Formulation Area

Area Operations Guide Prepared for:

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40 m/min Wallboard Factory

Caesarea, Israel

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Proven Technology Worldwide

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Introduction

This guide is an **Overview** containing original instructions written to assist in the normal operations of the **Formulation Area**.

For detailed information, refer to the **Maintenance** manual specific to the equipment being maintained.

For Safety information, consult the **Safety Overview** manual.

CAUTION: To avoid injury, personnel should complete formal safety training before operating any piece of equipment.

KEY: All personnel must follow **Lockout/Tagout (LOTO)** procedures, and operate in compliance with both their company policy and local regulations.

Contents

1 Formulation Area Overview

The scope of the **Formulation Area** covers the handling of **Stucco**, ball mill accelerator, dry and wet additives.

1.1 Formulation Area Systems

To optimize **Board Plant** performance and produce consistently high-quality Board, it is essential to supply an accurate quantity of uniform Stucco to the **Mixer**.

Dry Additives are stored in bins and loss-in-weight feeders meter these additives. Fiberglass tanks are used for **Wet Additives** agents, process water, and wastewater.

Formulation Area Systems:

- Stucco Handling
- Ball Mill Accelerator (BMA)
- Dry Additives
- Wet Additives

1.1.1 Stucco Handling System

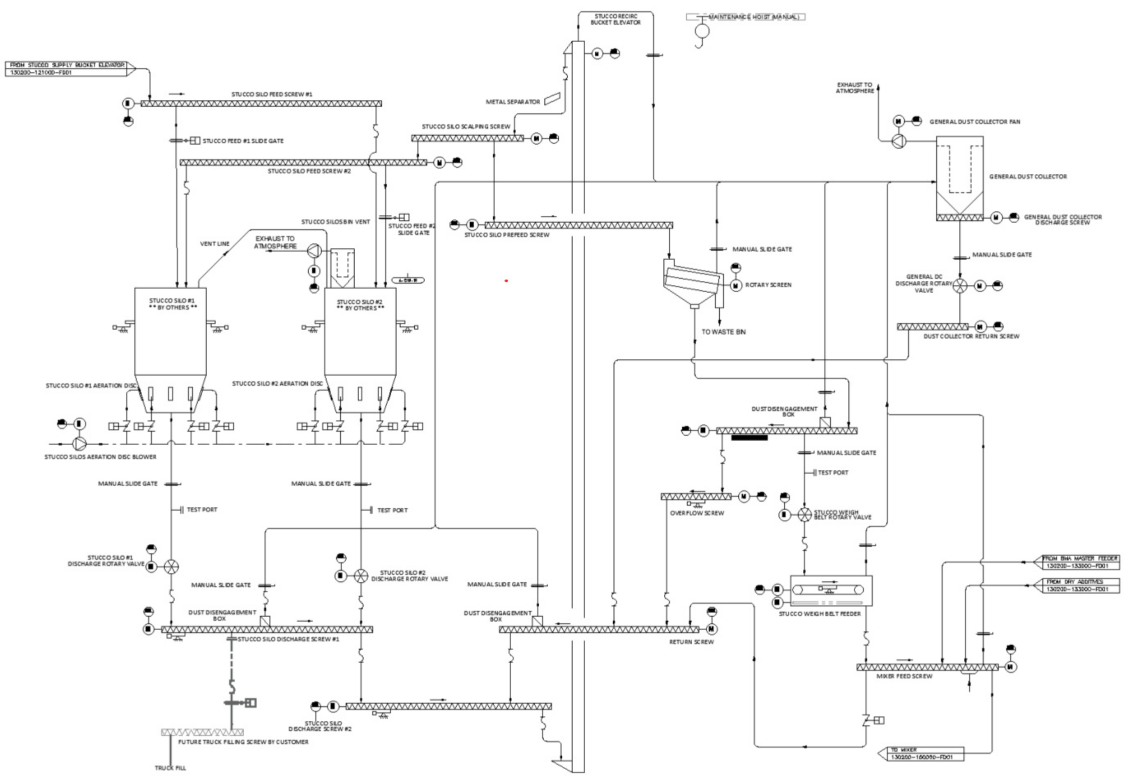

Figure 1.1.1 Stucco Handling Process Flow

1.1.2 Ball Mill Accelerator System

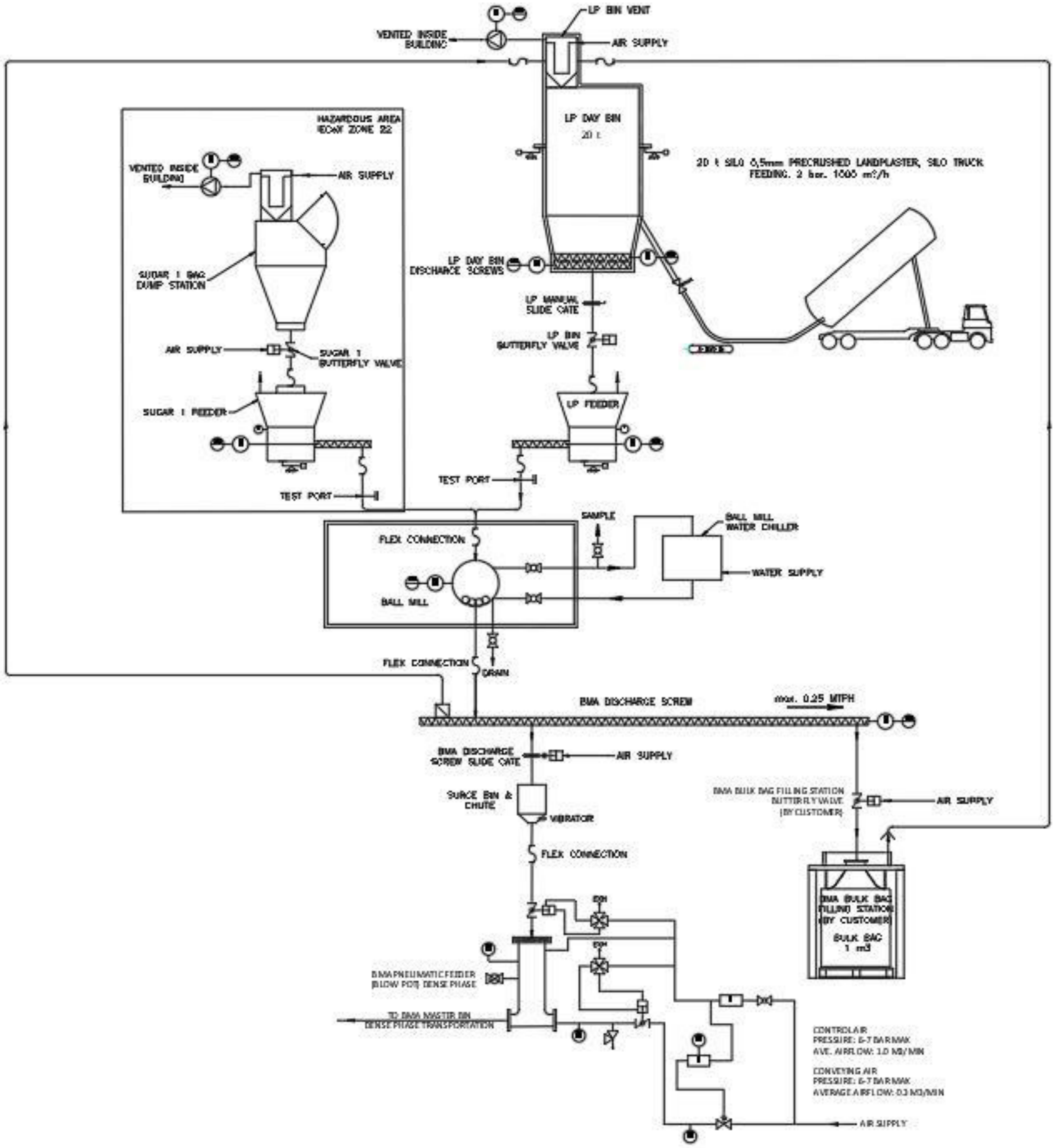

Figure 1.1.2 BMA Process Flow

1.1.3 Dry Additives System

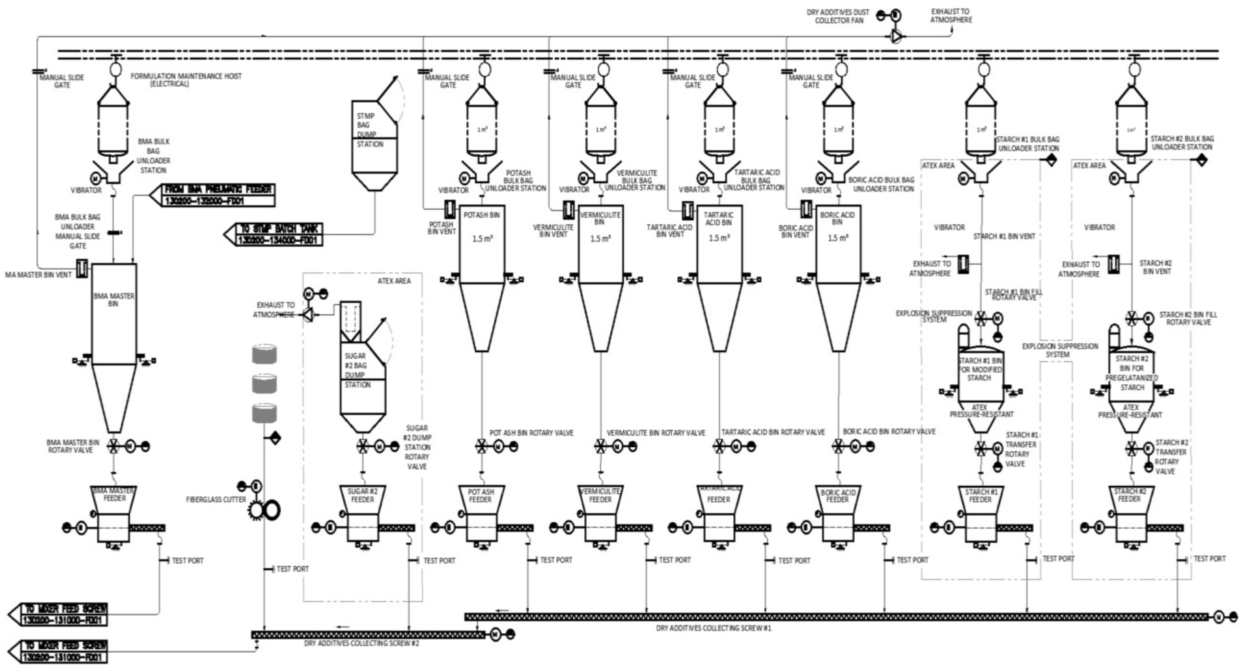

Figure 1.1.3 Dry Adds – Bulk Bag Unloading, Storage, Feed Process Flow

1.1.4 Wet Additives System

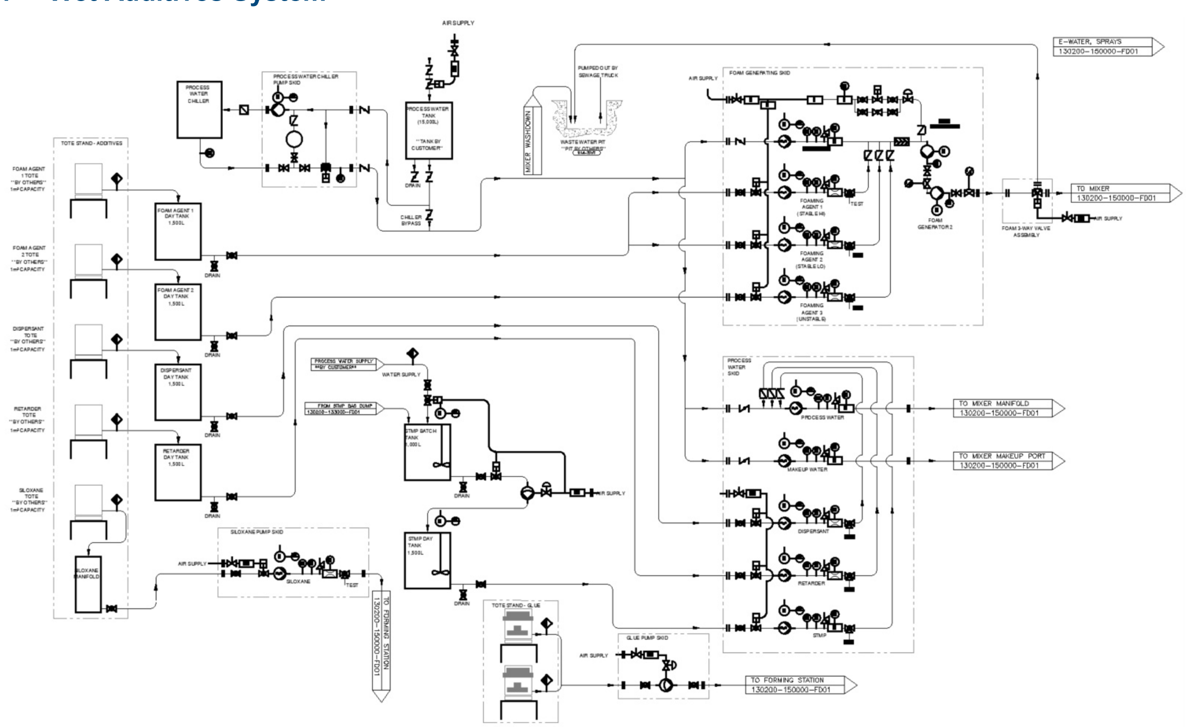

Figure 1.1.4 Wet Additives Process Flow

2 Stucco Handling System Overview

The **Stucco Handling System** operates at full capacity from a single **Stucco Silo** that delivers **Stucco** up to a blend of both Silos. Stucco is continuously circulated from the storage bin discharge back into the bin to achieve thoroughly blended and conditioned stucco.

A three-stage Stucco measuring system with a **Stucco Weigh Belt** provides precise control of the feed-rate to the **Mixer**. Stucco overflow from the Stucco Weigh Belt is recirculated back to the storage bins.

Whenever the **Board Line** is shut down, the **Recirculation Bucket Elevator** and screw conveyors return the stucco back to the storage bins. This allows the measuring system to operate and reach equilibrium prior to Board Line Startup ensuring immediate and accurate feed-rate. This is considered vital for a clean Startup at fast line speeds.

Bucket elevators, rotary valves and screw conveyors include zero speed switches.

Equipment in the Stucco Handling System includes:

- Stucco Silos (By others)
- Bin Vents
- Aeration Discs
- Bucket Elevator
- Screws (Discharge, Scalping, Return, Supply, Pre-Feed, Feed)
- Stucco Weigh Belt
- General Dust Collector
- Fan
- Rotary Valve

A precise Flow Rate of Stucco for producing Board is delivered to the **Mixer** through three operational systems:

- Recirculation
- Stucco Feed
- Dust Collection

2.1 Recirculation

The Stucco Recirculation System constantly recirculates the stucco to maintain and provide constant product to the Stucco Feed System and provide blending of the material in storage. Stucco is a very difficult material to handle because it is easily fluidized, and the parameters of the fluidization are difficult to quantify. Therefore, stucco continuously re-circulates to minimize stucco flow variations. When the plant is not producing board the stucco system will run in re-circulation mode.

Recirculation equipment includes:

- Stucco Silo Feed Screw 1 & 2
- Stucco Silos (2)
- Silos Bin Vent (1)
- Aeration Discs (2)
- Stucco Silo Slide Gate (2)
- Silo Discharge Rotary Valves (2)
- Silo Discharge Screw (2)
- Stucco Recirculation Bucket Elevator
- Silo Scalping Screw
- Silo Feed Screws (2)
- Silo Feed Slide Gate (2)
- Return Screw

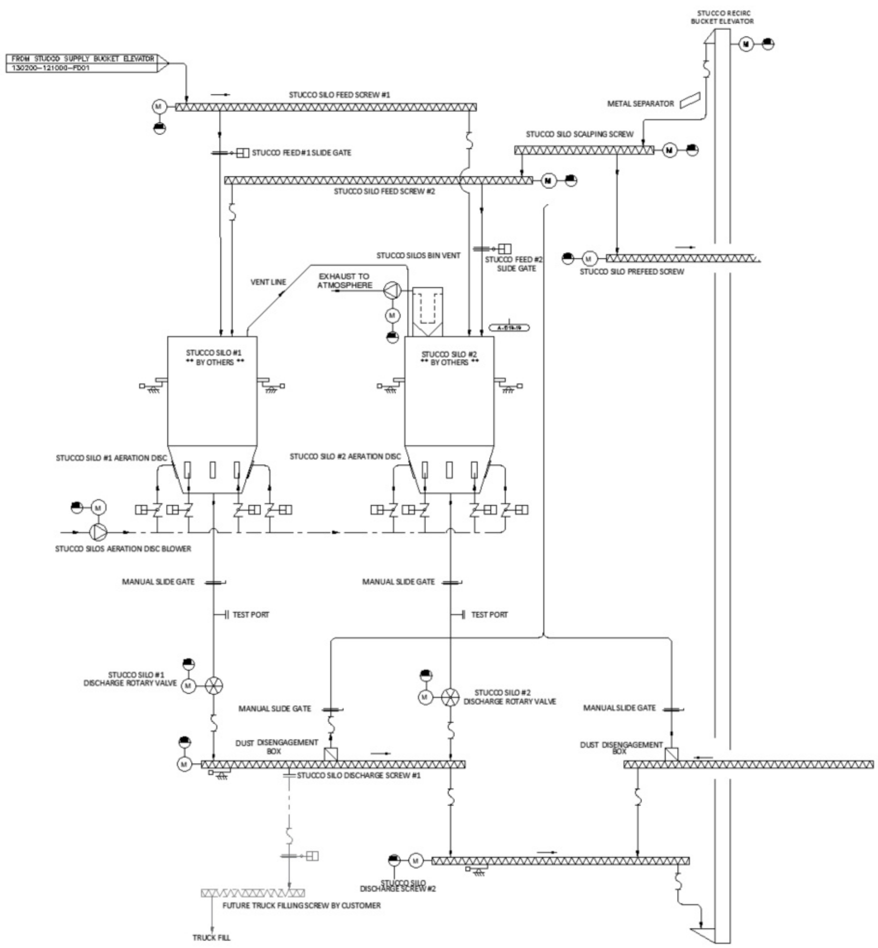

Figure 2.1 Recirculation Equipment

2.1.1 Stucco Silos (By others)

The **Mill Area** supplies a working volume of **Stucco** for the **Board Plant** to the two 250 m^3 Stucco **Silos** within the **Stucco Handling System** located in the **Formulation Area**. These Silos also receive recirculated Stucco returning from the Feed.

An **Aeration Disc** and **Rotary Valve** controls the discharge for each Silo to the **Discharge Screws** prior to the **Recirculation Elevator**. **Load Cells** control inventory and a **High-Level Limit** switch monitors **Silo Levels**.

