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Automation and Electronic Sensors in Seshasayee Paper and Boards Ltd, Unit: Erode

B. V. Sivakumar*
(DGM -CS)

C. Thirumalaisamy*
(M-CS)

D. Radhakrinhnan*
(CM-pulp operation)

S. Sivakumar*
(AO-pulp operation)

S. Santhoshkumar*
(JM-CS)

** Seshasayee Paper and Boards Ltd. Unit: Erode*

Abstract:

Seshasayee Paper and Boards Limited (SPB) exemplify the transformation of the pulp and paper industry through advanced automation and innovative technologies. Traditionally facing challenges from labor-intensive manual processes, SPB has embraced automation to enhance operational efficiency, ensure stringent quality control, and improve overall safety standards.

Before automation, SPB, like many in the industries in (1960-2000), dealt with issues such as human error, operational inefficiencies, high labor costs, and safety risks associated with manual handling of materials and chemicals. These challenges often led to inconsistent product quality and increased downtime.

With the adoption of automation technologies after the year 2000, SPB has revolutionized its operations. Automated systems, including programmable logic controllers (PLCs), distributed control systems (DCS), and advanced electronic sensors, now oversee critical processes such as wood handling, pulping, chemical preparation, and quality control. Real-time monitoring through sensors and IoT devices provides continuous data on parameters like temperature, pressure, and chemical concentrations, enabling precise adjustments and immediate responses to deviations.

Key benefits of automation at SPB include:

- ***Enhanced Efficiency:** Automated processes operate continuously and at optimal speeds, significantly increasing production capacity and reducing downtime through predictive maintenance.*
- ***Improved Quality Control:** Consistent product quality is achieved with automated sampling and real-time data analysis, ensuring adherence to strict quality standards.*
- ***Cost Savings:** Reduced labor costs, optimized resource utilization, and improved energy efficiency contribute to overall operational cost savings.*
- ***Enhanced Safety:** Automation minimizes worker exposure to hazardous conditions and enables quick, automated responses to emergencies, thereby enhancing overall safety protocols.*

SPB has implemented industry-leading automation solutions like chemical optimization sensors and sophisticated control systems, underscoring its commitment to technological advancement and sustainable manufacturing practices. These systems not only streamline operations but also support environmental goals by reducing waste and emissions.

Keywords: *Automation, Innovation logics, electronic sensors.*

1. Boosting Gamma Detection Efficiency with Scintillation Counters

1.1 Geiger Muller:

A Geiger Muller Counter is a type of electrical equipment that detects and monitors ionizing radiations. The basic principle of the Geiger Muller counter is when an ionizing particle passes through the gas in an ionizing chamber, it produces a few ions. If the applied potential difference is strong enough, these ions will produce a secondary ion avalanche whose total effect will be proportional to the energy associated with the primary ionizing event

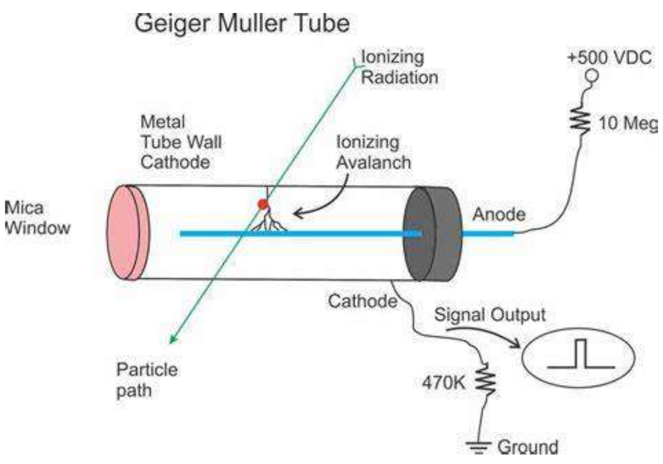

Figure1.1 – Geiger Muller Tube

1.2 Scintillation Counter

A scintillation counter is a device for detecting and measuring ionizing radiation by detecting light pulses produced by the excitation effect of incident radiation on a scintillator material. A scintillator is a device that detects and measures the intensity of high levels of radiation. It is made up of a phosphor with which particles collide, resulting in light flashes and are detected by a photomultiplier and transformed into electric current pulses that are counted for individual ionizing events.

