RENDERING START UP AND SHUT DOWN PROCEDURE

START UP

Check all necessary services, valves, switches and equipment are ready for operation. Hot water pump, compressed air, cooling water etc

Select **Auto** mode on screen for the equipment you want to run in each area.
If you do not want an item to run, place it in manual before starting the section and it will remain off unless manually selected to start.

Auto Start sequence using the Section start buttons on the left of the screen.

- **Decanter**
  Check back drive is on, grease bearings on start up, grease Flomor pump and Render vessel bearings

- **Separator**
  Brake off, soft water tank full, check sludge hopper and stickwater tank/pump Check tallow pump and drain valve

- **Meal**
  Bin selection, screw drain valves, drop out slide gates

- **Dryer**
  Infeed water jacket Cooling water, Burner panel check, liquid leaks from dryer exit, Cooling tower, condenser operation or evaporator duct operation

- **Liquid phase**
  Steam valve on, liquid phase screen bypass valve position check

- **Render Vessel**
  Full of liquid, Steam valve on

- **Ground Material**
  Set Speed for start up @ 20hz then adjust for rate

- **Raw Material**
  Set Speeds for type of material

Once the plant is running allow feed to the decanters and stop flushing them with water. When the LP tank is above Lo level start the separation process and stop hot water flushing.

If the on screen selection is **Manual** then the item will maintain its current state until changed by selection. Typically there are *no interlocks* apart from key safety items. The metal detectors will function, and the dryer area equipment will retain interlocks

The decanter and separator are started first.
These should be started individually and monitored for noise and vibration as they wind up to their operating speed.
Check the separator brakes are off and the soft water tank level is full. Check sludge hopper and stickwater tank/pump valve settings.
The separator is started with a 5 minute ramp up and the amps can be monitored on the meter, the seal water solenoid opens on starting. Hot water is turned on once up to speed to warm up the unit.
The Big decanter back drive starts up first and runs for a minute before the main drive motor starts. The main drive has a star delta starter with a 3 minute star timer and a PLC timer to prevent feeding the machine until up to full speed.
The small decanter starts the back drive and main drive at the same time and has a 2 minute star timer and PLC timer to prevent feeding the machine until up to full speed.
Hot water is turned on to these machines to flush them clean, aid balancing and bring them up to operating temperature. NB: see Decanter and Separator instruction manuals for details.

At this stage the raw material can start being worked through to the ground surge bin. With the associated conveyors going, material from the RM bin can start being discharged and then fed up towards the grinder. The grinder should not be allowed to run for any length of time without material as this rapidly wears the knives and the hole plate which adversely effects production. The ground material surge bin should be part full before starting the feed to the Render Vessel.

The Meal system and the Dryer are started next to run out any residual meal from the previous days production and warm up the system. The dryer burner motor starts if all the temperature/flow/pressure/run interlocks are OK but performs a 4-5 minute air purge before firing. When the dryer temperature is over 100 the infeed screw and decanter solids screw start. The Vender vessel and Liquid Phase sections should be started while the dryer is purging. The Render Vessel should be filled with water or liquid phase and the agitator started to bring it up to operating temperature. The Render Vessel and LP tank steam valve is not to be opened until the agitator is operating.

The decanter feed pumps are allowed to start automatically when the burner is running the dryer temperature is above the low temperature alarm and the screws running. The render vessel valves to the decanter feed pumps are opened and the flushing water turned off.
The ground material section feeding the Render Vessel is started and the hot water to the decanters should be turned off and the liquid phase divert to drain valve closed.

The liquid phase tank should be part full and up to temperature before starting to process through the separator. Starting the separator process cycle will start the liquid phase pump , the tallow pump and begin the timed auto de-sludging cycle.

SHUT DOWN

Auto Stop sequence using control panel Section stop buttons

- **Raw Material**
  Stop when last RM goes through grinder and hose all equipment

- **Ground Material**
  Allow surge bin to empty then flush out and stop

- **Render Vessel**
  Flush with water to remove solids then close pump valves and stop RV.
  Shut steam valve

- **Decanter**
  Flush with water then stop the decanter and continue to flush for 2-3 mins while slowing, turn off the water before it stops.
  Turn off back drive after completely stopped

- **Liquid phase**
  Divert water to drain, stop when at low level, shut steam valve

- **Separator**
  Run LP tank down to low level then flush with bypass water and manually desludge to clean out solids, stop flushing and shut down

- **Dryer**
  Stop when temperature reachs 135 and let it complete the cool down run on.

- **Meal**
  Shut down will stop feed but allow items to empty before finally stopping
  Run the Silo fan and Milling fan manually if concerned about condensation.

The last of the raw material is usually followed through the process by flushing and cleaning of each piece of equipment. As each area is finished they can be shut down.

The raw material bins, screw conveyors and grinder are all hosed clean of material. As the last of the ground material is leaving the surge bin the pump is flushed and the vessel allowed to continue running on water for approximately 5 minutes to dilute and remove as much solid material as possible.

Water should be turned on to the decanters then the Render Vessel agitator and decanter feed pump is turned off. The decanter should be flushed for a few minutes with the water being sent to the drain. The water can be sent to the LP tank to fill it for a CIP clean if required. When the large decanter is shut down the bowl rotates for approx 15 minutes and the water should be left on for approx 5 mins to flush and

balance the unit. The back drive continues to run for the 15 minutes to remove all solids from the machine.

The liquid phase pump continues feeding the separator until the liquid phase tank is at low level. The separator has manual bypass water turned on and is to be flushed with several manual cleaning cycles before shutting down. The tallow pipe from the separator to the tallow pump needs to be drained after the tallow pump has stopped and the air purge has been completed.
NB see separator instruction manual for more details.

The dryer is left to run for approximately 5-10 minutes after the Decanter feed pumps are turned off to dry the remaining meal. Then the section Stop is selected so the burner is turned off but the rest of the dryer is left running until the dryer temperature drops to an acceptable level. The dryer has an extended run on timer to ensure the equipment is sufficiently cool when it stops. A 45 minute count down to stopping timer appears on screen. Note:The dryer fan , barrel and cooling tower will try and run on even in manual if the burner has been operating.

The meal section should continue on until the meal has finished coming out of the dryer. When the meal system is shut down it has staged delay times between items to allow each of them to empty.
If concerned about condensation in the Meal system then manually run the Silo fan and Milling fan to maintain air flow and remove vapour.

FLO-DRY RENDERING PLANT

PROCESS DESCRIPTION

With reference to drawing no.s: 11055P001-01 & 11055G100-01

Raw Material is typically delivered to the plant in a pre-broken state from the abattoir. There is the ability for unbroken material to be added into screw 201C which elevates the RM up to Pre-Breaker 203 located over the RM bin. The broken RM is stored in RM bin 201 prior to processing. Screw conveyors inside the bin discharge a metered amount of raw material for processing, as set by the VFD speed selection.

The RM is discharged into the RM transfer screw 204 which delivers it onto Metal Detector Belt 205, this checks for metal and drops the material in to transfer Screw 206 which feeds via Diverter 206A into Grinders 207A or B where it is ground down to its final processing size.

The ground material is held in Surge Bin 208 and metered out by the discharge screw which has variable speed control for setting the feed rate to transfer pump 209 and then onto Render Vessel 210. The Lamella transfer pump 209 delivers the ground material into the bottom of Render Vessel 210 where it is agitated and heated at 95 ^{O}C to cook the product to release the fat or Tallow.

The cooked material is pumped by 212 A&B to the Decanters 213 A&B, which centrifugally separate the solids from the free liquids. The liquid is collected in buffer tank 214 then pumped by 214 A or B to LP Screen 215 and held in the Liquid Phase Tank 216 where it is treated with acid to maintain a pH of 4-5. The liquid phase is held at 90 ^{O}C and pumped by 217 A&B to the Separator 218 A&B where the tallow is extracted.

The tallow is then pumped by Pump 219 A&B to the Bulk Tallow storage tank 900. The Separator Stick water and sludge is discharged into the transfer tank 220 where it is pumped by 220A to the Evaporator or discharged into the main plant drainage system.

The Flo-Dryer is a direct fired, hot air, rotary type dryer. The Burner 504 heats the air which in turn heats the solids as they pass down the dryer, driving the moisture from the solid particles. Controlling the outlet air temperature controls the moisture content in the meal, so this is the parameter which is used to control the burner output.

The hot/humid air sucked from the dryer passes through a high efficiency Cyclone 505 to remove dust from the air stream before the Dryer Fan 507 blows it to the shell and tube Condenser 508 to cool/condense the air/water vapour exhaust. Cooling water is circulated through the condenser from a cooling tower 520. Approximately half the dryer air is recycled with the remainder being exhausted into the bio-filter.

The meal is conveyed by transfer Screw 601 and 602 to the Meal Mill 606. An Air Relief System removes dust and vapour from the Mill. The meal is discharged by screw 607 to the Rotary valve 800 where it is blown by 801 to the Meal Storage Bins 806 A&B.

FLO-DRY
RENDERING PLANT
OPERATORS MANUAL

INTRODUCTION

1. Process Summary

The basic operations of the Low Temperature Rendering process are:

a. Material size reduction
b. Cooking
c. Solid/Liquid Separation
d. Tallow/Water Separation
e. Solids Drying
f. Meal

1a Material Size Reduction

The pre-broken material is passed over a metal detector belt and then ground down to approx 12-16mm by a Grinder.

1b Cooking

The ground material is heated and agitated in the Render Vessel to melt out the fat or tallow.

1c Solid/Liquid Separation

The cooked mixture is pumped to the Decanter where the solids and liquids are centrifugally separated.

1d Tallow/Water Separation

The liquid phase is screened and pH corrected then pumped to the separator where the tallow and stick water are centrifugally separated.

1e Drying

The decanter solids are fed into the Flo-Dryer where the water is evaporated and the solids dried to give meal.

1f Meal

The dried meal is conveyed to the meal system where it is milled to its final size and conveyed into the storage silo.

DETAILED PROCESS DESCRIPTION

2. RAW MATERIAL

2a Material Size Reduction

Broken raw material is stored in RM bin prior to processing. Screw conveyors inside the bin discharge a metered amount of raw material for processing, as set manually by the VFD speed selection.

The broken material is transferred by Screw 204 onto Metal Detector Belt 205 which checks for metal. If metal is present the detector stops the raw material screws and the belt with the offending material in front of an air operated ram. The ram pushes the material off the belt into a sorting tray where the metal can be removed. The ram retracts then the belt reverses back over the metal detector then goes forward again to ensure that no metal escapes detection. The reject material has to be manually sorted and returned back onto the belt before the detector again.

The belt conveyor feeds the material into transfer Screw 206 which feeds via Diverter 206A into Grinders 207A or B. The Grinder reduces the material down to approximately 12-16 mm in size. The ground material goes into a small Surge bin 208 prior to being pumped 209 to the Render Vessel 210. Surge bin screw 206 has a VFD with speed adjustment for setting the plant processing speed to suit the type of material in the process.

2b Cooking

The Render Vessel uses steam coils to heat the material up to the set point (usually 95°C). RM drain sump water and/or Recycle liquid phase is added to the Render Vessel to help fluidise the ground material as it is agitated and provide a heating medium. It is critical that the mixture is always moving with a good agitation pattern. The agitator motor amps indicate how well the mixture is moving and can be used as a guide when an adjustment is necessary. Typically 30-35 amps. Excessive water addition will increase product losses and effluent which is undesirable.

Feed rate to the Render Vessel 210 is set by the variable speed controller on the Surge bin screw 208 and is usually set to match the vessels capacity. Cooked material leaves the vessel by overflow tube which goes direct to the decanter feed pumps 212 A&B.

2c Solid/Liquid Separation

The cooked material is pumped to the Decanter 213 A&B where the solids and liquids are centrifugally separated. The decanter feed pump 212 A&Bs speed is set

to pump all the material that flows from the outlet of the render vessel. The decanter rotates at high speed and has a long start up time to reach operating speed. Hot water is turned onto the decanter after start up to bring it up to operating temperature before product is put through. The decanter back drive rotates an internal screw which moves the solids to the discharge point. The motor amps indicate the solids loading on the decanter and can be used as a guide for adjusting the feed to the render vessel. The solids are ejected at high speed into the solids screw conveyor and should not be interfered with. The liquid is collected in buffer tank 214 then pumped by 214 A and/or B to LP Screen 215 which removes any light solid particles like plastic etc.

2d Tallow/Water Separation

The screened liquid is held in the LP tank 216 where it is dosed with dilute sulphuric acid to aid the separation process. The acid reacts with the liquid and this reaction takes a certain time to occur, for this reason the tank should always be agitated and remain part full. It should not be run empty.

The correct pH of 4-5 for the liquid phase is critical to the process. The liquid phase is pumped from the tank at 90-95°C to the Separators 218 A&B. The separators also operate at high speed requiring a long wind up time, after which, hot water is turned on to bring it up to operating temperature.

The separator produces tallow and stick water. The tallow is pumped to a storage tank and the stick water is pumped to the Evaporator holding tank or discharged down the drain. Tallow outlet from the separator has a visible product discharge. Tallow should always be a clear golden colour and the stick water an opaque light brown colour. If tallow goes milky/opaque and the stickwater a creamy/yellow colour then the separation process is failing and must be rectified.

Acid addition to the tank is controlled by a pH sensor in the liquid phase tank which automatically maintains a pH of 4-5. The separator automatically changes valve positions and process flows when the machine goes through its timed cleaning cycle. Note: See separate operating instructions for the Separators.

2e Drying

The decanter solids are screw conveyed into the Dryer 500. The dryer Infeed Screw 503 is water jacketed and uses cooling water to maintain a steady temperature.

The dryer is a direct fired, hot air, rotary type. Here the air is heated by a Gas fired Burner 504 in the combustion chamber and the hot air is then used to evaporate water from the solids as they tumble through the air flow. The burner is automatically controlled by sensing the dryer outlet air temperature. Gases exiting the dryer go through a Cyclone 505 to remove any light particles before continuing on to the main Fan 507 and then to Condenser 508. The Condenser removes heat from the gas/vapour in the form of hot water by condensing out previously evaporated water and cooling the air prior to recycle or discharge. Moisture content of the meal leaving the dryer is affected by the final end point temperature setting and barrel rotation speed which dictates material residence time within the dryer.

Dry meal is gravity discharged into the Exit screw 501 which also collects the cyclone fines discharged by the Cyclone rotary valve 506. Meal discharges from the Exit screw through Rotary Valve 502 which is an air lock for the Dryer system into transfer screw 601 then transfers by screw 602 to the meal milling system.

Note: See also the Dryer Controls and Safety Equipment appendix

2f Meal Milling

The meal is fed by screw 602 to the Mill 606. The Mill reduces the meal to 2-3mm size and is mounted on an air relief plenum, which includes Cyclone 606A and Mill air extraction Fan 608. The meal is discharged from the mill plenum screw 607 into Rotary valve 800 where Blower 801 conveys it to the Storage Bins.

2g Meal Load out

The silo is discharged by manual operation of the screws.

The storage Bins 608 A&B discharge into collection screw which feeds the load out system.

RENDERING START UP AND SHUT DOWN PROCEDURE

START UP

Check all necessary services, valves, switches and equipment are ready for operation. Hot water pump, compressed air, cooling water etc

Select **Auto** mode on screen for the equipment you want to run in each area.
If you do not want an item to run, place it in manual before starting the section and it will remain off unless manually selected to start.

Auto Start sequence using the Section start buttons on the left of the screen.

- **Decanter**
  Check main drive panel and back drive controller is on, grease bearings on start up, grease Flomor pump and Render vessel bearings

- **Separator**
  Brake off, operating water tank full, check sludge hopper and stickwater tank/pump
  Check tallow pump and drain valve

- **Meal**
  Bin selection, screw drain valves, drop out slide gates

- **Dryer**
  Infeed water jacket Cooling water, Burner panel check, liquid leaks from dryer exit, Cooling tower, condenser operation

- **Liquid phase**
  Steam valve on, liquid phase screen bypass valve position check

- **Render Vessel**
  Full of liquid, Steam valve on, temperature setting

- **Ground Material**
  Set Speed for start up @ 20hz then adjust for required rate

- **Raw Material**
  Set Speeds for type of material and rate

Once the plant is running allow feed to go to the decanters and stop flushing them with water. When the LP tank is above Lo level start the separation process and stop hot water flushing.

General operations notes

If the on screen selection is **Manual** then the item will maintain its current state until changed by selection. Typically there are *no interlocks* apart from key safety items. The metal detector will function, and the dryer area equipment will retain interlocks

The decanters and separators are started first.
These should be started individually and monitored for noise and vibration as they wind up to their operating speed.
Check the decanter liquid buffer tank drain valve.
Check the separator brakes are off and the soft water tank level is full. Check sludge hopper and stickwater tank/pump valve settings.
The separator is started with a 5 minute ramp up and the amps can be seen on the meter to monitor progress, the seal water solenoid opens when up to full speed. the seal water solenoid opens on starting. Hot water is turned on once up to speed to warm up the unit.
The Big decanter back drive starts up first and runs for a minute before the main drive motor starts. The main drive has a star delta starter with a 3 minute star timer and a timer to prevent feeding the machine until up to full speed.
The small decanter starts the back drive and main drive at the same time and has a 2 minute star timer and PLC timer to prevent feeding the machine until up to full speed.
Hot water is turned on to these machines to flush them clean, aid balancing and bring them up to operating temperature. NB: see Decanter and Separator instruction manuals for details.

At this stage the raw material can start being worked through to the ground surge bin. With the associated conveyors going, material from the RM bin can start being discharged and fed up towards the grinder. The grinder should not be allowed to run for any length of time without material as this rapidly wears the knives and the hole plate which adversely effects production. The ground material surge bin should be part full before starting the feed to the Render Vessel.

The Meal system and the Dryer are started next to run out any residual meal from the previous days production and warm up the system. The dryer burner motor starts if all the temperature/flow/pressure/run interlocks are OK but performs a 4-5 minute air purge before firing. When the dryer temperature is over 100 the infeed screw and decanter solids screw start. The Vender vessel and Liquid Phase sections should be started while the dryer is purging. The Render Vessel should be filled with water or liquid phase and the agitator started to bring it up to operating temperature. The Render Vessel and LP tank steam valve is not to be opened until the agitator is operating.

The decanter feed pumps are allowed to start automatically when the burner is running the dryer temperature is above the low temperature alarm and the screws running. The render vessel valves to the decanter feed pumps are opened and the flushing water turned off.
The ground material section feeding the Render Vessel is started and the hot water to the decanters should be turned off and the liquid phase divert to drain valve closed.

The liquid phase tank should be part full and up to temperature before starting to process through the separator. Starting the separator process cycle will start the liquid phase pump , the tallow pump and begin the timed auto desludging cycle.

SHUT DOWN

Auto Stop sequence using control panel Section stop buttons

- **Raw Material**
  Stop when last RM goes through grinder and hose all equipment

- **Ground Material**
  Allow surge bin to empty then flush out and stop

- **Render Vessel**
  Flush with water to remove solids then close pump valves and stop RV.
  Shut steam valve

- **Decanter**
  Flush with water then stop the decanter and continue to flush for 2-5 mins while slowing, turn off the water before it stops.

- **Liquid phase**
  Divert water to drain, stop when at low level, shut steam valve

- **Separator**
  Run LP tank down to low level then flush with bypass water and manually desludge to clean out solids, stop flushing and shut down

- **Dryer**
  Stop when temperature reachs 135 deg C and let it complete the full cool down cycle timed run on sequence
  Close cooling water to infeed jacket if not recycling other water

- **Meal**
  Shut down will stop feed but allow items to empty before finally stopping
  Run the Silo fan and Milling fan manually if concerned about condensation.

The last of the raw material is usually followed through the process by flushing and cleaning of each piece of equipment. As each area is finished they can be shut down.

The raw material bins, screws conveyors and grinder are all hosed clean of material. As the last of the ground material is leaving the surge bin the RM pump is flushed and the vessel allowed to continue running on water for approximately 5 minutes to dilute and remove as much solid material as possible.

Water should be turned on to the decanters then the Render Vessel agitator and decanter feed pump is turned off. The decanter should be flushed for a few minutes with the water being sent to the drain. The water can be sent to the LP tank to fill it for a CIP clean if required. When the large decanter is shut down the bowl rotates for

approx 10-15 minutes and the water should be left on for approx 5 mins to flush and balance the unit. The back drive continues to run for this time to remove all solids from the machine.

The liquid phase pump continues feeding the separator until the liquid phase tank is at low level. The separator has the manual bypass water turned on and is to be flushed with several manual cleaning cycles before shutting down. The tallow pipe from the separator to the tallow pump needs to be drained after the tallow pump has stopped and the air purge has been completed.
NB see separator instruction manual for more details.

The dryer is left to run for approximately 5-10 minutes after the Decanter feed pumps are turned off to dry the remaining meal. Then the section Stop is selected so the burner is turned off but the rest of the dryer is left running until the dryer temperature drops to an acceptable level. The dryer has an extended run on timer to ensure the equipment is sufficiently cool when it stops. A 45 minute count down to stopping timer appears on screen. Note: The dryer fan, barrel and cooling tower will try and run on even in manual if the burner has been operating.

