

Sequence of Operation	Job No. 0010	Doc No. 0010-INS-WSM-24-13-0001
WSM Biomass Handling System	Rev No.	D



Sequence of Operation

Biomass Plant

Bale Handling System

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Milling Process Sequence of Operation

There are 4 infeed processing lines and one waste collection system in the facility. The following describes the operation of one line. All referenced in this narrative are to Process Line 4. Instrument tags for Process Lines 1, 2 and 3 are similar. Refer to the WSM Instrument List 0010-LIS-WSM-24-41-0002 latest revision.

CV-10401 Bale Infeed Tipple / CV-10402 Bulk Bale Infeed

Trucks deliver large loads of corn stover bales to the unloading dock. The trailer will back against a fixed bumper stop to position the trailer for unloading.

The infeed conveyors are made up of the Bale Infeed Tipple and the Bulk Bale Infeed. These conveyors operate as a coordinated pair. The Bale Infeed Tipple along with the Bulk Bale Infeed accepts the entire load of bales.

The Bale Tipple will be elevated or lowered to match the bed level of the trailer. The truck driver moves the tipple up or down by pressing the up or down push button on a local control station. (HS-10401-6A Tipple Up, HS-10401-6B Tipple Down) The push buttons signal a hydraulic solenoid valve to shift, sending hydraulic fluid to a hydraulic cylinder attached to the tipple.(XSV-10401-6A,XSV-10401-6B). Position of the bale infeed tipple is entirely manual and will be controlled by the truck driver.

If the previous load on the Bulk Bale Infeed has been advanced to the Bulk Bale Transfer, a photo-switch (ZS-10402-3) will sense that the Infeed is clear. The two transfers will be started by the driver. A start and stop push button station will be provided at the start of the Bale Infeed Tipple, (HS-10401-5A Start Conveyor, HS-10401-5B Stop Conveyor) If bales are present (ZS-10402-3 is blocked) the “Start” button will not activate the transfer until the transfer is clear. When Bales are present on the Bulk Bale Infeed, the indicator light will be red. Once all of the bales and been moved to the to the Bulk Bale Transfer, the indicator light will turn green, signaling drivers that that bales may be delivered to the line. (YL-10401-8 Red Light,YL-10401-9 Green Light)

Once the truck is in position, and the infeed conditions are satisfied, tipple adjusted, running, and Bulk Bale Infeed running, the driver can then start the truck unload conveyor on the bed of the trailer. As the load begins to transfer off of the trailer and on to the Infeed Tipple, a loaded swing arm presses an idler sprocket to the bottom of the load. The sprocket rotates and is connected to a load pulse generator (ST-10401-2). The load speed pulse generator sends a speed signal to the controller. Each conveyor is driven by a variable frequency drive (VFD). The controller modulates the speed of the tipple conveyor and infeed deck conveyor to match the speed of the truck unload conveyor. (ST-10401-2)

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When the front of the load arrives at the front of the Bulk Bale Infeed, it will block the beam of a thru-beam photo-switch mounted to the Bulk Bale Infeed Frame, (ZS-10402-3) if the transfer is clear, the transfer will continue to run and move the load to the Bulk Bale Transfer. Each conveyor is equipped with a zero-speed switch to verify the conveyors are running when they should be running. If a shaft breaks or the drive chains break, it will be detected by the controller and the controller will annunciate an alarm.(SS-1040101,1040201)

YL-10401-8	Red Light
YL-10401-9	Green Light
HS-10401-6A	Tipple Up Push Button
HS-10401-6B	Tipple Down Push Button
HS-10401-5A	Start Conveyors Push Button
HS-10401-5B	Stop Conveyors Push Button
XSV-10401-6A	Tipple Up Hydraulic Valve Solenoid
XSV-10401-6B	Tipple Down Hydraulic Valve Solenoid
ST-10401-2	Load Speed Pulse Generator
SS-10401-1	Infeed Tipple Zero Speed Switch
ZS-10402-3	Load Present Photo-switch
SS-10402-1	Bulk Bale Infeed Zero Speed Switch

CV-10403 Bulk Bale Transfer

The Bulk Bale Transfer receives full loads of corn stover bales from the Bulk Bale Infeed.

When the front of the load arrives at the front of the Bulk Bale Transfer, it will block the beam of a thru-beam photo-switch mounted to the frame of the transfer. (ZS-10403-3) If there are bales on the speed-up deck (photo switch ZS 10404-3 is blocked), the infeed transfer deck conveyor will stop. If the Speed-Up deck is clear (photo switch ZS 10404-3 is un-blocked), the bales will transfer forward to the Speed-Up Deck Transfer.

Each time the speed-up deck is cleared of bales, the infeed transfer deck conveyor will advance one stack of bales until all of the bales are gone and the photo-switch light beam is not blocked anymore. This will signal the controller that the Bulk Bale Transfer is available to accept bales from the infeed and to advance another load of bales.

The conveyor on the Bulk Bale Transfer is equipped with a zero-speed switch to verify the conveyor is running when it should be running. If a shaft or drive chain breaks, it will be detected by the controller and the controller will annunciate an alarm.(SS-10403-1)

ZS-10403-3	Load Present Photo-switch
SS-10403-1	Conveyor Zero Speed Switch

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CV-10404 Speed-up Deck

The speed-up deck receives a single course of bales (2 wide x 3 high) from the infeed transfer deck. The speed-up conveyor pulls the stack of bales and creates a separation between the stacks of bales. The speed of the deck is controlled by a VFD and should match the speed of the Bulk Bale Transfer. This speed is 20 Ft/Min @ 60 Hz. The Speed-up Deck will run until the stack of bales block the beam of a thru-beam photo-switch mounted to the speed-up deck frame.(ZS-10404-4) This will signal the Bulk Bale Transfer drive to stop. The bales will continue on the Speed-up Deck until they block the second thru-beam photo-switch (ZS-10404-3) mounted to the speed-up deck frame which will signal the Speed-up Deck drive to stop. When the Bulk Bale Transfer Stops and the Speed-up Deck continues to run, the Bulk Bale Transfer Load Present Photo Switch (ZS-10403-3) will become un-blocked. The Bulk Bale Transfer will then start and run until The Load Present Photo Switch (ZS-10403-3) is blocked.

If the bale hoist conveyor is clear (ZS-10405-2 is unblocked) and the hoist is full down (ZS-10405-1), the hoist conveyor will run. The stack of bales will advance onto the hoist conveyor. If the hoist is not ready to receive a stack, then the speed-up deck conveyor will stop and hold the stack of bales until the hoist is clear to advance.

The conveyor on the speed-up deck is equipped with zero-speed switch to verify the conveyor is running when it should be running. If a shaft or chains break, it will be detected by the controller and the controller will annunciate an alarm (SS-10404-1)

The Speed Up Deck speed will be measured by a Speed Sensor (SS-10404-1) and compared to the speed of the Bale Hoist transfer and adjusted to match.

ZS-10404-4 Load Present Photo-switch
ZS-10404-3 Transfer Stop Photo-switch
SS-10404-1 Conveyor Zero Speed Switch

BS-10405 Bale Hoist (BS-10105, BS-10205 & BS-10405)

Note: The following applies to the Lines 1, 2 and 4 (BS-10105, BS-10205 & BS-10405)

The hydraulic driven bale hoist conveyor receives a single stack of bales from the speed-up deck conveyor. Each stack is 2 bales wide by 3 bales high. The purpose of the bale hoist is to un-stack the bales. The hoist conveyor advances the stack until the bale stack is nominally centered on the Bale Hoist Conveyor. The bale stack will advance until it blocks a limit switch mounted to the hoist frame (ZS-10405-2). The controller will stop the hoist conveyor.

