Control of System Software as per clause 5.18 of API16D edition 3rd

Rev	Reason of Change	Date	Prepared by	Reviewed by	Approved by	Status
0	Initial release	15-02-2024	PK	USR	JG	Released

Control of System Software as per clause 5.18 of API 16D edition 3rd.

1. Purpose

1.1. The scope of this procedure for BOP control system software design verification, installation and validation procedure. It also includes software FMEA and its maintenance.

2. Reference documents

2.1. API 16D

3. General requirement as per clause 5.18.1 of API16D

3.1. The control system software requirement per customer should be fulfilled. The proof of fulfilment should be verified , documented and provided to customer. The Proof of fulfilment is tobe covered through **Factory Acceptance Test (FAT) procedure for indivisual control unit. (R&D-CTP-0001)**

3.2. The referance standards and process involved in the design and development of the system software is tobe followed properly.

3.3. The processes involved in Design and Development beside upgrdation of software is tobe documented with traciblity records and revision no. **(eg**: The PLC input and Output addressing to be preseved with identification no.)

3.4. The software is passoward protected to prevent its use by the person do not have in proper knowledge of design and deveoploment of software.

3.5. Software used- 10.0 PAC Machine Edition Professional Development Suite or simatic step 7 version 19.0

programming language - Ladder Diagram OR LD

Standard used- IEC 61131-3

programmable logic controller (PLC) used – EMERSON or SIEMENS

4. Classification of Software Life Cycle Process as per clause 5.18.2 of API 16D

Software life cycle is process by which software is developed , deployed and sucessfully installed on the control unit.

The software life cycle process shall include the following:

4.1. Software functional specification

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4.2. Software Design and Development

4.3. Software Verification and Validation

4.4. Software Production and Maintenance

5. Software functional Specification per clause 5.18.3 of API16D

5.1. All the functional specfication is documented per clause **5.18.3.1 of API16D** in **Annexure 'A'** of CPC/**R&D-CTP-0002**

5.2. All the additional functional specification is documented per clause **5.18.3.2 of API16D** in **Annexure 'A'** of CPC/**R&D-CTP-0002**

5.3. Technical requirment of system capabilities represent in checklist and documented per clause **5.18.3.3 of API 16D** in **Annexure 'A'** of CPC/ **R&D-CTP-0002**

5.4. Software functional specification review format documented per clause **5.18.3.4 of API16D** in **Annexure 'B'** of CPC/ **R&D-CTP-0002**

6. Software Design and Development as per clause 5.18.4 of API 16D

6.1 Software design review should be conducted and tested at different stages as per clause **5.18.4.1 of API 16D**. All panel should be tested individualy at preliminary , critical and final design stages and documented in **Annexure 'B'** of CPC/ **R&D-CTP-0002**

6.2 The system design architecture drawing includes system topology,logic flow diagram as per clause **5.18.4.2of API16D** and documented in **Annexure 'C'** of CPC/R&D-CTP-0002

6.3 Failure modes effect analysis (FMEA) per clause **5.18.4.3 of API16D** is tobe carried out and documented in **Annexure 'G'** of CPC/ **R&D-CTP-0002**

6.4 The design and development of software code should follwed per IEC standard.

6.5 The software code includes the design and devoplement of programming software that it could be understood and implemented by other relevant software engineer. as per clause **5.18.4.5 of API16D**

6.6 Softcopy of installation and **devoplement tools guide** should be documented as per clause **5.18.4.6 of API16D** (manufecturer, software plateform and version) . .

6.7 Software itself enables developer to provide the possible solution if some error occured. Generally,this is possible by using PLC software inbuilt.

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7. Software Validation and Verification as per clause 5.18.5 of API 16D

7.1 Software verification and validation for BOP control system enable user to provide local, system and global effect per **Annexure 'G'** of CPC/ **R&D-CTP-0002**

7.2 **PLC** Software enable and validate all the operational logic , instructions and communication parameter

7.3 The Individual software component testing is tobe documened in **Annexure'B'** of CPC/ **R&D-CTP-0002**

7.4 Assembled panel testing performance is tobe documened in **Annexure'B'** of CPC/ **R&D-CTP-0002**

7.5 Every line of code and correspounding logic path having statement true/false is tobe executed at least once. This facility is availble in plc software itself.

7.6 The Software integration level test is tobe done to test the complete integrated Modules beside testing individually before integrating the components. Once all the module are tested,software integration testing is done by integrating all the modules and the system as a whole is tested. and the result is tobe documented in **Annexure'B'**

7.7 The testing shall be performed with BOP control unit per **Factory Acceptance Test procedure (FAT).**

7.8 In case of failure of the communication between the panels provision of communication fail alarm is to be incorporated through software.

7.9 Every line of code and logic path shall be tested as part of white box testing as per **Annexure 'E'**

7.10 Single Unit funcitionality which provides input v/s output shall bee treated as black box testing as per **Annexure 'B', Annexure 'F' & Annexure 'A'**

8. Software Production and Maintenance as per clause **5.18.6 of API 16D**

8.1. The modification to existing software shall be reviewed and documented in softcopy (retain old program and modify program)

8.2. The PLC software is developed ,deployed and installed under shoftware development life cycle (SDLC) with traciablity records.

8.3. The Updated software if amended is tobe reviewed and documented in softcopy.

8.4. The software shallbe recorded with its current revision having all the details i.e.date, time, reason, unique identification and name of person conducting change. Software Back-up is tobe stored in safe location seperately. in **Annexure'H'**

8.5. Risk assesment is not to be carried out for software scurity being no external excess and

internet accessiablity to software.

8.6. The latest version of manufacturer supplied software platform is to be used to create PLC Programme for control unit.Date of incorporation of latest software platform is tobe recorded.

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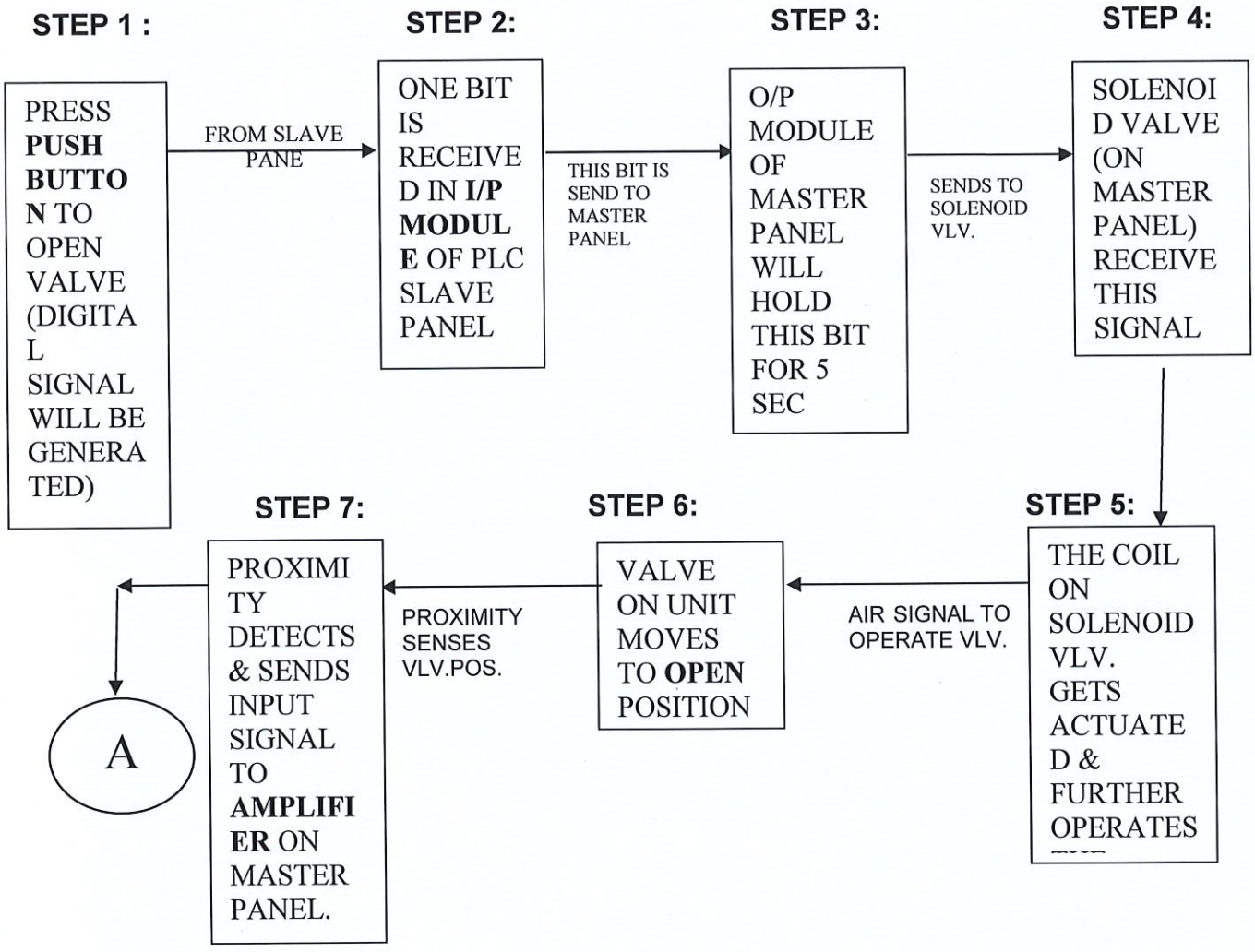
Annexure 'C'

