

# International Process Plants

*IPP Stock #600310*

## 600,000 TPY PET FACILITY

- 250,000 TPY PET “Bottle” Resin
- 250,000 TPY PET Fiber
- 100,000 TPY PET Amorphous



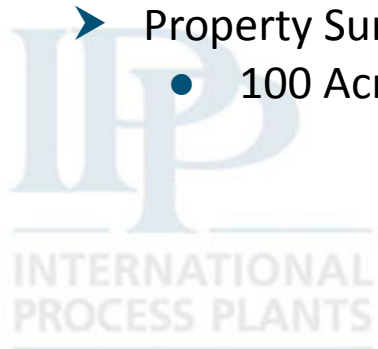
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# Highlights

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- **600,000 TPY** Total Plant Capacity Consisting Of:
  - 250,000 TPY PET “Bottle” Resin (*Lines H9, H10, H12*)
  - 250,000 TPY PET Fiber (*Lines H1 – H7*)
  - 100,000 TPY PET Amorphous (*Lines H8, H11*)
  
- Site Features:
  - 700 ton/day Polymer In (3) Lines Expandable to 850 tons/day
  - Fully Serviced By Rail
  - On-Site Rail Spur Capable of 200 Car Storage
  - Over 100 Silos (18MM lbs. Total Storage)
  - Easy Access to (2) Major Interstates
  - Low Cost Electrical Supply and Natural Gas Available
  
- Property Summary:
  - 100 Acres within Fence (Part of IPP Owned 760 Acre Industrial Park)



# Highlights

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- Products Produced:
  - Fiber Grade PET - 500 MM lbs/yr
  - Bottle Grade PET – 500 MM lbs/yr
  
- Available Lines:
  - (3) Central Monomer Plants – 150,000 lbs/hr (total)
  - (7) Staple Continuous Polymerization (CP) – 63,000 lbs/hr polymerization
    - Includes Spinning Lines
  - (5) Bottle Resin Continuous Polymerization Chip Lines – 92,000 lbs/hr
  - (3) Solid State Polymerizers (SSP) – State of the Art
    - (2) Bühler Plants – Built 1994, Rated 150 mtpd each
    - (1) Bühler Plant – Built 1997, Rated 300 mtpd
    - SSP Chip Feed and Storage System
    - (3) CP Lines Match the Capacity of the (3) SSP Plants





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~100 acres within manufacturing fence line.  
~1.1 mm sq. ft. under roof



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# **PET Plant Process Overview**



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# Process Description

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This facility manufactures amorphous PET resin, PET bottle chip, and polyester staple.

This plant uses a continuous process to produce polyester staple fiber and chips with the basic raw materials being ethylene glycol, Terephthalic acid and a catalyst. Production is maintained by three separate monomer trains located in Building H. The monomer trains feed (12) Polymer lines.

There are several ducts on various roofs that are insulated with polyurethane insulation. Polymer lines 1–7 produce approximately 500MM lbs/yr of polymer used in the production of polyester staple. Polymer lines 8–9 produce approximately 145MM lbs/yr of amorphous polymer.

Polymer line 8 produces amorphous chip for use in fiber production. Line 8 is currently shutdown and is to be converted to produce amorphous chip for bottle resin. Polymer line 9 currently produces amorphous resin for bottle chip; however, this line is rarely run due to limited capacity in the SSP Plant.

Polymer lines 10–12 produce approximately 500MM lbs/yr of polymer with approximately 420MM supplying the solid state polymerization process and approximately 80MM being sold to an outside customer.



# Process Description

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## Polymer Production

The chemical process to produce polyester from ethylene glycol and terephthalic acid is done in (3) separate monomer trains of continuous process equipment located in Building H.

The ethylene glycol and terephthalic acid are pumped into the primary esterifier which is heated by an HTF (heat transfer fluid) jacket to about 260°C at 40 psig pressure. The vessel is provided with a rupture disc and a relief valve in series. The mixture is continuously agitated and the small amount of water formed during the reaction is removed. This is an endothermic reaction. Excessive vibration switches and alarms are provided. The material (bis-hydroxy ethylene terephthalate, BHET) is pumped to the secondary esterifier, which operates at 3 psig at about 275°C with a HTF jacket. The excess unreacted ethylene glycol is boiled off, vapors condensed and recovered. The BHET monomer is transferred to one of (12) polymer lines. There are cross connections after the esterification process to allow each esterifier line to feed any of the polymerization lines.

Polymer lines 1–12 each begin with a low polymerizer (LP) which operates under a slight vacuum at 295°C. Ethylene glycol and off gas are removed from the LP vessel by steam jet vacuum and piped to the glycol recovery unit in the yard. For polymer lines 1–7 the in-process polymer is transferred to a high polymerizer (HP) which operates at 290°C under a vacuum with off gas being condensed in the steam jet vacuum system and then sent to glycol recovery. The (2) polymerizers are mounted horizontally on concrete pillars.

# Process Description

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## **Polymer Production** *(cont.)*

The polymer then flows to an extruder, which increases the pressure to 400 psi to feed a manifold of spinnerets. These (7) polymer production lines feed spinning machines for staple production. Polymer lines 8 – 12 have an intermediate polymerizer between the high polymerizer and the low polymerizer. The intermediate polymerizer operates in the same way as the LP and HP except the operating temperature and pressure is between the temperature and pressures used on the LP and HP. On these lines the polymer is pumped through spinnerets which produce strands of polyester, which are cooled in a water bath.

