DESIGN CRITERIA
UNIVERSITY OF FLORIDA PILOT PLANT PROJECT

Project No.:	Y7275
Project Title:	3 Ton Per Day Pilot Plant
Location:	Perry, Florida
Prepared by:	T. Koppari / S. McWilliams
Project Manager:	Dennis Goff
Client Representative:	Lonnie Ingram / Kevin Heinicka

Revision	Date	Page Affected	Approvals
A	01/25/10	Initial Issue	
B	02/10/10	Final Issue	

Initial Approval Date: _____

Initial Client Approval Signature: _____

Table of Contents

1.0 Scope of Project

This document is intended to give guidance with regard to design criteria, philosophies, and preferences. This document does not convey contractual obligations. It is expected that clarifications and deviations from this document will become necessary as the detailed engineering work progresses. Accordingly, it is intended that as engineering proceeds, this document be revised as necessary to provide an up-to-date summary for detailed engineering design.

The basic pilot plant process steps for this biomass to ethanol process from either sugar cane bagasse or wood chips utilizing phosphoric acid include:

- Feedstock handling.
- Acid hydrolysis.
- C5 / C6 sugar recovery.
- C5 processing
- C6 liquefaction
- C6/C5 SSF fermentation.
- Ethanol distillation, dehydration and lignin/phosphate recovery.
- Ethanol storage
- Chemical handling.
- Clean-in-Place (CIP) system.

The basic utilities that will be included are:

- Instrument / plant / sterile air
- Steam
- Chilled and cooling water.
- Power distribution.
- Fire protection

2.0 Basic Plant Data

2.1 Production

2.1.1 Product: E-85 Ethanol

2.1.2 Production Rate

Table 2.1.2 Ethanol Production Rates (normal rates @ 200 days/yr) - As E-85 Ethanol	
Production	Value
Production Rate, GPY	60,026
Production Rate, GPD	300
Production Rate, GPH	13
Production Rate, lbs/hr	81
Source: January 27, 2010 mass balance	

2.1.4 Operating Days/yr: Normal Pilot Plant Operations (intermittent, max of 200 days/yr)

2.1.5 Hours of Operation

- Production – 200 days per year at 24 hours per day

2.2 Site Conditions – See Attachment A

2.3 Feed Stocks

The process will potentially use the following feedstocks: 1) sugar cane bagasse, and/or 2) wood chips. The primary feed stock will be bagasse and is the basis for this design criteria. Typical feed stock processing rates and compositions are shown in Table 2.3

Table 2.3 Feed Stock Processing Rate and Composition		
Processing Rate	Bagasse	Wood Chips
Processing Rate, dry tons/day	3.0	TBD
Processing Rate, wet tons/day	6.0	TBD
Composition		
Biomass, wt %	50	unknown
Moisture, wt %	50	unknown
Inerts, wt %	0	unknown
Extractives wt%	3.04	7.85
Sucrose, wt % on dry basis	-	-
Starch, wt % on dry basis	-	-
Cellulose, wt % on dry basis	38.15	46.07
Galactose/Mannose	0/0	0.82 / 2.68
Xylan, wt % on dry basis	19.0	17.36
Arabinan, wt % on dry basis	1.38	0.71
Acetate, wt % on dry basis	2.93	unknown
Protein, wt % on dry basis	2.04	unknown
Lignin, wt % on dry basis	25.58	26.09
Total Ash, wt % on dry basis	7.88	1.15

Size / Format	<1” length	<1” chips
Source: Bagasse – Myriant lab data on Brazilian sample Wood chips – EERE biomass composition database - poplar		

2.4 By-Products and Process Liquid Wastes

2.4.1 Lignin

Table 2.4.1 Production Rate & Typical Composition	
Production Rate	Value
Production Rate, lbs/hr	346
Component	Typical Composition
Water, wt %	66.1
Lignin, wt %	34.0
Others, wt %	0.0
Source: January 27, 2010 mass balance	

2.4.2 Carbon Dioxide

Table 2.4.2 Production Rate & Typical Composition	
Production Rate	Value
Production Rate, lbs/hr	64.4
Component	Typical Composition
Carbon Dioxide, wt %	100
Nitrogen, wt %	0
Water, wt %	0
Oxygen, wt %	0
Ethanol, wt %	0
Source: January 27, 2010 mass balance	