The meal section should continue on until the meal has finished coming out of the dryer. When the meal system shuts down it has staged delay times between items to allow each of them to empty.
If concerned about condensation in the Meal system then manually run the Silo fan and Milling fan to maintain air flow and remove vapour.

PROCESS CONTROLLER SETTING

RENDER VESSEL TEMPERATURE

Set Point	Sv	95 - 97
Proportional Band	P	200
Integral	I	5
Derivative	D	1
High Alarm	Hi	100
Low Alarm	Lo	90

LIQUID PHASE TANK TEMPERATURE

Set Point	Sv	90
On temperature	On	88
Off temperature	Off	91
High Alarm	Hi	95
Low Alarm	Lo	85

LIQUID PHASE pH

Set Point	Sv	4.0 - 5.0
On Acid pump	On	5.3
Off Acid pump	Off	3.8
High Alarm	Hi	6.0
Low Alarm	Lo	3.0

EQUIPMENT VARIABLE SPEED SETINGS

ITEM	**Operating Hz**		**LSP**	**HSP**
	Range	Typical		
RM Bin screws 200 A&B	10-50	37	10	50
Transfer screw 204	25-50	33	10	50
Transfer screw 206	25-50	33	10	50
Ground Surge 208	25-50	33	20	50
RM Pump 209	25-50	33		
Decanter feed pump 212 A&B	30-60	50	30	60
Dryer Barrel 500	35-50	40	30	50
Meal Screw 607	25-50	35	20	50
Blood Coag Pump 303	25-50	50	25	50

PROBLEM SOLVING

NOTE: Always isolate any machinery locally and in the MCC before working on it.

Raw Material Flow Stops

Check the computer screen to see what has stopped and if there is a fault. If the fault light is flashing check to see what the fault message is and investigate. If anything is jammed, clear it, Reset the overload if required, Acknowledge the alarm to reset the PLC to restart the items. Typically high levels in the Render vessel and LP tank stop processing and Dryer low temps.

Check the metal detector and belt conveyor are operating correctly. If the metal detector is continually rejecting, clear the belt of material and hose it clean then let it run empty.
If still rejecting, stop and hose under the belt to make sure no thin foil or such is under the belt or around the detector. If still rejecting with the empty belt call an electrician.

Grinder rate very slow and unable to keep up.

Check the hole plate and knives for excessive wear, replace as necessary.
Check the barrel anti-spin lugs and screw front face for excessive wear, if bad, advise the fitters to change the barrel and screw at the first opportunity. If none of the above get the drive belt tension checked make sure the material being fed to the grinders is not excessively wet.

Render Vessel Temperature Drops.

Check the agitator motor amps, if high, the mixture has become to thick and is not fluidising properly. Adjust the liquid recycle rate and add water briefly to correct if necessary.
Check the steam control valve is working properly. Check steam traps and bypass.
Check the steam pressure is correct. Reduce the material feed rate if required to stabilise the temperature and do not continue with the temperature below 90°C.

Render Vessel High Level Alarm

Check the decanter feed pump is working. If working then check the various vessel incoming flow settings and if product is leaving the decanter. If the pump is unable to keep up then the pump may be worn and requires replacement. If the pump is stopped on fault then turn on the hot water to the decanters to flush the line then run the pump briefly in reverse then try and restart the pump while putting water into the pump suction.
If the pump won't start then check to see if the flushing water is getting through the decanter. If no water is getting through, then the pump, pipe or decanter are blocked and will have to be cleared.

Excessive Solids Carry Over to the liquid Phase Screen

Check to see if the feed rates through the render vessel are getting high and the mixture too thick, which may not allow the decanter to work properly. Check the render vessel and decanter amps. If high add liquid and reduce the decanter feed and see if the amps drop. If no change stop the feed and decanter feed pumps and flush with hot water, this should clear any build up of solids. If no change the decanter may have to be cleared.

Excessive Liquid Carry Over with Screen Solids

Check the automatic spray wash system is working open the bypass briefly. Hose clean and if necessary scrub clean the screen surface.

Liquid Phase Tank Losing Temperature

Check the steam supply valve, control valve is correct and working.

Tallow Separation Fails

(Milky opaque Tallow and Creamy yellow stick water)

Check the liquid phase and stick water pH with universal indicator strips and compare with the pH controller read out.

If the controller is significantly different check that the pH probe is clean and get the controller re-calibrated at the first opportunity. It may be necessary to run the pH controller or acid pump on manual to stabilise the liquids pH and allow proper separation. If the controller agrees with the test strips pH, check that the acid system is working properly. Also check the air pressure, separator filter/regulator and air lines going to control valves. Check there is no extra manual water addition via the bypass valve. Check the liquid phase feed rate to the separator is not to high and adjust throttling valve as required.

Dryer Burner won't Start

Check for dryer alarms and acknowledge to reset. Reset the Over temperature relay push button on MCC1 panel
Check the gas is on and the OPSO valve green indicator is hanging down in the clear plastic cover, the main fan is on, the water jacketed feed screw pump/valve is on, the condenser water is on and that the burner control panel switch is on and has been reset. Clear any burner panel faults.
Check UV cell is clean and ignition cables and probes are connected and clean.
Refer to the Burner and Dryer manuals for further checks.

Dryer Operation

Refer to the Dryer Manual trouble shooting section.

RENDERING PLANT MAINTENANCE SUMMARY

DAILY

1. Grease bearings on Render vessel, Flomor pump, Decanter
2. Check air line filters & drains
3. Check metal detector and belt reject operation
4. Change the grinder knives and hole plate
5. Clean the Render Vessel and process lines
6. Check the dryer temperature probes readings during operation are similar
7. Check the cyclone solids discharge and rotary valve run hot during operation

WEEKLY

1. Check all drive lubrication and adjustment
2. Check glands, packing, seals for leaks
3. Check conveyor belt tension and alignment
4. Clean the dryer temperature probes
5. Check the pH probe for fouling (leave out for chemical cleaning)
6. Chemically clean the Render Vessel, Decanter, liquid phase screen, tank, Separator
7. Check and clean Dryer internal lifting flights of build up if present.
8. Check the mill screens for wear, replace as required.
9. Check the meal blower system and bag filter operation

FORTNIGHTLY/MONTHLY

1. Check the metal detector belt sensitivity and calibration.
2. Check the grinder head , barrel and screw for wear
3. Check the decanter feed pump for wear and replace vanes as required.
4. Check the decanter solids scroll for wear
5. Clean the liquid phase screen
6. Check the liquid phase pump stator
7. Re-calibrate the pH probe, Chemically clean the separator
8. Check the dryer, cyclone, fan and condenser for build up

1 to 3 MONTHLY

1. Check Render Vessel agitator blades for wear
2. Check tallow pumps
3. Check the dryer combustion chamber ceramic
4. Clean the dryer ducts, cyclone, fan, condenser and rotary valves.
5. Check the mill hammers and pins plus the screen locating bottom bar.
6. Check the mill plenum for build up.

6 MONTHS to YEARLY

Usual annual maintenance work plus the following:

1. Check the Brentwood
2. Remove and change decanter solids scroll and bowl
3. Check the mill wear plates and transitions.
4. Check the meal rotary valves clearances
5. Check the dryer infeed screw and water jacket for wear.

FLO-DRYER DESCRIPTION

How It Works

Wet material is fed through the water cooled infeed screw to the distribution section of the rotating barrel where it is subjected to temperatures in the 650 - 800 °C range. These elevated drying temperatures provide the necessary rapid heat transfer rate to ensure sterilisation of the product (should this be necessary). The product then rapidly leaves the high temperature distribution section of the barrel and enters the drying section where it is gently dried as it cascades through the hot air stream.

The final moisture content of the product is controlled by measuring the outlet temperature of the dryer air. As the outlet air temperature can be directly related to the product temperature and its moisture content.
This enables very fine control of moisture content as the temperature variation can be detected immediately and corrected to suit with a very small lag-time.

The material travels through the dryer using predominantly gravity, which has many advantages,:

- Low air velocity gives low wear rates and low exhaust volumes
- Due to the low air volume necessary - energy losses and costs are also reduced
- Product does not travel through the duct work hence low wear rates and less potential blockages.

Features of the Flo-Dryer

1. Simple construction - Is not a pressure vessel and does not require certification or associated inspections.

2. The Flo-Dryer is direct fired therefore around 98% of energy from the fuel (gas or oil) is used directly for drying (compare this with indirect heat dryer where 15% - 20% of energy is lost in the stack and piping systems). To aid this the combustion chamber is lined with high quality ceramic fibre to minimise heat loss. The dryer barrel is also clad using the same high quality ceramic fibre insulation beneath a skin of corrosion resistant stainless steel.

3. The water cooled infeed screw performs the task of feeding the wet material into the dryer without a sticking or burning problem to cause blockages, this also has the added advantage of being able to introduce the raw material to the hottest part of the dryer and so maximise drying performance and sterilisation.

4. High inlet temperatures controlled from 650 deg.C to 800 deg.C gives high heat transfer rates which ensures high thermal and fuel efficiency.(refer enclosed graph). This provides equivalent conditions for destruction of pathogens to meet the high standards required for certification by New Zealand MAF.
   The distribution section is manufactured from high temperature resistant stainless steel for a long service life.

5. Speed of rotation can be adjusted to vary the residence time to control the drying of different materials at varying rates.

6. Fully modulating burner control means that the dryers can be operated from 25% capacity to 100% capacity.

7. Being a psychrometric dryer the outlet product moisture content can be controlled by the outlet air temperature. This enables accurate control of the moisture content in the product within the critical 7% - 10% range.

   This is a distinct advantage over indirectly steam heated dryers, which, due to high lag-times cannot consistently control the moisture content to 7% - 10%. Inevitably, products in these types of dryers are over dried to 4% -6% moisture.

8. Dryer can be emptied out quickly in 20 - 30 minutes and restarted immediately.

9. Due to the above, other products such as feather meal or coagulated and de-watered blood can be dried either immediately before or after the processing of offal products, in rendering operations.

10. Operators have easy access to get inside the dryer for cleaning and maintenance.

11. The heavy duty trunnion rings and wheel assemblies have very low wear rates due to slow speeds of rotation, and low air and product flow velocities inside dryer which minimises repair and maintenance costs. Product is gravity discharged from the barrel outlet into a screw conveyor in the bottom of the extraction hood, this negates the very high cost of duct maintenance which other high air velocity dryers may be subject to.

12. Being direct fired, does not require boilers. This in turn lowers initial capital cost and on going maintenance costs as there is no costly boiler associated in the drying process.

13. Approximately 50% of the air used in the dryer system is recycled back into the combustion chamber where a significant portion of the odours are incinerated by the high inlet temperatures of the dryer itself. This recycling has the added bonus of greatly reducing the volume of exhaust air that must be treated.

14. Inclusion of the heat recovery system using a shell and tube heat exchanger allows for reclamation of heat in the form of hot water. Also by condensing the exhaust gases, this greatly reduces the exhaust volume and odour.

15. PLC Automatic controlled operation. Automatic start up Automatic run interlocking and fault handling Automatic shut down

16. Multiple temperature indicator, alarm and control units for safe automatic operation.

FLO-DRYER OPERATION

AUTO START UP PROCEDURE

Check all equipment to ensure that the system is ready for operation.
Turn on power and open up water, steam, compressed air and Fuel valves as necessary
Check for any fault lights on the burner control panel and clear any faults.
Automatic start up will only proceed if Dryer safety checks are passed and the meal equipment is operating.
Set the on screen Selection to Auto mode.
Press the START section button.

The PLC program starts the equipment in the following order with small time delays between each item to reduce current draw off peaks.

1. Infeed cooling Pump, Cooling tower & pump
2. Dryer Fan
3. Meal screw
4. Exit Rotary Valve
5. Exit Screw
6. Cyclone Rotary Valve
7. Barrel Drive
8. Burner
9. Infeed Screw

Note: The decanter feed pump will not start until the dryer temperature is over 100ºC.

The Dryer Burner temperature controller has adjustable set value to allow for product variation.

SV1 Warm Up
The PLC restricts the output at start up by selecting SV1 setting with low output.
SV2 Product start
The PLC restricts the output at product feed starting by selecting SV2 setting with increased output available but still reduced from full output.
SV3 Full Load Operation
The PLC selects SV3 which allows the dryer to respond to normal loading with full output available.

NORMAL AUTOMATIC RUNNING INTERLOCKS

The burner will only operate if all dryer equipment is operating, the temperatures are below Hi alarm points and the following flow/pressure conditions are satisfied.

The Main Fan has a differential pressure switch across the inlet and outlet which checks that the fan is working. This switch circuit must be open (no pressure) for the fan to start and the switch then go from open to closed when the fan has started, for the burner to operate.

The condenser and water cooled feed screw each have a flow switch in their return water lines to ensure that water is reaching them. These switch circuit must be closed for the burner to operate.

When the dryer Burner is operating within normal operating temperature limits [ie Between the Hi and Lo alarm settings] the feed screw is allowed to run and the unit is processing meal.
If the burner stops or has an alarm condition during normal operation the feed will stop.
Any dryer high temperature alarm signal or no flow condition will shut down the burner. Acknowledge the fault to reset and allow a restart.
High Temperature Cut Out is a separate relay safety alarm that requires the MCC panel reset button to be pushed.
A burner panel fault requires the BURNER PANEL RESET button to be pushed on the burner control panel.

A dryer motor overload will cause the burner and all preceding equipment to be shut down except for the barrel, fan and the infeed pump. These will continue to run until manually switched off or an automatic stop sequence is initiated and timed out.

On screen Fault indication and alarms show what has caused a shut down

NOTE
Pressing the Emergency Stop will stop everything without a shut down sequence.

Power loss or pressing the system Emergency Stop will activate the Steam Fire Extinguisher.

After an emergency stop or power failure restart the Milling and Dryer as soon as possible by either an automatic start or by manually switching on, the barrel, fan and the infeed water pump.
Allow any wet meal to be dumped on to the floor before it gets to the mill. The dryer should be run until the wet product is removed and the dryer temperature is down to normal shut down temperatures if the unit is going to be stopped manually.

Manual CO2 addition is a backup should steam run out.

AUTO OPERATION

If any dryer plant item is not running The burner will not run.

When all the plant is running in Auto Mode, If one item is switched off (or trips on overload) all plant upstream *[except the barrel, fan, and infeed pump]* will stop. When switched on again (or reset) it will restart and all upstream plant will start sequentially.

If the plant is running from an Auto start, any item can be switched on or off manually.
All other items will continue to run in normal automatic sequence with interlocks, including the interlock from the item manually switched.

MANUAL OPERATION

When the plant is running, any item of the plant can be switched On or Off.
All items in manual [except the Burner] run without any interlocks.
Note:The burner can only be run and fire in Automatic Mode.

ALARMS

Operation of any dryer alarm will shut down the burner.
for-

- Burner temperature out of limits
- Dryer Exhaust High temperature.
- Combustion Chamber High temperature.
- Infeed Screw Water High temperature.
- Condenser Water High temperature.
- Condenser/Bio-filter Gas High temperature.
- Fire Extinguisher operated.
- Infeed Screw Water low flow.
- Condenser Water low flow.
- Fan Air Pressure low.
- Exhaust air flow low.
- Motor Overload/Run Fail.
- Burner Hi Limit

All alarms are provided with individual alarm mesages to show what has caused the problem.
On the operation of an alarm the alarm light will flash, and an audible alarm will sound.
Pressing the ALARM ACCEPT push button will mute the audible alarm and the light will keep flashing. The alarm remains illuminated and will automatically go out when the alarm condition is removed. Press the alarm Acknowledge to clear and reset.

AUTO SHUT DOWN PROCEDURE

Press the DRYER AUTO STOP button.

The PLC performs an automatic controlled shut down of the Dryer system.

1. Burner
2. Infeed Screw
3. Barrel
4. Main Fan
5. Cyclone Rotary Valve
6. Exit Screw
7. Exit Rotary Valve
8. Meal screw
9. Infeed cooling Pump and Cooling Tower

Turn the Burner off at the Burner Panel and shut the fuel valve if any internal dryer maintenance is to be done otherwise leave on.

The dryer runs for 45 minutes after pressing the stop button and the fan with the condenser spray for a further 5 minutes after the barrel stops.

This allows time for the equipment to cool to an acceptable temperature.

If the temperatures have not dropped to approx 50-60 oC when it stops, then run it manually until it does.

The Burner and Combustion Chamber temps should be monitored to ensure that dryer is cooling down.

Once stopped and if all the temperatures are below 50 oC, then turn all switches OFF and close all water, steam and fuel valves.
Leave power on the unit so that the temperature instruments are still operating and can be monitored if required.

Should the temperatures begin to rise rapidly again after initially falling, open up the manual steam fire extinguisher valve for approx 30 seconds and continue to monitor temps as before.

TEMPERATURE CONTROLLER SETTINGS

NOTE

Dryer set points and alarms are critical to the drying process and safety. They should not be changed with out reading the following explanations of how they effect the control systems. Temperature settings that should be matched on different controllers are indicated by a * , + .

BURNER CONTROLLER [TIAC]

Set Value	Controls the dryer outlet or end point temperature. Adjust to obtain correct meal moisture content.
High Alarm H	Shuts down the burner via the PLC output. *
Low Alarm L	Stops product feeding to the dryer.

EXIT SAFETY & CYCLONE INDICATOR ALARM [TIA]

High Alarm H	Shuts down the burner via the Hi Temperature Relay circuit. *
High Alarm H	Shuts down the burner via the PLC out put. *

FIRE EXTINGUISHER ALARM[TA]

Set Point HH	Shuts down the burner and starts the steam fire extinguishers

COMBUSTION CHAMBER CONTROLLER [TIAC]

High Alarm H	Shuts down the burner via the PLC output. +

INFEED SCREW WATER INDICATOR ALARM [TIA]

High Alarm H	Shuts down the burner via the PLC out put. #

CONDENSER WATER INDICATOR ALARM [TIAC]

High Alarm H	Shuts down the burner via the PLC out put. #

CONDENSER GAS INDICATOR ALARM [TIA]

High Alarm H	Shuts down the burner via the PLC out put.

P.I.D. TEMPERATURE CONTROLLER SETTINGS

The figures given are typical.

DRYER BURNER CONTROLLER

Parameter	Description	TempºC	P	I	d	Output Max %
SV1	Set Point	120	60	10	10	20
SV2	Set Point	125	40	10	2	50
SV3	Set Point	115-125	30	10	2	80

TEMPERATURE ALARMS

Description	Controller Type	Alarm type	Alarm TempºC
COMBUSTION CHAMBER	PLC	HH	850
FIRE EXTINGUISHER	PLC	HH	175
DRYER EXIT SAFETY HTR	SR64	H	140
DRYER BURNER CONTROL	PLC	H	135
DRYER EXHAUST	PLC	L	120
CYCLONE	PLC	H	135
INFEED SCREW	PLC	H	95
CONDENSER WATER	PLC	H	55
CONDENSER GAS	PLC	H	85

Other Safety Controls

Infeed Screw	Cooling Water Flow Switch.
Condenser	Cooling Water Flow Switch.
Main Fan	Differential Pressure Switch.=10mbar
Exhaust	Low Flow Switch.

MANUAL DAMPER SETTING

Knock Out Drum
Recycle damper 5 open of 9
Exhaust damper 6 open of 9

Milling Vapour Extraction
Fan discharge damper 6-8 open of 9

FLO-DRYER OPERATING INSTRUCTIONS

DAILY PRE-CHECK:

CHECK THE FOLLOWING BEFORE STARTING THE DRYER.

Open access door on extraction hood and check for build up on the lifting flights, on the temperature probes and in the exit air duct etc.

Check the cyclone for fines build up at the solids discharge outlet.

Check the Condenser gas inlet for material build up on the tube plate.

Check for water seepage from around the burner mounting flange to the combustion chamber. Check burner air inlet and linkages.

Check Dryer fan Vee belt condition and tension. Check fan dp switch hoses. Check Fan inlet and discharge flexible connections.

Check the barrel hot and cold seals.

Check oil levels in drive gearbox's, chains & sprockets lubed, trunnion ring and wheels greased.

Cooling water valves to the condenser and water jacketed infeed screw conveyor in the combustion chamber are open and pumps on.

Recycle air damper settings are correct. Duct drains clear and valves set.

The boiler is ON and the steam valve to the fire safety equipment is ON.

Fuel isolating valve is open.

Switch at the burner is on.

Process control Set point temperature on burner is correct (between 120°C - 125°C).

Over temperature controller settings are correct

burner & exit hi alarm temp for burner shut down @ 150°C (for meat & bone meal)

combustion chamber hi alarm temp @ 800°C (for meat & bone meal)

START UP PROCEDURE

MANUAL:- (Not for normal operation)

Note

That in manual mode there are no equipment interlocks to stop jams.
The burner safety interlocks are still active, so all the usual automatic conditions must be met for the burner to run.

1. Set the meal handling system feeding the storage bins.

2. Start the milling system.

3. Start the screw conveyor feeding the meal surge bin

4. Start the dryer exit rotary valve and exit screw.

5. Start the water cooling system, heat recovery system, dryer fan and barrel etc.

6. Start the dryer burner, when the Render Vessel agitator and vessel heating is turned on. This allows the dryer to purge and preheat while Render Vessel is coming up to temperature.