SOFTWARE FUNCTION PROCEDURE FOR PLC SLAVE PANEL

OBJECTIVE: TO CREATE A BLOCK DIAGRAM WHICH WILL SHOW HOW A VALVE CAN BE OPERATED FOR OPEN & CLOSE FUNCTIONS

BASIC LAYOUT: (A) FOR OPEN FUNCTION



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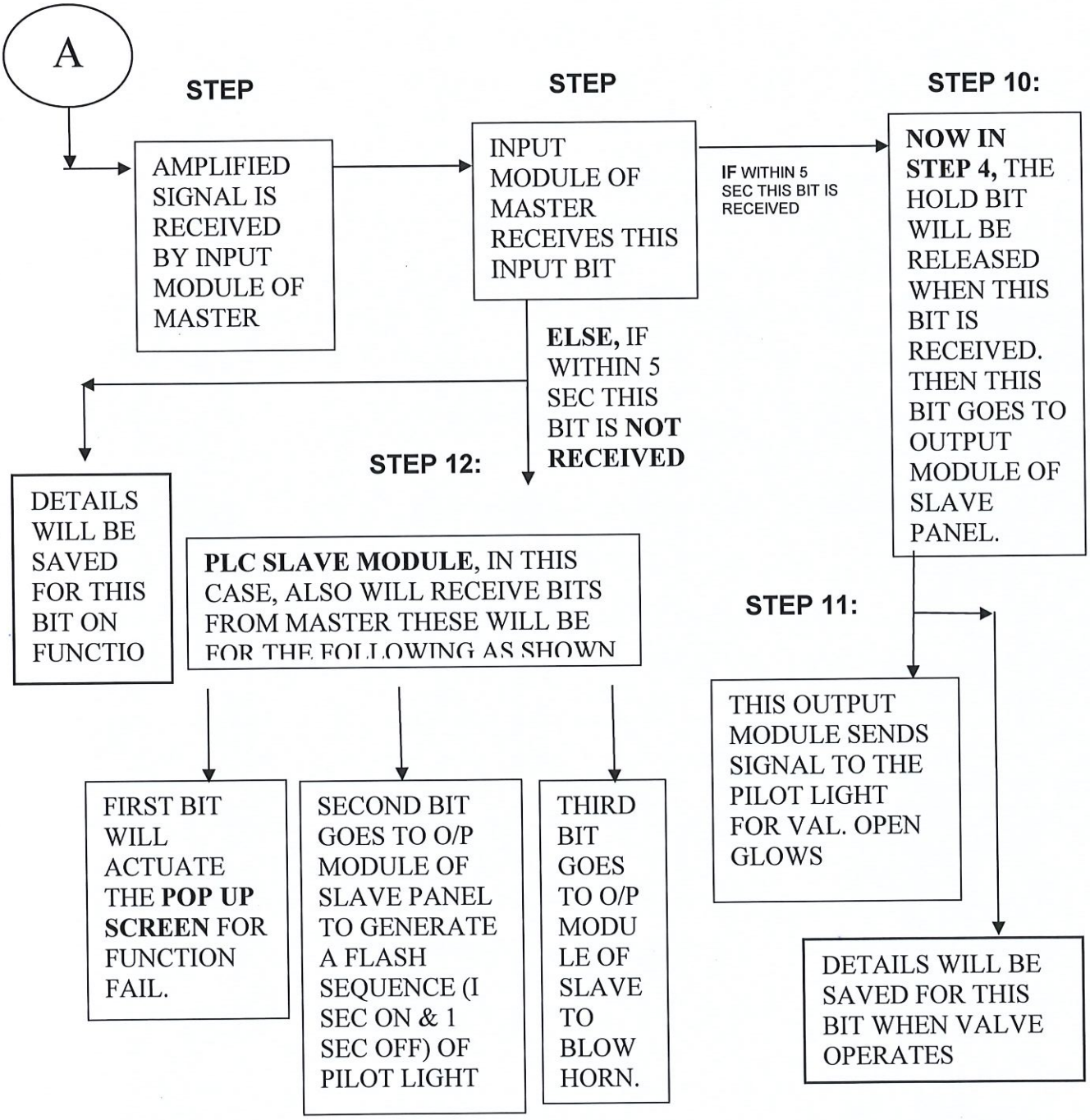

NOW THESE THREE BITS WILL HAVE TO RESET BY ACKNOWLEDGE (ACK.) BUTTON ON THE SLAVE MODULE.

STEP 13:

ACK. CAN BE DONE EITHER FROM TOUCH SCREEN OR RESET PUSH BUTTON ON PANEL.

→

STEP 14:

WHEN ACK. BUTTON IS PRESSED, THIS BIT GOES TO INPUT OF SLAVE PANEL.

→

STEP 15:

THIS BIT WILL CORRESPONDINGLY MOVE TO THE MASTER PANEL.

→

STEP 16:

THIS RESET WILL CHANGE THE STATE OF BITS (HIGH TO LOW) IN THE MASTER

↓

STEP 17:

NOW THE SCREEN POP UP WILL BE RESET, FLASH WILL STOP & HORN WILL BE SILENCED IN THE SLAVE PANEL.

(THIS WILL BE BECAUSE THERE WILL BE NO SIGNAL FROM MASTER PANEL FURTHER)

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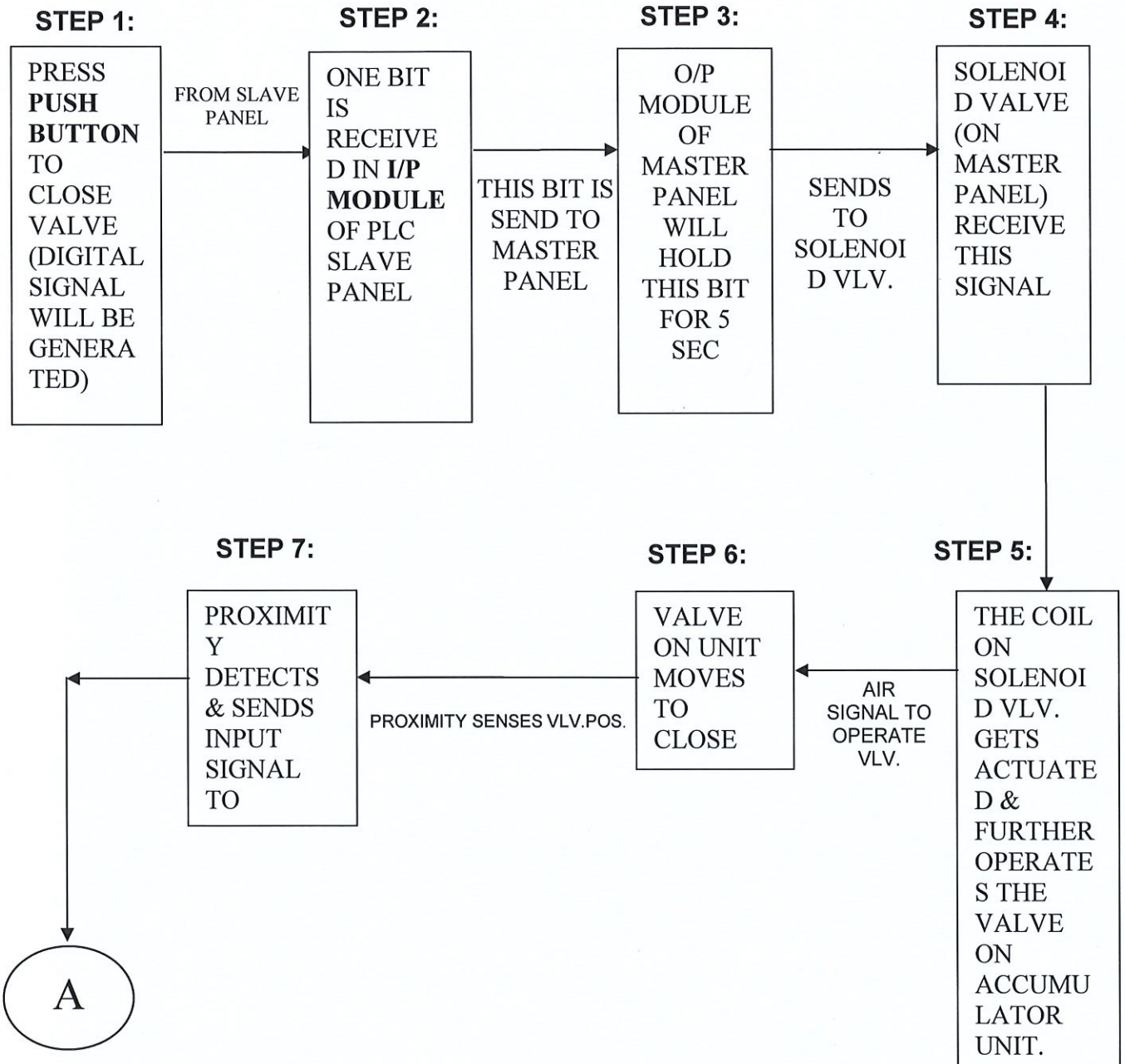
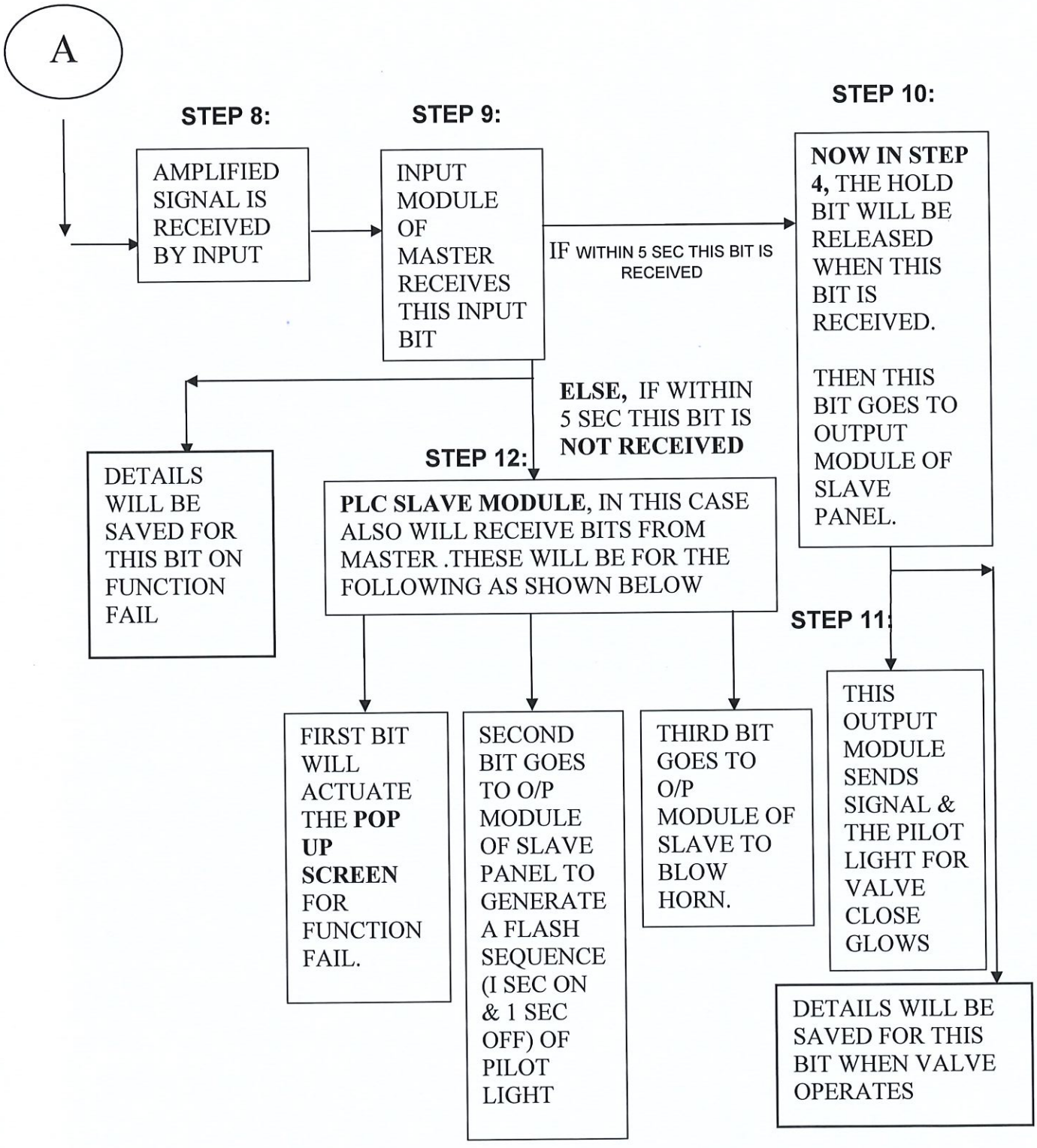
BASIC LAYOUT: (B) FOR CLOSE FUNCTION