2.4.3 Calcium Phosphate

Table 2.4.3 Production Rate & Typical Composition	
Production Rate	Value
Production Rate, lbs/hr	91
Component	Typical Composition
Water, wt %	64.1
Phosphate, wt %	30.7
Others, wt %	5.2
Source: January 27, 2010 mass balance	

2.4.4 Process Liquid Waste Streams

Table 2.4.4 Process Liquid Waste Stream Typical Composition	
Production Rate	Value
Production Rate, lbs/hr	3,077
Production Rate, gpm	6.1
Component	Typical Composition
Water, wt %	98.0
Insoluble Solids, wt %	0
Soluble Solids, wt %	1.2
Other, wt %	0.8
Phosphates, ppm (estimated)	3.62
Source: January 27, 2010 mass balance	

All liquid waste streams will be collected in the Waste Water Tank before being discharged to the Buckeye waste treatment facility.

2.5 Ethanol

Table 2.6 gives the composition of the E-85 ethanol produced from the pilot plant.

Table 2.5 E-85 Ethanol Composition	
Component	Typical Composition
Ethanol, wt%	85.0
Water, wt %	0.0
Denaturant, wt %	15.0

3.0 Design Basis

3.1 Process Control

3.1.1 Control System Philosophy

The process will be combination of both manual and automation with data collection via a computer programmable logic control system (PLC). There will be instances where local control panels (PLCs) furnished by vendor equipment packages will be used, and the central system will function only in a supervisory manner.

3.2 Equipment Mechanical Design

3.2.1 Atmospheric Tanks

Table 3.2.1 – Atmospheric Tanks Design Criteria		
Design Condition	Criteria	Comments
Design Code	API 650	
Design Pressure	1.0 psig / 6" wc (vac)	Will depend on the individual tank, 2.5 psig would be a max.
Design Temperature	-20 / 300 F	Will depend on the individual tank, 300 F max, 200 min for metal tanks
Venting	Atmospheric or breather vent	When possible vents will be sent to the CO2 scrubber
Residence Time		Depends on the service of the tank – see Attachment F
Height to Diameter Ratio (L/D)	1.0 to 2.0	Depends on individual tanks.
Materials of Construction	FRP, CS or 316L SS	
Code Stamp	Not required	
Corrosion Allowance	0 to 0.125 inches	Depends on individual tanks
Design Operating Level	95% max	No overflows except on water tanks
Type of Construction	Vertical, sloped or cone bottom, shop fabricated	
Insulation	0 to 3", fiberglass or mineral wool	
Manways	24 inch min. (normally one on top and one on the side for large tanks)	Manways required on all tanks with diameters > 6 feet. For tanks small than 6 feet 8" hand ways will be provided
Seismic and Wind Loads	Seismic zone 0, max wind load 120 mph	See Attachment A Site Conditions – Wind loads not applicable as tanks will be inside

3.2.2 Vessels and Columns

Table 3.2.2 – Vessels and Columns Design Criteria		
Design Condition	Criteria	Comments
Design Code	ASME Sec. VIII	
Design Pressure	50 psig / FV (full vacuum)	Will depend on the individual vessel, 50 psig would be a max.
Design Temperature	-20 / 400 F	Will depend on the individual vessel, 400 F max, 200 F min

Table 3.2.2 – Vessels and Columns Design Criteria		
Design Condition	Criteria	Comments
Venting	Pressure relief or atmospheric	Application and sizing will depend on vessel and its service. Vents to the CO2 scrubber if possible
Residence Time		Depends on the service of the vessel – see vessel design basis summary Attachment G
Height to Diameter Ratio (L/D)	1.0 to 3.0	Depends on individual vessels
Materials of Construction	316L SS	
Code Stamp	Yes	
Corrosion Allowance	No corrosion allowance	
Design Operating Level	0 to 95%	Depends on individual vessel
Type of Construction	Vertical, cone or dish bottom, shop fabricated	
Interior Surface finish	No 3 finish (Ra 56 – 96 µin)	Interior surface finish for propagators and fermentors
Exterior Surface finish	Mill finish	Exterior surface finish for propagators and fermentors
Insulation	0 to 4”, fiberglass or mineral wool	
Manways	24 inch min.	Manways required on all tanks with diameters > 6 feet. For tanks small than 6 feet 8” hand ways will be provided
Seismic and Wind Loads	Seismic zone 0, max wind load 120 mph	See Attachment A Site Conditions – Wind loads not applicable as vessels will be inside