Scintillation emerges in the scintillator, which is a critical component of a scintillation detector. A scintillation detector is made up of a scintillator and photodetector.The basic operating principle involves radiation responding with a scintillator, leading to a series of flickers of varying intensity. The intensity of flashes is directly proportional to the radiation’s energy.

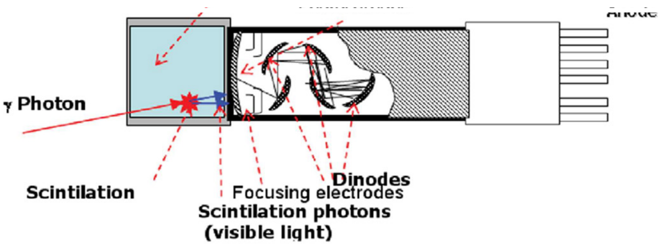

Figure 1.2 - Scintillation Counter

1.3 Enhancing Gamma Source Detection by Replacing Geiger Muller Detectors with Scintillation Tubes

Background: In the pulp mill process, gamma sources are used to measure the level of chips inside the digester. These sources contain the radiation isotope CO-60, which has a life span of 5.3 years at full potential. Our current gamma sources have reached half of their life span, reducing their radiation potential and making them less effective with the existing Geiger Muller detectors.

Problem:

As the gamma sources have lost half of their potential, the Geiger Muller detectors, which are not efficient at detecting low-intensity gamma rays, can no longer provide accurate measurements. Replacing the gamma sources with new ones is costly, with an estimated expense of around 500,000 INR per source. Adding to this, the disposal cost of the old gamma sources amounts to approximately 800,000 INR. Therefore, the total cost for purchasing new gamma sources and disposing of the old ones would be 13,00000 INR.

Solution - Replacing Geiger Muller Detectors with Scintillation Tubes:

To address this issue cost-effectively, we decided to replace the Geiger Muller detectors with scintillation tubes. Scintillation tubes are more sensitive to low-intensity gamma radiation, effectively multiplying the radiation counts and providing accurate measurements even with reduced source strength.

Implementation Steps

- **Evaluation of Current Gamma Sources:**
  - ◻ Assess the current state of the gamma sources and confirm that they have reached half their life span.
  - ◻ Determine the reduced intensity levels and how this affects the accuracy of the Geiger Muller detectors.
- **Selection of Scintillation Tubes:**
  - ◻ Research and select suitable scintillation tubes that can effectively multiply and detect the reduced gamma radiation from the CO-60 sources.
  - ◻ Ensure the selected scintillation tubes are compatible with the existing measurement system and can be integrated without extensive modifications.
- **Replacement Process:**
  - ◻ Carefully remove the existing Geiger Muller detectors from the measurement setup.
  - ◻ Install the new scintillation tubes, ensuring proper alignment and calibration to maximize detection efficiency.
  - ◻ Test the new setup to confirm that the scintillation tubes provide accurate readings with the half-potential gamma sources.
- **Calibration and Testing:**
  - ◻ Conduct thorough calibration of the scintillation tubes to ensure they are correctly detecting and multiplying the gamma radiation.
  - ◻ Perform a series of tests to validate the accuracy of the measurements provided by the new detectors.
  - ◻ Compare the new measurements with historical data to ensure consistency and reliability.

Benefits of Using Scintillation Tubes

- **Increased Sensitivity:** Scintillation tubes are more sensitive to low-intensity gamma rays, providing accurate measurements even with the reduced radiation potential of the CO-60 sources.
- **Cost Savings:** By reusing the existing gamma sources and replacing the detectors, we save approximately 13, 00000 INR per source, avoiding the high cost of purchasing new gamma sources.
- **Extended Usability:** The scintillation tubes effectively extend the usable life of the gamma sources, maximizing their value and delaying the need for replacement.
- **Improved Accuracy:** Enhanced detection capabilities of scintillation tubes ensure precise level measurements within the digester, maintaining process efficiency and safety.

2. Last Equipment Running Status:

Addressing Equipment Failure and Changeover in the RDH Process Using LR (Last Run) Tag

Background: In the pulp mill process, equipment. When such incidents occur, planed shutdowns might be necessary, which can result in extended downtime and complications during plant restarts. This challenge is compounded when shift changes occur, as new personnel might not be aware of the recent equipment changes, potentially leading to incorrect equipment operation and further delays.