NOW THESE THREE BITS WILL HAVE TO RESET BY ACKNOWLEDGE (ACK.) BUTTON ON THE SLAVE MODULE.

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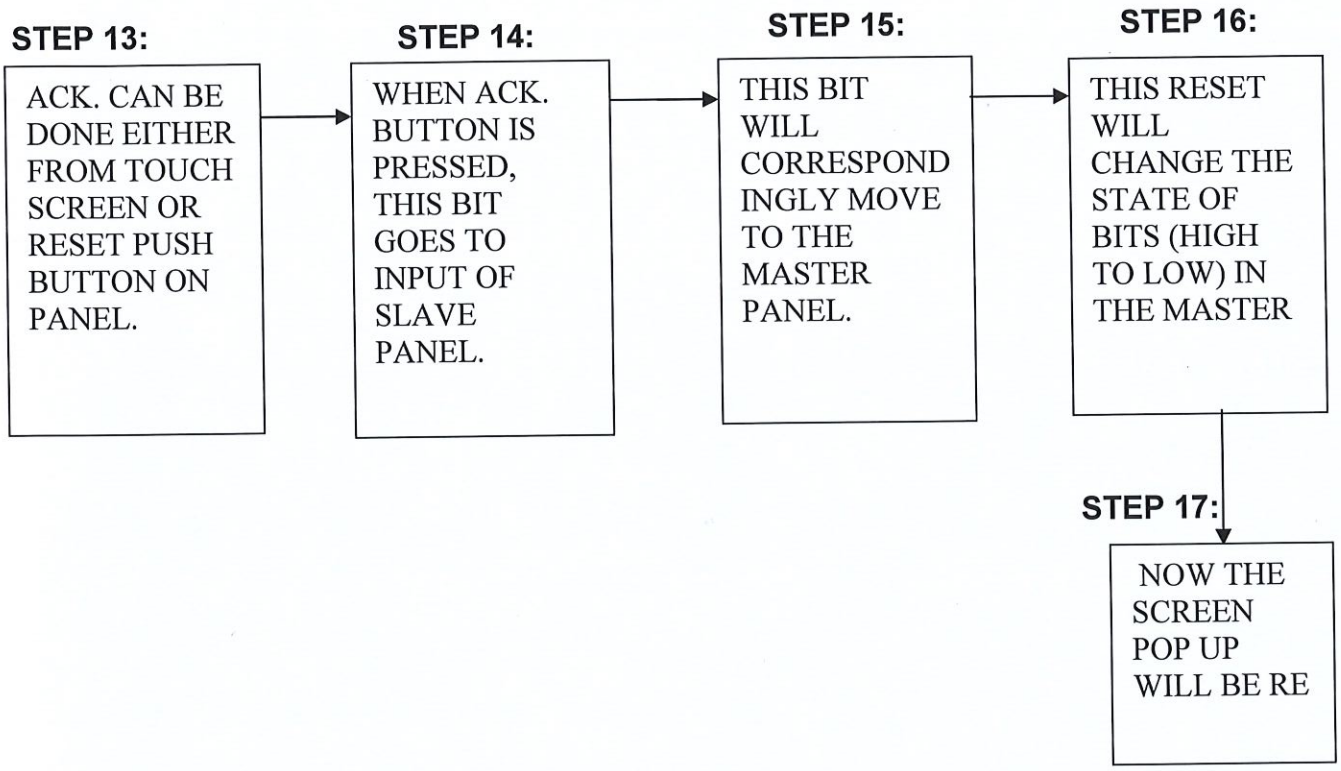

(THIS WILL BE BECAUSE THERE WILL BE NO SIGNAL FROM MASTER PANEL FURTHER)

