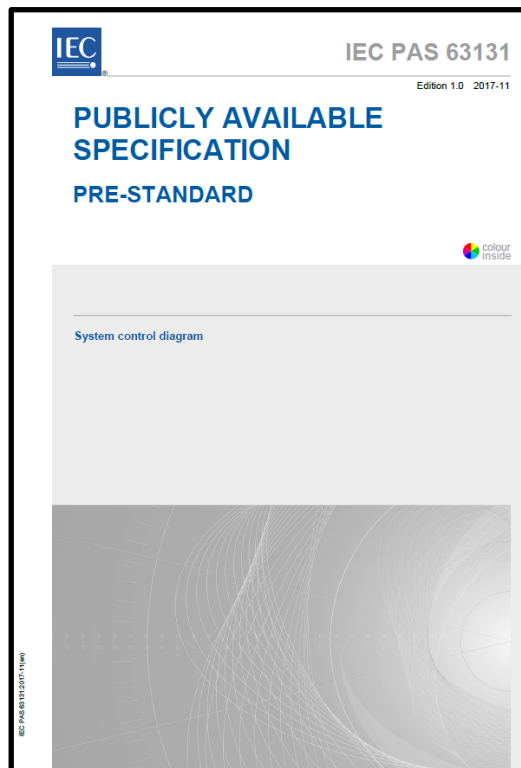
JOHAN SVERDRUP
 SYSTEM CONTROL DIAGRAM
 Oil Export Cooler and Pumps
 C168-AS-J-XZ-21001-01

The standard - What is the SCD concept

- Function blocks on a functional and operational high level
 - Tagnumbers on SCD corresponds to the object names on the operator station objects. Identifies 'the point of access' for operators.
- Control logic presented on a process-diagram, including the safety interlocks
 - Easy access to interlock logic during trouble shooting
- Focus on the control logic's multidisciplinary stakeholder input
 - Secure best possible quality of functionality during design phase

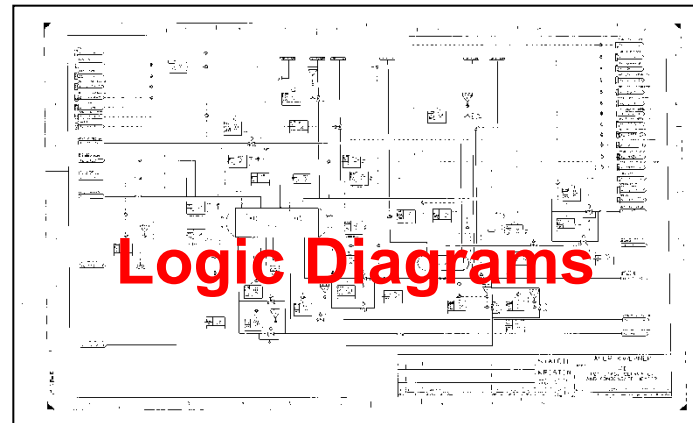
System Control Diagram - SCD - PAS IEC 63131

- A method of designing control system logic.
- Consist of 2 parts



A.4.4.3.4 Function template schematic

Inputs	SBV	Outputs
Position High feedback	XGH	Y Normal function output
Position Low feedback	XGL	YF Alarm Function failed
External fault	XF	BCH Output Position High Confirmed
External set high	XH	BCL Output Position Low Confirmed
External set low	XL	
External outside set high	XOH	
External outside set low	XOL	
Operator Station:		Operator Station:
Select Auto mode		Fault annunciation
Select Man. mode		Status Open/Closed
Select outside		Status manual / Outside
Select Open (high)		Blocked
Select Closed (low)		Suppressed
Blocking on		Status Disabled
Blocking off		Status Safeguard
Suppression on		Coincidence state
Suppression off		
Logic:		Logic:
Lock Safeguarding H	LSH	BA Status Auto/Man mode
Lock safeguarding L	LSL	BO Status Outside mode
Force Safeguarding H	FSH	BS Status Safeguarding mode
Force Safeguarding L	FSL	BB Status Blocked mode
Force Disable transition H	FDH	BU Status suppressed mode
Force Disable transition L	FDL	
Force suppress mode	FU	
Force block mode	FB	
Lock Auto mode	LA	
Lock Manual mode	LM	
Lock Outside operation mode	LO	



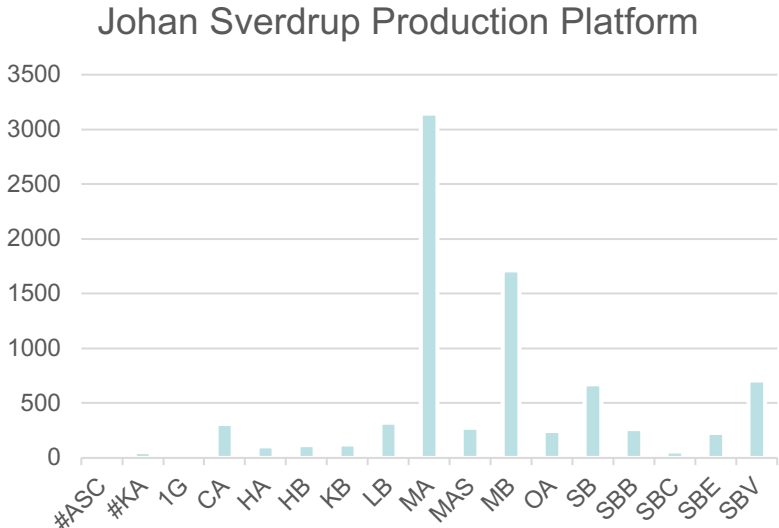
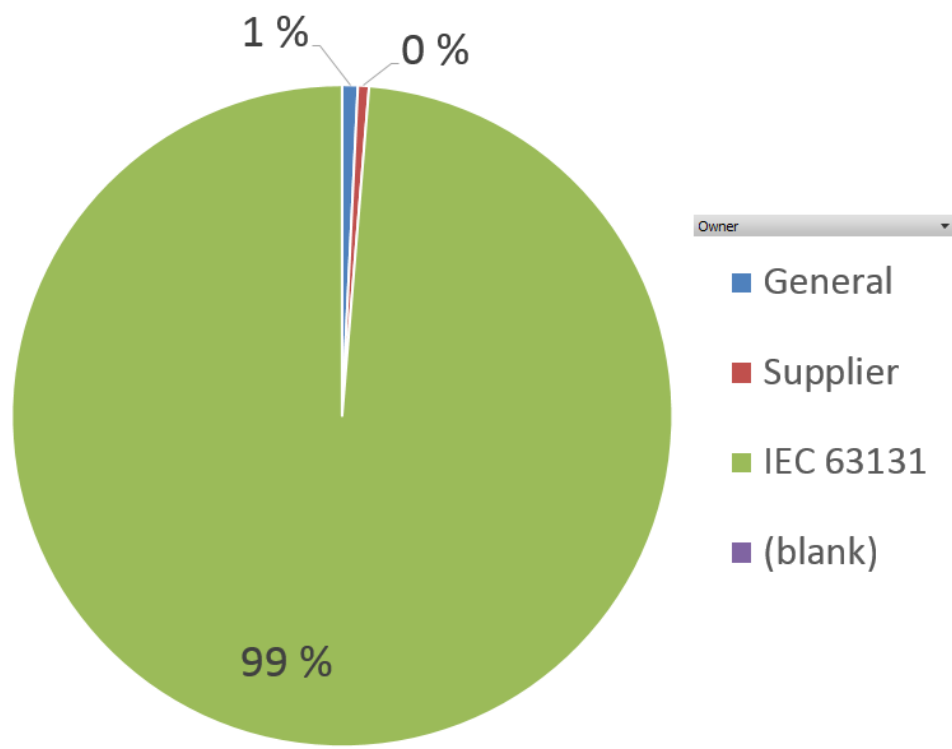
THE FUNCTION BLOCKS

A.4.4.3.4 Function template schematic		
Inputs	SBV	Outputs
Position High feedback	XGH	Y Normal function output
Position Low feedback	XGL	YF Alarm Function failed
External fault	XF	BCH Output Position High Confirmed
External set high	XH	BCL Output Position Low Confirmed
External set low	XL	
External outside set high	XOH	
External outside set low	XOL	
<u>Operator Station:</u>		
Select Auto mode		Fault annunciation
Select Man. mode		Status Open/Closed
Select outside		Auto / manual / Outside
Select Op. (H)		Status blocked
Select Closed		Status suppressed
Blocking on		Status Disabled
Blocking off		Status Safeguard
Suppression on		Coincidence state
Suppression off		
<u>Logic:</u>		
Lock Safeguarding H	LSH	BA Status Auto/Man mode
Lock safeguarding L	LSL	BO Status Outside mode
Force Safeguarding H	FSH	BS Status Safeguarding mode
Force Safeguarding L	FSL	BB Status Blocked mode
Force Disable transition H	FDH	BU Status suppressed mode
Force Disable transition L	FDL	
Force suppress mode	FU	
Force block mode	FB	
Lock Auto mode	LA	
Lock Manual mode	LM	
Lock Outside operation mode	LO	

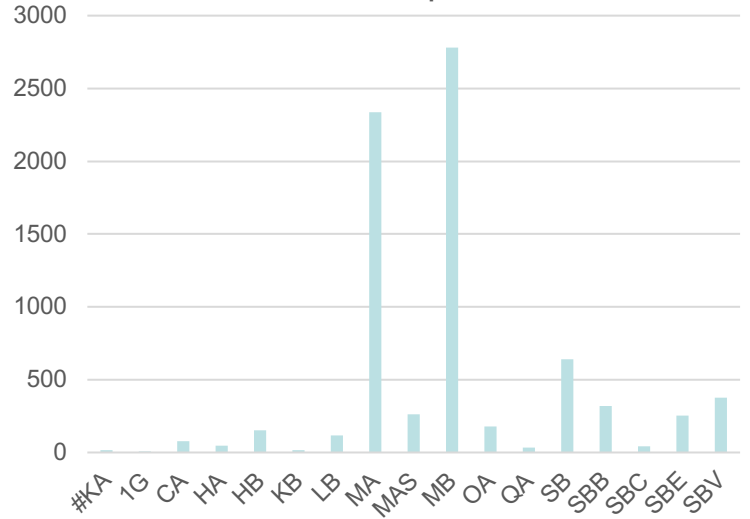
Function Template – 16 pcs

- ❑ **CA** – PID controller (Continuous Analog)
- ❑ **CS** – Step control (Continuous Step)
- ❑ **HA** – Manual analog input (Hand Analog)
- ❑ **HB** – Manual binary input (Hand Binary)
- ❑ **KB** – Sequence header (Sequencing Binary)
- ❑ **LB** – Shutdown level (Latching Binary)
- ❑ **MA** – Analog measurement (Monitoring Analog)
- ❑ **MAS** – Analog measurement from subsystem (Monitoring Analog Serial)
- ❑ **MB** – Digital input (Monitoring Binary)
- ❑ **OA** – Analog output (Output Analog)
- ❑ **QA** – Totalizer (Totalize Analog)
- ❑ **SB** – Digital output (Switching control Binary)
- ❑ **SBB** – El. breaker operation (Switching Binary Breaker)
- ❑ **SBC** – Coordination of multiple SBE (Switching Binary Coordination)
- ❑ **SBE** – Electrical equipment operation (Switching Binary Electrical)
- ❑ **SBV** – Pneumatic/hydraulic equipment operation (Switching Binary Valve)

FB usage statisticks – Johan Sverdrup project



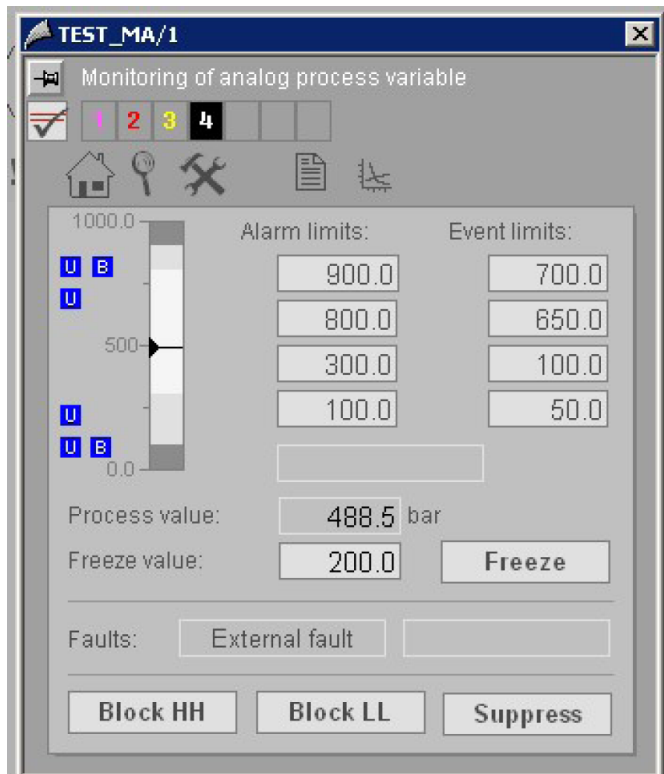
Total 8341
Johan Sverdrup Riser Platform