Table 2.1.1 Silo Levels

Level	Monitored by	Action
High	High-Level Limit switch (located in Silo)	• Alarm alerts operator • Alarm Triggers immediate Shutdown of upstream feed equipment **IMPORTANT**: This must be avoided
Stop Fill	Silo Load Cells	Initiates slowdown of material transfer from the Stucco feed
Optimum	Silo Load Cells	Provides an input for transfer-rate control to maintain a constant Silo level
Low	Silo Load Cells	• Alarm alerts operator • Initiates a controlled Shutdown of the Mixer **IMPORTANT**: This must be avoided

2.1.2 Bin Vent

The **Stucco Silo** has a **Bin Vent** mounted on top for dust control. The Vent fan runs all time to maintain de-dusting of the vessel. For proper airflow and efficiency, solenoids pulse in sequence and blast air into the Bags to knock off dust that has attached onto the Bags.

If the Vent air header low-pressure switch indicates low pressure, then the air to that Vent can be turned off while it is investigated, or the system comes to a controlled stop.

The PLC monitors differential pressure of the Bin Vent and displays pressure on the HMI along with alarms:

- **No Pressure**: A bag may be broken, check bags
- **High Pressure**: Bags are blinded over with dust, replace bags or check pulsing system

2.1.3 Aeration Disc

Each **Silo** has an **Aeration Disc** that activates the Stucco Storage Bin to prevent bridging and promote consistent flow, and their own positive displacement blower to pressurize the system.

The Aeration Discs are divided into four quadrants that can be activated in different patterns depending on stucco flow characteristics.

2.1.4 Discharge Rotary Valve

Each Silo has a **Discharge Rotary Valve** which acts as an airlock with modulated speed to maintain a Setpoint load in the **Discharge Screws**. Variable-Frequency drives control speed to provide accurate control of Bin discharge rates. The Slide Gate located above the Valve provide for maintenance access.

2.1.5 Discharge Screws

The **Discharge Screws** convey Stucco to the **Recirculation Bucket Elevator**. Each Discharge Screw is mounted on a **Load Cell** which controls and provides feedback to the **Discharge Rotary Valve** PID loop. Mass flow-rate output is determined by weight value in conjunction with the Screw speed. This Load Cell adjusts the speed of the Rotary Valve to hold weight constant.

When a Discharge Screw:

- **Speeds Up**: The Screw empties and the Rotary Valve speed increases to maintain load
- **Slows Down**: The Load begins to rise, and the Rotary Valve slows down for correction

Note: During an emergency Shutdown or a controlled Shutdown of the **Mixer**, the Stucco Silo Discharge Screws immediately reduce RPM to reduce material flow to the **Recirculation Bucket Elevator** and minimize surge volume.

2.1.6 Stucco Recirculation Bucket Elevator

The **Stucco Recirculation Bucket Elevator** delivers **Stucco** to the **Mixer** and back to the **Stucco Silos** in the **Recirculation Zone**. This promotes blending of old and new stucco to avoid sudden changes at the Mixer. This Elevator has a speed sensor, inspection hatches, and a metal separator at the exit (discharge) to trap any loose metal from entering the **Stucco Handling System**.

The Elevator uses Motor current to transfer Stucco to the **Silo Scalping Screw**. When the **Recirculation Zone** is on, the **Elevator** always runs. This Elevator is sized for full production and scalping at two locations, plus some buffer for additional blending. Inlet and Outlet level sensors detect overload. If this Elevator becomes overloaded, the HMI displays an alarm, and the **Stucco Handling System** stops.

2.1.7 Stucco Silo Scalping Screw

The **Silo Scalping Screw** delivers **Stucco** to the **Prefeed Screw** in the **Stucco Feed Zone**. Any overage scalping is transferred back to the **Recirculation Zone** and blended with new Stucco from the **Mill Area**.

2.1.8 Stucco Silo Feed Screws

The **Stucco Silo Feed Screw** 1 transports Stucco from Stucco Supply Bucket Elevator into the Stucco Silos. The **Stucco Silo Feed Screw** 2 transfers Stucco scalped by the **Silo Scalping Screw** over the **Prefeed Screw** back into a **Stucco Silos**.

2.1.9 Stucco Silo Feed Screws Slide Gates

The **Stucco Silo Feed Screw Slide Gates** are used to direct material flow towards either Stucco Silo 1 or 2 based on the storage availability and system requirements during operation of the plant.

2.1.10 Return Screw

The **Return Screw** receives unused stucco from overflow screw, dust collector return screw and mixer feed screw. It transfers the collected stucco to the stucco silo discharge screw 2.