The strands are chopped, then conveyed pneumatically to silos in the yard for storage and then either further processed in the solid state polymerization or processed through a crystallizer prior to being stored in silos prior to shipment. The crystallizer is a heated oven that the pellets pass through on a conveyor to alter their intrinsic viscosity and enhance their molding properties. From the crystallizer the pellets are pneumatically conveyed to storage silos for bulk shipment by road mainly to another plant.

The remainder of the pellets passes through a series of pre-crystallizers, similar to crystallizers, prior to being pneumatically conveyed to the solid state polymerization plant.



# Process Description

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## Staple Fiber Production

From the extruders, molten resin is fed to a total of (7) fiber spin beams in Building H. Each spin beam has a total of (24) spin packs, which are heated using the heat transfer fluid system. The spin packs are dies with many small holes and each pack receives a metered supply of polymer paste, which is forced through the holes to form fiber strands of the proper size. The strands of polymer paste then fall by gravity to a take up unit. As the strands fall they are air cooled and a spin finish is applied. The fibers are then gathered together to form a tow band which is then transferred to creel cans in Building J to await further processing.

The tow bands are then pulled from the creel cans and routed overhead to draw machines where it is heated, washed, and stretched. The tow is crimped, and then deposited 1" to 2" high on a metal conveyor and passes through a steam-heated oven. The tow is cut to the desired length on a rotary cutter and then pneumatically fed into a bale press. The bales are transported by automatic conveyors to Building W.

Sprinkler protection in Building J is designed to provide 0.20 gpm/sq. ft. over 3,000 sq. ft. The spin pack and quench section of Building H are provided with hose station for manual fire fighting and no automatic sprinkler protection.



# Process Description

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## **Solid State Polymerization (SSP)**

The SSP process takes place in the SSP Building. There are (3) SSP production lines in this area. Chip from the amorphous chip silos is transferred to feed bins for the SSP process. The SSP process involves heating the chips with hot air and nitrogen to increase the polymer chain length and to remove impurities.

The chip is first fed into a pre-crystallizer feed silo then is metered into the pre-crystallizer where the chip is heated to approximately 150°C with a chip residence time of approximately 15-minutes. The chip is then fed into the crystallizer where the chip is heated to approximately 185°C with a residence time of approximately 30-minutes. Both the Precrystallizer and the crystallizer are heated using steam-heated air.

The chip is then fed into the preheater feed hopper and then to the pre-heater where the chip is heated to approximately 220°C and has a residence time of approximately 8-hours.

The chip is then fed into the reactor feed hopper and metered into the reactor. The reactor maintains a temperature of approximately 200°C with a residence time of approximately 18-hours. The pre-heater and reactor use hot nitrogen to heat the chip. The chip is then cooled in a product cooler. The finished product (polyester bottle chip) is pneumatically conveyed from the SSP plant to outside storage silos. From the storage silos the bottle chip is shipped, mainly for the production of PET bottles, in bulk via road or rail.



# Process Description

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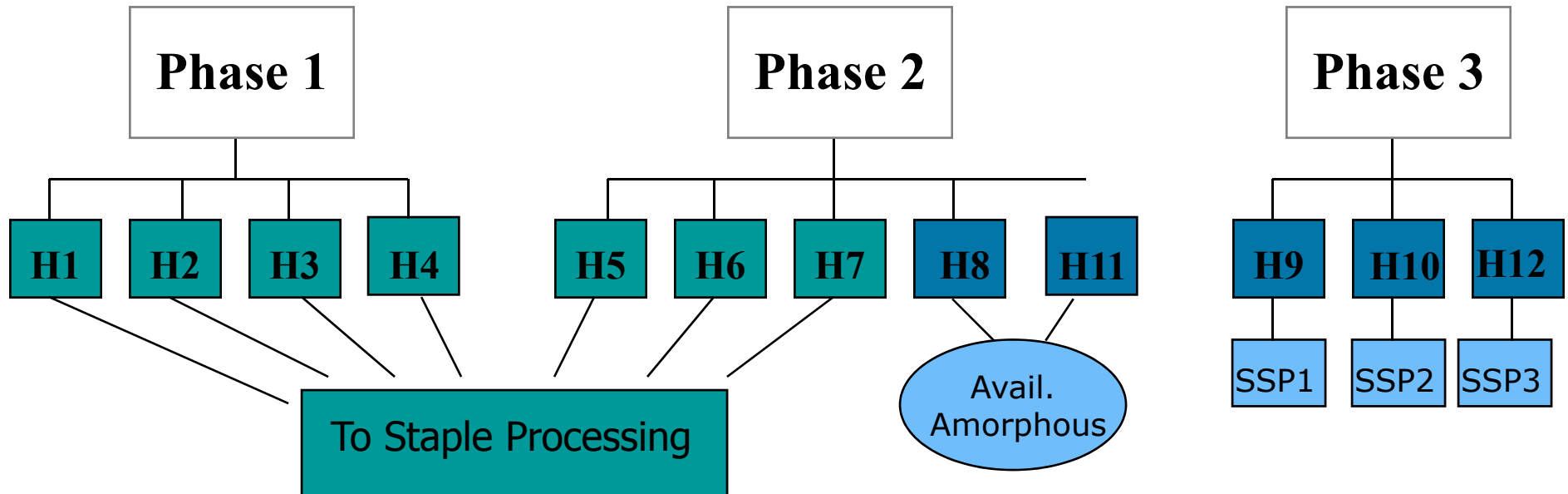
## **Solid State Polymerization** *(cont.)*

The nitrogen gas used in heating the chip in the preheater and reactor has to be cleaned prior to being reused in the process. In the process, a certain amount of water vapor is created in the nitrogen gas stream, which is removed in platinum bed reaction scrubbers. Air is introduced in this stage and nitrogen and oxygen leave the platinum bed reaction scrubber. The oxygen in this gas stream must be removed prior to reusing the nitrogen in the gas stream.

