DEVELOPMENT OF THE SAFETY CONSOLE FOR THE NUCLEAR POWER PLANT SIMULATOR

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Abstract- TheOSSA(OperatingSupport Services Agreement) is the agreement between the KHNP(Korea Hydro Nuclear Co.LTD) and the ENEC(Emirates Nuclear Energy Corporation) to support the operation for nuclear power plant in UAE(United Arab Emirates).Development of the OSSA Simulator to ensure the training for the OSSA operator while the operators neededto be trained before they actually start operate for the BNPP(Barakah Nuclear Power Plant(the nuclear power plant in UAE). This paper shows the development and configuration of the hardware(safety console) part of the simulator.

Index Terms- Safety Console, OSSA(OperatingSupport Services Agreement), HardwareConsole

I. INTRODUCTION

As many peopleknow that the simulator is to imitate of something. The OSSA simulator is the imitation of the main control room of the Barakahnuclear power plant. To have the effective train for the operator needs the closest feel and reaction of the simulation is very important aspect of the creating a main control room environment and especially for the hardware is the major part of the development of the simulator.
The safety console is the one that connects directly to the Simulation server because whenever the operator controls the switches or the sees the indicators in the console to finds the reaction of the system, the simulator shall reflect to the safety console so that the operator feels as he or she is in the actual main control room.
Figure 1.in the red areashows where safety console is located in the simulator,the blue area is where the OWS(operators workstation) is located and the green area is the LDP(large display panel).

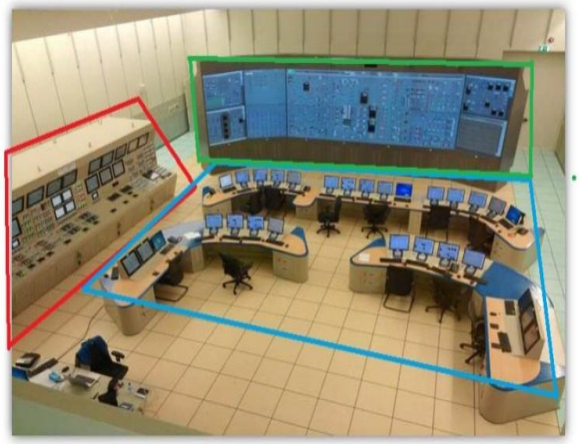

Figure 1. The OSSA Simulator overview

Figure 2.is shown the actual image of the OSSA safety consoleand is known as the hardware which the operator usesfor the turbine trip, controls the safety related hardware switches, OWS is out of service, and etc.

Figure 2. Safety Console

II. CONFIGURATION OF THE SAFETY CONSOLE

Figure 3.is shown the connection of the simulation server and the safety console. There is the system called the “master node”between the simulation server and the safety console. The master node is the system that checks the values between the simulation server and the safety console. And also the system will check the connection between the safety console to the master node.

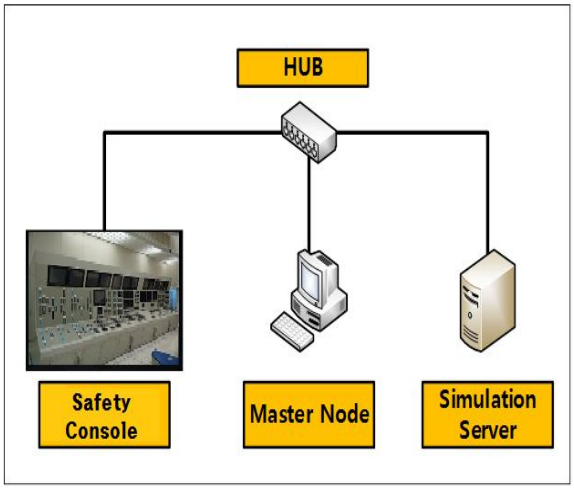

Figure 3. Connection of Simulation server, Master Node and Safety Console

The master node is necessary to have when the safety console acts different than the design or to check if it is affected by the simulation server. There could be many reasons thatthe safety console's behavior could be judged, the safety console itself works different than the design or it could be affected by the simulation server. For example, if the simulation server is sending the wrong value or signal to the safety console and the indication of the safety console is showing the value from the simulation server. If the value is wrong from the simulation server then the fix needs for simulation server.Every time when the safety console acts different than the usual the developer needs to check out the problems are in the safety console or the problems comes from elsewhere like the value is coming from the simulation server.

