FCL

Enhanced Bio Green Technology

GLOBAL TRENDS as it affects tire recycling

Natural Rubber Prices

The price of natural rubber keeps increasing.....

Natural rubber is a key component in making tires.

.... so recovering some of that rubber to be used again in new tires will be a great cost benefit

.... recycling some of that rubber and blending it with recycled plastics will be a big environmental benefit ....

Thus making a used tire increasingly more valuable!

GLOBAL TRENDS as it affects tire recycling

Global Warming - Impacts every daily process in our lives driving us toward better energy efficiency.

The Three R's – Reduce, Reuse, Recycle

Maximize the inherent value in recycled products!

Don't burn tires. It takes 140,000 BTU's to make one lb. of tire, you can only generate 14,000 BTU's per lb. of tire when burning them! What a waste of energy!

Don't shred and bury tires!

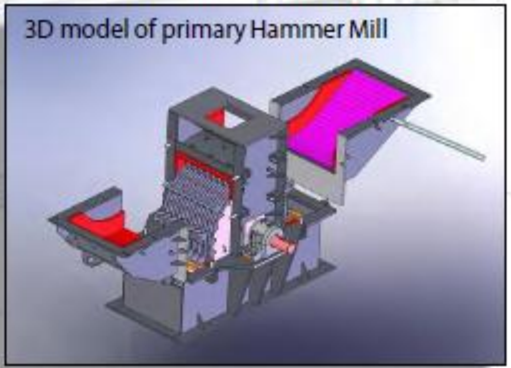
Don't just make crumb rubber!

Primary Turnkey Cryogenic Tire Recycling

Our primary cryo system is designed to process up to 3+ million tires per year on a 7 day per week basis. Each system is sold with integrated shredder and granulator.

The typical primary crumb is separated into the following mesh sizes:

4+	4 - 10	10 - 14	14 - 30	30- - mesh



FINE MESH

- Standard Fine Mesh is 20 mesh through 80- mesh (.75 mm through 0.425 mm)
- Ambient systems are limited to 30 mesh
- Our cryogenic process produces crumb with rounded edges which flows more smoothly than sharp edged ambient crumb
- Higher value output per dollar of input

VERY FINE MESH

- Very Fine Mesh is 30 mesh through 100- mesh (0.6 mm through 0.149 mm)
- Even higher value output than Fine Mesh

BLENDING

- Blends recycled tire cryo crumb rubber with post industrial and post consumer recycled plastic to produce a thermoplastic elastomer (TPE) without any additives
- 10 year global off take agreement with take or pay, payment of invoices backed by a revolving Letter of Credit (LC) which can generate as much as $90M USD per year in revenue

Pictures from pre-production plant in Michigan

RUBBER ASPHALT:

- A time tested proven solution – over 30 years for all climates
- Proven alternative to costly reconstruction
- Uses 1,000 tires per lane-mile in pavements 1” thick

Pre-building the California Turnkey System

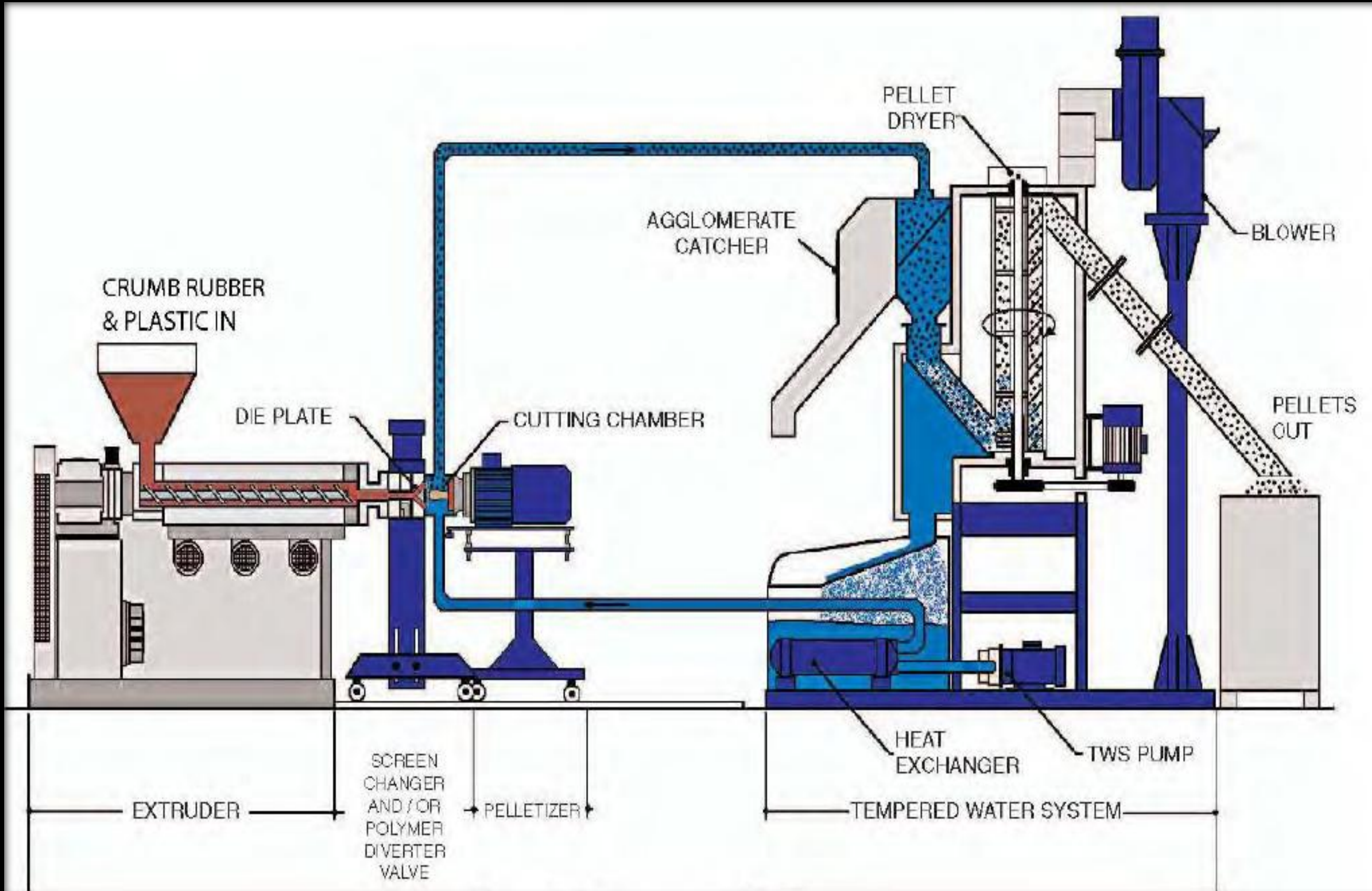
- ***Does not emit* any pollutants**
  into the environment