3.2.3 Shell & Tube Heat Exchangers

Table 3.2.3 – Shell & Tube Heat Exchangers Design Criteria		
Design Condition	Criteria	Comments
Design Code	ASME Section VIII, TEMA	
Design Pressure (shell / tube)	50 to 150 psig / 50 to 150 psig	Will depend on the individual heat exchanger
Design Temperature (shell / tube)	200 to 400 F / 300 to 500 F	Will depend on the individual heat exchanger
Materials of Construction (shell / tube)	CS or 316L SS / CS or 316L SS	Will depend on the individual heat exchanger
Code Stamp	Yes	

Table 3.2.3 – Shell & Tube Heat Exchangers Design Criteria		
Design Condition	Criteria	Comments
Corrosion Allowance	0 to 0.125 inches	Depends on individual heat exchanger, carbon steel side
Type of Construction	Vertical or horizontal	Depends on individual heat exchanger
Insulation	0 to 3", fiberglass or mineral wool	
Service	Steam or water on shell side, process on tube side where possible	
Fouling Factor	Steam – 0.0005 Water – 0.001 Process – 0.002 Ethanol – 0.0005	
Allowable Pressure Drop (shell / tube)	10 psig max / 10 psig max	Vendor to select

3.2.4 Plate & Frame Heat Exchangers

Table 3.2.4 – Plate & Frame Heat Exchangers Design Criteria		
Design Condition	Criteria	Comments
Design Code		Standard for plate & frame
Design Pressure	50 to 150 psig	Will depend on the individual heat exchanger
Design Temperature	-20 / 300 F	Will depend on the individual heat exchanger
Materials of Construction (Frame / plate)	CS / 316L SS	
Gaskets	EPDM	Glued – dirty service Clip – clean service
Code Stamp	No	
Corrosion Allowance	Vendor to select	Depends on individual heat exchanger
Type of Construction	Inlet and outlet on the same side (face plate), wide gap	Single pass preferred but number of passes depends on service. Multiple passes will be an even number for drainability.
Insulation	None	
Service	Process or cooling / chilled water	
Fouling Factor	Steam – 0.0005 Water – 0.001 Process – 0.002 Ethanol – 0.0005	

Table 3.2.4 – Plate & Frame Heat Exchangers Design Criteria		
Design Condition	Criteria	Comments
Allowable Pressure Drop (cold / hot)	15 psig max	Vendor to select

3.2.5 Pumps

Four types of pumps will be used for this plant, they are: 1) centrifugal, 2) metering, 3) positive displacement and 4) air operated diaphragm.

Table 3.2.5 – Pumps Design Criteria		
Design Condition	Criteria	Comments
Design Code	ANSI	
Types	Centrifugal, metering, positive displacement and diaphragm	Will depend on application
Seals	Single mechanical seal for water, ethanol and non-slurry service. Double mechanical seals with flush system for pumps in slurry service	
Design Pressure	Will depend on the application	
Design Temperature	-20 / 400 F	Will depend on the individual pump supply source
Motors	Standard 1800 rpm where practial	Motors to be non overloading on horsepower
Motor Type	TEFC, Nema 4	
VFD	Will depend on the application	
Application	Recirculation/circulation – only centrifugal pumps Transfers – air operated diaphragm pumps where possible	Will depend on the application
Materials of Construction	316L SS	
Motor Service Factor	1.15	
Bearings	Ball or roller with 50,000 hour life min.	

3.2.6 Agitators / Mixers

Table 3.2.6 – Agitators / Mixers Design Criteria		
Design Condition	Criteria	Comments
Design Code	None	
Types	Top entering, single and double blades	
Surface finish	Same as vessels or tanks	
Seals	Single mechanical seal	
Service	Complete suspension of solids but will depend on the application	Continuous service
Motors	Standard 1800 rpm,	
Motor Type	TEFC	
VFD	Yes	Flexibility for speed control
Materials of Construction	316L SS	
Motor Service Factor	1.15	
Bearings	Ball or roller with 50,000 hour life min.	