Problem: During equipment changeover, if the plant undergoes a planned shutdown, it can take considerable time to restart. The lack of awareness about equipment status during shift changes can lead to the wrong equipment being started, causing further delays and production losses. Effective communication and accurate tracking of equipment status are crucial to mitigate these issues.

Solution - Implementing the LR (Last Run) Tag: To address these challenges, the introduction of an LR (Last Run) tag is proposed. The LR tag records and indicates the last run status of each piece of equipment, helping the process department and shift personnel to know exactly which equipment needs to be started during plant operation. This improves efficiency and reduces the likelihood of errors.

2.1Step-by-Step Implementation of LR Tag in RDH Process

- **System Analysis:**
  - Identify all critical equipment and their respective operational sequences in the RDH process.
  - Map out the standard operating procedures (SOPs) for equipment startup and shutdown.
- **LR Tag Setup:**
  - Implement LR tags for all critical equipment. These tags will record the last run status, including whether the equipment was running or stopped at the time of failure or shutdown
  - Integrate the LR tags with the existing control systems and sensors to automatically update the status.
- **Data Logging and Monitoring:**
  - Ensure the LR tags log data continuously, recording the operational status and any changes in real-time.
  - Store the logged data in our DCS SERVERS that can be easily accessed by process department personnel and shift operators.
- **Shift Change Protocols:**
  - Develop clear protocols for shift changes, emphasizing the importance of checking LR tag status before restarting equipment.
  - Train all personnel on how to access and interpret LR tag data to ensure they are aware of the equipment status.
- **User Interface and Alerts:**
  - Create a user-friendly interface that displays the LR tag status for all equipment. This interface should be accessible from the control room and remote monitoring stations.
  - Implement alert systems that notify operators of any discrepancies or issues detected by the LR tags during equipment startup.
- **Procedure for Handling Equipment Failures:**
  - Establish standard procedures for handling equipment failures, incorporating the use of LR tags to ensure accurate and efficient troubleshooting.
  - Include steps to verify LR tag status before attempting to restart any equipment.

Benefits of Using LR Tag in RDH Process

- Accurate Status Tracking: LR tags provide a reliable record of the last operational status of equipment, reducing errors during restarts.
- Improved Communication: Enhanced communication between shifts ensures that all personnel are aware of the current status of the equipment, minimizing the risk of starting the wrong equipment.
- Reduced Downtime: Efficient identification of the equipment that needs to be restarted helps in reducing downtime and accelerating the plant restart process.
- Enhanced Safety: Accurate tracking of equipment status helps in maintaining operational safety, preventing potential accidents due to incorrect equipment operation.
- Increased Production Efficiency: By minimizing errors and reducing restart times, LR tags contribute to maintaining consistent production output.

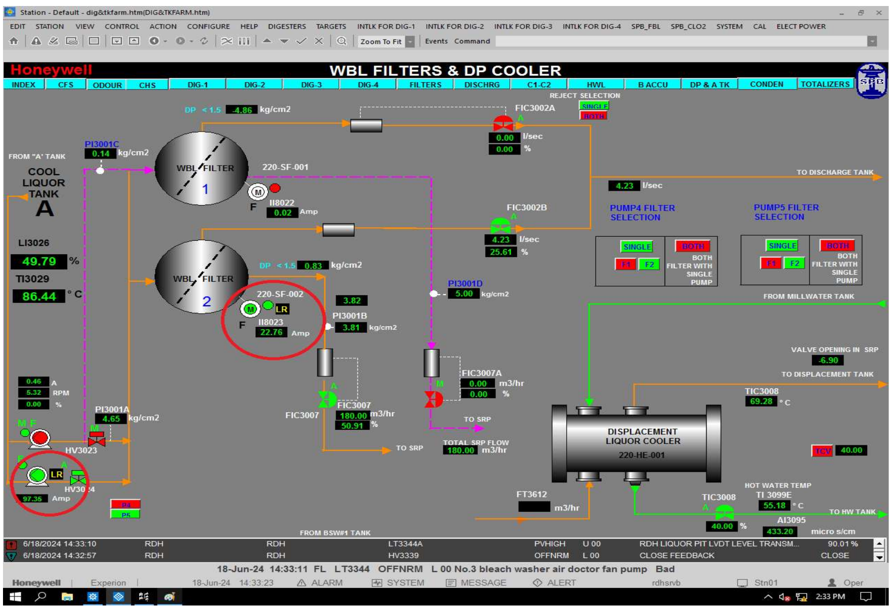

Figure 2: LR indication in HMI

3. E-Server Implementation In Our Plant

3.1 Enhancing Plant Operational Visibility through Integrated e-Server

Introduction: In our mill, the effective control of various processes is achieved through a sophisticated Distributed Control System (DCS). The DCS ensures precise control and monitoring of our processes. To further enhance operational efficiency and transparency, we have implemented E-servers. These E-servers provide real-time access to the plant's running status for HODs, plant engineers, employees, and other plant personnel, thereby facilitating their knowledge .