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The hydraulic driven conveyor on the bale hoist is equipped with a zero-speed switch (SS-10405-29) to verify the conveyor is running when it should be running. If a shaft or drive chain break, it will be detected by the controller and the controller will annunciate an alarm. The drive is engaged by energizing the Hoist Conveyor Forward Hydraulic Valve Solenoid (XSV-10405-27) to reverse the drive, Hoist Conveyor Reverse Hydraulic Valve Solenoid (XSV-10405-28) would be energized.

If the double bale hoist carriage is at the retracted (home) position (ZS-10405-4) and the left and right clamps are full open as indicated by the left and right hand clamp open sensors (ZS-10405-5,ZS-10405-5A) the controller will energize a hoist up, hydraulic solenoid valve to send hydraulic fluid to a hydraulic cylinders to raise the hoist. (XSV-10405-17) The hoist will elevate the stack until the top of the stack hits a sensor shoe that triggers a proximity switch, (ZS-10405-3). This will signal the controller to de-energize the hoist hydraulic solenoid valve and stop the hoist travel upward. The hoist hydraulic solenoid valve is a 3 position, dual solenoid valve with a blocked center section to hold the hoist in position without power.

The controller will then energize a double bale clamp hydraulic solenoid valve to close the clamp on the top two bales of the stack (XSV-10405-20). A pressure switch senses when the clamps are in contact with the bales (ZS-10405-6). Once XSV-10405-20 is energized to close the clamp, a software timer (initial setting 10 seconds) will look for the Pressure Switch (ZS-10405-6) to make pressure (initial setting 1300 psi). If the pressure switch does not make pressure within the timed period an alarm must be sent to the HMI. The double bale clamp, hydraulic solenoid valve is a 3 position, dual solenoid valve with a blocked center section to hold the bales in position without power. Then the controller will energize the hoist down, hydraulic solenoid valve (XSV-10405-18) to lower the hoist for a short timed interval which generates a gap between the top most bales held in bale clamp and the bales still on the hoist. The timer should initially be programmed to create a gap of 2-3"

If the singulator deck infeed area is clear, the controller will then energize a hydraulic solenoid valve to extend the double bale carriage with suspended, clamped bales, forward (XSV-10405-23). This will transport the row of two bales from the hoist to a position over the singulator deck infeed area. When the double bale carriage is in the fully extended position, the carriage extended limit switch will be actuated. (ZS-10405-7) This will signal the controller to energize a hydraulic solenoid valve to open the double bale clamp and release the two bales onto the singulator deck infeed area. (XSV-10405-19)

The controller will then energize the hydraulic solenoid valve to retract the double bale carriage to the home/hoist position,(XSV-10405-24). When the double bale carriage is in the fully retracted position, the double bale carriage retracted (home) limit switch will be actuated. (ZS-10405-4) With the left and right clamp open limit switches actuated this will signal the controller to permit the hoist to elevate again (ZS-10405-5,ZS-1040507-5A).

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The hoist will repeat the process until the last row of bales is transferred to the singulator deck infeed area. The controller will then energize the bale hoist down hydraulic solenoid valve (XSV-10405-18) to lower the hoist to the full down position where it will actuate the bale hoist full down limit switch (ZS-10405-1).

The controller will de-energize the bale hoist down hydraulic solenoid valve. When the bale hoist is down and clear, the controller will start the hoist conveyor motor and permit the speed-up deck to advance another stack of bales.

SS-10405-29	Hoist Conveyor Zero Speed Switch
XSV-10405-17	Hoist Up Hydraulic Valve Solenoid
XSV-10405-18	Hoist Down Hydraulic Valve Solenoid
XSV-10405-23	Hoist Carriage Extend Hydraulic Valve Solenoid
XSV-10405-24	Hoist Carriage Retract Hydraulic Valve Solenoid
XSV-10405-27	Hoist Conveyor Forward Hydraulic Valve Solenoid
XSV-10405-28	Hoist Conveyor Reverse Hydraulic Valve Solenoid
ZS-10405-2	Stack In Position on Conveyor Limit Switch
ZS-10405-1	Hoist Full Down (Home) Limit Switch
ZS-10405-3	Stack at Up Position Limit Switch
ZS-10405-7	Hoist Carriage at Extended Limit Switch
ZS-10405-4	Hoist Carriage at Retracted (Home) Limit Switch
ZS-10405-5	Double Bale LH Clamp Open Limit Switch
ZS-10405-5A	Double Bale RH Clamp Open Limit Switch
ZS-10405-6	Double Bale Clamp Closed Pressure Switch
XSV-10405-20	Double Bale Clamp Hydraulic Valve Solenoid
XSV-10405-19	Double Bale Release Hydraulic Valve Solenoid

BS-10305 Bale Hoist

Note: The following applies to the Line 3 (BS-10305) which is capable of receiving 3 ft. or 4 ft. high bales as discussed below.

The hydraulic driven bale hoist conveyor receives a single stack of bales from the speed-up deck conveyor. Each stack is 2 bales wide by 2 bales high (36" height bale or 48" height bale) or by 3 bales high (36" height bales only). The purpose of the bale hoist is to un-stack the bales. The hoist conveyor advances the stack until the - bale stack is nominally centered on the Bale Hoist Conveyor. The bale stack will advance until it blocks a limit switch mounted to the hoist frame (ZS-10305-2). The controller will stop the hoist conveyor.

The hydraulic driven conveyor on the bale hoist is equipped with a zero-speed switch (SS-10305-29) to verify the conveyor is running when it should be running. If a shaft or drive chain break, it will be detected by the controller and the controller will annunciate an alarm. The drive is engaged by energizing the Hoist Conveyor Forward Hydraulic

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Valve Solenoid (XSV-10305-27) to reverse the drive, Hoist Conveyor Reverse Hydraulic Valve Solenoid (XSV-10305-28) would be energized.

With the bale stack in position, a set of stack height limit switches will be blocked, the number of switches blocked depends on the stack height configuration:

- Switch (ZS-10305-18) blocked for a 2 bale high stack of 48" height bales.
- Switch (ZS-10305-17, 18 & 19) blocked for a 3 bale high stack of 36" height bales.

Each stack configuration requires 2 or 3 preprogrammed set points for the analog output from the Hoist Lift Position Sensor (ZT-10305-1). The Hoist Lift Position Sensor (ZT-10305-1) is a temposonic sensor attached to the rod end of one of the lift cylinders and gives position feedback of the movement of the cylinder rod end. Each set point is in the lifted position such that the bottom edge of the top most bale of the stack is approximately 2" to 3" above the Singulator Infeed deck. Below are suggested set points for cylinder extended distances, which may need to be verified and adjusted in the field:

- (2) 48" bales - 27", 3"
 - Cylinder fully extended for hoist in full down position.
 - Cylinder extension = 27" for hoist in position for top bale pair to be transferred.
 - Cylinder Extension = 3" for hoist in position for bottom bale pair to be transferred.
- (3) 36" bales - 39", 21", 3"
 - Cylinder fully extended for hoist in full down position.
 - Cylinder extension = 39" for hoist in position for top bale pair to be transferred.
 - Cylinder extension = 21" for middle bale pair to be transferred.
 - Cylinder Extension = 3" for hoist in position for bottom bale pair to be transferred.

If the double bale hoist carriage is at the retracted (home) position (ZS-10305-4) and the left and right clamps are full open as indicated by the left and right hand clamp open sensors (ZS-10305-5,ZS-10305-5A) the controller will energize a hoist up, hydraulic solenoid valve to send hydraulic fluid to a hydraulic cylinders to raise the hoist. (XSV-10305-17) The hoist will elevate the stack until linear sensor (ZT-10305-1) reaches the first or next programmed set point. This will signal the controller to de-energize the hoist hydraulic solenoid valve and stop the hoist travel upward. The hoist hydraulic solenoid valve is a 3 position, dual solenoid valve with a blocked center section to hold the hoist in position without power.

