**Solution to In Process Pulp Mat Measurement of   
Dirt Contamination and Whiteness**

The intention in this agreed initial stage of the implementation is to showcase the use of one, high resolution, fast capture, camera to collect both Whiteness, related directly to Berger Whiteness Index, and Dirt Particulate Contamination. The dirt contamination detection requirements are as specified in ISO-5350-2, (2006).

There are two systems operating at Atholville, each with a bed of 3250mm, (128”), width and with speed of fibre mat flow of 3ft/s in one case and 4.6ft/s in the second case. (Broadly defined as being 1m/s and 1.5m/s).

Ideally, we would use independent cameras for the Whiteness measurement and the Dirt Detection however constraints placed on us by Site have forced our using only the one camera to meet both requirements. The Dirt Detection is the more onerous challenge so forcing the limited field of view and configuration constraints.

As the deployment of this solution is in Atholville, New Brunswick the project approach is that the system be assembled and fully tested in Hyderabad prior to shipping the “solution” to Aditya Birla, Mumbai for their on-shipping to Canada. Certain elements of the solution will be locally sourced by the Site, these items being, the Edge PC Screen, Keyboard and Mouse, the Lighting Battens and the Interface Control Cabinet that will be positioned local to the camera.

The installation work will also be undertaken by Site personnel including running the fibre from the camera through to the Edge PC. A detailed configuration diagram will be supplied with the kit of parts as supplied and the Edge PC will enable remote connection so that any fine configuration adjustments can be made by the Development Team in Hyderabad.

The lighting will need to be switched from pulp mat front to pulp mat back to accommodate Whiteness Monitoring with light from the front and Dirt Contamination with lighting from the back. This switching will be facilitated using the timers which will be in the Local Control Cabinet.

The following drawing shows the architecture of the system.

A diagram of a computer system

AI-generated content may be incorrect.

**Whiteness Detection:**

As we have been guided to use only a single camera to achieve both Whiteness Monitoring and Dirt Detection, we have opted to use a 45MP, UHD camera with a wide bandwidth CoaXpress communication channel.

The SP-45000C, colour camera does not have the advantages of a Prism Camera system, using a single sensor and Bayesian Interpolation for colour separation, rather than three individual sensors, one for each primary colour. The rendered RGB colour values will therefore be more susceptible to shadowing and reflected light purity however, as the pulp mat is predominantly flat and the imaged area is comparatively small, these issues should not significantly complicate the derivation of Berger Index values required.

For the Whiteness Monitoring we will require that there be incident light above the pulp mat, to this end two 6500k LED battens will be positioned, one either side of the camera enclosure. At the time that Whiteness Monitoring is being undertaken the lighting under the pulp mat must be off. The camera enclosure will be positioned such that the camera is perpendicular to the pulp mat. It has been agreed that the Site will provide the light battens.

The camera can be remotely set to image the pulp mat at up to ten frames per second, (consistent with maintaining a single coaxial fibre feed). It is intended that for an individual “run”, twenty images be gathered for the Berger Index value to be determined. Several “runs” will be completed, to enable a mean BI Value to be displayed alongside any other metrics that me be required such as the Maximum and Minimum BI Value through the aggregated “runs”. The dashboard content and presentation format is to be determined in conjunction with the Site personnel.

The frequency of dashboard updates will be determined based on the speed with which the BI values can be determined from each set of twenty images gathered by the Edge PC. As has been determined at ABG Vilayat, too frequent updating of the available detail on local monitors, has the effect of creating confusion so a necessary level of “damping” of displayed detail will be required.

All results gathered should be maintained in a historian for subsequent interrogation, this will not require the storage of anything but the most recent images. The location of this storage is yet to be defined; the Edge PC will be linked to Optimon which at this point appears to be the most appropriate and flexible place to hold this detail. Such decisions will be made in conjunction with Site personnel at a later stage.

**Dirt Contamination Detection:**

The controlling document for Dirt Contamination Detection is ISO 5350-2. It is a requirement that we be able to identify all Classes of Contraries as listed in Table 1 of the ISO Document Section 7.4. This means that our objective is to identify contrasting particulate within the pulp mat with the following characteristics shown below.

A table with numbers and symbols

AI-generated content may be incorrect.The SP-45000C has a pixel size of 3.2μm². The lens and distance of the camera from the pulp mat, as shown in the architecture detail above, has been determined to ensure that there are ≥3 pixels per 40μm particulate.

The requirements of ISO 5350-2 are that a report be generated representing an area of the inspected pulp of 0.5m². This report is to show the count of all dirt particles within each of the five classifications shown to the left; the areas inspected to generate this report should not be from a single surface but from non-contiguous areas of the pulp mat. If ten images are captured each second, then each image will be separated from another by 40mm in the case of the pulp mat moving at 1m/s and by 70mm in the case of the pulp mat moving at 1.5m/s, this then meeting the controlling document requirements.

To accumulate sufficient detail for the generation of a report as required by the ISO controlling document it will be necessary to collect seventy-five images. The detail from each of the seventy-five images will be summed and presented on a dashboard showing the general distribution of the contamination dirt particulate by size. The format of the dashboards will be defined at a later stage in conjunction with Site personnel.

For the Dirt Detection Monitoring we will require that there be incident light below the pulp mat, to this end two 6500k LED battens will be positioned below the pulp mat directed towards the camera. At the time that Dirt Contamination Monitoring is being undertaken the lighting above the pulp mat must be off.

**Current BoM Based on Architecture Shown**



**Future Development Capability**

The system as shown will enable the two primary functions of Whiteness Monitoring and Dirt Contamination Counting.

This is all based on a single camera which fully meets the requirements of ISO 5350-2 for Dirt Detection within the pulp mat. Whiteness monitoring is covering an area in each run of 0.12m², this could easily be extended by adding additional cameras or alternatively separating the two functions and placing an Apex Series Prism Camera to monitor Whiteness, leaving the Spark Series Camera to monitor the higher precision Dirt Detection. Either approach would require only the camera and nominal additional communication support to run from the camera to the Edge PC.

It has been indicated that the Moisture of the pulp mat may be required to be measured. In this case, as with the above, a Moisture Sensor, (KLED-70), can be added to the configuration without substantial complication. The development work that we undertook with KLED enables the positioning of the moisture sensor such that we can look at an area of ≈1m² in a single capture so meaning that with only two moisture sensors we could be scanning >60% of the surface of the pulp mat continuously. The system hardware, as designed, is therefore scalable to meet the growing demands of the Site.

The long-term goal is to establish the reliability of the measurements being gathered and then use that detail to automatically closed-loop-control the pulp generation process. The timescales associated with this have not been indicated.

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