Objective: The primary objective of implementing e-Servers is to democratize access to critical plant information, enabling informed decision-making at all levels of the organization. This initiative aims to:

- Provide real-time visibility into plant operations.
- Enhance troubleshooting capabilities.
- Foster a culture of transparency and continuous improvement.

Implementation Strategy:

- **e-Server Setup:**
  - ◻ Procure and set up e-servers that will be used to pull data from the DCS.
  - ◻ Ensure that the e-servers have sufficient processing power and storage capacity to handle the data load.
- **Network Configuration:**
  - ◻ Assign a unique IP address to the e-servers within the DCS network.
  - ◻ Configure the DCS to push real-time data to the e-servers using the assigned IP address.
  - ◻ Ensure secure data transmission between the DCS and e-servers.
- **Integration with Company LAN:**
  - ◻ Connect the e-servers to the company's LAN, ensuring they are accessible to authorized personnel.
  - ◻ Set up user access controls to manage who can view and interact with the data on the e-servers.
- **Data Visualization and Access:**
  - ◻ Develop a user-friendly interface on the e-servers that displays real-time data and plant status.
  - ◻ Implement dashboards and visual aids (e.g. trend) to make data interpretation easier.
  - ◻ Provide remote access capabilities so management and HODs can view the data from any location within the company's network.
- **Testing and Validation:**
  - ◻ Conduct thorough testing to ensure data is accurately pulled from the DCS and displayed on the e-servers.
  - ◻ Validate the system by comparing e-server data with direct DCS data to ensure consistency and accuracy.

Benefits:

- Improved Transparency: Real-time access to plant data for all personnel enhances transparency and informed decision-making.
- Empowered Workforce: Providing access to critical information empowers employees at all levels.