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The controller will then energize a double bale clamp hydraulic solenoid valve to close the clamp on the top two bales of the stack (XSV-10305-20). A pressure switch senses when the clamps are in contact with the bales (ZS-10305-6). Once XSV-10305-20 is energized to close the clamp, a software timer (initial setting 10 seconds) will look for the Pressure Switch (ZS-10305-6) to make pressure (initial setting 1300 psi). If the pressure switch does not make pressure within the timed period an alarm must be sent to the HMI. The double bale clamp, hydraulic solenoid valve is a 3 position, dual solenoid valve with a blocked center section to hold the bales in position without power. Then the controller will energize the hoist down, hydraulic solenoid valve (XSV-10305-18) to lower the hoist for a short timed interval which generates a gap between the top most bale held in bale clamp and the bales still on the hoist. The timer should initially be programmed to create a gap of 2-3”

If the singulator deck infeed area is clear, the controller will then energize a hydraulic solenoid valve to extend the double bale carriage with suspended, clamped bales, forward (XSV-10305-23). This will transport the row of two bales from the hoist to a position over the singulator deck infeed area. When the double bale carriage is in the fully extended position, the carriage extended limit switch (ZS-10305-7) will be actuated. This will signal the controller to energize a hydraulic solenoid valve to open the double bale clamp and release the two bales onto the singulator deck infeed area. (XSV-10305-19)

The controller will then energize the hydraulic solenoid valve to retract the double bale carriage to the home/hoist position,(XSV-10305-24). When the double bale carriage is in the fully retracted position, the double bale carriage retracted (home) limit switch (ZS-10305-4) will be actuated. With the left and right clamp open limit switches (ZS-10305-5, ZS-10305-5A) are actuated this will signal the controller to permit the hoist to elevate again.

The hoist will repeat the process, raising the lift to the next set points, until the last row of bales is transferred to the singulator deck infeed area. After the Stack in Position Switch (ZS-10305-2) is no longer blocked. The controller will then energize the bale hoist down hydraulic solenoid valve (XSV-10305-18) to lower the hoist to the full down position where it will actuate the bale hoist full down limit switch (ZS-10305-1).

The controller will de-energize the bale hoist down hydraulic solenoid valve. When the bale hoist is down and clear, the controller will start the hoist conveyor motor and permit the speed-up deck to advance another stack of bales.

SS-10305-29	Hoist Conveyor Zero Speed Switch
XSV-10305-17	Hoist Up Hydraulic Valve Solenoid
XSV-10305-18	Hoist Down Hydraulic Valve Solenoid
XSV-10305-23	Hoist Carriage Extend Hydraulic Valve Solenoid
XSV-10305-24	Hoist Carriage Retract Hydraulic Valve Solenoid
XSV-10305-27	Hoist Conveyor Forward Hydraulic Valve Solenoid

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XSV-10305-28	Hoist Conveyor Reverse Hydraulic Valve Solenoid
ZS-10305-2	Stack In Position on Conveyor Limit Switch
ZS-10305-1	Hoist Full Down (Home) Limit Switch
ZS-10305-18	Bale Stack Indicator Switch
ZS-10305-19	Bale Stack Indicator Switch
ZS-10305-7	Hoist Carriage at Extended Limit Switch
ZS-10305-4	Hoist Carriage at Retracted (Home) Limit Switch
ZS-10305-5	Double Bale LH Clamp Open Limit Switch
ZS-10305-5A	Double Bale RH Clamp Open Limit Switch
ZS-10305-6	Double Bale Clamp Closed Pressure Switch
ZT-10305-1	Hoist Lift Position Sensor
XSV-10305-20	Double Bale Clamp Hydraulic Valve Solenoid
XSV-10305-19	Double Bale Release Hydraulic Valve Solenoid

BS-10405 Bale Singulator

The Bale Singulator will receive two bales at a time from the bale hoist. The bale singulator will discharge one bale at a time to the Moisture Transfer (CV-10406).

The bale singulator has a table that consists of an infeed area and a discharge deck area. A single bale carriage operates over the singulator and runs perpendicular to the double bale carriage. A single bale clamp is attached to a single bale carriage. The single bale carriage must be parked in the fully retracted position over the singulator discharge area or in the single bale clamp clear area to allow the double bale carriage to transfer a pair of bales to the singulator deck infeed area.

When the double bale carriage has extended to the full forward position with bales in the double bale clamp it will actuate the double bale carriage full extend limit switch. This will allow the controller to release the double bale clamp and deposit the bales on the singulator deck infeed area. (Ref. 10405 Bale Hoist)

Once the double bale carriage has deposited a pair of bales in the Singulator deck infeed area, the double bale carriage is retracted to position over the hoist. This will actuate the double bale carriage fully retracted limit switch (ZS-10405-4).

With the double bale carriage in the retracted position, and a bale pair in position on the Infeed Area, the controller will energize a hydraulic solenoid valve (XSV-10405-25) to extend the carriage so it is partially extended to a position over the first bale sensed by the Singulator Bale Edge limit switch (ZS-10405-11). This limit switch will signal the controller when the single bale carriage is in position. The controller will energize a hydraulic solenoid valve (XSV-10405-22) on the single bale clamp to grip the bale by the ends. A pressure switch senses when the clamps are in contact with the bales (ZS-10405-15) (initial setting 1300 psi). Once XSV-10405-22 is energized a software timer (initial setting 10 seconds) will look for the Pressure Switch (ZS-10405-15) to make pressure. If the pressure switch does not make pressure within the timed period an

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alarm must be sent to the HMI. With the double bale carriage retracted and the single bale discharge area clear, the controller will energize a hydraulic solenoid valve (XSV-10405-26) and the single bale carriage then retracts to position over the discharge area dragging the single bale with it. When the single bale carriage is fully retracted, it will actuate the single bale carriage full retract limit switch (ZS-10405-8). With the carriage fully retracted and the moisture analyzer conveyor stopped this will signal the controller to energize a hydraulic solenoid valve (XSV-10405-21) to release the single bale clamp and open to the clamp open sensors (ZS-10405-13,ZS-10405-14). The bale is now positioned on the Moisture Transfer.

The single bale carriage is then fully extended to a position over the second bale in the infeed area of the singulator. With the single bale carriage in the clear zone area or with it fully extended this will signal the controller to allow the bale in the discharge area be advanced to the moisture analyzer. If the Moisture Transfer is ready, the bale can be moved from the discharge area and advance the next bale to the Moisture Analyzer.

When the front edge of the bale is detected the Bale Present Photo Switch (ZS-10406-2) on the Moisture Transfer, it will signal the controller to actuate the single bale clamp and grip the second bale by the ends. The single bale carriage will then be fully retracted to position over the singulator discharge area. When in detected at the clear zone or the fully retracted position, it will allow the double bale carriage to extend and deposit another pair of bales in the singulator deck infeed area.