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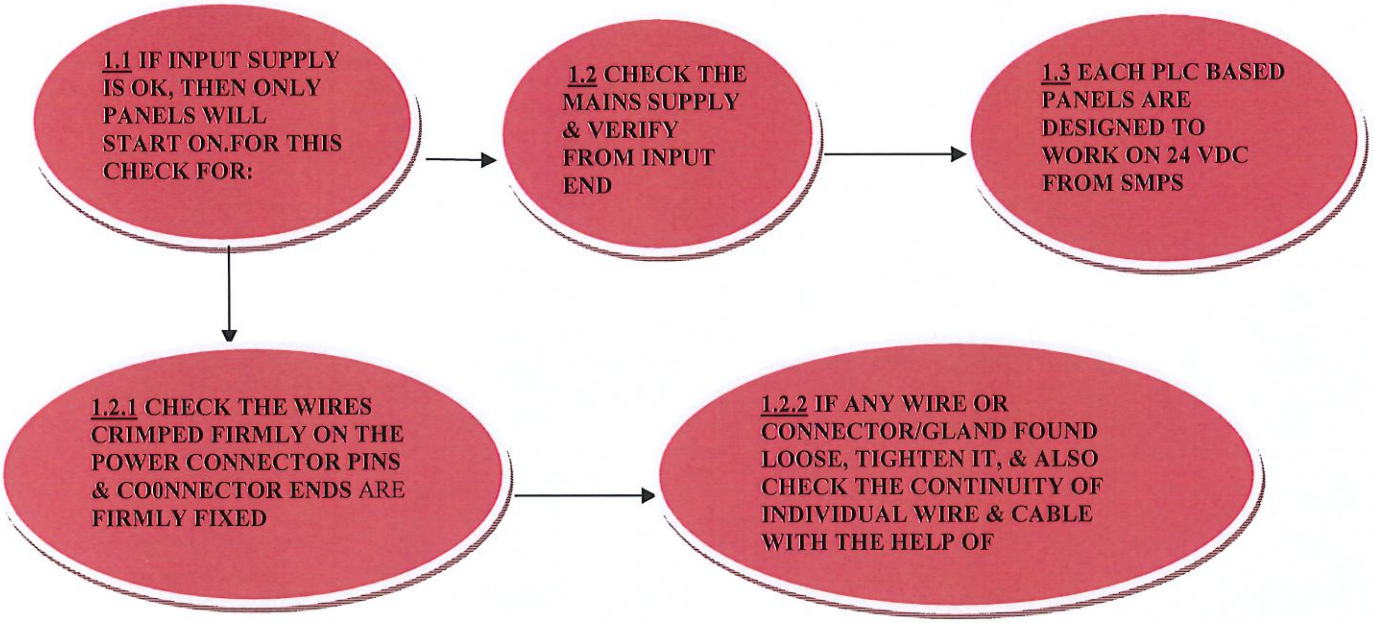
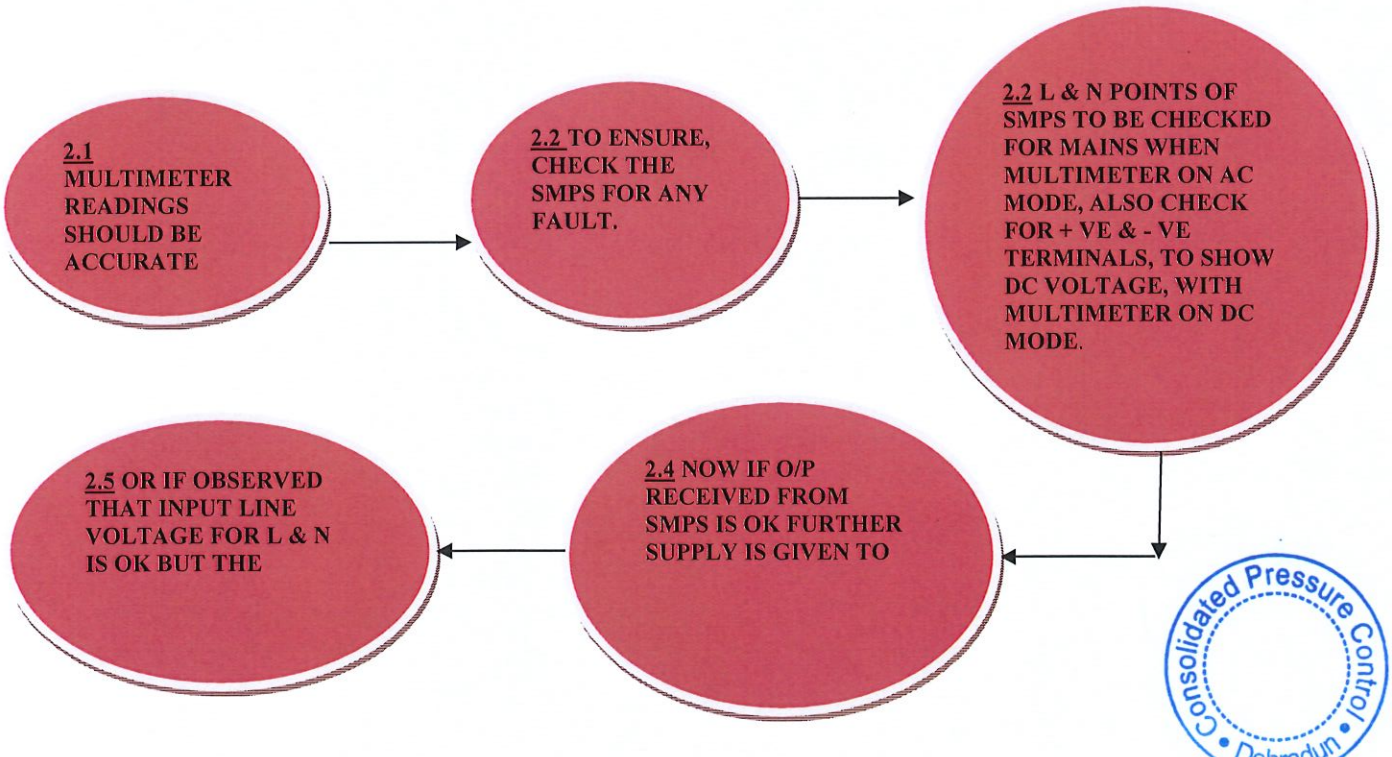
Annexure 'D'

TROUBLESHOOTING GUIDE FOR SMART CONTROL PLC PANEL

FAULT - 1: ON TURNING ON THE PANEL, NOTHING COMES UP



FAULT - 2: AC –DC CONVERTER (SMPS) IS SUSPECTED TO RECEIVE MAINS SUPPLY & CONVERT TO DC



FAULT - 3: PROBLEMS OBSERVED ON PLC MODULES

- POWER SUPPLY
- CPU MODULE
- INPUT MODULE/s
- OUTPUT MODULE/s
- ANALOG I/O

3.1 DURING NORMAL OPERATION, PWR SUPPLY WHEN GIVEN 24VDC SHOULD SHOW LED'S GREEN FOR PWR, OK & RUN

→

3.2 NOW IF PWR LED IS NOT GLOWING GREEN THEN IT IMPLIES THAT THE PWR SUPPLY HAS ENCOUNTERED SOME HARDWARE PROBLEM & NEEDS TO BE REPLACED.

→

3.3 IF PWR LED GLOWS BUT OK LED IS NOT GLOWING GREEN, IT IMPLIES CPU MODULE NOT RECEIVING PWR FROM PWR SUPPLY

↓

3.5 IN SUCH CASE, IT IS ADVISABLE TO REPLACE CPU MODULE.

←

3.6 ALSO SOMETIMES IT IS OBSERVED THAT PWR, & OK, LED ARE ON BUT RUN LED IS NOT COMING UP

←

3.7 IN SUCH A CONDITION IT IS COSIDERED THAT THE PLC IS NOT IN RUN MODE & HAS TO

TO BRING THE PLC INTO RUN MODE FOLLOW THE STEPS BELOW:

STEP - 1 → 3.7.1 WHILE THE PANEL IS ON, MOVE THE KEY SWITCH OVER THE PLC FROM STOP TO RUN POS. 2-3 TIMES SIMULTANEOUSLY.IN SERIES 90-3O PLC THIS KEY IS VERY WELL SEEN .

STEP - 2 → 3.7.2 STOP THE PLC PANEL.ENSURE THERE IS NO POWER INSIDE THE ENCLOSURE, NOW PLUG OUT THE INTERNAL BATTERY (3V), FROM THE PWR SUPPLY MODULE.AGAIN REPLACE THE BATTERY IN THE SAME POSITION AFTER 4-5 SEC.

STEP - 3 → 3.7.3 STORE THE SOFTWARE LOGIC AGAIN INTO THE PLC CPU MODULE.BEFORE STORING A NEW PROGRAM CHECK THE FAULT TABLE & CLEAR IF ANY BY F9 COMMAND.TO DOWNLOAD THE SOFTWARE PROGRAM ONE NEEDS TO HAVE:(1)PROGRAMMING SOFTWARE INSTALLED I.E.–VERSAPRO. (2)PROGRAMMING CABLE RS 485 TO RS 232 SNP CABLE. (3)SOFTWARE PROGRAM FOR THE DESIRED PLC PANEL.
NOW SOFTWARE CAN BE RETRIEVE FROM : \\172.24.23.12\R&D Data\Share R&D\ENGG-JOB.

↓

(A)

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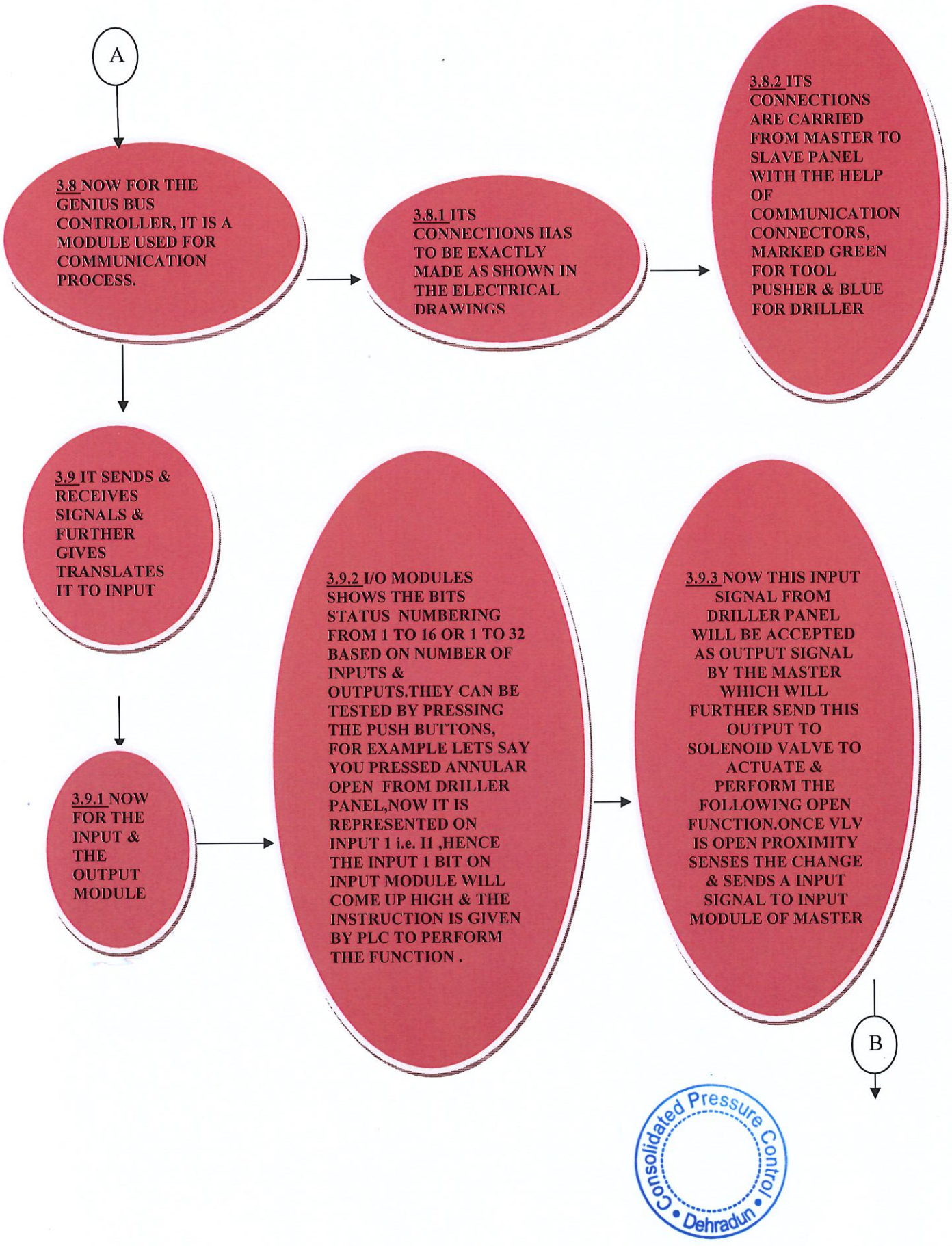