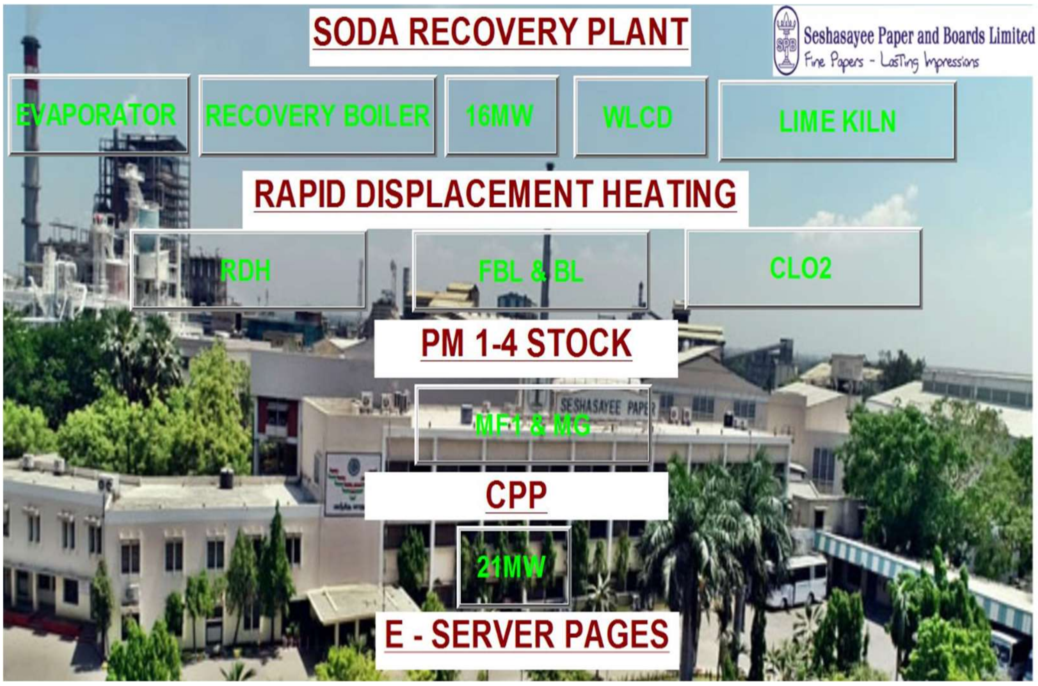

Figure 3: e-Server page

4. First In And First Out Logic:

4.1 Trouble shooting Using FIFO Tag

Background: The pulp mill process is a continuous operation that involves multiple pieces of equipment working in tandem. Each piece of equipment often relies on the status of other equipment to function correctly. For instance, a pump may transfer pulp between tanks, but this action is safeguarded by numerous interlocks to ensure safety and efficiency. However, any failure in equipment or parameters during this transfer can cause significant production losses. Diagnosing the exact cause of failure is challenging due to the complexity and number of interlocks involved.

Problem: When a failure occurs during the pulp transfer process, it can be difficult to quickly and accurately identify which interlock or parameter failed. This difficulty in pinpointing the problem can lead to substantial downtime and production losses. The complexity and interdependence of the system's interlocks exacerbate the issue, making it hard to isolate and resolve the specific fault.

Solution - Implementing the FIFO Tag: To address this challenge, the introduction of a FIFO (First-In, First-Out) tag was proposed. This FIFO tag helps in tracking and identifying the sequence of interlock activations and failures, allowing for quicker identification of the root cause when a failure occurs and it automatically reset while restarting the plant .

4.2 Step-by-Step Implementation of FIFO Tag in RDH Process:

- **System Analysis:**
  - ◻ Identify all critical equipment and interlocks in the RDH process.
  - ◻ Map out the sequence of operations and interlocks for each piece of equipment, particularly the pump.
- **FIFO Tag Setup:**
  - ◻ Introduce a FIFO tagging system that logs the activation and deactivation of each interlock in a chronological order.
  - ◻ Ensure that each interlock activation is recorded with a timestamp, creating a real-time sequence of events.
- Integration with Existing Controls:
  - ◻ Integrate the FIFO tagging system with the existing control systems and sensors of the RDH process.
  - ◻ Ensure that the FIFO tag can capture data from all relevant interlocks and equipment parameters.
- **Failure Detection and Analysis:**
  - ◻ Develop a user interface that displays the sequence of interlock activations in real-time.
  - ◻ When a failure occurs, the system highlights the exact point of failure based on the FIFO tag sequence, showing the most recent interlock or parameter issue.
- **Troubleshooting and Resolution:**
  - ◻ Use the FIFO sequence to quickly identify the failed interlock or parameter.
  - ◻ Implement corrective actions based on the identified failure, minimizing downtime and production losses.

Benefits of Using FIFO Tag in RDH Process

- **Enhanced Troubleshooting:** Rapid identification of the specific interlock or parameter failure reduces troubleshooting time.
- **Minimized Downtime:** Quick resolution of issues helps in minimizing production losses and maintaining continuous operation.
- **Improved Safety:** Accurate identification of failures ensures that interlocks and safety mechanisms function correctly, reducing the risk of equipment damage or accidents.
- **Efficient Data Management:** The FIFO system provides a clear, chronological record of equipment status and interlock activations, aiding in maintenance and operational decisions.

