C&I Learnings at NTPC Koldam – Issues & Solutions

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ABSTRACT

This paper is about the various problems faced in C&I Systems of NTPC's maiden Hydro Power Project which ultimately initiated enormous system improvements, rectifications and modifications. Koldam Hydro Power Project was commissioned in March to June 2015 and all four units were declared commercial on 18th July 2015. In our journey from commissioning to O&M Phase various typical problems were faced in Supervisory Control and Data Acquisition System, Governing System etc which are elaborated along with the methods adopted for their rectification.

1. INTRODUCTION

Koldam Hydro Power Project (4x200 MW) is the first Hydro Power Project of NTPC Ltd. Commissioned in year 2015 and is under commercial operation since 18th July 2015. The project's scheme is a ***Run of the River*** type with pondage facilities for initial years of about 30 years. The salient features of Koldam Hydro Power Project are listed in the table below:

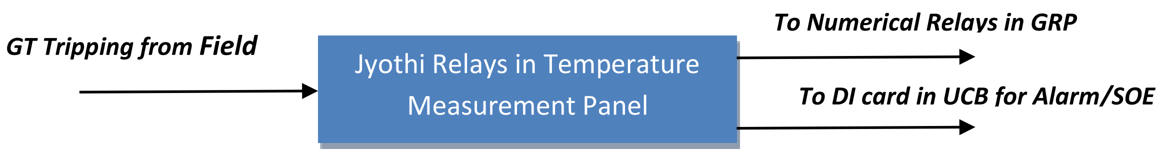
Location	On river Satluj in Bilaspur Distt.(H.P.) 6 Kms upstream of Dehar Project of BBMB
Capacity	800 MW (4 X 200 MW)
Design Energy	3054 MU (90% dependable year)
Power evacuation	400 KV Integrated transmission system
Beneficiary States	Delhi, Haryana, Punjab, Rajasthan, UP, HP, J&K, Chandigarh
Reservoir	Full Reservoir Level = 642metres which is kept below the elevation (EL 642.38 m) of HPSEB's Chaba Hydro Power Station
	Minimum Draw Down Level = 636meters
	Gross capacity at FRL = 576 MCM
	Live Storage = 90 MCM
	Dead Storage = 486 MCM
	Area at FRL = 13.20 km2
Land Req.	1486 ha (Forest 954 /Pvt. 365 / Govt. 167)
Power House	Surface power house having 04 units with Main inlet valves, Vertical Francis type of turbine having rated speed as 166.67 rpm and Generator having 36 poles/rated terminal voltage 13.8 kV/static type excitation system. Discharge through turbine for 200 MW load is 176 cumecs at FRL.
Commercial Operation Date for all four Units	18.07.2015

2. CONTROL & INSTRUMENTATION AT KOLDAM

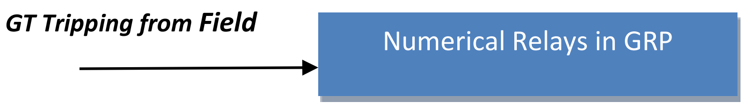
Control and Monitoring system provided at Koldam HPP is a maxDNA based distributed digital control system having powerful processors, Input/ Output modules and conventional control devices (i.e. pushbuttons, lamps, meters) at Local control panels and computer based Human Machine Interface (HMI) in Central Control Room .The Turbine Speed/Load Governor has been supplied by GE, erstwhile Alstom.

3. GRP TO SCADA INTERFACE FOR ALARM MONITORING VIA IEC 103 PROTOCOL

As per the original scheme GT trippings from the field were multiplied in Jyothi make relays in the temperature measurement panel and distributed to Generator Relay Protection Panel (GRP) for initiation of Electrical Trippings and Unit Control Board for logging of Alarm and SOEs, as shown in the scheme below.



Very high failure rate of Jyothi relays lead to spurious unit tripping (07nos). The relays were checked, meggered and even replaced but the problem still persisted. In order to avoid unit outage the scheme was modified to interface the field signals directly to Numerical relays in GRP as follows:



The modified scheme was instrumental in eliminating the spurious trips due to malfunction of Jyothi relays but the operator was unaware of the cause of Electrical Trippings as all the alarms and SOE's were lost.