XSV-10405-25	Singulator Carriage Extend Hydraulic Valve Solenoid
XSV-10405-26	Singulator Carriage Retract Hydraulic Valve Solenoid
XSV-10405-22	Single Bale Clamp Hydraulic Valve Solenoid
XSV-10405-21	Single Bale Release Hydraulic Valve Solenoid
ZS-10405-8	Singulator Carriage Fully Retracted (Home) Limit Switch
ZS-10405-11	Singulator Carriage Extended Bale Edge Limit Switch
ZS-10405-10	Singulator Carriage Fully Extended Limit Switch
ZS-10405-9	Bale on Singulator Deck Infeed Photo-switch
ZS-10405-12	Bale on Singulator Deck Discharge Photo-switch
ZS-10405-13	Single Bale LH Clamp Open Limit Switch
ZS-10405-14	Single Bale RH Clamp Open Limit Switch
ZS-10405-15	Single Bale Clamp Closed Pressure Switch
ZS-10405-16	Single Bale Clamp Clear Limit Switch (Future optimization)
HS-10405-34	E-Stop
HS-10405-44	Singulator Carriage Extend Push Button
HS-10405-45	Singulator Carriage Retract Push Button
HS-10405-46	Single Bale Clamp Push Button
HS-10405-47	Single Bale Release Push Button

The bale hoist, bale singulator unit will have a local, manual operation station. This panel will have an Auto/Manual mode selector switch (HS-10405-35). When the switch is in Auto mode, the PLC controller will perform all actions. When the switch is in

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Manual mode, the action of each actuator will be controlled by push buttons on the local control panel.

HS-10405-35	Auto / Manual Mode Selector Switch
HS-10405-36	Conveyor Forward Push Button
HS-10405-42	Conveyor Reverse Push Button
HS-10405-37	Hoist Up Push Button
HS-10405-38	Hoist Down Push Button
HS-10405-39	Hoist Carriage Extend Push Button
HS-10405-40	Hoist Carriage Retract Push Button
HS-10405-41	Double Bale Clamp Push Button
HS-10405-43	Double Bale Release Push Button
HS-10405-44	Singulator Carriage Extend Push Button
HS-10405-45	Singulator Carriage Retract Push Button
HS-10405-46	Single Bale Clamp Push Button
HS-10405-47	Single Bale Release Push Button

CV-10406 Moisture Transfer

The Moisture Transfer receives a single bale from the bale singulator. The Moisture Transfer discharges to the Weigh Belt Transfer.

A variable speed drive transports the bale until the front of the bale arrives at the Moisture Scan Start thru-beam photo-switch (ZS-10406-4). The speed of the transfer is 24.7 Ft/Min at 60 Hz. The controller will then signal the moisture analyzer (AT-10406-3) to start taking a measurement. The bale will continue on the Moisture Transfer where it will block a thru-beam photo-switch (ZS-10406-2) mounted to the moisture Transfer Frame. This will signal the drive to stop.

If there is a bale still on the weigh scale conveyor, the moisture analyzer conveyor will stop and wait for the weigh scale conveyor to clear. If the weigh scale conveyor is clear, the moisture analyzer conveyor will continue to run and advance the bale to the weigh scale conveyor. The Moisture Analyzer (AT-10406-3) will only scan moisture if the Moisture when the transfer is running.

The moisture analyzer conveyor is equipped with a zero-speed switch to verify the conveyor is running when it should be running. If a chain or the shaft breaks, it will be detected by the controller and the controller will annunciate an alarm (SS-10406-1).

AT-10406-3	Moisture Analyzer
ZS-10406-2	Bale Present Photo-switch
ZS-10406-4	Moisture Scan Start Photo-switch
SS-10406-1	Conveyor Zero Speed Switch

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Bale moisture must be reported to the DCS system. Bale moisture will also be used as a reject criteria. The criteria for rejection based on bale weight will be determined by ABBK. Tracking logic developed by the system programmer must be used to follow bales that are targeted to reject from the Bale Moisture Transfer to the Bale Reject Transfer.

CV-10407 Weigh Belt Transfer

The Weight Belt Transfer receives a single bale from the Moisture Transfer. The weigh scale conveyor discharges to the reject transfer conveyor.

The Weight Belt Transfer has a variable speed motor that advances the bale until the front of the bale blocks the thru-beam photo-switch mounted to the weigh scale conveyor deck (ZS-10407-2). The speed of the transfer is 24.7 Ft/Min at 60 Hz. Once blocked the drive stops

The controller will signal the weigh scale instrument to take a measurement. When complete the weigh scale will signal controller to release the bale to advance.

If there is a bale still on the reject transfer conveyor, the weigh scale conveyor will not start and will wait for the reject transfer conveyor to clear. If the reject transfer conveyor is clear, the weigh scale conveyor will run and move the bale to the reject transfer conveyor.

The weigh scale conveyor is equipped with a zero-speed switch (SS-10407-1) to verify the conveyor is running when it should be running. If the belt or shaft breaks, it will be detected by the controller and the controller will annunciate an alarm.

WT-10407-3 Load Cell Weight Transmitter
 ZS-10407-2 Bale Present Photo-switch
 SS-10407-1 Conveyor Zero Speed Switch

Bale weights must be totalized for reporting to the DCS system. Bale weight reporting formats will have to be developed with input from the Owner, but it is thought to include hourly, daily and monthly weight totals by line, at a minimum. Bale weight may also be used as reject criteria. The criteria for rejection based on bale weight will be determined by ABBK.

CV-10408 Reject Transfer Section No.1

The Reject Transfer receives a single bale from the Weigh Scale Belt. The Reject Transfer conveyor has a variable speed drive that advances the bale until the front edge of the bale blocks the beam of a thru-beam photo-switch (ZS-10408-2) mounted to the

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reject transfer conveyor deck. The speed of the transfer is 24.7 Ft/Min at 60 Hz. Once blocked the drive will stop.

Programming in the controller (AT-10406-3 and or WT10407-3) will determine if the bale now stopped on the reject transfer conveyor is of acceptable quality to process (quality parameters by others). If it is acceptable, the bale will advance to the de-stringer. If the bale does not meet the quality criteria, the controller will energize a hydraulic solenoid valve (XSV-10408-8) to extend a bale pusher to move the bale off of the Bale Reject Transfer Section No.1 and onto the Bale Reject Transfer Section No. 2. The bale pusher will stay extended until the Reject Present Limit Switch (ZS-10409-3) is energized. Once the Reject Present Limit Switch is energized, the hydraulic solenoid will be de-energized to retract the bale pusher. When the pusher is in the home position, the pusher present Proximity switch will be actuated (ZS-10408-6). If the Pusher Home Proximity Switch (ZS-10408-6) does not confirm the home position, bales will not be allowed to move onto CV-10408.

If there is a bale still on the De-stringer Infeed Transfer (CV-10410), the Reject Transfer will stop and wait for the De-stringer Infeed Transfer to clear. A bale present on the De-stringer infeed Transfer is sensed by a photo-switch on the De-stringer Outfeed Transfer Section No. 1 (ZS-10412-2). If the de-stringer infeed conveyor is clear, the reject transfer conveyor will run and advance the bale to the De-stringer infeed conveyor.

The reject transfer conveyor is equipped with a zero-speed switch (SS-10408-1) to verify the conveyor is running when it should be running. If a drive chain or shaft breaks, it will be detected by the controller and the controller will annunciate an alarm.

ZS-10408-2	Bale Present Photo-switch
ZS-10408-6	Pusher Home Position Prox
SS-10408-1	Conveyor Zero Speed Switch
XSV-10408-8	Extend Pusher Hydraulic Valve Solenoid

CV-10409 Reject Transfer Section No.2

The bale reject conveyor has the capacity to hold two bales. There are two bale position limit switches installed on the side of the reject conveyor deck. If a bale is rejected and the reject conveyor is clear, the reject conveyor will run at the same time as the pusher is extended. As the bale is transported on the reject conveyor, it will actuate the first bale position limit switch (ZS-10409-3). This will signal the controller to stop the Reject Transfer No.2.

If a subsequent bale is determined to be a reject, the controller will re-start the Reject Transfer Section No.2 at the same time, the reject pusher is actuated. The first reject bale will advance to the second bale position (ZS-10409-4) and the second bale will advance to the first reject bale position (ZS-10409-3). When the second bale position limit switch is actuated, the controller will stop the reject conveyor.

