3 CASE STUDY: DEVELOPMENT RCM ON COLD BRINE INJECTION SYSTEM

3.1 PLANT OVERVIEW

Development of northern cold brine injection system is mean to accommodate brine which production from separation process of well production at PAD 7 and PAD 29. In the PAD 7 use three pump consist of one horizontal pump(deep blue) and two vertical pump (VA and VB). While at PAD 29 use three horizontal pump consist of SC, DB-1, and DB-2. Configuration of piping line from each brine injection system which originated from PAD 7 and PAD 29 can be viewed from Fig.27 and Fig.28.

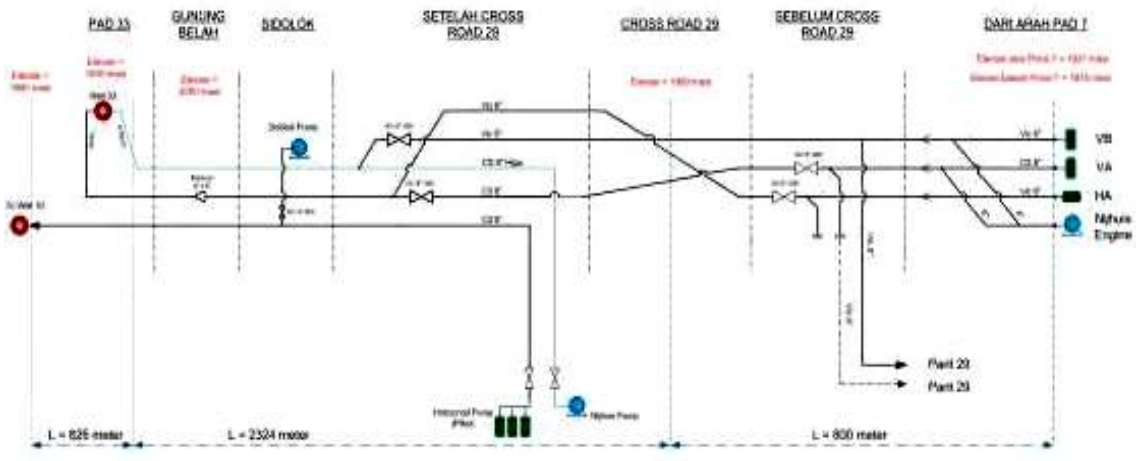

Fig 27 Brine Lay Out

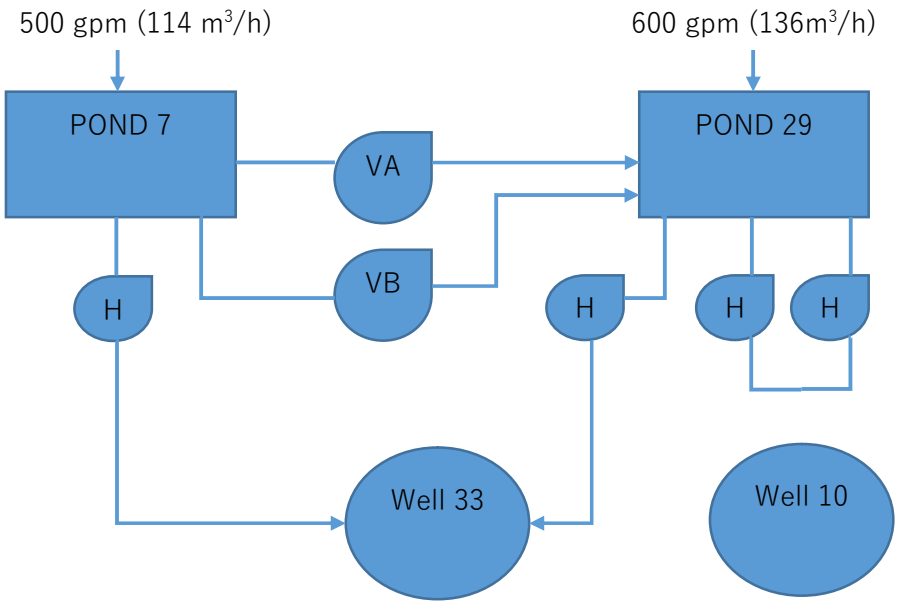

Fig.28 Configuration of Cold Brine Injection System

Data of production well can be viewed from Table 3, data *pond* from Table 4 below.