The challenge ahead was to integrate the two third party systems i.e., max DNA based SCADA and Numerical relays in a manner that no additional hardware was used, no binary outputs were to be configured and no additional wiring was to be done. IEC 103 protocol was best suited for integration of these two systems.
Originally IEC 103 protocol was used only to send time synchronization pulses to Numerical Relays through Engineering PC on maxNET via an NPort MOXA Ethernet to RS485 Converter.

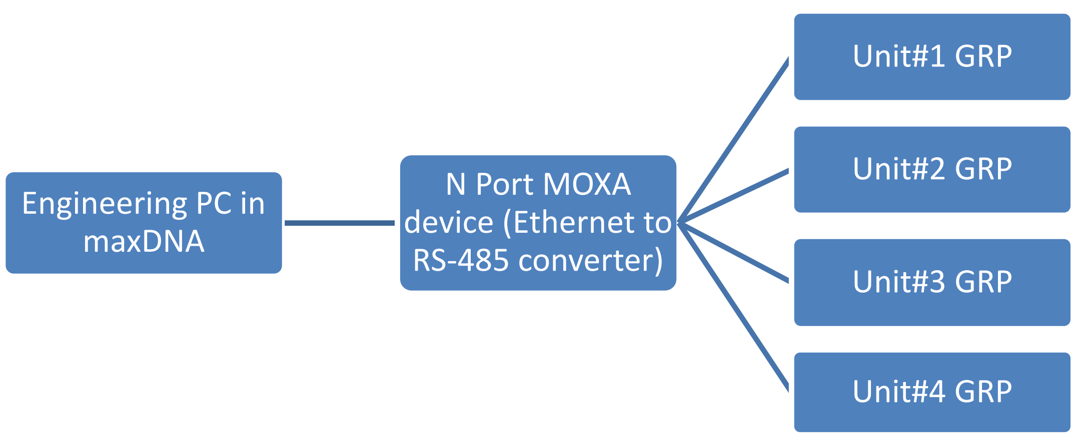


Figure 1 GRP TO SCADA INTERFACE

The existing database file that was meant for time synchronization of Numerical relays was re-configured to incorporate more than 100 alarm/trip signals pertaining to Generator and GT for interfacing with SCADA in all the four units. The scheme has been successfully implemented in all the units.

4. OPTIMIZATION OF STARTING PARAMETERS TO REDUCE STARTING VIBRATIONS

High startup vibrations were observed in all units, which is not good for machine safety. It was found that some bearing vibrations even crossed 1000 microns at some point during startup. To reduce the high startup vibrations various parameters in the governing system that influence the way in which the machine is started were modulated to achieve desirable vibrations. Following were the parameters available for optimization:

- Starting Ramp (START_SL)
- Start up Opening Limitation (LO_DEM)
- Speed Threshold for Fall Back (VT_SRA)
- Fall Back value of Opening Limit (LO_RAB)

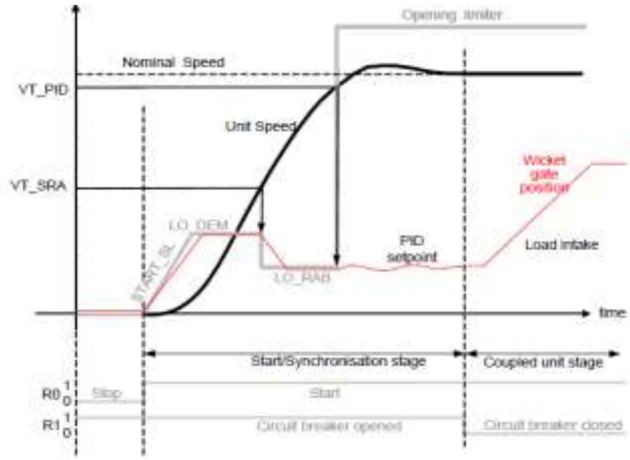


Figure 2 STARTING DIAGRAM

The Starting Ramp time was changed from 60seconds to 100seconds and considerable reduction in vibrations was observed in all the bearings as shown in the table below.