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The Reject Transfer Section No.2 is equipped with a zero-speed switch (SS-10409-1) to verify the conveyor is running when it should be running. If a drive chain or shaft breaks, it will be detected by the controller and the controller will annunciate an alarm.

ZS-10409-3 Reject Present Limit Switch
ZS-10409-4 Reject Present Limit Switch
SS-10409-1 Conveyor Zero Speed Switch

CV-10410 De-stringer Infeed Transfer

The De-stringer Infeed Transfer receives a single bale from the Reject Transfer Section No.1. The De-stringer Infeed Transfer and De-stringer Outfeed Transfer run as a coordinated pair. The De-stringer Transfers are driven by variable speed drives that advance the bale until the front of the bale arrives at the front of the De-stringer Outfeed Transfer Section No.1 where it will block a thru-beam photo-switch (ZS-10412-2) mounted to the De-stringer Outfeed Transfer frame. This will signal the controller to stop the conveyors.

The De-stringer machine will cut and discard the strings holding the bale together. When this operation is complete, the de-stringer will signal the controller to release the bale.

If the De-Stringer Outfeed Transfer Section No.2 is clear, CV-10410 and CV-10412 will start and advance the bale onto the Destringer Outfeed Transfer No.2 until it is stopped by photo switch ZS-10413-2

Each transfer is equipped with a zero-speed switch (SS10410-1, SS10412-1) to verify the conveyor is running when it should be running. If a chain or shaft breaks, it will be detected by the controller and the controller will annunciate an alarm.

SS-10410-1 Conveyor Zero Speed Switch

DS-10411 De-stringer

(Note: A copy of the De-stringer code written for Allen-Bradley PLC has been provided to Abengoa for reference)

The De-stringer Infeed Transfer and De-stringer Outfeed Transfer run as a coordinated pair. The transfers will position the bale until the front of the bale arrives at the front of the De-stringer Outfeed Transfer where it will block a thru-beam photo-switch (ZS-

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10412-2) mounted to the De-stringer Outfeed Transfer frame. This will signal the controller to stop the conveyors.

Once the bale is in position this will start the Destringer cycle. The “Lower Puller Carriage” solenoid (XSV-10411-9) is energized and the carriage begins lowering. When XSV-10411-9 is energized a software timer (initial setting 10 seconds) begins counting. As the carriage lowers the bale contact arms on the carriage contact the top of the bale first. As the carriage continues to lower the contact arms rotate upward until the “Puller carriage In Down Position” sensor” (ZS-10411-2) is actuated. If ZS-10411-2 does not see the Puller Carriage in Down Position before the software timer times out, the De-stringer will be reset to the Home Position to begin a new cycle and an alarm will be sent to the HMI that identifies the fault. The “Lower Puller Carriage” solenoid (XSV-10411-9) is de-energized stopping the carriage in position against the bale. The “Raise Cutter Blade” solenoid (XSV-10411-11) is energized, raising the cutter blade up thru the lower portion of the bale, cutting the strings. When XSV-10411-11 is energized, a software timer (initial setting 10 seconds) begins timing the Cutter Blade cycle. When the cutter is in the full up position, “Cutter Blade in up Position” sensor (ZS-10411-6) is actuated indicating the string cutter is at the end of the stroke. If ZS-10411-6 does not sense the Cutter Blade in the full up position prior to the software counter completing its sequence, the De-stringer will be reset to the Home Position to begin a new cycle and an alarm will be sent to the HMI which identifies the fault. Once the cutter blade is in the full up position, the “Extend Stripper Carriage” solenoid (XSV-10411-13) is energized, driving the string gathering fork across the bale top, collecting the strings. When XSV-10411-13 is energized a software timer (initial setting 10 seconds) begins counting. The string puller motor continues to extend until the “Stripper Carriage In Extended Position” sensor (ZS-10411-4) is actuated and the string “Extend Stripper Carriage” solenoid (XSV-10411-13) is de-energized. If ZS-10411-4 does not acknowledge that the Stripper Carriage is fully extended prior to the software timer timing out, the De-stringer will be reset to the Home Position to begin a new cycle and an alarm will be sent to the HMI that identifies the fault. The “Lower Winder Carriage” solenoid (XSV-10411-16) is energized (starting a software timer (initial setting 10 seconds)) lowering the winder carriage fingers to insert into the bale string loop created by the string gather fork. At the full lowered winder position, the “Winder Carriage In Down Position” sensor (ZS-10411-8) is actuated. Then the “Winder Rotate” solenoid (XSV-10411-17) is energized, rotating the winder fingers, winding up the cut bale strings. If the software timer times out before ZS-10411-8 indicates that the Winder Carriage is in the Full Down Position, the De-stringer will be reset to the Home Position to begin a new cycle and an alarm will be sent to the HMI which identifies the fault. During this time the “Lower Cutter Blade” solenoid (XSV-10411-12) is energized, lowering the cutter blade until actuating the “Cutter Blade In Down Position” sensor (ZS-10411-5). When XSV-10411-12 is energized, a software timer (initial setting 10 seconds) begins counting. If ZS-10411-5 does not indicate the Cutter Blade is fully down prior to the timer counting out, then an alarm will be sent to the HMI that identifies the fault. The De-stringer cannot continue until the reason for this fault is identified and fixed. The “Winder Rotate” solenoid (XSV-10411-17) remains energized until a programmable time-delay times out. It is recommended that the initial setting for the time-delay should be 6 seconds. The

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“Raise Puller Carriage” solenoid (XSV-10411-10) is then energized (which starts a software timer counting (initial setting 10 seconds)), raising the carriage to activate the “Puller Carriage In Up Position” sensor (ZS-10411-1). If ZS-10411-1 does not see the Puller Carriage in the Up Position before the software timer times out an alarm will be sent to the HMI that identifies the fault. The De-stringer will NOT be reset to the Home Position with this alarm. The “Raise Winder Carriage” solenoid (XSV-10411-15) is energized until the “Winder Carriage in Up Position” sensor (ZS-10411-7) is actuated. When the “Raise Winder Carriage solenoid (XSV-10411-15) is energized, a software time (initial setting 10 seconds) begins counting. When the winder carriage is raised, this strips the coiled bale strings off of the winder fingers, and the strings drop into the system’s discharge chute. If the Winder Carriage in Up Position sensor (ZS-10411-7) does not indicate the Winder Carriage is in the full up position before the software timer times out, then an alarm will be sent to the HMI that identifies the fault. At the same time the “Retract Stripper Carriage” solenoid (XSV-10411-14) is energized the puller carriage returns to its home position actuating the “Stripper Carriage in Retracted Position” sensor (ZS-10411-3). Once the “Retract Stripper Carriage” solenoid (XSV-10411-14) is energized a software timer (initial setting 10 seconds) will begin counting. If stripper carriage is not validated in the retracted or home position as sensed by ZS-10411-3 before the software timer times out, an alarm will be sent to the HMI that identifies the fault. Once all step functions are complete and the bale moves toward the Bale Chopper as indicated by a clear photoswitch (ZS-10412-2) the De-stringing cycle is complete. This will signal the controller that the cycle is complete.

ZS-10411-1	Puller Carriage in Up Position (<u>Home Position</u>)
ZS-10411-2	Puller Carriage in Down Position
ZS-10411-3	Stripper Carriage in Retract Position (<u>Home Position</u>)
ZS-10411-4	Stripper Carriage in Extend Position
ZS-10411-5	Cutter Blade in Down Position (<u>Home Position</u>)
ZS-10411-6	Cutter Blade in Up Position
ZS-10411-7	Winder Carriage in Up Position (<u>Home Position</u>)
ZS-10411-8	Winder Carriage in Down Position
SS-10411-8A	Winder Zero Speed Switch
XSV-10411-9	Puller Carriage – Lower Solenoid
XSV-10411-10	Puller Carriage – Raise Solenoid
XSV-10411-11	Cutter Blade – Raise Solenoid
XSV-10411-12	Cutter Blade – Lower Solenoid
XSV-10411-13	Stripper Carriage – Extend Solenoid
XSV-10411-14	Stripper Carriage – Retract Solenoid
XSV-10411-15	Winder Carriage – Raise Solenoid
XSV-10411-16	Winder Carriage – Lower Solenoid
XSV-10411-17	Winder Rotate - Solenoid

The De-stinger cycle will be complete when the bale exits the De-stringer and the Bale Present Photo-switch ZS-10412-2 is unblocked.