Table 3 Production Well

Well Name	Load Assumptions (MW)	WHP (psi.g)	Brine (gpm)
HCE-7B	3	450	200
HCE-7C	15	455	650
HCE-29	3	407	150
HCE-29A	4	661	200

Table 4 Data of Pond

Pond Name	Capacity (m^3)
Pond PAD 7	5400
Pond PAD 29	8200

3.2 System Boundary Definition

Main Component:

1. Canal System
2. Pond at PAD 7 and PAD 29
3. Pump
4. Piping
5. Power Line

Main Physic Boundary

Start from:

- Brine to the canal
- Electricity to the pump

End with:

- Brine enter to injection well
- Silica sludge dredged and is carded

Table 5 Boundary Overview

Type	*Bounding System*	*Interface Location*	*Reference*
In	Hot Brine	Brine from Silencer enter to pond via canal	P&ID
In	AC Power Supply	Electric Motor	P&ID
Out	Cold Brine	Cold Brine enter to injection well via piping	P&ID
Out	Silica Scaling	Silica Sludge dredged via canal	P&ID

Canal:

Trench serves to drain the brine out of Silencer heading to the pond. In the trenches temperature decreases will lead to silica easier to settle so expect a silica content as brine enter the pond is already much lower.

Pond:

Pond serves to accommodate provisional brine that will be injected into the injection wells. At the pond is also expected silica deposition process so that the amount of silica that is flowing through the pipe leading to the injection wells have been even lower. Capacity pond at PAD 7 is 5200 m^3, while the capacity of PAD pond at 29 is 8400 m^3.

Pump:

Pump function provides the necessary head to overcome the head of the piping system so that the target can be achieved the desired discharge.

Piping:

Piping line of northern brine injection system cover of,

1. Pond 7 – Reinjection well 33
2. Pond 29 – Reinjection well 33
3. Pond 29 – Reinjection well 10
4. Pump VA – Canal 29
5. Pump VB – Canal 29

Power Line:

Electricity networkwhich used from the PLN with 380 Volt of voltage, 3 phase and 50 Hz of Frequency.