DATE	TIME	UNIT	LO_DEM	VT_SRA	LO_RABT	START_SL	TGB	LGB	UGB	TGB(u)		LGB(u)		UGB(u)	
							mm/s	mm/s	mm/s	x	y	x	y	x	y
											250				
29-04-16	11:26:00 AM	U#4	0.16	0.75	0.15	60	8.29	0.66	1.39	10.6	670.2	429	450	81	78
30-04-16	12:26:00 PM	U#4	0.16	0.75	0.15	100	6.4	0.61	1.43	10.8	517	456	332	56	39
29-04-16	18:59:00	U#2	0.16	0.75	0.15	60	5.7	1.5	2.76	1074	1019	299	93	148	165
30-04-16	17:30:00	U#2	0.16	0.75	0.15	100	6.34	1.26	1.7	600	600	239	96	168	193
26-04-16	18:23:00	U#3	0.16	0.75	0.15	60	2.75	0.77	1.74	791	586	337	103	191	359
02-05-16	11:16:00	U#3	0.16	0.75	0.15	100	4.5	1.4	1.2	612	670	126	40	223	224
02-05-16	11:34:00	U#1	0.16	0.75	0.15	60	6.79	2.29	1.14	796	919	260	82	114	122
02-05-16	12:56:00	U#1	0.16	0.75	0.15	100	6.43	2	1.3	706	652	252	65	81	150

(blue)	Initial Value
(white)	Optimized Value
(green)	Vibration < Previous Value
(red)	Vibration > previous value

Figure 3 COMPARATIVE STUDY OF UNIT VIBRATIONS AFTER CHANGING THE STARTING PARAMETERS IN GOVERNOR

5. ELECTRO-HYDRAULIC ACTUATOR (TR 10) SERVICING IN UNIT #2

During synchronization of Unit #2 after overhauling at 17:46 hrs on 28.04.2016 unit tripped on Governor Failure. Guide Vanes failed to open when system was taken into manual mode for dry stroking. Further analysis of the problem revealed blockage in the ‘Heart of the System’ i.e., Electro hydraulic Transducer (TR10) used to drive the Main Distribution Valve owing to impurities in oil. TR10 was isolated from the Hydro Mechanical Cabinet (HMC), serviced and re-installed. Unit was successfully made available at 23:00hrs on 28.04.2016.

6. INVESTIGATION OF HYDRAULIC OVERSPEED IN UNIT #1

On 03.09.2015 during the execution of shutdown sequence of Unit#1 even after the issuance of Governor Stop Command the Guide Vane position increased from speed no load position to 98% in 16seconds leading to Hydraulic Over speed. On investigation it was found that the insulation of the cable from Servo positioning Controller (SPC) to the Electro-hydraulic Actuator (TR10) was damaged and was getting earthed. The theory was confirmed by the spikes observed in the Valve Position Signal and the Actuator Control Signal.