2.1.11 Recirculation Zone Modes

When the **Board Plant** is not producing Board, the **Stucco Handling System Recirculation Zone** runs in **Recirculation** mode to control the mass flow of stucco transferred through the **Discharge Screws**. The mass flow Setpoint of the Discharge Screw loop controls the Volume:

- **Low Volume**: Discharge Screw runs at a lower mass flow Setpoint; Discharge Rotary Valve runs slower to maintain load in the downstream Screw
- **High Volume**: Discharge Screw increases output; Discharge Rotary Valve speeds up to maintain loading in the downstream Screw

The Discharge Screw PID loop Set Point automatically changes based on the **Mode** selected.

Table 2.1.11 Recirculation Zone Modes

Mode	Board Plant	Operating Condition
Recirculation	Not running	• No board is being produced • All Stucco bypasses the Stucco Feed Zone and is returned to the Stucco Silo (SS) • Only the Stucco from the Recirculation Bucket Elevator is recirculated • The SS Discharge Rotary Valve runs at low volume
Supply	Preparing to run	• No board is being produced • Stucco is fed to the Stucco Feed only as far as the Mixer Feed Screw and returned via the Return Screw • The Stucco Recirculation Bucket Elevator must recirculate Stucco from the SS and Stucco Feed Zone • The SS Discharge Rotary Valve runs at low volume
Production	Running	• Board is being produced • Stucco is fed to the Stucco Feed Zone and consumed to make Board • The Stucco Recirculation Elevator recirculates Stucco from the SS, and also a small overflow amount from the Stucco Feed • The SS Discharge Rotary Valve runs at high volume

2.2 Stucco Feed

The **Stucco Feed** system accurately meters a measured amount of **Stucco** from the **Recirculation Zone** into the **Screw Conveyor** that feeds into the **Mixer**. When the **Board Plant** is preparing to make product, Stucco is fed as far as the **Mixer Feed Screw** and then the **Return Screw** feeds Stucco back to the **Recirculation** system until flow rate is stable.

Stucco Feed equipment includes:

- Prefeed Screw
- Rotary Screen
- Scalping Screw
- Stucco Weigh Belt Rotary Valve
- Stucco Weigh Belt Feeder
- Mixer Feed Screw
- Mixer Diverter Butterfly Valve
- Overflow Screw
- Return Screw

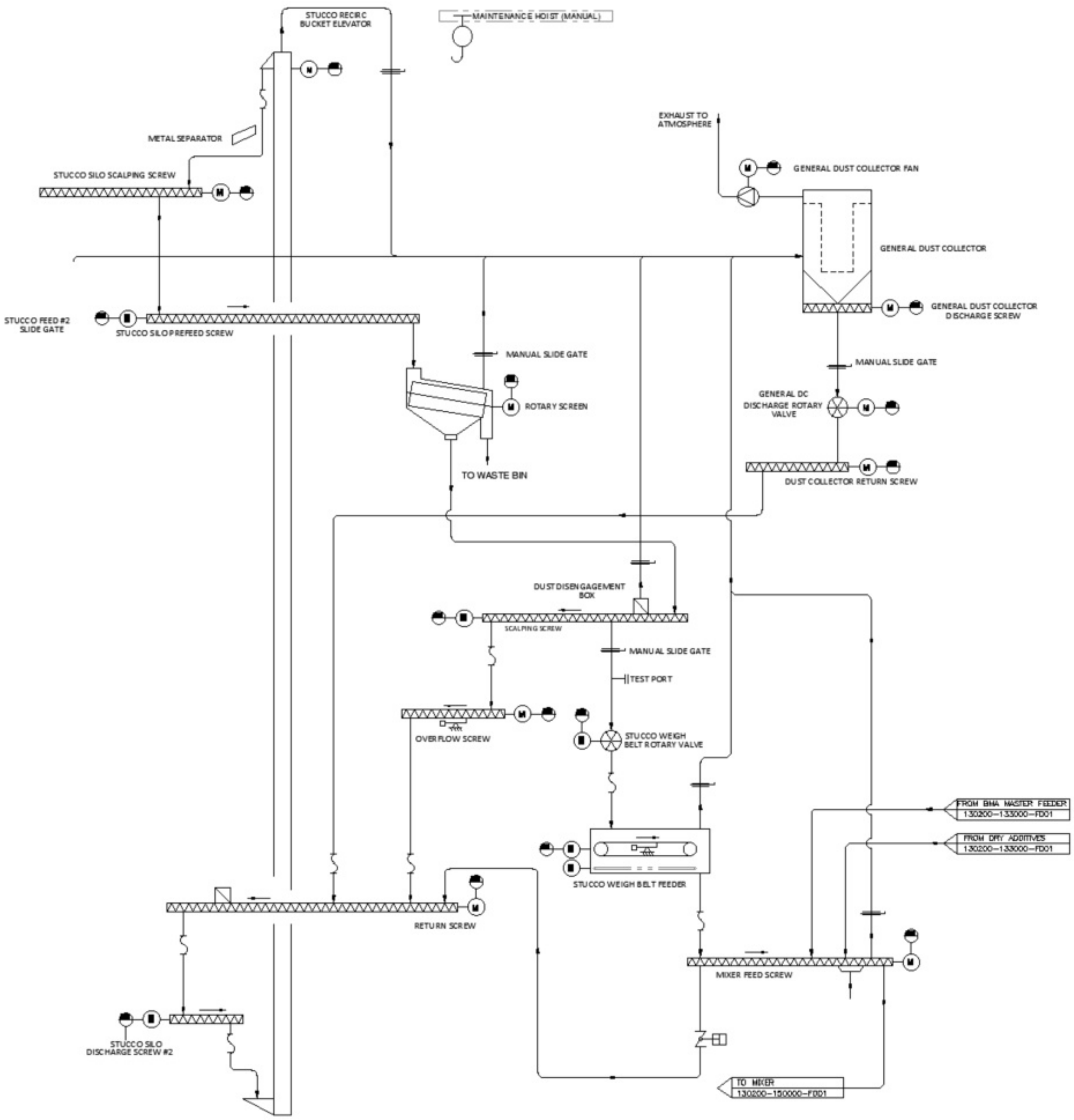

Figure 2.2 Stucco Feed Equipment

2.2.1 Prefeed Screw

The Pre-Feed Screw is the first of a series of specially designed screw conveyors which control the flow of stucco to the Mixer. The Pre-Feed Screw is a volumetric feeder fed by the Stucco Silo Scalping Screw of the Stucco Recirculation System. The Pre-Feed Screw's inlet is maintained at 100% fill via a PID based upon the amount of stucco passing through the Overflow Screw.

The Pre-Feed Screw's RPM is adjusted as required to maintain the established over-flow set point. Pre-Feed Screw can be operated in manual or automatic mode. It is recommended to only use the manual made during establishing initial system start-up or during testing. **At no time should the Pre-Feed Screw be operated in manual mode during production runs.**

In **Manual Mode**, the Pre-Feed Screw runs at a constant speed that is adjustable by the operator using the Stucco Speed Setup HMI control screen.

In **Auto Mode**, the Pre-Feed Screw speed is controlled using a correlated data function (CDF) in the PLC at start-up and then a PID algorithm during production.

A CDF is a graph that establishes a relationship of the volume of stucco required for making board to the required speed of the Pre-Feed Screw. Using this relation, the speed of the Pre-Feed Screw can be obtained and set such that the required stucco volume is supplied to the Rotary Screen. CDF control is only used during the start-up of the Feed System. After a brief period, the speed of the Pre-Feed Screw is controlled using a PID algorithm.

Prefeed Screw Modes:

- **Manual**: Runs at a constant speed; HMI **Stucco Speed Setup** control screen is adjustable by operator
- **Auto**: A correlated data function (CDF) in the PLC controls the speed at Startup; Control during normal running conditions is by PID algorithm

IMPORTANT: It is recommended that **Manual** mode be used Only during initial system Startup or testing. Never operate the **Prefeed Screw** in Manual mode during production runs.

2.2.2 Rotary Screen

The Rotary Screen disperses lumps and separates foreign material (e.g., paper) from the stucco. It has two discharges: one for clean stucco and one for waste material.

The Rotary Screen contains an inclined, rotating drum with walls made of perforated metal. As stucco enters the drum, finer material easily passes through the small holes on the perforated metal and out the clean discharge. Foreign and unwanted material is unable to pass through the perforations and instead travels down the drum and out the waste material discharge. The rotating drum also facilitates breaking up of any lumps of stucco material. The Rotary Screen runs at a constant feed when the Stucco Feed system is enabled.

2.2.3 Scalping Screw

The function of the Scalping Screw is to collect material from the Rotary Screen and supply it to the Stucco Weigh Belt Feeder via rotary valve in a scalping action, with excess material conveyed to the Overflow Screw, which returns the material to the Recirculation System via the Return Screw. The Scalping Screw runs at a constant speed when the Feed System is enabled.

2.2.4 Stucco Weigh Belt Rotary Valve

Stucco Weigh Belt Rotary Valve acts as an airlock with modulated speed to maintain a Setpoint load in the Stucco Weigh Belt Feeder based on process requirements. Variable-Frequency drives control speed to provide accurate control of Scalping Screw discharge rates. The Slide Gate located above the Valve provides for maintenance access. Test port above the Valve is used to take samples of the material for testing purposes.

2.2.5 Stucco Weigh Belt Feeder

The Weigh Belt is used to measure the quantity (flow rate) of stucco. The function of the Weigh Belt is to provide a consistent reference of weight measurement which is used to control and modulate (as required) the measuring devices upstream of the Mixer. The Weigh Belt consists of a Belt conveyor mounted on a weigh scale bridge.

The load of the stucco on the belt is measured by a load cell. This measurement when combined with the speed of the belt is used to calculate the stucco flow rate.

2.2.6 Mixer Feed Screw

The Mixer Feed Screw is a tubular reversible screw that meters a consistent flow of Stucco to the Mixer during production. When the Mixer is stopped, this Screw runs in reverse to clear itself and feed Stucco back into the Recirculation Zone prior to Startup. This ensures that each Mixer start can be repeatable. When running in reverse the Mixer Feed Screw operates as part of the Stucco Recirculation System.

This Screw is a special design with ribbon-type flights which operates at a high RPM to eliminate the surge-type flow normally presented with a standard screw conveyor. The speed of the Mixer Feed Screw is set during commissioning and does not change.

2.2.7 Mixer Diverter Butterfly Valve

A pneumatic Mixer Diverter Butterfly Valve is used to divert Stucco from the Recirculation Zone to the Mixer during operations. With the Butterfly Valve open, Stucco is delivered to the supply side and sent back to the Stucco Recirculation Bucket Elevator. Once the Stucco feed-rate is at setpoint and stabilized, the Mixer can start up with a repeatable Stucco delivery.

2.2.8 Overflow Screw

The Overflow Screw is a screw conveyor with weight measurement mounted on a pivoting joint at the Outlet end. The Inlet end of the Screw is mounted on a Load Cell to control the Prefeed Screw speed. The presence of material in this Screw is a gage of how much, if any, is being scalped off the Inlet of the stucco weigh belt feeder via rotary valve.

2.2.9 Return Screw

When the Mixer Diverter Butterfly Valve is closed, the Return Screw conveys Stucco to the Stucco Recirculation Bucket Elevator in the Recirculation Zone.

2.3 Dust Collection

The **Dust Collection** system vents air, dust, and moisture. Pressure is equalized throughout the conveying loops to remove moisture which reduces material buildup, clumping, and binding. Recovered **Stucco** dust is reintroduced into the **Stucco Feed Zone**.