7. Dryer requires to perform a preset time fresh air purge before ignition and establishment of flame.

8. Ensure the dryer end point temperature is at least 100°C before beginning to feed material in.

9. Start dryer infeed screw conveyor, put the burner panel switch on to automatic if on partial load/low fire before.

10. Check decanter solids entering dryer are not too fatty - if so material could stick to the flights, becoming a fire risk.

11. Check when material is entering dryer that the burner is modulating correctly.

12. Watch dryer exit temperature (controller display) and after 15 - 30 minutes the dryer should have stabilised out to the set point temperature or 1- 2°C either side of set point.

13. Dryer now operating normally switch the dry section to automatic mode if required.

WHILE IN OPERATION

INSPECT THE DRYER AREA EVERY 30 - 45 MINUTES AND LOOK FOR THE FOLLOWING:

Moisture dripping from burner fan cowling or combustion chamber end plate.

Excess heat from the combustion chamber end plate or paint discolouration.

Steam puffing from the barrel hood seal.

Cyclone solids discharge and cyclone rotary valve entry are hot to touch. If these cool off during normal operations it indicates blocking.

Check condensate is draining from the condenser and K.O. Drum

Fan bearing and Vee belt drive temperature. Fan vibration.

Drive chain is not catching, rubbing (that tension is correct).

Trunnion wheels are rotating freely and not leaving a regular pattern in the grease on the trunnion ring.(indicative of bearing failure or material pick up on a wheel)

Check fuel supply (gauge on supply).

After approximately one hour check position of modulating cam on the burner - this should not vary excessively during normal operation.

Check for excessive variation in outlet temperature (over or under shooting by 5-10°).

Check condenser water and K.O. drum air temps are within limits.

Check temperature on water jacket of inlet screw conveyor does not exceed 95°C

CLOSE DOWN PROCEDURE

After the render vessel is completely flushed and the decanter has finished discharging solids stop the decanter feed pump and decanter. Approximately 2-3 minutes later stop the solids screw conveyor or when all the solids have been discharged into the dryer feed screw conveyor.

Stop the dryer infeed screw conveyor (water jacketed) approximately 2 - 3 minutes after stopping the decanter solids screw conveyor.

The burner can be stopped 2 - 3 minutes after the infeed screw conveyor has stopped.
Very little material should have been entering the dryer following the previous flushing so the burner should of modulated back to minimum low fire. The heat remaining in the dryer after burner shut down should dry the remaining product in the dryer barrel.

Check burner has extinguished.

The dryer and meal equipment should remain operating as this allows the last of the material to be taken out of barrel. This is important for fire prevention.

Run the dryer without the burner operating until all temperatures are down to at least 50°C.

Shut fuel supply valve.

TROUBLE SHOOTING

PROBLEM	CAUSE	SOLUTION
MOISTURE LEVEL IN MEAL TOO HIGH.	OUTLET TEMPERATURE TOO LOW	CHECK BURNER PANEL ON AUTOMATIC
	SET POINT TOO LOW	RE ADJUST SET POINT ON CONTROLLER
	FLAME FAILURE IN BURNER	CHECK AND PUSH THE RESETS ON THE CONTROL BOX
	BURNER FAULT AND OR LOCKOUT	REFER TO BURNER MANUAL
	AIR FUEL RATIO WRONG	CHECK FUEL & AIR LINKAGES. CLEAN PRIMARY FAN
	LOW FUEL FLOW	CHECK FUEL FILTER PUMP AND NOZZLE
	PRODUCT FLOW RATE TOO HIGH	REDUCE THE FEED OF THE RENDER VESSEL FEED PUMP
	RESIDENCE TIME OF MEAL IN DRYER TOO SHORT	SLOW DOWN MAIN DRYER DRIVE ROTATIONAL SPEED
	DECANTER SOLIDS MOISTURE LEVEL TOO HIGH	DECANTER OVERLOADED OR MALFUNCTIONING, REFER TO DECANTER MANUAL
	MALFUNCTION IN AIR HANDLING SYSTEM	CHECK FOR BLOCKED DUCTS OR CONDENSER. CHECK FOR SUCTION LEAKS AT SEALS & FLEXIBLE JOINTS.
	CONDENSER NOT OPERATING	CHECK CONDENSATE FLOW
		CHECK COLD WATER FLOW TO CONDENSER
	RECYCLE AIR DAMPER SETTINGS CHANGED	RESET TO CORRECT SETTING

PROBLEM	**CAUSE**	**SOLUTION**
MOISTURE LEVEL IN MEAL TOO LOW	OUTLET TEMPERATURE TOO HIGH	SET POINT TEMPERATURE TOO HIGH READJUST TO CORRECT SETTING
	TEMPERATURE PROBE FALSE READING	CHECK PROBE & CLEAN OR REPLACE
	BURNER STUCK ON FULL FIRE	CHECK BURNER PANEL ON AUTOMATIC
	BURNER LINKAGES DISCONNECTED	CLOSE DOWN AND CHECK. CONSULT BURNER MANUAL
	FUEL FLOW TOO HIGH	CHECK FUEL REGULATOR ON VALVE TRAIN.
	THROUGHPUT ENTERING DRYER TOO LOW	INCREASE FEED TO RENDER VESSEL
FAT LEVEL IN MEAL TOO HIGH	RENDER VESSEL TEMPERATURE TOO LOW	TURN OFF RAW MATERIAL FEED TO RENDER VESSEL UNTIL THE RENDER VESSEL REACHES TEMPERATURE. CHECK STEAM PRESSURE TO THE RENDER VESSEL
	FEED RATE TO RENDER VESSEL TOO HIGH	REDUCE THE SPEED OF THE RENDER VESSEL.
	DECANTER MALFUNCTION	REFER TO DECANTER MANUAL.
	BLOCKED LIQUID PHASE DECANTER OUTLET OR PIPING TO LP SCREEN	CHECK PIPING FROM DECANTER TO LP SCREEN
	RAW MATERIAL COMPOSITION EXCESSIVELY FATTY	RE-ADJUST THE PLANT TO PROCESS THE CHANGE IN PRODUCT.

PROBLEM	**CAUSE**	**SOLUTION**
OUTLET TEMPERATURE TOO HIGH	HIGH SET POINT	REDUCE SET POINT
	MATERIAL FEED RATE TO DRYER TOO SLOW	INCREASE FEED RATE
	BURNER ON HIGH FIRE	CHECK BURNER PANEL ON AUTOMATIC
	EXCESSIVE FUEL FLOW	CHECK FUEL REGULATOR ON VALVE TRAIN.
	BURNER LINKAGES DISCONNECTED	CLOSE DOWN AND CHECK. CONSULT BURNER MANUAL
OUTLET TEMPERATURE TOO LOW	LOW SET POINT	INCREASE SET POINT
	MATERIAL FEED RATE TOO HIGH	REDUCE FEED RATE.
	FUEL FLOW LOW	CHECK FUEL FILTER PUMP & REGULATOR ON VALVE TRAIN.
	LACK OF FUEL	CHECK SUPPLY AT THE STORAGE TANKS.
	BURNER STUCK ON LOW FIRE	CHECK BURNER PANEL ON AUTOMATIC. REFER TO BURNER MANUAL AND CALL SERVICE AGENT.
		CHECK CONTROLLER IS SENDING AN OUT PUT SIGNAL TO BURNER.

PROBLEM	**CAUSE**	**SOLUTION**
VAPOURS AND FUMES EMITTED FROM DRYER.	DRYER OVERLOADED MATERIAL FEEDRATE TOO HIGH	REDUCE FEED RATE
	DRYER MAIN FAN MALFUNCTION	CHECK FAN AND BELTS. RESTART FAN IF NECESSARY.
	FLEXIBLE COUPLING IN DUCTING FAILED	REPLACE COUPLING AND RESTART.
	BURNER ON HIGH FOR AND EXCESSIVE PERIOD	IF TEMPERATURE IS BELOW THE SET POINT THE BURNER SHOULD BE ON HIGH FIRE. IF TEMPERATURE IS ABOVE SET POINT THEN SHUT DOWN AND REFER TO THE BURNER MANUAL OR CONTACT THE SERVICE AGENT.
	BLOCKED - DUCTS - CONDENSER - BIO-FILTER	CHECK AND CLEAN AS REQUIRED
	LOSS OF COOLING WATER	CHECK COOLING WATER SUPPLY
	EXHAUST DAMPER CLOSED	OPEN/RESET
EXCESSIVE VIBRATION OF BURNER	OUT OF BALANCE FAN	REMOVE AND CHECK BALANCE.
	EXCESSIVE BUILD UP ON FAN BLADES	REMOVE AND CLEAN FAN.
	BEARINGS IN FAN MOTOR FAULTY	REMOVE MOTOR AND REPLACE BEARINGS.
ERRATIC OUTPUT OR TEMPERATURE READING FROM CONTROLLER	FAULTY PROBE FAULTY CONTROLLER	CHECK PROBE CIRCUIT FOR CONTINUITY CONSULT AGENT.

POWER FAIL PROCEDURE BY-PRODUCTS

In the event of a total Power Failure follow the procedure outlined below;

1. Isolate Burner Panel
2. Isolate Steam to Flo-Dryer
3. Isolate Steam to Render Vessel
4. Shut off all equipment manual water valves
5. Shut down Computer if the UPS is running low

Follow the Procedure below when Power Resumes

1. Turn on the Computer
2. Check PLC has no Fault Alarms
3. Check on overload/Contactors for trips and reset
4. Restart the Dryer section to clear product form the hot dryer
5. If it wont start then Manually start items as fllows
6. Open up Bliss Mill and clear unmilled material
7. Run mill area (DO NOT FEED ANY MATERIAL TO MILL)
8. Manually operate mill rejects slide gate to reject damp product
9. Manually Run Mill Feed Screw M601
10. Manually Run Dryer Exit Rotary Valve M502
11. Manually Run Dryer Exit Screw M501
12. Manually Run Cyclone Rotary Valve M 506
13. Manually Run Dryer Barrel M 500
14. Manually Run Dryer Fan M 507
    7 to 12 must be done until such time as all material has been cleared from within inside the Dryer
15. Turn the Steam back on to the Fire extinguisher inlet to the Flo-Dryer.
16. Switch Burner Panel back on
17. Place the dryer area in Auto and start the dryer area
18. Start the Decanter on Auto. If unable to start, open and check for blockages. Once running, water flush for 5-10 minutes
19. Start Separator (If unable to start disassemble top and hose out)
20. Start Liquid Phase Area
21. Start Render Vessel and run hot water with Steam on for 10 minutes.
22. Start Ground Area
23. Start Grinder Area (first ensure that the hopper is not full of Raw Material)
24. Start RM Area

PLANT MAINTENANCE SCHEDULE

DAILY

1. Grease bearings as required
2. Check air line oilers and drains
3. Check the cyclone exit for fines build up by checking that the rotary valve runs hot
4. Check the dryer unit for loose fittings or equipment
5. Clean the screen, storage vessel and process lines

WEEKLY

1. Check all drive lubrication and adjustment
2. Check glands, packing's, seals for leaks
3. Check trunnion rings, support wheels, thrust wheels for lubrication and alignment
4. Chemically clean the Render Vessel, decanter and separator
5. Check and clean Dryer internal lifting flights of build up if present.
6. Check the mill screens for wear, replace as required.
7. Check the meal system and filter operation

FORTNIGHTLY/MONTHLY

1. Check pumps
2. Check the dryer, ducting, cyclone, fan and condenser for build up
3. Check Automatic fire extinguisher operation

1 to 3 MONTHLY

1. Check the dryer combustion chamber ceramic
2. Clean the dryer ducts, cyclone, fan, condenser and rotary valves.
3. Check the mill hammers and pins
4. Check the meal system for wear/build up.
5. Check and clean the burner fan blades

YEARLY

Usual annual maintenance work plus the following:

Remove and check decanter and separator rotating assemblies
Service the Burner unit
Check the mill wear plates and meal blow line bends and diverters

NOTE
ALLWAYS ELECTICALLY ISOLATE AND LOCK OUT ANY EQUIPMENT AND CLOSE ANY RELEVANT WATER, STEAM, COMPRESSED AIR OR GAS VALVES PRIOR TO UNDERTAKING ANY KIND OF WORK

See individual equipment manuals for detailed maintenance information.

DANGER

Before Entering Dryer.

Isolate **All** Motors, Switches and Valves
Including Fire Extinguishing Equipment

Authorised Personnel Only

TYPICAL FLO-DRYER ENTRY PROCEDURE.

Run the Dryer for 30 minutes with automatic control dampers set manually full open for max air flow through the Dryer to remove all remaining material from the Dryer unit.
If the Dryer temperature is over 40 C do not enter, continue to run the Dryer fan and cooling water until the temperature, with the fan off, is below 40 C.

Switch Off and Isolate the burner unit. Electrically and at the fuel supply valve.
Undo the burner units air damper control linkage and fully open the air damper.
Open the combustion chamber flame inspection cover.
At the knock out drum, fully open the manual exhaust damper and close the recycle damper so that fresh air will be drawn through from the burner opening and fully exhausted.
Run the Dryer fan for approx 15-30 minutes to ventilate the Dryer unit.

Isolate ALL Dryer associated equipment at the local isolator and the MCC.
Isolate all fire extinguisher equipment including the Steam and CO_2 supplies.
Use suitable “Danger” or “Do Not Operate” tags and locks where applicable.
Open fully the manual recycle damper and exhaust damper on the knock out drum then manually open the bio-filter exhaust by pass valve to allow fresh air ventilation.
Open the cyclone inspection door and the hood inspection door to allow for maximum free ventilation.

Advise others on plant of your intention to enter the Dryer.
Follow any Site Policy or Procedure for entry into a confined space.
Always have a person at the hood entry point to check on any body inside the Dryer.

After exiting the Dryer return all dampers, valves, switches, isolators etc to their normal operating positions.

NORTHERN AUSTRALIAN BEEF LIMITED
DARWIN ABATTOIR PROJECT
RENDERING FACILITY

EVAPORATOR PROCESS
OPERATIONS MANUAL

Prepared for:	**NABL**
Prepared by:	
Revision:	**0**
Date:	**11 August 2014**
File Ref:	**O&M_Evap**

CONTENTS

1. PROCESS DESCRIPTION

1.1 PRINCIPLES FOR UNDERSTANDING

The boiling temperature of a liquid is affected by the pressure over the liquid. The higher the pressure, the higher the temperature of boiling. With vacuum conditions, more vacuum [lower absolute pressure] gives a lower temperature of boiling. This principle is used in the design of the evaporator.

The evaporator is a falling film type, such that the liquid is pumped to the top of the heat exchanging tubes where it is then distributed via a distribution plate and subsequently falls with gravity as a thin film on the inside of the tubes. This thin film characteristic of the liquid improves heat transfer.

Three effects are supplied, each operating at different vacuum pressures allowing the heat from the vapours evaporated in the first stage to be used as the heat supply for further evaporation in the second and third stages.

1.2 OPERATION DESCRIPTION

Each effect comprises of an integral calandria, liquid boot and separator. Stickwater is introduced from the feed tank to the first effect, of which is under vacuum. The stickwater is then pumped to the top of the calandria heat exchanging tubes where it is distributed around the tops of the tubes via a distribution plate and subsequently falls with gravity as a thin film on the inside of the tubes at where the first stage evaporation takes place. The concentrated stickwater from the first effect is fed into the second and third effects where further evaporation takes place. At a fixed heat load and initial stickwater concentration, the final liquid concentration is increased when the extraction flow rate is reduced (less retention time); conversely, the final liquid concentration is decreased when the extraction flow rate is increased (longer retention time). The system automatically controls the level in each effect with make up stickwater from the feed tank.

Steam is admitted to the shell of the first calandria, supplying the energy for evaporation. The steam (vapours) produced from the stickwater evaporaton in the first effect (tube side) supplies the energy (heat) for the second and third effect evaporation. The second effect vapours (tube side) are condensed in the surface condenser with the energy being dumped into the cooling tower. The temperature measurement on the First Effect Separator is used for controlling the waste heat flow rate into the first calandria.

There are priority orders for introducing or reducing heat into the first effect calandria as described below.

Priority order when measured separator #1 temperature TT712 is below set point, i.e. introduce more heat.
Open steam control valve TCV711-12 (position 0-100%) until the set point is achieved.

Priority order when measured temperature separator #1 TT712 is above set point, i.e. reduce heat.
Close steam control valve TCV711-12C until the set point is achieved

Vacuum is maintained by a vacuum pump. A progressively lower absolute pressure [higher vacuum] is maintained across the calandrias, with the lowest absolute pressure being in the surface condenser. Each effect is vented to remove any incondensable gases which are subsequently pumped to atmosphere.

Condensate from the first effect shell is sent directly to drain, whilst condensate from the second and third effects is collected in the surface condenser and is then pumped to drain.

Cleaning is accomplished, after the evaporator has been shutdown, by adding hot water and caustic as required to the CIP Tank and circulating the solution through-out the evaporator system.

2. TECHNICAL SPECIFICATION

Evaporator Type	Three Effect, Falling Film	
Evaporator Duty	Feed	4,000 kg/h at 3% TS, 80C
	Product	400 kg/h at 30% TS, 55C
	Evaporation	3,600 kg/h
	Cooling Tower Capacity	860 kW, 82 m3/h, 40°C in, 31°C out
Expected Operation	No.1 Calandria	50% vacuum
	No.2 Calandria	72% vacuum
	No.3 Calandria	90% vacuum
	Surface Condenser	90% vacuum
Electrical Load	P706 Feed Pump	0.55 kW
	P714 Circulation Pump, Calandria1	2.2 kW
	P715 Transfer Pump, Calandria1	0.55 kW
	P724 Circulation Pump, Calandria2	2.2 kW
	P725 Transfer Pump, Calandria2	0.55 kW
	P734 Circulation Pump, Calandria3	2.2 kW
	P735 Extraction Pump	2.2 kW
	P743 Vacuum Pump	7.5 kW
	P742 Condenser Pump	2.2 kW
	P751 Cooling Tower Pump	15 kW
	F750 Cooling Tower Fan	5.5 kW
	P703 Product Transfer Pump	1.1 kW
	P704 Conc. Tank CIP Return Pump	0.55 kW
	P707 CIP Supply Pump	2.2 kW

3. OPERATING PROCEDURES

3.1 CHECK LIST PRIOR TO START UP

The following plant utilities are required to operate the system:

- Electrical Power
- Compressed Air
- Process Water
- Boiler Steam

The Operator is able to access the PLC using the SCADA screen and keyboard located in the Control Room. To prepare the System Start Sequence the Operator places the devices and controllers in "Automatic" and physically check the below points.

1. Check there is water flow to the vacuum pump.
2. Shut manual drain valves on pump suctions.
3. Open pump suction manual valves.
4. Check vacuum breaker valve is closed.

3.2 START UP PROCEDURE and OPERATION

1. Stick water tank (T705) needs to be at least half full of product.
2. Start vacuum pump (P743).
3. Start cooling tower fan (F750) and cooling water pump (P751).
4. Start feed pump (P706).
5. As level is established in the boot of each calandria, start the relevant circulation and transfer pumps. When level is established in the second effect, start the extraction pump and allow flow through the extraction pump (P735) to return to the feed tank using valve V731-14.
6. Wait while the vacuum in the condenser climbs to around 80% [20 kPa absolute]. During this time the levels in the separators should stabilize at operating level and the liquor should be circulating through each effect. Check the cooling water at the condenser is satisfactory.
7. Introduce heat to the first effect by taking TC712 out of manual and putting into automatic. The absolute pressure in the first effect boot should rise to around 85 kPa absolute [15% vacuum]. This will only be achieved gradually as the liquor in the effects heats up to evaporation temperature.

8. Monitor the concentrate taking samples from the flow ex the extraction pump and as the concentrate approaches 30% TS then adjust the concentrate flow control set point and continue monitoring until the concentrate stabilizes at 30% TS. Monitor the vacuum in each effect and adjust the set point for TC712 to increase or decrease evaporation.

   NOTE There are the two main adjustments available for the operation of the evaporator.

   Temperature set point (TC712) - The temperature set point will automatically control the evaporation rate to match the required production rate. The temperature set point will correlate with vacuum in the first effect. It is not recommended to increase the temperature set point to where the vacuum in the first effect is less than 5% [95 kPa absolute].

   Extraction - The extraction flow rate controls the concentration of the extract. This will need to be monitored, particularly after the temperature set point has been adjusted.

9. Adjust the vent valves, if required. These valves vent the incondensable gases to the surface condenser and vacuum pump. There is also a loss of steam through these valves. Air is heavier than steam, so the main adjustment is the lower vent of each calandria.
   Adjust the vent valves by:
   - Just cracking open the top valves.
   - Close off the bottom valves and open them slowly until the pipe is warmed from steam passing through.

10. The vacuum should be maintained at least at 88% [12kPa absolute] in the surface condenser. If the vacuum falls below this
    Check:
    - Operation of the vacuum pump, seal water in the tank.
    - Cooling water temperatures. The design assumes water to the condenser is a maximum of 30°C. The temperature rise should not be more than 15°C.

11. Monitor the level in the feed tank and adjust the temperature set point (TC712) to match the liquor production rate. If the level gets too low and the evaporator is in danger of running out of feed then hot water should be added to the feed tank.