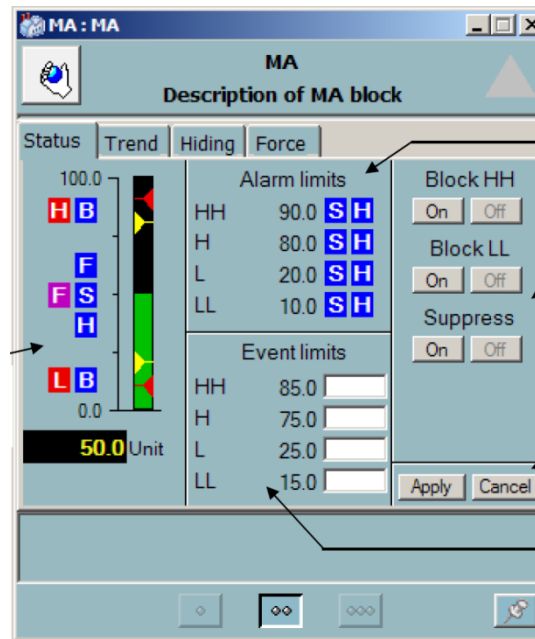
Total 7659

Standardisation of operation

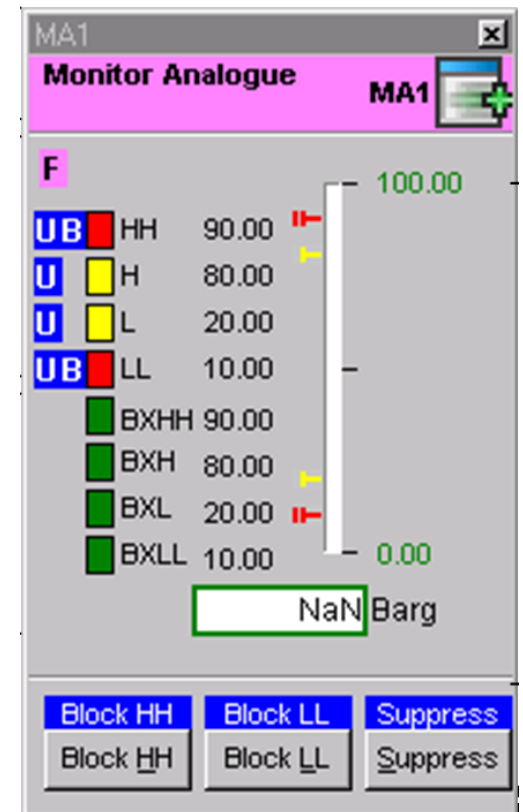
Vendor 1



Vendor 2

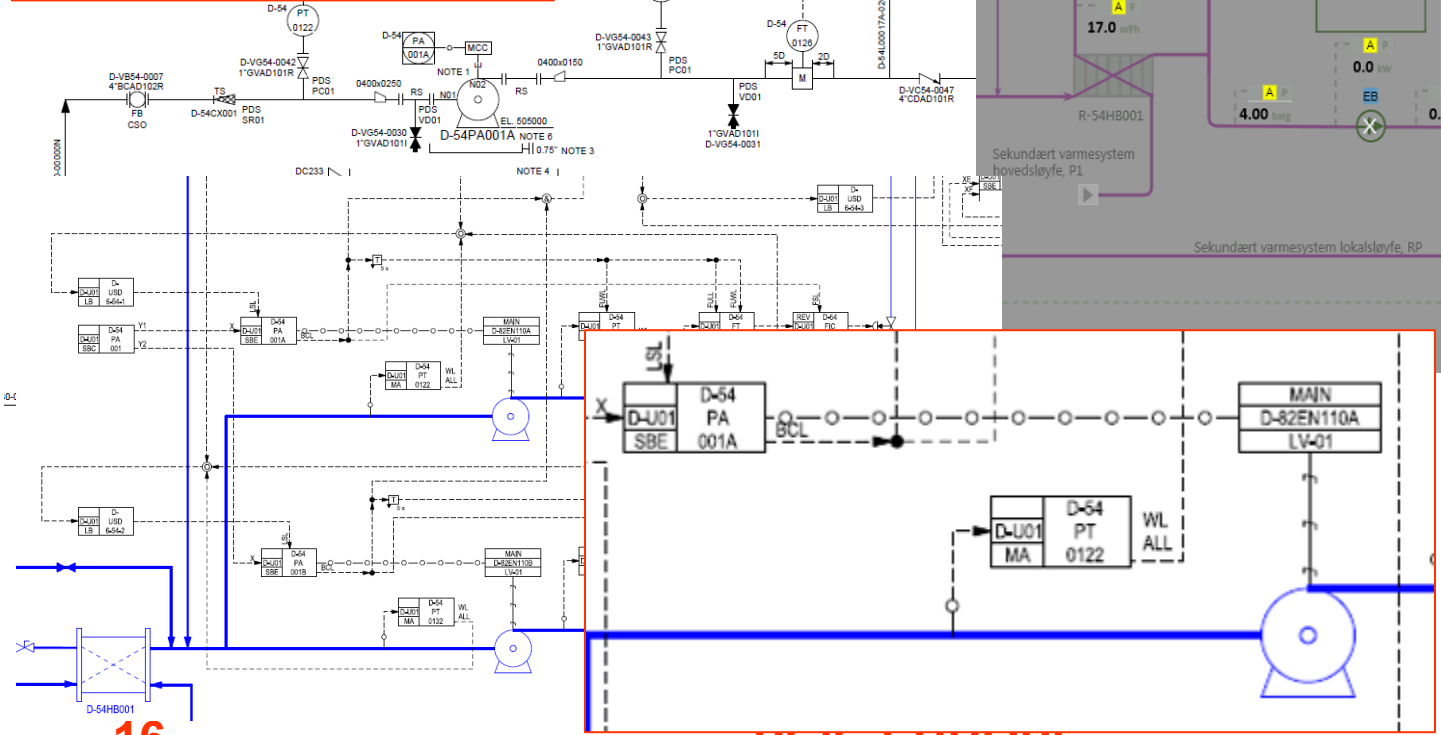
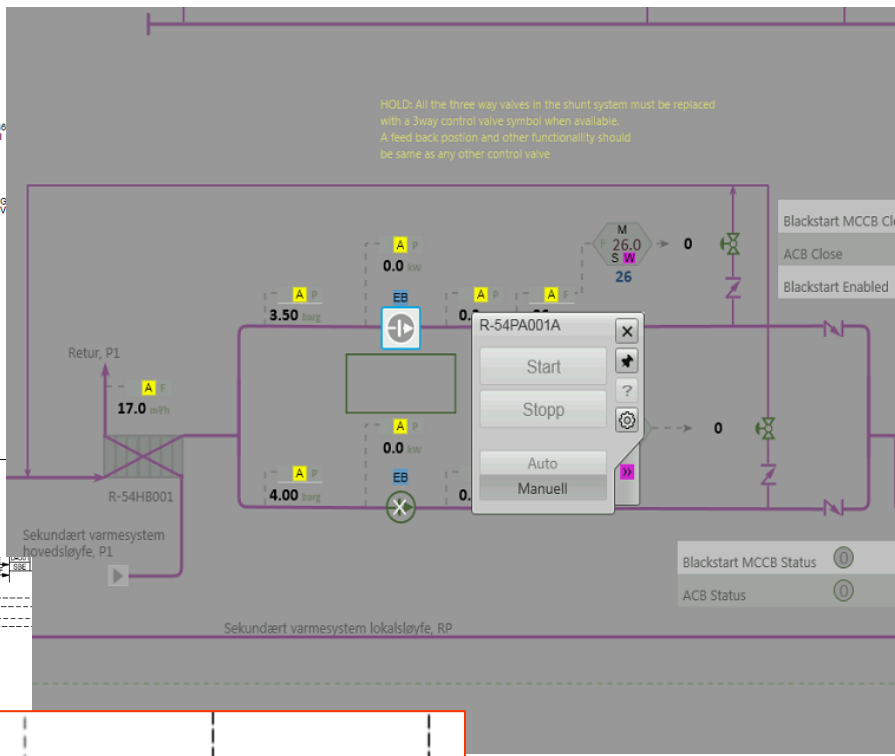
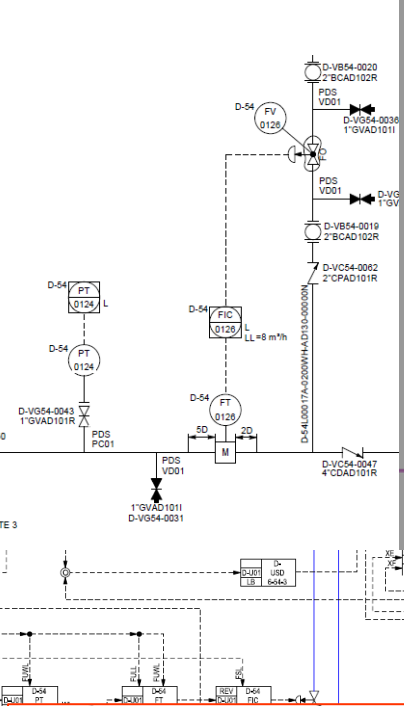
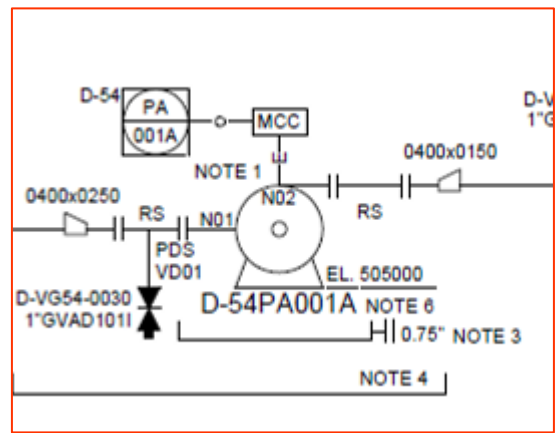


Vendor 3



Object orientation

- Reduced need for tagging – the software object

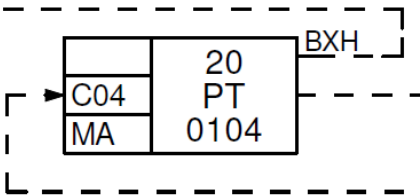


16

PCIC EUROPE

MA – Monitoring of Analog process value

A.4.6.2.1 Function template schematic



Inputs

- Normal function input
- External fault
- Force blocking alarm HH
- Force blocking alarm LL
- Force suppression alarm HH
- Force suppression alarm WH
- Force suppression alarm WL
- Force suppression alarm LL

MA	
X	
XF	
FBHH	
FBLL	
FUHH	
FUWH	
FUWL	
FULL	

Outputs

- Y Normal function output
- YF Function failed
- AHH Action alarm HH
- BHH Status alarm HH
- WH Warning alarm H²⁾
- WL Warning alarm L²⁾
- ALL Action alarm LL
- BLL Status alarm LL
- BBHH Action alarm HH is blocked
- BBLL Action alarm LL is blocked
- BU Status suppressed
- BB Status blocked
- BXHH Status event HH
- BXH Status event H
- BXL Status event L
- BXLL Status event LL

AHH	binary output	Action alarm high-high
ALL	binary output	Action alarm low-low

BXH	binary output	Status event high status high	True, when X-value > Event high limit. No alarm annunciation, event only.
BXL	binary output	Status event low	True, when X-value < Event low limit. No alarm annunciation, event only.

Suppression on/off

Blocked
Suppressed

X and Y:

Normal Input (X) and Normal Output (Y) is **not** given terminal code on the SCD, unlike all other terminals.

ate schematic

SBV – Output control of a Binary Valve

A.4.15.2.1 Function template schematic

Inputs		SBV		Outputs	
	Position high feedback	XGH	Y		Normal function output
	Position low feedback	XGL	YH		Pulsed normal function output high
BCH	binary output	Output position high confirmed	Output Y compared to feedback position high from MCC or limit switch and validated as true		Position output low
	External outside set high	XOH		BCH	Output position high confirmed
	External outside set low	XOL		BCL	Output position low confirmed
	External fault	XF		BS	Status safeguarding
	Lock safeguarding high	LSH		BB	Status blocked
	Lock safeguarding low	LSL		BU	Status suppressed
	Force safeguarding high	FSH		BA	Status auto/man
	Force safeguarding low	FSL		BO	Status outside
	Force disable transition high	FDH			
	Force disable transition low	FDL			
	Force blocking	FB			
	Force suppression	FU			
	Lock auto	LA			
	Lock manual	LM			
	Lock outside	LO			
	Operator station: Auto/Manual/Outside				Operator station: Alarms and faults
LSL	binary input	Lock safeguarding low	Safeguarding - signal overrules operator inputs (locking the template to manual mode with Y- output to low -stop motor-). Input is subject to blocking. After signals disappear the template remains in manual mode and the output low.		Open/Opening/Closed/Closing
					Safeguarding Conflict

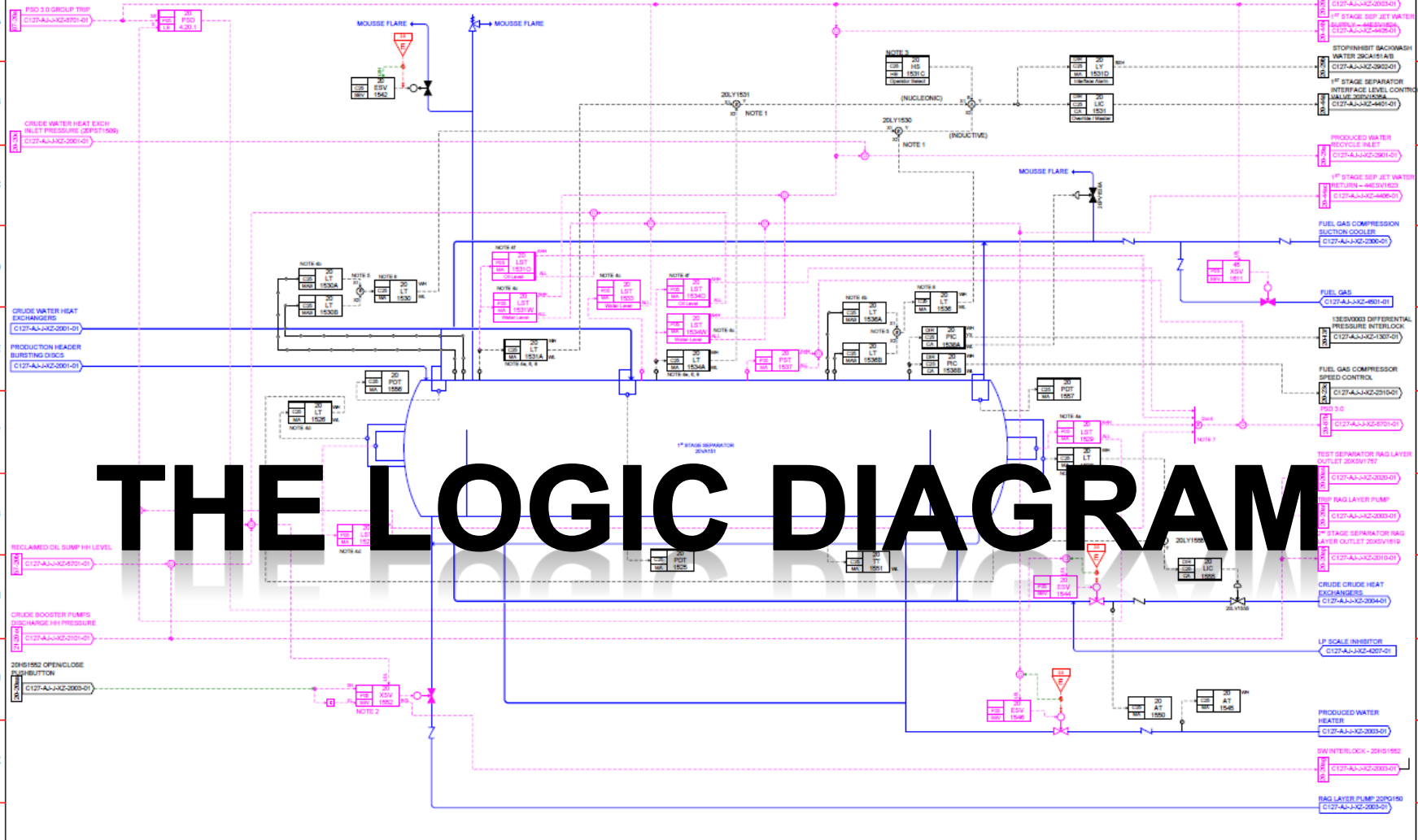
A.4.3.2.1 Function template schematic

<u>Inputs</u>	CA	<u>Outputs</u>
Normal function input	X	Y Normal function output
External fault	XF	YF Function failed
External setpoint value	XR	YR Reference setpoint value
External tracking value	XT	YX Measured value output
Position low feedback	XGL	BCL Output position low confirmed
Position high feedback	XGH	BCH Output position high confirmed
Feed forward	XFF	BS Status safeguarding
Lock safeguarding high	LSH	BB Status blocked
Lock safeguarding low	LSL	BU Status suppressed
Force safeguarding high	FSH	BA Status auto/man
Force safeguarding low	FSL	BX Status external/internal
Force tracking	FT	BT Status tracking
Force blocking	FB	WV Deviation warning ²⁾
Force suppression	FU	WH Warning alarm H ²⁾
Lock auto	LA	WL Warning alarm L ²⁾
Lock manual	LM	
Lock external setpoint	LX	
Lock internal setpoint	LI	
<u>Operator station:</u> Auto/Manual Internal/External Internal setpoint		<u>Operator station:</u> Alarms and faults Closed Auto/Manual

LSH	binary input	Lock safeguarding high.	Safeguarding - signal overrules operator inputs (locking the template to manual mode with Y- output to high -open valve-). Input is subject to blocking .After signals disappear the template remains in manual mode and the output high.
LSL	binary input	Lock safeguarding low .	Safeguarding - signal overrules operator inputs (locking the template to manual mode with Y- output to low -stop motor-). Input is subject to blocking. After signals disappear the template remains in manual mode and the output low.