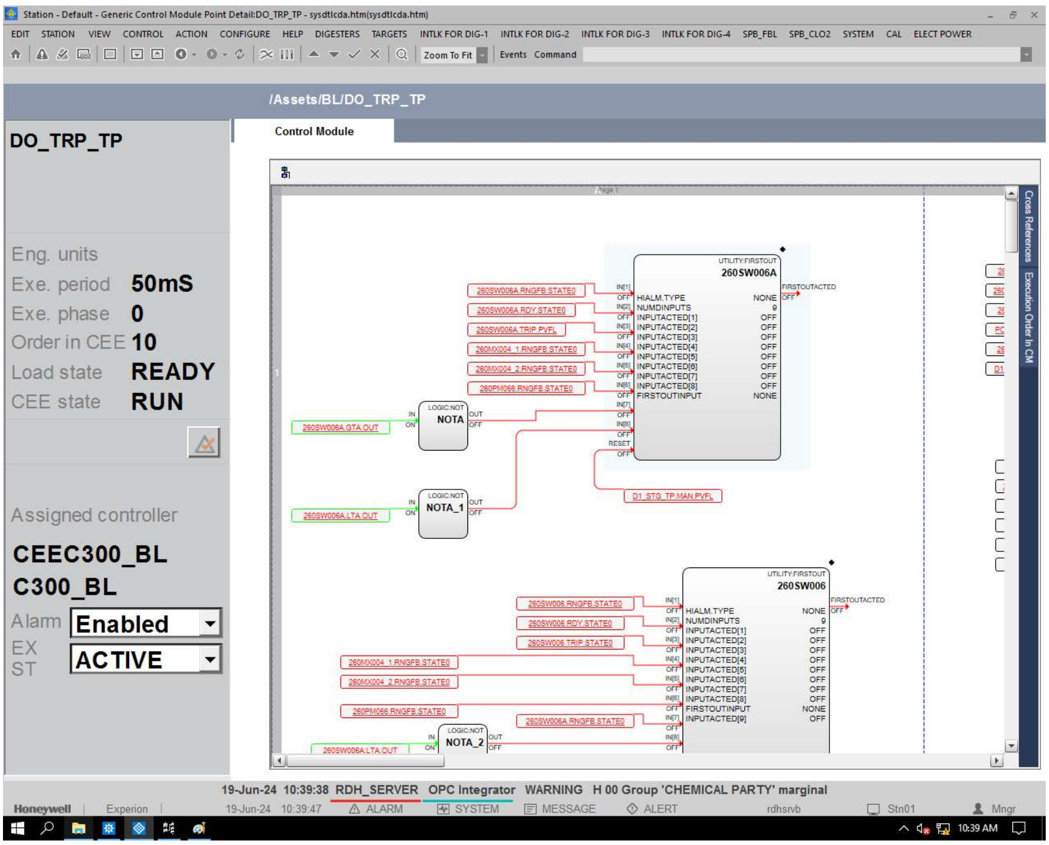

Figure 4 - FIFO logic

5. Dcs Card Status Identification Logic:

In our pulp mill plant, we use a Distributed Control System (DCS) to control various process equipment such as on/off valves, control valves, pressure transmitters, temperature transmitters, pumps, and more. Each type of equipment requires separate I/O cards, such as Digital Input (DI), Digital Output (DO), Analog Input (AI), and Analog Output (AO) cards. These cards are specified as follows:

- DI and DO Cards: Each card supports 32 I/O points.
- AI and AO Cards: Each card supports 16 I/O points.
- Card Slots: Up to 15 slots are provided for storing these I/O cards.

Objective: Develop an innovative logic system that leverages the DCS database to monitor, identify, and report the status of each I/O card, providing real-time failure identification and location information.

Importance of the Logic

Without this innovative logic, several issues can arise:

- Delayed Problem Identification: Without a real-time monitoring system, identifying which I/O card has failed can take considerable time, leading to prolonged downtime.
- Increased Downtime: Delays in identifying and fixing card failures can disrupt the process, causing inefficiencies and increased downtime.

Logic Implementation

The logic system works by continuously checking each I/O card's status and providing accurate information to the DCS page. Here's how it operates:

- **Monitor Card Status:**
  - Continuously monitor the status of each I/O card in the DCS system.
  - Retrieve real-time status data from the database, including operational status (OK/Fail), error codes, signal integrity, and communication status.
- **Check and Validate Data:**
  - Compare the current status of each I/O card with predefined operational parameters.
  - Identify discrepancies that indicate potential failures.
- **Error Detection:**
  - Use specific error codes provided by the I/O cards to pinpoint the type of failure (e.g., communication failure, signal loss).
  - Analyze historical data for patterns that might indicate a developing issue.
- **Immediate Response to Errors:**
  - If an error is detected, log the issue and update the database with detailed information about the faulty card.
  - Provide real-time alerts to the DCS interface, including the slot number and specific I/O point affected.
- **User Interface Integration:**
  - Design a user-friendly DCS interface to display real-time status of each I/O card.
  - Highlight cards with detected issues and provide detailed error information.