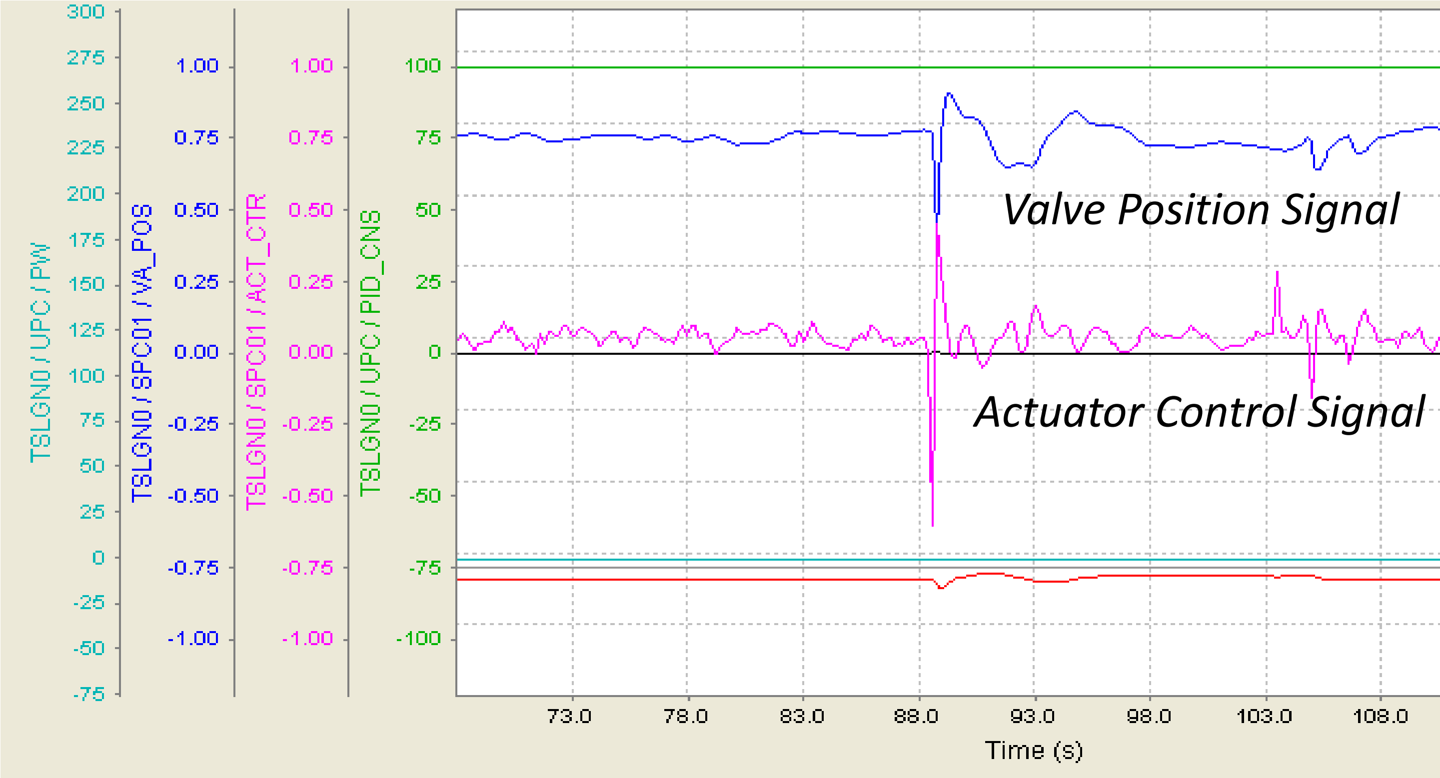


Figure 4 SPIKES IN VALVE POSITION AND ACTUATOR CONTROL SIGNAL

The cable was replaced and the behavior of the unit has been found normal ever since. Governor Stop command was also used to de-energize the emergency solenoid valve to eliminate chances of Unit Over speed on shutdown. The modification has been successfully implemented in all the units.

7. COMMISSIONING OF MODBUS TO HARDWIRED CHANGEOVER IN GOVERNING SYSTEM

Primary Mode of Communication between SCADA and Alstom's Neypric Turbine Speed/Load Governor is Modbus. Governing System being a third party system is interfaced with maxDNA through a LinkPC that hosts the interface files for two way communication. Failure of LinkPC lead to simultaneous tripping of all four units on 20.08.2015 at 05:35 Hrs. on "Low Forward Power' as the Guide Vanes closed fully thereby cutting down the motive power due to the non-availability of the backup hardwired link between SCADA and Governing System.