- Will reduce pollution by using more recycled rubber and more recycled plastic –

- Will divert rubber from tire derived fuel (TDF) due to the higher value stream

Can generate up to approximately $90 Million USD a year in revenue with the Offtake Agreement

- Exhibits the same properties of rubber and plastic but with broader application and versatility
- Uses 30- mesh and finer cryogenic rubber tire crumb as an input along with recycled post industrial plastic
- Rubber blend percentages can be from 10% rubber to as high as 80% rubber depending on customer requirements
- Can either be pelletized for injection molding or extruded



PELLET DRYER
AGGLOMERATE CATCHER
BLOWER
CRUMB RUBBER & PLASTIC IN
DIE PLATE
CUTTING CHAMBER
PELLETS OUT
HEAT EXCHANGER
TWS PUMP
EXTRUDER
SCREEN CHANGER AND / OR POLYMER DIVERTER VALVE
PELLETIZER
TEMPERED WATER SYSTEM

- Rubber and plastic is blended using a **high speed, high horsepower, patent pending blending unit**
- Hourly production rates can be from 2,000 lbs. to 7,000 lbs. per hour

Pre-production plant in Michigan

- Injection molding outputs - feature a pelletizer and a dryer
- Profile materials like artificial lumber - a profile die is added along with a melt pump, a puller, a cooling trough and an automatic cut off saw

Pre-production plant in Michigan

Injection Molding Benefits

- **Lower processing temperatures** than virgin plastic resins, saving on electricity costs
- **Mold cycle times can consistently be reduced** by 15% to 25% for the injection molder
- **Cools rapidly and evenly** throughout the molded part

Pre-production plant in Michigan

- **Lower raw material cost** due to the lower cost of recycled rubber compared to the cost of virgin rubber in other TPEs
- **More parts produced per hour** with the same number of machines
- **Can be painted** with oil, latex or epoxy paints
- **Lower utility costs** and **less floor space** over time

Extruded Product Benefits

Pre-production plant in Michigan

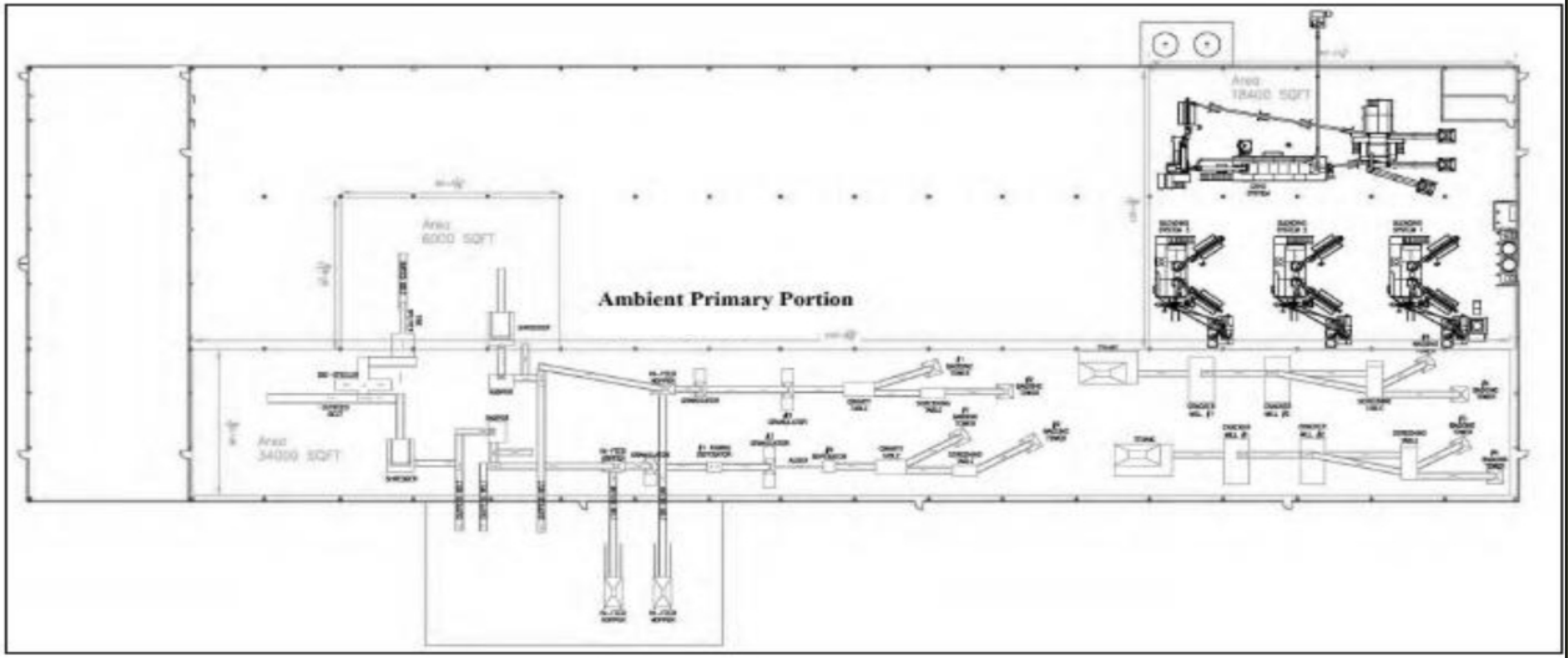
- Lumber and wood replacement products **do not expand or contract** like plastic or wood fibre composite products
- Decking will **outlast the structures** the deck surrounds
- Testing concludes that there is no migration of nails or screws for **25 years**
- Will not splinter, warp or rot
- UV, termite and skid resistant