3.3 FUNCTIONAL BLOCK DIAGRAM

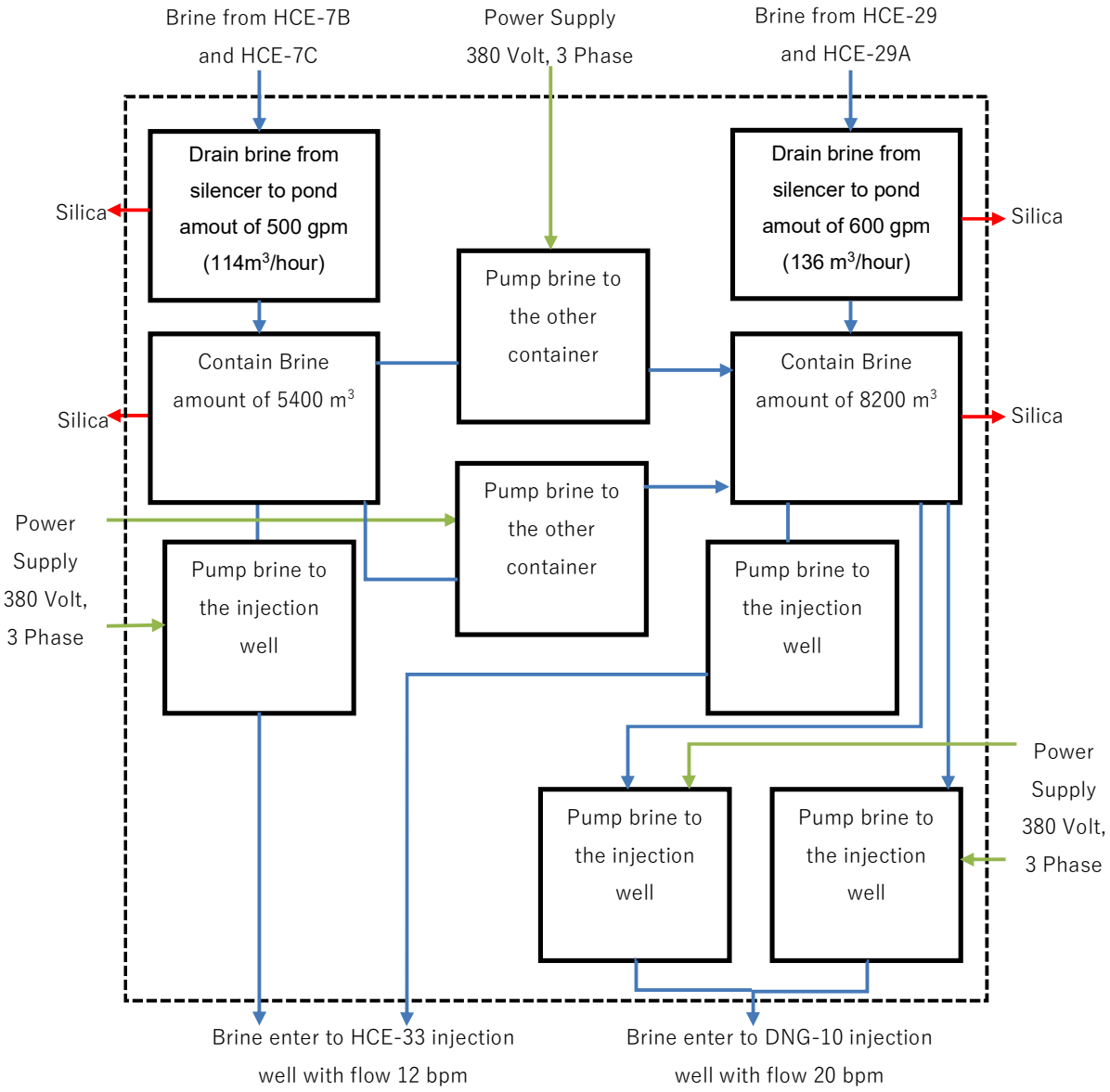

Fig.29 FBD Brine Injection System

3.4 ASSET BLOCK DIAGRAM

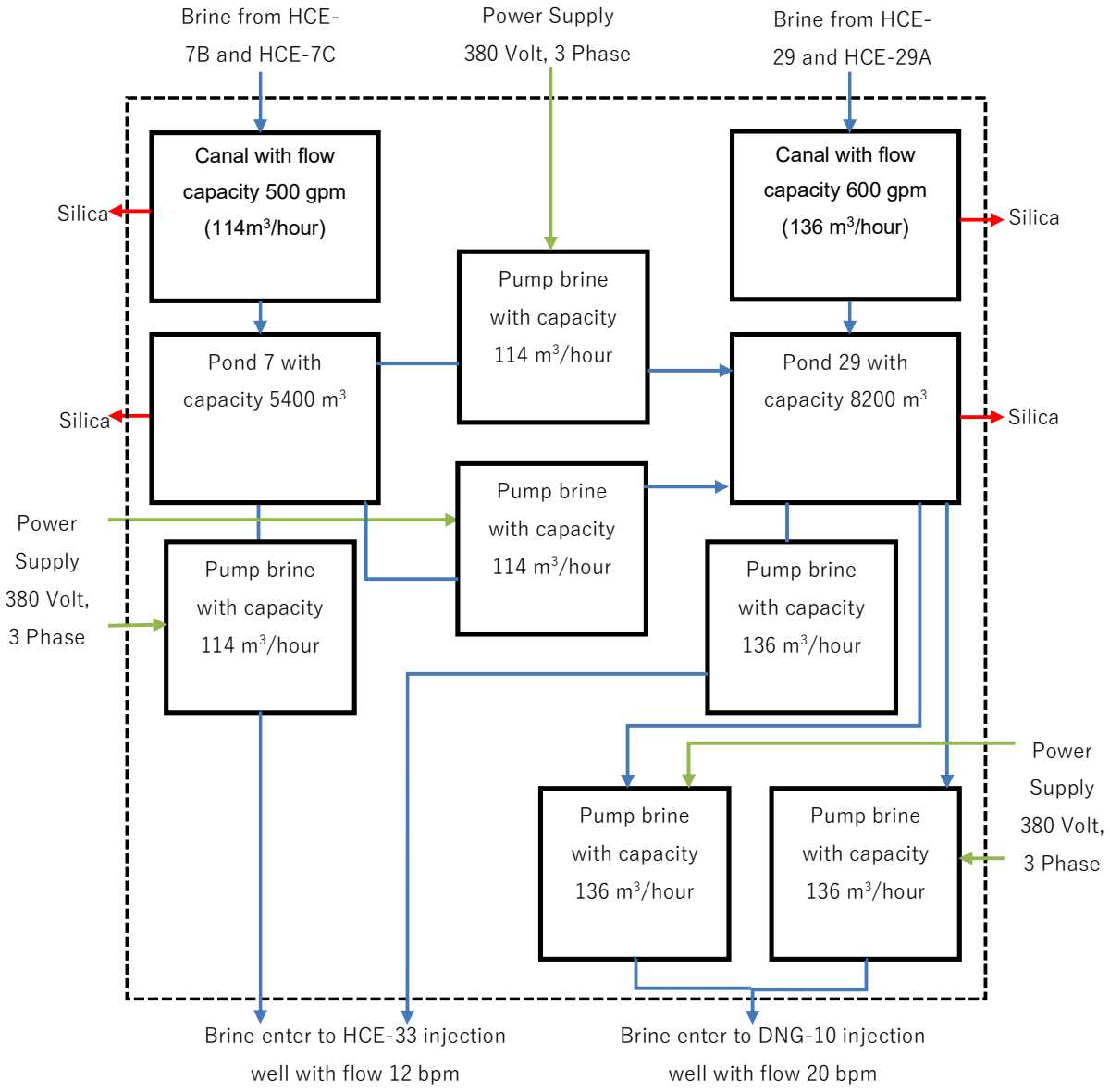

Fig.30 ABD Brine Injection System

3.5 FUNCTIONAL FAILURE AND FUNCTION

Table 6 Functional Failure and Function

No.	ID#	ASET NAME	FUNCTION (F)		Failure Mode	
1	A1	Electric motor	1.1	Pump rotate at 1450 rpm rotation	1.1.1	Motor fails to start / spin
					1.1.2	Motor fails to reach speeds
					1.1.3	Motor too hot
					1.1.4	Motor vibrates
					1.1.5	Motor too noisy
2	A2	Horizontal pump	2.1	Produce brine discharge of 114 m^3/hour	2.1.1	Pump does not rotate
					2.1.2	Pump rotating but no running water
					2.1.3	Reduced capacity
					2.1.4	Motor overload
					2.1.5	Vibrating pump redundant and noisy
					2.1.6	Excess wear
					2.1.7	Corrosion / rust
3	A3	Canal PAD 7	3.1	rain brine from the silencer to the pond with a capacity of 114 m^3/hour	3.1.1	Siltation due to scalling silica
4	A4	Canal PAD 29	4.1	Drain brine from the silencer to the pond with a capacity of 136 m^3/hour	4.1.1	Siltation due to scalling silica
5	A5	POND 7	5.1	Floats brine with a capacity of5400 m^3	5.1.1	Overflowing due to a broken pump
					5.1.2	Leak
6	A6	Pond 29	6.1	Accommodate brine with a capacity of8200 m^3	6.1.1	Overflowing due to a broken pump
					6.1.2	Leak
7	A7	Piping	7.1	Drain the brine with a capacity of 114 m^3/hour	7.1.1	Reduced capacity