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CV-10412 De-stringer Outfeed Transfer Section No.1

The De-stringer Outfeed Transfer helps position a single bale in the De-stringer Infeed Transfer. Transfers CV-10410 & CV-10412 operate as a coordinated pair.

The De-stringer Outfeed Transfer Section No.1 is driven by a variable speed motor that advance the bale until the front of the bale arrives at the front of the De-stringer Outfeed Transfer Section No.1. The speed of the transfer is 24.7 Ft/Min at 60 Hz. The bale will block the thru-beam photo-switch mounted to the transfer frame (ZS-10412-2). This will signal the controller to stop the transfers.

The transfer has a zero speed switch (SS-10412-1) to verify the conveyor is running. If a chain or shaft breaks, it will be detected by the controller and the controller will annunciate an alarm.

ZS-10412-2 Bale Present Photo-switch
SS-10412-1 Conveyor Zero Speed Switch

CV-10413 De-stringer Outfeed Transfer Section No.2

The De-stringer Outfeed Transfer Section No.2 receives a single bale from the De-stringer Outfeed Transfer Section No.1

The De-stringer Outfeed Section No.2 is driven by variable speed motor that will advance the bale until the front of the bale arrives at the front of the De-stringer discharge Transfer Section No.2. The speed of the transfer is 12.04 Ft/Min at 60 Hz. The Bale will block the thru-beam photo-switch (ZS-10413-2) mounted to the transfer frame This will signal the controller to stop the transfers.

The transfer has a zero speed switch (SS-10413-1) to verify the conveyor is running. If a chain or shaft breaks, it will be detected by the controller and the controller will annunciate an alarm.

A 3D image sensor will be mounted in view of the Destringer Outfeed Transfer Section No.2 and the Bale Chopper Infeed Transfer. The image sensor will control the VSD drives to close the gap between the bales.

ZS-10413-2 Bale Present Photo-switch
SS-10413-1 Conveyor Zero Speed Switch
ZT-10413-3 3D Image Sensor

CV-10414 Bale Chopper Infeed Transfer

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The Bale Chopper Infeed Transfer receives bales from the De-stringer Outfeed Transfer Section No.2. The Bale Chopper Infeed Transfer is driven by a variable speed motor that will advance the bale into the chopper. The speed of the transfer is 8 Ft/Min at 40Hz. Should the Bale Trailing Edge Photo Switch become unblocked, (ZS-10414-2) this will signal the controller to advance the next bale from the De-stringer Outfeed Transfer Section No.2. Nominally, the speed of the Bale Chopper Infeed Transfer will determine the mass flowrate through the chopper.

The bale chopper infeed advances bales and pushes them into the infeed rotor of the bale chopper machine.

The bale chopper motor load will be monitored by the controller and provide a feedback signal to the variable speed motor on the bale chopper infeed transfer. As the load increases on the chopper the variable speed motor will slow the transfer and as the load decreases, the transfer speed will increase.

The bale chopper infeed conveyor is equipped with a zero-speed switch (ZS-10414-1) to verify the conveyor is running when it should be running. If a chain or shaft breaks, it will be detected by the controller and the controller will annunciate an alarm.

ZS-10414-2 Bale Trailing Edge Photo-switch
SS-10414-1 Conveyor Zero Speed Switch

G-10415 Bale Chopper

The bale chopper receives bales that are fed to it by Bale Chopper Infeed Transfer. The bale chopper has two rotors, each driven by a separate variable speed motors. The motor loading on both of the chopper rotors is monitored by the controller. The load signal is used to command the speed of the chopper infeed transfer. As the load increases, the transfer speed (CV-10414) is commanded to decrease. The objective is to operate the chopper at full load to obtain maximum throughput, but not so much that it becomes overloaded. As a starting point it is recommended that the primary and secondary rotors should be set to full load amperage with a timer circuit. Initially the timer should be set to zero so that if either rotor hits full load amperage the infeed should slow down. Final tuning of the amperage and timer loops can be determined with the input of the WSM liaison in the field following installation. Full load amperage for the primary rotor motor (150 hp) is 174 Amps.

The chopper has a vibration switch on it which will signal the controller should the chopper exceed the set point. (VSH-10415A-3) it will be detected by the controller and the controller will annunciate an alarm. The vibration switch (VSH-10415A-3) is a normally open contact which closes when excessive vibration occurs. Baseline vibration will be determined by WSM liaison and the set-point will be adjusted in the field.

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Both rotors on the chopper are equipped with zero Speed indicators. (ST-10415A-1,ST-10415B-1) These will send a signal to the controller that should either rotor be moving, the shredder access door solenoid remains in the closed position.(XSV-10415A-2) so that the doors cannot be opened.

VHS-10415A-3	Chopper Vibration Switch
ZS-10415-4	Chopper Door Safety Switch
ST-10415A-1	Main Rotor Encoder
ST-10415B-1	Secondary Rotor Encoder

Before the DCS can enable the Bale Chopper to Start, the Bale Chopper Discharge Conveyor (CV-10416) must be running.

CV-10416 Bale Chopper Discharge Conveyor

The Bale Chopper deposits loose corn stover onto the bale Chopper Discharge Conveyor. The conveyor runs continuously at a constant speed. The conveyor transports the chopped corn stover past an overhead magnet conveyor that pulls out any ferrous materials. The Bale Chopper Discharge Belt operates at a fixed speed.

The bale chopper discharge conveyor dumps loose corn stover into a chute that feeds the disc screen. The chute is equipped with a plug switch (LSH-10416-12) that will signal the controller if material builds up in chute. If a plugged condition is detected, the controller will stop the upstream conveyors (10414 and 10416) and annunciate an alarm.

The bale shredder discharge conveyor is equipped with a zero-speed switch (SS-10416-1) to verify the conveyor is running when it should be running. If the belt or shaft breaks, it will be detected by the controller and the controller will annunciate an alarm.

The conveyor is equipment with belt alignment sensors on the Headdrum (ZS-10416-2, ZS-10416-3) and the Tail drum (ZS-10416-6,ZS-10416-7) and bearing temperature sensors on the head and tail Pulleys (TSH-10416-4,TSH-10416-5,TSH-10416-8,TSH-10416-9). An alarm should annunciate if any of these signals are detected.

It is recommended that the belt conveyor have installed two (2) IR sensors(BS-10416-10, BS-10416-11) or as recommended by a qualified supplier, installed in the chute of the conveyor. These will indicate to the controller that there is an object that could be a potential fire issue and will activate solenoid valves to release water into the conveyor. The IR or other sensors and any water supply and control is outside of the WSM scope.

SS-10416-1	Conveyor Zero Speed Switch
LSH-10416-12	Plug Switch

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ZS-10416-6	Tail drum belt Alignment Sensor
ZS-10416-7	Tail drum belt Alignment Sensor
ZS-10416-2	Headdrum belt Alignment Sensor
ZS-10416-3	Headdrum belt Alignment Sensor
TSH-10416-8	Tail Drum Bearing Temperature probe / transmitter
TSH-10416-9	Tail Drum Bearing Temperature probe / transmitter
TSH-10416-4	Head Drum Bearing Temperature probe / transmitter
TSH-10416-5	Head Drum Bearing Temperature probe / transmitter
BS-10416-10	IR sensor No.1 (By Others)
BS-10416-11	IR sensor No.2 (By Others)

Prior to starting CV-10416 the Stolz De-Dust system must be running (FAN-11600) and the Disc Screen (SC-10418) must be running.