Potential Applications

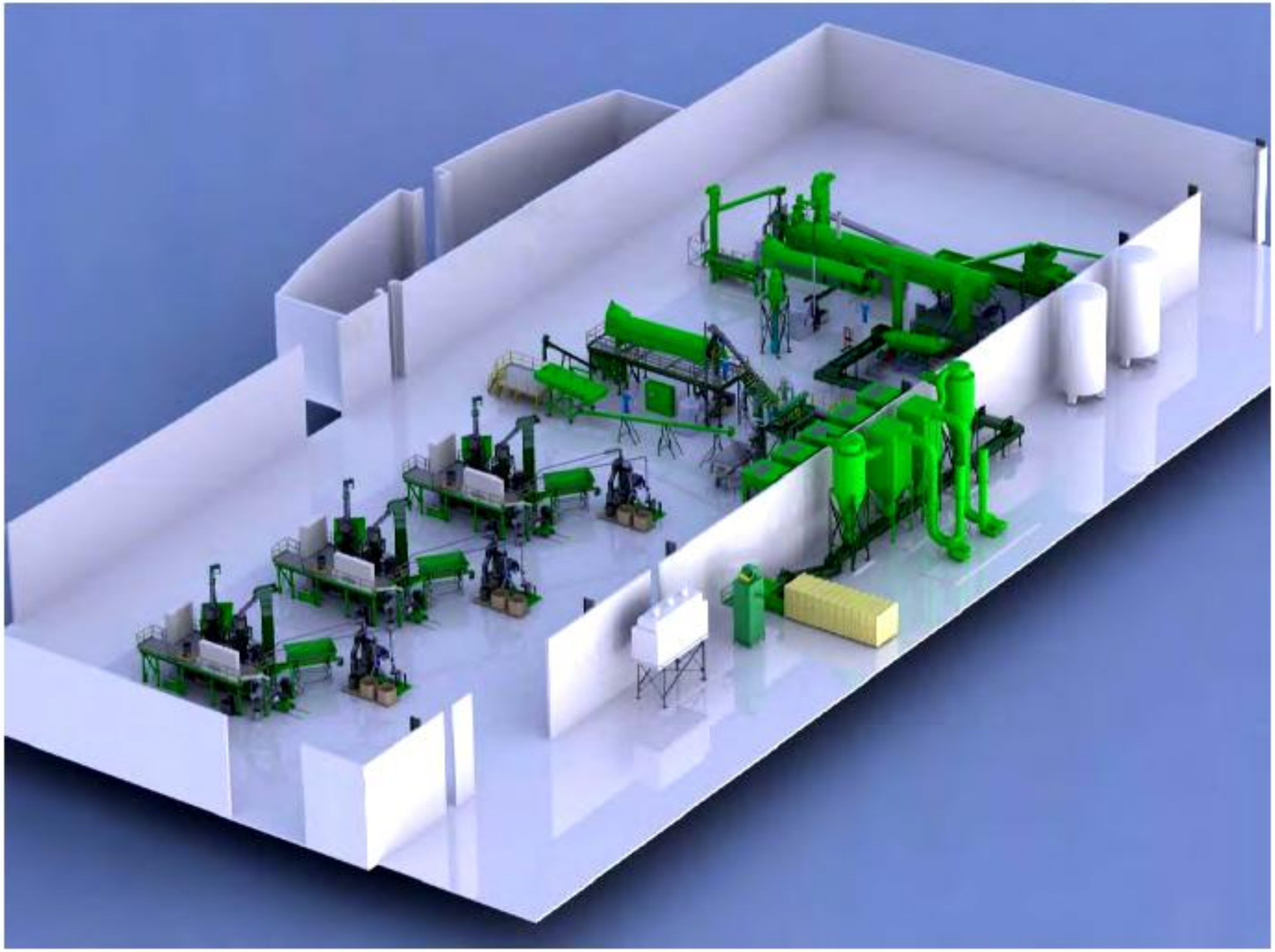
ASTM Specifications Available

- Automotive black plastics
- Truck bed liners
- Home and garden plastics
- Trash and garbage cans
- Electronics
- Housings
- Knobs
- Outer shells
- Running boards
- Cowlings
- Bins
- Toolboxes
- Lumber
- Marine Decking
- Casings
- Conduit
- Posts
- Pipe
- Marine products
- Railroad ties
- Skid plates