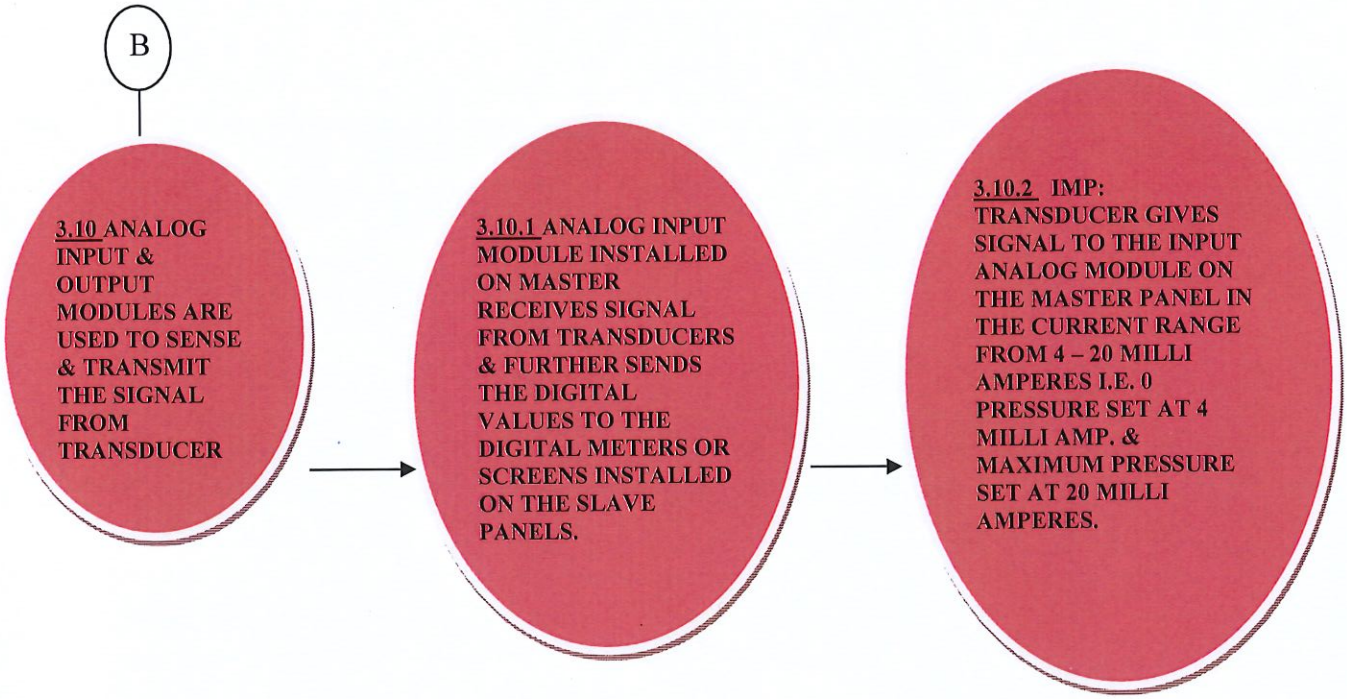

FAULT- 5: NO COMMUNICATION BETWEEN MASTER PANEL & SLAVE PANELS.

IF FAULT IS SUCH THAT THERE IS NO COMMUNICATION AMONG THE PANELS .MAKE THE FOLLOWING CHECKS ONE BY ONE.

4.5.1 STEP 1

> FIRSTLY VERIFY THAT ALL THE PANELS ARE SWITCHED ON

>NOW ENSURE THAT ALL PANELS ARE IN RUN MODE.

>TO CHECK WHETHER PANELS HAVE PROGRAM STORED IN EACH OF THEM, PRESS LAMP TEST BUTTON (LTB).

>NOW IF WORKING ON PANELS WITH TOUCH SCREEN, ON PRESSING LTB, ALL LIGHTS WILL COME UP, IF PROGRAM IS STORED IN CPU MODULE.

>IF WORKING WITH DIGITAL GAUGS, ON PRESSING LTB, LIGHTS WILL COME UP FOR MOTOR RUN & ALARM INDICATION.

> NOW IT ABOVE CONDITION IS NOT SATISFIED THEN PROGRAM NEEDS TO BE STORED INTO THE PLC CPU MODULE.
SEE STEPS 3.7.1 -3.7.3

>DURING THIS PROCESS ALSO MAKE SURE THAT I/P BIT IS GENERATED EVERYTIME LAMP TEST IS PRESSED.ELSE CHECK WIRE CONNECTION FOR LAMP TEST.

4.5.2 STEP 2

> CHECK THE PLUG & SOCKET OF COMM. CONNECTOR TO BE LOOPED PROPERLY.IF FOUND LOOSE TIGHTEN THEM.

>CABLE WIRES MUST BE FIRMLY CRIMMPED INTO PINS OF SOCKET, IF FOUND LOOSE AGAIN DISMANTLE IT AND CRIMP.

>COMMUNICATION CABLE TO BE CHECKED FOR ANY BREAKAGES OR TAMPERED IN BETWEEN THEIR LENGTHS.

>IF CABLE FOUND NOT FIT FOR USE, REPLACE THE COMPLETE CABLE.

>CHECK THE WIRING CONNECTIONS OF GENIUS BUS CONTROLLER

>IF USING SERIES 90-30 PLC SEE THAT SER 1, SER 2 FROM MASTER IS CONNECTED IN SERIES WITH SLAVES & SHLD IN & SHLD OUT ARE LOOPED AS PER DRAWING.

>IF WORKING WITH VERSA MAX PLC MODULES TWO POSSIBILITIES EXIST.
IF WORKING ON WIRED ETEHRNET COMM. FOLLOW FIRST FOUR STEPS AS ABOVE.

IF WORKING WITH WIRELESS MODULE ENSURE FOR ACCURATE CONNECTIONS B/W PLC TO SWITCH & SWITCH TO ANTENNA, *SEE OPERATIONAL MANUALS FOR DARWINGS.*

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FAULT- 6: NO READINGS IS OBSERVED ON DIGITAL GAUGES

6.1 DIGITAL METERS (DM) ARE USED TO SHOW PRESSURE READINGS OF ACCUMULATOR, MANIFOLD, ANNULAR & RIG AIR PRESSURE.POSSIBILTY EXIST THAT THESE DIGITAL METERS (DM) WOULD NOT SHOW READINGS OR WOULD NOT WORK AS DESIRED.FOLLOW THESE TROUBLE SHOOTING STEPS

6.1.1

IF DM IS NOT SHOWING ANY READINGS FIRSTLY CHECK THE 24 VDC SUPPLY ON IT.

NOW CHECK THE CONNECTIONS BETWEEN THE ANALOG OUTPUT MODULE & THE DM WITH THE HELP OF MULTIMETER MAKE SURE YOU SWITCH OFF THE PANEL EVERYTIME, BEFORE CHECKING THE CONTINUITY.CONNECTIONS HAS TO BE ACCORDING TO ELECTRICAL DRAWINGS ATTACHED WITH THE MANUALS.

6.1.2

UPTILL NOW IF THINGS ARE OK, THEN CHECK THE INPUT SIGNAL RECEIVED FROM MASTER PANEL.
TRANSDUCER PROVIDES THE OUTPUT SIGNAL IN THE RANGE FROM 4 – 20milli Amp.
TRANSDUCER SIGNAL IS FED TO ANALOG INPUT MODULE WHICH READS THE PRESSEURE VALUES & SENDS IT TO ANALOG OUTPUT MODULE FOR FURTHE DISPLAY TO DM.
CROSS CHECK ALL THE CONNECTIONS WITH ELECTRICAL DRAWINGS & TRANSDUCERS FOR ANY LEAKAGES.

6.1.3

AFTER FOLLOWING THE FIRST TWO STEPS, IF ALL THE CONNECTIONS & SETTINGS ARE FOUND OK & STILL NO READING IS DISPLAYED ON DM WHEN THERE IS READINGS ON ANALOG GAUGEA ON UNIT, PROGRAM THE GAUGE AS PER THE PROGRAMMING STEPS ATTACHED ABOVE.

6.1.4

ANOTHER FAULT THAT A DM CAN HAVE IS, GAUGES SHOWS CORRECT READINGS BUT WHEN PRESSURE DROPS, NO CUTOFF RELAY IS ACTIVATED FOR ALARM SIGNAL TO BLOW & INDICATE LOW PRESSURE.
IN SUCH CASE FIRSTLY CHECK THE CONNECTIONS FOR ALARM ON DM AS PER DRAWINGS.
IF CONNECTIONS ARE FOUND OK AND STILL ALARM NOT COMING, THEN MAKE THIS VISUAL CHECK, OBSERVE SETPRESSURE INDICATOR (SP) OUT OF SP1/SP2/SP3/SP4 HIGHLIGHTED RED ON THE RIGHT PORTION OF THE DM .IT SHOWS THAT THE PARTICULAR RELAY IS ACTIVATED FOR THE ALARM TO ACTIVATE.IF THIS SP INDICATION IS NOT VISIBLE,

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Software	Qty	Description	Serial Number	Legacy Serial Number	Contract Level	Contract End	Activation Code	Action
PAC Machine Edition	1	Machine Edition v10.0 Professional Development Suite 700 Points	7-43959401-003-001	7-43915201-003-001,7-43915201-003-002	None		6be0106c-db65-446a-ae0e-b2a4d4d12a9e	Updated

License keys - 10411000916198869831

Status	Family	Product	Version	Number of lice...	License key	License number	Standard licens...	License type	Validity	Article No.
✓	SIMATIC STEP 7	STEP 7 Basic	19.0	1	SIFLS7BASB1900	10411000916198869831	Floating	Unlimited	Unlimited	-

Objectives

Programming Languages are LD, SFC, FBD, CFC and ST.