Dust Collection equipment includes:

- General Dust Collector (DC)
- DC Collector Fan
- DC Discharge Screw
- DC Rotary Valve
- DC Return Screw

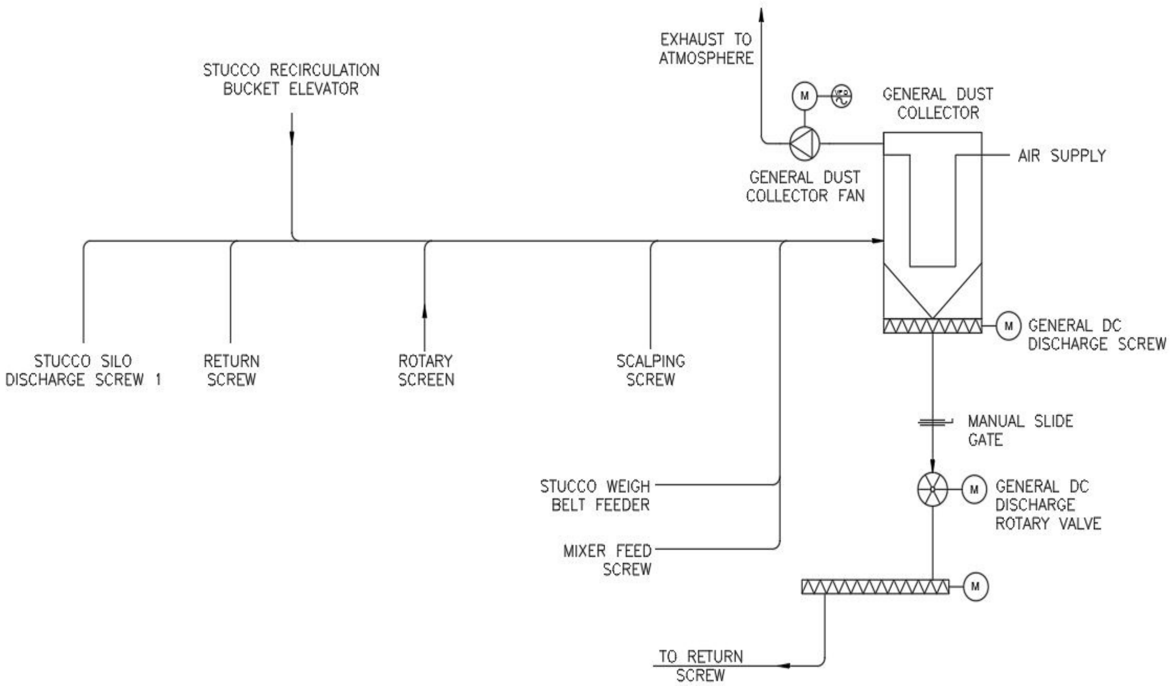

Figure 2.3 Dust Collection Equipment

2.3.1 General Dust Collector

The **General Dust Collector (DC)** collects the **Stucco Dust** in the **Stucco Handling System**. The DC Hopper has a screw conveyor live bottom that discharges dust to the **General DC Rotary Valve**. This Valve feeds the **General DC Return Screw** which feeds to the **Return Screw** in the **Stucco Feed Zone**.

This DC is connected with ductwork to ventilate the conveyor systems for dust control. It discharges into the **Recirculation Zone** for dispersion and blending.

The General Dust Collector picks up Stucco Dust generated from the following equipment:

- Stucco Recirculation Bucket Elevator
- Stucco Silo 1 Discharge Screw
- Return Screw
- Rotary Screen
- Scalping Screw
- Mixer Feed Screw
- Stucco Weigh Belt Feeder

The **General DC Controller** individually pulses many rows of bags using compressed air and solenoid valves. Rows are not pulsed one after the other, for example, pulse one row, skip two rows. Solenoid valve pulse and dwell times are controlled so that dust does not get knocked onto adjacent rows of bags. This also allows the header air pressure to recover before pulsing again.

A differential pressure transmitter monitors **Dust Collector** loading by measuring the pressure across the DC from clean-side to dirty-side. The DC starts a cleaning cycle at the **High** setpoint (inches water column), pulsing through all the bags in the system until differential pressure is below the **Low** setpoint, then the cleaning cycle stops.

Table 2.3.1 Dust Collector Pressure

If…	Then…
Differential pressure reaches 5-in.	A pulsing cycle begins and continues until the differential pressure is 3-in.
Pressure does not drop after an attempted pulse of a bag row	The PLC flags that row as not pulsing and triggers an alarm
Pressure drops but does not recover after a pulse	The PLC flags the valve in that row as not closing and triggers an alarm
Header Pressure is too low	The PLC alarms the operator

In the **Dust Collection Zone**, a High-level switch monitors the level in the **DC Hopper**. When the level is above this switch, an alarm is generated. If the switch is not cleared by a predetermined time set by a programmer or maintenance personnel, stops pulsing its bags and the **DC Fan** stops.

Note: The General Dust Collector falls into the category of nuisance dust collection and does not affect production when shut down, so the **Stucco Handling System** continues to operate.

2.3.2 General DC Fan

The **General Dust Collector (DC) Fan** draws air and dust through the **Dust Collection Zone**. The Dust Collection Control loop controls its operations.

2.3.3 General DC Discharge Screw

The **General Dust Collector (DC) Discharge Screw** collects and transfers material from the **DC** to the **General DC Discharge Rotary Valve** to keep the **DC Hopper** clear at all times.

2.3.4 General DC Discharge Rotary Valve

The **General Dust Collector (DC) Discharge Rotary Valve** serves as an airlock and discharges material from the **DC**.

2.3.5 General DC Return Screw

The **General Dust Collector (DC) Return Screw** moves material from the **Dust Collection Zone** to the **Return Screw** in the **Stucco Feed Zone**.

3 Ball Mill Accelerator System Overview

The Ball Mill System stores Land Plaster (LP) and Sugar which is fed to the Ball Mill for production of the high potency fine mixture known as Heat Resistant Accelerator or Ball Mill Accelerator (BMA).

The most common accelerator used for reducing the setting time of calcined gypsum is BMA, which is LP and Sugar that has been ground to a high degree of fineness. When freshly prepared, BMA has high potency. When stored prior to use, particularly near moisture or heat, the effectiveness of BMA is lost. Intermixing LP with sugar, a stabilizing aid, protects it from calcining during the milling operation and stabilizes it for prolonged storage purposes. Refer **Figure 2.2** for process flow.

The Ball Mill System consists of the following equipment:

- LP Day Bin with Discharge Screws
- LP Bin Vent
- LP Bin Butterfly valve
- LP Feeder (LIW)
- Sugar 1 Bag Dump Station
- Sugar 1 Butterfly Valve
- Sugar 1 Feeder (LIW)
- Ball Mill
- Ball Mill Discharge Screw
- Ball Mill Discharge Screw Slide Gate
- BMA Pneumatic Feeder (Blow Pot) Dense Phase
- BMA Bulk Bag Unloader Station
- BMA Master Bin
- BMA Master Bin Vent
- BMA Master Bin Rotary Valve
- BMA Master Feeder

3.1 LP Day Bin and Discharge Screws

The LP Day Bin stores and feeds LP to the LP Feeder. Material is discharged automatically to the feeder through the LP Bin Discharge Screws and LP Bin Butterfly Valve at the request of the LP Feeder.

3.2 LP Bin Vent

The LP Bin Vent vents the bin to prevent fugitive dust emissions. Venting is done via a PID loop to ensure the desired negative pressure is maintained.

3.3 LP Bin Butterfly Valve

LP Bin Butterfly Valve is used to shut-off or direct the material flow to the LP Feeder at the desired flow rate. It is pneumatically operated.

3.4 LP Feeder

The LP Feeder receives LP from the LP Day Bin, and then transfers it to the Ball Mill. The LP Feeder runs gravimetrically via loss in weight to provide the required amount of material being fed to the Ball Mill while monitoring the load cell readings to adjust the feed rate gravimetrically to suit. The feeder's metering mechanism produces a continuous, reliable, and uniform discharge of material which is controlled on a volumetric basis. When running in PID/AUTO mode the speed of the feeder will be controlled by the HMI formulation set points. This can be adjusted from the HMI BMA screen. Periodic drop checks should be recorded to confirm the feed rate of land plaster.

The LP Feeder and the Sugar Feeder are interlocked such that both must run at the same time. This interlock ensures the correct formula of Land Plaster and Sugar.

3.5 Sugar 1 Bag Dump Station

Sugar 1 Bag Dump Station located above the Feeder drops material to the Sugar 1 Feeder. A Bin Vent mounted on the Dump Station collects the dust and releases clean air inside the building.

3.6 Sugar 1 Butterfly Valve

Sugar 1 Butterfly Valve is used to shut-off or direct the material flow to the LP Feeder while maintain desired flow rate. It is pneumatically operated.

3.7 Sugar 1 Feeder

The Sugar 1 Feeder receives the material from the Sugar Dump Station, and then transfers it to the Ball Mill. The Sugar Feeder runs gravimetrically via loss in weight to provide the required amount of material being fed to the Ball Mill while monitoring the load cell readings to adjust the feed rate gravimetrically to suit. The feeder's metering mechanism produces a continuous, reliable and uniform discharge of material which is controlled on a volumetric basis. When running in PID/AUTO mode the speed of the feeder will be controlled by the HMI formulation set points. This can be adjusted from the HMI BMA screen. Periodic drop checks should be recorded to confirm the feed rate of Sugar.

The Sugar Feeder and the LP Feeder are interlocked such that both must run at the same time. This interlock ensures the correct formula of Land Plaster and Sugar.

3.8 Ball Mill

The Ball Mill produces BMA by grinding materials into extremely fine powder. When the Ball Mill is enabled, LP and sugar are continuously fed at one end and BMA discharged at the other end. The mill discharges into the Ball Mill Discharge Screw. For more details refer Ball Mill manual and drawings.

3.9 BMA Discharge Screw

The BMA Discharge Screw runs below the Ball Mill, collects the BMA from the Ball Mill above and moves the material to the Surge Bin & Chute through BMA Discharge Screw Slide Gate.

3.10 Surge Bin

The Surge Bin acts as a buffer or reservoir for material, ensuring steady and consistent supply to downstream processes, even in the face of fluctuations in material input or processing demands.

3.11 BMA Pneumatic Feeder (Blow Pot) Dense Phase

The BMA Dense Phase Blow Pot is a pneumatic conveying vessel, and it transfers BMA from the Surge Bin & Discharge Screw to the BMA Master Bin. It is designed to transfer the BMA at the rate of 250 kg/hr.

3.12 BMA Bulk Bag Unloader Station

The BMA Bulk Bag Unloader Station feeds the BMA to the BMA master bin. It has a pneumatic vibrator on the wall to aid in the material discharge. The loading of bulk bags is manually performed by the operator according to plant demands using hoist.

3.13 BMA Master Bin

The BMA Master Bin is a storage bin for the BMA Feeder that will hold $1.5m^3$ of material. The Day Bin is mounted on load cells for inventory control. The Bin discharge has a Slide Gate for maintenance followed by the Bulk Bag Unloader Station.

3.14 BMA Master Bin Vent

The BMA Bin Vent controls dust inside the day bin and remove air put into the bin by the BMA pneumatic transfer system. The bin vent is equipped with pulsing solenoids that are programmed to pulse in sequence, causing air to be blasted into the bags which knocks off dust attaching onto the bags, restoring proper airflow and dust collecting efficiency. The differential pressure across the bags is monitored by a differential pressure transmitter. The supply of compressed air to the bin vent is monitored by a pressure switch.