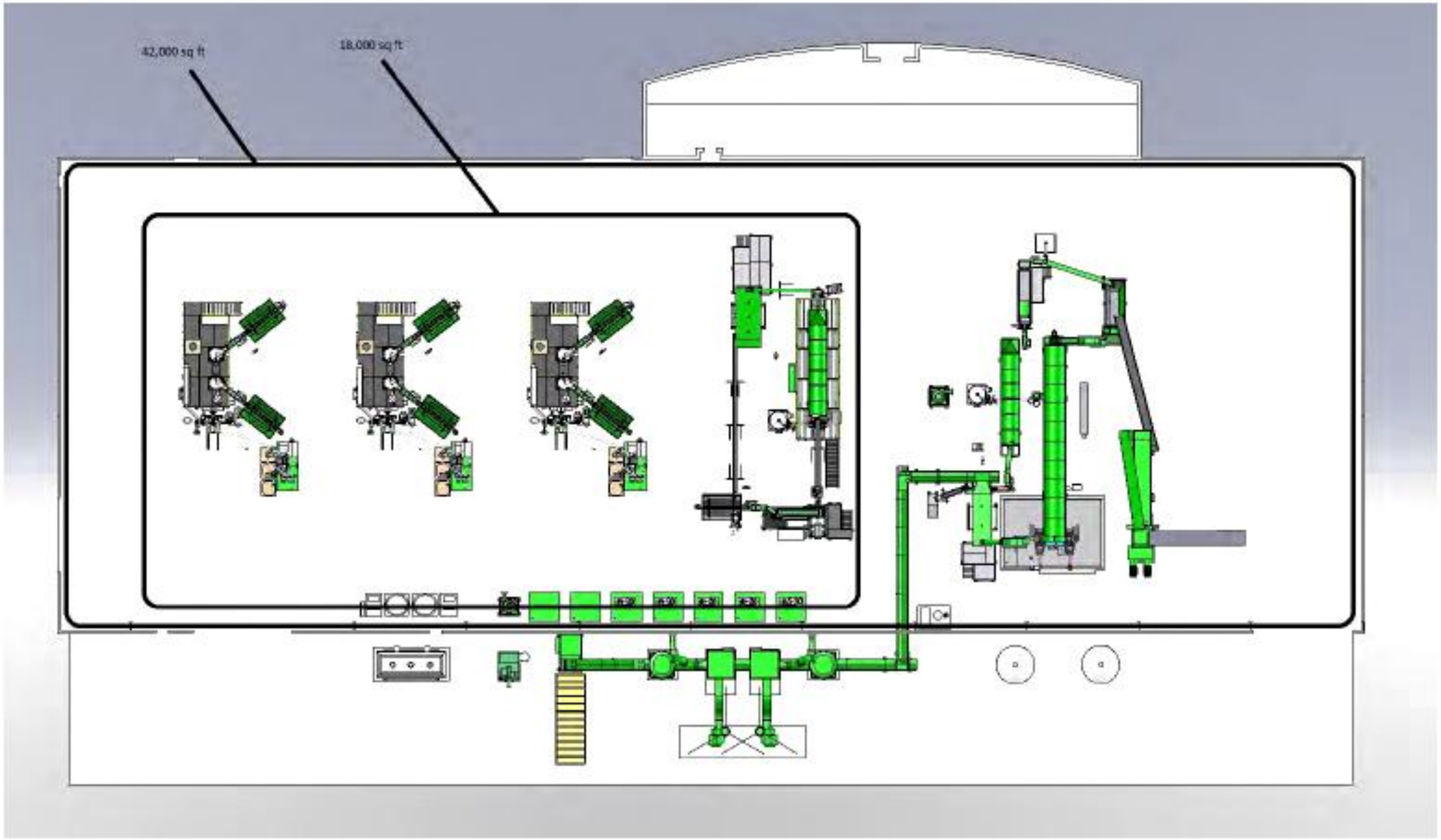
TPE Layout



3D model of an integrated Primary, Fine Mesh & three TPE blending lines



PlanView showing the square footage required for an integrated Primary, Fine Mesh & three TPE blending lines



Background

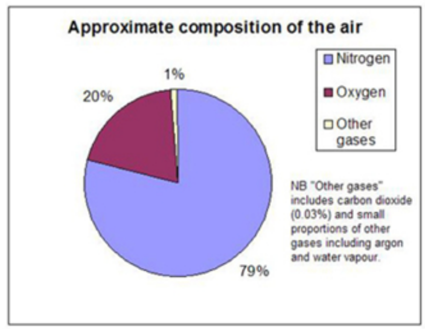
When broken down, a typical North American passenger tire consists of approximately 70% rubber, 22% fiber and 8% steel (by weight). All materials are considered to be "**non-hazardous**" by North American Standards.

Collection Systems

Fine material collected throughout the dust collection system consists of approximately 37 microns (0.037 mm) and finer dust. This dust is a combination of nylon/rayon tire fiber, trace amounts of very fine tire rubber and trace amounts of other dust collected throughout the process. Through timers on the dust collectors the fine dust is allowed to enter air locks which in turn transport waste material onto a conveying system into the compactor. Bag specification for exhausted air to the atmosphere from dust collectors is clean to 99.99% to two (2) microns (0.001").

Emitted Nitrogen

Immediately upon exposure to the atmosphere any liquid nitrogen (LIN) from either of the cryogenic systems reverts back to its gaseous state. Since LIN is derived through the process of compressing ambient air, which in turn is 79% nitrogen, any emissions from the system are simply discharged back to the atmosphere.



FCL Complete Primary Cryo Systems, Fine Mesh Cryo Systems, and Blending Units Operational Description

Shredding

- Shredder reduces whole tires or oversized shred, either car or truck, into smaller pieces of nominal size 7.5 cm and drops Shredded Pieces onto the Taper Slot Screener which separates and returns Oversize Pieces back to the Shredder and allows Correct Sized Pieces to continue to the Granulator Surge Hopper.

- The Shredder has hexagonal twin shafts, with removable Two (2) hook blades, powered by two (2) sixty (60) kw hydraulic motors turning at about Twenty-Two (22) rpm.

- These types of motors are extremely important in Processing Truck Tires which can require a very large amount of Torque to cut through them.

- The Shredder has its own Control Panel to monitor Power Usages.

Granulation

- The Large Granulator takes the properly sized shred from the Surge Hopper and reduces it from the nominal 7.5 cm size to a nominal two (2) cm size.

- At the same time this machine removes a large amount of steel and fibre.

- There is a Spark Detection System with this machine; as well as water supply should anything begin to catch fire.

- The Rotor on this machine turns at about 900 rpm, and the blades cut against a Stationary Bed Knife.

- The Granulator has its own Control Panel to monitor Power Usages and Temperatures.

- The Spark Detection System has its own Control Panel and also has its own Dust Collection System.

Hopper Feeders

- All Hopper Feeders or Surge Hoppers in the Primary System are of similar design.

- They have a Drag Chain to pull the material out of the Feeder at a Controlled

Rate determined by the Control Panel that controls that particular Feeder.

- It is powered by a Variable Speed Motor so that the Feed Rates can be increased or decreased as the situation demands.

- In other cases, the Drag Chain is replaced with an Auger, depending on the Material.

Freezing

- Liquid Nitrogen is injected into the Freeze Chamber at the Exit End of the Chamber.