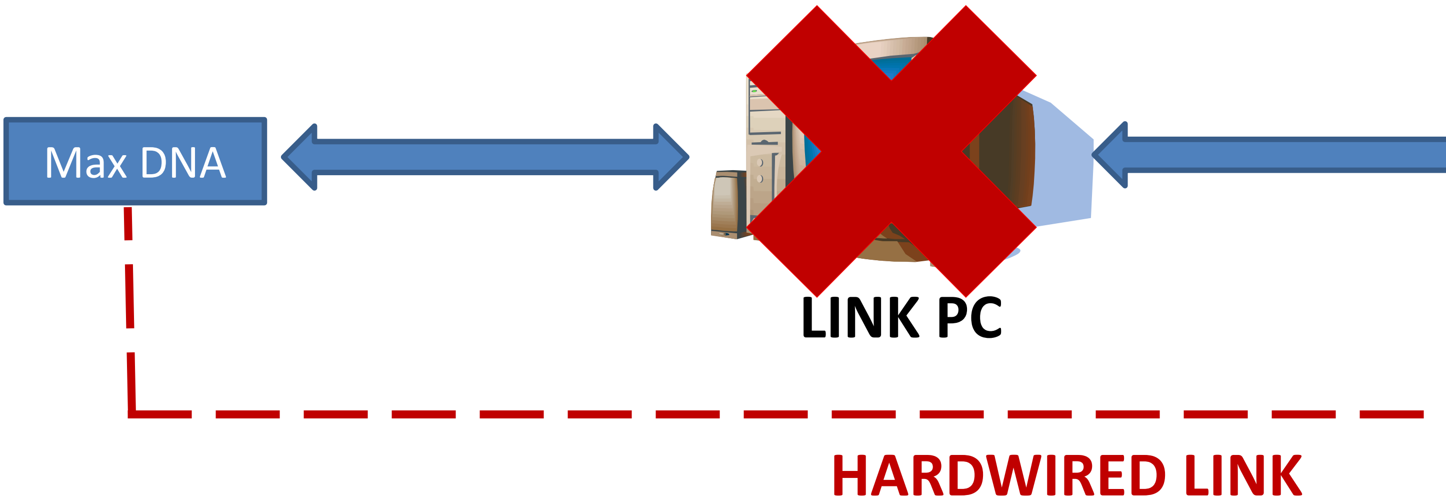


Figure 5 HARDWIRED COMMUNICATION BETWEEN SCADA AND GOVERNING SYSTEM

In house commissioning of seamless Changeover from Modbus to Hardwired communication was carried out in order to avoid unit tripping due to failure of Link PC. The backup hardwired link has been successfully tested in all four units. Alarms for making the operator aware of failure of Modbus link have also been configured.

8. MODIFICATION IN THE BRAKE AIR SYSTEM

Brake Air System is critical for safety of the Machine as it prevents it from creeping at low rpm at the time of Unit Shutdown. Accidental Braking in Unit#3 at 220MW on 04th June 2016 resulted in a catastrophic damage to brake pads. A modification in the scheme was proposed in-house wherein accidental braking in Auto/Manual can be avoided by draining the pilot pressure to atmosphere so long as the machine is running. The scheme has also been approved by OEM.