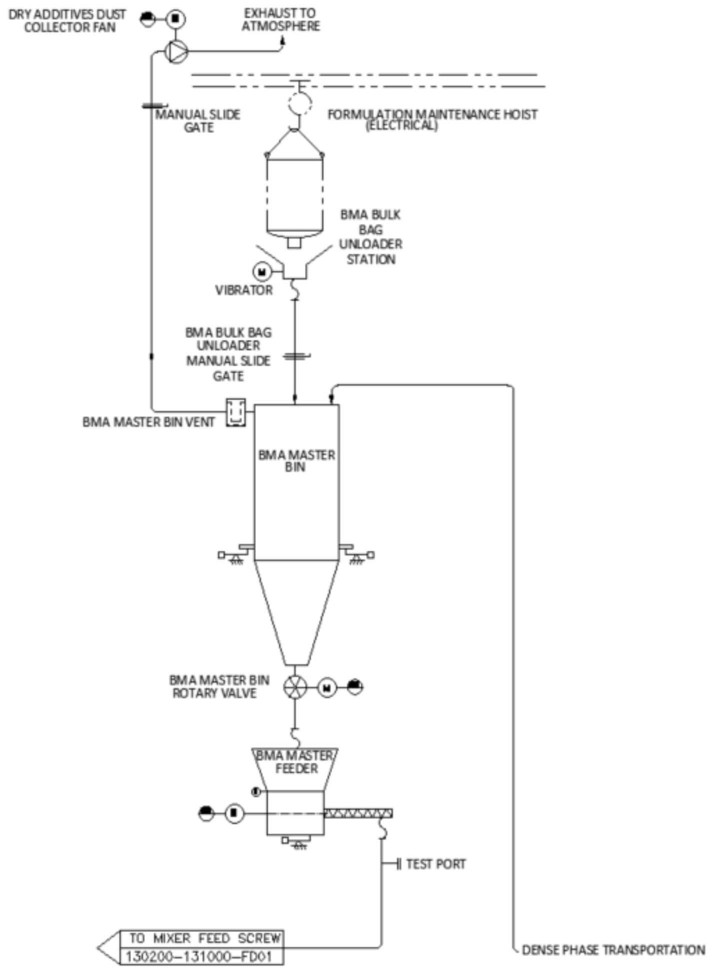

Figure 3.14 BMA Feed System

3.15 BMA Master Bin Rotary Valve

The BMA Master Bin Rotary Valve starts and stop automatically to fill the feeder when required.

3.16 BMA Master Feeder

The BMA Feeder is a loss-in-weight (LIW) volumetric Feeder that transfers BMA material from the BMA Master Bin to the Mixer Feed Screw. This Feeder runs gravimetrically to provide the required amount of material required for formulation requests, monitor load cell readings, and adjust feed-rate. Two separate-sized augers provide a wider range of feed-rates.

The metering mechanism of the BMA Feeder produces a continuous, uniform, and reliable discharge of material which is controlled on a gravimetric basis. The HMI formulation set points control BMA Feeder speed when running in PID/AUTO mode. The operator can adjust settings from the BMA or Main Formulation screen.

Periodic drop checks should be recorded to confirm the feed rate of BMA.

4 Dry Additives System Overview

The **Dry Additives System** is made up of several additive bins, each connected to loss-in-weight (LIW) feeders. All **Feeders** have vents. All Dry Additives are filled from bulk bags at dump station level with the bags lifted using the **Material Hoist**, except for the BMA Master bin and Sugar 2 Bag Dump Station. BMA system has been explained in Chapter 4. Refer **Figure 1.1.3** for Dry Additives system process flow. Control of the blow-up equipment and the vacuum system is done at the operator **HMI** station.
Dry Adds systems:

- Starch System
- Sugar 2 Feed System
- Dry Adds Bulk Bag Unloading, Storage and Feed systems
- Fiberglass Cutter and Feeder system

4.1 Starch System

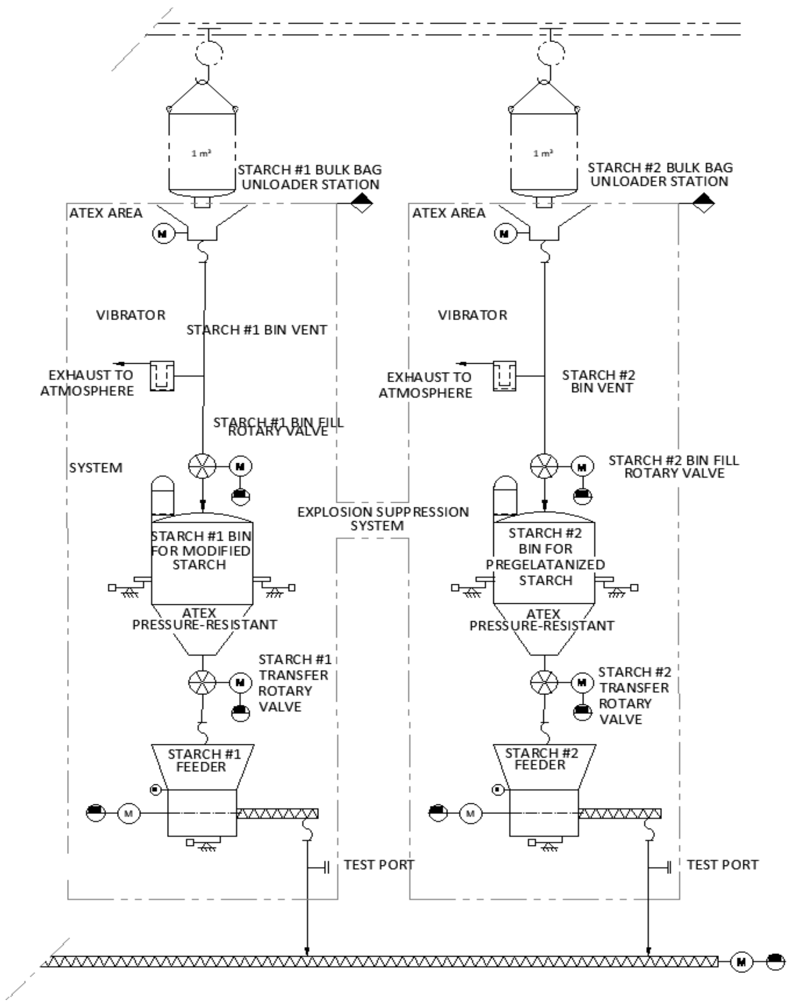

Figure 4.1 Bulk Starch

4.1.1 Starch #1 & #2 Bulk Bag Unloader Stations

Bag Unloader located above the bins drops material to the Starch #1 & #2 bins. A **Vibrator** mounted on the Unloader encourages smooth material flow. The **Rotary Valve** controls the flow of material into the storage bins and acts as a pressure lock to prevent back charges.

4.1.2 Starch #1 & #2 Bins

The Starch #1 Bin stores **modified starch** and Starch #2 Bin stores **pregelatinized starch**.

Note: The **Starch Systems are** a **Hazardous Zone**. **Explosion Proof rating, IECEx, Zone 22**.

The **Bin Vent** on top of the Bins evacuates excess air that enters during the bin-filling process and limits the amount of dust released into the atmosphere. This Vent is equipped with pulsing solenoids that are programmed to pulse in sequence, causing air to be blasted into the bags which knocks off dust that attaches onto the bags, restoring proper airflow and dust-collecting efficiency.

4.1.3 Starch #1 & #2 Feeders

The Starch #1 & #2 Feeders receive the material from the Bins, and then transfers it to the Dry Additives Collecting Screw 1. The Starch Feeders run gravimetrically via loss in weight to provide the required amount of material being fed to the Dry Additives Collecting Screw 1 while monitoring the load cell readings to adjust the feed rate gravimetrically to suit. The feeder's metering mechanism produces a continuous, reliable and uniform discharge of material which is controlled on a volumetric basis. When running in PID/AUTO mode the speed of the feeder will be controlled by the HMI formulation set points. This can be adjusted from the HMI BMA screen. Periodic drop checks should be recorded to confirm the feed rate of the related materials.

Table 4.1.3.1 Starch #1 System Requirements

Density	Mass Flow Range	Exhaust Vented	Combustible Dust	Hazardous Zone
520 kg/m³	25 to 133 kg/hr	Externally	Yes	Yes

Table 4.1.3.2 Starch #2 System Requirements

Density	Mass Flow Range	Exhaust Vented	Combustible Dust	Hazardous Zone
520 kg/m³	98 to 398 kg/hr	Externally	Yes	Yes

4.1.4 Explosion Protection System

The **Starch Bin**, and **Pregelatinized Bin**, are pressure rated vessels designed to contain any dust explosion. The vessels are fitted with a pressure sensor, and controller to alert operators and the PLC of an event and stop the process.

4.2 Sugar 2 Feed System

Sugar 2 Feed System Consists of:

- Sugar 2 Bag Dump Station
- Sugar 2 Dump Station Rotary Valve
- Sugar 2 Feeder

4.2.1 Sugar 2 Bag Dump Station

Bag Dump Station located above the feeder drops the material to the Sugar 2 Feeder. The bag of sugar is dumped into the hopper manually by operator to suit the process requirements.

4.2.2 Sugar 2 Bag Dump Station Rotary Valve

The **Rotary Valve** controls the flow of material into the feeder and acts as a pressure lock to prevent back charges.

4.2.3 Sugar 2 Feeder

The Sugar 2 Feeders receive the material from the Dump Station, and then transfers it to the Dry Additives Collecting Screw 2. The Sugar 2 Feeder runs gravimetrically via loss in weight to provide the required amount of material being fed to the Dry Additives Collecting Screw 2 while monitoring the load cell readings to adjust the feed rate gravimetrically to suit. The feeder's metering mechanism produces a continuous, reliable and uniform discharge of material which is controlled on a volumetric basis. When running in PID/AUTO mode the speed of the feeder will be controlled by the HMI formulation set points. This can be adjusted from the HMI BMA screen. Periodic drop checks should be recorded to confirm the feed rate of the sugar.

Table 4.2.3 Sugar 2 System Requirements

Density	Mass Flow Range	Exhaust Vented	Combustible Dust	Hazardous Zone
640 kg/m³	5 to 17 kg/hr	Externally	Yes	Yes

4.3 Dry Adds Bulk Bag Unloading, Storage, and Feed Systems

The **Dry Adds Bulk Unloading, Storage, and Feed** system supplies the **Mixer** of various **Dry Additives** needed by various systems according to recipe requirements.

Dry Adds Bulk Bag Unloading, Storage, and Feed Systems include:

- Potash System
- Vermiculite System
- Tartaric Acid System
- Boric Acid System

All the above systems have:

- Bulk Bag Unloading Station
- Bin with Bin Vent
- Roary Valve
- Feeder

4.3.1 Bulk Bag Unloading Station

Bulk Bag Unloading Stations are located above their related bins. A **Vibrator** mounted on the Unloader encourages the smooth material flow. The **Rotary Valve** controls the flow of material into the feeders.

Note: The **Bulk Bag Unloading Stations** have bin vents to vent displaced air during the filling process.

4.3.2 Bin Vents

Bin Vents control dust during loading cycle so that no visible dust is generated.

4.3.3 Feeders

All the Feeders receive the material from their related Unloading Stations, and then transfer the material to the Dry Additives Collecting Screw 1. The Feeders run gravimetrically via loss in weight to provide the required amount of material being fed to the Dry Additives Collecting Screw 1 while monitoring the load cell readings to adjust the feed rate gravimetrically to suit. The feeder's metering mechanism produces a continuous, reliable and uniform discharge of material which is controlled on a volumetric basis. When running in PID/AUTO mode the speed of the feeder will be controlled by the HMI formulation set points. This can be adjusted from the HMI BMA screen. Periodic drop checks should be recorded to confirm the feed rate of the related materials in the various systems.

Table 4.3.3.1 Potash System Requirements

Density	Mass Flow Range	Exhaust Vented	Combustible Dust	Hazardous Zone
1360 kg/m³	6 to 20 kg/hr	Externally	No	No

Table 4.3.3.2 Vermiculite System Requirements

Density	Mass Flow Range	Exhaust Vented	Combustible Dust	Hazardous Zone
980 kg/m³	118 to 880 kg/hr	Externally	No	No

Table 4.3.3.3 Tartaric Acid System Requirements

Density	Mass Flow Range	Exhaust Vented	Combustible Dust	Hazardous Zone
1740 kg/m³	2 to 19 kg/hr	Externally	No	No

Table 4.3.3.4 Boric Acid System Requirements

Density	Mass Flow Range	Exhaust Vented	Combustible Dust	Hazardous Zone
1440 kg/m³	5 to 17 kg/hr	Externally	No	No

4.3.4 Dry Additives Collecting Screw 1

Two **Dry Additives Collecting Screw 1** collects the additives and deliver them to the **Dry Additives Collecting Screw 2**. Calibration checks are done through **Test Ports** for all the additives.