Figure A.2 - CA function template schematic

THE LOGIC DIAGRAM



NOTES:

- # 4 P1 + X2Y - Average Interface level to provide input to level controller 20L1531. Average not required if fault on 1 transmitter.
- Software interlock required to prevent Bag Layer removal from more than one vessel simultaneously. Valves to be interlocked are 20X3V1502 (1st Stage Separator), 20X3V1510 (2nd Stage Separator), 20X3V1506 (Cooler S), 20X3V1757 (Test Separator) and 440XV1541 (Bypass Valve).
- Nuclear Profile selected in normal operation.
- Discrepancy alarm to be configured between pairs of PCS/PSD transmitters on same section. Transmitter pairs identified by suffix to this note e.g. 44, 45, 46, 47 etc.
- Due to Inductive Level Transmitter length limitation, software in SAS will combine level signals via modulus providing a single control output in PCS.
- Additional safety/shutdown information for profiles and LCP transmitted to SAC via a total of 4 of module TCP/IP link.
- 2004 Wiring arrangement described in document ref. C127-AJ-SP-4070 App A.
- Alarm only if first up between 20L1531A and 20L1531A & 20L1531B is the operator selected average.

REFERENCES:

SCD BASED ON P&ID:
 C127-AJ-XZ-2015-01 REV 06,
 C127-AJ-XZ-2015-02 REV 06,
 C127-AJ-XZ-2015-03 REV 06,
 C127-AJ-XZ-2015-04 REV 06,
 C127-AJ-XZ-2015-05 REV 06.

DATE:
 C127-AJ-XZ-2002-01 Rev 02.

REV.	DATE	REASON FOR ISSUE	PREPARED	CHECKED	APPROVED	SCALE	SIZE	AREA	SYSTEM
04	22-07-16	ISSUED FOR CONSTRUCTION	DHB	MS	PN				
03	06-02-15	ISSUED FOR DESIGN	MS	SK	PN				
02	07-06-14	ISSUED FOR REVIEW	MS	DB	SLR				
01	06-03-13	ISSUED FOR IDC	MS	DB	SLR				

PLANT:
MARINER

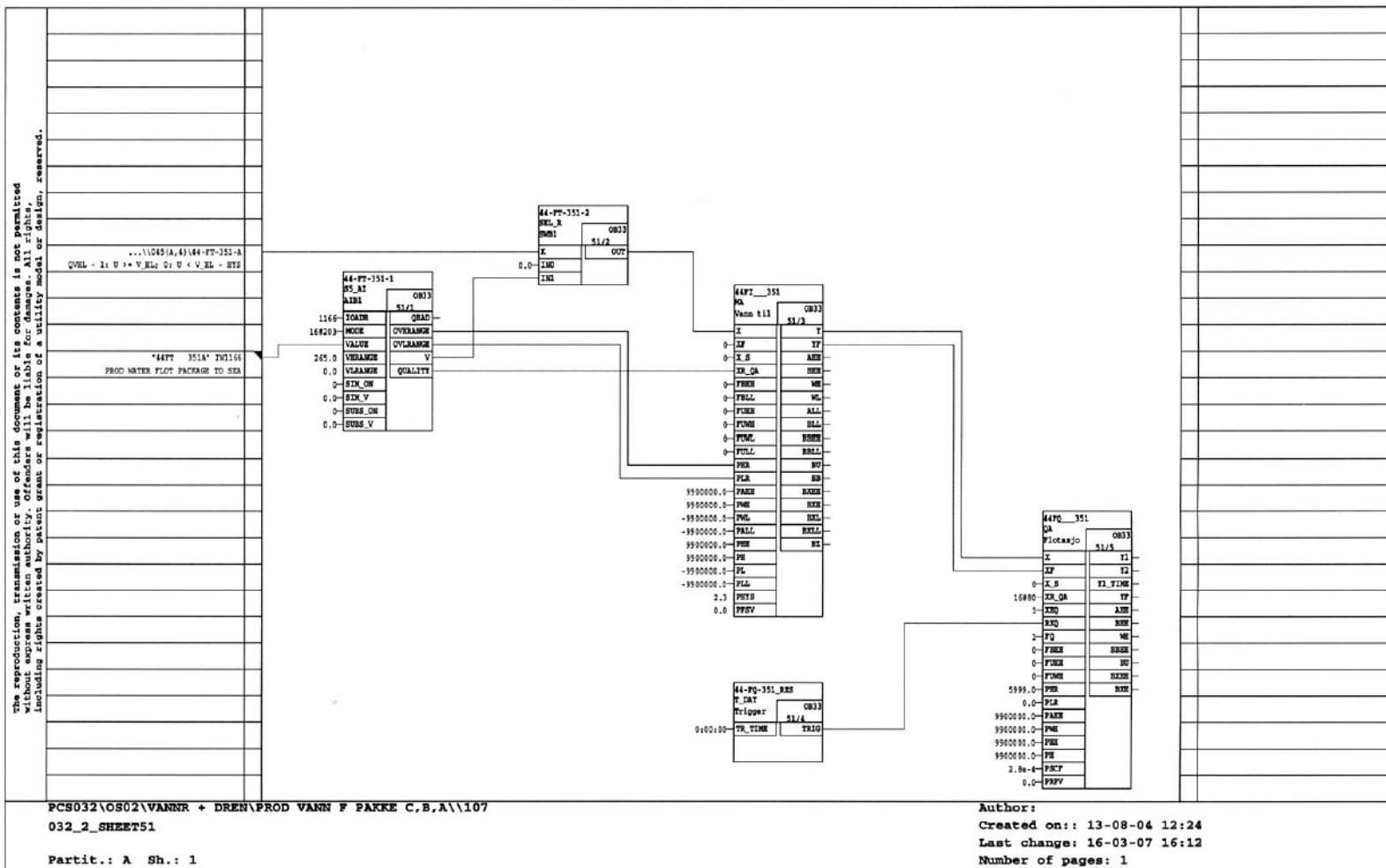
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1ST STAGE SEPARATOR

CONTR. NO: 4502662660
 NTS AT A1 P330 20

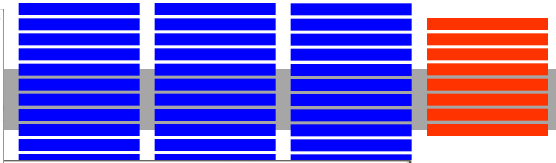
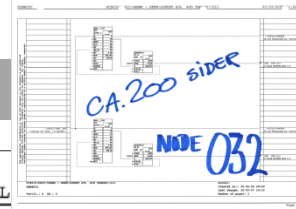
C127-AJ-XZ-2002-01 04

DRAWING NUMBER REV.

Logic Diagrams for the programmer



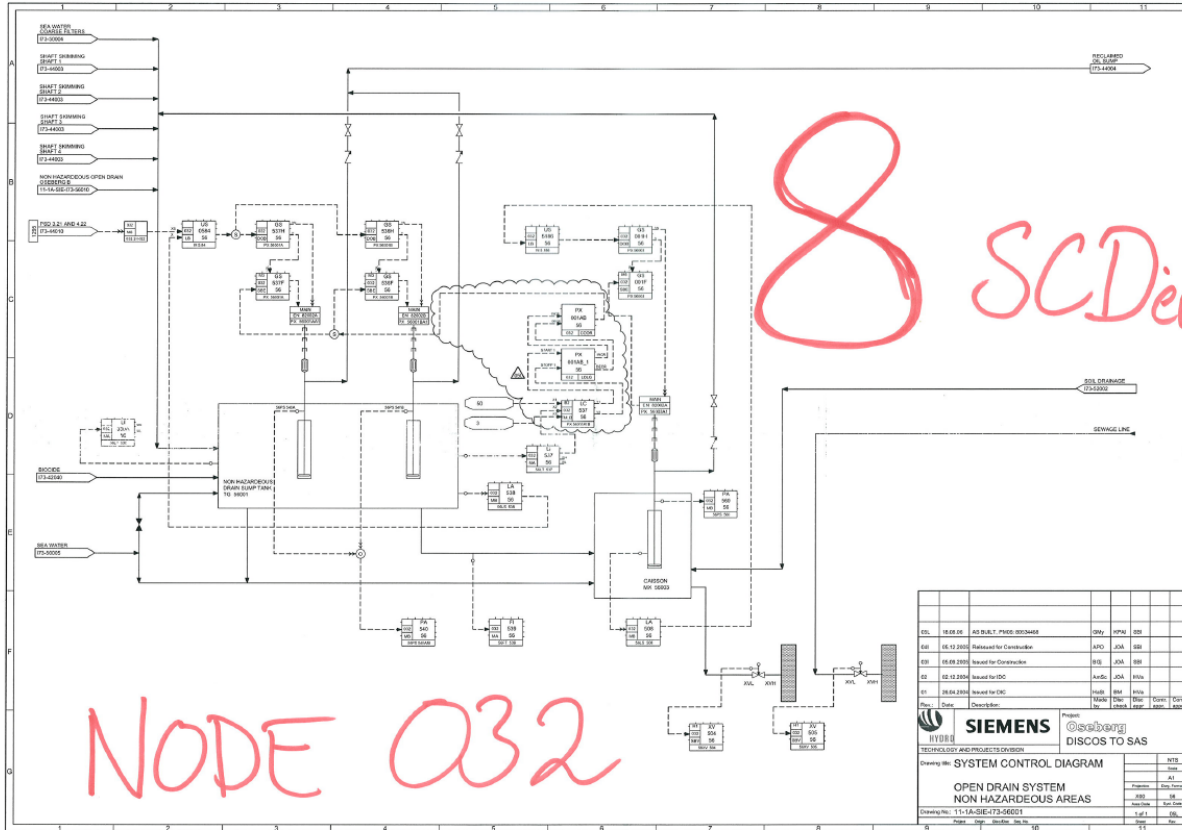
FRD vs SCD



SIMATIC

PCS032\OS02\VANNR + DREN\LUKKET AVL

03/23/2007 11:02:33 AM



NODE 032

8 SCDer

...	\\010(A,4)\PX44004A	LSL Lock Safeguarding Low, overrule operat
...	4406 301H* 03.0	PX 44004A SHUTDOWN LEVEL 5.35
...	\\011(A,4)\PX44004B	LSL Lock Safeguarding Low, overrule operat
...	4406 302H* 04.0	PX 44004B SHUTDOWN LEVEL 5.35

032

REV	NO	DATE	BY	APP	DESCRIPTION
01	01.02.2006	ASB	JDA	001	Issued for Construction
02	02.12.2006	ASB	JDA	001	Issued for O&M
03	06.04.2006	ASB	JDA	001	Issued for O&M

SIEMENS **Discos to SAS**

HYDRONICS TECHNOLOGY AND PROJECTS DIVISION

Drawing No: 11-IA-SIE-473-06001

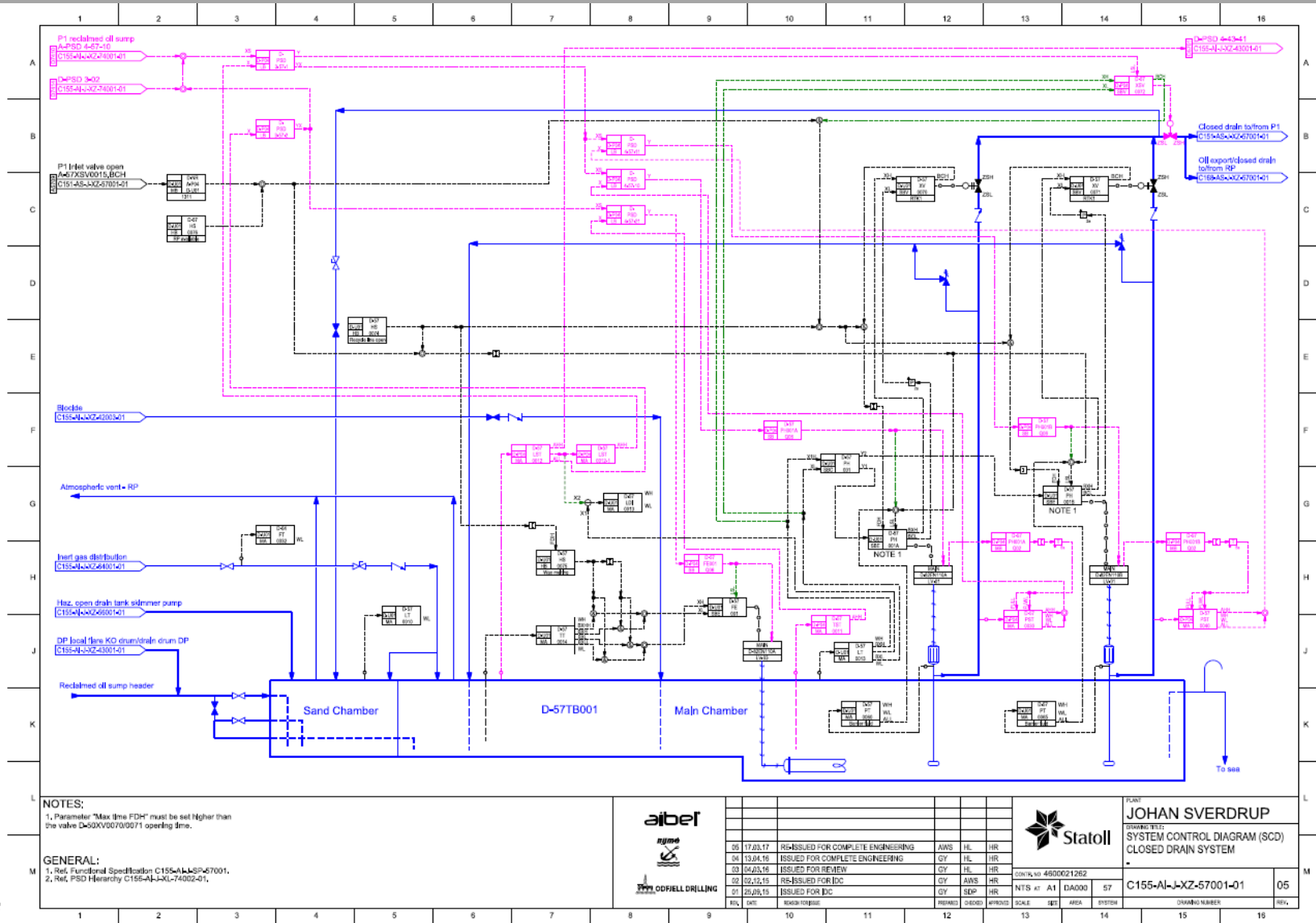
Project: OPEN DRAIN SYSTEM NON HAZARDOUS AREAS

PCS032\OS02\VANNR + DREN\LUKKET AVL AVG TANKER\013
 SHEET12
 Partit.: A Sh.: 4

Author:
 Created on:: 30-06-04 08:40
 Last change: 16-03-07 16:12
 Number of pages: 2



Logic Diagrams for all «Stakeholders»



NOTES:
 1. Parameter "Max time FDI" must be set higher than the valve D-50XV00700071 opening time.