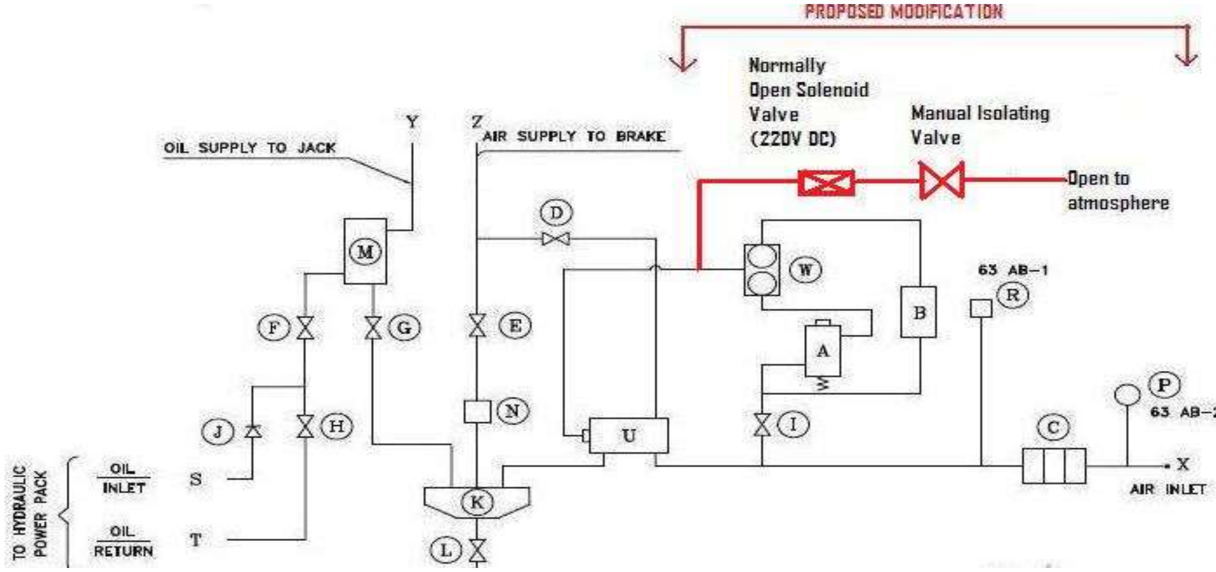


Figure 6 MODIFICATION IN THE BRAKE AIR SYSTEM

9. MODIFICATION IN POWER INTAKE GATE POSITION SCHEME

Power Intake Gate Position is a critical signal to be monitored round the clock.As per the original scheme, Output of CIMS converter (Position Transducer for Gate Position) fed the Gate Level Indicator for local display. The signal was multiplied in the Gate Position Indicator and distributed to the PLC via Single Input Single Output Current Isolator. Based on Limit Value monitored, PLC is used to generate limits for Gate Close, Open, Creep, Excess Creep and Overshoot. On multiple occasions problems were observed in the current output given to the PLC via Gate Position Indicator.

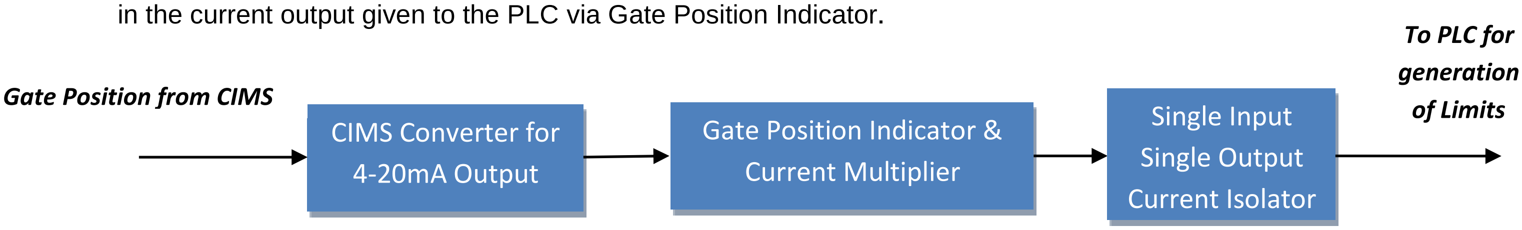


Figure 7 ORIGINAL SCHEME FOR POWER INTAKE GATE POSITION

In order to improve the reliability of the system a single input dual output current isolator was installed in Unit#1 on trial basis and connected to the CIMS converter. One output was connected to the PLC for generation of limits and the other feeds the Gate Level Indicator for local display. The modification is successful and shall be carried out in rest of the three units.