3.3 SHUT DOWN PROCEDURES and CLEANING

1. As the liquor runs out in the feed tank, make up with hot water, adding water to the feed. Monitor the concentrate TS and as the solids reduce, reduce the temperature set point TC712 and divert the liquor to the drain. The evaporator will then be operating on water at reduced evaporation rate. As the liquor clears then divert the extract back to the feed tank using valve V731-14.

2. Break the vacuum at the vacuum break valve adjusting, the vacuum to about 75% [250kPa absolute, equivalent to 65C] in the surface condenser. Reduce the temperature set point as necessary to maintain a small amount of evaporation.

3. Add cleaning chemicals to the CIP Tank and introduce to the first effect using valve V711-02 in conjunction with the feed pump (P707). Circulate for the prescribed time. Divert the chemicals to drain and rinse through with hot water. Repeat the procedure with different chemicals as appropriate.

   After the final rinse through:

   - Shut off the steam and / or waste heat.

   - Turn off the vacuum pump, cooling tower fan and cooling tower pump.

   - Turn off circulation pumps, extraction pump, feed pump and condensate pump. When no vacuum, drain the vessels, if required at the pump inlets.

4. To clean the concentrate tank, add cleaning chemicals to the CIP Tank and transfer to the concentrate tank directly by closing V701-061 and opening V701-03 in conjunction with running feed pump (P707). The CIP is returned from the concentrate tank by utilising the CIP Return pump (P704). Circulate for the prescribed time. Repeat the procedure with different chemicals as appropriate.

5. To clean the stickwater feed tank, add cleaning chemicals to the CIP Tank and transfer to the stickwater tank directly opening V701-03 in conjunction with the feed pump (P707). Once the CIP chemicals have been transferred, select valve V701-06 to recirculate the flow within the stickwater feed tank. Circulate for the prescribed time. Repeat the procedure with different chemicals as appropriate.

REFERENCE DRAWINGS

INST AIR — 25NB-CA01-SS304L — V711-24 — V711-25 — V711-12 — 80NB
STEAM — 80NB-ST01-CS — (5.5 BAR) — V711-16 — V711-15 — 50NB — V711-14 — 150NB
25NB-CD01-CS
INST AIR — 25NB-CA02-SS304L — V711-22 — V711-23
V711-19 — V711-20 — V711-21 — V711-18
150NB-ST02-CS
(0.5 BAR) — V711-11 — PI 711B — V711-10 — 350NB
40NB — V711-04
50dia-SK04-SS316L
38dia-CP05-SS316L
V711-26 — 25dia-VA01-SS316L
250dia-VA03-SS316L
V711-27 — ROP 711
TC 712 — TI 712
50dia-CD02-CS
PI 711A — V711-08 — V711-09
CALANDRIA 1 711 — SEPARATOR 1 712
LC 711 — LT 711
63dia-SK03-SS316L — 63dia-SK06-SS316L — 63dia-SK05-SS316L
V711-03 — V711-02 — V711-01 — V711-05 — 38dia-SK07-SS316L
PUMP 714 — V711-06 — V711-07 — PUMP 715

40NB — V721-04
V721-10
25dia-VA02-SS316L
250NB
25dia-VA04-SS316L
250dia-VA07-SS316L
25dia-VA05-SS316L
P120-03
V721-11
PI 721 — V721-08 — V721-09
CALANDRIA 2 721 — SEPARATOR 2 722
50dia-CD03-SS316L
50dia-SK09-SS316L
38dia-CP06-SS316L
INST AIR
LC 721 — LT 721
63dia-SK08-SS316L — 63dia-SK11-SS316L — 63dia-SK10-SS316L
V721-03 — V721-02 — V721-01 — V721-05 — 38dia-SK12-SS316L
PUMP 724 — V721-06 — V721-07 — PUMP 725

SOFT W. — 50dia-SW01-SS304L
HOT W. — 50dia-HW01-SS304L — 38dia-HW02-SS304L — 38dia-HW03-SS304L
POTABLE W. — 50dia-PW01-SS304L — 38dia-PW02-SS304L — 38dia-PW03-SS304L
STEAM — 50NB-ST03-CS
STICK WATER — 38dia-SK01-SS316L
CHEMICALS
V701-01 — V701-02 — V705-01 — V705-02
V701-05 — V705-06 — 76dia
CIP TANK 701
STICKWATER TANK 705 — LT 705
50dia-SK02-SS316L
V701-08 — V701-04 — V701-07 — V701-03 — PUMP 707
V705-05 — V705-03 — V705-04 — PUMP 706
50dia-CP04-SS316L
50dia-CP02-SS316L
50dia-CP03-SS316L
152dia-VA12-SS304 — 2
FLOW PLATE 708 — V701-06
FILTER 709
50dia-CP01-SS316L
38dia-CP08-SS316L
38dia-CP09-SS316L

LEGEND FOR P&ID
PRODUCT FLOW
PROCESS LINES
MAJOR SERVICES
MINOR SERVICES
VAPOUR / ODOUR
COMPR. AIR
CONTROL LINES
SOFTWARE LINKS

LIMIT OF CONTRACT — OTHERS | CONTRACT

HOLDS:
1. ---

REV	DATE	DETAILS	BY
2	28.01.14	REVISED AS MARKED	AIP
1	15.01.14	REVISED AS MARKED	AIP
0	23.12.13	ISSUED FOR CONSTRUCTION	AIP
B	21.12.13	COMMENTS INCORPORATED	AIP
A	07.02.13	ISSUED FOR APPROVAL	AIP

	Date:	Int:
Approved:	23.12.13	DG
Draw:	30-03-13	AIP
Last saved:	28-01-14	AIP

Projection:
Tolerance:
Scale: N/A
Sheet size: A1
Weight:
Part no: 11055 – 700

HAARSLEV INDUSTRIES

Description:
PROCESS FLOW DIAGRAM
THREE EFFECT EVAPORATOR
ITEM 700

Drawing no: 11055P120-02-2

REFERENCE DRAWINGS

P120-02
38dia-VA05-SS316
50dia-CD03-SS316
38dia-SK12-SS316
50dia-SK14-SS316
38dia-CP07-SS316
50dia-SW01-SS304
50dia-HW01-SS304
50dia-PW01-SS304
50NB-ST03-CS
50dia-CP03-SS316
152dia-VA12-SS304
38dia-CP08-SS316
38dia-CP09-SS316
2
V731-04
V731-10
250NB
38dia-VA08-SS316
25dia-VA07-SS316
300dia-VA10-316L
50dia-CD04-SS316
V731-11
ROP 721
ROP 731
PI 731
V731-08
V731-09
CALANDRIA 3 731
SEPARATOR 3 732
LC 731
LT 731
INST AIR
63dia-SK13-SS316
63dia-SK16-SS316
63dia-SK15-SS316
V731-03
V731-02
V731-01
V731-05
PUMP 734
PUMP 735
V731-06
V731-07
38dia-SK17-SS316
DC 731
DE 731
ø25
V731-12
V731-13
ø38 (BYPASS)
V731-14
V731-15
V731-16
50NB
50NB
PI 740
V740-03
TI 740A
V740-02
TI 740B
CONDENSER 740
65NB-CD05-SS304
V740-04
PUMP 742
3m LOOP
V742-01
50NB-CD06-SS304
COND DRAIN
PI 743
V743-04
V743-03
VAC PUMP 743
V743-01
V743-02
V743-06
V743-07
V743-05
25dia-SW02-SS304
100NB-CW02-SS304
100NB-CW01-SS304
VSD 750
TC 750
TT 750
V750-05
V750-01
V750-03
V750-04
V750-02
COOLING TOWER 750
PUMP 751
38dia-HW04-SS304
38dia-PW04-SS304
V702-01
V702-02
25dia-SK20-SS316
TO VAPOUR FAN ITEM 701b
P101-04
40NB-ST04-CS
V702-05
CONCENTRATE TANK 702
LT 702
V702-06
V702-07
V702-08
V702-04
38dia-SK18-SS316
V702-03
PUMP 703
25dia-SK19-SS316
TO MIXER SCREW ITEM 222
P101-03
SWING BEND (LOCATE NEAR MIXER SCREW)
PUMP 704

LEGEND FOR P&ID
PRODUCT FLOW
PROCESS LINES
MAJOR SERVICES
MINOR SERVICES
VAPOUR / ODOUR
COMPR. AIR
CONTROL LINES
SOFTWARE LINKS

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OTHERS | CONTRACT

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HAARSLEV INDUSTRIES

Description:
PROCESS FLOW DIAGRAM
THREE EFFECT EVAPORATOR
ITEM 700

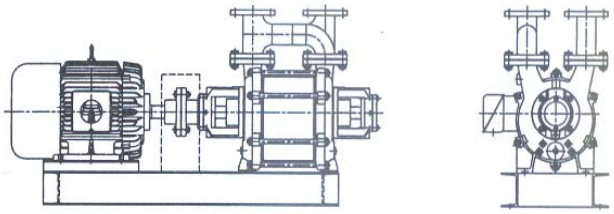
Drawing no: 11055P120-03-2

MAINTENANCE MANUAL

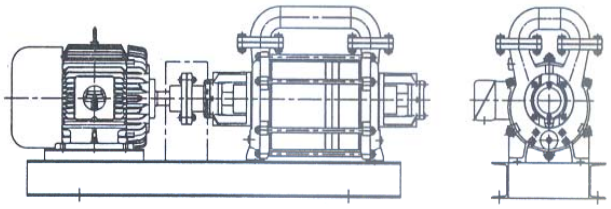
FOR

LIQUID RING VACUUM PUMP

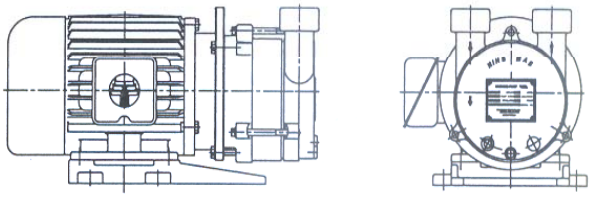
SW Series



SWD Series



SWM Series



SAMSHIN VACUUM CO., LTD.

INTRODUCTION TO SAMSHIN VACUUM LIQUID RING VACUUM PUMPS

SAMSHIN VACUUM's liquid ring pumps offer efficient compression of condensable vapors and gases in the rough va
with a capability of up to 29" Hg vacuum (depending on the application and pump type used).

SAMSHIN VACUUM pumps use the liquid ring principle to ensure maximum safety in compression of hazardous mix
Reliability is ensured through the use of only one rotating assembly with no internal metal to metal contact.

should you need any further information or assistance, please contact the SAMSHIN VACUUM office or distributor o
Major locations appear on back cover of this manual.

THE LIQUID RING PRINCIPLE

The 'liquid ring' pump takes its name from its principle of operation.
A cool liquid is introduced into a round casing and, due to centrifugal force when rotated, forms a nearly concentric ring around the pump casing.

The impeller is eccentrically mounted in the casing.
Hence, at one side, the cells formed by the impeller blades and the boundary of the liquid ring increase in size;
and on the other side, they decrease in size.

A suction port is positioned in the area where the cell size is increasing.
This port ducts the gas from the pump inlet into the lower pressure cells.

The gas introduced into the cells is then compressed by the operating liquid in the area where the cell size is decreasing.
A discharge port is positioned to duct the compressed gas to the pump discharge.

Since the liquid absorbs the heat generated during compression, a small quantity of fresh cooling liquid is continually introduced via the service liquid supply port, and the resulting excess warm liquid discharges with the gas to a downstream gas/liquid separator.

The liquid used as compress ant allows the liquid ring pump to perform cool, reliable compression of
virtually all gases and condensable vapors while easily handling liquid and soft solid carryover.

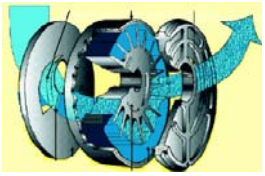


FIGURE 1

SECTION A

INSTALLATION AND OPERATION

INSTALLATION

1. Remove the pump unit from the shipping carton or skid and check for mechanical damage.
   Should damage be observed, report this to the shipping company responsible.

2. If the pump was purchased as a bare pump unit, mount the unit on your base or supporting frame and connect to your motor assembly using suitable flexible coupling.
   NEVER operate the unit without a OSHA guard, but do not install a guard until alignment and pre-start-up rotational checks have been performed.

3. Remove all plastic shipping plugs from the inlet, outlet and service liquid connections.
   Rotate pump shaft manually to ensure shaft is capable of turning.
   Rotation may not be easy, and a pipe wrench may be required due to packing or seal drag.
   If the shaft cannot be turned with a suitable wrench, contact the factory for information.

4. Align the pump and motor (per Alignment Methods - page 4) preferably using the dial gauge method.

   NOTE : Improper alignment is a major contributing factor to pump noise, vibration and premature failure.

5. Connect inlet, discharge and service liquid connections.
   Minimum piping size is the size of pump connections.

   SEE NOTE ON PAGE 3.

   NOTE : When installing inlet connections, we suggest a temporary inlet screen be employed to prevent ingress of weld slag and debris into the pumps body. Be careful to check operation when screen is installed since debris can foul the screer and result in cavitation. Do not leave temporary screens installed as they can lead to failure due to plugging, deterioration and loss in performance.
   To assist in the removal of the temporary screens a suitable section of inlet pipe should be removable or a spool piece installed before the screen.

CAUTION : Pumps and baseplates are not designed to carry pipe loads.
Ensure that suitable pipe supports are in place and flexible connections and/ or thermal expansion provisions used as necessary. Vertical piping rise from the pump discharge should be limited to a maximum of 24".
It is also recommended that a vacuum gauge be installed at the pump inlet. A suitable 1/4" plug is provided on most pump inlet flanges for the gauge.

NOTE : At the very minimum, all liquid ring pumps should be fitted with an inlet check valve of special low loss type, and a correctly sized service liquid separator in the discharge.

Suitable accessories can be obtained from your local SAMSHIN VACUUM representative.
SAMSHIN VACUUM can also provide complete factory assembled package for your application.
Contact the factory or your local representative for information.

6. Connect service liquid supply.

7. On initial start-up, or upon installation after repairs, half fill the pump with service liquid **(do not overfill!)** prior to operation. This will ensure that the seals (if installed) are not damaged by dry operation, and unit is ready for liquid priming if installed in a recirculation system (refer to section B).

DO NOT OPERATE THE PUMP DRY OR PREMATURE FAILURE MAY OCCUR.

8. Connect the motor and any electrically controlled accessories such as service liquid solenoid valves as required. Ensure motor speeds, voltages and frequencies agree with the supply and the pump requirements.

9. Recheck alignment done previously, then install suitable OSHA specified coupling guard.

NEVER OPERATE ROTATING EQUIPMENT WITHOUT SUITABLE GUARDING.

10. Jog the pump motor and check pump rotation. All pumps with model number BN rotate in a clockwise direction viewed from the motor end. Pumps with BO in the model number rotate counter clockwise viewed from the motor end. Arrows are provided on the pump cover. Should there be any confusion, please call the factory before operating the unit.

11. If the pump is to be used in a new installation, refer to the system arrangements depicted in section B.

12. Once the type of system has been determined and the accessories required installed, proceed with section C, "Typical Operating Sequences…".

ROUTINE MAINTENANCE

SAMSHIN VACUUM liquid ring pumping equipment is designed for continuous industrial usage.
Routine maintenance is minimal, however, as with all equipment some precautionary checks should be made.

CHECK FOR:

1) Leaks and satisfactory vacuum conditions.

2) Unusual noises.

3) Grease bearings every 3000 hours with a lithium based bearing grease to NLGI -3 specifications, where applicable. **NOTE: some pumps are fitted with bearings sealed for life. pumps so fitted do not have grease nipples and are not to be greased. (Do not mix bearing greases without checking, as some grease additives are not compatible between makes)**

For troubleshooting, refer to Appendix 4.

ALIGNMENT METHODS

PREFERRED - DIAL GAUGE

The service life of the pump is dependent on good coupling alignment.
Flexible couplings will not compensate for shaft misalignment. If the motor was mounted by SAMSHIN VACUUM, the pump and motor were aligned prior to shipment from the factory. Since baseplates are not perfectly rigid, handling during shipment, pipe loading and foundatio stresses mandate an alignment check prior to start-up. Changes to alignment should be made by adding shims, as necessary, under the motor feet.

The dial indicator method for checking coupling alignment is preferred (refer to figures 2 and 3). To measure parallel misalignme attach dial indicator to one coupling hub, or mount on one shaft end with the indicator button resting on the O.D. of the other cou hub (figure2) or shaft.
To measure angular misalignment, the indicator button rests on the face of the other coupling hub near the O.D. (figure3).
Measure misalignment by rotating the shaft and dial indicator one full revolution; the other shaft remains stationary.
Record the Total Indicator Reading (T.I.R.). Parallel and angular misalignment should be limited to ±0.002" T.I.R.

If a dial indicator is not available, an adequate alignment is possible using a straight edge, feeler gauge, micrometer or caliper. This method should be used as a last resort only.

NOTE : Reverse dial indicator alignment, or laser optical alignment, can be used satisfactorily.
Please contact the factory if details are required.

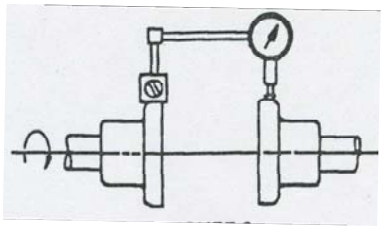


FIGURE 2

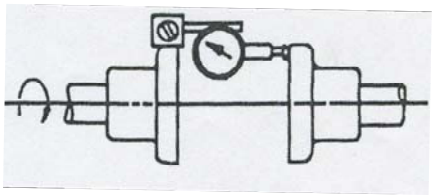
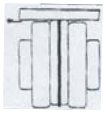
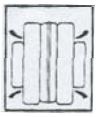


FIGURE 3



CHECK PARALLEL ALIGNMENT

Check parallel alignment by placing a straight edge across the two coupling flanges and measuring the maximum offset at variou points around the periphery of the coupling.
DO NOT rotate the coupling. If the maximum offset exceeds the figure shown, correct alignment to an acceptable level.



CHECK ANGULAR ALIGNMENT

Check angular alignment with a micrometer or caliper. Measure from the outside of one flange to the outside of the other at inter around the periphery of the coupling. Determine the maximum dimensions. DO NOT rotate the coupling.
The difference between the maximum and minimum must not exceed the figure given. If a correction is necessary, be sure to recheck the parallel alignment.
NOTE : For maximum life, keep misalignment values as near to zero as possible.

SECTION B

GENERAL NOTES CONCERNING SERVICE LIQUID SUPPLY

The operation of the liquid ring pump is dependent upon a continuous supply of cool, clean service liquid, which enters the pump on the suction side and is discharged with the compressed gas. The volume of the liquid ring within the pump should be regulated optimum performance. The service liquid entering and leaving serves to carry away the heat of compression imparted.
The temperature rise from inlet to discharge normally is approximately 4℃(7°F).
NOTE : Actual temperature rises may be higher depending on: 1) Point of operation; 2) quantity of service liquid supplied; 3) gas characteristics: and 4) service liquid properties.

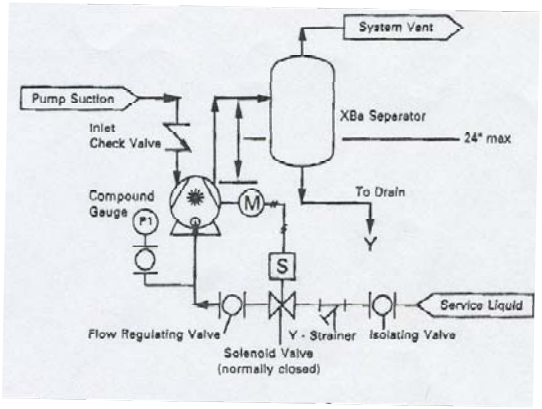
Figures 4,5 and 6, show typical systems for supply of service liquid. In each instance, different accessory items are recommended These items or a complete factory assembled system may be purchased from SAMSHIN VACUUM.
CAUTION : The drawings and arrangements following are for reference, and may not be satisfactory for your application. Should you have any concerns, please contact the factory for information. Refer to Appendix Ⅰ for pipe sizes and locations, Appendix Ⅱ for the effects of service water vapor pressure, and Appendix Ⅲ for recommended service liquid flow rates for each pump model.

DESCRIPTION OF SUPPLY SYSTEMS

System 1 - Once Through

Once through service liquid supply requires liquid to be available at some positive pressure to the liquid supply accessories prior to the pump. (You may with to consider the use of a SAMSHIN VACUUM standard XBa package).

Normal accessories in this mode of operation are: compound gauge, flow regulating orifice (or flow control valve), normally clos solenoid valve, 'Y' pattern strainer and manual isolating valve.