GENERAL:
 1. Ref. Functional Specification C155-AJ-JX-67001.
 2. Ref. PSD Hierarchy C155-AJ-JX-74002-01.

aibel					
ODPIELL DRILLING					
REV	DATE	ISSUED FOR	BY	APPROVED	SCALE
05	17.03.17	ISSUED FOR COMPLETE ENGINEERING	AWS	HL	HR
04	13.04.16	ISSUED FOR COMPLETE ENGINEERING	GY	HL	HR
03	04.03.16	ISSUED FOR REVIEW	GY	HL	HR
02	02.02.15	ISSUED FOR EDC	GY	AWS	HR
01	25.05.15	ISSUED FOR EDC	GY	SEP	HR

Statoll

CLIENT: **JOHAN SVERDRUP**

DRAWING TITLE: **SYSTEM CONTROL DIAGRAM (SCD) CLOSED DRAIN SYSTEM**

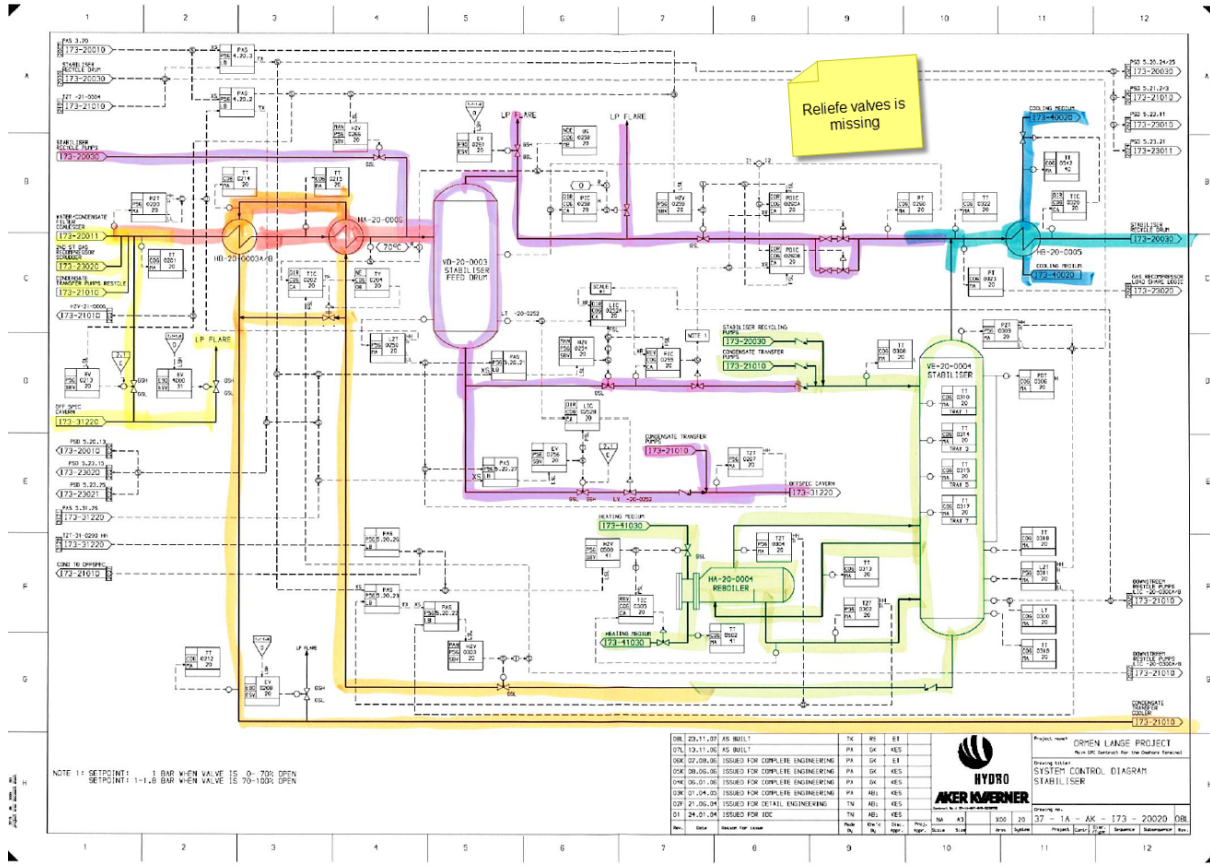
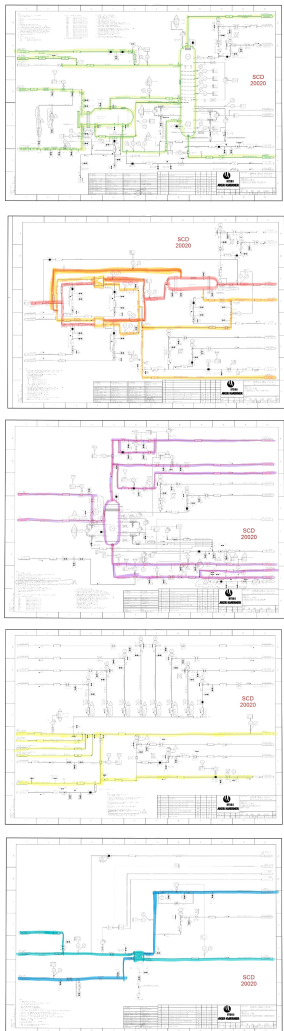
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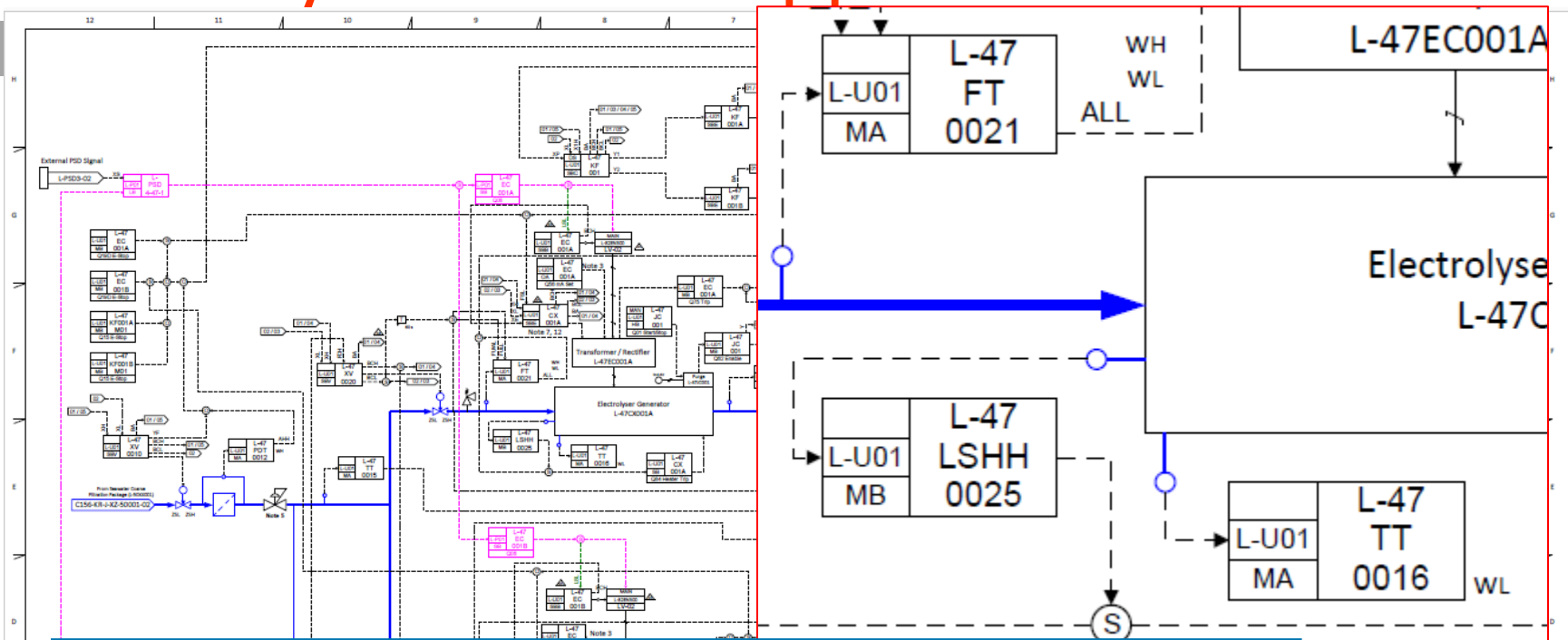
C155-AJ-JX-57001-01

05

Extent P&ID vs SCD



The main symbol - The Application Blocks



B.4.2 Function template symbol

Function template shall be used for all tagged functions related to instrumentation and control.

System in SAS e.g.

PCS	- C
PSD	- P
ESD	- E
F&G	- F

Function template mode or typical reference

Node reference

Function template type

DIR	20
C01	PIC
CA	1001A

Function template tag. number

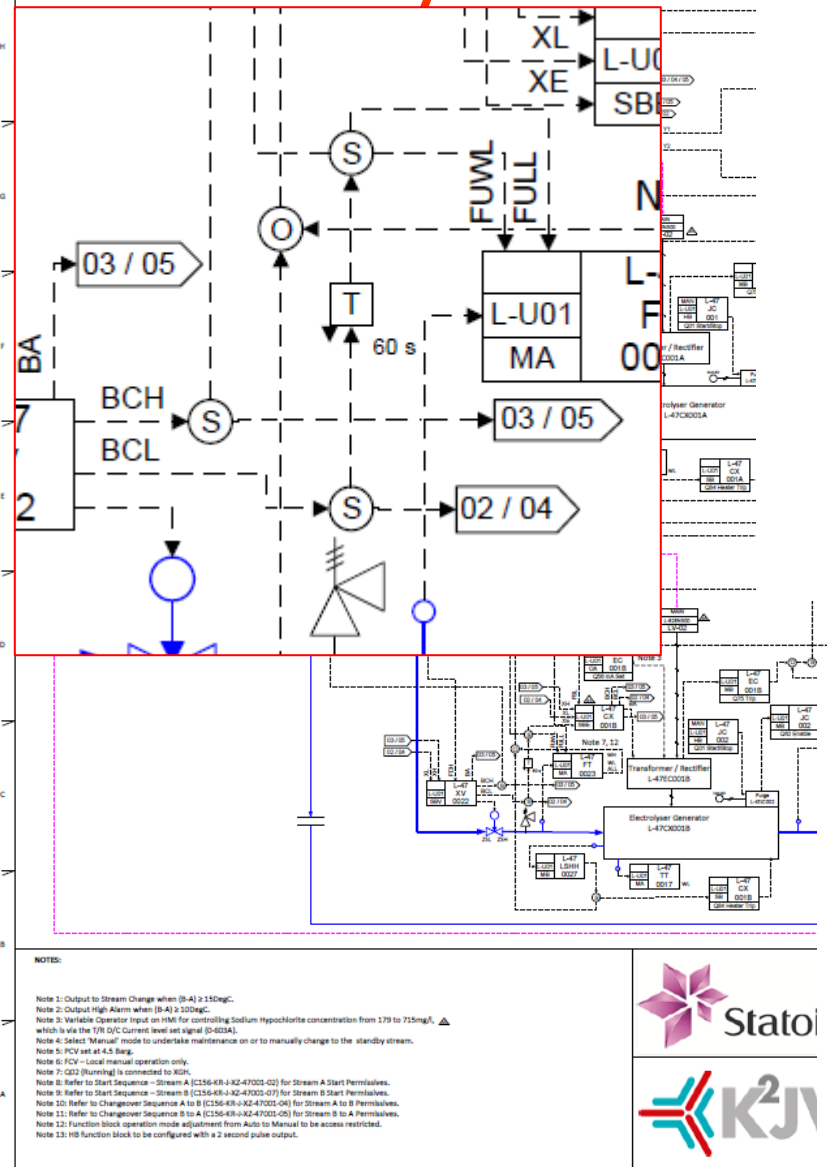
an Sverdrup

System 47 –	Scale
trichlorination	N/A
Control Diagram	Format
	A1
7001-01	Sheet
	Revision
	001 05

Figure B.1 - The function template symbol

Elementary Function Bl

Table B.3 - Timer/pulse logic diagrams



Description	Symbol	Logic diagram
		A
Inverter		C
Timer (delay on rising edge)		C
Timer (delay on falling edge)		C
Pulse generator (pos. pulse on false - true)		C
Pulse generator (pos. pulse on true - false)		C

Table B.2 - EFB function notations

Notation	Function	Extended connection line	Terminals to be shown
o	Logic "OR" ($X1 \text{ OR } X2 = Y$)	Can be used	NA
&	Logic "AND" ($X1 \text{ AND } X2 = Y$)	Can be used	NA
≠	Logical "XOR" (Exclusive $X1 \text{ OR } X2, Y=1$)	Can be used	NA
H	High selector ($Y = \text{the higher of } X1 \text{ and } X2$)	NA	NA
L	Low selector ($Y = \text{the lower of } X1 \text{ and } X2$)	NA	NA
>	Comparator high ($Y = 1 \text{ when } X1 > X2, \text{ otherwise } Y = 0$)	NA	$X1, X2$
<	Comparator low ($Y = 1 \text{ when } X1 < X2, \text{ otherwise } Y = 0$)	NA	$X1, X2$
+	Arithmetic plus ($X1 + X2 = Y$)	NA	NA
-	Arithmetic minus ($X1 - X2 = Y$)	NA	$X1, X2$
*	Arithmetic multiply ($X1 * X2 = Y$)	NA	NA
/	Arithmetic division ($X1 / X2 = Y$)	NA	$X1, X2$
M	Memory element (S=set, R=reset) ¹⁾	NA	S,R
S	Split of signal	NA	NA
#	Optional formula – Terminal names users choice. See figure B.8.	Can be used	All
A	Analogue select by digital input $Y=X1 \text{ when } S=0, Y=X2 \text{ when } S=1$	NA	S, $X1, X2$

Positive logic - High or Low

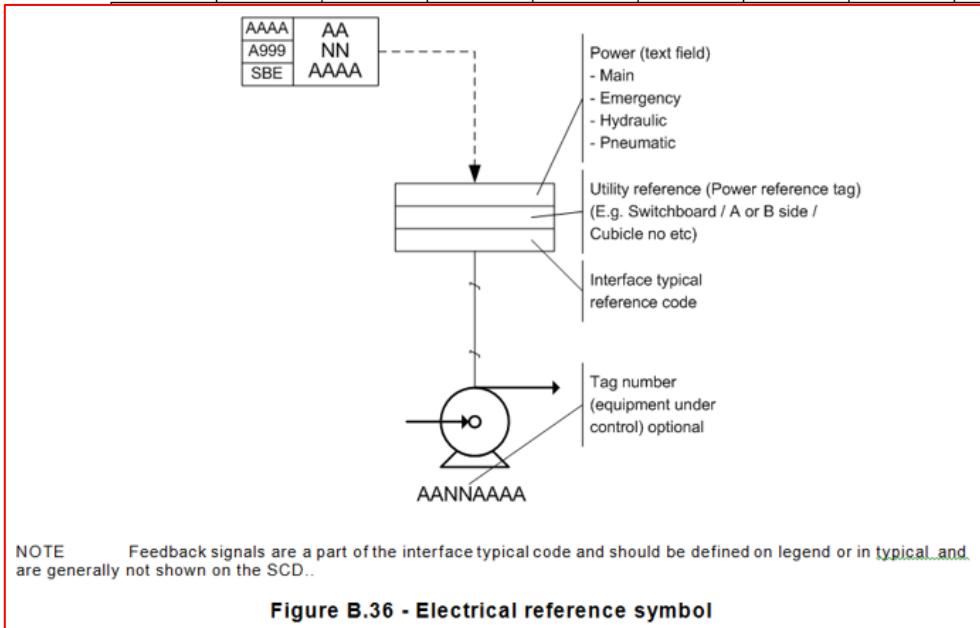
- High (H)
 - Valve Open
 - Motor Start
 - Heater On
 - Connector Connected
- Low (L)
 - Valve Closed
 - Motor Stop
 - Heater Off
 - Connector Disconnected