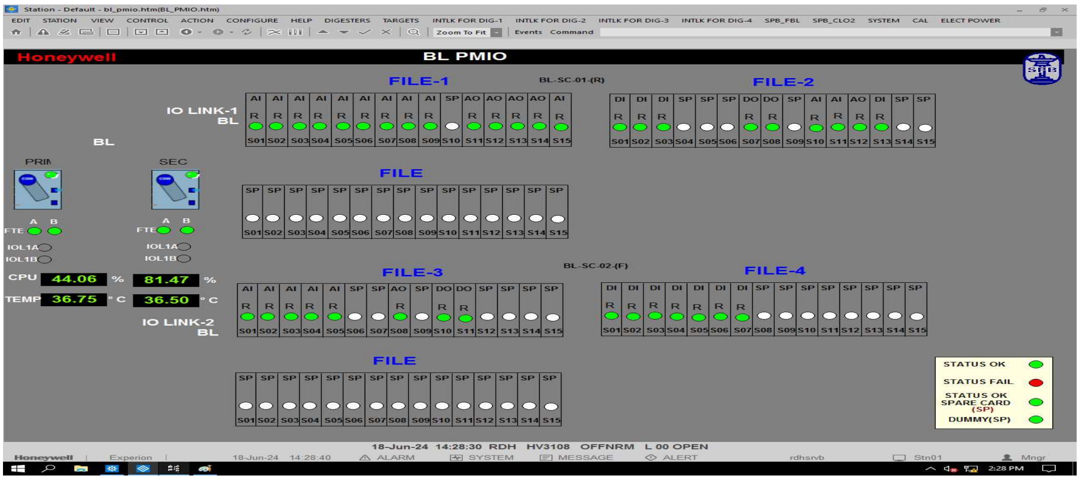

Figure 5(A)- DCS card status identification HMI

Figure 5(B)

6. Chemical Conception:

6.1 Implementation of Advanced Chemical Optimization in Pulp Bleaching to Reduce Chemical Wastage

Introduction:

In our pulp mill, we bleach pulp using various chemicals such as chlorine dioxide (ClO_2), sulfuric acid (H_2SO_4), hydrogen peroxide (H_2O_2), and sodium hydroxide (NaOH). The bleaching process occurs in three distinct stages: D0, EOP, and D1, with chemicals added within a standard range. Despite these efforts, we faced significant chemical wastage after the washing stage.

- **Objective:** Optimize chemical usage in pulp bleaching while maintaining quality and reducing waste.
- **Challenges:** Significant chemical wastage in traditional bleaching methods due to manual operation.

Traditional Bleaching Process:

- **Chemicals Used:**
  - ClO_2 (Chlorine Dioxide)
  - H_2SO_4 (Sulfuric Acid)
  - H_2O_2 (Hydrogen Peroxide)
  - NaOH (Sodium Hydroxide)
- Stages:
  - D0 (First Stage)
  - EOP (Extraction with Oxygen and Peroxide)
  - D1 (Final Stage)

Issues with Traditional Method:

- **Chemical Wastage:**
  - High levels of chemical wastage post-washing.
  - Inconsistent control over kappa number and brightness.

Innovative Solution by Chemical Conception Team :

- Implementation of advanced software and new instruments.
- Instruments Used:
  - BLT (Brightness and Kappa Number Sensor): Measures kappa number and brightness.
  - BT (Brightness Sensor): Measures brightness only.

Sensor Placement and Workflow:

- **Sensor Placement:**
  - BLT Sensors: Installed at the inlets of D0 and D1 stages.
  - BT Sensor: Installed at the outlet of the D1 stage.
- **Measurement and Data Collection:**
  - BLT sensors measure kappa and brightness at D0 inlet and D1 inlet.
  - BT sensor measures brightness at the D1 outlet.
- **Data Integration:**
  - Sensors are interconnected, feeding data into the software system.
- **Control System Integration:**
  - Software analyzes data and sets points for the Distributed Control System (DCS).
  - DCS adjusts the set points for chemical control valves in real-time.

Advantages of the New System:

- **Automation:**
  - Eliminates manual calculations.
  - Software manages all chemical and bleaching controls.
- Efficiency:
  - Reduces chemical wastage significantly.
  - Saves approximately 2.3 lakhs per day in chemical costs.