To remove the oxygen, a small amount of hydrogen is fed into the nitrogen gas stream prior to going through a palladium catalyst bed scrubber. The hydrogen supply is automatically shutdown upon hydrogen detection. Gaseous hydrogen is fed to the process from bulk gaseous hydrogen trailers to the process at a very low flow rate. The first floor area where hydrogen is used is open-sided, has LEL detectors and classified electrical equipment. There is no heat transfer media used in this building. Due to minimal combustible loading, sprinkler protection is not needed in this area. An automatic carbon dioxide gaseous protection system is provided beneath the raised floor in the SSP control room.

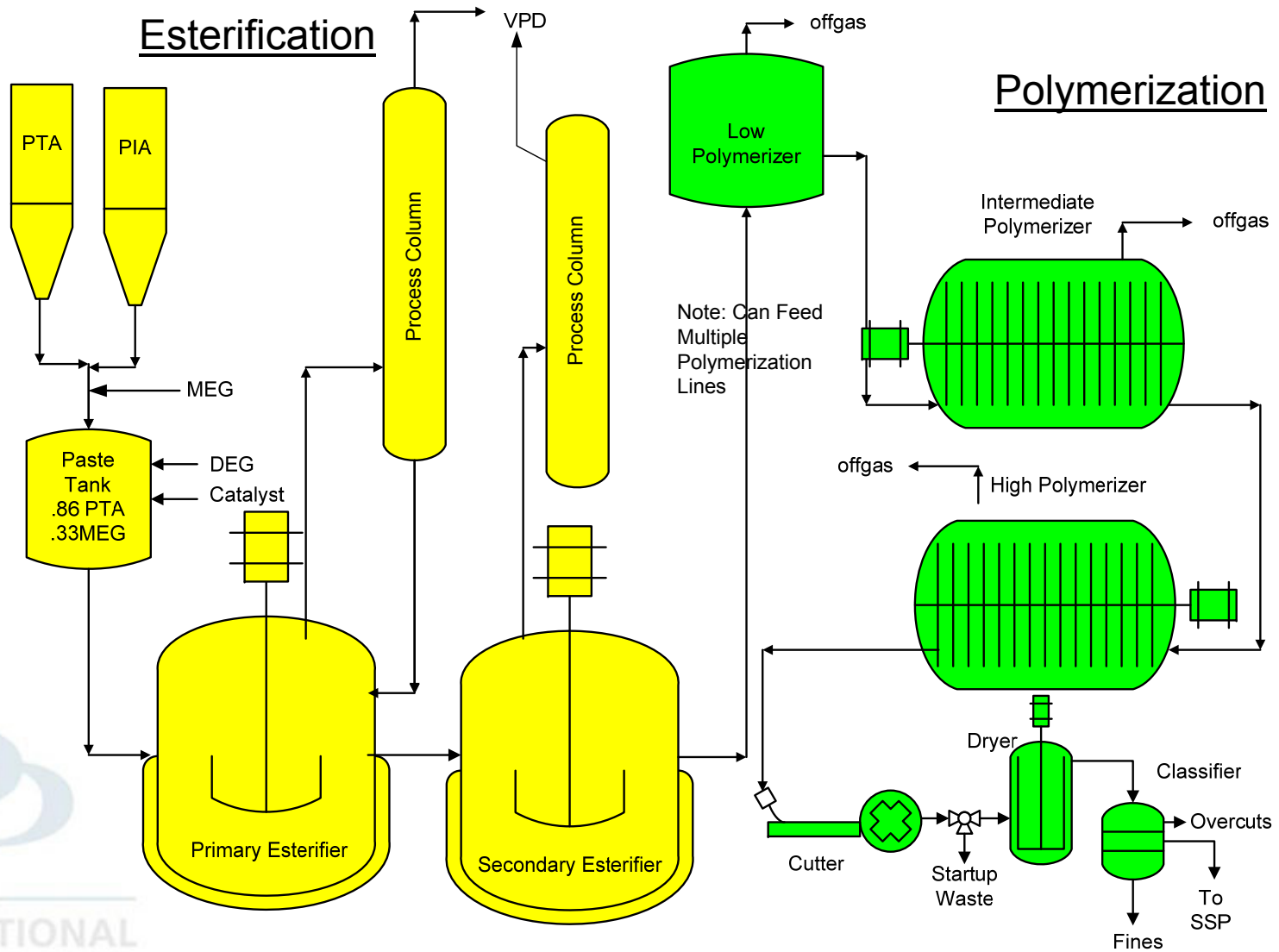


# PET Plant Process Layout

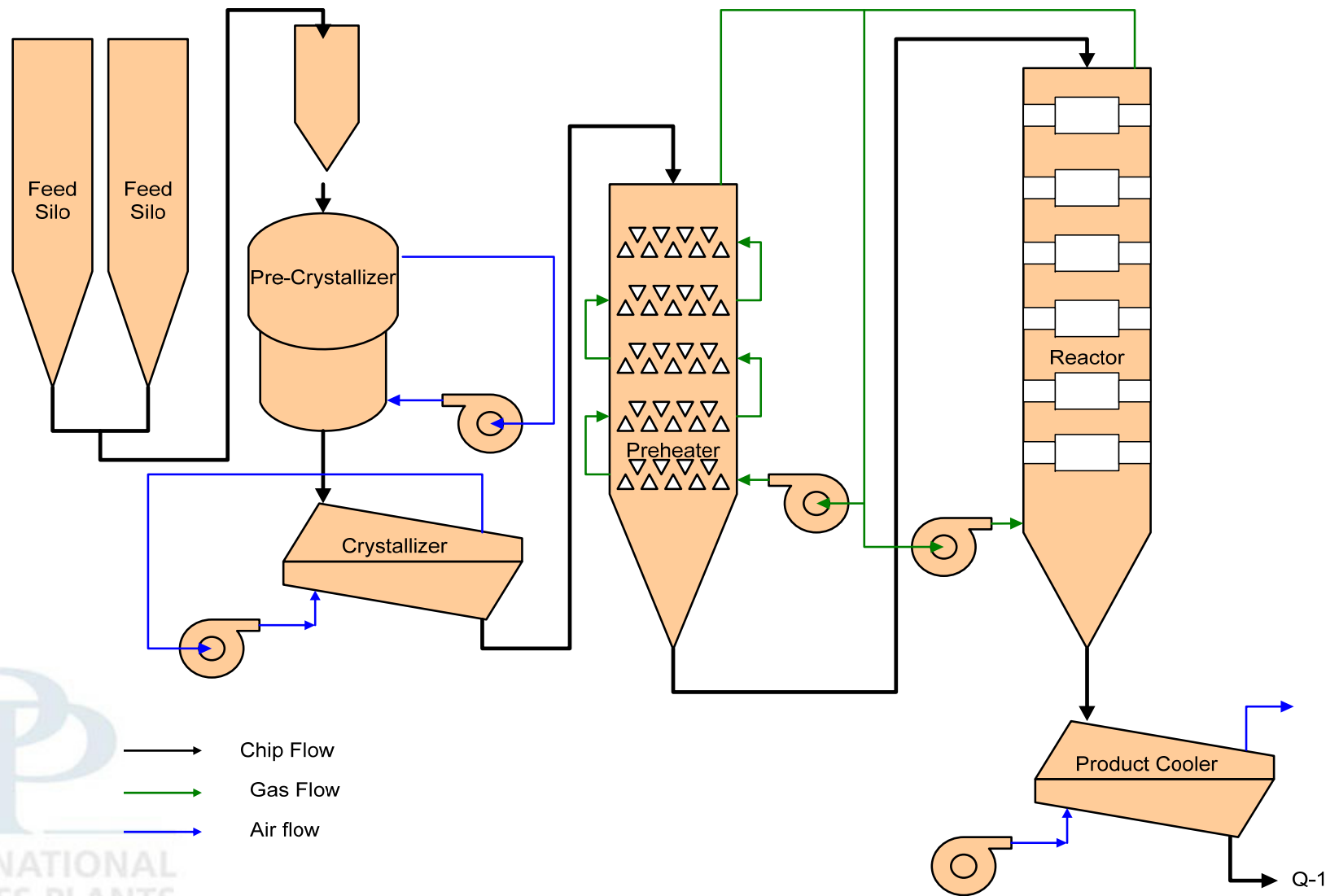


- **Three Central Monomer Plants**
- **Seven Staple Continuous Polymerization (CP) Spinning Lines**
- **Five Bottle Resin Continuous Polymerization Chip Lines**
- **Three Solid State Polymerizers (SSP)**