NOTE! SCD are ALWAYS drawn with positive logic

Signal ACTIV = ON (PÅ) = OPEN (ÅPEN) = HIGH (HØY)
= 1 = True = Positive

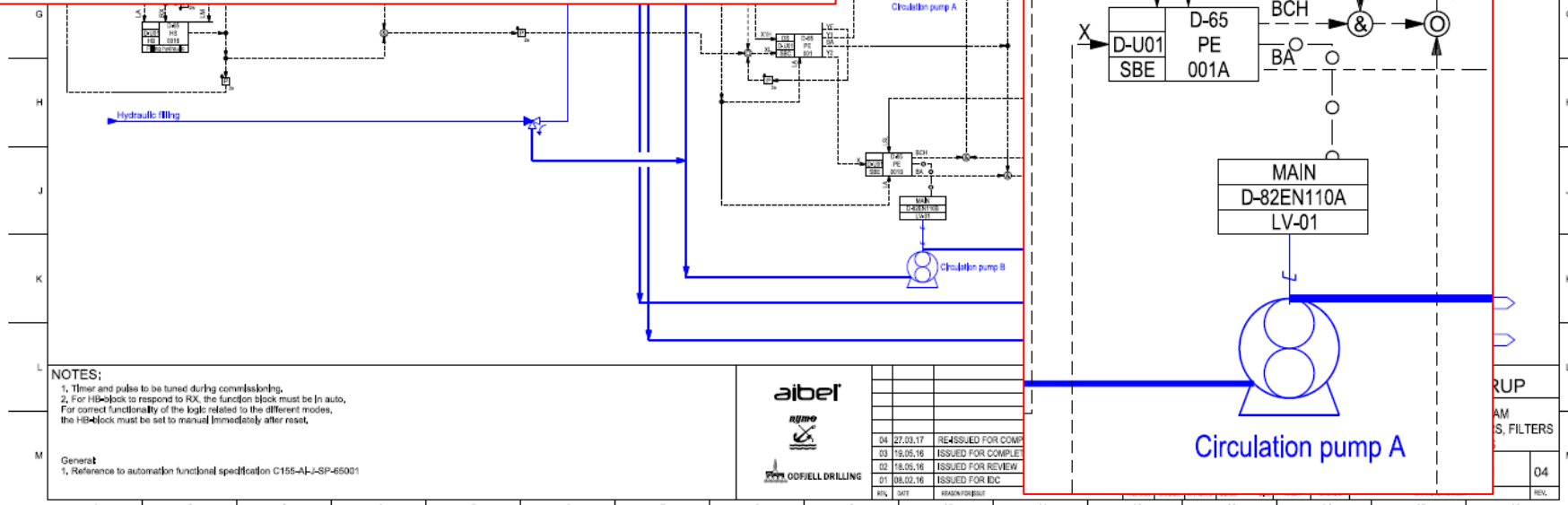
Signal NOT ACTIVE = OFF (AV) = CLOSED (LUKKET) = LOW
(LAV) = 0 = False = Negativ

Electrical reference symbol



NOTE Feedback signals are a part of the interface typical code and should be defined on legend or in typical and are generally not shown on the SCD.

Figure B.36 - Electrical reference symbol



NOTES:
 1. Timer and pulse to be tuned during commissioning.
 2. For HIB block to respond to RX, the function block must be in auto.
 For correct functionality of the logic related to the different modes, the HIB block must be set to manual immediately after reset.

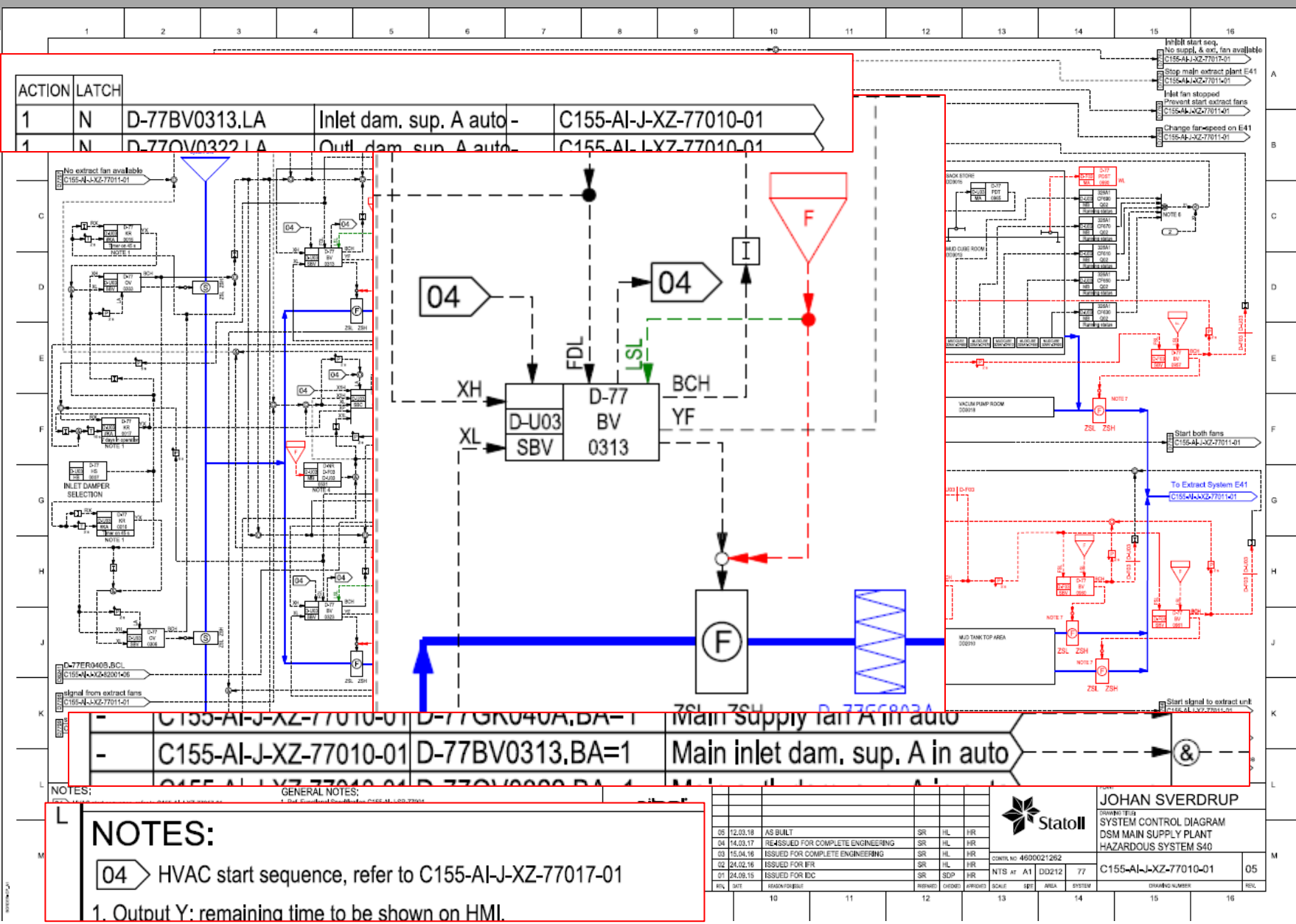
General
 1. Reference to automation functional specification C155-A1-J-SP-65001



REV.	DATE	REVISION/REASON
04	27.03.17	REISSUED FOR COMP
03	18.05.16	ISSUED FOR COMPLETE
02	18.05.16	ISSUED FOR REVIEW
01	08.02.16	ISSUED FOR IFC

04	REV.
----	------

Sequence by Sequential Function Charts (SFC)



ACTION	LATCH
1	N	D-77BV0313.LA	Inlet dam. sup. A auto -	C155-AI-J-XZ-77010-01
1	N	D-77BV0322.LA	Outl. dam. sup. A auto -	C155-AI-L-XZ-77010-01

-	C155-AI-J-XZ-77010-01	D-77GR040A,BA=1	Main Supply fan A in auto	→
-	C155-AI-J-XZ-77010-01	D-77BV0313,BA=1	Main inlet dam. sup. A in auto	→

NOTES:

04 HVAC start sequence, refer to C155-AI-J-XZ-77017-01

1. Output Y: remaining time to be shown on HMI.

REV.	DATE	ISSUED FOR	BY	CHKD.	APPROV.	SCALE	SPT.	AREA	SYSTEM	DRAWING NUMBER	REV.
05	12.03.18	AS BUILT	SR	HL	HR						
04	14.03.17	RE-ISSUED FOR COMPLETE ENGINEERING	SR	HL	HR						
03	15.04.16	ISSUED FOR COMPLETE ENGINEERING	SR	HL	HR						
02	24.02.16	ISSUED FOR IFR	SR	HL	HR						
01	24.09.15	ISSUED FOR IDC	SR	SDP	HR						

Statoll

JOHAN SVERDRUP

DRAWING TITLE:
SYSTEM CONTROL DIAGRAM
DSM MAIN SUPPLY PLANT
HAZARDOUS SYSTEM S40

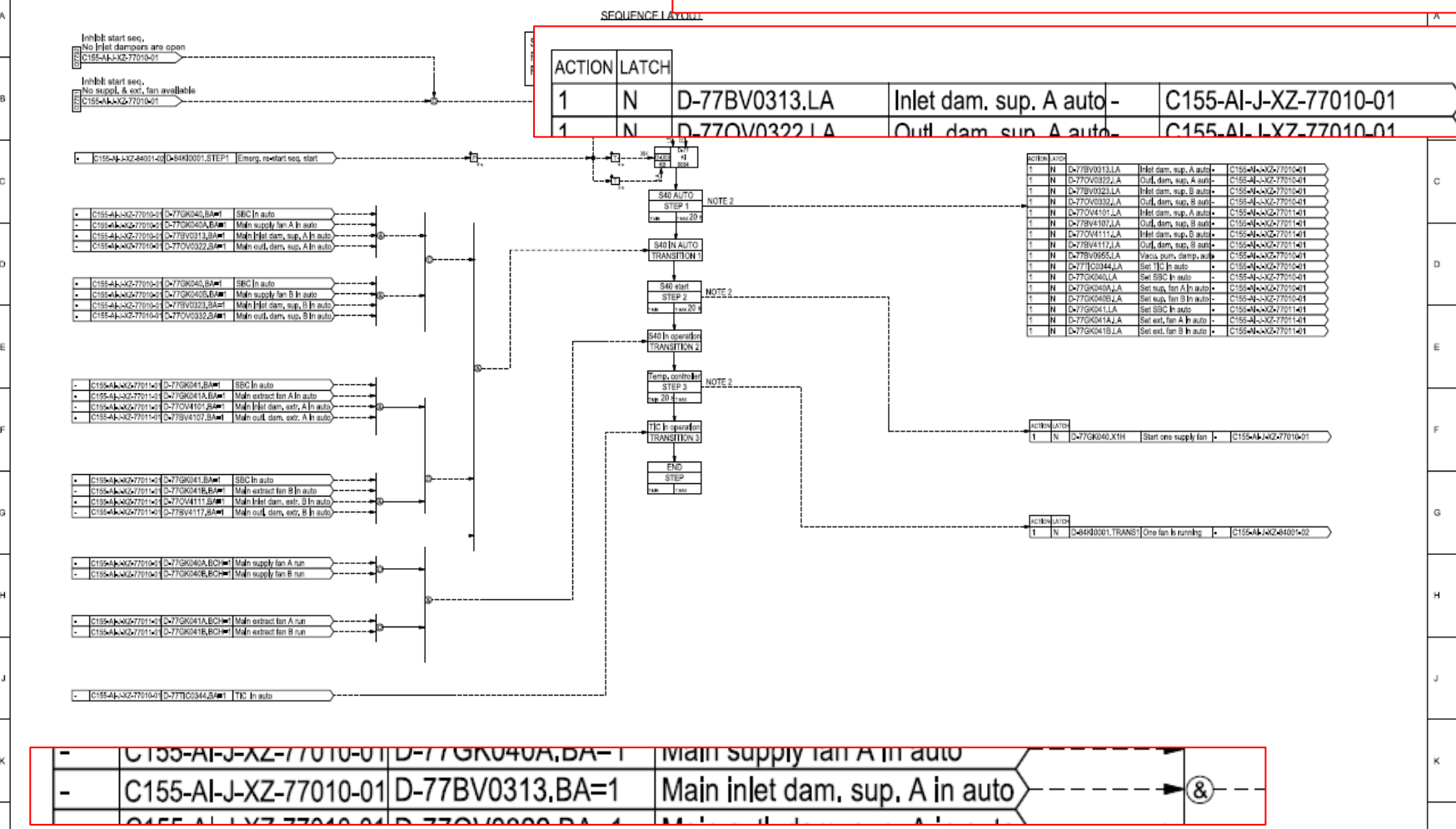
CONTROL no: 4600021262

NTS at A1 D0212 77

C155-AI-J-XZ-77010-01 05

The SFC SCD

SEQ. 04
 FB D-77KI0004 HVAC SYSTEM START SEQUENCE S40/E41
 REF. SCD C155-AI-J-XZ-77010-01 & C155-AI-J-XZ-77011-01



NOTES:
 1. If the line out is present, the sequence shall give an alarm and stop executing the next step.
 2. All steps to be pulsed 2 s output.