- This Nitrogen Flow is Controlled by a Control Valve, which is in turn controlled by the Operator at the Control Panel.

- Liquid Nitrogen is stored outside of the building in large vertical insulated tanks at a pressure of approximately 4 bar.

- As Nitrogen continues to "boil" in the tank, any Excess Pressure Buildup is Exhausted to the atmosphere at top of the tank by a Pressure Relief Valve.

- The Pressure Relief Valve can be adjusted manually on the outside of the tank, which is usually not necessary to be done, unless the Tank Level has dropped to near empty.

- Nitrogen is produced by taking the air that we breathe and condensing the air in Compressors until it turns to a liquid.

- Air that we breathe is approximately 78% Nitrogen, the balance being mostly Oxygen (approximately 20%) and Argon (about 1%)

- At this point, the liquid is less than -196^{o}C.

- The Liquid Nitrogen boils at this temperature.

- When the Liquid Nitrogen is fed into the Freeze Chamber, it is sprayed onto the chips that have entered the Freeze Chamber about Fifteen (15) minutes prior to this point, and have been Pre-Cooled with the Gaseous Nitrogen that is drawn up the Freeze Chamber by a Fan.

- Once the Liquid Nitrogen has been sprayed on the chips near the Exit End of the Rotating Chamber, it boils off into a Nitrogen Gas, and at the same time expands about Seven Hundred (700) times.

- The Fan at the Entrance End of the Freeze Chamber pulls this gas along and through the chips that are moving down the Rotating Chamber from the Entrance to the Exit End.

- This Gas Exhaust, being mostly Nitrogen, is sucked through the Dust Collection System and Exhausted into the Air Exit to the Filter House, at some Ten (10) metres in the air.

- At the Entrance End of the Freeze Chamber there is an Air Lock which allows the rubber chips to enter the Freeze Chamber, but doesn't allow air into the Chamber nor Nitrogen to escape the Chamber.

  The Chamber itself is quite long and rotates on six (6) rubber wheels on a frame, and is driven by a Small Motor with a Chain Drive around the body of the Freeze Chamber.

  The interior of the Chamber is made of Stainless Steel, with Angular Flights welded to the inside so that as the Chamber turns, the rubber chips are shifted down the length of the Chamber, similar to a cork screw action.

  One thing to understand is that rubber goes into a glass state when it is frozen below about -80^{o}C.

  In this state it is brittle like glass, and so fractures very easily into many small pieces. The FCL Cryo Process, although typically @Patented-Pendings, is very Proprietary, and is the most efficient Cryogenic Process for whole tires in the World.

Fragmentation

- The frozen chips drop out of the Freeze Chamber into Two (2) Hammer Mills which by way of Steel Hammers, pulverize the frozen chips into millions of smaller pieces.

- This operation also allows for separation of the remaining steel and fiber from the rubber.

- The Tip Speed of the Hammers on the Rotor of the Mill is approximately Ninety-Eight (98) metres per second.

- Each Mill contains 96 Hammers made of Work Hardening Material, and each Rotor is powered by a 150 kw Electric Motor.

Separation

- The Primary Screener is used to separate the fiber from the steel and rubber.

- This is done on the Top Deck of the Vibrating Screen, as the rubber and most of the steel pass though the holes in the Top Deck to the Bottom Deck.

- The rubber and steel are passed over a Magnetic Belt Separator which magnetically separates the steel from the rubber.

- The Magnet in this Separator is a “Rare Earth” Magnet.

- The Drying Tunnel utilizes warm air from the Dryer Furnace to remove any excess moisture from the rubber.

- Fine Airborne Fiber is also removed at this point as the air blown over the rubber in the Rotating Dryer moves through the Dryer and takes the airborne dust to the Dust Collection.

- Rubber passes over a Rare Earth Double Drum Magnet Separator which removes Fine Steel Remnants.

- This Double Drum Magnet is made of Stainless Steel, which is not affected by the Magnets.

- The Crumb Rubber then passes to a Screener that is set up with three (3) Decks in order to accommodate the separation of the rubber crumb into different sizes.

- However, the main purpose of the Deck in this type of System is to remove any last bits of fibre that may be accumulated on the Screens.

- Since most of the rubber for this System set up is going to the Fine Mesh Cryogenic System, there is no need to separate the Rubber Crumb into separate sizes.

- Any Oversize Rubber larger than five (5)mm is returned to the Freeze Chamber to repeat the freezing and Fragmentation Process.

Dust Collection

- The Primary System from the Freeze Tunnel to Storage Silos is equipped with two (2) Dust Collection Systems which utilize a Vacuum generated in the two (2) Filter Houses to remove the dust created during the Process.

- One (1) Collection System removes the Airborne Fiber from the shaking and processing actions and the other Collection System draws mostly Nitrogen Gas (some air) through the Hammermills and the Exit End of the Freeze Chamber and exhausts it through the other Filter House.

- Each Filter House is preceded by a Large Cyclone that captures the heavier material and dispenses it onto the Scrap Fibre Belt.

- The movement of air through each Dust Collection System is about Two-Hundred-Eighty (280) M^3 per minute.

- The exhaust from each Filter House is at about Ten (10)M from the ground.

- The Filter Medium collects all particles larger than Two (2) microns in size.

` The Hammermills in the Primary System are the prime source of any sparks that may be generated, due to the presence of steel in the frozen rubber chips at this point.

However, with the suction of Gaseous Nitrogen out of the Freeze Chamber by this Dust Collection System (known as the Wet Collection System), and the absence of Oxygen in this air, the chance of fire is greatly reduced due to the high concentration of the LN2 in the Air Stream.

Primary Electrical Control System

- Controls for the Primary System including PLC and all Electrical Connections are contained in one (1) Electrical Panel.

- The Operator controls the Complete Primary Process from Hopper Feeder through to the Storage Silos using a Touch Screen Interface with the Electrical Controls.

- The whole Start Up and Shut Down Process is programmed into The System and is automatic.

- The System also has a “Kill” Button which shuts all Power Off to all of the equipment under the Command of the Operator.