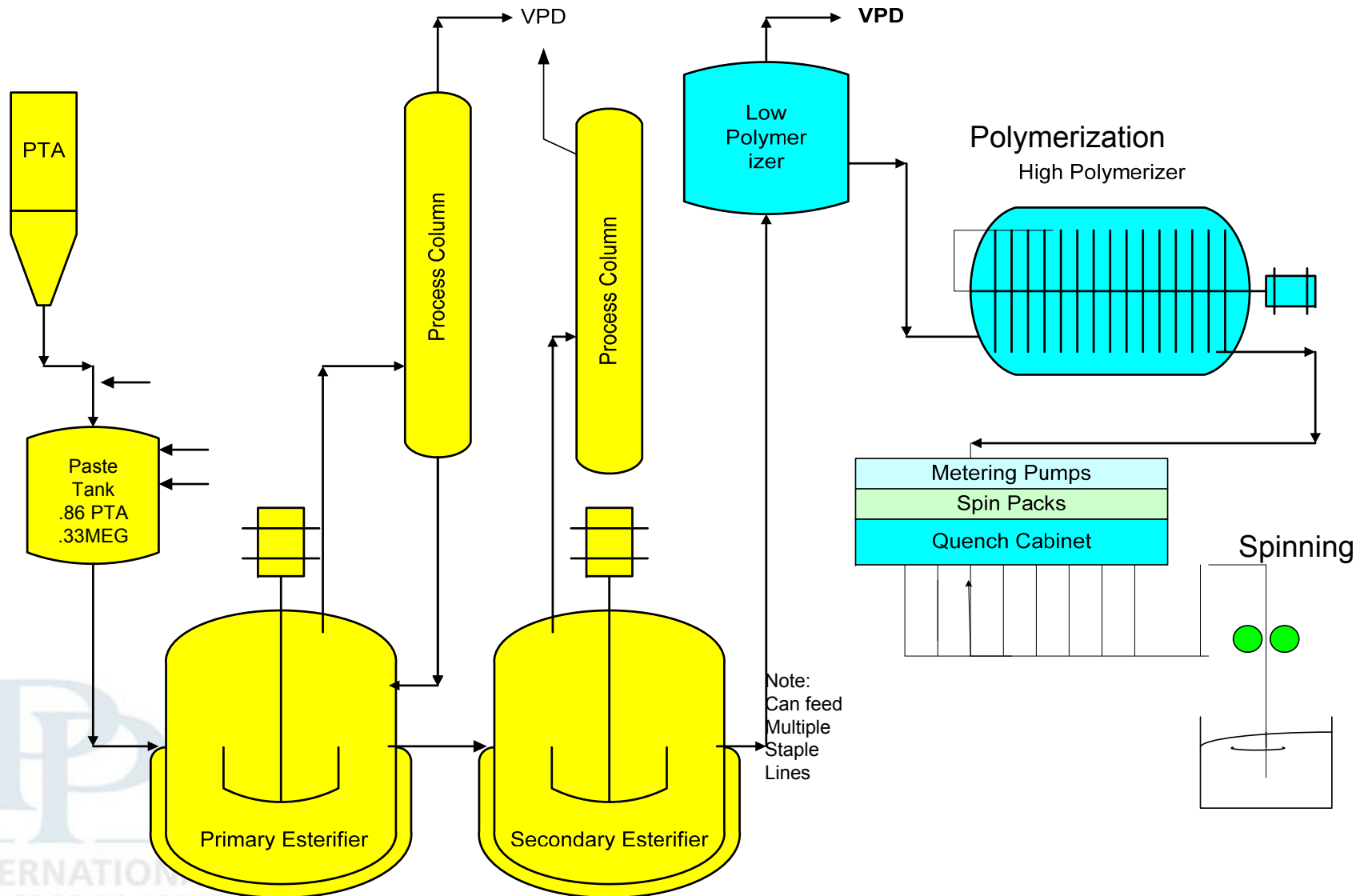
# PET Resin Melt Phase



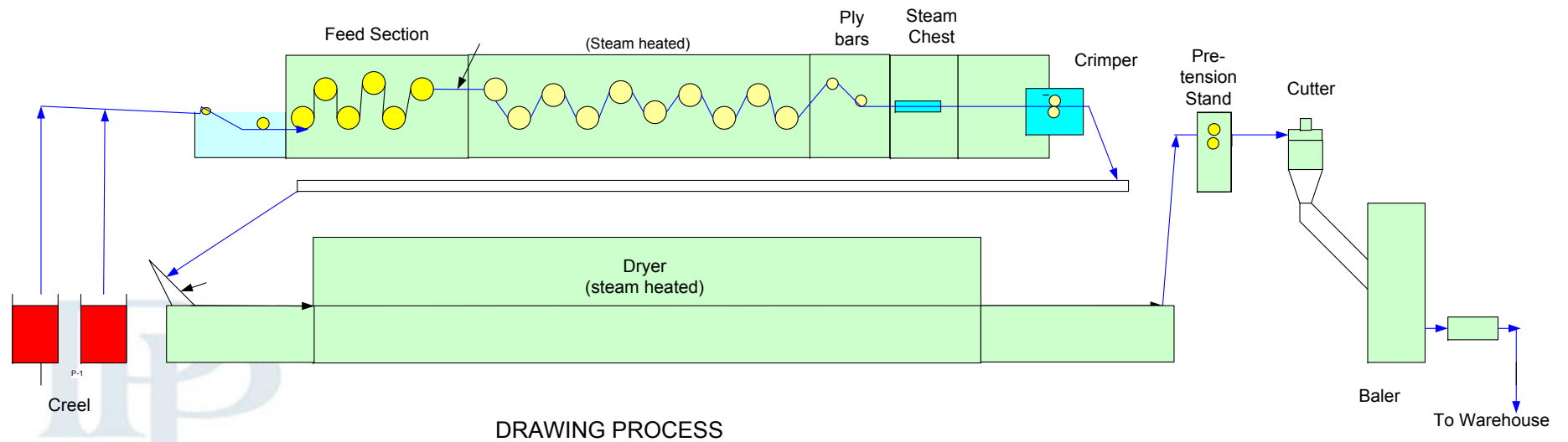
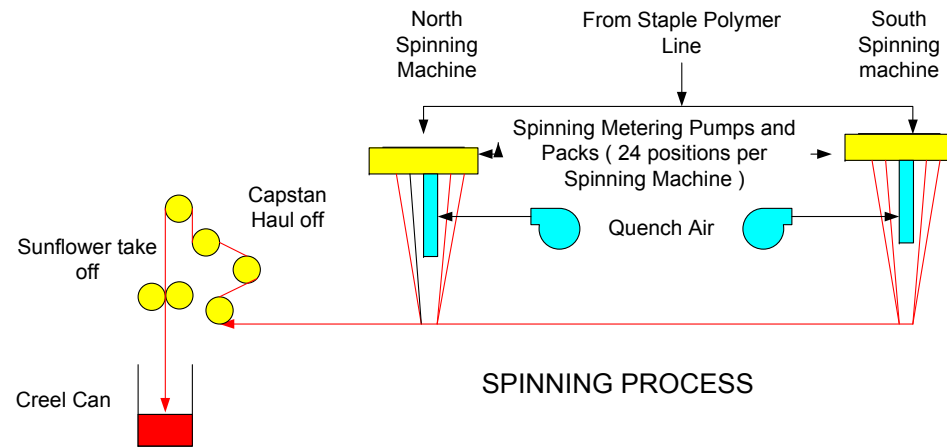
# Solid-State Polymerization