				PLANT JOHAN SVERDRUP	
		DRAWING TITLE SYSTEM CONTROL DIAGRAM SEQUENCE DIAGRAM S40/E41		DRAWING NUMBER C155-AI-J-XZ-77010-01	
		DATE 05 12.03.18 AS BUILT SR HL HR 04 14.03.17 RE-ISSUED FOR COMPLETE ENGINEERING SR HL HR 03 08.04.16 ISSUED FOR COMPLETE ENGINEERING SR HL HR 02 02.03.16 ISSUED FOR IFR SR HL HR 01 24.09.15 ISSUED FOR IDC SR SDP HR		CONTROL NO 4630021262 NTS at A1 DD000 77	
REV. DATE REASON FOR ISSUE		SCALE: 1:1 AREA: SYSTEM		05	

A.4.13.2.1 Function template schematic

Inputs	SBC	Outputs
Auto start requested number	XH	Y1 – Y6 ⁶⁾
Auto stop all	XL	YF
Enable function	XE	YQ
Request number	XQ	BA
Rotate priority	XP	BCH
		BCL
		BCQ
Call for 6 - increasing	X6H	
Call for 5 - increasing	X5H	
Call for 4 - increasing	X4H	
Call for 3 - increasing	X3H	
Call for 2 - increasing	X2H	
Call for 1 - increasing	X1H	
Call for 5 - decreasing	X5L	
Call for 4 - decreasing	X4L	
Call for 3 - decreasing	X3L	
Call for 2 - decreasing	X2L	
Call for 1 - decreasing	X1L	
Lock auto	LA	
Lock manual	LM	
<u>Operator station:</u>		<u>Operator station:</u>
Start requested		For each SBE :
Stop all		Running/stopped
Increment		Alarms and faults
Decrement		Available (SBE in auto)
Shift		Start disabled (FDH)
Set priority for each SBE		Stop disabled (FDL)
Set number requested as value		Safeguarding
Suppression on/off		Current priority
		Suppressed
<u>Information from SBE⁶⁾⁷⁾</u>		<u>Information to SBE⁶⁾</u>
<ul style="list-style-type: none"> • Running • Failure • Enabled for duty/standby (auto mode) • Safeguarding • Start disabled (FDH) • Stop disabled (FDL) 		<ul style="list-style-type: none"> • Set high • Set low • Priority

6) Dependent of vendor solution.

7) Will not be shown on SCD

8) Terminal name will be shown as Y1...Y6 connected to X on SBE 1 .. 6 on the SCD.

Inputs	SBE	Outputs
Pos high feedback (MCC)	XGH	Y Normal function output
External set high	XH ⁹⁾	YH Pulsed normal function output high
External set low	XL ⁹⁾	YL Pulsed normal function output low
External outside set high	XOH	YF Function failed
External outside set low	XOL	BCH Output position high confirmed
External fault	XF	BCL Output position low confirmed
Externally enabled (MCC)	XE	BA Status auto/man
Lock safeguarding high	LSH	BO Status outside
Lock safeguarding low	LSL	BS Status safeguarding
Force safeguarding high	FSH	BB Status blocked
Force safeguarding low	FSL	BL Status suppressed

BCH	binary output	Output position high confirmed	Output Y compared to feedback position high from MCC or limit switch and validated as true
-----	---------------	--------------------------------	--

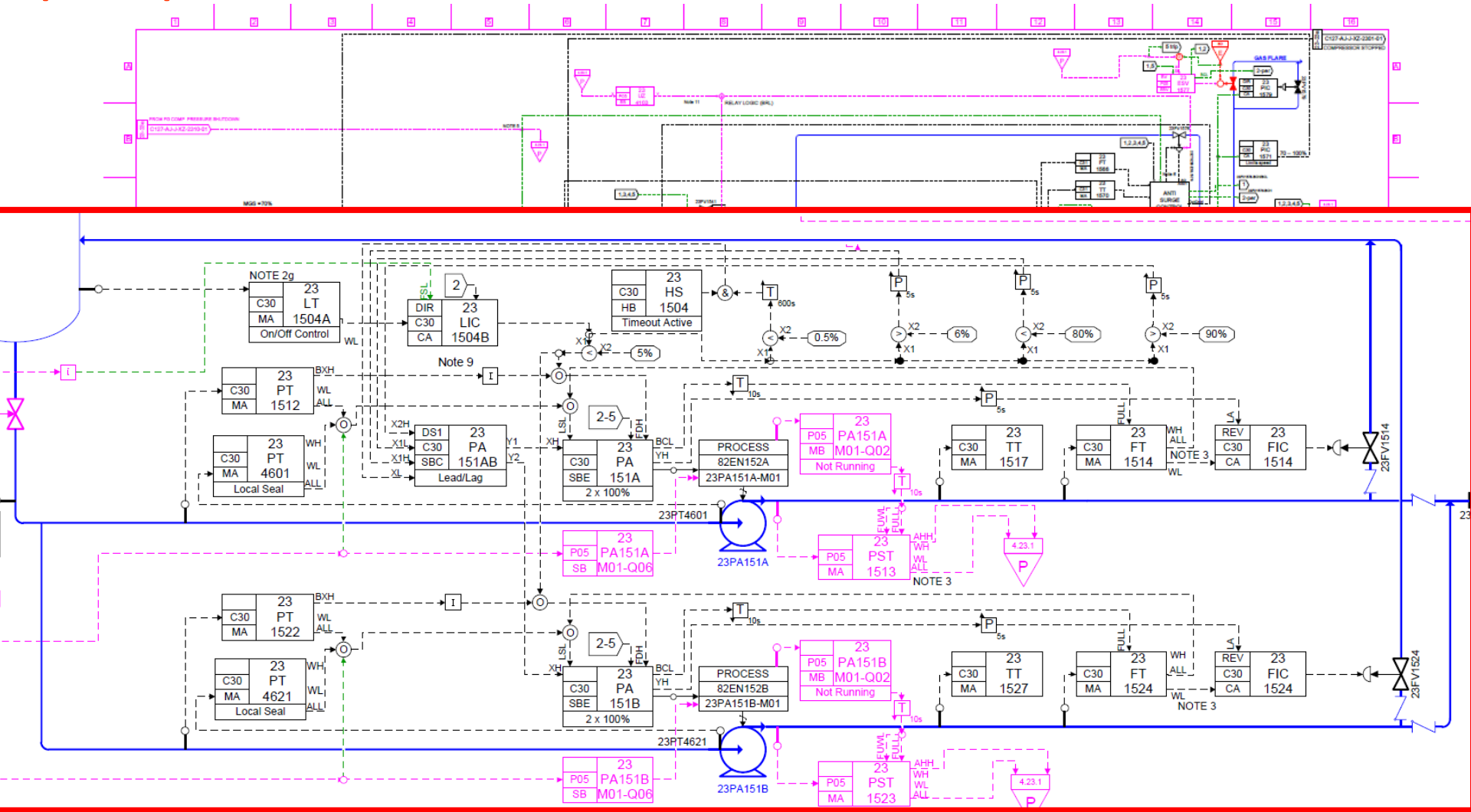
Force suppression Lock auto Lock manual Lock outside <u>Operator station:</u> Auto/Manual/Outside Set output on(high)/off(low) Blocking on/off Suppression on/off <u>Information from SBC⁶⁾⁹⁾</u> External set high External set low Priority provided by SBC	FU LA LM LO	<u>Operator station:</u> Alarms and faults Running/Stopped Auto/Manual/Outside Blocked Suppressed Disabled Safeguarding Conflict Priority <u>Information to SBC⁶⁾⁷⁾</u> Run Fault Available (SBE in auto) Start disabled (FDH) Stop disabled (FDL)
--	----------------------	--

LSL	binary input	Lock safeguarding low	Safeguarding - signal overrules operator inputs (locking the template to manual mode with Y- output to low -stop motor-). Input is subject to blocking. After signals disappear the template remains in manual mode and the output low.
-----	--------------	-----------------------	--

7) Will not be shown on SCD.
 9) Terminal name will be shown as X connected to Y1....Y6 on SBC on the SCD.

Figure A.16 - SBE function template schematic

An example – one measurement controls several pumps



3. Discrepancy alarm to be configured between pairs of PCPSGD transmitters on same service. Transmitter pairs identified by suffix to this table tag. (e.g. 23.25.50.004)
3. Low Low Trip to be initiated and require manual reset by operator on HMI
4. Adjustable software minimum stop to be provided to prevent overloading of compressor
5. PG compressor SID follows 1" & 2" stages ADV's minimum open for a defined time period.
6. Quick open signal from AS Function Block/function of output terminal: "Surge Detector"
7. Compressor to Minimum Governor Speed when inlet valve closed
8. Interlock signal - trip compressor when ADV position does not follow AS-controller AC
9. Pump control - only the Modulating Mode is shown. For the ON/OFF Mode see system 23PV C127-AJ-JX-2300-01 ch. 5.2.3
10. Pump control - only the Modulating Mode is shown. For the ON/OFF Mode see system 23PV C127-AJ-JX-2300-01 ch. 5.2.3
11. Force ADV opens when low pressure to avoid LL pressure trip
12. Back-up Relay Logic (BRL) See C127-AJ-JX-2300-01 and C127-AJ-JX-2300-01 ch. 7.2.8

CONTR. NO 4502052050

NTS at A1 A000 23

REV	DATE	REASON FOR ISSUE	PREPARED	CHECKED	APPROVED	SCALE	SIBS	AREA	SYSTEM	DRAWING NUMBER	REV
07	08-11-08	ISSUED FOR CONSTRUCTION	JAK	YTL	OWL					C127-AJ-JX-2300-01	08
08	13-09-10	ISSUED FOR CONSTRUCTION	JAK	YTL	OWL						
09	13-04-10	ISSUED FOR CONSTRUCTION	YTL	OWL	MJS						
10	27-11-14	ISSUED FOR CONSTRUCTION	JAK	MS	SLR						
11	22-10-14	ISSUED FOR CONSTRUCTION	JAK	MS	SLR						
12	27-11-14	ISSUED FOR CONSTRUCTION	JAK	MS	SLR						
13	27-11-14	ISSUED FOR CONSTRUCTION	JAK	JM	SLR						
14	27-11-14	ISSUED FOR CONSTRUCTION	JAK	JM	SLR						
15	27-11-14	ISSUED FOR CONSTRUCTION	JAK	JM	SLR						
16	27-11-14	ISSUED FOR CONSTRUCTION	JAK	JM	SLR						
17	27-11-14	ISSUED FOR CONSTRUCTION	JAK	JM	SLR						

CONTR. NO 4502052050

NTS at A1 A000 23

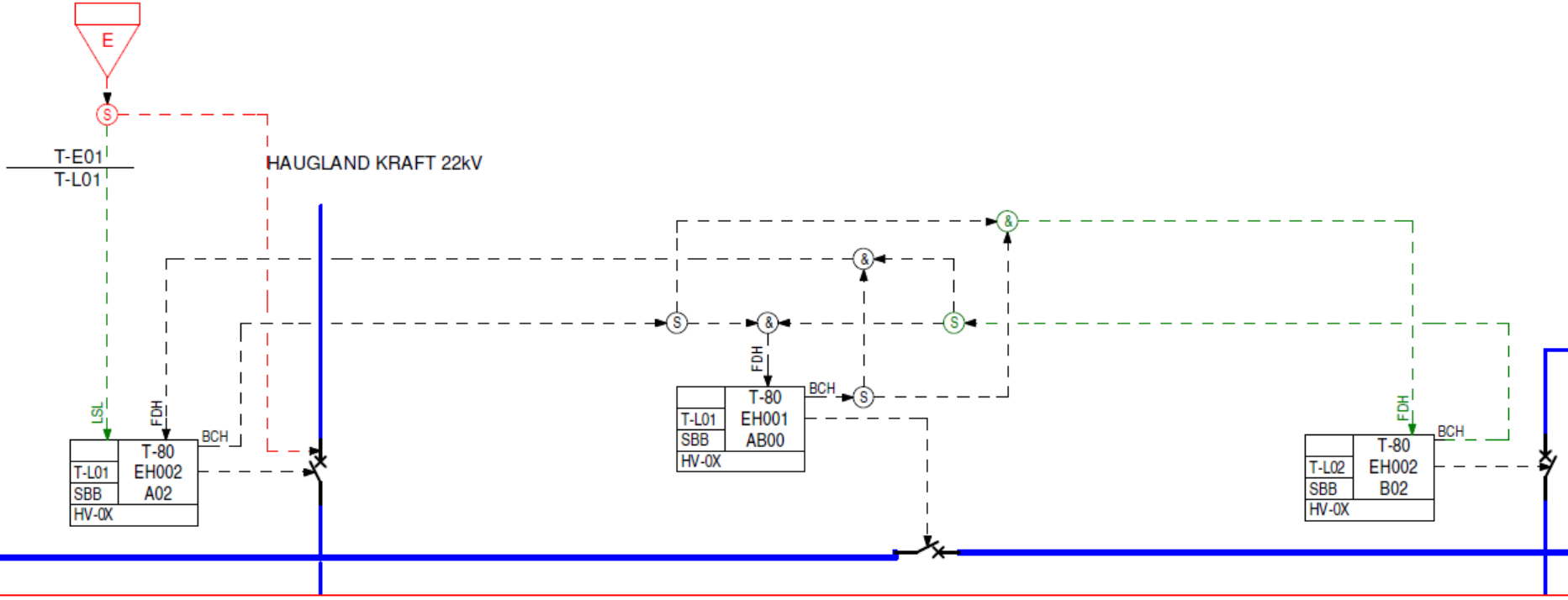
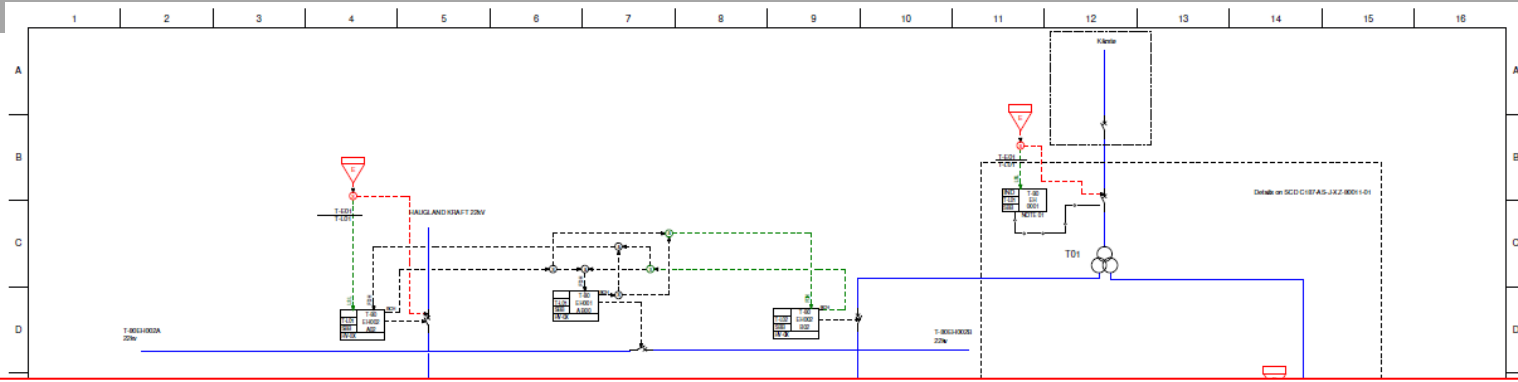
	<p>SYSTEM CONTROL DIAGRAM 1 1/2 STAGE RECOMPRESSOR 23KA200 / 23KA201</p>
<p>CONTR. NO 4502052050</p> <p>NTS at A1 A000 23</p>	<p>C127-AJ-JX-2300-01</p> <p>08</p>