4.3.5 Dry Additives Collecting Screw 2

Two **Dry Additives Collecting Screw 1** collects the additives and deliver them to the **Mixer Feed Screw**.

4.4 Fiberglass Cutter

The Fiberglass Cutter cuts the fiberglass strips and feeds into the Mixer via Dry additives Collecting Screw 2 and Mixer Feed Screw. Figure 4.4 shows the process flow.

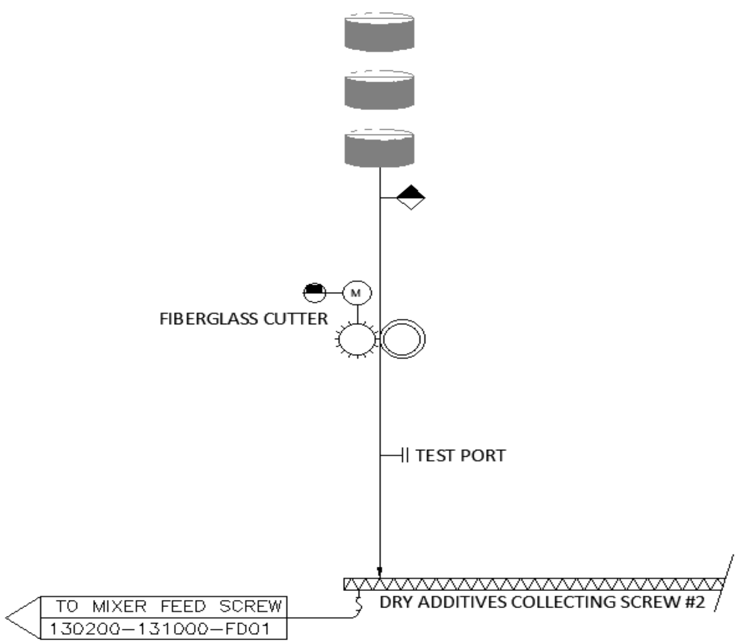

Figure 4.4 Fiberglass Operational Systems

5 Wet Additives System Overview

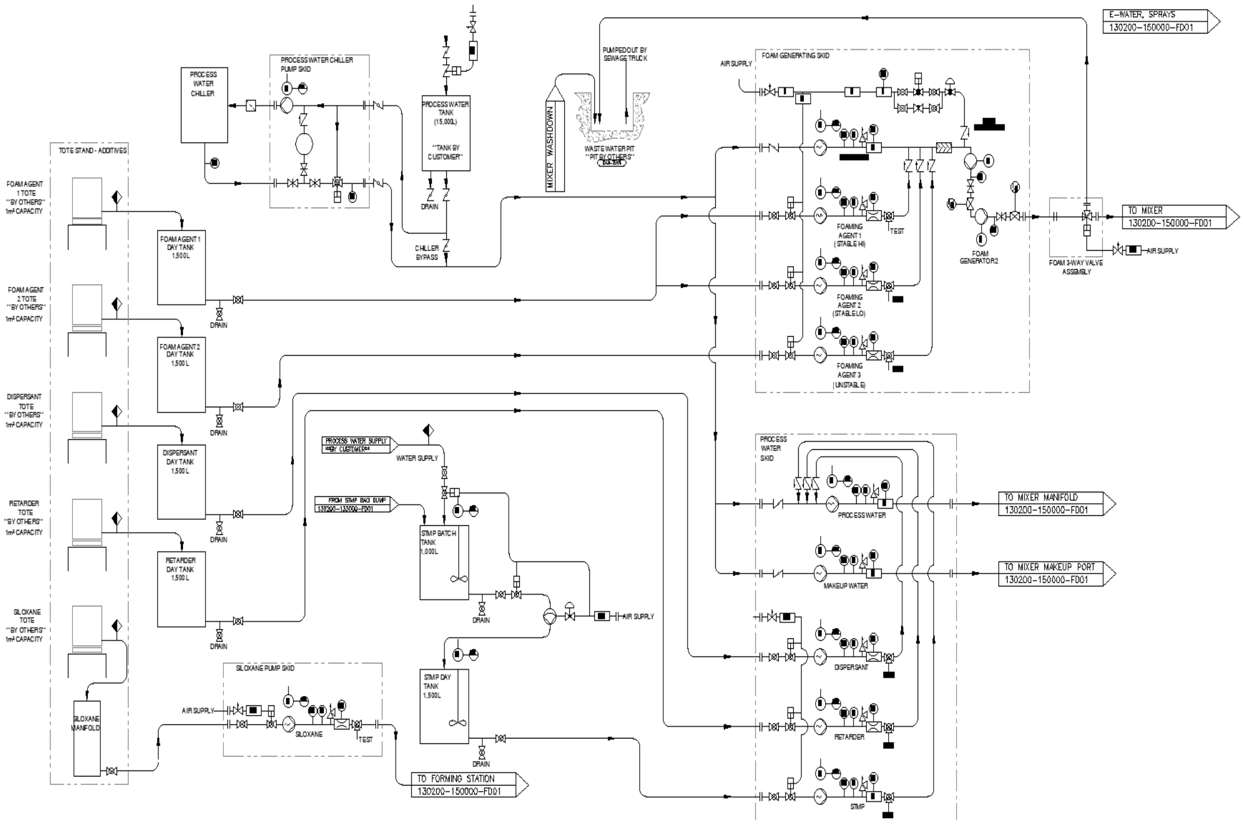

Figure 5.1 Wet Additives Process Flow

The operational systems within the Wet Additives are:

- Process Water System
- Liquid Retarder System
- Dispersant System
- Foam System
- STMP System
- Make-Up Water Pumping System
- Siloxane System
- Edge Paste System

5.1 Pump Control & Flow Rates

It is important to have accurate control of the flow rate of each wet additive. From the HMI formulation controls screen the operator can set the volume set point and the different process control modes (Auto/Manual/Volumetric/PID) for each of the additives. Depending on the process control mode selected the additive's pump will respond differently.

When an additive's process control is selected for manual then the operator has full control of the speed of the pump and can directly enter the speed reference from the HMI screen (0-100% speed reference).

When the additive's process control is selected for Auto the speed of the pump can run either in Volumetric or PID mode:

Auto-Volumetric mode will set the speed of the pump based on a calibration curve. The calibration curve is obtained by performing a drop sample of the running pump and entering the measured data into the calibration screen for the additive. Using this calibration curve the additive's feed rate set-point correlates to a motor speed in percentage. This percentage value is then used to command the speed of the motor. Auto-Volumetric mode is used to run the pump in open loop mode where no flow feedback is required. This mode is useful if the plant wishes to continue to run even if the additives flow meter has malfunctioned.

Auto-PID mode the pump will run at a commanded speed from a PID loop control where the flow meter is used to modulate the speed of the motor (Closed Loop). From the HMI Formulation screen the operator can set the volume set point and view the actual flow rate. The operator will be alerted if the additive's PID control deviates too much from the set point and an alarm will be displayed on the HMI screen. It is important to know that when starting the pump in Auto-PID mode the pump actual starts first in volumetric mode for a short duration and then switches to the PID loop control, this provides a smooth start-up of the PID control and prevents large overshooting of the motor speed.

5.2 Process Water System

The main function of the Process Water System is to provide Process Water to the mixer. Large amounts of water are used to produce fluid and workable slurries. Components on the Process Water system include:

- Process Water Chiller System
- Process Water Tank
- Process Water Pumping System

5.2.1 Process Water Chiller System

The Process Water Chiller System is used to cool the process water down to the desired temperature. This in turn lowers the mixed slurry temperature to the desired level. Components on the Process Water Chiller System include:

- Process Water Chiller Pumping System
- Process Water Chiller

5.2.1.1 Process Water Chiller Pumping System

The Process Water is fed from the Process Water tank to the Process Water Chiller Pump Skid. At the Process Water Chiller Pump Skid, the water splits up. Some of the water runs through the Process Water

Chiller Pump to be transferred to the Process Water Chiller. The cooled water is reintroduced back to the Process Water Pump Skid where is re-mixes with the warm water to produce a water temperature that is acceptable for making board. The Process Water Chiller Pumping System has a temperature transmitter which are responsible for controlling the 3-way mixing valve to ensure the proper temperature is reached.

5.2.1.2 Process Water Chiller

The Process Water is fed from the Process Water Chiller Pump Skid. The Chiller cools the water down and it returns to the Process Water Chiller Pump Skid to mix with warmer water so that a required output temperature is reached.

5.2.2 Process Water Tank

The Process Water is fed from a Process Water Tank. The Process Water Tank has a pressure level transmitter that determines the actual level of water in the tank. The level is shown on the HMI and is also used in the PLC to turn on alarms. The tank unit has a Low-Level Alarm and a High-Level Alarm. It is also equipped with a High-Level Limit Switch. This limit switch serves as a backup alarm indicator should the level transmitter fail to indicate a high-level situation in the tank. If the tank is overfilled past the High-Level Alarm limit, then a High Limit Switch Alarm will be indicated on the HMI for the operators to see.

The tank supplies the Process Water Pump, Makeup Water Pump and Foam Water Pump when the board line is running. It is critical that the tank maintains a constant supply of water. The tank is automatically maintained at approx. 70% level through automatic control of the process water modulating valve. Should the tank level get too low while the board line is running then the "Process Water Tank Low Level Fatal Alarm" will be triggered which will cause a mixer shutdown. The fatal alarm will be displayed so the operator will know what caused the shutdown.

5.2.3 Process Water Pumping System

The Process Water is gravity fed from the Process Water Tank and goes through a progressive cavity pump. Do NOT run the pump dry as this will cause damage. The water then goes through a flow meter which gives out a volumetric flow rate. This Process Water then goes to the Mixer manifold.

5.3 Liquid Retarder System

The function of the Liquid Retarder system is to lengthen the set time of the slurry so that it is controllable. More Liquid Retarder means that the stucco will crystallize further down the production line. Retarder counteracts the initial stiffening of the slurry caused by BMA and minimizes the effects of short setting stucco.

Components of the Liquid Retarder System include:

- Liquid Retarder Day Tank
- Liquid Retarder Pumping System

5.3.1 Liquid Retarder Day Tank

The Liquid Retarder is fed to Retarder pump from a day tank. This day tank is fed from totes that empty into the day tank. The tank has a low-level switch that is used to determine when the tank needs to be refilled. The Low-Level Alarm is used to bring attention to the Operator so that a refill of the day tank can be completed before starving the board making process. The status of the switch is shown on the HMI and is also used in the PLC to turn on alarms.

5.3.2 Liquid Retarder Pumping System

The Liquid Retarder Pumping System consists of a pump and a flow meter.

The Liquid Retarder is gravity fed from the day tank to flood the inlet of the metering pump. Do NOT run the pump dry as this will cause damage. The Retarder is then pumped through a flow meter to merge with the process water before the inlet of the Process Water Pump.

5.4 Dispersant System

The function of the Dispersant is to act as a water reducing agent to reduce the amount of water needed for turning the stucco into manageable slurry.

Components of the Dispersant System include:

- Dispersant Day Tank
- Dispersant Pumping System

5.4.1 Dispersant Day Tank

The Dispersant is fed to Dispersant pump from a Day Tank. This day tank is fed from totes that empty into the day tank. The tank has a low-level switch that is used to determine when the tank needs to be refilled. The Low-Level Alarm is used to bring attention to the Operator so that a refill of the day tank can be completed before starving the board making process. The status of the switch is shown on the HMI and is also used in the PLC to turn on alarms.

5.4.2 Dispersant Pumping System

The Dispersant Pumping System consists of a pump and a flow meter.

The Dispersant is gravity fed from the day tank to flood the inlet of the Metering Pump. Do NOT run the pump dry as this will cause damage. The Dispersant is then pumped through a flow meter to merge with the process water before the inlet of the Process Water Pump.