3.2.7 Air Compressor Systems

Table 3.2.7 – Air Compressors Design Criteria		
Design Condition	Criteria	Comments
Design Code	ASTM Section VIII on receivers	
Types	Instrument air – air cooled rotary screw	
Service	Continuous	
System Pressure, psig	90 to 100	
Dryer Performance	-20 F Dew point	
Motor Type	General purpose (indoor service)	
Motor Service Factor	1.15	
Auxiliaries	Package should include receiver, dryer and sterile filter	

3.2.8 Boilers

Steam to be supplied from the Buckeye plant at 600 psig

3.2.9 Centrifuges

Table 3.2.9 – Centrifuges Design Criteria		
Design Condition	Criteria	Comments
Design Code	None	
Types	Decanting	
Service	Continuous	
Motor Type	TEFC	Soft starts where necessary
VFD	Yes	
Motor Service Factor	1.15	
Materials of Construction	316L SS	

3.2.10 Chillers

Table 3.2.10 – Chillers Design Criteria		
Design Condition	Criteria	Comments
Design Code	None	
Types	No requirement	Air cooled
Service	Continuous	
Motor Type	General purpose (indoor service)	
VFD	Optional	
Motor Service Factor	1.15	
Design Temperature	45 / 55 F	Cooling media - Water at 80 F
Refrigerant	Vendor to specify	

3.2.11 Column Internals

Table 3.2.11 – Column Internals Design Criteria		
Design Condition	Criteria	Comments
Design Code	None	
Types	Beer Column – sieve valves, Rectifying Column valve trays or vendor specification	
Service	Continuous	
Materials of Construction	Trays – 304L SS	

3.2.12 Cooling Tower - None

3.2.13 Filters

Table 3.2.13 – Filters Design Criteria		
Design Condition	Criteria	Comments
Design Code	ASTM	
Types	Inline, cartridge,	
Service	Continuous	
Media Size	Depends on service	
Design Pressure	150 psig	
Design Temperature	-20 / 300 F	
Materials of Construction	Body 316L SS Internals – Polypropylene / 316L SS Gasket – Buna N or EPDM	

3.2.14 Solids Handling

Table 3.2.14 – Solids Handling Design Criteria		
Design Condition	Criteria	Comments
Design Code	None	
Types	Screw	
Service	Continuous	
Motor Type	General purpose (indoor/ outdoor service)	
VFD	Depends on service	
Motor Service Factor	1.15	
Materials of Construction	CS or will depend on service	

3.2.15 Hydrolyzer

Table 3.2.15 – Hydrolyzer Design Criteria		
Design Condition	Criteria	Comments
Design Code	ASME Section VIII	
Types	Vendor specification	
Service	Continuous	
Motor Type	General purpose (indoor service)	
VFD	Yes	Vendor specification
Motor Service Factor	1.15	
Materials of Construction	By vendor	May depend on dilute acid type
Design Pressure	400 psig max	
Design Temperature	500 F max	

3.2.16 Specialty Items

Will depend on types and service, this will include such things as spargers, traps, strainers, sterile filters and hoses. All hoses will be chemical resistant, 150 psig rated.

3.2.17 Vacuum Pumps

Table 3.2.17 – Vacuum Pumps Design Criteria

Design Condition	Criteria	Comments
Design Code	None	
Types	Liquid ring	
Service	Continuous	
Motor Type	TEFC	
VFD	Yes	
Motor Service Factor	1.15	
Materials of Construction	304L or 316L SS	

3.2.18 Other Equipment

Will depend on the type of equipment and service, this will include inline mixers, etc.

3.3 Equipment Sizing Design Factor

No additional design factor has been applied to the equipment or flow rates. However some equipment will be sized based on equipment vendor size availability. Since the pilot plant is primarily a batch operation, sizing will be dependent on optimum operating size based on intermittent operations.

3.4 System Hydraulics

3.4.1 Pipe Sizes

The following nominal pipe sizes will not be used in this project:

3/8 inch
1 ¼ inch
2 ½ inch
3 ½ inch
5 inch

3.4.2 Pipe Line Sizing and Velocities

Piping velocities shall be limited to the maximum values listed. Most piping will be small-bore pipe of 2" or below. However settling velocities must be considered when dealing with slurries

Table 3.4.2 – Pipe Line Velocities	
Application	Pipe Nominal Velocities
Pump discharge, liquid with slurry	9 ft/sec
Pump discharge, liquid without slurry	6 ft/sec
Pump suction line	3 ft/sec
CIP lines	12 ft/sec
Cooling water lines	8 ft/sec
Condensate lines	3 ft/sec
Sulfuric or phosphoric acid lines	5 ft/sec
Gravity flow lines	3 ft/sec
Column vapor lines	150 ft/sec
CO2 recovery lines	25 ft/sec
Sterile air lines	65 ft/sec
Vent lines	25 ft/sec
Natural gas	100 ft/sec
Steam lines, low, intermediate and high pressure	125 ft/sec

3.4.3 Pipe and Value Specification

3.4.3.1 Clean in Place and Steam in Place Piping

Piping and fittings will be completely drainable and cleanable leaving no dead legs or entrapment areas. Deadlegs will be minimized with a deadleg maximum length of three pipe diameters.