# Staple Melt Phase



# Staple Processing





# **Asset Description by Production Line**



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# PET Plant Major Assets

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## Utilities

- (4) Steam Boilers: 100,000 lbs/hr @ 315 psig
- (6) DOWTHERM Fluid Heaters: (5) 35 million btu/hr input and (1) 50 million btu/hr input
- (5) Chillers: (1) 2,300 tons and (4) 1,500 tons
- (5) Air Compressors: (4) 3,000 icfm and (1) 7,000 icfm (all compressed air dried)
- (7) Cooling Towers: 10,000 gpm flow each
- (1) Glycol Recovery Unit
- (4) Deep Wells for Process Water (300 to 500 gpm each)
- (7) Sand Filters for Process Water
- (6) Deionizer Units for Finish / Additive Makeup Water
- (1) 750,000 gal/day Activated Sludge Waste Water Plant and (1) 1 million gal Emergency Holding Tank
- Esterfication and Paste Mixing Completely Installed
- 36ME Heavy Duty Grid Connected Electricity (Dual Feed Protection)
- Raw Materials Handling and Infrastructure

*Note: Boilers and DOWTHERM Heaters are Switchable between Natural Gas and Fuel Oil*

# PET Plant Major Assets

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## Manufacturing

- Esterification
  - (3) Primary Esterifiers (FII Design)
  - (4) Secondary Esterifiers (FII design)
- Resin Polymerization
  - (1) 2-Vessel Polymerization line (FII design) for resin production (idle)
  - (2) 3-Vessel Polymerization lines (Hitachi design) for resin production
  - (1) 3-Vessel Polymerization line (ICI – design) for resin production (idle)
  - (1) 3-Vessel Polymerization line (Zimmer design) for resin production
- Staple Polymerization
  - (7) 2-Vessel Polymerization lines (FII design) for staple production
- Solid Stating Polymerization
  - (2) Bühler design 150 mtpd SSP units
  - (1) Bühler design 300 mtpd SSP unit

# PET Plant Major Assets

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## Manufacturing (continued)

### ➤ Spinning

- (14) outflow quench spinning beams with 24 positions each (FII design)

### ➤ Drawing

- (6) 2mm Denier single stage drawlines ( FII design), Neumag crimpers, Lummus cutters and balers.
- (9) 3mm Denier single stage drawlines ( FII design), Neumag and Fleissner crimpers, Lummus cutters and balers
- (2) 3mm Denier single stage Drawlines (FII design), Neumag crimpers, Lummus cutters, Autefa baling system

# Stated Max Process Equip-Instantaneous Cap.

## Esterification (Monomer)

Primary Esterifier 1	40,000 pph
Primary Esterifier 2	40,000 pph
Primary Esterifier 3	70,000 pph
Secondary Esterifier 1	40,000 pph
Secondary Esterifier 2	40,000 pph
Secondary Esterifier 3	45,000 pph
Secondary Esterifier 4	70,000 pph

## Melt Polymerization (Staple Polymer) @ stnd IV

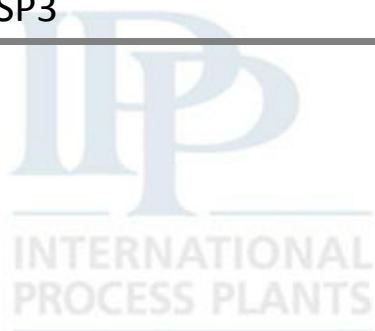
Polymer Line H1 - Staple	8,707 pph
Polymer Line H2 - Staple	8,006 pph
Polymer Line H3 – Staple	7,800 pph
Polymer Line H4 – Staple	8,500 pph
Polymer Line H5 – Staple	9,200 pph
Polymer Line H6 – Staple	9,984 pph
Polymer Line H7 - Staple	9,984 pph

## Solid State Polymerization (SSP)

SSP1	14,000 pph
SSP2	14,000 pph
SSP3	31,000 pph

## Melt Polymerization (Resin Polymer)

Polymer Line H8-Resin (down)	9,300 pph
Polymer Line H9-Resin	14,000 pph
Polymer Line H10-Resin	14,000 pph
Polymer Line H11-Resin (down)	24,000 pph
Polymer Line H12-Resin	31,000 pph