3.6 FAILURE MODE AND EFFECT

Table 7 Failure Mode and Effect Analysis

No	Asset name	Failure Mode		Failure cause		Failure effect		
-	-	-	-	-	-	Local	Injection system	Brine system
1	Electric motor	1.1.1	Motor fails to start/spin	1.1.1.1	The power supply is not perfect or damaged	Motor cannot be start	Brine injection fails	Brine meluap
				1.1.1.2	The main fuse broken or old			
				1.1.1.3	A second fuse broken or old			
				1.1.1.4	Open the control circuit			
				1.1.1.5	Overload trip sare open			
				1.1.1.6	Coil magnetic switch is damaged			
				1.1.1.7	Connections			

					loose or lax control circuit			
				1.1.1.8	Magnetic buttons loose			
				1.1.1.9	Contact Button weak			
				1.1.1.10	Open circuit in control panel			
				1.1.1.11	Cable to the motor regardless			
				1.1.1.12	Cables connected imperfect			
		1.1.2	Motor fails to reach speed	1.1.2.1	Voltage is weak or does not match	Pump rotate slowly	Less injection brine	Overflowing brine
				1.1.2.2	Improper connection to the motor			
				1.1.2.3	Overload - mechanical			
				1.1.2.4	Overload-hydraulic			
		1.1.3	motor overheat	1.1.3.1	The air vents are not enough	Motor was burned	Less injection brine	Overflowing brine
				1.1.3.2	overload			
				1.1.3.3	Supply voltage is not balanced			
		1.1.4	Motor vibrates	1.1.4.1	shaft misalignment	Motor is damaged	Less injection brine	Overflowing brine
				1.1.4.2	Bent shaft or bearing damaged			
				1.1.4.3	Hydraulic disturbances in the discharge pipe			
		1.1.5	Motor too noisy	1.1.5.1	Bearing wear axial	Motor is damaged	Less injection brine	Overflowing brine
				1.1.5.2	electrical noise			
2	pompa	2.1.1	Pump doesnot rotate	2.1.1.1	Open contactor overload protection: a. one contract controls, b. wrong connections, c. wrong signal overload, d. low voltage, e. the ambient temperature of the control box or starter box is too high	Motor was burned	Less injection brine	Overflowing brine
				2.1.1.2	Damaged or			

					missing electrical connector			
				2.1.1.3	Motor imperfect or flawed			
				2.1.1.4	Error			
				2.1.1.5	error button			
				2.1.1.6	pump locked			
		2.1.2	Pump rotating but no running water	2.1.2.1	Checkvalve reversed	Pump too hot	Less injection brine	Overflowing brine
				2.1.2.2	Checkvalve deadlock			
				2.1.2.3	Round pump reverse			
				2.1.2.4	The load is too great for pumps			
				2.1.2.5	The pump is not submerged			
				2.1.2.6	Too much air or gas			
				2.1.2.7	Enclosed inlet strainer or pumping mud or sand			
				2.1.2.8	There impeller slack			
		2.1.3	Reduced capacity	2.1.3.1	Bypass valve open	Pump is damaged	Less injection brine	Overflowing brine
				2.1.3.2	Power lift is too high for the pump			
				2.1.3.3	The motor does not reach speeds			
				2.1.3.4	Starter or partially closed impeller			
				2.1.3.5	Corroded or leaking pipes			
				2.1.3.6	Excess air or gas			
				2.1.3.7	Wear and tear due to the abrasive			
				2.1.3.8	Impeller is not set correctly			
				2.1.3.9	impeller loose			
		2.1.4	Motor overload	2.1.4.1	Input voltage is not appropriate	Motor is damaged	Less injection brine	Overflowing brine
				2.1.4.2	One measuring instrument			
				2.1.4.3	Gravity is too high compared to the design			
				2.1.4.4	Operation at point on pump			