A.4.12.2.1 Function template schematic

<u>Inputs</u>	SBB	<u>Outputs</u>	
Position high feedback (connected/closed)	XGH	Y	Normal function output
Position low feedback (disconnected/open)	XGL	YH	Pulsed normal function output high (connect/close)
External set high	XH	YL	Pulsed normal function output low (disconnect/open)
External set low	XL	YF	Function failed
External outside set high	XOH	BCH	Output position high confirmed (connected/closed)
External outside set low	XOL	BCL	Output position low confirmed (disconnected/open)
External fault	XF	BE	Status enabled
Function externally enabled	XE	BA	Status auto/man
External test position	XGX	BO	Status outside
External earthed	XGZ	BS	Status safeguarding
Lock safeguarding high	LSH	BB	Status blocked
Lock safeguarding low	LSL	BU	Status suppressed
Force safeguarding high	FSH		
Force safeguarding low	FSL		
Force disable transition high	FDH		
Force disable transition low	FDL		
Force blocking	FB		
Force suppression	FU		
Lock auto	LA		
Lock manual	LM		
Lock outside	LO		
<u>Operator station</u> Auto/Manual Close (high)/ Open (low)			<u>Operator station</u> Alarms and faults Open (disconnected) / Closed(connected) Suppressed
Blocking on/off Suppression on/off			Auto/Manual/Outside Earthed Available Test mode Blocked Disabled Safeguarding Conflict

Figure A.14 - SBB function template schematic

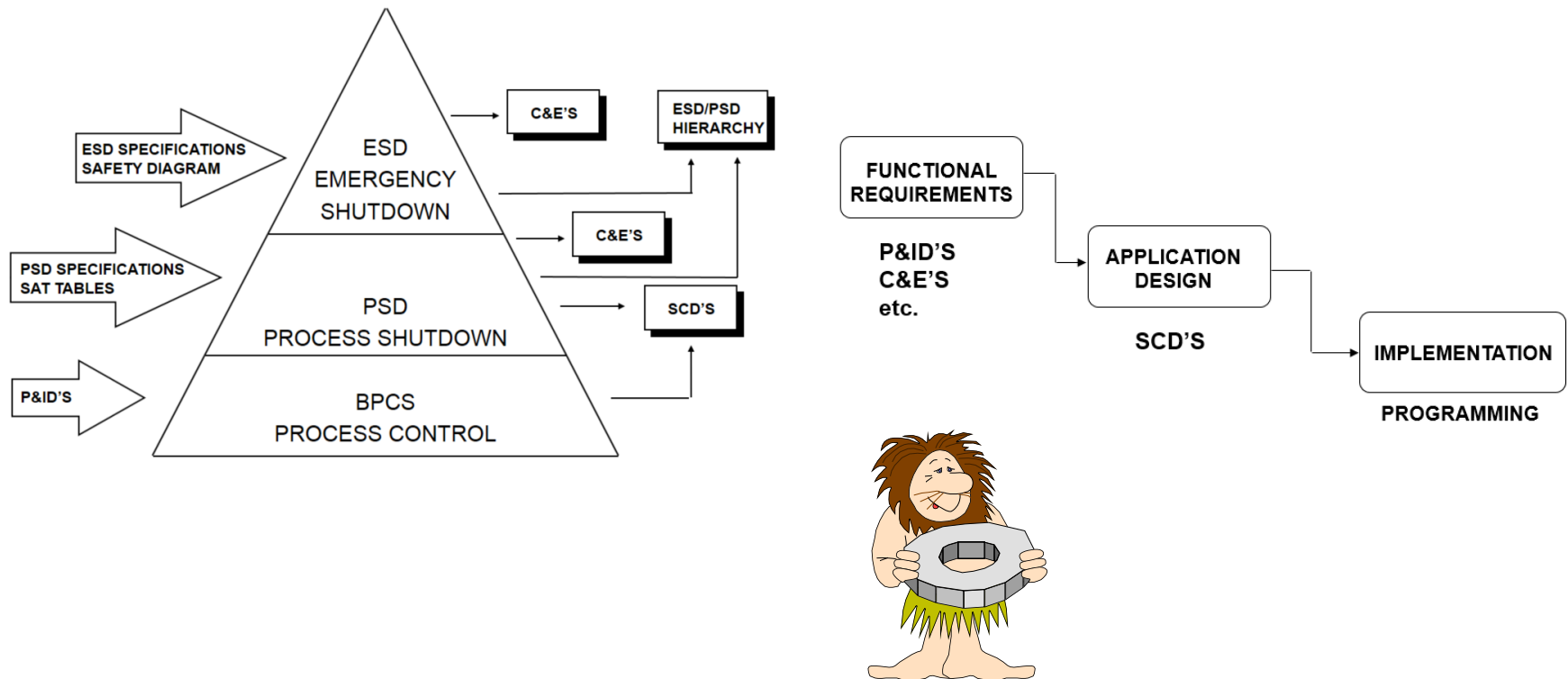
Power distribution SCD example - SBB



THE METHOD

Application design

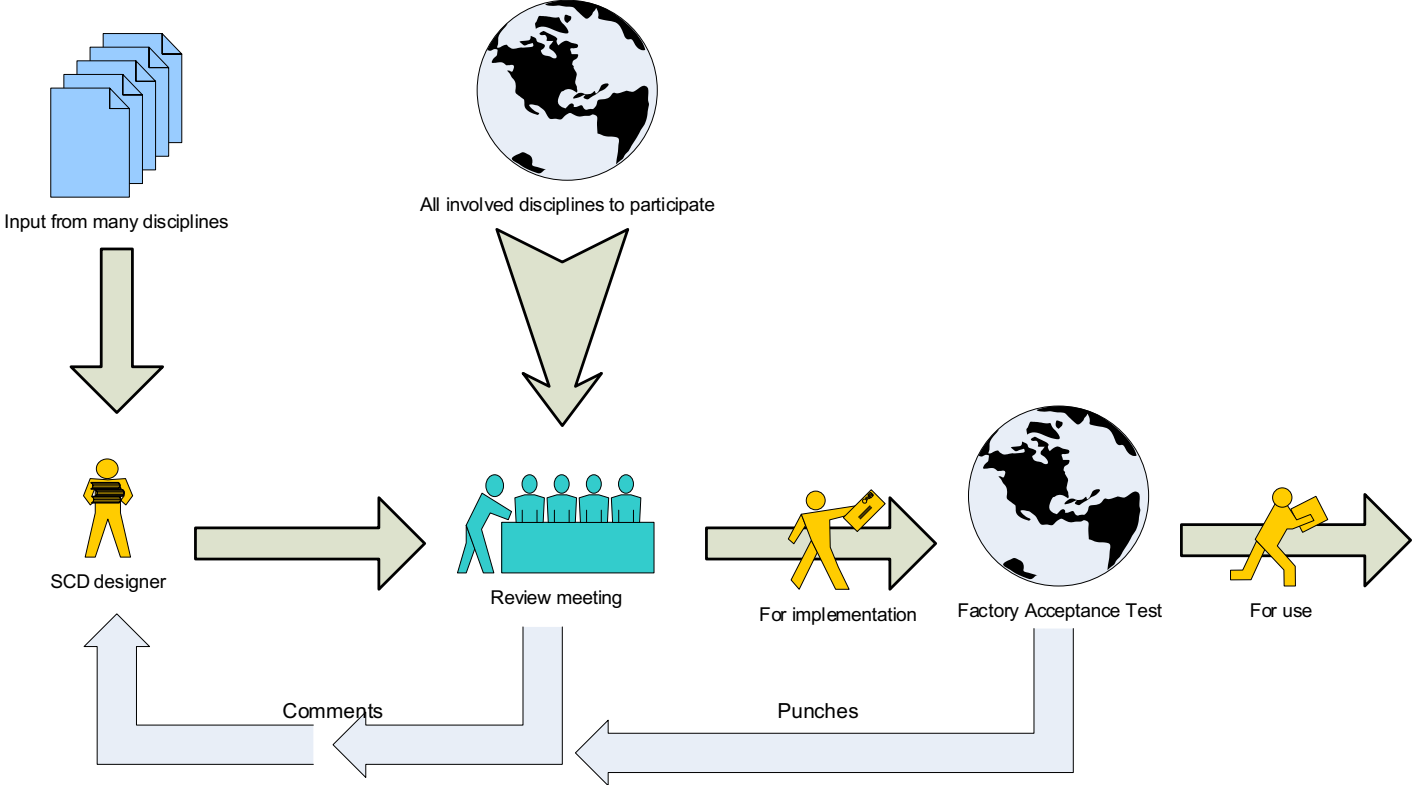
- The SCDs should be jointly developed by the system disciplines, driven by user requirements, not by technology/discipline organization.
- The SCDs should as far as possible be developed in parallel with the P&IDs.



Predefined operational functions

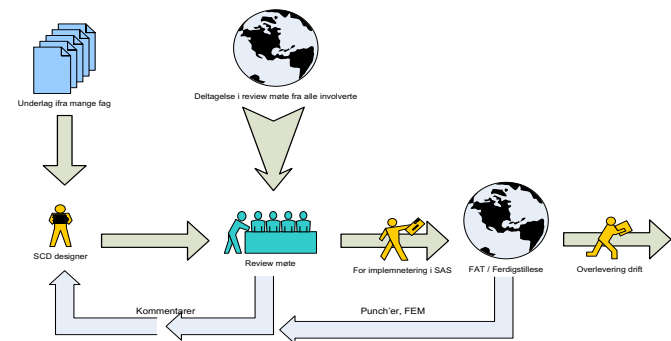
- The P&ID developed by process department identifies the controllable objects. i.e instruments, valves, compressors, sentrifuges, pumps, heaters etc.
- Each object have their standard way to be operated, “PCE request” (P&ID) → Functblock (SCD) → attributes, the FB is an independent object itself.
- There will be some FB’s that are not directly a “child” of an P&ID object. We should not make the need for them to be present on the P&ID.
- The “PCE requests” we have on the P&ID is much simpler identified, it is when you use the “Shared display/control” symbol (ref ISA 5.1) . But again they will only link to some of the FB’s

SCD cooperation – The review meeting



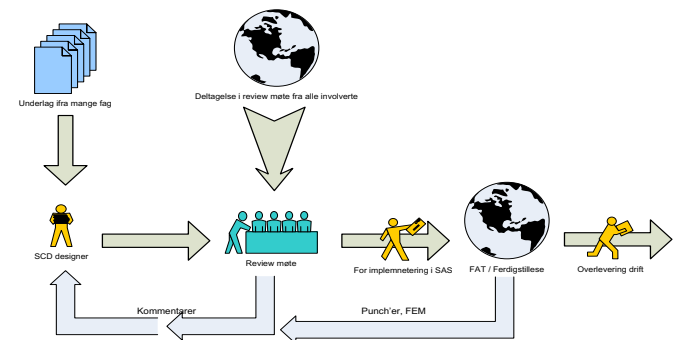
SCD'er – A multidiscipline cooperation

- The SCD methodology should create a common understanding across the involved disciplines, of how the equipment and process are controlled/operated
- Preparation of SCD's is started early
- Based on documents from other disciplines, mechanical package and their attendance in "SCD review" meetings
- Used in HAZOP and other multidisciplinary reviews
- Basis for programming of logic
- Verified against during FAT
- Used by Commissioning
- Used for training



Other discipline contributions to SCD

- Define instrumentation location and shutdown alarm actions (trip).
- Proposed control strategies and structures
- Point out considerations that must be taken care of with respect to control strategy in terms of limitations on equipment and process design
- Clarify requirements for startup and shutdown
- Define shutdown valves location and their function in terms of process shutdown and pressure relief
- Ensure that requirements for maintenance operability is followed
- Input documentation:
 - P&IDs, C&E, Shutdown hierarchy
 - D&IDs
 - Safety philosophies, SAT tables
 - Package suppliers P&ID's/ Control narratives / Logic diagrams / C&E



Supporting Functional specification

- ICSS FS

App A FS Template example (INFORMATIVE)

Document No.: XXXXXXXXXXXXXXXXXX		Rev.: 02	Page: 26 of 21	
Classification Code:				
Originator: XXX	Tag No.:	System No. : XX	Area Code:	
<i>All text in blue and italic shall be modified to suit each specific document, i.e. deleted, re-written or expanded. No numbered section shall be deleted. Superfluous numbered sections shall have the text "Not applicable". Additional numbered sections may be included.</i>				
CTR No.:				
Document Title: SAS FUNCTIONAL SPECIFICATION TEMPLATE <i>Document titles shall be:</i> SAS FUNCTIONAL SPECIFICATION SYSTEM <SYST.NO> <SYSTEM NAME> e.g.: SAS FUNCTIONAL SPECIFICATION SYSTEM XX GAS COMPRESSION AND RE-INJECTION SYSTEMS				
02	<i>DD.MM.YYY Y</i>	ISSUED FOR ITT		
01	<i>DD.MM.YYY Y</i>	ISSUED FOR CLIENT REVIEW		
Rev.	Issue date	Description	Made by	Chk'd by
			Disc. Appr.	Proj. Appr.
Project no.:XXXXXX		Contract No.: XXXXXXXXXXXX		
<i>Plant X</i>				

A.1 RESPONSIBILITY MATRIX FOR THIS DOCUMENT

Insert NA in column "Representative" in all rows that are not relevant. Expand with additional rows as needed, e.g. to accommodate additional packages.
 Each responsible party's signature below confirms that the parts of this document that are relevant for that party have been worked out in a manner satisfactory to that party, and that the result is complete and acceptable to that party.
 The Instrumentation discipline is formally responsible for this document. The signature of the Instrumentation representative is found on the front sheet, and is not relevant here.

Responsible party	Package	Representative	Initials	Signature	Date	Notes
Instrumentation ¹	XXXX			See front sheet	See front sheet	
Process ²	XXXX					
Safety ³	XXXX					
HVAC ⁴	XXXX					
Electrical ⁵	XXXX					
SAS package vendor ⁶	XXXX					
Package vendor ⁷	XXXX					1
MTO workgroup ⁸	XXXX					
Subcontractor ⁹	XXXX					

If a signature applies only to part of the document, e.g. for MTO signature for VDU picture specifications, this may be documented in the form of a note.
Notes:
 Insert any reservations that "Responsible party" needs to make in order to sign the matrix, e.g.: Strategy for control of xxx can not be finalised at this time, because of ...
 Insert NA in column Representative for rows that is not applicable.

Supporting Functional specification

1.2 Scope

This document covers monitoring and control of system *<sys.no>*, *<system name>*, by SAS directly, and/or indirectly via separate control systems where relevant. The document shall contain, either directly or by reference:

- Brief description of the process to be controlled (section 2)
- Description of the protective functions, including detailed specification of all SAS safety system functionality to be implemented for this system (section 4)
- Detailed specification of all non-protective SAS functionality to be implemented in SAS for this system, as well as listings of alarm groups and trends/reports (section 5)

Relevant Process system description, Operational Manual, System Control Diagrams (SCDs), control sequence specifications/tables, Cause & Effect charts, HMI screens and package specifications are referenced.

For efficiency and maintainability, references shall be used instead of text whenever there exists an official document with sufficient quality that can be referenced.