5.5 Foam System

The function of the foam system is to supply foam to the mixer. The foam is used to add micro-bubbles to the board to reduce the weight of the board. The foam system includes the following equipment:

- Foaming Agent Day Tank
- Foaming Agent Pumping System
- Foam Water Pumping System
- Foam Air System
- Foam Generator System

5.5.1 Foaming Agent Day Tank

The Foaming Agent 1 and 2 are fed from day tanks. These day tanks are fed from totes that empty into both day tanks. Both tanks have a low-level switch that is used to determine when the tanks need to be refilled. The Low-Level Alarm is used to bring attention to the Operator so that a refill of the day tank can be completed before starving the board making process. The status of the switch is shown on the HMI and is also used in the PLC to turn on alarms.

5.5.2 Foaming Agent Pumping System

Each Foaming Agent System consists of a pump and a flow meter.

The Foaming Agent is gravity fed from the day tank to flood the inlet of the metering pump. Do NOT run the pump dry as this will cause damage. The Foaming Agent is then pumped through a flow meter to the intake of the static mixer which mixes the Foaming Agent additive with the Foam Water additive before passing through the two Foam Generators.

5.5.3 Foam Water Pumping System

The Foam Water System consists of a pump and a flow meter.

The water is gravity fed from the process water tank. DO NOT run the pump dry as this will cause damage. The above Foaming Agent is injected into the Foam Water line and mixed in a static mixer to ensure proper and thorough mixing. This mixture is then injected with air and passed through the Foam Generators.

5.5.4 Foam Air System

The Foam Air System consists of 2 regulators, a filter, a flow meter, a control valve, a needle valve and a shut off valve. The amount of air that is injected is controlled automatically by the control valve. If the control valve is malfunctioning, the manual needle valve can be used until the control valve is operational. The flow rate of the air is monitored by the flow meter. The airline has two regulators placed in series which function to limit the fluctuations of the air being supplied. The first regulator is set to around 80 psi to limit most of the waves that occur in air supply and the second regulator is set to around 60 psi to get the proper pressure and eliminate the remaining fluctuations in the air line. These pressures are estimates and depend on plant air pressure and required foam weight. The first regulator is also fitted with a filter to clean any debris that may be found in the air line.

5.5.5 Foam Generator System

The Foam Generator System consists of 2 generators, 2 pressure gauges, and 2 gate valves. The mixture of the Foam Water, Foaming Agent, and Foam Air is passed through a Foam Generator to be beat into thick Foam. After the first generator there is a pressure gauge and a gate valve. The gate valve is used to control the back pressure on the first generator. This ensures that the Foam is beat properly. After the first generator there is another generator that again beats the Foam. This one also has a gate valve and a pressure gauge to control the back pressure on the generator. Standard back pressures for the two Foam Generators are 60 psi for #1 Foam generator and 70 psi for #2 Foam Generator. These values are estimates as the back pressures on the generators depend on the weight of Foam that is to be achieved as well as general running conditions. From the second generator, the Foam travels through reinforced hose to the Foam 3-Way Valve to be distributed to the Mixer.

5.6 STMP System

The STMP system consists of the following components:

- STMP Batch Tank
- STMP Day Tank

- STMP Pumping System

5.6.1 STMP Batch Tank

The STMP Batch Tank has a level transmitter for continuous level read out. The agitator is started once the water fill is complete, and the powder fill is started by the operator. It is also equipped with a High-Level Limit Switch. This limit switch serves as a backup alarm indicator should the level transmitter fail to indicate a high-level situation in the tank. The tank unit has a Low-Level Alarm and a High-Level Alarm.

5.6.2 STMP Day Tank

The STMP Day Tank is fed from the STMP Batch Tank, using an air-operated diaphragm pump. The Agitator runs continuously. The STMP Day Tank has a level transmitter for continuous level read out. The fill valve is closed once the STMP Batch Tank is empty. It is also equipped with a High-Level Limit Switch. This limit switch serves as a backup alarm indicator should the level transmitter fail to indicate a high-level situation in the tank. The tank unit has a Low-Level Alarm and a High Level Alarm.

5.6.3 STMP Pumping System

The STMP Pumping System consists of a pump and a flow meter.

The STMP is gravity fed from the STMP Day Tank to flood the inlet of the STMP metering pump. Do NOT run the pump dry as this will cause damage. The STMP is then pumped through a flow meter to merge with the process water before the inlet of the Process Water Pump.

5.7 Make-Up Water Pumping System

The Make-Up Water Pumping System consists of a pump and a flow meter.

The Makeup Water is gravity fed from the Process Water Tank and goes through a progressive cavity pump. Do NOT run the pump dry as this will cause damage. The water then goes through a flow meter which gives out a volumetric flow rate. This Makeup Water then goes to the Mixer.

5.8 Siloxane System

The function of the Siloxane System is to supply Siloxane to the Mixer. The Siloxane is used to make the gypsum core water resistant. The Siloxane System consists of the following equipment:

- Siloxane Manifold
- Siloxane Pumping System

5.8.1 Siloxane Manifold

The Siloxane is fed to the Siloxane pump from a manifold. This manifold is fed from totes that empty into the manifold. The manifold has a low-level switch that is used to determine when the tote supplying the manifold is empty. The Low-Level Alarm is used to bring attention to the Operator so that a refill of the tote can be completed before starving the board making process. The status of the switch is shown on the HMI and is also used in the PLC to turn on alarms.

5.8.2 Siloxane Pumping System

The Siloxane Pumping System consists of a pump and a flow meter.

The Siloxane is gravity fed from the manifold to flood the inlet of the metering pump. Do NOT run the pump dry as this will cause damage. The Siloxane is pumped through a flow meter and then directly to the Mixer.

5.9 Edge Paste (Glue) System

The function of the Edge Paste System is to bond the front paper to the back paper to form an envelope around the slurry. The Edge Paste System consists of the following components:

- Edge Paste Totes
- Edge Paste Pumping System

The Edge Paste is fed from a tote into the Edge Paste Pumping System. The diaphragm pump pumps the Edge Paste to the quills on the Forming Station. Between the pump and the quill there is a pressure gauge, and a filter. The pressure gauge tracks the pressure in the line and signals when the filter or the line is clogged, by signaling when the pressure becomes too high. The filter is used as a final cleaning of the line just before the Edge Paste reaches the quills, so the quills do not clog up.

The Edge Paste System should be placed in auto to link with the master start function.

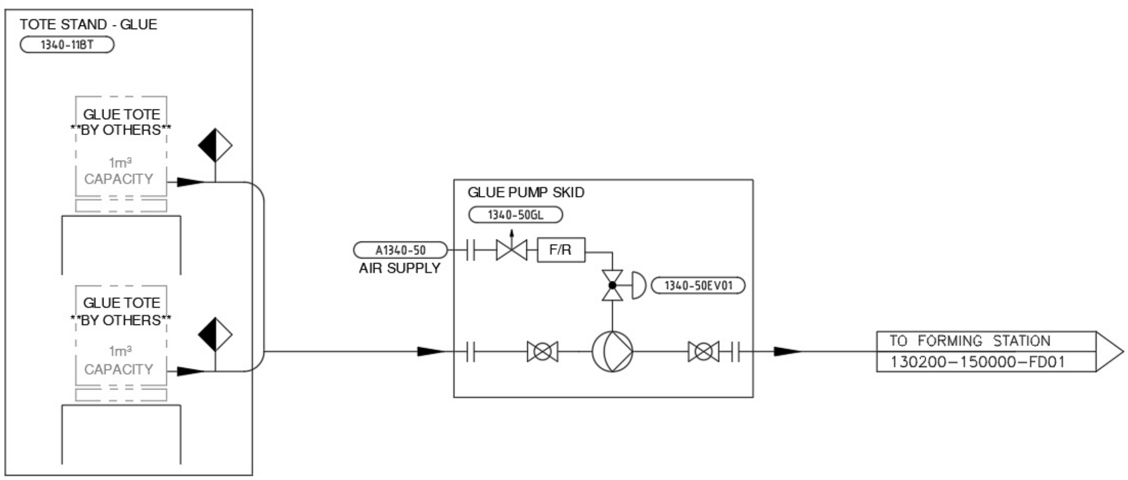

Figure 5.9 Edge Paste System

6 Operator Procedures

Before Startup of the **Formulation Area** – **Stucco**, Ball Mill Accelerator (**BMAO)**, **Dry** and **Wet Additives** systems, confirm that:

- All air valves are open
- All water valves are open
- All equipment is ready
- The HMI shows all motors and valves as READY
- Grinding Agent and LP recipe formulation Set Points are correct for Ball Mill Accelerator (BMA)
- Local selector switches must be running in AUTO with no faults and all loops running within a configurable error tolerance for the Stucco Handling Feed Ready to Mixer signal

The **HMI** indicates if any of the above conditions are not met prior to starting the Line. Click on the **STATUS** box to bring up a screen that highlights any equipment that is not in a **READY** state.

If any of the **Startup** conditions fail during operation, the affected motor automatically shuts down, and the HMI displays the reason for the **Shutdown**.

6.1 Stucco Handling Startup

The HMI **Stucco Overview** screen starts the **Recirculation** system first, and then the **Feed** system. A Stucco Handling interlock associated with the **Master Start Sequence** requires the **Feed** system to be running properly prior to a **Startup**.

The **Stucco Dust Collection (DC)** system automatically starts when the Recirculation or Feed system is turned on. When making Board, the **Mixer Feed Screw** runs forward and delivers metered stucco to the **Mixer**. This Screw runs in reverse when not making Board and sends Stucco back to the Recirculation System.

6.2 Ball Mill Accelerator Startup

For the **Ball Mill Accelerator (BMA)**, Startup of the **LP Feeder** and **Grinding Agent Feeder** is based on the **High** level of the **Ball Mill Run-Around Screw**. These Feeders are interlocked to ensure the correct formula of Land Plaster (LP) and Grinding Agent. Both Feeders must run at the same time.

Before starting the BMA System, confirm that:

- All manual water valves are open.
- All air valves are open.
- The HMI shows all motors and valves in the system: **Ready**
- LP and Grinding Agent recipe formulation set points (feed rates) on the HMI are correct

6.2.1 Stop Fill Condition

The **BMA System** runs continuously unless the BMA Master Feeder reaches the **Stop Fill Condition**. The **Ball Mill Accelerator (BMA) System** Master Feeder starts and stops as required for production. The **BMA Feeder Inlet Rotary Valve** starts and stops as required to refill the **BMA Feeder**.

6.2.2 Refill BMA Bin

Equipment start sequence for **BMA Bin** refill:

1. BMA Bucket Elevator
2. BMA Transfer Screws
3. BMA DC Discharge Rotary Valve
4. BMA Dust Collector Fan
5. BMA Collecting Screw
6. Ball Mill selected
7. Ball Mill Feeder corresponding to mill(s) selected
8. Ball Mill Run-Around Screw

6.2.3 Refill LP Feeder

Equipment start sequence for **LP Feeder** refill:

1. LP Bin Vent
2. LP Feeder Fill Rotary Valve
3. LP Bin Discharge Screw

6.2.4 Refill Grinding Agent

Equipment start sequence for **Grinding Agent Feeder** refill:

1. Grinding Agent Bin Vent
2. Grinding Agent Feeder Fill Rotary Valve
3. Grinding Agent Bin Discharge Screw

6.2.5 Refill Grinding Agent Day Bin

Equipment start sequence for **Grinding Agent Day Bin** refill:

1. Grinding Agent Bin Vent
2. Grinding Agent Bin Fill Rotary Valve
3. Grinding Agent Bulk Bag Dump Frame Vibrator

BMA equipment **Shutdown** is in the reverse order.

6.3 Wet and Dry Additives Startup

6.3.1 Dry Additive Charge Function

To minimize waste during a **Startup**, initiate the **Dry Additive Charge Function** for the new product formulation to fill the Additive **Feeders** and **Dry Adds Screws**. The HMI **Dry Additive Charge** button runs all the Additive Feeders in sequence into the Screws.