					curve other than design			
				2.1.4.5	Motor speed is too high			
				2.1.4.6	impeller swipe			
				2.1.4.7	pump locked			
		2.1.5	Vibrating pump redundant and noisy	2.1.5.1	Unit run counter	Motor trip	Less injection brine	Overflowing brine
				2.1.5.2	Broken pump suction pipe and pump air			
				2.1.5.3	loose fasteners			
				2.1.5.4	Bearing the motor or pump is damaged			
				2.1.5.5	impeller loose			
				2.1.5.6	Misaligment shaft pumps and large motors			
				2.1.5.7	Misalignement pipe			
				2.1.5.8	shaft fracture			
		2.1.6	excesswear	2.1.6.1	Conceded abrasive	Pump performance down	Less injection brine	Overflowing brine
				2.1.6.2	Pumping coarse grain			
				2.1.6.3	Vibration			
		2.1.7	Corrotion	2.1.7.1	Dirt	Pump performance down	Less injection brine	Overflowing brine
				2.1.7.2	Corrosive fluid			
		2.1.8	Pump is leaked	2.1.8.1	Packing is leak	Pump performance down	Less injection brine	Overflowing brine
				2.1.8.2	Mechanical seal is leak			
3	Canal pad 7	3.1	Siltation	3.1.1	Scalling silica	Brine flow without direction	Less injection brine	Overflowing brine
4	Canal pad 29	4.1	Siltation	4.1.1	Scalling silica	Brine flow without direction	Less injection brine	Overflowing brine
5	Pond 7	5.1	Siltation	5.1.1	Scalling silica	overflow	Less injection brine	Reduce production
		5.2	Leak	5.2.1	Leak	Less	Less injection brine	Contamination
6	Pond 29	6.1	Siltation	6.1.1	Scalling silica	Overflow	Less injection brine	Reduce production
		6.2	Leak	6.2.1	Leak	Overflow	Less injection brine	Contamination
7	Pipa	7.1	Reduced capacity	7.1.1	Scalling silica	Flow capacity down	Less injection brine	Overflowing brine

3.7 CRITICAL ANALYSIS

Table 8 Critical analysis

No	Asset Name	Failure mode		Critical analysis			
				Visual definitely	Safety	Outage	Category
1	Vertical motor	1.1.1	Motor fails to start/spin	Y	N	Y	B
		1.1.2	Motor fails to reach velocity standart	Y	N	Y	B
		1.1.3	Motor too hot	Y	N	Y	B
		1.1.4	Motor vibrates	Y	N	Y	B
		1.1.5	Motor too noisy	Y	N	Y	B
2	Process and booster can type pumps	2.1.1	Pump can be rotating	Y	N	Y	B
		2.1.2	Pump rotating but no running water	Y	N	Y	B
		2.1.3	Reduced capacity	Y	N	Y	B
		2.1.4	Motor overload	Y	N	Y	B
		2.1.5	Motor a lot of vibration & too noisy	Y	N	Y	B
		2.1.6	Excessive wear	N	N	Y	B
		2.1.7	Corrosion	N	N	Y	B
		2.1.8	Pump is leak	Y	N	Y	B
3	Canal pad 7	3.1	Siltation	Y	N	Y	B
4	Canal pad 29	4.1	Siltation	Y	N	Y	B
5	Pond 7	5.1	Siltation	Y	N	Y	B
		5.2	Leak	Y	Y	Y	S
6	Pond 29	6.1	Siltation	Y	N	Y	B
		6.2	Leak	Y	Y	Y	S
7	Pipa	7.1	Reduced Capacity	Y	N	Y	B