MG-10417 Overhead Magnet

The Overhead magnet is mounted suspended above and at right angle to the bale shredder discharge conveyor. The magnet will attract ferrous metals that may be in the corn stover and remove it from the product stream. The magnet belt will transport the tramp metal and drop it into a ferrous waste bin.

The magnet conveyor in the bale processing area is equipped with a zero-speed switch (SS-10417-1) to verify the conveyor is running. If a belt or shaft breaks, it will be detected by the controller and the controller will annunciate an alarm.

SS-10417-1 Conveyor Zero Speed Switch

MB-10417 should always run when CV-10416 is running.

SC-10418 Disc Screen

The Disc Screen receives material from the bale chopper discharge conveyor. There are three sections, each driven by a separate variable speed motor. The speed of each Disc Screen Section must be manually adjustable from the HMI by the operator. The overs from the last section discharge into a chute that feeds a shredder. The undersize material from the disc screen falls onto the Vibrating Screen.

SS-10418A-1	Screen Zero Speed Switch
SS-10418B-1	Screen Zero Speed Switch
SS-10418C-1	Screen Zero Speed Switch

Prior to starting SC-10418, the Vibrating Screen (SC-10419) and the Shredder (G-10420) should be running.

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SC-10419 Vibrating Screen

The Vibrating screen receives the undersize from the disc screen. The Vibrating screen is used to separate dirt and fines from the stover that falls through the disc screen. The dirt and fines that pass through the shaker screen falls onto a fines collection conveyor. The separated stover fines that do not fall through the Vibrating Screen are ducted to drop into the air conveyor suction stream that is used to convey discharge from the shredder.

The Vibrating screen is driven by a fixed speed motor that drives the screen at its resonant frequency. The motor is equipped with a zero-speed switch (SS-10419-1) to verify the Vibrating Screen is running when it should be running. If a shaft breaks, it will be detected by the controller and the controller will annunciate an alarm.

SS-10419-1 Screen Zero Speed Switch

Prior to running SC-10419 the Stolz rotary airlock (SSL-11402-16) must be running and the chute plug detector (LSH-11402-23) should indicate that the chute is not plugged. The Fines Collection Belt (CV-10501) must also be running.

G-10420 Shredder

The shredder receives overs from the disc screen discharge chute. The shredded corn stover discharges into an air conveyor duct that carries it away to another process. The shredder is driven by two large motors. The bearings that support the shredder rotor shaft are equipped with temperature transmitters (TSH-10420-5, TSH-10420-6). Temperature set point of 175 degrees F and an alarm should be annunciated if temperatures exceed the set-point. The shredders also have a vibration switch (VSH-10420-8) should any of these reach their upper limit (setpoint = 4 mils), it will be detected by the controller and the controller will annunciate an alarm.

Prior to the Shredder starting, the air evacuation system MUST be operating.

The rotor on the shredder is equipped with zero Speed indicators. (ST-10420-1) This will send a signal to the controller that should the rotor be moving, the shredder access door solenoid remains in the closed position (XSV-10420-2). Access doors on the shredder are equipped with safety switches (ZS-10420-3, ZS-10420-4) to stop the motors if the signal is broken.

The motor load of the shredder is monitored by the controller. The initial setpoint for the motor (200 hp) load should be set at 100% FLA, or 225 Amps per motor with a timer loop initially set at zero seconds. If the load exceeds a this preset threshold for the specified timer count, the controller will cause an immediate reduction in the speed commands of the Disc Screen, Bale Chopper Discharge Conveyor, Bale Chopper Infeed Conveyor. This will prevent the shredder from receiving too much material and becoming plugged. A reduction in all of the speed commands at the same time will

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prevent creation of a slug of material. The WSM field liaison can assist in final tuning of current and time setpoints.

ZS-10420-3	Door Safety Switch
ZS-10420-4	Door Safety Switch
TSH-10420-5	Bearing Temperature Switch
TSH-10420-6	Bearing Temperature Switch
VSH-10420-8	Bearing Vibration Switch
ST-10420-1	Rotor shaft Motion Sensor
XSV-10420-2	Shredder Door Solenoid Lock

Prior to running the Shredder (G-10420) the Stolz Air System (FAN-11400) must be running and the Fines Collection Belt (CV-10501) must be running.

G-10421 Hydraulic Unit

All of the hydraulic functions for the line are on a single unit (except the Shredder). Initial hydraulic pressure should be at least 1300 psi. The hydraulic unit for the line is equipped with **four** pumps. The hydraulic tank has a Level Transmitter (LT-10421-31) that monitors the oil level in the tank. If the level in the tank drops below the sight glass level on the tank (to field adjusted by WSM Liaison) , the controller will annunciate an alarm. The Tank also is equipped with a Temperature Transmitter. (TT-10421-30) If the temperature of the oil were to go below 80 deg F the controller will annunciate an alarm. If the temperature of the oil is 140 F or greater, the heat exchanger fan (M-10421E-1) will be turned on and start to cool the oil and the controller will annunciate an alarm. The Cooling Fan (M-10421E-1) will continue to run until the temperature is below 140 F. If the Temperature of the oil should reach 160 deg the controller will shut down all of the hydraulic pumps (M-10421A-1, M-10421B-1, M-10421C-1 and M-10421D-1). The hydraulic tank will also have a heater installed in it.

LT-10421-31	Level Transmitter
TT-10421-30	Temperature Transmitter

All of the Hydraulic Pumps must run for the bale line to function. If one of the pumps (M-10421A-1, M-10421B-1, M-10421C-1 and M-10421D-1) fails, the other pumps should be shut down. The ability to process bales will stop at this point. Alarms should be sent to the HMI and the failure must be investigated.

H-10422 Clean-up Hopper Conveyor

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The clean-up hopper conveyor receives material that is collected from cleaning operations in the facility. Per NFPA regulations **NO FLOOR SWEEPINGS MAY BE DUMPED IN THIS CONVEYOR.** The material is dumped into a hopper that has a conveyor in the bottom.

The operator will press the Start Button (HS-10422-1) console at or near the end of the conveyor. This will start the conveyor and it will for a programmed time and then shut off. The conveyor transports the material and discharges onto the chopper discharge conveyor where the material re-enters the product stream.

The clean-up hopper conveyor is equipped with a zero-speed switch (SS-10422-1) to verify the conveyor is running when it should be running. If a chain or shaft breaks, it will be detected by the controller and the controller will annunciate an alarm.

SS-10422-1 Conveyor Zero Speed Switch

CV-10501 Fines Collection Belt

The fines conveyor receives material that falls through the Vibrating Screens of the four infeed lines. The material is transported to a Fiber Recovery screen. The fines conveyor is driven by a fixed speed motor.

The fines conveyor is equipped with a zero-speed switch (SS-10501-1) to verify the conveyor is running when it should be running. If the belt or shaft breaks, it will be detected by the controller and the controller will annunciate an alarm.

SS-10501-1 Conveyor Zero Speed Switch

The Fines Collection Belt (CV-10501) must be running prior to the Shredder (G-10420) starting. Prior to CV-10501 running, the Fiber Recovery Screen (SC-10502) must be running.

SC-10502 Fiber Recovery Screen

The fiber recovery screen receives material from the fines collection belt. The screen is driven by a fixed speed motor that drives at its resonant frequency. The screen is equipped with a zero-speed switch (SS-10502-1) to verify the screen is running when it should be running. If a shaft breaks, it will be detected by the controller and the controller will annunciate an alarm.