Fire and Explosion Suppression

- All of the areas that could possibly generate sparks are monitored by a PLC Controlled Flamex System.

- Because of the importance of this aspect of the Complete Operation, all of this equipment will be installed by Flamex, as they know the local guidelines.

- Also included in this System is a Water Tank under the proper pressure and a Stand-Alone Water Pump to ensure that water is available to douse any sparks that might be generated and to maintain the proper pressure in the Spark Detection System.

Noise Suppression

- It is understandable that in this type of Industrial System, some of the components generate a significant amount of noise.

- In order to keep the noise generated at a safe level, the pieces of equipment that generate the major part of the noise will be housed underground with an Insulated Cover over them (Primary System Hammermills).

- All noise levels will be muffled to an acceptable level for local laws.

Fine Mesh Cryo System:

- The first step in the Fine Mesh Cryo System is a Surge Bin that is fed from the Storage Bin that has been filled by the Primary Cryogenic System.

- The material is clean and dry and is of the size of four (4)mm down to 0.6mm.

- This Hopper Feeder will Metre the Rubber Crumb into the Fine Mesh Cryo Tunnel at a Rate Controlled by the Control Panel, to match the Production Capability of the Fine Mesh Hammermill.

- The Fine Mesh Cryo Freeze Chamber is next, and is a Stainless Steel Insulated Tunnel of approximately Fifty (50)cm outside diameter, with a Screw Auger moving the Rubber Crumb down the length of the Tunnel.

- There are Three (3) Liquid Nitrogen Nozzles fitted on the top of the Tunnel, which sprays Liquid Nitrogen (LN2) onto the Rubber Crumb as it passes down the length of the Tunnel.

- At the end of the Freeze Chamber, the material goes through a Stainless Steel Airlock, and into the Single Hammermill.

- There is also an Airlock at the Exit to the Fine Mesh Hammermill.

- This is necessary to keep the Nitrogen in the Hammermill that has been Injected there to keep the material Cold.

- The Hammermill is the Workhorse of the System.

- It is connected by Direct Drive to a Variable Speed Motor that will be approximately Two Hundred Fifty (250) kW.

- The Speed of the Mill is controlled through the Control Panel, and can be adjusted as necessary to obtain the proper size of Rubber Crumb desired for the Blending Operation.

- There is also LN2 Injected into the Mill, again to manage the Size of the Rubber Crumb being Produced.

- More LN2 will reduce the Size of the Rubber Crumb, and also, More Speed in the Hammermill will reduce the Size of the Rubber Crumb.

- The Hammermill has a Screen in it, and the Size of the Holes in The Screen affect the size of the Rubber Crumb Produced, as well as the Throughput Capability of the mill.

- From the Mill, the Rubber Crumb is transported to a Dryer, that is Heated by a Furnace.

- When the Rubber Crumb is still Frozen or nearly frozen coming out of the Hammermill, condensation forms on The Crumb, and when Crumb is wet, it sticks together.

- The Dryer removes the Moisture so that The Crumb will Flow out of the Storage Bin and also so that there is no Moisture going into The Blenders.

- From the Dryer, the material flows over a Double Drum Rare Earth Magnet to remove any remaining Steel Particles.

- After the Magnets, the Crumb is introduced onto a Screen, that removes any material that is still larger than Six Hundred (600) microns, and returns it to the Hopper Feeder at the start of this system for refreezing and further size reduction. This ensures that the material going to the blenders is all smaller than 600 microns.

- All of the smaller than Six Hundred (600) micron sized material is then sent to a Storage Bin ready to be fed to the Blending Systems.

- This movement of Crumb to the Storage Bins will be done by Pneumatic Transport.

- A Control Panel monitors the many aspects of this part of the Operations, such as the Feed Rate of Material, Power Usages of The Mill, Temperature of The Mill, LN2 Rate, and Dryer Temperature.

- It also Monitors the Amount of Material in the Storage Bin at the End of The Process.

BLENDING:

- Typically there are Three (3) Blenders which in effect are Twin Screw Extruders.

- These Extruders are set up using the FCL Blending Technologies that has been Registered for Patented Process - and is also Patent Pending.

- The First (#1) Stage of the Blending Operation is that each Blender will have an Initial Material Storage Bin, one (1) for Rubber Crumb, and one (1) for Recycled Plastic.

- Rubber and Plastic is automatically drawn from these Holding Bins into a Loss of Weight Feeder for each of the Feeders.

- These are very accurate Feeders, that Meter these materials into the Extruder.

- The Plastic is Fed into The Extruder at the First (#1) Barrel, and the Rubber Crumb is fed into The Extruder at the Fifth (#5) Barrel.

- All of this Metering of the material is Controlled Automatically through the Control Panel at Each System.

- The Blender (i.e. Twin Screw Extruder) is Powered by a Four Hundred Fifty (450) kW Variable Speed Motor, that will Power a High Speed Gear Box, that will turn the Screws of The Extruder to up to Nine Hundred (900) rpm.

- Each Extruder will Process a Total Throughput of 2000 kg per hour.

- The Blender has Thirteen (13) Barrels, with a Relief Vent at Barrel #Twelve (12) in order to let any Moisture in the Process then Escape.

- Each barrel is Heated Individually by Electricity and Each Barrel is also Connected to a Chiller that can Cool the barrel.

- Processing this material generates Heat in the barrels, and the heating and cooling keeps the temperatures Constant and at the Proper Temperatures for Optimum Processing throughout the length of the barrel.

- At the end of The Extruder, there is an Underwater Chiller.

- The Blended Material is Extruded out The End of The Extruder through a Die Plate, and there is a Knife that Rotates Rapidly on the Die Plate to Cut-Off the Extruded Material as it Enters the water passing by, so that Pellets are Formed, which is the form of the End Product.

- The water is being pumped through the pipe where the Pellets are cooled, and then dropped into a Centrifuge which separates them from the water, and dries The Product at the same time.