3.4.3.2 Piping Material

Unless noted otherwise, material to be 304L stainless steel or better. All tubing shall meet ASME BPE standards (most recent edition at the time of material purchase). I.D. finish to be ASME-BPE SF2 or better. O.D. non-polished and bright annealed. Mill finish O.D. is acceptable only if bright annealed is not available. Sulfur content to be between 0.005% minimum and 0.017% maximum.

3.4.3.3 Piping Size

All piping with the exception of pumps suctions lines will be sized such that the process flowrate is at least 5 ft/sec and flow is turbulent. Flowrate maximums are listed in section 3.4.2.

3.4.3.4 Welding
All welds will be orbitally welded and mechanically polished.

3.4.3.5 Valves, Fittings & Instrument Connection

All valves and fittings will be appropriate for sanitary application. With the exception of the sulfur content, ASME BPE fittings to match tubing per this specification. Internal finish to be ASME-BPE surface finish designation of SF2 or better.

3.4.3.6 Ferrules

ASME BPE buttweld ferrule, grooved for a gasket. Internal finish to be ASME-BPE surface finish designation of SF2 or better.

3.5 Clean Service

The following are the clean service design basis for the plant.

3.5.1 Vessels

The propagators and fermentors will be designed to be CIP'd and SIP'd. A full CIP/SIP cycle will be performed after each batch. Each vessel will be equipped with CIP spray nozzle(s) or ball(s). The number of CIP nozzles or balls will depend on the size of the vessel. Each vessel will be equipped with full SIP capability. SIP hold conditions will be 250 F for 30 minutes. Vessel interior finish will be No. 3 (Ra 96 – 56 µin). All flanges will be pad flanges for ease of cleaning.

3.5.2 CIP/SIP

CIP conditions will be: 1) ambient temperature pre-rinse, 2) followed by 180 F, 2 to 3% caustic solution, and 3) followed by 140 F rinse with sterilized water. SIP will be done at 250 F (15 psig) for 30 minutes unless otherwise specified.

3.5.3

3.5.3 Piping

See sections 3.4.3 for sanitary piping specifications. All propagator transfer lines will be CIP'd and SIP'd after each batch.

3.5.4 Steam

No clean steam will be provided in this design. SIP will use plant steam from the main Buckeye plant.

3.5.5 Water

The city water supply to the plant has been assume to be adequate without further treatment. If necessary a UV unit could be provided to further sterilize the water.

4 General Design Guidelines

4.1 Electrical Supply and Distribution

The current design calls for purchased power. There will be no backup power supply.

Standard three-phase induction motors will be used for this project, with motors of 250 hp or less utilizing 460 volt power supplies and motors of greater than 250 hp will utilize power supplies of 4160 volts. Motors, depending on electrical classification will be: 1) totally enclosed fan cooled (TEFC), 2) waterproof (general purpose) or 3) explosion proof.

The Motor Control Center (MCC) will be located centrally with local depending on the final pilot plant layout.

4.2 Natural Gas Supply and Distribution

Natural gas will be used only in the building for HVAC purposes and in the laboratories.

4.3 Plant and Buildings

A tentative pilot plant layout has been developed. The pilot plant will be inside a building the type has yet to be determined. Provided inside this building will be space for:

- Control room, offices and laboratory
- Utilities including the air compressor and refrigeration unit
- Maintenance and warehousing space
- Operating areas

The control room, offices and laboratory will have full HVAC systems. The rest of the pilot plant building will have ventilations systems as needed.

4.4 Redundant or Spare Equipment

There will be no spare or redundant equipment installed.

4.5 4.5 Platforms, Stairs and Ladders

In order to provide a safe and adequate work area for pilot plant technicians, fixed platforms will be provided in the area of any piece of equipment that is elevated at least 10 feet above grade. These platforms will be provided with proper handrails and kick plates, and will meet all requirements of the appropriate safety regulations.