3.8 Task Selection

Table 3.7 Task Selection

No	Asset Name	Type of Failure		Failure Mode		Optional Guide							Candidate Task	Est Freq.
						1	2	3	4	5	6	7		
1	Electrical motor	1.1	Motor failure to start/spin	1.1.1	The power supply is not perfect or damaged	N	N	N	Y	Y	Y	N	Check the Voltage before fuse	Before Start
				1.1.2	The main fuse broken or old	N	N	N	Y	Y	Y	N	Check the voltage	Before Start
				1.1.3	A second fuse broken or old	N	N	N	Y	Y	Y	N	Check the voltage	Before Start
				1.1.4	Open the control circuit	N	N	N	Y	Y	Y	N	Push reset button	Before Start
				1.1.5	Overload trip sare open	N	N	N	Y	Y	Y	N	Push reset button	Before Start
				1.1.6	Coil magnetic switch is damaged	N	N	N	Y	Y	Y	N	Failure finding	Before Start
				1.1.7	Connections loose or lax control circuit	N	N	N	Y	Y	Y	N	Visual inspection	Before Start
				1.1.8	Magnetic buttons loose	N	N	N	Y	Y	Y	N	Failure finding	Before Start
				1.1.9	Contact Button weak	N	N	N	Y	Y	Y	N	Failure finding	Before Start
				1.1.10	Open circuit in control panel	N	N	N	Y	Y	Y	N	Failure finding	Before Start
				1.1.11	Cable to the motor regardless	N	N	N	Y	Y	Y	N	Failure finding	Before Start
				1.1.12	Cables connected imperfect	N	N	N	Y	Y	Y	N	Failure finding	Before Start
		1.2	the motor failed to achieve the expected speed	1.2.1	Voltage is weak or does not match	N	N	N	Y	Y	Y	N	Check the voltage	Before Start
				1.2.2	Improper connection to the motor	N	N	N	N	-	N	N	Check the cable	Before Start
				1.2.3	Overload - mechanical	N	N	N	N	-	N	N	Check the impeller setting	Before Start
				1.2.4	Overload-hydraulic	N	N	N	N	-	N	N	Check the impeller setting	Before Start
		1.3	Motor too hot	1.3.1	The air vents are not enough	N	N	N	N	-	N	Y	Failure finding	On condition
				1.3.2	overload	N	N	N	N	-	N	N	Check the electric current	On condition
				1.3.3	Supply voltage is not balanced	N	N	N	Y	Y	Y	N	Check the voltage	On condition
		1.4	Motor vibrates	1.4.1	shaft misalignment	N	N	Y	N	-	Y	N	Check the alignment	On condition
				1.4.2	Bent shaft or bearing damaged	N	N	Y	N	-	Y	N	Vibration analysis	On condition
				1.4.3	Hydraulic disturbances in the discharge pipe	N	N	N	N	-	N	N	Check the connection of discharge pipe	On condition
		1.5	Motor too noisy	1.5.1	Bearing wear axial	N	N	Y	N	-	Y	N	Check the vibration	On condition
				1.5.2	electrical noise	N	N	Y	N	-	Y	N	Check the vibration	On condition

2	Pompa	2.1	Pump does not rotate	2.1.1	Open contactor overload protection: a. one contract controls, b. wrong connections, c. wrong signal overload, d. low voltage, e. the ambient temperature of the control box or starter box is too high	N	N	N	N	-	N	N	a. Check the name plate b. Check wiring diagram c. Change d. Check the voltage e. Check the ventilation	On condition
				2.1.2	Damaged or missing electrical connector	N	N	N	N	-	N	N	Check the safety fuse	On condition
				2.1.3	Motor imperfect or flawed	N	N	N	Y	Y	N	N	Maintenance	On condition
				2.1.4	Error	N	N	N	Y	Y	N	N	Check the circuit	On condition
				2.1.5	error button	N	N	N	Y	Y	N	Y	Change the material	On condition
				2.1.6	pump locked	N	N	N	Y	Y	Y	N	Visual inspection	On condition
				2.1.7	Checkvalve reversed	N	Y	N	N	N	Y	Y	Visual inspection	On condition
				2.1.8	Checkvalve deadlock	N	N	Y	N	N	Y	N	Visual inspection	On condition
		2.2	Pump rotating but no running water	2.2.1	Round pump reverse	N	N	N	N	-	N	N	Visual inspection	On condition
				2.2.2	The load is too great for pumps	N	N	N	Y	N	N	N	Visual inspection	On condition
				2.2.3	The pump is not submerged	N	N	N	N	-	N	N	Visual inspection	On condition
				2.2.4	Too much air or gas	N	N	N	N	-	N	N	Check pump performance	On condition
				2.2.5	Enclosed inlet strainer or pumping mud or sand	N	N	N	N	-	N	Y	Visual inspection	On condition
				2.2.6	There impeller slack	N	N	N	Y	N	N	N	Maintenance	On condition
				2.2.7	Open contactor overload protection: a. one contract controls, b. wrong connections, c. wrong signal overload, d. low voltage, e. the ambient temperature of the control box or starter box is too high	N	Y	N	Y	Y	Y	Y	Clean up	On condition
				2.2.8	Damaged or missing electrical connector	N	N	N	Y	N	N	N	Maintenance	On condition
		2.3	Reduced capacity	2.3.1	Bypass valve open	N	N	N	Y	Y	N	N	Check bypass valve	On condition
				2.3.2	Power lift is too high for the pump	N	N	N	Y	N	N	N	Check pump performnce	On condition
				2.3.3	The motor does not reach speeds	N	N	N	N	-	N	N	Check the voltage	On condition