Legend: pph = pound per hour

# PET Plant Major Equip. Assets

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## Logistics

### Staple Fiber Storage

4 million lbs in flat warehouse  
21 million lbs in automated warehouse facility

### Resin Storage

4 million lbs amorphous chip storage  
4.3 million lbs of SS chip storage  
9 million lbs of unused chip storage  
(F area)  
Space for 60 RCs

### Resin Load Out Facilities

(13) Truck shipping bins  
(2) Rail automated rail load facilities  
(8 RCs/day capacity)

### PTA Storage

5.4 million lbs of silo storage  
(2) Automated unloading stations  
(14 RCs/day capacity)  
Space for 64 RCs

### MEG

1.3 million gallons of tank storage  
(9) Aluminum and SS tanks  
Rail and truck unloading capabilities  
Space for 23 RCs

### Miscellaneous

(3) locomotives on site  
(260) offsite railcar storage spots

### Chip Bagging

Contracted offsite

# Process Control Technologies In Use

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- Utilities – SqD PLC, AB PLC, AC Combustion Control, Moore Controls
- Monomer – Foxboro I/A DCS, RTP DCS
- Polymer – Foxboro I/A DCS, Foxboro Spec 200
- SSP – SqD PLC, RTP DCS
- Spinning – SqD PLC, Foxboro DCS
- Staple – Foxboro I/A DCS, AB PLCs
- Services – SqD PLC



# Assets Off Book for Impairment

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- H11 Polymerization Line
  - Could be re-started for business opportunity (\$500m+)
- H8 Polymerization Line
  - Could be re-started for business opportunity (\$350m+)
- J17 and J18 Sands Balers





# Maintenance



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# Reliability Programs

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## ➤ Predictive Maintenance

- Oil Analysis
- Vibration Analysis
- Steam Trap Program
- Infrared Thermography
- Ultrasonic Testing
- NDT Program
- RTX database for condition monitoring
- Barcode Scanning for process and equipment information

## ➤ Preventative Maintenance

- Scheduled PMs with metrics for effectiveness
- OptiAlign Laser Alignment
- Dedicated Lubrication Mechanics/Routes
- RCA (Root Cause Analysis)
- Routine information sharing with Pearl River Plant

## ➤ Personnel

- Certified Vibration Technicians
- Certified Thermography Technician
- SMRP Certified Reliability Staff

# Major Asset Turnaround PM Schedule

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- Monomer Plants – 7-9 yrs
- Staple Polymer Lines – 5-6 yrs
- Resin Polymer Lines – 3 yrs
- SSP Lines – 3 yrs
- Drawlines – Major PM @ 5,000 run hrs.
- Boilers and HTM Heaters – Annually
- Air Compressors – Quarterly
- Chillers – Annually
- Inert Gas Compressors – 5,000 run hrs.
- Cooling Towers – 2 yrs.