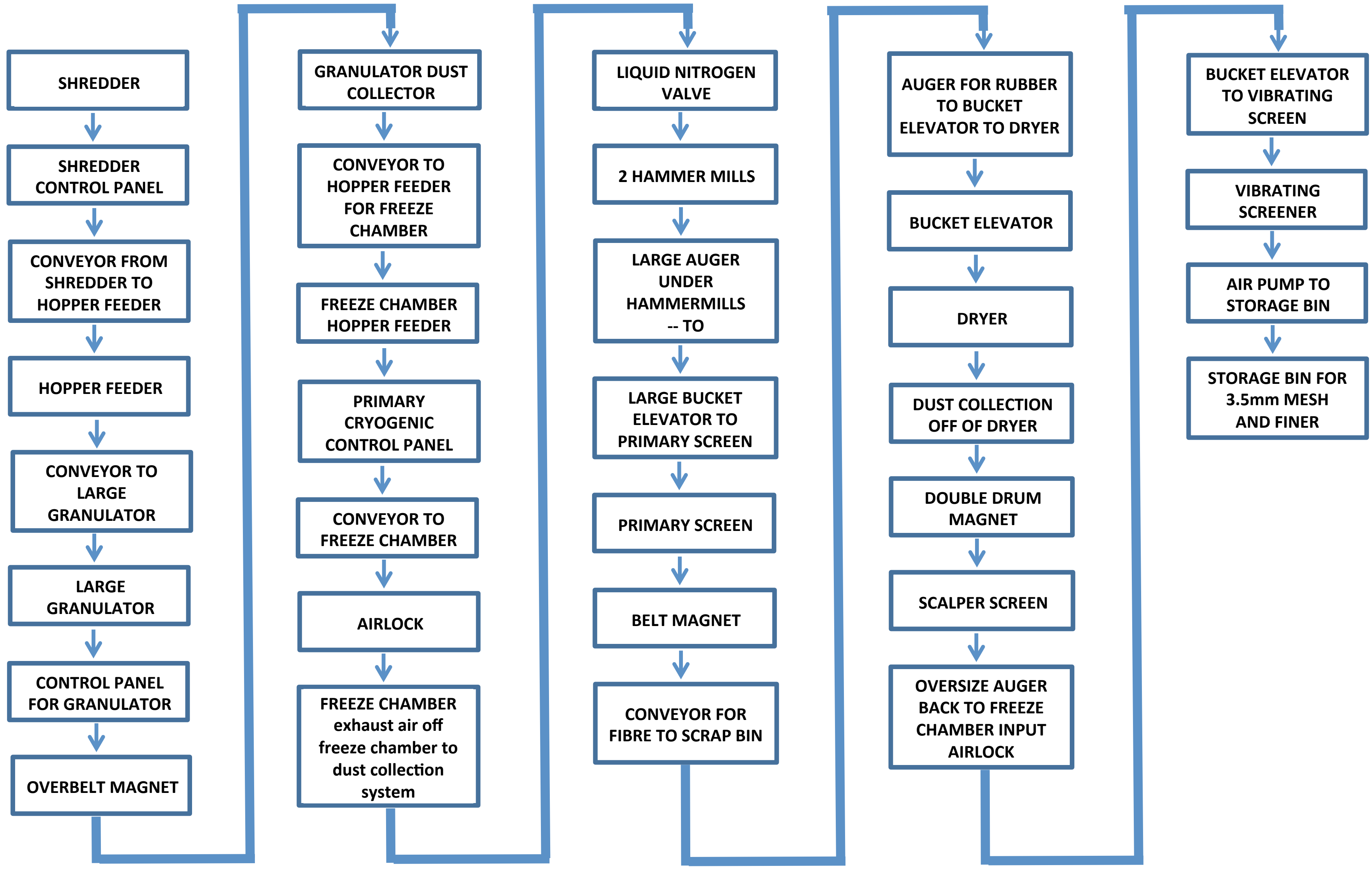
- The Finished Product is then Ejected from The Dryer, and Loaded into a Bag for Shipping to the End Customer.

- All of the Blending Operation is Monitored/Directed through a Control Panel that manages/Monitors/Directs the Feed Rates, The Temperatures, the Processing Speed, Power Usages, Temperature of Water in The Chiller as well as Temperature in The Pelletizer.

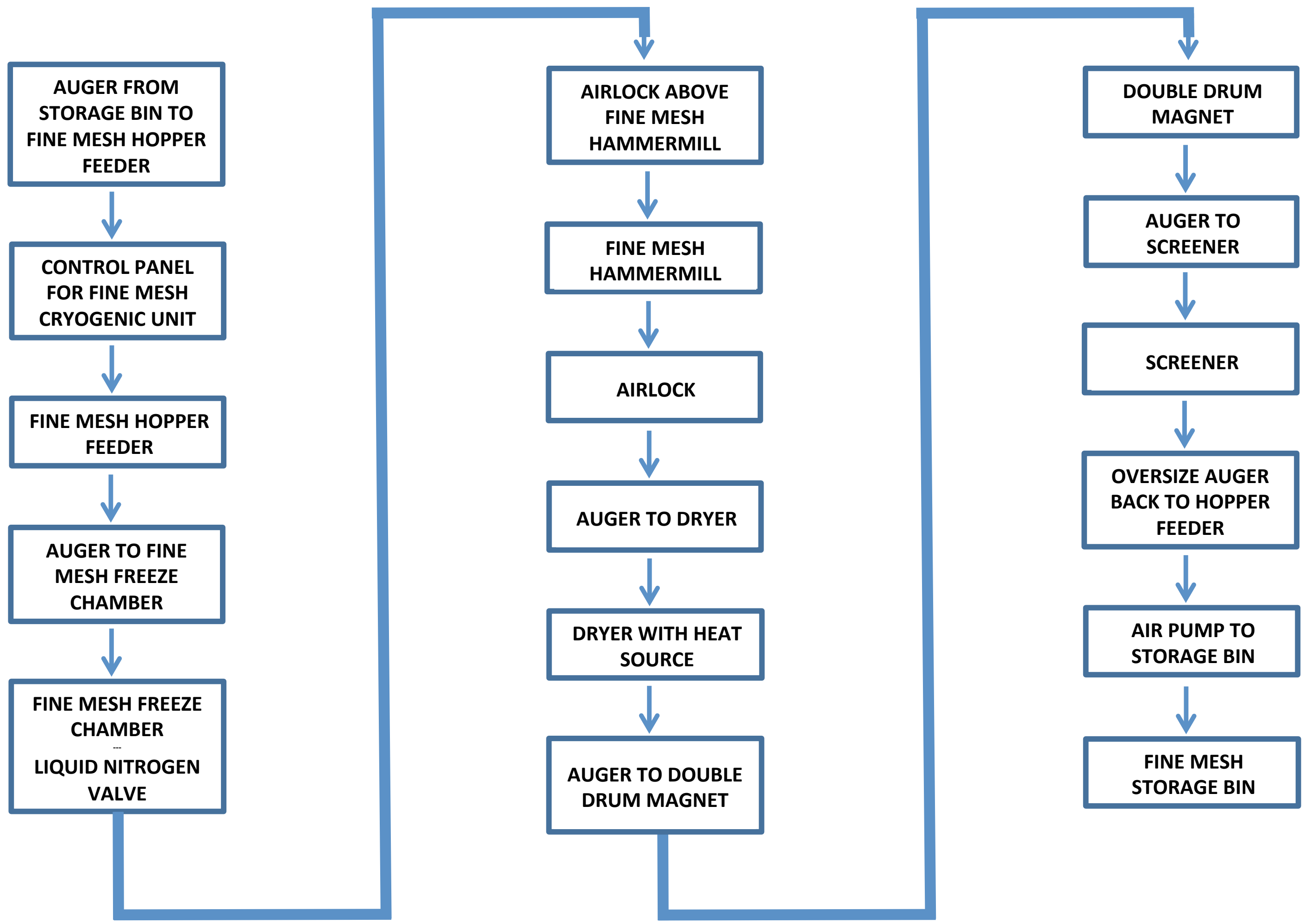
- Gear Box Temperature is also Monitored.