Ladder Diagram remains popular and easier because of its graphical nature so we used LD (Ladder Diagram).

As with lawn power tools, it is most efficient to use the best programming language for the application, to avoid the complexity of driving the square application peg into the round tool hole. With IEC 61131-3 programming languages, PLC programming and maintenance are enhanced when the strengths of all the languages are used.

Programming languages: LD, SFC, FBD, CFC and ST

the strengths and best applications Ladder Diagram (LD) and Sequential Function Chart (SFC).

"Which IEC 61131-3 Programming Language is best? Part 2" will discuss Function Block Diagram (FBD), Continuous Function Chart (CFC), Structured Text (ST), and how they can be mixed and matched for optimal results.

What is Ladder diagram (LD) programming?

Ladder diagram programing or LD, traces its history back some 100 years to relay ladder logic (RLL), which was created to describe systems of electrical components such as relays, timers and motors. In the early days of automation, when PLCs were replacing relays and timers, it made perfect sense to create a programming language familiar to the user base and similar to the tool it was replacing. Unfortunately, as controllers became more capable and evolved past relays and timers, the original LD language was pressed into services it was never intended for and was poorly suited.

This situation was exacerbated by the slow pace at which PLC vendors provided new languages better suited to PLC and programmable automation controllers (PAC) applications. This was particularly true with controllers originating in North America, which explains the global differences in the enduring popularity of LD.

Strengths of LD programming

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The strength of LD and the key to its enduring popularity is its graphical nature. Of all the generalizations one can say about engineers, it is safe to say engineers tend to be graphically oriented. (Who among us can effectively communicate without paper and pencil, or a white board?) Early on, most LD programming alternatives were text-based languages that did not resonate with engineers' graphical nature. This led to further reluctance to move on from LD. Fortunately, that situation is changing.

LD remains a great language for which it was originally intended – complex Boolean logic. Staying within this realm, LD logic is simple to design and simple to debug. Figure 3 illustrates this point by showing the same Boolean logic in several IEC 61131-3 languages. Say we are expecting "Inspect" to be TRUE. How easy is it to determine why the result is not as expected? In LD, the answer is quickly determined by observing where the path of solid blue contacts is interrupted.

Use the right language for control system programming

To communicate effectively in the English language, it's important to have the right vocabulary and know how to use that vocabulary effectively. To create effective industrial controls programs, it is important to have the right languages and know how to use those languages effectively. IEC 61131-3 provides the languages, and this article has provided guidance on effective use of LD

Refer below annexures for detailed specification and supplementary specifications.

Annexure 'A'
ASSEMBLY AND TESTING PROCEDURE FOR PLC MASTER PANEL
ASSEMBLY AND TESTING PROCEDURE FOR PLC SLAVE PANEL (Driller's/Tool Pusher's/Muster)

*** Data for the Annexure 'A' to be recorded as per CPC/ R&D-CTP-0002-1**

Annexure 'B'
SOFTWARE FUNCTION PROCEDURE FOR PLC MASTER PANEL
SOFTWARE FUNCTION PROCEDURE FOR PLC SLAVE PANEL (Driller's/Tool Pusher's/Muster)

*** Data for the Annexure 'B' to be recorded as per CPC/ R&D-CTP-0002-2**

Annexure 'E'
SOFTWARE/HARDWARE CODE REVIEW FOR PLC MASTER PANEL
SOFTWARE/HARDWARE CODE REVIEW FOR PLC SLAVE PANEL (Driller's/Tool Pusher's/Muster)

*** Data for the Annexure 'E' to be recorded as per CPC/ R&D-CTP-0002-3**

Annexure 'F'
MASTER SOFTWARE SECURITY REVIEW FOR PLC MASTER PANEL
MASTER SOFTWARE SECURITY REVIEW FOR PLC SLAVE PANEL (Driller's/Tool Pusher's/Muster)

*** Data for the Annexure 'F' to be recorded as per CPC/ R&D-CTP-0002-4**

Annexure 'H'
PLC PROGRAMME TRACEABILITY RECORD

*** Data for the Annexure 'H' to be recorded as per CPC/ R&D-CTP-0002-5**

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CONSOLIDATED PRESSURE CONTROL

FAILURE MODE EFFECTIVE ANALYSIS (FMEA)

(According to IEC 60812)

DATE:-
PO. NO:-
D.D NO:-

SOFTWARE (REMOTE PANEL)

Before Corrective Action														After Corrective Action					
S.No.	Items/ function	Design Intentions	Potential Mode of Failure	Cause	Local Effects	System Effects	Global Effects	Corrective / Recommended Action	Severity	Detection	Probability Of Occurance	Risk Priority Number (RPN)	Current Control	Responsibility	Severity	Detection	Occurance	Risk Priority Number (RPN)
1	Hardware configuration	To Create a hardware configuration in software for physical data processing,sequencing and execution	Program execution fails to start. Program Cant be download.	• CPU and Modules failure • RAM data corruption • Hardware configuration errors •Wrong Hardware Selection, Hardware Not Installed Properly .I/O Moudle Rack Pins Not Fixed Properly	• PLC Goes into fault mode and fault LED WILL GLOW	• Loss of communication. • Loss of well control system functionality • Operational shutdown due to system failure. • Cascading failure in other system	• Delay in well control operations • In case of failure hardware modules remote panel will not be able to operate BOP Ram.	• Immediate replace the faulty component • Create contingency plans for harware failure • Conduct routing inspections and electrical testing	7	6	4	168	• Use quality products • Verify in FAT • Verified hardware configuration in program • Critical spare parts are kept on hand to replace any damaged components	PLC programmer/Assembly department	5	2	3	30
2	Press	To Create a control Program for pressure execution, Convert pressure into an electrical signal and diplayed as a digital reading on the gauges and HMI	All Preessure Program execution stops in the CPU.	• PLC program may be not correct • Hardware configuration errors • Analog input module may be faulted • losse wiring	• PLC Goes into fault mode and fault LED WILL GLOW • Applicable status indicator is lit on CPU module • Wrong Reading can be show on the HMI Screen and Digital Gauges	• Loss of ability to see all the pressure of the BOP /diverter • Loss of alarm capability for pressure • Loss of logging capability of pressure values.	• Delay in well control operations • Could not see all the pressures of BOP control unit.	• Diagnose the problem in PLC program	6	7	4	168	• Verify in FAT • Verified Pressure Logic in PLC program	PLC programmer	4	3	3	36
3	FAULT	To Create a control Program for execution of fault alarm, and execute visual and	All alarms in program execution will stop.	• PLC program may be not correct	• Inability to see BOP's alarms • All alarms execution will stop	• Loss of ability to see all the alarms of the BOP /diverter • Loss of ability to see low	• Delay in well control operations • Could not	• Diagnose the problem in PLC program	5	5	4	100	• Verify in FAT • Verified Fault Logic in	PLC programmer	3	2	3	18

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		audiable on Panels		•Ethernet Cable can be short.		pressure alarms • Loss of ability to see any fault alarms	see any alarms of BOP control unit.					PLC program					
4	IP_OP	To Create a control Program for input/output logic and received signal from sensors/Pressure switches/push button, processes the information and display on remote panels	operation and feedback of four way valve Program execution will stop.	• PLC program may be not correct • Input/Output module may be faulty • losse wiring	• PLC Goes into fault mode and fault LED WILL GLOW • 4-way valve will not operate and feedback of valve position will also not execute	• 4-way valve will not operate for open/block/close • Operational Delays	• Operational inefficiency • Extended downtime • Delay in well control operations	• Diagnose the problem in PLC program	7	6	5	210	• Verify in FAT • Verified Fault Logic in PLC program • Critical spare parts are kept on hand to replace any damaged components	PLC programmer/Assembly department	3	4	4	48
5	HOOTER	To Create a control Program for BOP alarms	In the event horn for alarm in program execution will stop.In This Mode, Sounder can or Cant be stop	• PLC program may be not correct • Rung Can be Short ,Incomplete, or Wrong NO/NC Coil Selected	• Horn will not activate if any alarm appeared	• Loss of ability to hear alrm sound • Loss of alarm capability for low pressure and funcatios fail	• Operational inefficiency	• Diagnose the problem in PLC program	6	6	4	144	• Verify in FAT • Verified Alrms Logic in PLC program	PLC programmer	4	2	3	24
6	VLV_ACT	To Create a control Program for 4-way valve activation.	In the event of a module or rack loss program execution will stop.	• PLC program may be not correct • Rung Can be Short ,Incomplete, or Wrong NO/NC Coil Selected	• Execution of communication of panels will stop • It can possible that some valves operate or Not	• Loss of ability to operate the BOP RAM/diverter (via remote interface only). • Loss of sequencing timing or interlock function • Loss of alarm capability • Loss of logging capability.	• Operational inefficiency • Extended downtime • Delay in well control operations	• Diagnose the problem in PLC program	8	3	4	96	• Verify in FAT • Verified Valve Logic sequencing in PLC program	PLC programmer	5	2	3	30
7	Press	To Create a control Program for pressure execution on remote panels	Preessure Program execution stops.	• PLC program may be not correct • Hardware configuration errors • Analog output module may be faulted • losse wiring	• PLC Goes into fault mode and fault LED WILL GLOW • Applicable status indicator is lit on CPU module	• Loss of ability to see all the pressure of the BOP /diverter • Loss of alarm capability for pressure • Loss of logging capability of pressure • Pressure Values Can be Freeze on the HMI Screen or Digital Gauges	• Operational inefficiency • Loss of ability to see all the Correct pressure values on the HMI Screen	• Diagnose the problem in PLC program • Verify Hardware configuration	7	5	4	140	• Verify in FAT • Verified Pressure Logic in PLC program and hardware configuration	PLC programmer	5	3	3	45