The overs from the fiber recovery screen discharge into a chute that discharges into a pneumatic conveyance to supplement the boiler fuel.

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The undersize material from the fiber recovery screen consists mainly of dirt that has been separated from the corn stover. The fiber recovery screen undersize material discharge into a Fines Collection Screw

SS-10502-1 Screen Zero Speed Switch

Prior to starting the Fiber Recovery Screen (SC-10502), the Fines Collection Screw (CV-10503) must be running and LSH-1800-23 (Stolz chute plug detector) must indicate that the chute is clear and the Stolz Airlock (SSL-11800-16) must be running.

CV-10503 Fines Collection Screw

The Fines Collection Screw receives undersize material from the Fiber Recovery Screen. The screw feeds material to the infeed hopper of the Fines Bucket Elevator. The screw is driven by a fixed speed motor. The screw is equipped with a zero speed switch (SS-10503-1) to verify the auger is running when it should be running. If a shaft breaks, it will be detected by the controller and the controller will annunciate an alarm.

SS-1050301-1 Conveyor Zero Speed Switch

Prior to starting the Fines Collection Screw (CV-10503) the Fines Bucket Elevator (BE-10504) must be running.

BE-10504 Fines Bucket Elevator

The fines bucket elevator receives material from the Fines Collection Screw. The elevator discharges material into a chute that feeds the Fines Storage Silo. The elevator is driven by fixed speed motor. The elevator is equipped with a zero speed switch (SS-10504-1) to verify the elevator is running when it should be running. If a belt or shaft breaks, it will be detected by the controller and the controller will annunciate an alarm. Note this conveyor must ALWAYS run less than 500 feet/min

The discharge chute is equipped with a plug switch (LSH-10504-2) to detect a buildup of material in the chute. If a plug condition is detected, the controller will shut down the Bucket Elevator, Fines Collection Screw, Fiber Recovery Screen and the Fines Collection Belt and annunciate an alarm.

The Bucket Elevator motor load will be monitored by the controller and provide a feedback signal to shut down the equipment should the motor be in an over current situation.

SS-10504-1 Conveyor Zero Speed Switch
LSH-10504-2 Plug Switch

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The Fines Bucket Elevator (BE-10504) is the first drive to start in the Fiber Recovery area. It will be either started manually at the HMI or will start automatically during a programmed start sequence.

T-10505 Fines Storage Silo

The Storage Silo receives material from the Fines Bucket Elevator. The Fines Storage Silo discharges material via a live bottom reclaimer screw.

The hopper has a discharger screw that is internal to the silo. This auger collects material from the base of the hopper and draws it toward the center where the material drops into the load spout. The discharger is equipped with a Zero Speed Switch to verify that it is running. If it stops, it will be detected by the controller and the controller will announce an alarm.

The fines hopper is equipped with an electric motor for the sweep advance. The main auger drive (M-10505A-1) and the Sweep Advance (M-10505B-1) will run only during times when the operator is loading a truck. These drives must be interfaced to the local control pendant so they can be started and stopped by the local operator (see DLS-10506).

The silo is equipped with a level transmitter. This is a RADAR device that measures the height of the material in the bin. Should the level of the silo exceed the programmed level, the controller will announce an alarm.

LSH-10505-4	Level Transmitter
ZS-10505B-3	Slewing Drive Position Limit Switch
SS-10505A-1	Discharger Zero Speed Switch

High Alarm set point will have to be set for the Fines Storage Silo based on the signal from the Level Transmitter (LSH-10505-4). It is recommended that there be three alarms sent to the HMI:

50% Silo Full: Silo ready to dump

75% Silo Full: High Level Alarm indicating silo getting full. Silo dump required.

90% Silo Full: High High Level Alarm indicating shutdown of dirt fines system.

Shutdown of dirt fines system should shut down feed into the Bale Chopper meaning that the Bale Chopper Infeed Transfer (CV-10414) would stop with a High High Level Alarm. The Bale Chopper Infeed Transfer (CV-10414) should not be enabled to start until the operator acknowledges that the Dirt/Fines truck is in position and is loading.

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DLS-10506 Dustless Loading Spout

The dustless loading spout (DLS) receives material from the silo. The loading spout discharges material into load out trucks. The truck will be placed in position by the driver. The loading spout has an extendable chute with a hoist fixed speed motor that lowers into the bed of the truck and elevates as the material fills the truck. The driver will start the process manually by pendant control. The control pendant has an “Up” and “Down” push button which controls the up and down movement of the DLS locally. There is also an “Open/Close” selector switch that can control a slide gate. There is no slide gate currently supplied with the system and it is suggested that this button be field modified to control different functions. This switch will need to be an on-off selector switch. When the driver lowers the DLS into an empty truck, the local Operator will turn the added selector switch to the “On” position. The “On” position will engage several things in the following order:

1. Open Duct Damper (XSV-10506-2) via the 120V actuator.
2. Engage the higher speed setting on the Filter Fan (M-10507-1).
3. Start Main Auger Drive (M-10505A-1).
4. Start Sweep Advance (M-10505B-1).

Opening the filtration system Damper Actuator (XSV-10506-2) will ~~open~~ allow de-dust air to be pulled from the DLS using the Filter Fan. At the same time the VSD will speed up the fan from its lower speed limit. (Low speed ~30 Hz. High Speed ~60 Hz.) While the fan speeds up the reclaim screw in the bottom of the bin will start to move material out of the bin to the load spout. The Sweep Advance Power Unit will start to move the reclaim screw around the bottom of the bin. The spout is raised and lowered with a cable winch by the driver using the local pendant. The loading spout has a double wall. The outer wall forms an annulus around the inner loading spout that that draws in dust generated from the transfer of material into the truck trailer. Turning the Selector Switch to “Off will return the damper to the closed position, return the Filter Fan (M-10507-1) to the lower speed setting (30 Hz.) and stop the Sweep Advance Drive (M-10505B-1) and the Main Auger Drive (M-10505A-1). It is important that the Sweep Advance Drive (M-10505B-1) stop before the Main Auger Drive (M-10505A-1) stops. The DLS has a rotate limit switch and two slack cable limit switches which are used internally to the DLS to control the operation from the pendant.

F-10507 Filter/Fan

Dust generated in the Fines Storage Silo and loading spout are captured and vented into the filter. Dust captured is separated by the filter and falls back into the Fines Collection Screw while the air is exhausted via the Filter fan.

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The fan will have a VSD drive. When venting the silo only, the fan will turn down to a pre-set speed (~1800 rpm for 500 cfm = 30 Hz.) to provide de-dust air for the bucket elevator and the Fines Storage Silo. When the loading of the Silo is taking place, the Damper Actuator (120V) will open and the Fan will speed up to a preset speed (~3500 rpm for 1800 cfm, = 60 Hz.) to provide de-dust for the silo, bucket elevator and Dustless Load Spout. Once the load out of the truck is complete, the fan will turn back down and the Damper will close.

The filter cleaning will be done with compressed air solenoid valves and fired by use of a timer. These all will be enclosed in a cabinet.

XSV-10506-1 Damper Actuator

The Filter Fan (M-10507-1) should start concurrently with the Fines Bucket Elevator (BE-10504) and it should always run when the Fines Bucket Elevator is running and/or when trucks are being loaded.

RV-10508 Filter Air Lock

Dust and material picked up in the filter will be deposited into the Fines Collection Screw thru the air lock. The Filter Air Lock will be mounted to the underside of the filter. The air lock is driven by a fixed speed motor and is equipped with a zero speed switch (SS-10508-1) to verify it is running. The Airlock must be running before the air system can be started.

SS-10508-1 Zero Speed Switch

The Filter Airlock (RV-10508) should start concurrently with the Fines Collection Screw (CV-10503).