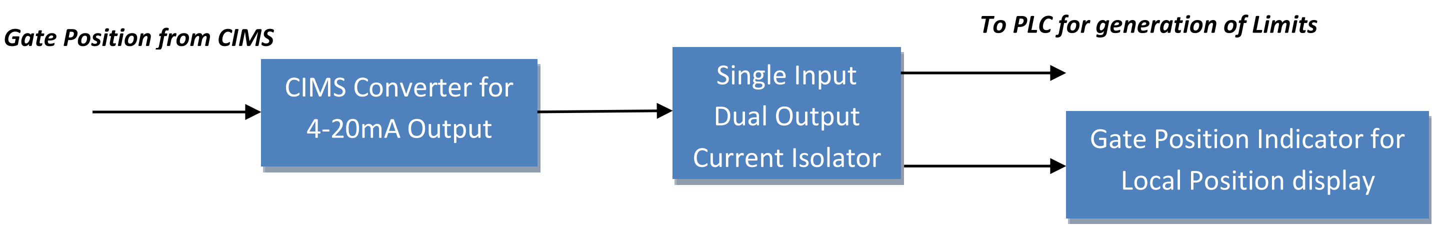


Figure 8 MODIFIED SCHEME FOR POWER INTAKE GATE POSITION

10. COMMISSIONING OF LINE CHARGING/BLACK START GOVERNING MODE OF OPERATION

Commissioning of Line Charging/Black Start governing mode of operation was successfully carried out for all four Units from 27.04.2016 to 29.04.2016 as per CERC guidelines. Online tuning of PID Parameters for Line Charging Governing Mode of Operation in Alstom's Neyrpic T.SLG (Turbine Speed Load Governor) for response to variations in load at far end was carried out.

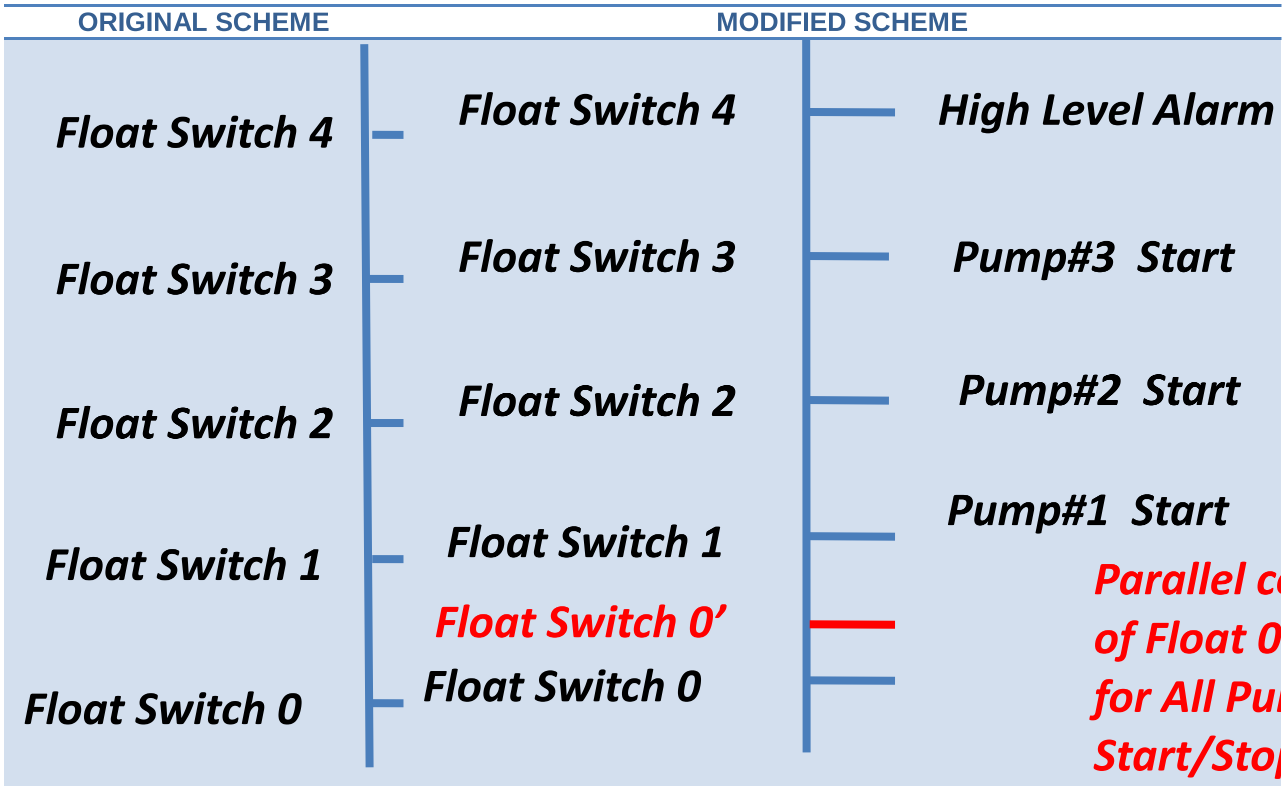
Bump less Changeover from Line Charging Mode to Interconnected (Synchronized) Governing Mode of Operation after normalization**.**