Supporting Functional Specification

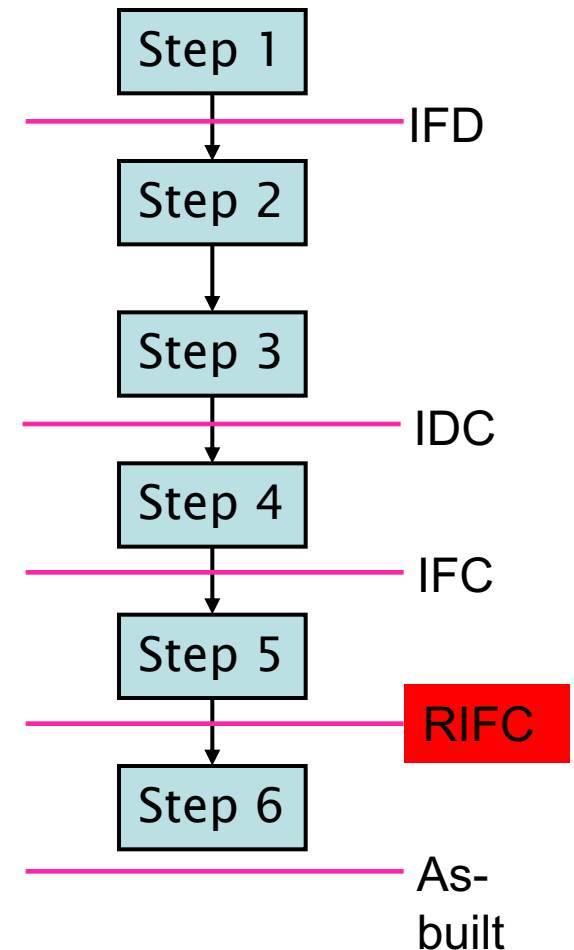
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SCD development sequence - General

- SCD shall have complete **multi-disciplined IDC check** at each release
- IDC prior to release for implementation is done in the form of a **technical review meeting** where all parties are present.
- SCD ' are distributed to those who get the P & ID's
- SCD ' are being developed and issued pr. process system
- Suggestions: 6 step sequence

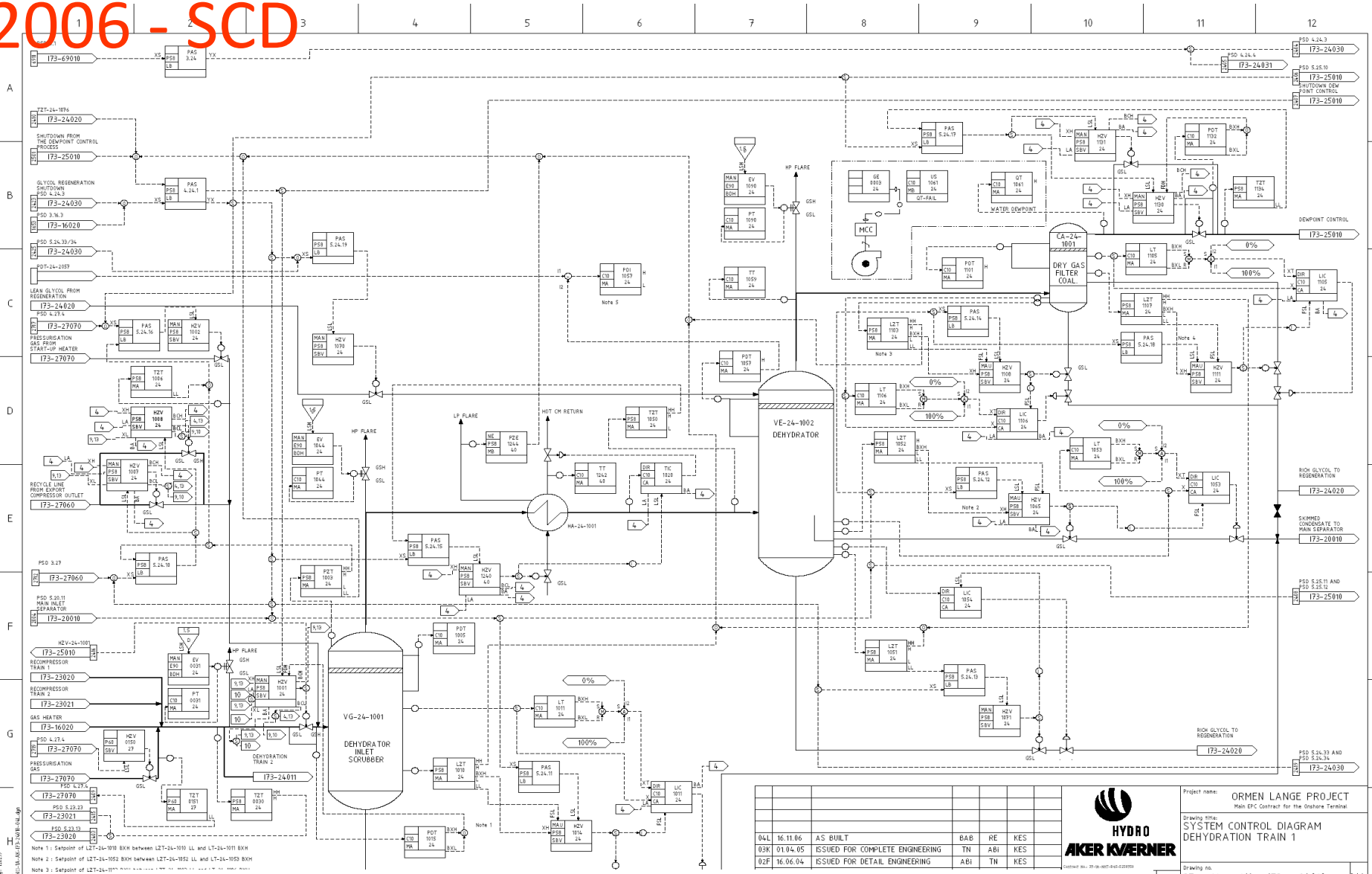


Export of SCD to DCS supplier

Johan Sverdrup phase 2 will digitalise the SCD export to DCS supplier in the purpose of automatically generate the control application.

- Minimize DCS SW engineering manhours
- Avoid time spend «yellowlining» at FAT
- Go directly into functional verifaction on Simulator





How does the corresponding HMI look like?

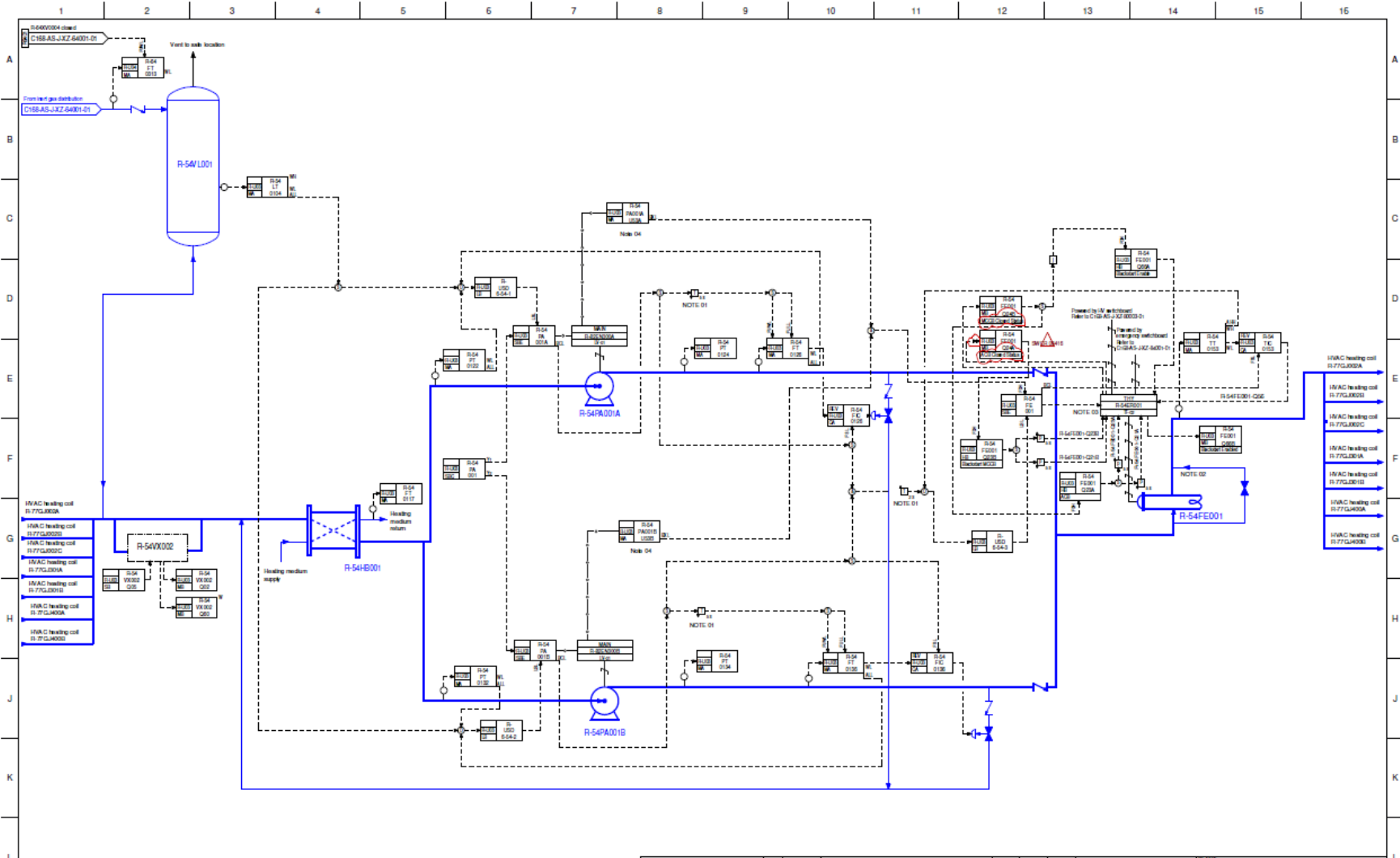
Project name: **ORMEN LANGE PROJECT**
Main EPC Contract for the Shale Terminal.

Drawing title: **SYSTEM CONTROL DIAGRAM DEHYDRATION TRAIN 1**

Drawing no: **37 - 1A - AK - I73 - 24.010**

System: **37** Project: **1A** Contr: **AK** Design: **I73** Sequence: **24.010** Subsequence: **04L**

2017 - SCD

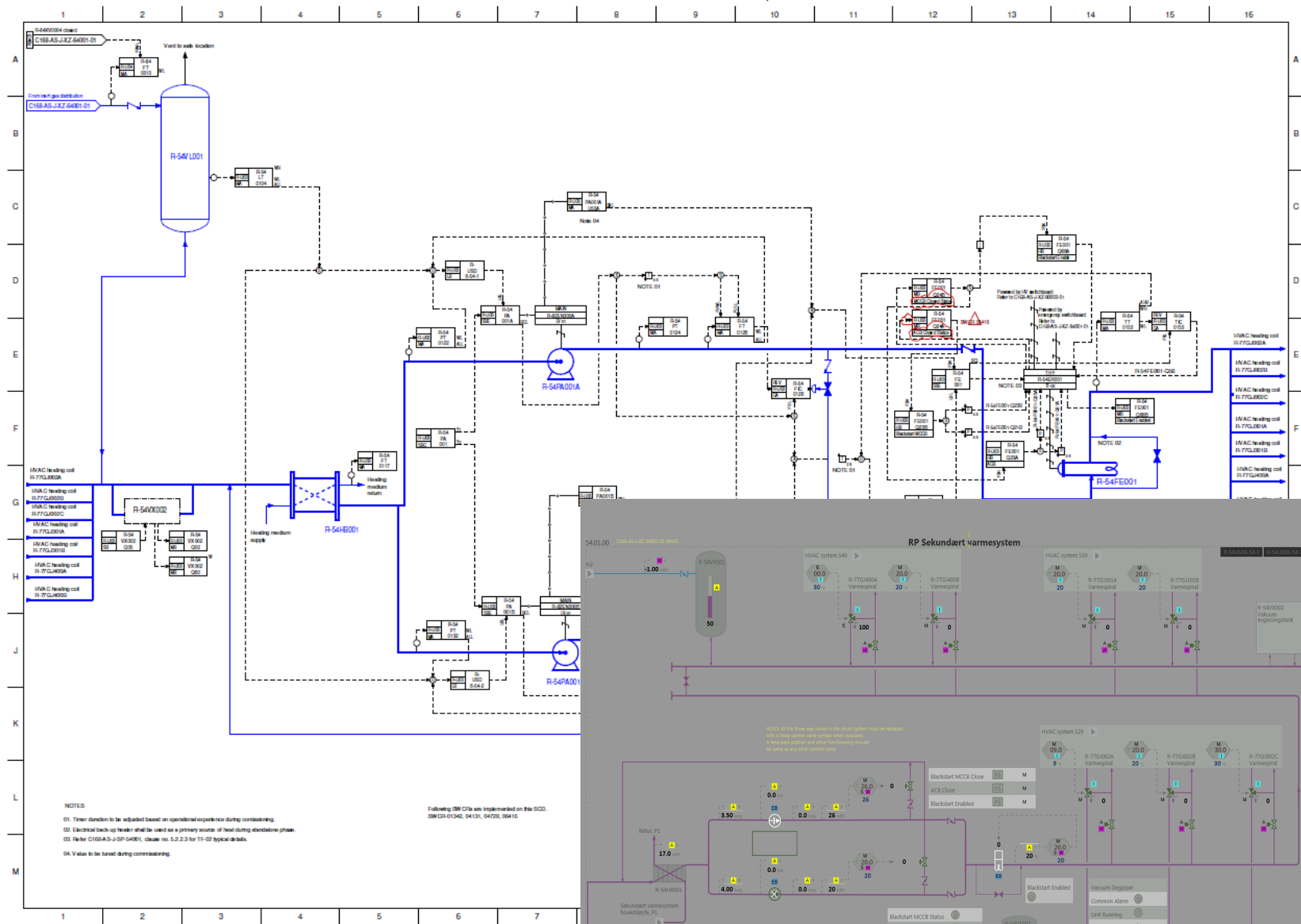


How does the corresponding HMI look like?

DRAWING TITLE		Johan Sverdrup	
System Control Diagram		atoil	
Secondary heating medium-local loop		05	
NO	DATE	ISSUED FOR REVIEW	05
01	18.06.2016	INITIAL DESIGN AND CHECK	05
REV	DATE	REASON FOR ISSUE	ISS

NO	DATE	ISSUED FOR REVIEW	05
01	18.06.2016	INITIAL DESIGN AND CHECK	05
REV	DATE	REASON FOR ISSUE	ISS

NO	DATE	ISSUED FOR REVIEW	05
01	18.06.2016	INITIAL DESIGN AND CHECK	05
REV	DATE	REASON FOR ISSUE	ISS



NOTES

01. Tower duration to be adjusted based on operational experience during commissioning.
02. Electrical back-up heater shall be used as a primary source of heat during start/stop phase.
03. Refer C160 AS-J-SF-54001, clause no. 5.2.2.3 for TF-02 typical details.
04. Values to be tuned during commissioning.

Following SW CIs are implemented on this SCC:
SW CI-01342, 04131, 04720, 05415

PAS IEC 63131 content

NORSOK standard I-005

Rev. 2, April 2005

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- Next step is to requirite experts to transfer it into a IEC standard.
 - Adopt IEC terminology
 - Clarify alignment towards existing standards

IEC PAS 63131:2017

System control diagram

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Abstract

PREVIEW

IEC/PAS 63131:2017(E) defines a set of operational control functions (objects) and the associated logical diagram (System Control Diagram (SCD)), for use in the continuous control process industry – e.g. as used in Oil and Gas processes.

The main drivers for establishing this as a standard are the advantage of efficient engineering, implementation, and commissioning, as well as reuse of the control application across different suppliers of control systems. The diagrams give a logical representation that is suited for data transfer.

This PAS also includes a method of documenting sequences and their interaction with the control objects.

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Additional information

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