As a general rule, stairs will be provided to all elevated platforms where operating and maintenance requirements dictate regular access. Regular access means a frequency of at least once per week, or where the personnel are required to carry tools, sample bottles, or anything else that would impede their ability to climb a ladder. Otherwise, ladder access in conformance with applicable safety regulations and design guidelines will be used.

4.6 Materials of Construction

Ford, Bacon & Davis will select process and utility materials of construction with the assistance of equipment vendors. 316L SS and carbon steel are the predominant materials of construction.

4.7 Operating Range

The process equipment will be designed for effective operation at rates down to a minimum of 50% (if possible) and up to a maximum of 110% of the steady state nominal flow rate.

4.8 Roads, Rails and Parking

Paved roads will be provided for the efficient movement of trucks around the pilot plant. Trucks will include solids hauling, bulk raw materials and ethanol trucks. Parking facilities will be provider as required at the Perry site.

4.9 Utility Station

The design will include sufficient utility stations for wash down of all equipment and floors. Each utility station will include a steam/water mixer.

4.10 Lighting

Lighting will be specified to meet federal, state and local codes and/or industry standards.

4.11 4.11 Water Supply Quality

City water will be provided by the main Buckeye plant. The current water quality has been assumed to be adequate.

4.12 Shipping and Receiving

Ethanol, lignin and phosphate cakes will be the main materials shipped from the plant. Raw materials and chemicals will be shipped to the plant in drums or tote bins. Table 4.12 indicates what types of loading and unloading facilities will be necessary for handling products and raw materials.

Table 4.12 Loading and Unloading Facilities				
Products / By-Products	Bulk Handling		Containers (Indicated type)	Comments
	Truck	Rail		
Ethanol	Yes	No		
Phosphate Cake	No	No	Dumpster	Possible land application
Lignin Cake	No	No	Dumpster	
Raw Materials				
Phosphoric Acid	No	No	Totes	May receive from Buckeye
Caustic	No	No	Totes	May receive from Buckeye
Denaturant	Truck	No		
Enzymes	No	No	Drums	
Nutrients (trace metals, MgSO4)	No	No	Drums, bags, small containers	
Aqueous Ammonia / other bases	No	No	Totes	
Lime	No	No	Bags	
Feed Stock	Yes	No	Bails or fiber lever paks	

4.13 Steam Supply

Steam will be supplied from the Buckeye plant as 600 psig saturated. It will be desuperheated and then the pressure reduced to individual headers. Reduced pressures will include 300, 75 and 30 psig.

4.14 4.14 Cooling Tower Water Supply

Cooling water will be supplied by utilizing the chiller to cool water for this purpose. Cooling water temperature will be 80 F. No cooling tower will be provided for this project.

4.15 Microorganism Containment

Per requirements of 40CFR Subchapter R (TSCA) Part 725, the design aspects that have been included in this design to contain the microorganism are:

- All vents that could contain the microorganism are passed through the CO2 scrubber and the bleach scrubber (air containment).
- All liquid streams that could contain the microorganism are collected and sent to the beer well for processing through the beer or stripper column.

- The beer or stripper column functions as the kill device in the process (temperature of 240 F).

5 Environmental and Safety Considerations

5.1 Environmental

5.1.1 Sanitary Sewage

The pilot plant will be tied into the local sanitary sewer.

5.1.2 Storm Water and Site Drainage

Site drainage will be provided such that any storm water run off will run off to the existing plant storm water system.

5.1.3 Solid Waste Disposal

Solids will include lignin and phosphate wet cake, these will be collected in movable dumpster for disposal. Other solid waste will be collected and disposed of off site.

5.1.4 Atmospheric Emissions

Most vents in the plant will be routed to the CO2 scrubber.

5.1.5 Spill Containment

Spill containment of ethanol and processing chemicals will be controlled with the construction of secondary containment concrete curbs around the pilot plant. The ethanol and denaturant storage tanks will be contained with a concrete dike. These containment dikes and curbs will be constructed to meet codes, good industry practices and requirements of 40CFR Subchapter R Part 725.

5.2 Safety

5.2.1 Electrical Classifications

The electrical classifications for the various areas of the plant are included in Attachment E

5.2.2 Noise

Equipment will be specified to obtain a maximum noise level whenever possible (82 db at 3 feet distance).

5.2.3 Safety Showers / Eye Baths

Safety showers and eye baths will be included in the design and installed in areas that would require them. Potable water will be used for these showers and baths.