III. HARDWARE

A. The Switches and LED Signal Lamp

The switches that we used are not the same switches that used in the main control room because if we used the ones that the same as the main control room will be expensive because it has the redundancy and the rigidity which are not necessaryfor simulator because the simulator doesn't require the hard proof like in the main control room but it has same feeling and looking of the switches to create the similar environment. Figure 5.Is shown what we used.

Figure 5. Switches and LED Signal Lamp

All the board, console, and cabinet that we used for the name plate and mimic are as same as the main control room. Inside of the safety console, the cables(signal cables, electric cables, and etc.) are grouped with the labels so that it is easy to be recognized which cables are for what. Inside of the console has the lamp for maintain the safety console.

B. Synchroscope

Synchroscope is used for comparing the phase between the output of generator and GRID. For the simulator it simulates both of the output of the generator and the GRID phase so the signal comes from the simulation server. The GRID signal is 110VAc with 50 Hz signal and the output of the generator are 110 VAC, 45Hz ~ 55Hz, -5Hz ~ +5Hz phase difference shall shows to the synchroscope to indicate the signals.

C. Audible Counter

The audible counter converts the voltage signal which is from the simulation server signal thru the input/output system to make the audio sound.The simulation server Analog Output is proportion to 2177Hz, 7.5ms sin pulse cycle for the audio AMP.

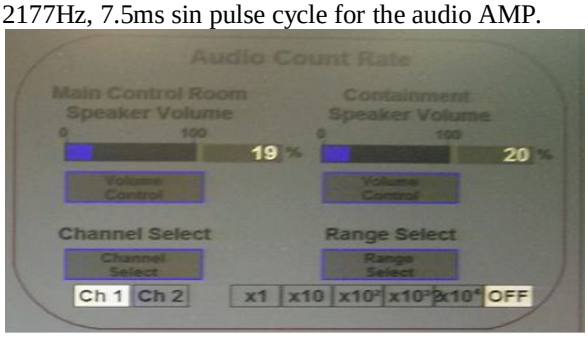

Figure 6. Audible Counter

It has the capability to choose the sound and change the track speed which is 10 sec thru 0.1 sec. Figure 6. Is shown the Audio Count Rates display panel.

D. Communication HUB

The communication HUB has the capability of the more than 1Gbps of the Ethernet network and the each of the nodes are connects to the HUB. The control nodes are controlled by the workstation PC which has the faster than 3GHz speed of the CPU and the main memory of 4 GB of RAM. Figure 7 is shown the installed HUM in the safety console.

Figure 7. Communication HUB

IV. INPUT/OUTPUT SYSTEM

The architectural for the IO(Input/Output) System that we used is the standard system that used the ISA(Industry Standard Architecture) Bus is supported and the IO card are classified as DOC(Digital Output Card), DIC(Digital Input Card), ROC(Relay Output Card), AIC(Analog Input Card), and AOC(Analog Output Card). The CPU board that we used is the half-size single board computer that has the CPU of embedded mobile processor 1Ghz with the intel-852 chipset with the DDR 200/266 DRAM. The operating system for the two of the CPU board is Linux based and the VTBP(Virtual Terminal BoxProtocol) is installed in each of the board.Figure 8.Is shows the image of the CPU Board.

Figure 8. CPU Board

I/O Tester is necessary because the card itself can be damaged or abnormal. The tester we used has the capability to check the Analog Input Control Card (AIC) Test- 32 Channel AIC, Analog Output Control Card (AOC) Test- 16 Channel AOC, Digital Input Control Card (DIC) Test- 64 / 32 Channel DIC, Digital Output Control Card (DOC) Test- 64 / 32 Channel DOC and LOC, and Relay Output Control Card (ROC) Test- 32 Channel ROC.

V. HARDWARE TEST

E. Board Test

I/O tester is used to check the each of the board if the board is defected or not. And each part of the switches and the light has been tested.

F. Integration Test

VTBP is installed on the two nodes in the safety console, and the VTBP for the master node is installed in the separate system. To check the communications between the master node and the safety console is to send the signal from the master node. The master node has the VTBP programs that the user can edit the signal values for Digital Input/Output, and Analog Input/Output. The tests that conduct are 832 of the DIs, DOs, AIs, and AOs.The entire test was done by hand and there was abnormal behavior that found and fixed such as the pressing the switch was supposed to behave as sending the “on” signal but it was opposite as sending the “off” signal.

CONCLUSION

The entire tests were conducted to prove that the performance of the safety console was working as designed. Later the feel and look of the switches and the indicators were tested by the operators. The results came out to be as unrecognizable as it is used the same switchesas the main control room. The safety console for the OSSA will be used for the train purpose and many of the operators will be trained as the expert operators for the nuclear power plant.

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