				2.3.4	Starter or partially closed impeller	N	N	N	Y	N	N	N	Turn off and turn on	On condition
				2.3.5	Corroded or leaking pipes	N	Y	N	Y	N	Y	Y	Change material	On condition
				2.3.6	Excess air or gas	N	N	N	Y	N	N	N	Maintenance	On condition
				2.3.7	Wear and tear due to the abrasive	N	Y	N	Y	N	N	N	Change	On condition
				2.3.8	Impeller is not set correctly	N	N	N	Y	N	N	N	Disassembly and reset	On condition
				2.3.9	impeller loose	N	N	N	Y	N	N	N	Disassembly and reset	On condition
		2.4	Motor overload	2.4.1	Input voltage is not appropriate	N	N	N	Y	Y	Y	N	Check	On condition
				2.4.2	One measuring instrument	N	N	N	Y	Y	N	N	Check measureing instrument	On condition
				2.4.3	Gravity is too high compared to the design	N	N	N	Y	Y	N	N	Check spesific gravity	On condition
				2.4.4	Operation at point on pump curve other than design	N	N	N	Y	Y	N	N	Check pump performance	On condition
				2.4.5	Motor speed is too high	N	N	Y	Y	Y	Y	N	Check the voltage	On condition
				2.4.6	impeller swipe	N	N	Y	Y	Y	N	N	Resetting	On condition
				2.4.7	pump locked	N	N	N	Y	Y	Y	N	Disassembly and reset	On condition
		2.5	Vibrating pump redundant and noisy	2.5.1	Unit run counter	N	N	N	N	-	N	N	Check cable connection	On condition
				2.5.2	Broken pump suction pipe and pump air	N	N	N	Y	Y	N	N	Visual inspection	On condition
				2.5.3	loose fasteners	N	N	N	N	-	N	N	Visual inspection	On condition
				2.5.4	Bearing the motor or pump is damaged	N	N	Y	N	-	Y	N	Vibration analysis	On condition
				2.5.5	impeller loose	N	N	N	Y	Y	N	N	Resetting	On condition
				2.5.6	Misaligment shaft pumps and large motors	N	N	Y	Y	Y	Y	N	Vibration analysis	On condition
				2.5.7	Misalignement pipe	N	N	Y	Y	Y	N	Y	Modification	On condition
				2.5.8	shaft fracture	N	N	Y	N	N	N	Y	Change the material	Modificati on
		2.6	excessive wear	2.6.1	Conceded abrasive	N	N	N	Y	Y	N	N	Filtering	On condition
				2.6.2	Pumping coarse grain	N	N	N	Y	Y	N	N	Check the fluid	On condition
				2.6.3	Vibration	N	N	Y	Y	Y	Y	N	Vibration analysis	On condition
		2.7	Corrosion	2.7.1	Dirt	N	N	N	Y	Y	N	Y	Filtering	On condition
				2.7.2	Bypass valve open	N	N	N	N	-	N	Y	Change the material	Modificati on
3	Canal pad 7	3.1	Siltation	3.1.1	Scalling silica	N	Y	N	N	N	Y	Y	Dump scalling	50 days
4	Canal pad 29	4.1	Siltation	4.1.1	Scalling silica	N	Y	N	N	N	Y	Y	Dump scalling	50 days

5	Pond 7	5.1	Siltation	5.1.1	Scalling silica	N	Y	N	N	N	Y	Y	Dump scalling	50 days
		5.2	Leak	5.2.1	Leak	N	N	N	N	N	Y	N	Visual inspection	On condition
6	Pond 29	6.1	Siltation	6.1.1	Scalling silica	N	Y	N	N	N	Y	Y	Dump scalling	50 days
		6.2	Leak	6.2.1	Leak	N	N	N	N	N	Y	N	Visual inspection	On condition
7	Pipa	7.1	Reduced capacity	7.1.1	Scalling silica	N	Y	N	N	N	Y	Y	Dump scalling	50 days