Once Through System
FIGURE 4

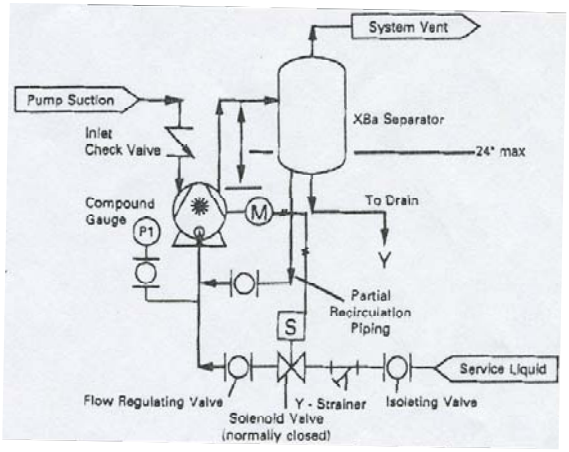
System 2 - Partial Recirculation

Figure 5 details a partial recirculation system. Partial recirculation can be employed in instances where make-up liquid is availabl a temperature lower than the service liquid design temperature.

Service liquid enters the pump and is discharged at a slightly higher temperature to the separator. Heat is lost due to radiation and convection, and a portion of the liquid (still at higher than the design temperature) is returned to the pump.
The returned liquid is cooled to the design temperature by mixing with a suitable quantity of cool fresh liquid (make-up) at a low temperature.

The quantity of make-up required is dependent on the difference in temperatures between the design service liquid temperature, the discharge. Temperature, the pump required operating pressure and capacity, the actual pump capacity, and the normal require liquid flow. In many instances it is possible to reduce the fresh liquid flow to 50% of the normal flow or less.
The excess liquid is drained from the separator via the normal overflow.

Partial recirculation requires a SAMSHIN VACUUM XBa type separator (or similar liquid reservoir), inlet check valve normally solenoid valve, 'Y' strainer, and shut-off valve, as shown in figure 5.



Partial Recirc System
FIGURE 5

System 3 - Complete Recirculation

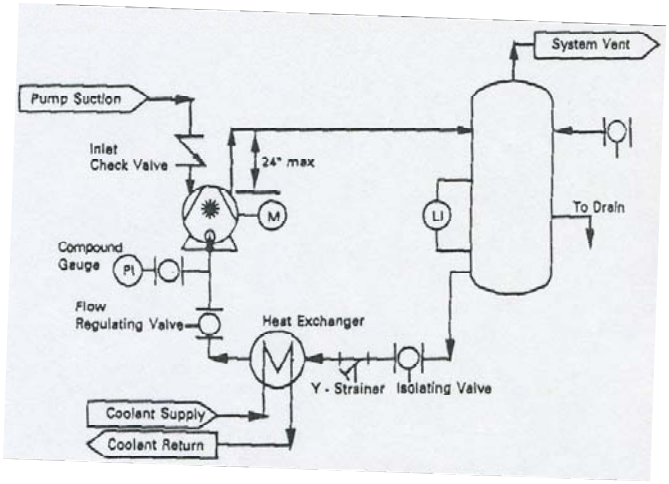
Figure 6 details the normal installation of a self-contained service liquid supply system. SAMSHIN VACUUM has standard TRE packages designed and stocked for this application. Contact your representative for more details. This arrangement is normally us where, due to cost, availability, or disposal limitations, it is desired to eliminate or minimize service liquid make-up and drain nee

Service liquids chosen under these conditions can be water, solvents, oils, or other liquids compatible with pump materials, performance requirements, and the process.

CAUTION : Where it is desired to use liquid other than water, please contact your local SAMSHIN VACUUM representative or the factory with details of the proposed application,, prior to selection of operation of the equipment.

In this arrangement, liquid used is discharged to a separator and returned to the pump via a sealed cooling device such as a liquid liquid cooler (heat exchanger), or an air to liquid cooler (radiator).

Accessories required are: recirculation separator or container fitted with some form of level monitoring device(s), isolating valve the heat exchanger, 'Y' pattern strainer, flow control valve, compound gauge, and a cooler.



Total Recirc System
FIGURE 6

Other accessories which may be required could include: gas demister and/or filters on the vents, gas coolers or condensers, and various accessories to make the system fit the requirements of the user.

In the event the pump will be required to operate for an extended time below 10" Hg vacuum, an orifice should be installed in the pump suction, or a recirculation pump should be employed to positively supply liquid. Please contact the factory for information.

SECTION C

TYPICAL OPERATING SEQUENCES FOR LIQUID RING PUMPS IN THE VARIOUS SERVICE LIQUID SUPPLY MODES

SYSTEM 1 - ONCE THROUGH SERVICE LIQUID SUPPLY NORMAL OPERATION

The normally closed solenoid valve should be wired to open in conjunction with motor start.

If the pump is new or repaired, or the system has been worked on, perform the checks noted in section A, items 1 through 12, prior to doing the following.

Ensure all protective guards are in place prior to proceeding, then jog the pump while observing the compound gauge. A variation in the pressure should occur if the solenoid valve is opening. If no variation occurs, check the solenoid and the supply line for closed valves or plugs.

Start the pump and run it down to the normal operating pressure. Monitor the service liquid pressure on the compound gauge with pump operating in the normal operating range, and adjust the liquid flow using a manual valve.
Approximate setting on the compound gauge should be zero.
However, the optimal setting occurs with valve set at the minimum opening possible, providing the pump runs smoothly and gas and water discharge temperatures are satisfactory.

After setting the flow, mark the reading on the compound gauge. Monitor the service liquid pressure routinely to ensure variation are not occurring and pump operation is satisfactory.

If in the course of normal operation it is necessary to shut the unit off, stop the pump and check that the solenoid closes.
If pressure is indicated on the gauge, the solenoid valve is not closing and the pump may be flooded. Repair solenoid and drain pu to shaft centerline before restarting.

CAUTION: Starting liquid ring pumps with excessive water in the casing can lead to motor overload and possible damage.

System 3 - Complete Recirculation

The normally closed solenoid valve on the make-up (fresh liquid) line should be wired to open in conjunction with the motor star

If the pump is new or repaired, or the system has been worked on, perform the checks in section A, items 1 through 12, prior to proceeding. Ensure all guards are properly installed prior to proceeding.

Jog the pump while observing the compound gauge. If the solenoid valve is opening, a variation in pressure should occur.
If no variation occurs, check the solenoid and all liquid lines for closed valves or plugs.

Operation with automatic control orifice

If a make-up (fresh liquid) orifice is installed, start the pump unit and monitor operation.
When the system is operating under normal conditions, check to ensure the pump runs smoothly and that pump temperature stabi
If pump operating temperature does not stabilize, liquid make-up rate is unsatisfactory. Re-check for plugs in the fresh liquid sup
Do not continue to operate the unit if temperature continues to rise.

Operation without automatic orifice

Partial recirculation always requires introduction of some cool liquid. However, the actual quantity required varies, depending on system conditions and operating requirements.

Optimum make-up rate is the minimum flow rate required to maintain a stable service liquid supply temperature at the lowest ope pressure (highest vacuum), while maintaining smooth, quiet operation. NOTE: SAMSHIN VACUUM recommends a minimum c fresh make-up in most instances, since the separators used have relatively small liquid volumes.
Leakage or evaporation could quickly result in failure, due to dry running. Should it be desired to reduce make-up liquid rates fur consult the factory, or consider installing a SAMSHIN VACUUM complete recirculation system.

Start the pump with the make-up line manual flow control valve open, approximately halfway.

Monitor the system inlet pressure until pump operates at the desired vacuum. Reduce the liquid make-up setting until the pump is capable of maintaining system vacuum with a stable service liquid temperature.

Monitor the system in operation for a period of time to ensure temperatures are stable and pump operates smoothly
Remove flow control valve handle and wire to the line to prevent loss and ensure availability.

Monitor pump operation from time to time to ensure all remains normal during the operation cycle. If in the course of operation necessary to shut the unit off, stop the pump and check that the solenoid valve closes.

CAUTION: Starting liquid ring pumps with excessive water in the casing can lead to motor overload and possible pump damage.

SYSTEM 3 - COMPLETE RECIRCULATION

Liquid to liquid cooler system: prior to operation of the pump unit, ensure coolant is available to the heat exchanger.

Fill the separator/liquid reservoir to the normal operating level. In most systems, the maximum normal operating level will be the pump shaft centerline, and an overflow will be located at this level. NOTE: If separator runs under positive pressure, a drain trap system mus employed on the overflow. Connect the overflow to vented drain.

WARNING: If toxic or hazardous gases are handled, safety precautions must be followed.

Open all isolating valves in the service liquid lines between the separator and the pump, and allow service liquid to fill the lines. Refill the separator as necessary to the normal level.

Check that the pump is half full of liquid. If not, fill to the pump shaft centerline.

CAUTION: Do not operate the vacuum pump dry, or premature failure may occur, especially if fitted with mechanical seals. In addition, do not start the pump unit completely filled with liquid, or high motor shaft loads may result leading to motor overload and possible pump damage.

If the system is fitted with a recirculation pump, half close the flow control valve before starting.

NOTE: The recirculation pump motor should be wired to start in conjunction with the start of the vacuum pump.

Jog the vacuum pump motor and ensure coolant automatic valves (if applicable) open, and recirculation pump motor (if applicabl starts and stops with vacuum pump motor. Ensure all motors rotate in the correct direction.

Start the system and check the inlet pressure and service liquid compound gauge for pressure variation.
If pressure does not decrease, stop the unit and check the service liquid lines for plugs, closed valves, leaks, etc.

Restart the unit and monitor operation. Check to ensure pump operates smoothly and quietly, and that temperature of all water lir and pump are suitable.

Ensure all piping connections are tight and leak free. Routinely monitor operation from time to time to check for proper service liquid levels, leakage and smooth pump operation. Should you have any concerns, contact your local SAMSHIN VACUUM representative or the factory at your discretion.

CAVITATION PROTECTION

SAMSHIN VACUUM two stage liquid ring pumps are fitted with provisions to allow a cavitation reducing air bleed between stages. Should it be necessary to utilize this feature, check the pump drawing and remove plug denoted as part(78). Connect a bleed line with manual regulating to the connection, and separator vent piping.

CAUTION: Do not open plug to atmosphere, since in some operating conditions, water and/or gas may be vented from the connection. Also ensure the gases entering the pump will not create a hazard.

Operate the pump at the design conditions and open the bleed valve until the cavitation noise subsides.
Leave the air bleed open at this setting (in severe cavitation conditions, inlet air bleed to the service liquid line may also be neces

SAMSHIN VACUUM LPH type single stage pumps have provisions for inlet air bleed. Due to the higher operating pressure leve cavitation is normally minimal in this equipment. Please contact the factory should further information be desired.

SOLID CARRYOVER RECOMMENDATIONS

All liquid ring pumps can have their effective lives shortened due to abrasive particle carryover. If abrasive particle carryover is possible, a knockout vessel should be employed and/or a suitable inlet filter or service liquid filtration system used.

Further, it is recommended in these cases that the pump bodies be drained from time to time at shut-down to remove trapped particulates from the casing. Once drained, the pump should be refilled to shaft centerline before restarting. Most larger SAMSHIN VACUUM pumps have provisions for continuous drains. Should this be of interest, contact the factory or your SAMSHIN VACUUM representative for information

DESCALING

WARNING: Liquid ring pumps used in areas where water has a high level of calcium carbonate or iron scale may becom fouled, leading to seize-up, high motor loads and possible mechanical seal leakage.

In these instances, pump should be periodically flushed with a descalant as frequently as necessary to ensure scale build-up is ren Recommended descalant is "Rydlyme". Please call SAMSHIN VACUUMfor information.

STORAGE

Cast iron pumps should be Installed and put into service as soon as possible. In the event storage or installation followed by inactivity is possible, the units should be filled with a suitable rust preventative, and the shafts rotated weekly.

If the units are installed where freezing might occur, ensure that the preventative remains liquid. If the preventative solidifies, cra of the pump parts may occur which will not be covered under warranty.

TUROBLESHOOTING TABLE - REFER TO APPENDIX IV FOR DETAILS

PROBLEM:	Motor Speed Low	High Discharge Pressure	High Svc. Water Temp.	Too Much Liquid	Too Little Liquid	Worn Mech. Seal or Packing
REDUCED CAPACITY	●	●	●	●	●	
EXCESSIVE NOISE		●	●	●	●	
HIGH POWER CONSUMPTION		●		●		
OVERHEATING	●	●	●		●	
VIBRATION	●	●	●	●	●	
SEAL LEAKAGE OR EXCESSIVE PACKING		●				●

Typical problems and their possible causes are indicated in the above table. If the problem persists, contact your local SAMSHIN VACUUM distributor or the nearest SAMSHIN VACUUM repair facility.

NORTHERN AUSTRALIAN BEEF Ltd

LIVINGSTONE MEAT PROCESSING PLANT

WASTEWATER TREATMENT PLANT

OPERATIONS MANUAL

Prepared for:	**UBP Ltd**
Prepared by:	**Weston Burnett**
Revision:	**0**
Date:	**11 August 2014**
File Ref:	**NABL Insts.doc**

CONTENTS

1. PROCESS DESCRIPTION

Please refer to the attached Process Flow Diagram 11055PD02-01-02 titled 'Waste Water Treatment Plant Flow Sheet.

The NBAL wastewater treatment plant consists of primary screening by the Client and physico-chemical separation in the Haarslev DAF unit followed by TP reduction through the Lamella Settler.

The wastewater plant effluent is discharged into the Client's pipework and we have not been advised of possible usage.

The Haarslev DAF unit is designed to remove most of the suspended solids, protein and the grease and oil that is present as a colloidal dispersion in the rendering and meat processing plant wastewater.

The Lamella Settler is designed to remove the TP to meet the discharge requirements. The sludge will be used in the Client's Composting system.

The Haarslev DAF unit has been designed to cope with the future rendering and meat plant waste water flow of 1,500 m^3/d. This equates to a maximum peak flow of 75 m^3/h. The Lamella Settler is designed to handle a similar flow rate.

1.1 DRAINAGE SUMP PUMP

The rendering plant wastewater and meat processing wastewater is extracted from the combined wastewater sump located in the main plan area by a sump pump. This wastewater is delivered through a screen located above the sump to provide removal of gross solids. The screened waste discharges by gravity to the sump. The sump pump and screen work independently of the Haarslev DAF unit.

1.2 BALANCE TANKS TK-D104A & B

Flow balancing provides a significant function in the operation of the waste water treatment plant by reducing or even eliminating peak hydraulic and peak organic loading to the treatment unit.

The NABL Plant has two 35 m^3 Balance Tank used to eliminate peaks or surges flows and permits the use of smaller process units designed to treat equalised flows rather than peak flows. This allows the treatment processes to function under more stable and constant conditions.

Turbulence must always be provided in the balance tanks to:-

a) Prevent deposition or accumulation of solids.
b) Prevent anaerobic conditions.
c) Provide equalisation of the organic loads.

For rendering plant and meat plant wastes where high levels of organics are present it is critical to treat the waste water as fresh as possible.

Balance tank mixing will be achieved initially with the installation of a single Flygt submerged propeller mixer into each balance tank.

The balance tank should be emptied daily so that the suspended material present is not broken down by the bacteria present in the waste into additional soluble BOD_5. Soluble BOD_5 is not readily removed by the SYSDAF plant.

The balance tanks will be filled individually with the flow into TK-D104A initially. TK-D104A will be the Duty Tank at all times unless it has been removed from service or the level reaches high level.

This requires that the inlet valve VA-D104A to be open at all time with the valve to TK-D104B closed.

The level inside each tank will be monitored by pressure sensors at the base level. The mixer will be activated once the level reaches 1.5 metres. Also once the level falls under this level the mixer must be switched off again.

The Haarslev DAF will be actuated once the Balance Tank level reaches 50 % (adjustable to be set on Site) including chemical activation as described below.

The DAF operation will be terminated once the tank level reaches 25 %.

Balance Tank TK-D104 will be continuously monitored with a signal fudge to eliminate level fluctuations. When high level is reach the flow will continue to be extracted from this tank but we need a high level alarm and the delivery into the tank transferred to the second tank TK-D104B. This requires that the inlet valve VA-D104B to be open with the valve to TK-D104A closed.

1.3 INLET FEED PUMP CONTROL

The inlet pump suction line is controlled by two activated butterfly valves with the duty tank actuated prior to polymer delivery.

The discharge line is fitted with a flow control valve to ensure adequate head loading is available on the pump.

Actuation is made when required by the DAF controller requires.

The level of the Balance thanks should check relative levels in the two Balance Tanks and a decision made on the duty Balance Tank. This should accept all load from the Drainage Sump Pump.

In addition, the appropriate discharge valve should be opened.

When the duty balance tank reaches low level the control should check on the second tank and if this is above low level then both discharge valves should be opened and the pump continue to operate until maximum drainage is achieved when it should shut off along with all chemical lines feeding the DAF.

1.4 HAARSLEV DAF

1.4.1 General

The Haarslev DAF process is that of Dissolved Air Flotation with chemical treatment to efficiently remove suspended solids, protein, fats and insoluble BOD_5.

Wastewater is pumped from the process and rendering plants collection sump to the Balance Tanks.

The Balance Tank contents are pumped to the DAF for separation of removal of the suspended solids, protein and fats.

1.4.2 Solids Coagulation

The DAF tank has three compartments at the front of the flotation section. The compartments carry out the following functions:-

1.4.3 pH and Coagulant Dosing Chamber

This compartment generates finely divided suspended solids by mixing incoming total solids with the coagulant. Acid can be added using the pH monitoring and control system to maintain the pH in the required range of 4.5 to 5.5.

The chamber is mechanically mixed with a high speed agitator. pH monitoring occurs in this cell.

1.4.4 Flocculant Dosing and Mixing Chamber

Flocculant is added into the second chamber that is gently stirred to allow the coagulated material to combine into larger floc particles. The chamber is mechanically mixed with a medium speed agitator.

1.4.5 Stabilisation Chamber

The stabilisation chamber is hydraulic mixed by the incoming flow allowing separation of the floc particles and the clarified water. Correct DAF coagulation can be gauged by observing the quantity and quality of the flocculated particles in this chamber and the clarity of the carrier water.

Treated liquid from the stabilisation chamber discharges over the distribution weir that feeds the treated liquid across the width of the DAF Flotation Cell.

1.4.6 Solids Separation

Separation of the coagulated clumps occurs in the main body of the DAF where air is introduced across the width using air sparges. Lamella plates within the main body force the coagulated clumps upward where the float is created.

High pressure aerated water is injected into the body of the DAF allowing the release of its air as microfine air bubbles that saturate the water and attach to the particles. These particles float to the surface combining to form a sludge layer.

Scraper blades move the sludge layer towards the sludge beach. The beach is a sloped ramp coming up out of the water where the scrapers remove the flocculated solids by pushing them up the sludge beach into the sludge trough.

The scrapers continuously remove the floating material off the DAF surface as it forms preventing any re-entrainment of the solids.

1.4.7 Haarslev DAF Discharge

Clean water is discharged hydraulically under the sludge beach and sludge trough into a chamber at the end of the tank. The clarified water is use to two purposes; aeration and transfer to the Lamella Settler for further treatment.

Transfer to the Lamella Settler should continue to operate until the DAF Inlet Pump PU-D201 is shut off and the level in the DAF Discharge Chamber has reached low level.

The DAF discharge compartment will be used for pH adjustment to increase the pH to 7.0. This is required to ensure adequate alum coagulation in the Lamella Settler.

Discharge water is removed from the chamber using a submersible pump which will have VSD speed control based on the level in the tank. The discharge is measured by a flow meter prior to delivery into the inlet of the Lamella Settler Flash Mixer.

1.4.8 Aeration

The aeration pump induces a controlled stream of air into the water using a venturi across the pump. The aerated water passes into the retention vessel where the air dissolves into the water under the pump pressure. The water leaving the vessel is distributed across the bottom of the DAF flotation cells by four sparge pipes.

The retention vessel has a pressure monitor to ensure adequate pressure is achieved.

1.4.9 Sludge Collection

Sludge is collected in the sludge hopper that collects sludge directly from the sludge beach. The hopper has a sloped bottom to assist in the removal of sludge to the sludge pump connection.

The sludge pump will start when the intermediate level in the sludge hopper is activated. The pump delivers sludge to the Haarslev rendering plant sludge decanter.

Sludge must be processed by the decanter within four hours. This achieves a good split through the decanter and ensures that the discharged decant water is not heavily loaded in solids and BOD_5 content.

The decanter is located so that when the Rendering Plant is in operation the dried sludge can be dropped into the dryer feed screw. Decanted sludge can also be diverted to a holding bin when the dryer is not in operation.

Using the sludge as meal supplement provides the plant with a definite means of paying for the cost involved in running the DAF unit.

1.4.9 DAF Chain

The chain is safeguarded using micro-switches located under the chain.

1.5 COAGULANT SYSTEM

The coagulant powder is contained in a bulk bag supported over the feeder metering auger. The powder is mixed continuously in a small agitated tank and pumped to the DAF first pH and coagulant dosing chamber and mixed with the incoming wastewater.

Coagulant strength can be adjusted by altering the speed of the coagulant feed auger thereby increasing or decreasing the strength of the coagulant solution. The VSD controlled coagulant pump allows the pump delivery to be adjusted over a relatively wide range.

Coagulant is added continuously to the fully mixed coagulant mixing tank. The coagulant is not dissolved in the solution and remains in a slurry form. This means that should mixing stop for even a short period the coagulant will fall out of its slurry formation.

When mixing is re-established, five minutes agitation must be allowed before the solution is pumped on to the DAF. This allows the coagulant to be re-suspended in its slurry form.