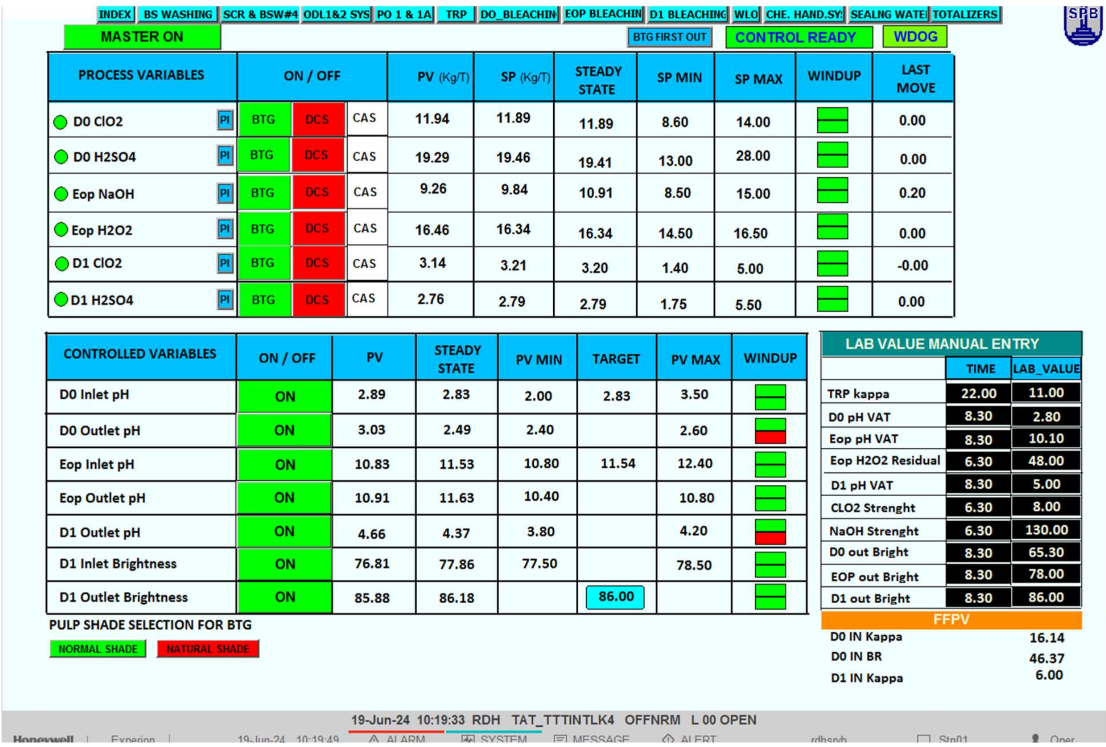

Figure 6: Chemical conception HMI

- **Precision:**
  - Utilizes kappa and brightness values for accurate control.
  - Ensures consistent product quality.

Technical Details:

- Control Variables (CV): Kappa number, brightness.
- Manipulated Variables (MV): Chemical dosages (ClO_2, H_2SO_4, H_2O_2, and NaOH).
- Feed-Forward Variables (FF): Incoming pulp properties, flow rates.
  - Constraints: Maintain CVs within desired limits using real-time data from sensors.

System Integration:

- DCS Integration: Sensors and software are fully integrated with the plant's DCS.
- **Self-Tuning:**
  - Software assists in loop tuning of control valves.
  - Adjustments are automated, requiring no human intervention.

Results and Benefits:

- **Cost Savings:**
  - Significant reduction in chemical costs.
  - Daily savings of approximately 2.3 lakhs.
- **Quality Control:**
  - Improved consistency in pulp brightness and quality.
- **Environmental Impact:**
  - Reduced chemical wastage, contributing to sustainability.

7. Conclusion

Seshasayee Paper and Boards Limited (SPB) have demonstrated a profound transformation through the integration of advanced automation and innovative technologies. By embracing cutting-edge systems such as Distributed Control Systems (DCS), and advanced electronic sensors, SPB has addressed traditional challenges and significantly enhanced its operational efficiency, quality control, and safety standards. The implementation of innovative solutions, such as replacing Geiger Muller detectors with scintillation tubes, using FIFO tags for troubleshooting, and integrating e-servers for real-time plant visibility, has led to substantial cost savings, improved accuracy, and reduced downtime. Additionally, the advanced chemical optimization in pulp bleaching has minimized chemical wastage and reinforced SPB's commitment to sustainability. SPB's journey underscores its dedication to operational excellence, setting new benchmarks in the pulp and paper industry for efficiency, quality, safety, and environmental stewardship.