8	VLV_RST	To Create a control Program for BOP alarms reset logic	In the event reset of alarms in program execution will stop.	• PLC program may be not correct • Rung Can be Short ,Incomplete, or Wrong NO/NC Coil Selected	• All alarms Reset execution will stop • Alarms Generate Continously/Frequentl y	• Loss of ability to reset the alarm of the BOP /diverter • User can not able to stop /identified alarms	• Operational inefficiency • Loss of ability to reset the all alarms • Horn will continues blow	• Diagnose the problem in PLC program	5	5	4	100	• Verify in FAT • Verified Pressure Logic in PLC program and hardware configuration	PLC programmer	3	3	3	27
9	INPUT	To Create a control Program for input logic and received signal from push button, processes the information and execute on master panel for 4-way valve operation	operation and of four way valve execution will stop.	• PLC program may be not correct • Input module may be faulty • losse wiring	• PLC Goes into fault mode and fault LED WILL GLOW • 4-way valve will not operate	• Loss of operation capability of 4-way valve. • Can be opertae wrong Selector Valve • Selector Valve Can be Work in Reverse direction.	• Operational inefficiency • Extended downtime • Delay in well control operations	• Diagnose the problem in PLC program • Verify Hardware configuration	7	4	5	140	• Verify in FAT • Verify PLC program in INPUT block • Verify Input and module hardware • Critical spare parts are kept on hand to replace any damaged components	PLC programmer	3	2	3	18
10	OUTPUT	To Create a control Program for output logic and received signal from master control panel of 4-way valves and alarm status	Feedback of four way valve execution will stop.	• PLC program may be not correct • Output module may be faulty • losse wiring	• PLC Goes into fault mode and fault LED WILL GLOW • Feedback of 4-way valve position will also not execute	• Loss of capability to see the position of 4-way valve • Can be operate wrong Selector Valve or Regulator, Selector Valve / Regulator Can be Work in Reverse direction • This Can be Possibe the Wrong Selector Valve Feedback and alarms appear on the Remotes Panels	• Operational inefficiency • Loss of ability to see 4-way valve position,alarms • Delay in well control operations	• Diagnose the problem in PLC program • Verify Hardware configuration	7	4	5	140	• Verify in FAT • Verify PLC program in INPUT block • Verify Outputt and module hardware • Critical spare parts are kept on hand to replace any damaged components	PLC programmer	3	2	3	18

11	VLV_CON	To Create a control Program for bop 4-way valve configuration	In the event program execution will stop.In this Mode, Execution of communication rung stop	● PLC program may be not correct● Rung Can be Short ,Incomplete, or Wrong NO/NC Coil Selected	● Impaired BOP functionality● Inability to operate 4-way valve from remote panels● Lack of 4-way valve status visibility●Inability to detect BOP alarms● Execution of communication of panels will stop	● Loss of operation capability of 4-way valve.● Loss of capability to see the position of 4-way valve● Loss of sequencing timing or interlock function; loss of alarm capability● Loss of logging capability.● Pressure Values Can be Freeze on the HMI Screen or digital gauges● Alarms Generate Continously/Frequently●User can not able to stop /identified alarms Data Communication Between Panels Breaks	● Operational inefficiency● Loss of operation capability of 4-way valve.● Loss of capability to see the position of 4-way valve position,alarms ● Delay in well control operations	● Diagnose the problem in PLC program	8	6	4	192	● Verify in FAT● Verify in PLC program in VLV_ACT block	PLC programmer	5	4	3	60

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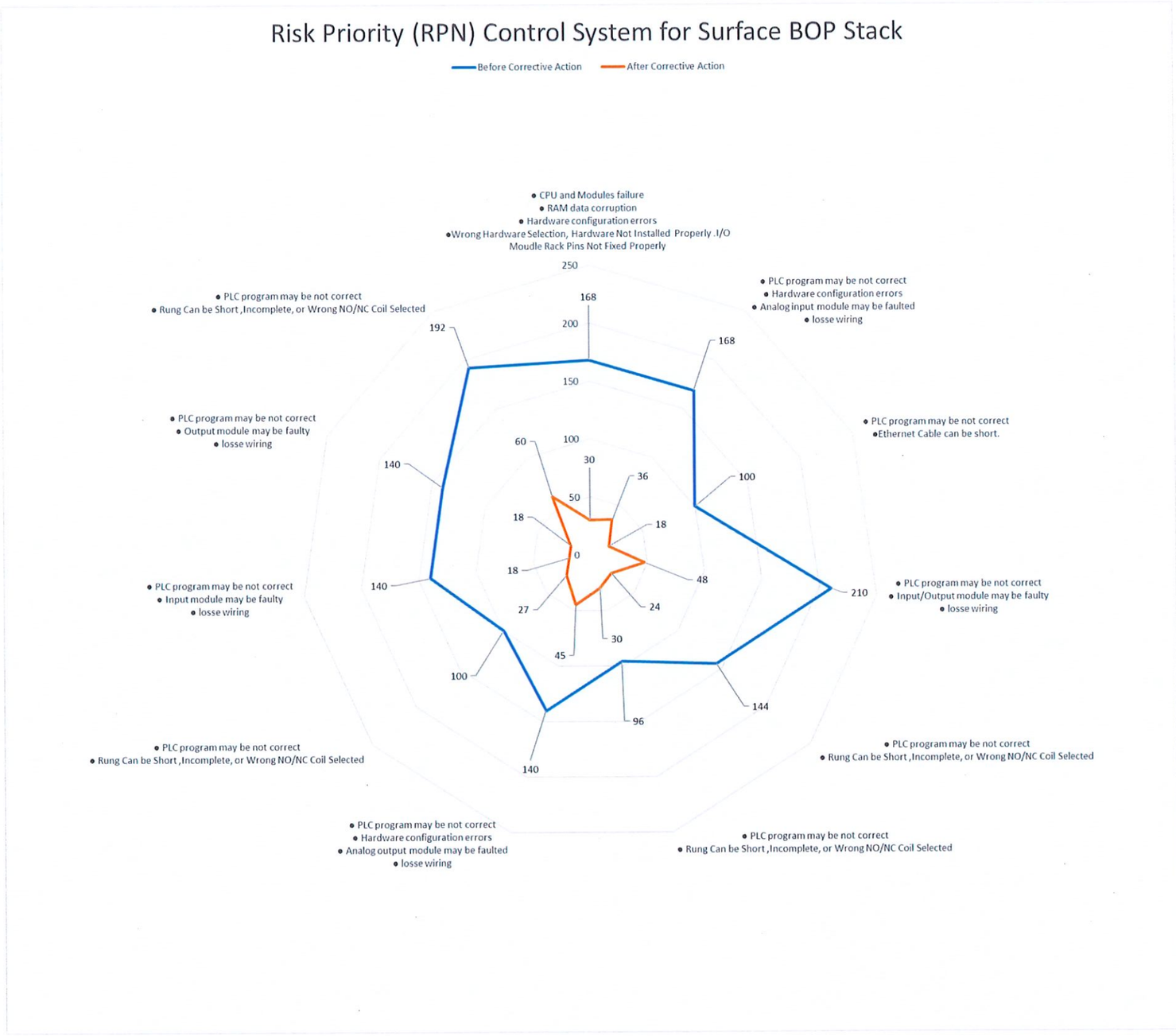
		Before Corrective Action	After Corrective Action
1	● CPU and Modules failure ● RAM data corruption ● Hardware configuration errors ●Wrong Hardware Selection, Hardware Not Installed Properly .I/O Moudle Rack Pins Not Fixed Properly	168	30
2	● PLC program may be not correct ● Hardware configuration errors ● Analog input module may be faulted ● losse wiring	168	36
3	● PLC program may be not correct ●Ethernet Cable can be short.	100	18
4	● PLC program may be not correct ● Input/Output module may be faulty ● losse wiring	210	48
5	● PLC program may be not correct ● Rung Can be Short ,Incomplete, or Wrong NO/NC Coil Selected	144	24
6	● PLC program may be not correct ● Rung Can be Short ,Incomplete, or Wrong NO/NC Coil Selected	96	30
7	● PLC program may be not correct ● Hardware configuration errors ● Analog output module may be faulted ● losse wiring	140	45
8	● PLC program may be not correct ● Rung Can be Short ,Incomplete, or Wrong NO/NC Coil Selected	100	27



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9	• PLC program may be not correct • Input module may be faulty • losse wiring	140	18
10	• PLC program may be not correct • Output module may be faulty • losse wiring	140	18
11	• PLC program may be not correct • Rung Can be Short ,Incomplete, or Wrong NO/NC Coil Selected	192	60

CONSOLIDATED PRESSURE CONTROL

FAILURE MODE EFFECTIVE ANALYSIS (FMEA)
(According to IEC 60812)

DATE:-

PO. NO:-

D.D NO:-

HARDWARE (REMOTE PANEL)