When in operation, the coagulant tank is topped up with fresh water by solenoid valve control on the inlet water supply. This allows the level in the tank to remain between two level points at the top of the coagulant tank.

1.6 ACID DOSING

Acid dosing is required to break the fat/protein emulsions present in meat processing wastewater. The acid will be automatically dose to maintain the required pH in the first chamber.

The acid will be supplied from a NABL supplied IBC located close to the Acid Pump position.

1.7 FLOCCULANT SYSTEM

Flocculant is prepared a Klein PFAS 1500 Polymer Preparation Unit. This will require having process control from the Haarslev DAF Control system. Reference to the Klein Process Diagram A2-00830-00 should be made.

The unit consist of two tanks, a 1,500L polymer makeup tank and a 3,000L storage tank.

The makeup controls the operation of the system with the makeup activated when the activation level of the storage tank. The storage tank also has a low low level designed to protect the polymer dosing pump.

When the storage tank activation level is reached the Transfer Pump is activated and solution is transferred.

The Preparation tank should then start the high speed Mixer and the Polymer feed pump started as well as the hopper activator mixer.

Water is also added to the polymer wetting box with polymer added until the feed timer is exceeded. The wetting solenoid is shut off along with the polymer feed screw.

The water solenoid continues to load water into the Preparation tank until high level is reached.

The tank will continued to be mixed for a required pre-determined period

The polymer storage hopper also has a low level sensor.

The polymer delivery pump is activated from the Haarslev DAF Plant activation. The pump has also a water solenoid valve for polymer dilution as required.

A 30 minute period for flocculant chain development is required during Flocculant make up to ensure good flocculation of coagulated material.

In addition the Flocculant has a limited mixing life of no more than 48 hours. Aged flocculant allows the links to become matted together thus preventing flocculation of the coagulated solids.

The Flocculant used has been especially selected to work in conjunction with the coagulant and should not be changed without consulting with Haarslev Industries.

When the flocculant tank reach low level the Flocculant make-up will automatically will be refilled.

The flocculant is pumped to the DAF Flocculation Chamber to bind the coagulated particles together and provide a supporting platform for the micro-bubbles to float the suspended material to the surface.

Aerated water is used to dilute and mix the flocculant solution prior to introduction to the DAF Flocculation Chamber. It is important that the flow of aerated water is maintained at a reasonable level to aid the upward movement of the large flocculated material particles.

1.7.1 Flocculant Make Up

Flocculant should be manually delivered to the Klein PFAS Polymer Hopper on a regular basis.

25 Kg of Flocculant is added to the polymer makeup hopper.

After the 20 minute blending period, the flocculant tank contents should be inspected to ensure the contents are visually smooth.

1.8 LAMELLA SETTLER

1.8.1 General

The EPA wastewater release conditions for the NABL Livingstone Beef Processing Plant include the removal of Total Phosphorus to below 3 mg/l.

This requires that the DAF discharge water be further treated to coagulate the normally dissolved phosphorus with a metal coagulant to settle this out of solution.

The coagulant proposed is Alum (Aluminium Sulphate) and this needs to be made up from powder in a batch arrangement similar in principle to the Coagulant Makeup.

The alum coagulant is added it a flash mixer and the solution is flocculated by medium speed mixer to provide development of flocculated material.

Haarslev Industries will also add polymer into this flocculation chamber to accelerate the coagulant growth and strength so that good compression of the sludge is achieved.

The coagulated and flocculated water is then transferred to the Lamella Settler where the water is developed to the discharge weirs using lamella plates. This allows the sludge to settle out of solution and accumulate on the plates before discharging to the Lamella sludge hopper.

The lamella velocity is slow so that any solids will fall out onto the plates.

The cleaned water discharges up through the lamella plates to an elevated weir arrangement where it is collected to NABL's discharge.

1.8.2 Inlet Pump PU-D801

PU-D801 is a submersible pump allocated in the DAF discharge chamber.

The pump speed is VSD controlled based on maintaining the level in the discharge chamber.

The pump is also be protected by a low level switch.

The discharge will be monitored for flow prior to discharge into the Lamella Settler's Flash Mixer.

1.8.3 Caustic Pump PU-D1000

Caustic dosing is required to provide hydroxide ions to the water being treated with the Alum Coagulant. The caustic will be dose when flowthrough the Inlet Pump PU-D801 to the Lamella Clarifier is undertaken.

The caustic will be supplied from a NABL supplied IBC located close to the Caustic Pump position.

1.8.4 Alum Coagulant Makeup

The alum coagulant powder is contained in a bulk bag supported over the feeder metering auger. The powder is mixed continuously in a small agitated tank.

The Alum Coagulant strength can be adjusted by altering the speed of the coagulant feed auger thereby increasing or decreasing the strength of the coagulant solution. The VSD controlled coagulant pump allows the pump delivery to be adjusted over a relatively wide range.

When in operation, the coagulant tank is topped up with fresh water by solenoid valve control on the inlet water supply. This allows the level in the tank to remain between two level points at the top of the coagulant tank.

The Alum Tank Mixing system should operate when the Transfer Pump PU-D801 is in operation.

The Alum solution is delivered to the Alum Storage Tanks TK-D805A and B using the Alum Transfer Pump PU-D807.

1.8.5 Alum Solution Tanks TK-D805A & B

The NABL Wastewater Plant has two 10 m^3 Alum Solution Tanks to allow for makeup of consistent Alum solution based on the solution strength achieved in the Alum Makeup Tank TK-D804.

Alum Makeup Tank mixing will be achieved with the installation of a top mounted propeller mixer into each tank.

The Alum tanks will be filled individually with the flow into TK-D805A initially. TK-Both tanks will be loaded up to provide sufficient alum solution for a reasonable period.

D805A will be the start up tank and will be activated when LC-D805A reaches low level.

This will start the Alum Coagulant delivery plant as covered above. Mixer MX-D802 should operate for 5 minutes before additional Alum powder is introduced.

Alum delivery pump PU-D807 should then start until the level delivering to tank TK-D805A with the inlet valve VA-D805A opened.

Delivery should continue until the 40 % level within the tank is reached. The water inlet valve VA-806A should then open until the tank level reaches 90 %.

The Alum Makeup Plant and Alum delivery Pump PU-807 should then shut down.

The tank's mixer will be activated once the level reaches 1.5 metres. Also once the level falls under this level the mixer must be switched off again.

The level inside each tank will be monitored by pressure sensors at the base level with both tanks continuously monitored with a signal fudge to eliminate level fluctuations.

This operation described will be duplicated for TK-D805B so that there is a working tank and a tank either full or being made up on Site at all times.

Alum solution should always be delivered to the Lamella Flash Tank 30 seconds prior to starting the Transfer Pump PU-D801.

1.8.6 Flocculant System

A second Flocculant Makeup unit has been selected to ensure the Operators are able to make up a suitable flocculent that will likely be diffident from that used in the Haarslev DAF system.

Flocculant is prepared a Klein PFAS 1500 Polymer Preparation Unit. This will require having process control from the Haarslev DAF Control system. Reference to the Klein Process Diagram A2-00830-00 should be made.

The unit consist of two tanks, a 1,500L polymer makeup tank and a 3,000L storage tank.

The makeup controls the operation of the system with the makeup activated when the activation level of the storage tank. The storage tank also has a low low level designed to protect the polymer dosing pump.

When the storage tank activation level is reached the Transfer Pump is activated and solution is transferred into storage.

The Preparation tank should then start the high speed Mixer and the Polymer feed pump started as well as the hopper activator mixer.

Water is also added to the polymer wetting box with polymer added until the feed timer is exceeded. The wetting solenoid is shut off along with the polymer feed screw.

The water solenoid continues to load water into the Preparation tank until high level is reached.

The tank will continued to be mixed for a required pre-determined period.

The polymer storage hopper also has a low level sensor.

The polymer delivery pump is activated from the DAF Transfer Pump PU-D801 activation.

A 30 minute period for flocculant chain development is required during Flocculant make up to ensure good flocculation of coagulated material.

In addition the Flocculant has a limited mixing life of no more than 48 hours. Aged flocculant allows the links to become matted together thus preventing flocculation of the coagulated solids.

The Flocculant used has been especially selected to work in conjunction with the coagulant and should not be changed without consulting with Haarslev Industries.

When the flocculant tank reach low level the Flocculant make-up will automatically will be refilled.

The flocculant is pumped to the Lamella Flocculation Chamber to bind the coagulated particles together and provide a supporting platform for the micro-bubbles to float the suspended material to the surface.

1.8.7 Flocculant Make Up

Flocculant should be manually delivered to the Klein PFAS Polymer Hopper on a regular basis.

25 Kg of Flocculant is added to the polymer makeup hopper.

After the 20 minute blending period, the flocculant tank contents should be inspected to ensure the contents are visually smooth.

1.8.8 Lamella Coagulation

The importance of achieving good flocculation is absolutely critical to good operation of the Lamella Settler.

The Flash Mixer MX-D903 and Flocculator MX-D805B must be in operation before delivery of wastewater from the DAF Discharge through Transfer Pump PU-D801.

Alum is delivered to the Flash Mixer using Alum Delivery Pump PU-D806. This is VSD controlled based on the delivery flow from the delivery Flow Meter FC-801. This will need to be set up with an algorithm control relating to coagulation achieved against flow delivered.

The Lamella Discharge will be monitored by a turbidity monitor. When turbidity reaches a high level then an alarm will be raised to alert the Operators.

1.8.9 Lamella Sludge Production

Sludge produced will slide down the lamella plates and fall into the hopper area for a degree of consolidation. Sludge from the lamella plant will be handled by NABL into a storage tank for removal off Site for use in a composting process.

The quantity of sludge produce will depend on the suspended solids and the level of TP experienced in the wastewater reaching the Wastewater Plant.

2. START UP PROCEDURE

2.1 WASTEWATER DELIVERY SYSTEM

Check the Inlet Filters and delivery pumps are operational and free of blockages.

It is critical that the screen provides wastewater with under 1.0 mm materials as passage of large particles or solids will potentially block the inlet pipework and pump.

The Inlet Filters will provide the DAF Plant with its grit removal system. The DAF Plant cannot be expected to remove grit and this will progressively build up in the chemical mixing chambers and in the aeration sections if grit is not adequately removed by the Inlet Filters.

The screen needs to be maintained in good operating condition to prevent any overflowing that result in oversized material discharging into the wastewater sump.

Failure to observe this requirement will prevent the DAF plant from operating correctly and cause the balance tanks to overflow back to the Wastewater Sump TK-D0102.

2.2 SLUDGE PROCESSING

Sludge can only be processed by the Haarslev Rendering Plant with it is in operation. If this is not the case the DAF sludge must be either discharged into storage bin or the DAF Plant cannot be operated.

Check that the Sludge Decanter is operational and that the Rendering Plant Drier in feed screw is operational. Check that the steam coagulation system on the sludge line is operational and correctly set up.

2.3 BALANCE TANKS

Check the balance tank levels.

Check that the balance tanks are clean and are free of solids on the top surface. With good agitation, the scum layer on top should not occur but this will depend on the agitation achieved by the submerged mixer within the tanks.

The Inlet Filters will provide the DAF Plant with its grit removal system. However any grit that manages to reach the plant will be removed in the Balance Tanks.

It may also be necessary to regularly drain the Balance Tanks separately to ensure remove of all the grit collected within the Tank.

2.4 DAF PLANT

2.4.1 Preliminary

Check over the DAF plant for any problem ie: loose pipes, leaks, sludge build up, etc.

Flush water down the sludge return line to the Sludge Pump connection to ensure the line is clear before DAF start up.

Check that the Coagulant and Flocculant supplies are adequate and refill if necessary.

Skim off any floating sludge that might be at the discharge end of the DAF into the sludge trough.

Check the aeration pump pressure measured at the retention tank is between 450 and 550 kPa.

Check airflow into aeration pump by pass is between 3 to 4 lpm.

2.4.2 DAF Start Up

Check that all necessary valves and motor isolators are correctly position and on.

To start operations switch the following control switches to Automatic.

Inlet Pump
Coagulant Pump
Flocculant Pump
Acid Pump
Caustic Pump
DAF Discharge Pump

Providing all other DAF control switches are in the Automatic Position the plant will start operation after the AUTO START button is pressed.

The DAF equipment will start in the following order with the time delays designated.

Sequence	Ref.	Description	Delay (Seconds)
1	PU-D203	Aeration Pump	30
2	TK-D204	Check Retention Tank Pressure	10
3	MX-D205	DAF Coagulant Mixer	
	MX-D206	DAF Flocculant Mixer	
	MM-D202	DAF Scraper	10
4	PU-D406	Flocculant Pump	
	MX-D302	Coagulant Mixer	
	SC-D303	Coagulant Feeder	10
	PU-D307	Coagulant Pump	10
5	PU-D201	Inlet Pump	

The above start up process allows the coagulation and flocculation chambers to retain the required mixture strengths of chemicals and allows virtually instantaneous start up.

When the start-up sequence is complete and the fault checks are satisfied, the delivery pump is activated and the process begins.

The DAF equipment can be started manually using individual SCADA equipment switches that should normally be switch to automatic. This protects the pumps and mixers by shutting them down should low levels in the respective tanks occur.

All equipment can be individually switched off on the SCADA screen. This will cause the PLC to stop any other interlocked items from operating.

2.5 Lamella Clarifier

Flow will process through the DAF into the Discharge chamber where the discharge pump PU-D801 will start the process prior to discharging water to the Lamella Clarifier.

The Lamella equipment will start in the following order with the time delays designated.

Sequence	Ref.	Description	Delay (Seconds)
1	MX-D903	Lamella Flash Mixer	10
2	MX-D904	Lamella Flocculator	10
3	PU-D806	Lamella Alum Dosing Pump	10
	PU-D866	Lamella Polymer Dosing Pump	
	PU-D1000	DAF Caustic Dosing Pump	
4	PU-D801	DAF Discharge Pump	

3. MONITORED PARAMETERS & ALARMS

The PLC monitors the operation of the plant by checking flows, pressures and levels of at various points in the plant. The DAF and Lamella Plant Alarms are detailed in Table 3 below.

TABLE 3: NABL LIVINGSTONE WASTEWATER PLANT DAF & LAMELLA CLARIFIER ALARMS				
ALARM REF	**ALARM CAUSE**	**REFERENCE**	**ALARM MESSAGE**	**ACTION**
1	Retention Tank Pressure Switch	PS-D204	Retention Tank Low Pressure	Plant Shut Down
2	DAF Floc. Hopper Probe	LS-D404	Floc Hopper Low level	Alarm Plant
				Plant Shutdown in 15 minutes
3	DAF Floc. Storage Tank Low Level	LS-D405	Floc Storage Tank Low Level	Plant Shut Down
4	DAF Sludge Tank High Level Probe	LA-D202	Sludge Tank at High Level	Stop Scrapers Stop inlet, coagulant and polymer pumps
5	DAF Sludge Tank High Level Probe		Sludge Tank at High Level	Hold Automatic Operation
6	Balance Tank TK-D104A Level Probe	LC-D104A	Balance Tank Low Level	Automatic Plant Shut Down
7	Balance Tank TK-D104A Level Probe		Balance Tank High Level	Alarm Plant
8	Balance Tank TK-D104B Level Probe	LC-D104B	Balance Tank Low Level	Automatic Plant Shut Down
9	Balance Tank TK-D104B Level Probe		Balance Tank High Level	Alarm Plant
10	DAF Discharge Chamber Low Level	LC-D203	Low Level (extended)	Plant Shut Down
11	DAF Coag. Tank Level Probe	LS-D301	Low Level (extended)	Alarm Plant
12	Lamella Floc. Hopper Probe	LS-D864	Floc Hopper Low level	Alarm Plant
				Plant Shutdown in 15 minutes
13	Lamella Floc. Storage Tank Low Level	LS-D865	Floc Storage Tank Low Level	Plant Shut Down
14	Coagulant Tank TK-D805A&B Low Level	LC-D805A LC-D805B	Coagulant Tank Low Level	Lamella Dosing Shut Down
15	Lamella Discharge High Turbidity	TT-D901	High Discharge Turbidity	Alarm Plant

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The only faults that will not remove the plant from automatic operation is when the balance tank levels are high and when the Lamella discharge has high turbidity.

Should any other fault be detected the plant will be closed down under Automatic operation. The fault or faults will be displayed on the SCADA page display on the Rendering Plant SCADA.

The faults listed must be cleared individually before the plant will run automatically. **There should be no attempt to by-pass fault notification by operating the plant on Manual Control.**

4. TYPICAL OPERATION SETTINGS

Plant controls have been set up at commissioning. Changing plant control settings should be avoided.

4.1 DAF INLET

A flow control valve has been incorporated into the Inlet Pump PU-D201 discharge line to handle the high range of levels possible in the Balance Tanks. This control valve is adjustable to a minor degree with adjustment to the pressure exerted onto the top of the valve's control diaphragm.

4.2 CHEMICAL DILUTION VALVES

DAF Mixing Chamber:	30% open.
Flocculant Water Addition:	30% open.

4.3 AERATION PUMP

Suction valve full open.
Delivery valve 100 % open.
Venturi bypass valves full open
Venturi Air Flow 3- 4 lpm.
Retention Vessel Pressure 450-550 kPa.

4.4 DAF COAGULANT AGITATOR

On.

4.5 DAF FLOCCULANT AGITATOR

On.

4.6 COAGULANT TANK AGITATOR

On.

4.7 FLOCCULANT SYSTEM

On.

4.8 COAGULANT PUMP

On.

4.9 COAGULANT FEEDER

VFD setting 25 to 35 Hz.

4.10 DAF FLOCCULANT PUMP

VFD setting 20 to 40 Hertz.

4.11 DAF SCRAPER

VFD setting 15 to 30 Hertz.

4.12 DAF SPARGE VALVE SETTINGS

Sparge valve settings as from the DAF inlet end are detailed in the following Table.

Valve No.	Valve Setting
No 1	40 %
No 2	40 %
No 3	50 %
No 4	40 %

4.13 DAF DISCHARGE PUMP

VSD controlled on level in DAF Discharge Chamber.

4.14 LAMELLA CLARIFIER FLASH MIXER

On.

4.15 LAMELLA FLOCCULATOR

On.

4.16 ALUM TANK AGITATOR

On.

4.17 ALUM TRANSFER PUMP

On.

4.18 LAMELLA COAGULANT TANKS MIXERS

On.

4.19 LAMELLA ALUM DOSING PUMP

On.

4.20 LAMELLA FLOCCULANT SYSTEM

On.

4.21 LAMELLA POLYMER DOSING PUMP

On.

5. STOP PROCEDURE

5.1 OVER NIGHT SHUT DOWN PROCEDURE

The overnight shut down procedure will occur automatically once the wastewater balance tanks reaches low level. The shutdown procedure should follow the following sequence: -

1. Turn off Inlet Pump switch. Increase scraper speed control by 20 % more that the present VSD Hertz setting.

2. One hour later turn off all switches except for the

   Aeration pump - Auto

3. Apply wash water to the sludge hopper. Clean all adhering sludge into the bottom of the hopper.

5.2 AUTOMATIC SHUT DOWN

Automatic shutdown occurs when the duty balance tank empties.

The auto stoplight will come on and the system will stage down in the order detailed in the following table.

Sequence	Ref.	Description	Delay
1	PU-D201	DAF Inlet Pump	20 sec
2	PU-D307	Coagulant Pump	240 sec
	SC-D303	Coagulant Feeder	
3	PU-D406	Flocculant Pump	10 min
	MX-D205	DAF Coagulant Mixer	
	MX-D206	DAF Flocculant Mixer	
	PU-D806	Lamella Alum Dosing Pump	
	PU-D866	Lamella Polymer Dosing Pump	
	PU-D801	DAF Discharge Pump	
4	DM-D202	Scraper	30 sec
5	MX-D302	Coagulant Mixer	1,800 min
6	PU-D203	Aeration Pump	

The sludge hopper and duty balance tank should be emptied and the plant left as clean as possible to avoid product going off.

If the Balance tank level is Low then the system does an Auto stop.

If the Balance tank level is High then the DAF alarm sounds.

6 PLANT OPERATION

6.1 DAF OPERATIONS

The plant must be operated with correct coagulation of the incoming solids fat and protein dispersion for the DAF to remove these from the meat processing plant's wastewater. The most important aspect for the DAF plant Operator is to achieve good coagulation of the incoming wastewater.

The DAF discharges wastewater into the Lamella Clarifier which is used to reduce the level of Total Phosphorus present in the wastewater by coagulating the wastewater with Alum.

The amount of Alum required is proportional to the suspended solids still in the wastewater and it is therefore important that as much of the suspended material and fats be removed in the DAF.

It is recommended that **daily jar tests** of the water in the DAF stabilisation chamber (third chamber) be undertaken. Equipment required checking the coagulation is as follows: -

Plastic Containers 600 ml
Graduated Glass Beaker 100 ml
Stirring Rod
pH Paper for range 3.0 to 8.0
Standard 5 % w/v Coagulant solution
Standard 0.5% w/v Flocculant Solution
5 ml Measuring Syringe

The standard solutions should be accurately made up in the laboratory. This provides accuracy assessment of the coagulation achieved and what additional chemical alterations are required to improve operations.