11. REPLACEMENT OF TERMINAL BLOCKS

Owing to high initial vibration and poor quality of Terminal Blocks installed spurious tripping due to RTDs becomes inevitable. 06 nos. of tripping due to looseness of RTD Connections have taken place from 26.06.2015 to 28.06.2016. Old terminal blocks have been replaced with Phoenix Make Spring Loaded terminal blocks for all RTD Signals (1200nos). 700 Terminal Blocks for critical signals were replaced in Unit#1 during overhauling.

12. MODIFICATION IN DRAINAGE/DEWATERING PUMPS TO AVOID DRY RUNNING

Drainage/Dewatering System is crucial for any Hydro Power Plant. It is equivalent to a BFP in 200MW with a pumping capacity of 6000lpm (360Tonnes Per Hour). They are used to prevent flood like situations in Power House. According to the original scheme whenever water level in the pit receded below the lowermost float switch all the running pumps were given stop command. In case of failure of the float switch the pumps would run dry. A modification was done by installing an additional switch in parallel to the lowermost switch so as to prevent the dry running of this critical drive due to switch malfunction.



In addition to the above modification various Level Monitoring alarms have been generated from the transmitters installed in the drainage & dewatering pits.

13. REMOTE OPERATION OF SWITCHGEAR

Remote operation 11KV Station Service Boards i.e., SSB #1 and SSB#2 Breakers through CALCP (Common Auxiliaries Local Control Panel) has been successfully commissioned in-house. Slow Changeover logic of SSB #1 and SSB #2 Tie Breakers has been implemented in SCADA over and above the already commissioned hardwired changeover logic. Commissioning of Remote Operation and Changeover logics of Unit Transformer Main Boards #1 & #2, Unit Auxiliary Main Boards #1, #2,#3 and #4, Safety Auxiliary Distribution Boards #1 & #2, Power House DG Sets, DGLTAC Boards etc.

14. INSTALLATION OF LEVEL SENSOR IN LOWER GUIDE BEARING

Numerous Unit trippings have been observed owing to low oil level in Lower Guide Bearing. A proposal was put forward for installation of Guided Wave Radar Type Level Transmitter for continuous level monitoring in Lower Guide Bearing to enable suitable measures to be taken beforehand so as to avoid unit outage.

15. PROPOSAL FOR INSTALLATION OF RTD CARDS IN SCADA

As per the original tripping scheme, if any of the RTDs votes high that particular recorder channel generates a trip signal. This has resulted in 06nos trippings as RTDs are inherently prone to spikes due to improper connections. The Yokogawa Recorder that interfaces the RTDs is obsolete and does not envisage 'Rate of Rise' or '2/3 Voting' features. A proposal has been put forward for installation of max DNA RTDs cards in SCADA for all units to implement 2/3 logic and incorporate Rate of Rise feature thereby preventing unit tripping owing to malfunction of RTDs.

CONCLUSION

Key considerations addressed in this paper are the various issues faced during Commissioning and Maintenance of C&I Systems in Koldam Hydro Power Project and the remedial actions taken for rectification and system improvement. Statistics are in support of the fact that modifications carried out in the system have proved instrumental in reducing the number of trippings due to C&I from 28.05.2015 to 04.09.2015 from 15 to 01no. in the current financial year.

REFERENCES:

1. Technical Diary for Power House.
2. Operation and Maintenance Manual of Koldam HEPP.
3. Volume 06 of Contract Agreement of Electro Mechanical Package of Koldam HEPP.
4. Operating Instructions Speed Governor for Hydraulic Turbines