Before Corrective Action													After Corrective Action					
S.No.	Items/ function	Design Intentions	Potential mode of Failure	Cause of failure	Local Effects	System Effects	Global Effects	Corrective / Recommended Action	Severity	Detection	Probability Of Occurance	Risk Priority Number (RPN)	Current Control	Responsibility	Severity	Detection	Occurance	Risk Priority Number (RPN)
1	Proximity Sensor	Feedback of 4-way valve position.	Feedback of four way valve execution will stop.	• Proximity Sensor may be faulty • connection loose between proximity Sensor to amplifier • Disc detaint pointer may not come within sensor range	• Inability to detect position of 4-way valves • Loss of local Monitoring	• Loss of capability to see the position of 4-way valve. • Degraded efficiency	• Delay in well control operations • Legal and Regulatory Consequences	• Replace the Faulty Proximity Sensor • Upgrade Sensor system • Inspect the wiring and connections • Cunduct routine inspections • Adjustment disc detaint pointer	7	3	4	84	• Verified in FAT • Use Quality products • Experienced workers will do the Assembly and connections	Assembly department.	5	2	3	30
2	Solenoid valve	Operation of 4-way valves (Open/Block/Close)	Operation of 4-way valve will stop from Driller/Tool pusher panels	• Solenoid valve may be faullty • connection loose between Solenoid valve to PLC modules	• Inability to operate 4-way valves • Operational disruptions • Impaired BOP functionality	• Loss of well control system functionality • Increased downtime for unplanned repairs	• Delay in well control operations • increased risk of blowout • In case of failure solenoid valve will not be able to operate BOP rams open/close	• Immediately replace the faulty component • Inspect the wiring and connections • Check the air filter of solenoid valve input line	7	5	4	140	• Verified in FAT • Use Quality products • Circuit protection, Testing • Spare part list	Assembly department.	4	2	3	24
3	Push button	Giving Signal to operate 4-way valve funcations (Open/Block/Close)	Inability to Activate BOP Functions from remote control pnaels	• Pushbutton may be faulty • connection loose between push button to PLC modules • Faulty Actuation mechanism	• Partial or complete failure of specific BOP functions. • Operational disruptions	• 4-way valve will not operate for open/block/close • Operational Delays	• Operational inefficiency • Extended downtime	• Immediately replace the faulty component • Inspect the wiring and connections	7	5	4	140	• Verified in FAT • Item must be in stock. • Party recommended spare part list.	Assembly department.	3	2	3	18
4	Pilot light	Indicates the 4-way valve positions either open,block or close	Inability to see 4-way valve position on remote control panels (open/block/close)	• Pilot light may be faulty • connection loose between pilot light to PLC modules • LED may be burned	• Inability to detect 4-way valve positions • Operational disruptions	• Loss of well control system functionality • Increased downtime for unplanned repairs	• Compromised well control • degraded efficiency • missed preventive maintenance triggers	• Immediately replace the faulty component • Inspect the wiring and connections	7	3	4	84	• Verified in FAT • Item must be in stock. • Party recommended spare part list.	Assembly department.	5	2	3	30

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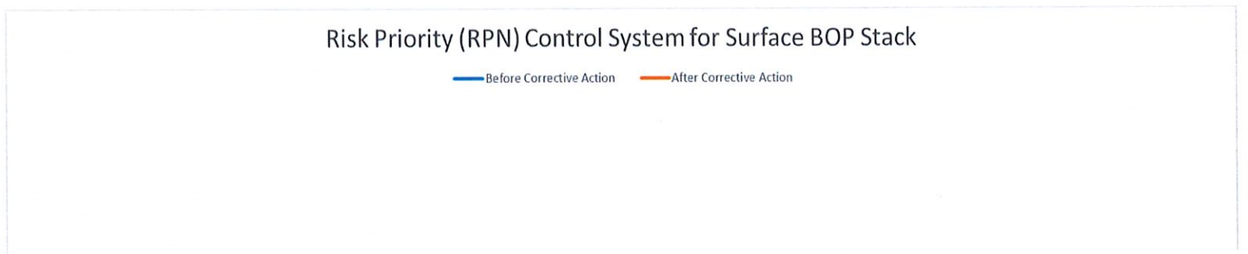
5	Digital Gauge	Receive electrical signal from Transducer and diplayed as a digital reading on the gauge's screen	Inability to see pressure reading on remote control panels	• Digital Gauge may be faulty • Loose wiring • Excessive vibration • Extreme Temerature	• Inability to see pressure reading • Localized failure of BOP operations • Operational disruptions	• Loss of well control system functionality • Undetected failure leading to cascading system issues • Reduced safety margins	• Safety and Well Control Risks • Operational Delays and Loss of Revenue	• Immediately replace the faulty component • Inspect the wiring and connections • perform system pressure test • Verify pressure readings on digital gauges	7	4	4	112	• Verified in FAT • Proper surging to reduce vibrations • Use quality product • Party recommended spare part list.	Assembly department.	4	2	3	24
6	Amplifier	Low signal received from sensors and give to plc modules with amplify signal.	Feedback of four way valve execution will stop.	• Proximity Sensor may be faulty • connection loose between proximity Sensor to amplifier • Amplifier may be faulty	• Inability to detect position of 4-way valves • Loss of local Monitoring	• Loss of capability to see the position of 4-way valve. • Degraded efficiency	• Delay in well control operations • Legal and Regulatory Consequences	• Replace the Faulty • Inspect the wiring and connections • Cunduct routine inspections • Verify the input voltage	7	3	4	84	• Verified in FAT • Use Quality products • Experienced workers will do the Assembly and connections • Party recommended spare part list.	Assembly department.	5	2	3	30
7	Pressure Swtich	Feedback of 4-way valve position.	Feedback of four way valve execution will stop.	• Pressure switch may be faulty • Wiring fault or loose connections • Sunbber oil may be jammed • Adjustment wheel may be not set properly	• Inability to detect position of 4-way valves • Loss of local Monitoring	• Loss of capability to see the position of 4-way valve. • Degraded efficiency	• Delay in well control operations • Legal and Regulatory Consequences	• Replace the Faulty Pressure switch • inspect and clean sanubber oil • Inspect the wiring and connections • Cunduct routine inspections • Adjustment pressure switch wheel	7	4	4	112	• Verified in FAT • Use Quality products • Experienced workers will do the Assembly and connections	Assembly department.	4	2	3	24
8	Pressure Transducer	Convert pressure into an electrical signal and diplayed as a digital reading on the gauge's screen	Inability to see pressure reading on remote control panels	• Pressure transducer may be faulty• Loose wiring• Sunbber oil may be jammed	• Inability to see pressure reading on remote panels• Localized failure of BOP operations• Operational disruptions	• Loss of well control system functionality• Undetected failure leading to cascading system issues• Reduced safety margins	• Safety and Well Control Risks• Operational Delays and Loss of Revenue	• Immediately replace the faulty component• Inspect the wiring and connections• perform system pressure test• Verify pressure readings on digital gauges• inspect and clean sanubber oil	7	4	4	112	• Verified in FAT • Use quality product • Critical spare parts are kept on hand to replace any damaged components	Assembly department.	4	2	3	24
9	Purge	To prevent explosion in hazardous areas by continuosly removing potentially flammable gases from the system	Reduced system readiness and safety	• Purge may be faulty • Air supply failure • Insufficiant air supply	• Flamable Gases Can be enter inside the Panels. • Short circuit or PLC System can be Burn or Failure	• Degraded efficiency • BOP control system failure	• Safety and Well Control Risks • Regulatory and Legal Consequences	• Repair or Replace Faulty Components • Compressor with sufficient air supply	5	3	4	60	• Critical spare parts are kept on hand to replace any damaged components	Assembly department.	3	2	3	18

10	PLC CPU and it's module	Receives input signal from sensors/Pressure switches/push button, processes the information and control devices	Inability to Activate BOP Functions form remote control panels and monitor 4-way valve position, pressure readings, alarms	• Frequent power outage or fluctuations • Input/Output (I/O) module disconnected between CPU • Communication Break • Connection loose between PLC modules • PLC CPU and it's module may be faulty	• Complete failure of BOP functions. • Operational disruptions • Personnel injuries or fatalities • Evacuation delays • Inability to operate 4-way valves • Inability to detect position of 4-way valves • Loss of local Monitoring	• Loss of well control system functionality • 4-way valve will not operate for open/block/close • Operational Delays • Loss of capability to see the position of 4-way valve. • Communication Breakdown of Valves Remote operation, Alarm & indication.	• Blowout Risk • Operational Delays and Financial Loss • Regulatory Compliance Issues	•Immediate Diagnosis • Repair or Replace Faulty Components • Check Communication Links • Power Supply Inspection • Inspect the wiring and connections • Cunduct routine inspections	8	2	4	64	• Verified in FAT • Simulate the failure condition & check the redundant working of both panel. • Software valiation to be verified • Experienced workers will do the Assembly and connections • Party recommended spare part list.	PLC programmer/Assembly department.	5	1	3	15



		Before Corrective Action	After Corrective Action
1	• Proximity Sensor may be faulty • connection loose between proximity Sensor to amplifier • Disc detaint pointer may not come within sensor range	84	30
2	• Solenoid valve may be faullty • connection loose between Solenoid valve to PLC modules	140	24
3	• Pushbutton may be faulty • connection loose between push button to PLC modules • Faulty Actuation mechanism	140	18
4	• Pilot light may be faulty • connection loose between pilot light to PLC modules • LED may be burned	84	30
5	• Digital Gauge may be faulty • Loose wiring • Excessive vibration • Extreme Temerature	112	24
6	• Proximity Sensor may be faulty • connection loose between proximity Sensor to amplifier • Amplifier may be faulty	84	30

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7	• Pressure switch may be faulty • Wiring fault or loose connections • Sunbber oil may be jammed • Adjustment wheel may be not set properly	112	24
8	• Pressure transducer may be faulty • Loose wiring • Sunbber oil may be jammed	112	24
9	• Purge may be faulty • Air supply failure • Insufficiant air supply	60	18
10	• Frequent power outage or fluctuations• Input/Output (I/O) module disconnected between CPU• Communication Break• Connection loose between PLC modules• PLC CPU and it's module may be faulty	64	15

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