- Rubber/Plastic Ratios are also monitored and controlled.

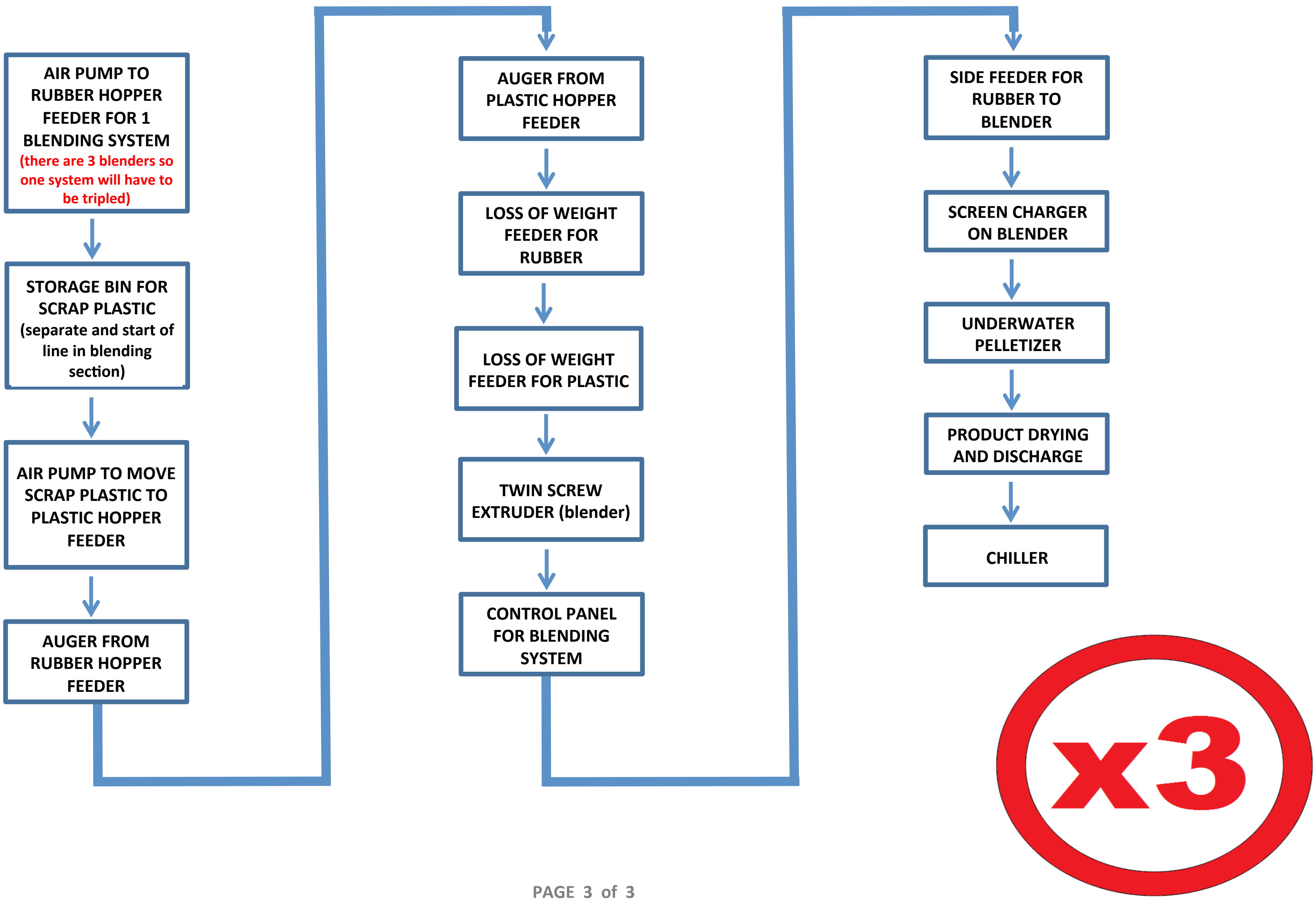
PRIMARY CRYOGENIC SYSTEM



FINE MESH CRYOGENIC SYSTEM



BLENDER SYSTEM - 3 BLENDERS SIDE BY SIDE

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