This Function is also useful in preparing for a new product run when the line is down and there is no opportunity for a flying change-over.

Note: The Stucco **Recirculation** and **Feed** systems must be running when using this Function.

6.3.2 Wet Run Function

For system setup, and future **Master Start System** testing or troubleshooting, initiate the **Wet Run** function to allow for a Master Start Sequence to begin without the introduction of Stucco. This Function makes tests cleaner by keeping the Stucco from hitting the **Mixer**. It is also safer when there is no potential of Stucco seizing up the Mixer or other **Forming** system equipment.

To use this Function, run a hose from the Mixer boot into the waste trench, then initiate the Master Start System normally from the Master Start Timer set-up screen. This provides time to observe the system without the pressure of making Board.

6.3.3 Master Start Sequence

When the plant is ready to make Board, a **Master Start Sequence** is initiated. **Master Start Timers** are adjusted for additives to feed in sequence and arrive at the **Mixer** by the correct time to begin making the slurry.

When timing is not adjusted correctly, the initial mix will be either too light (watery) or too heavy (thick). If an additive is not selected in the current formulation, HMI status indicators appear “grayed” out and are ignored during the **Master Start Sequence**.

6.4 Ball Mill Accelerator Control

6.4.1 Feeder Rates

Accurate control of LP and Grinding Agent **Feed Rates** are part of the HMI formulation controls through auger-type loss-in-weight (LIW) feeders. The Total Feed Rate and Grinding Agent percentage set points can be set. Process control modes can be selected from the HMI **Formulation Controls** screen, e.g., Manual, Auto-LIW.

It is important for the Plant to:

- Perform periodic drop checks
- Confirm feed rates
- Do laboratory testing of materials for moisture and composition
- Ensure equipment is adjusted as needed

Note: Grinding Agent Set Points are not part of the recipe system and do not change from product to product.

6.4.2 Feeder Modes

Feeder Speed is manual or in an automatic mode.

Table 6.4.2 Feeder Speed Modes

Mode	Operation
MANUAL	• Operator has full control of the Feeder for additive process control • Enter speed reference in the HMI screen (0-100% speed-reference)
AUTO-VOLUMETRIC	• Feeder operates volumetrically • Speed is based on the Calibration Curve and does not use any LIW feedback for correction
AUTO-PID	• Feeder operates gravimetrically • Speed is based on both the calibration curve generated when the Feeder was commissioned and loss-in-weight (LIW)

6.4.3 Refills

Refills are performed manually. The **Grinding Agent Day Bin** has a Low-level Alarm that indicates when additional **Additive** bags need to be added into the Bag Dump Station. Once filled to the proper level, the Low-level sensor contacts the material and clears the Alarm. Continue to fill the station until full in order to minimize Refill cycles.

6.5 Motors

Feeder and Pump Motors operate in Auto-Remote mode (Loss-in-Weight Feeders) Auto-Volumetric mode (for volumetric Feeders and Pumps), or Auto-PID mode (flow meter modulates speed of the motor).

6.5.1 Motor HOA Operation

Table 6.5.1 Motor Settings

Switch Position	Operation
HAND	• Manually starts the Pump Motor, overrides any interlocks • Operator has full control of Pump speed • Speed reference (0-100%) can be entered from the HMI screen **Note**: Do Not use **Hand** mode while the plant is making Board.
OFF	• Stops the Pump
AUTO	• Automatic setting allows control from the PLC, including interlocks • Pump begins sending its Additive to the Mixer according to Board Line Master Start sequence **Note**: Moving the selector switch out of AUTO mode while the Line is making Board could cause a Line Shutdown.

6.6 Wet Additives Control

Accurate control of Flow Rate for each **Wet Additive** is essential. The Volume Set Point and various process control modes (Auto/Manual/Volumetric/PID) for each of the additives can be set from the HMI **Formulation Controls** screen.

6.6.1 Pump Modes

Pump Speed is manual or in an automatic mode. For **Additive** process control, **AUTO-Volumetric** mode runs **Pumps** in Open-loop mode when no Flow feedback is required. This mode is useful if the plant wishes to continue running even if the Additives Flow Meter malfunctions.

Note: When starting a Pump in Auto-PID mode, the Pump starts first in Volumetric mode for a short duration, and then switches to the PID loop control to provide a smooth start-up of the PID control and prevent large overshooting of the Motor speed.

Table 6.6.1 Pump Speed Modes

Mode	Operation
MANUAL	• Operator has full control of the Feeder for additive process control • Enter speed reference in the HMI screen (0-100% speed-reference)
AUTO-VOLUMETRIC	• Open Loop • No Flow feedback required • Pump Speed based on calibration curve **Note**: This mode is useful if the plant wishes to continue running even if the Additives Flow Meter malfunctions.
AUTO-PID	• Closed Loop • Volume Set Point can be set, and actual flow rate monitored from the HMI Formulation screen • Pump runs at commanded speed from a PID Loop control where the Flow Meter is used to modulate the speed of the Motor **Note**: An Alarm displays on the HMI screen if the PID-control for an Additive deviate too much from the Set Point

6.6.2 Wet Additives Pumps

All Wet Additives Pumps have a field HOA selector switch.

Table 6.6.2 Wet Additives Pumps

Pump	Action
Process Water	Feeds to the Mixer manifold

Pump	Action
Liquid Retarder	The Liquid Retarder is pumped to the intake of the Process Water Pump to mix with the Process Water additive **Note**: Do <u>Not</u> use **Hand** mode unless the Process Water Pump is running; otherwise, pumped Retarder will have no flow path.
Dispersant	The Dispersant is pumped to the intake of the Process Water Pump to mix with the Process Water additive. **Note**: Do <u>Not</u> use **Hand** mode unless the Process Water Pump is running; otherwise, pumped Dispersant will have no flow path.
STMP	The STMP is pumped to the intake of the Process Water Pump to mix with the Process Water additive. **Note**: Hand mode should only be used when the plant is not making board.
Foam Agent	The Foaming Agent manifold feeds to the intake of the Static Mixer which then mixes the Foaming Agent additive with the Foam Water additive before passing through the Foam Generators **Note**: Do <u>Not</u> use **Hand** mode for long periods; otherwise, undiluted Foaming Agent will be circulated to the Wastewater Sump.
Foam Water	The Process Water Tank feeds circulating Foam Water through the two Foam Generators and then back to the Wastewater Sump through the Foam System Three-Way Valve when the valve is energized **Note**: Set each Foam Generator field HOA selector to AUTO mode to ensure that both Foam Generators start when the Foam Water Pump starts.
Make-Up Water	Feeds to the Mixer
Siloxane	Feeds to the Mixer

6.6.3 Pump HOA Operation

Table 6.6.3 Pump Settings

Switch Position	Operation
HAND	• Manually starts the Pump Motor, overrides any interlocks • Operator has full control of Pump speed • Speed reference (0-100%) can be entered from the HMI screen **Note**: Do <u>Not</u> use **Hand** mode while the plant is making Board.

OFF	• Stops the Pump
AUTO	• Automatic setting allows control from the PLC program, including interlocks • Pump begins sending its Additive to the Mixer according to Board Line Master Start sequence **Note**: Moving the selector switch out of AUTO mode while the Line is making Board could cause a Line Shutdown.

6.6.4 Pump Control

During a **Board Line Start Sequence**, a **Master Start Timer** delays and controls when the various **Pumps** start pumping. When a "Pump Start Delay" timer expires during a Start Sequence, the Pump starts, and then the **Additive** is pumped to the **Mixer**.

6.6.5 Foam Air Control

Foam Air is controlled by a control valve, and a shut-off solenoid valve that responds to commands from the PLC program. During a **Board Line Start Sequence**, a **Master Start Timer** delays and controls when the **Foam Air Solenoid** is energized. When the "Start Delay" timer expires during a Start Sequence, the Solenoid energizes, and then air is added to the Foam Water/Foaming Agent mixer before flowing through the foam generators. If the control valve malfunctions, the manual needle valve can be used to control the amount of air being added to the Foam.

6.6.6 Foam Water Control

When the **Foam Water Pump** runs, both **Foam Generators** also start to run. To test the **Foam Generating Skid**, use the **HMI JOG FOAM** mode to do a test run which simulates how the system will run on a Startup. Make sure all Foam system motors and valves are ready to run prior to pressing the **JOG FOAM** button.

6.7 Calibration

A Loop **Calibration Curve** is the set of data that the PLC uses to correlate Feed rate to Motor speed. The value of the Feed rate entered is passed through the Calibration Curve and the result is a motor percentage speed. This speed combined with the PID Loop output is the basis for **Additive** Control.

Figure 6.7: HMI Calibration Data

6.7.1 Feeder Calibration

Three ways to **Calibrate** a **Gravimetric** device on the **HMI**:

- Enable **Calibration**, enter the **Feed** amount and **Motor** speed, and then press **Accept**.
- While running equipment, press **Accept** – the current PV and motor speed instantly populate the **Calibration Curve**

On both the **x**-axis and **y**-axis points of the **Calibration Curve**, enter the number **11**

6.7.2 Calibration Curve

A **Calibration Curve** is obtained by performing a drop sample of the running **Feeder** or **Pump** and entering the measured data for the **Additive** into the **Calibration** screen. The Feed-rate Set Point of the Additive correlates to a **Motor** speed in percentage, and that percentage value commands the speed of the Motor.

6.7.3 Drop Test Calibration

The **Wet Additives** are normally run in **PID** mode with Flow-rate data from the **Flow Meters**.

Note: Check the Flow Meters each week to evaluate wear and tear on the progressive cavity Pumps.

Run the **Drop Test Calibration** during a down day:

1. At the **Calibration** screen, put the **Additive** in **Calibrate** mode
2. Enter desired output to run the **Pump** at
3. Run the **Pump** with **HOA** switch set to Manual mode at the motor
4. Record the Flow reading on the **HMI** or local display at the **Flow Meter**
5. Collect a Drop sample and compare it against the **Flow Meter** reading

Test Tips:

- Use a long enough sample time to minimize the sample testing error
- If the numbers do not match, then the Flow Meter is defective and needs to be replaced
- Flow Meters are more accurate than the drop sampling methods that are typically used with high volume flow rates, e.g., process water, which is prone to timing errors on Drop sampling

All of the **Pumps** and **Feeders** can be run in **Manual** mode. When the **Loop** is in Manual mode, the operator can set manual output to whatever is required and the PID does not write to it.

6.8 Fatal Faults

While the **Board Line** is running, the PLC program monitors **Additives** and conditions for **Fatal Fault**s that mandate a **Mixer Shutdown** or immediate **Board Line Shutdown**. These Faults are called **First Outs**.

Fatal Faults can be configured from the **First Out Setup** screen:

- **Alarm**: Enable or Disable
- **Fault**: Critical or Non-critical – the magnitude of Mixer flushing allowed during Shutdown sequence
- **Delay Buffer**: How long an Alarm condition is allowed to occur before actual Shutdown

Note: Faults that can be enabled or disabled from the **HMI Fatal Faults Enable** screen are listed with their **Alarm** descriptions.

6.8.1 Stucco Handling Faults

Stucco Handling Faults are generally with Screws and Motors, or closed Valves:

- **Recirculation System**: Any motor
- **Feed System**: Any critical motor
- **Mass Flow Meter**: Not responding
- **Low Flow**: Deviation too large (starving system)
- **Mixer Bypass Butterfly Valve**: No longer closed while Board Line running

6.8.2 Wet Additives Faults

If any of the following **Pumps Fault** while a Line is running and the corresponding **ENABLE** is on, the **Mixer** shuts down and the **HMI** screen displays **Alarm** condition with cause of Shutdown:

- Process Water Pump: Faults while Line is running
- Retarder Agent Pump: Faults
- Foam Water Pump: Faults while Line is running
- Foam System Valve: The 3-way valve no longer open while running
- Foam Agent Pump: Faults while Line is running
- Fiberglass Water Pump: Faults while a Board Line is running

END OF DOCUMENT