5.2.4 Pressure Relief Devices

Relief devices will be designed for all pressure vessels where required by Code. All tanks that are not designed for full vacuum and that could be subjected to low internal pressure will be equipped with conservation vents and/or emergency vacuum relief devices to prevent implosion or escape of vapor.

5.2.5 Fire Protection System

A fire protection system will be provided to supply water to the sprinkler system for various parts of the plant. The current plan is to tap into the existing fire protection system.

6 Engineering Standards

6.1 Codes and Standards

The applicable codes and standards for this project are listed in Attachment B

6.2 Equipment Numbering System

The equipment numbering system for this project is listed in Attachment C

6.3 6.3 Process Area Numbering System

The process area numbering system is listed in Attachment D

6.4 Units of Measurement

Units will be US “Customary” or common English units.

7 Attachments

Attachment A – Site Conditions
Attachment B – Design Codes and Standards
Attachment C – Equipment Numbering
Attachment D – Process Area Numbering System
Attachment E – Electrical Voltage and Area Classification
Attachment F – Tank Design Basis
Attachment G – Vessel Design Basis

ATTACHMENT A
SITE CONDITIONS

Location	**Perry, Florida**
Site Elevation (above sea level)	42 feet
Average Yearly Temperature (data from 1/1/1999 to 1/1/2009)	67.4 F
Minimum Winter Average Temperature	41.0 F
Average Winter Temperature (Nov, Dec, Jan, Feb and Mar)	44.8 F
Maximum Summer Average Temperature	92.1 F
Average Summer Temperature (Apr, May, June, July, Aug, Sept, Oct)	76.3 F
Historical Minimum Temperature (20 yr.)	17 F
Historical Maximum Temperature (20 yr.)	99 F
Average Atmospheric pressure	14.7
Average Annual Wind Direction	166 Degrees
Average Basic Wind Speed	6.1 MPH
Maximum Basic Wind Speed	120 MPH (Building code)
Average Annual Precipitation	58.2 inches
Average Annual Snowfall	0
Design Frost Depth	20 inches (Building code)
Seismic Zone	Zone 0

ATTACHMENT B

Design Codes & Standards

Unless specifically noted to the contrary, the design specifications for the process and the plant will conform to the applicable sections and parts of the codes and standards set forth below, including the most recent revisions and supplements at the time of the execution of the Agreement.

Applicable Standards:	Federal, State, Local, OSHA, Air quality, ANSI
Building Codes:	
Cable Marking:	ICEA (Insulated Cable Engineers Association)
Concrete:	ACI (American Concrete Institute)
Corrosion:	NACE (National Association of Corrosion Engineers)
Environmental (GMO)	Environmental Protection Agency – 40 CFR Part 725
Electrical/Instrumentation:	NEMA (National Electrical Manufacturers Assoc)
	NEC (National Electrical Code)
	ISA (Instrumentation, Systems & Automation Society)
Electrical Components:	UL (Underwriters Laboratories)
Flanges:	ANSI standard
Fire Protection	NFPA
Heat Exchanger:	TEMA (Tubular Exchanger Manufacturers Association)
Nuts, Bolts, Fittings	ASTM (American Society of Testing Materials)
& Line Components:	SAE (Society of Automotive Engineers)
Painting:	SSPC (Steel Structure Painting Council)
Personnel Safety:	OSHA (Occupational Safety and Health Association)
Piping, pumps:	ANSI (American National Standards Institute)
Process Safety	OSHA Process Safety Management 1910.119
Structural Steel:	AISC (American Institute of Steel Construction)
Tanks	API (American Petroleum Institute)
Valves and Fittings:	MSS (Manufacturers Standardization Society)
Vessels (Where required):	ASME (American Society of Mechanical Engineers)
Welding:	AWS (American Welding Society)

ATTACHMENT C
EQUIPMENT NUMBERING

The following standard format will be sued for equipment identification on all project drawings and documentation:

TF-2201A

Where:

TF	Equipment Abbreviation (from the following chart)
2	Area Number
2	Sub-Area Number
01	Sequence Number
A	Optional – Unit identifier (for multiple units)