6.1.1 Coagulation Test

a) Collect a 500 ml sample from the DAF's Stabilisation chamber (third chamber). The coagulated material should rapidly float to the surface leaving a relatively clear liquid.

b) If rapid separation does not occur or the remaining liquid is highly coloured, tip out the floating solids and carry out the following checks on the remaining solution.

c) Check the pH of this liquid to ensure it is within the 5.0 to 6.0 range. If this is not the case check the pH level on the balance tank water at the inlet pump.

d) If the pH is within the required limits a check on the chemical dosing must be made. Add 2 ml of flocculant solution to the sample jar and stir the solution gently in one direction for 30 seconds. If additional float particles appear this indicates that the flocculant dose is not sufficient. Increase the flocculant dosing in small steps until the float produced is as good as that achieved in the plastic container. A delay of fifteen minutes is required to allow the chemical addition to take effect in the DAF. Additional coagulant may also be required.

e) If no change is noticed in the container add 10 ml of coagulant to the beaker and stir as described in d above. If additional float particles appear this indicates that the coagulant dose is not sufficient. Increase the coagulant and flocculant dosing in small steps until the float produced is equal to that achieved in the plastic container. A delay of fifteen minutes is required to allow the chemical addition to take effect in the DAF. Additional coagulant and/or flocculant can be added if required.

f) If no additional float is noticed the sample will be chalky grey and will need to be disposed of into the stabilisation chamber.

g) Refill the container with untreated wastewater collected prior to the DAF. Adjust the pH to the required range by carefully adding small quantities of acid and stirring as described above.

h) Carry out further coagulation testing as described above until a good split of material is achieved.

i) Adjust the coagulant and flocculant dosing pumps as required by the testing procedure.

6.1.2 Daily DAF Operation Checks

DAF operations are best monitored and recorded on a regular three or four hour basis. This allows the plant operations to be reviewed by both management and local authorities and indicates that the plant has been operated in an efficient and professional manner.

A DAF monitoring sheet is attached to the Manual. This provides the minimum of information that needs to be reviewed during plant inspections.

It is important for the continued successful operation of the DAF that the following **daily steps** be taken as detailed: -

a) Once a day the Sparge pipes should have all the aeration flow sent through one Sparge pipe to ensure the bottom of each the compartment gets a strong blast to prevent any heavy particle build up.

b) Check that the aeration pump airflow and pressure in the retention tank is as specified.

c) Carry out the coagulation test as detailed above.

d) Check that coagulant and flocculant supplies are adequate.

e) Inspect and clean the pH sensor.

f) Hose sludge trough and hopper to remove dried out sludge.

g) Sample DAF influent and effluent on twice weekly basis and have analysed for suspended solids and COD reductions achieved. This will ensure the reductions achieved are monitored and signals a deviation in plant operation should results begin to deviate

6.1.3 Weekly DAF Operation Checks

a) Once a week the Sparge pipes should be flush internally to remove build-up of solids on the Sparge internal surface. Close the Sparge flow control valve and remove the plug at the other end of the Sparge. Open the control valve and apply full flow for a short period.

b) Repeat the above procedure on all four Sparges.

c) Check that the scraper system is in order. There is potential corrosive gas production within the DAF tank so that the chain needs to be coated regularly with edible grease that can be dumped into the water if this occurs by accident.

6.2 LAMELLA CLARIFER OPERATIONS

The Lamella Plant must be operated with correct coagulation of the incoming DAF discharge to remove ant remaining suspended material and total phosphorus (TP) from the DAF's discharge water. The most important aspect for the Lamella Clarifier plant Operator is to achieve good coagulation of the incoming DAF discharge water.

Alum is used to combine with any TP present by chemical coagulation of the phosphorus by converting it to PO_4 cations. These combine with the Sodium ions introduced into the DAF discharge and precipitate out of solution in the lamella clarifier.

The alum dosing levels will be worked out during the Lamella Clarifier commissioning however it will be necessary to monitor the Lamella Clarifier discharge water to ensure the optimum dose regime is maintained.

As covered under section 6.1 above, It is recommended that **daily jar tests** of the water in the Lamella Clarifier Flocculation Chamber be undertaken.

Equipment required checking the coagulation is as follows: -

Plastic Containers 600 ml
Graduated Glass Beaker 100 ml
Stirring Rod
pH Paper for range 2.0 to 6.0
Standard 5 % w/v Alum solution
Standard 0.5% w/v Flocculant Solution
5 ml Measuring Syringe

The standard solutions should be accurately made up in the laboratory. This provides accuracy assessment of the coagulation achieved and what additional chemical alterations are required to improve operations.

6.2.1 Coagulation Test

a) Collect a 500 ml sample from the Lamella Clarifier's Flocculation chamber second chamber). The coagulated material should rapidly sink to the bottom leaving a relatively clear liquid.

b) If rapid separation does not occur or the remaining liquid is highly coloured, tip out the floating solids and carry out the following checks on the remaining solution.

c) Check the pH of this liquid to ensure it is within the 5.0 to 6.0 range. If this is not the case check the pH level on the DAF Tank discharge water.

d) If the pH is within the required limits a check on the chemical dosing must be made. Add 2 ml of flocculant solution to the sample jar and stir the solution gently in one direction for 30 seconds. If additional float particles appear this indicates that the flocculant dose is not sufficient. Increase the flocculant dosing in small steps until the float produced is as good as that achieved in the plastic container. A delay of fifteen minutes is required to allow the chemical addition to take effect in the Lamella Clarifier. Additional coagulant may also be required.

e) If no change is noticed in the container add 5 ml of coagulant to the beaker and stir as described in d above. If additional flocculated particles appear this indicates that the coagulant dose is not sufficient. Increase the coagulant and flocculant dosing in small steps until the float produced is equal to that achieved in the plastic container. A delay of fifteen minutes is required to allow the chemical addition to take effect in the Lamella Clarifier. Additional coagulant and/or flocculant can be added if required.

f) Refill the container with untreated DAF discharge water. Adjust the pH to the required range by carefully adding small quantities of acid and stirring as described above.

g) Carry out further coagulation testing as described above until a good split of material is achieved.

h) Adjust the coagulant and flocculant dosing pumps as required by the testing procedure.

6.2.2 Daily Lamella Clarifier Operation Checks

Lamella Clarifier operations are best monitored and recorded on a regular three or four hour basis. This allows the plant operations to be reviewed by both management and local authorities and indicates that the plant has been operated in an efficient and professional manner.

A Lamella monitoring sheet is attached to the Manual. This provides the minimum of information that needs to be reviewed during plant inspections.

It is important for the continued successful operation of the Lamella Clarifier that the following **daily steps** be taken as detailed: -

a) Once a day inspect the Lamella Flash Mixer and Flocculation Chamber and ensure good separation of solids and clarified water is being achieved.

b) Carry out the coagulation test as detailed above.

c) Check that Alum Slurry make up system and flocculant supplies are adequate.

d) Check the operation of the discharge turbidity monitor and clean if necessary.

e) Check the sludge hopper sludge level using the sludge valves on the hopper.

f) Sample DAF influent and effluent on twice weekly basis and have analysed for suspended solids and TP reductions achieved. This will ensure the reductions achieved are monitored and signals a deviation in plant operation should results begin to deviate

6.2.2 Weekly Lamella Clarifier Operation Checks

a) Once a week check the operation of the flash mixer and the Flocculator.

b) Check the Lamella discharge zone to ensure there is no build-up of solids on the discharge weirs and that sludge is not discharging up through the clarified water.

c) Also checked there is no obvious sludge build up on the lamella plates. If this occurs then the lamella plates will need to be extracted and cleared.

7. EQUIPMENT SPECIFICATION

7.1 INFLUENT SYSTEM

7.1.1 Plant Waste Filters (Supplied by NABL)

Ref:	TBA
Brand:	TBA
Model:	TBA
Drive	TBA

7.1.2 Combined Sump Pump (Supplied by NABL)

Ref:	PU-102A, P-102B
No Off:	Two
Brand:	Grundfos
Model:	SEI.80.100.75.4.50B.b
Drive	7.5 kW

7.1.3 Influent Balance Tanks (Supplied by HI)

Ref:	TK-D104A&B
No. Off:	Two
Volume:	35 m^3
Mixers:	Flygt
Mixer Type:	SR4640.01
Mixer Power:	4 kW
Control:	Pressure Level Sensors

7.1.4 DAF Inlet Pump

Ref:	PU-D201
Design Flow:	80m^3/h
Design Head:	12 m
Brand:	Regent Isoflow
Model:	100x65-200
Construction:	Stainless steel body, stainless steel internals
Seal:	Mechanical
Drive	5.5 kW 4 pole IP 54

7.2 DAF SYSTEM

7.2.1 DAF Unit

Ref:	TK-D202
Model:	8820
Size:	10.5(I) x 4.2(w) x 2.0(h)
Maximum Design Flow:	80.0 m^3/h
Process:	Micro fine Pressurised Air Flotation

7.2.2 Aeration Pump

Ref:	PU-D203
Flow:	90.0 m^3/h
Total Head:	55 m
Brand:	Regent Isoflow
Model:	100x65-200
Construction:	Stainless Steel Centrifugal Pump
Seal:	Mechanical (water flushed)
Drive	30 kW 2 pole IP 55

7.2.3 Retention Tank

Ref:	T-204
Brand:	HI
Volume:	2,650 litres
Tank Diameter:	1,300 mm
Tank HOS:	2,000 mm
Tank Material:	Type 304L Stainless Steel

7.2.4 Sludge Scraper

Drive Unit

Brand:	Bonfiglioli
Model:	A55 UH50
Output Speed:	4 rpm
Drive:	1.5 kW 4 pole IP 54 motor
Speed Control:	Variable Speed Drive

Scraper Chain

Brand:	Renold Christian
Type:	C188 Rivetted Cast Combination Chain
Chain Pitch:	66.3 mm
Links:	#69
Sprockets:	14 tooth

7.2.5 DAF Coagulant Blender

Ref:	MX-D205
Brand:	HI
Drive Brand:	WEG
Drive Motor:	1.1 kW 4 pole
Wetted Material:	Type 304 Stainless Steel

7.2.6 DAF Flocculant Blender

Brand:	HI
Drive Brand:	Bonfiglioli
Model:	W75 U
Output Speed:	120 rpm
Drive Motor:	0.75 kW 4 pole
Wetted Material:	Type 304 Stainless Steel

7.3 DAF Discharge Pump

Ref:	PU-D801
Flow:	80.0 m^3/h
Total Head:	15 m
Brand:	Tsurumi
Model:	80SFQ27.5
Construction:	Stainless Steel Submersible Pump
Drive	7.5 kW 2 pole IP 65

7.4 DAF CHEMICAL PREPARATION

7.4.1 Coagulant Preparation

Coagulant Mixing Tank

Ref:	TK-D301
Brand:	HI
Volume:	200 litres
Tank Material:	Type 304 Stainless Steel
Drive Brand:	WEG
Drive:	0.70 kW 4 pole
Impellor Shaft Material:	Type 304 Stainless Steel
Impellor Diameter:	100 mm

Powder Dry Feeder

Ref:	SC-D303
Brand:	HI
Feed Rate:	65 kg/h @ 50 Hz
Model:	165-65-DM
Drive:	Brevini Gear Reducer 0.55 kW 4 pole
Speed Control:	Electrical Variable Speed Drive

Coagulant Dosing Pump

Ref:	PU- D307
Brand:	Mono
Model:	CP800
Drive:	0.95kW 4pole IP54
Design Flow:	3.6 m^3/h

7.4.2 Flocculant Preparation

Flocculant Preparation Unit

Ref:	FS-401
Brand:	KLEIN
Model:	PFAS-1500
Chamber Number:	Two
Chamber Volume:	1,500l / 3,000l
Mixer Number:	One
Mixer Type:	Gear reduced 2.2 KW 4 pole IP 55
Powder Feeder:	Variable speed gear reduced 0.18 KW
Powder Storage:	90 litres

Flocculant Transfer Pump

Ref:	PU-403
Brand:	SPX
Model:	FIP50S1-BSP02M01F100
Pump Flow:	3,000 l/h @ 50 Hz
Total Head:	15 m
Drive:	1.5 kW Gear reduced

Flocculant Dosing Pump

Ref:	PU-D406
Brand:	Netzsch
Model:	NM021BYO2312B
Pump Flow:	3,0 l/h @ 50 Hz
Total Head:	15 m
Drive:	1.1 kW Gear reduced
Speed Control:	Electrical Variable Speed Drive

7.4.3 Acid Dosing System

Acid Pump

Ref:	PU-D502
Brand:	LMI
Model:	C946-312TI
Liquid End Material	PVDF
Seal Material	PTFE
Valve Ball Material	Ceramic
Stroke Adjustment	Automatic on 4-20 mA signal
Pump Flow:	30 l/h
Total Head:	25 m

pH Controller

Ref:	I-502A
Brand:	LTH
Model:	MPD 53 S1
Probe:	Broadley James
Model:	ST973-T331-N10FF c/w Probe Guard
Signal Output	4-20mA

7.5 DAF SLUDGE DISPOSAL

7.5.1 Sludge Hopper

Brand:	HI
Volume:	1,100 litres
Tank Material:	Type 304 Stainless Steel
Sludge Discharge:	Sloped Bottom Discharge

7.5.2 Sludge Pump

Ref:	PU-D601
Brand:	FMK
Model:	KX 0452A-CD-7R-PTFE-OHBP-EM
Pump Flow:	6 m^3/h
Total Head:	60 m
Maximum Pump Speed:	325 rpm @ 50 Hz
Drive:	3.0 kW 4 pole IP55

7.6 LAMELLA CLARIFIER SYSTEM

7.6.1 Flash Mixer

Ref:	TK-D903
Model:	T265
Size:	265 litre
Mixer:	0.37kW gear reduced motor IP55

7.6.2 Flocculation Chamber

Ref:	TK-D904
Model:	T1900
Size:	1,900 litre
Mixer:	0.37kW gear reduced motor IP55

7.6.3 Lamella Clarifier

Ref:	LA-2D901
Brand:	Parkson EcoFlow
Settling Area:	80 m^2
Loading Rate:	1.25 m/h
Tank Size:	2.85(w) x 3.91(l) x 4.77(h)
Tank Material:	Painted mild steel

7.7 LAMELLA CHEMICAL PREPARATION

7.7.1 Alum Slurry Preparation

Alum Slurry Mixing Tank

Ref:	TK-D804
Brand:	HI
Volume:	200 litres
Tank Material:	Type 304 Stainless Steel
Drive Brand:	WEG
Drive:	0.70 kW 4 pole
Impellor Shaft Material:	Type 304 Stainless Steel
Impellor Diameter:	100 mm

Alum Powder Dry Feeder

Ref:	SC-D803
Brand:	HI
Feed Rate:	80 kg/h @ 50 Hz
Model:	165-65-DM
Drive:	Brevini Gear Reducer 0.55 kW 4 pole
Speed Control:	Electrical Variable Speed Drive

Alum Slurry Transfer Pump

Ref:	PU- D807
Brand:	Mono
Model:	CP1600
Drive:	0.95kW 4pole IP54
Design Flow:	10.0 m^3/h

Alum Coagulant Tanks

Ref:	TK-D805 A&B
Brand:	MDPE
Capacity:	10 m^3
Mixer Ref:	MX-D805 A&B
Brand:	HI
Drive:	Bonfiglioli
Model:	W75 U 7:1
Motor:	2.2 kW 4pole IP54

Alum Dosing Pump

Ref:	PU- D806
Brand:	Mono
Model:	CP25
Drive:	0.37kW 4pole IP54
Design Flow:	600 l/h

7.7.2 Flocculant Preparation

Flocculant Preparation Unit

Ref:	FS-D810
Brand:	KLEIN
Model:	PFAS-1500
Chamber Number:	Two
Chamber Volume:	1,500l / 3,000l
Mixer Number:	One
Mixer Type:	Gear reduced 2.2 KW 4 pole IP 55
Powder Feeder:	Variable speed gear reduced 0.18 KW
Powder Storage:	90 litres

Flocculant Transfer Pump

Ref:	PU-863
Brand:	SPX
Model:	FIP50S1-BSP02M01F100
Pump Flow:	3,000 l/h @ 50 Hz
Total Head:	15 m
Drive:	1.5 kW Gear reduced

Flocculant Dosing Pump

Ref:	PU-D866
Brand:	Netzsch
Model:	NM021BYO2312B
Pump Flow:	3,0 l/h @ 50 Hz
Total Head:	15 m
Drive:	1.1 kW Gear reduced
Speed Control:	Electrical Variable Speed Drive

7.8 LAMELLA CLARIFIER SLUDGE DISPOSAL

7.8.1 Lamella Sludge Hopper

Brand:	Parkson
Volume:	6,000 litres
Tank Material:	Painted Mild Steel
Sludge Discharge:	Sloped Conical Bottom Discharge

7.8.2 Sludge Pump (Supplied by NABL)

Ref:	PU-D1100
Brand:	TBA
Model:	TBA
Pump Flow:	TBA m^3/h
Total Head:	TBA m
Maximum Pump Speed:	TBA rpm @ 50 Hz
Drive:	TBA kW 4 pole IP55

8. MAINTENANCE REQUIREMENTS

Maintenance for the Haarslev Industries supplied equipment is summarised in weekly, fortnightly, monthly, six monthly, annually and biannually maintenance requirement tables. Full details including detailed installation, operations and maintenance requirements including parts lists are included in Section 9 Equipment Manuals.

8.1 Daily

Ref.	Description	Maintenance
	DAF Aeration Sparge	Apply full Aeration Pump pressure to each aeration Sparge individually for five minutes

8.2 Weekly

Ref.	Description	Maintenance
PU-D201 PU-D203	Inlet Pump Aeration Pump	Check seal leakage rate and tighten if rate greater than 15 drops per minute.
	DAF Scraper Chain	Lubricant Chain Joints
FS-401A	Flocculant Make Up System	Check operation and control of the water supply system. Clean and replace any component not operational.
FS-D810	Flocculant Make Up System	Check operation and control of the water supply system. Clean and replace any component not operational.
PU-D307 PU-D406 PU-D807 PU-D806	Coagulant Pump DAF Flocculant Pump Lamella Alum Slurry Pump Lamella Alum Dosing Pump	Check pump visually whilst in operation.

8.3 Fortnightly

Ref.	Description	Maintenance
PU-D307 PU-D406 PU-D806 PU-D866	DAF Coagulant Pump DAF Flocculant Pump Lamella Alum Dosing Pump Lamella Flocculant Pump	Check pump delivery rate. If not satisfactorily check speed control setting followed by pump and valve connections etc.

8.4 Monthly		
Ref.	**Description**	**Maintenance**
PU-D601	Sludge Pump	Check pump delivery rate. If not satisfactory inspect rotor and stator Internally. It is recommended that a spare rotor and stator be held on Site for easy installation.

9.5 Six Monthly

Ref.	Description	Maintenance
	DAF Scraper Bearings	Grease scraper bearings.
	DAF Coagulant Mixer	Replace mixer bearing and seal.
	Coagulant Tank Mixer	Replace mixer bearing and seal.
	DAF Chain Support Strips	Check for wear on chain support strip. Arrange to replace if necessary.
	SYSDAF Scraper Drive Flocculant Blender	Check lubricant level. Sample lubricant quality and replace if not clean.

9.6 Annually

Ref.	Description	Maintenance
	Coagulant Feeder Flocculant Feeder	Replace feeder seal assembly.
	Coagulant Pump	Replace diaphragm and seals
	DAF Flocculant Pump Sludge Flocculant Pump	Strip pump and replace worn or damaged components.

9.7 Biannually

Ref.	Description	Maintenance
	Inlet Pump Aeration Pump	Replace bearings.
	Coagulant Feeder Flocculant Feeder	Replace gear reducer lubricant and drive bearings.
	DAF Scraper Drive Flocculant Blender Flocculant Mixers	Replace gear reducer lubricant.

9. EQUIPMENT MANUALS

Equipment manuals are incorporated into this manual.

NORTHERN AUSTRALIAN BEEF Ltd

LIVINGSTONE MEAT PROCESSING PLANT

RENDERING PLANT BIO-FILTER

OPERATIONS MANUAL

Prepared for:	**NABL Ltd**
Prepared by:	**Weston Burnett**
Revision:	**0**
Date:	**19 August 2014**
File Ref:	**NABL Bio-Filter Operations Manual.doc**

CONTENTS

1. SAFETY ISSUES

The NABL Rendering Plant Bio-Filter is designed to treat and remove odour from the air associated with the Haarslev FPSS Plant.

Rendering Plant odour is made up of a range of odorous gases principally ammonia, ethlyamines, hydrogen sulphide, and mercaptans.

The component gases depend on a number of things including the freshness of the raw material being processed, and the retained cleanliness of the rendering plant equipment and solids collection equipment.

A number of gases mentioned above are dangerous even in low quantities and have been responsible for fatalities in a number of industries.

It is therefore essential that the Bio-filter ductwork and access manholes are not entered under any circumstances during normal operating conditions. This includes the removal of sealed manhole covers for inspection purposes.

It should not be necessary to entry the manhole or duct work on a regular basis. The only time entry may be necessary is when the Bio-Filter efficiency has reduced significantly and an inspection and cleaning of the distributor system may be recommended.