# Staple and Resin Products

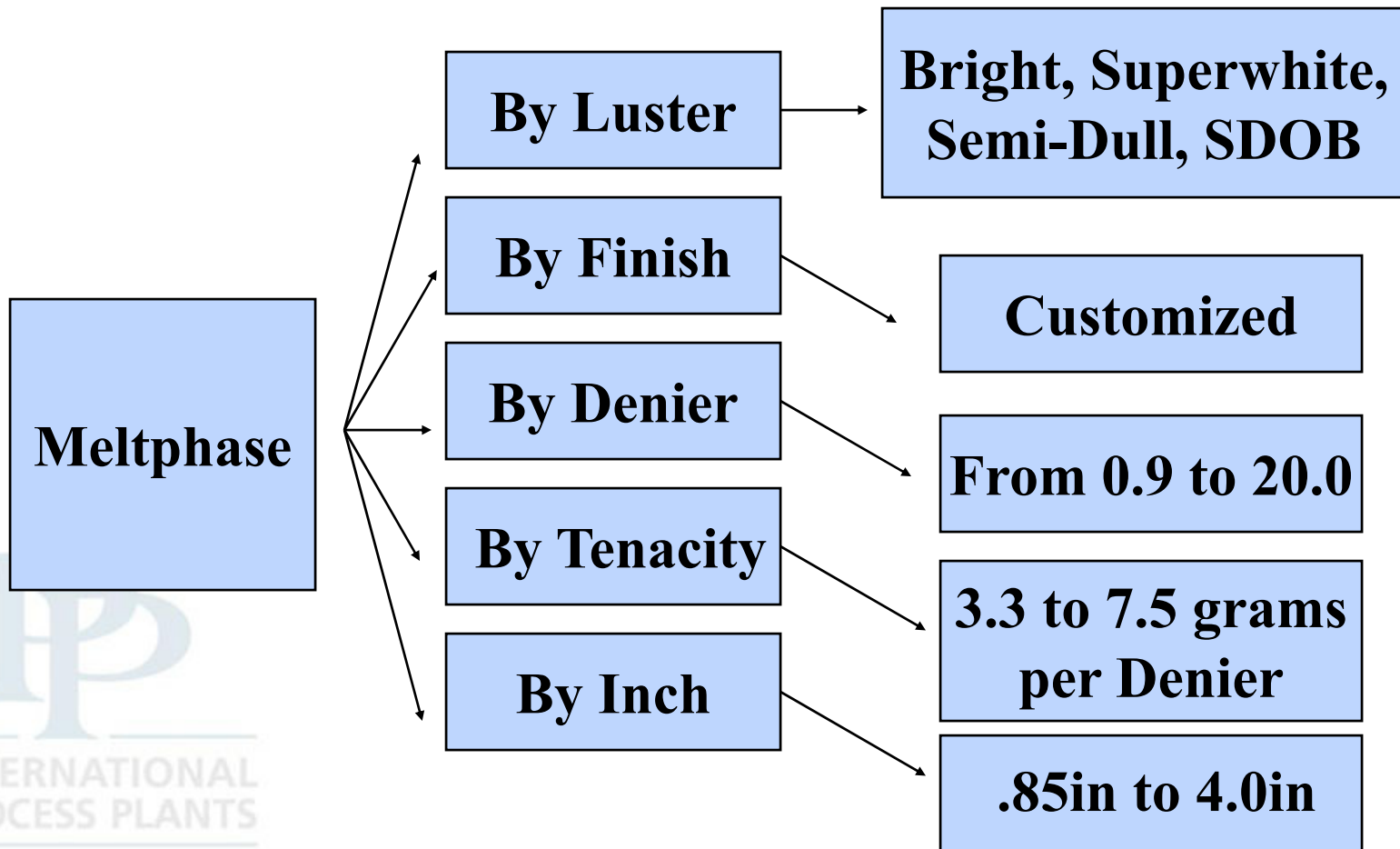


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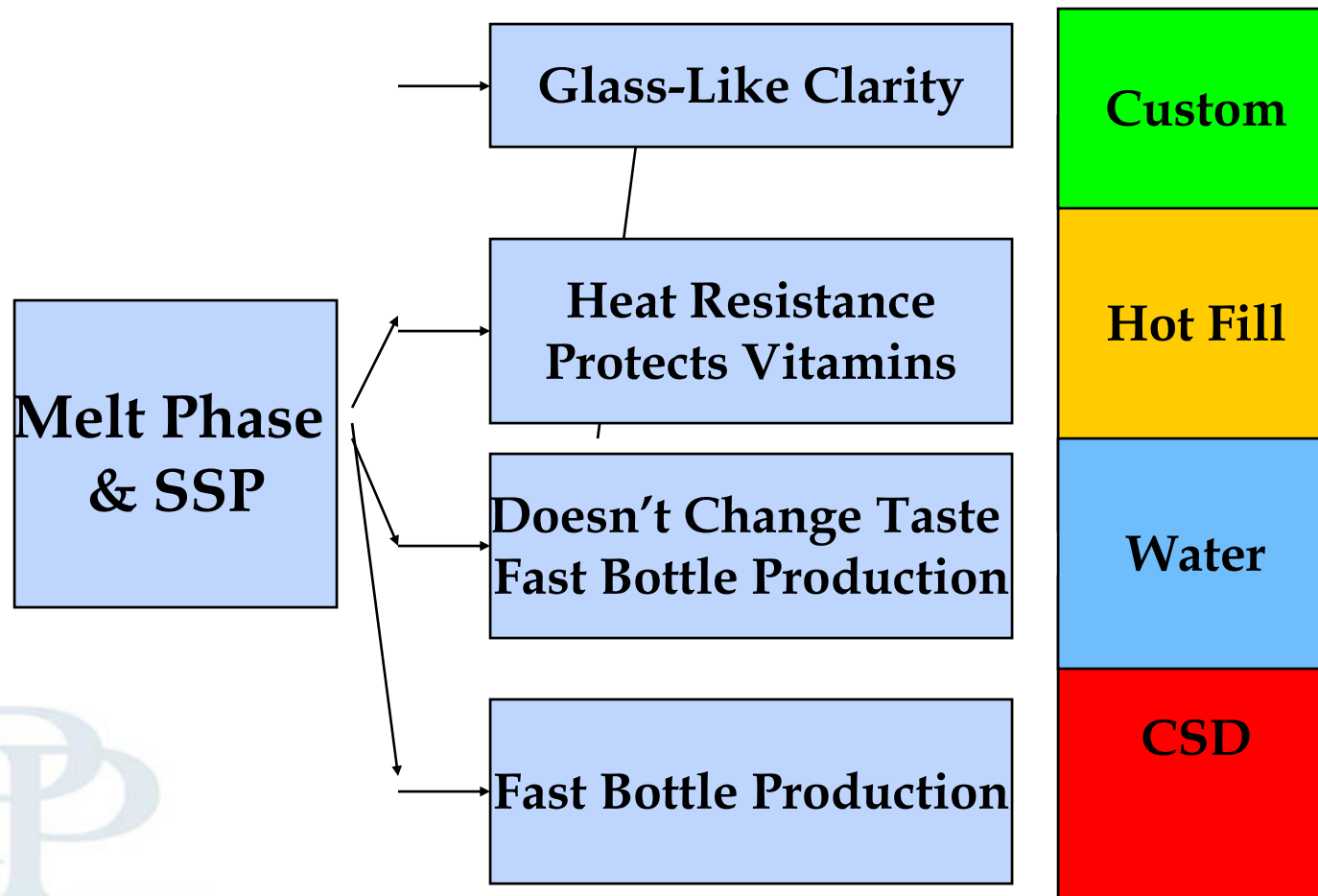
# Polyester Staple Market

**Polyester Staple is a Differentiated Product**



# PET Resins

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# Photos

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# Photos

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