Because of the confirmed spaces involved and the probability that poisonous gases will be present, entry must be carried out to the requirements of AS 2865:1995 ‘Safe Working in a Confined Space’.

An outline of the recommendations covered by this standard is available from NT WorkSafe with the same title as the Australian standard.

2. SPECIFICATION

TABLE 2: NABL HAARSLEV FPSS PLANT BIO-FILTER BIO-FILTER SPECIFICATION		
Parameter	**Unit**	**Value**
Bio-Filter Feed		Rendering Plant Process Plant
Design Air Flow	m^3/s	2.8
Mean Odour Discharge	OU/m^3	30,000
Bio-Filter Design		Single bed
Bio-Filter Length	m	27.6
Bio-Filter Width	m	15.6
Bio-Filter Area	m^2	430
Area Velocity	mm/s	7.8
Residence Time	s	180
Average Bio-Filter Discharge	OU	< 500
Bio-Filter Base		Organic material sealed with HDPE Liner
Media Support Media		Graded Metal
Distribution Media		Graded Pea Metal
Fine Media		Fine Pea Metal
Filtration Bark		12/38 Graded
Media Moisture System		Water Spray
Nozzle Type		Sumisansui K2
Dryer Fan Brand		Hoyer
Fan Model Type		HCR 630-BD
Dryer Fan Duty Volume	m^3/s	6.1
Dryer Fan Duty Pressure	KPa	8.0
Evaporator Fan Brand		Hoyer
Fan Model Type		HCR2-400
Dryer Fan Duty Volume	l/s	325
Dryer Fan Duty Pressure	KPa	4.2
Back Pressure Monitor		Monometer type

3. INTRODUCTION

Haarslev Industries Ltd has designed and installed the FPSS Bio-Filter for the treatment of odour from the Haarslev FPSS Plant Building and Stickwater Evaporator at the NABL Livingstone Meat Processing Plant.

A Bio-Filter operates by converting the air pollutants to CO_2 and water when the pollutants interact with the active microbes, oxygen and water within the media. For this reason they must be treated as a dynamic living process requiring regular attention to maintain a healthy environment.

The process is cost effective, requiring no fuel or chemicals as the microbial enzymes continually regenerate themselves. It is a process that produces no secondary pollutants, making it ecologically sound and safe to operate.

4. BIO-FILTER DESIGN

Each Bio-Filter is individually designed to suit the particular application and the site location. The NABL Haarslev FPSS Plant Building Bio-Filter has been designed using the following parameters: -

4.1 SITE CONSIDERATIONS

The Haarslev Bio-Filter has been constructed adjacent to the Haarslev FPSS Plant where the main odour stream is discharges from the Knock-Out Drum 509. The odour stream is a proportion of the air flow through the Flo-Dryer with the majority being recycled back to the Flo-Dryer Combustion Chamber. Vapour and odour is also extracted from the Reactor, Decanters and LP Screen.

There is also an extraction from the Flo-Dry Evaporator Plant which is handled separately within the Bio-Filter.

4.2 BIO-FILTER CONSTRUCTION

The Bio-Filter is located adjacent to the Rendering Plant Building allowing access between the two if required.

The Bio-Filter has been enclosed using block work onto a ring foundation.

The odour delivery from the FPSS Plant is discharge underground to a manhole which connects into the Bio-Filter manifold within the Bio-Filter media.

The distribution manifold is located across the centre of the Bio-Filter. A drain is located underneath the distribution manifold to collect drainage water. The drain discharges to the inlet manhole and liquid is discharge through a submersible pump into the feed to the Wastewater Sump.

4.3 BIO-FILTER ASSEMBLY

4.3.1 Distribution

Gases from the FPSS Plant Knock-Out drum are transferred using stainless ducting which transfers underground to concrete ducting for transfer to the Bio-Filter Manhole.

Inlet gasses are distributed into the bio-filter media using plastic drainage ducting located at 919mm centres. The media distributors may be accessed from the outside of the Bio-Filter through capped access ports.

4.3.2 Bio-Filter Sealing

It is necessary to seal the surrounding ground and underground water table from liquid discharges from the Bio-Filter. This is due to the potentially acidic nature of bacterial discharge that occurs with the development, growth, reproduction and die off phases associated with all bacterial populations.

The Haarslev Bio-Filter has been installed with a 1.5 mm thick HDPE liner between the graded ground level and the supporting support media. The liner has been extended onto the concrete block at the wall perimeter to provide a complete seal that will collect all discharges into the centrally located drain.

4.3.3 Bio-Filter Support Media

Basalt metal is used to support the biologically active bark media.

Coarse metal is located at the bottom to support the media distributors and to allow full drainage of the bio-filter media.

A medium pea metal grade is placed on top to provide distribution into the bark layers. An additional fine metal layer is used to separate the bark layer from the distribution metal.

4.3.4 Bio-Filter Bark

One layer of bark are placed over the support media layers to ensure that the gases permeate evenly through the entire filter bed. The bark provides the organic surface for bio-filtration.

4.3.5 Evaporator Discharge

Odour extraction form the Stickwater Evaporator is handled through one Bio-Filter lateral which is not connected to the main Bio-Filter manifold.

5. BIO-FILTER OPERATIONS AND MONITORING

Haarslev Bio-Filters operate by converting the air pollutants to CO_2 and water when the pollutants interact with the active microbes, oxygen and water within the media. The bio-filter will operate without problems providing care is taken to maintain the active microbes in a healthy state.

It is critical that the following operation states are applied at all times.

1. Temperature of the inlet gases must not exceed 50^0 C. Gas temperature from the FPSS Building or Stickwater Evaporator should never exceed this upper limit.

2. To ensure that there is sufficient moisture, the bed must be inspected regularly (at least daily initially) and if required water must be sprinkled on to the top of the bed using the installed sprinkler system. Optimum moisture levels should be 40% to 50%.

3. The pressure drop of the bed must be measured regularly using the pressure manometer located at the distribution manhole chamber. This back pressure must be between 10 mm and 100 mm water gauge.

4. If the back pressure is below 10 mm, the gases are permeating too freely through the bed resulting in insufficient residence time for the Bio-filter to be affective. Check that gas flow to the bio-filter is adequate.

5. If the back pressure is too low, turn the irrigation system on to the bio-filter daily for 2 to 3 hours to raise the back pressure. Also, check that there are no obvious leaks in the bed and the concrete manholes are well sealed.

6. If the back pressure is more than 80 mm, check that the media is not saturated by measuring the moisture content. If the moisture content is within the 30 to 50 % level, then the bed may be choked and compacted. The top of the bed may require hoeing or loosening up.

7. High back pressure may also be due to biological build up in the plastic distributors. Access to the distributor pipes is from the edge of the bio-filter and from the main distribution pipe.

8. The humidity of the gases entering the bio-filter should be maintained above 60%. If necessary a water spray nozzle can be located in the fan discharge transition to humidify the air while the fan is in operation.

9. It is however important not to have the water flow into the fan casing as this will prevent the fan re-starting properly.

10. The pH of the organic media of the bed must be ideally between 5 and 6.

11. Every month the organic filling must be checked by taking a core sample and tested to ensure that the material is not breaking down. Core samples should be also tested for total counts of micro-organisms.

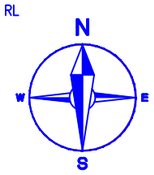
12. A total bacteria count on the sample can be made based on the sample extracted. It may be necessary to reduce the size of some of the bark media depending on the method adopted by the testing laboratory. Typically total counts of $>10^5$ must be present.

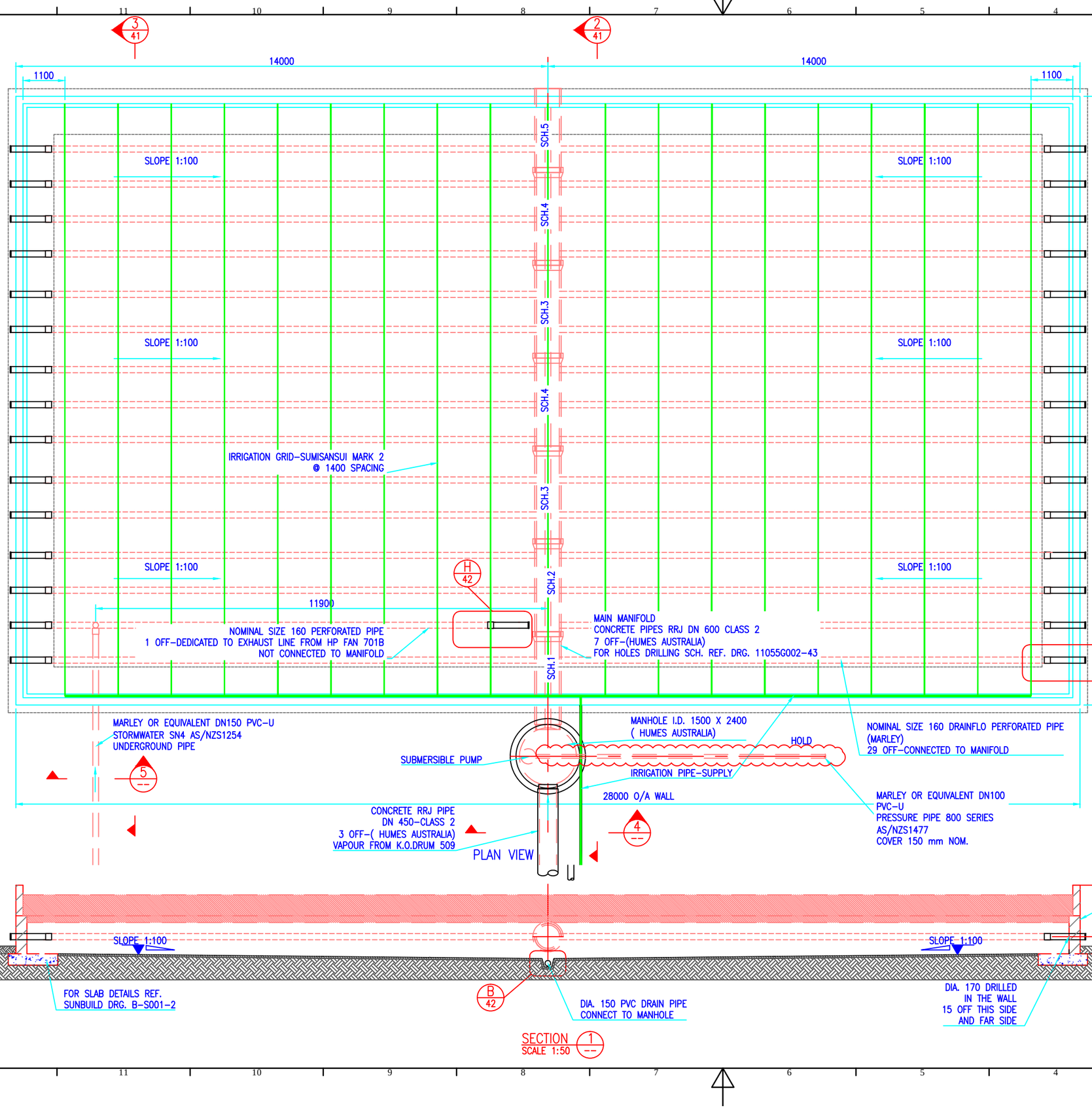
6. DRAWINGS

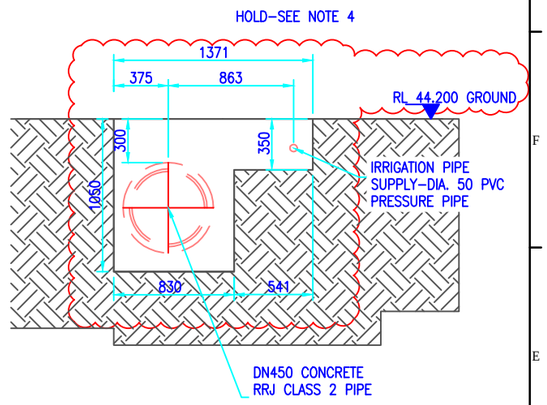
- Bio-Filter Site Layout Drawing 11055G002-40 Rev 0
- Bio-Filter Sections Drawing 11055G002-41 Rev 0

REFERENCE DRAWINGS	
11055G002-01	EQUIPMENT FOUNDATION-KEY PLAN

NOTE:
1. ALL ELEVATIONS ARE FROM RL 44.400 m
2. ALL DIMENSIONS ARE REFERENCED FROM GRID LINES
3. FOR LOCATION AGAINST R.B. REF. DRAWING 11055G100-12
4. TCM/SUNBUILD TO ADVISE MIN. DEPTH FOR UNDERGROUND PIPES , COMMENT TRENCH DIMS AND CONFIRM GROUND RL

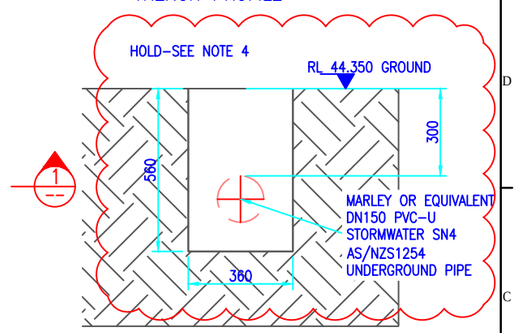






SECTION 4
SCALE 1:20

TRENCH PROFILE



SECTION 5
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TRENCH PROFILE

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A	31/01/14	ISSUED FOR COMMENT	NZDVJ

	Date:	Init:	Projection:
Approved:	-	WEB	
Drawn:	14/01/14	NZDVJ	
Last saved:	31/01/14	NZDVJ	

Tolerance: | Scale: 1:50 | Sheet size: A1 | Weight:

Part no: 11055

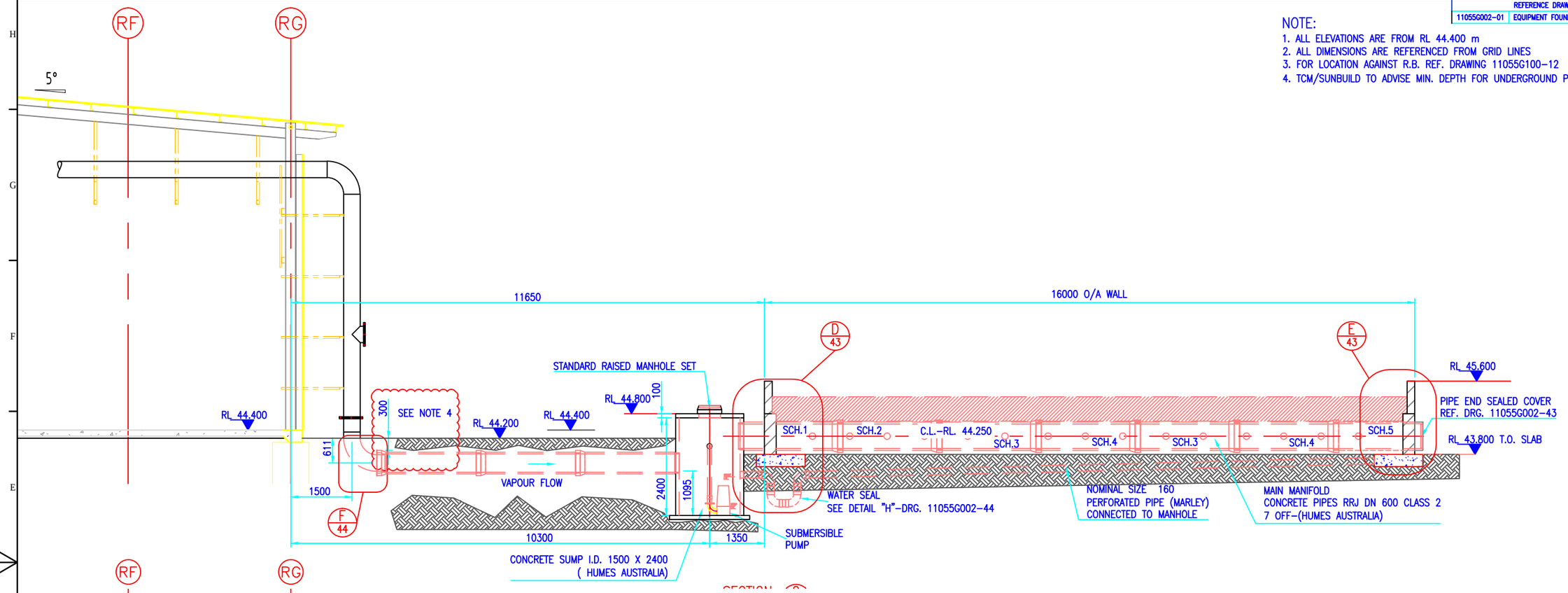
HAARSLEV INDUSTRIES

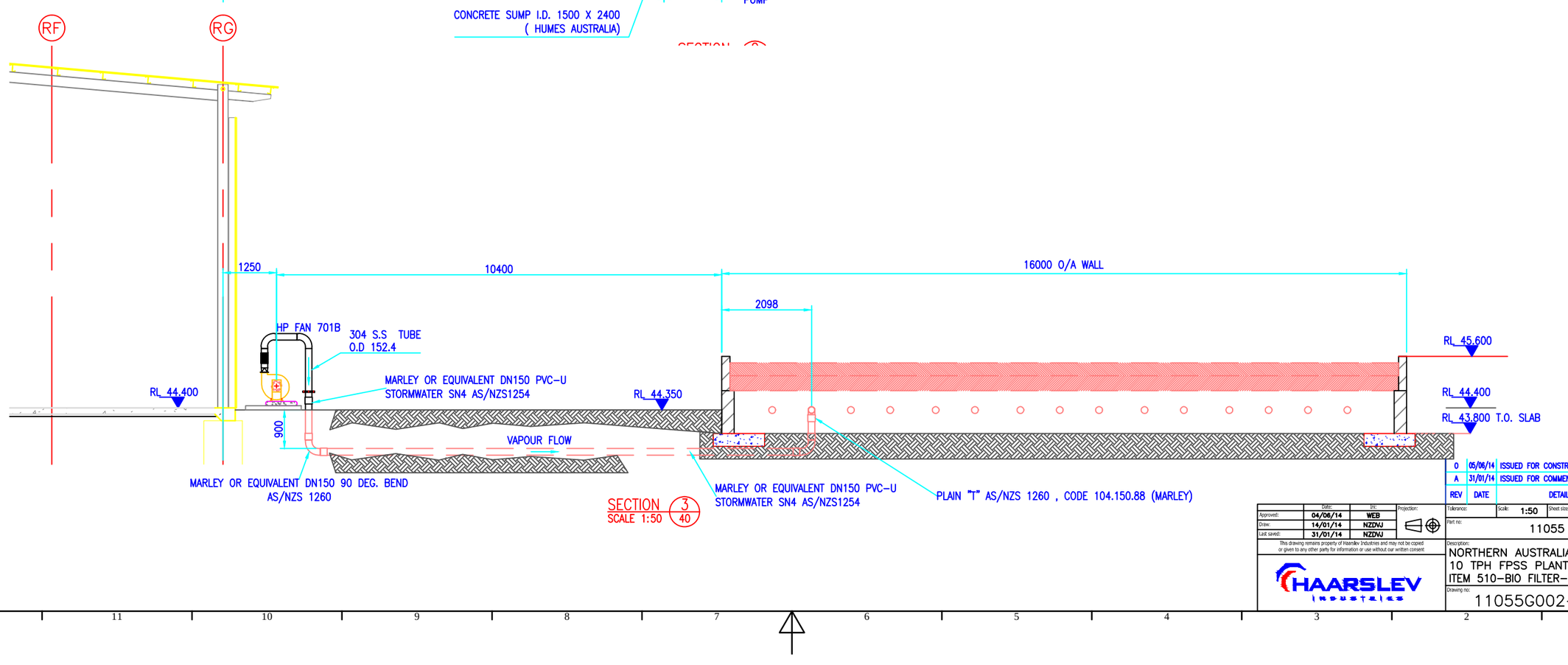
Description:
NORTHERN AUSTRALIAN BEEF LTD.
10 TPH FPSS PLANT
ITEM 510-BIO FILTER G.A.

Drawing no: 11055G002-40-0

REFERENCE DRAWINGS	
11055G002-01	EQUIPMENT FOUNDATION-KEY PLAN

NOTE:
1. ALL ELEVATIONS ARE FROM RL 44.400 m
2. ALL DIMENSIONS ARE REFERENCED FROM GRID LINES
3. FOR LOCATION AGAINST R.B. REF. DRAWING 11055G100-12
4. TCM/SUNBUILD TO ADVISE MIN. DEPTH FOR UNDERGROUND PIPES





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A	31/01/14	ISSUED FOR COMMENT	NZDVJ

	Date:	Int:
Approved:	04/06/14	WEB
Draw:	14/01/14	NZDVJ
Last saved:	31/01/14	NZDVJ

Projection:

HAARSLEV Industries

Tolerance: | Scale: 1:50 | Sheet size: A1 | Weight:

Part no: 11055

Description:
NORTHERN AUSTRALIAN BEEF LTD.
10 TPH FPSS PLANT
ITEM 510-BIO FILTER-SECTIONS

Drawing no: 11055G002-41-0