Equipment Designation Abbreviations

AC	Air Compressor	FR	Flare
AG	Agitator	HP	Heat Exchanger, Plate & Frame
BH	Bag house	HS	Heat Exchanger, Shell & Tube
BL	Blower	M	Motor, Electric
BN	Bin / Hopper / Silo	MI	Mill, Hammer, roller, etc
BO	Boiler	MS	Magnetic Separator
C	Column (Tray)	ME	Mechanical Equipment, Misc.
CB	Conveyor, Bucket	PK	Package Unit
CF	Centrifuge	PA	Pump, Air Driven
CHR	Chiller	PC	Pump, Centrifugal
CT	Cooling Tower	PM	Pump, Metering
CV	Conveyor, Mechanical or Pneumatic	PP	Pump, Progressive Cavity
CY	Cyclone	PR	Pump, Positive Displacement
DA	Deaerator	PS	Presses
DC	Dust Collector	PV	Pump, Vacuum
DR	Dryer	RV	Rotary Valve
DS	Desiccant Dryer	SC	Column or Scrubber (Packed)
DV	Diverter Valve	SM	Static Mixers
EJ	Ejector or Eductor	SN	Screens
FA	Fan	SV	Slide Gate Valves
FE	Feeders	TC	Tank, Concrete
FH	Fired Heater	TF	Tank, Field Erected
FL	Filters, Cartridge or Pressure	TS	Tank, Shop Fabricated
FV	Filter, Vacuum	VS	Vessels
FB	Filters, Belt	WS	Weigh Scales

ATTACHMENT D
PROCESS AREA NUMBERING SYSTEM

1000		Feed Stock Storage and Handling
	1100	Not used
	1200	Feed Stock Feeding
2000		Acid Hydrolysis
	2100	Hydrolyzer, Screw Press and C5 Storage
	2200	Flash Condenser and Recovery Tanks
	2300	Liquefaction
3000		Propgation and Fermentation
	3100	Not used
	3200	Propagation and Fermentation
	3300	Not used
	3400	Not used
	3500	Not used
4000		Beer Well and Nutrient Recovery
	4200	Not used
	4500	Not used
	4600	Beer Well and Distillation & Dehydration
	4900	Nutrient Recovery
5000		Ethanol Storage and Loadout
	5100	Ethanol Storage
6000	6100	Not used
7000		Waste Treatment
	7100	Not used
	7200	CO2 and Bleach Scrubbers
8000		Chemical Storage
	8100	Phosphoric Acid Handling
	8200	Caustic and CIP Storage
	8300	Acid / Base Drum Unloading Stations, Cellulase and Nutrient
	8400	Lime Handling
	8500	Aqueous Ammonia and Base Handling
9000		Utilities

	9100	Not used
	9200	Chiller and Cooling Water
	9300	Condensate Distribution
	9400	Instrument, Process Air
	9500	Recycled and Waste Water
	9600	Not used
	9700	Not used
	9800	Not used

ATTACHMENT E
ELECTRICAL VOLTAGE AND AREA CLASSIFICATION

Chart A: Voltage

Drivers	Voltage	Phase
Above 250 HP	4160	3
3/4 to 250 HP inclusive	460	3
Up to 3/4 HP	120	1
Lighting	240	1
Instruments	120 v AC or 24 v DC	1

Chart B: Electrical Area Classifications

Process Area	Electrical Classification
Feed Stock Receiving, Storage and Preparation	General Purpose
Hydrolysis	General Purpose
Sugar Recovery (Screw Press)	General Purpose
Fermentation, including CO_2 Scrubbing	General Purpose
Distillation & Dehydration	Class I Div. 2 Gr. D
Solids Handling	General Purpose
Clean-in-Place	General Purpose
Ethanol and Denaturant Storage	Class 1 Div. 2 Gr. D
Chemical Storage	General Purpose
Ethanol Load-out Systems	Class 1 Div. 2 Gr. D
Utility Building	General Purpose

The above table represents a general description of the area classifications anticipated in this facility.

ATTACHMENT F				
Tank Design Basis – Pilot Plant (Tanks not in Packages)				
New Tank No.	Name	Retention Time (HR)	Capacity, gallons	Materials of Construction
TS-2108	C5 Storage Tank		350	316L SS
TS-2109	C5 pH Adjustment Tank		300	316L SS
TS-2203	Nutrient Recovery Tank	2	1,440	FRP
TS-4601	Beer Well	NA	19,700	316L SS
TS-4901	Decanter Feed Tank	4	1,440	FRP
TS-4903	Phosphate Conversion Tank	4	1,440	FRP
TS-5101	Product Shift Tank	40	1,000	CS/Concrete
TS-5102	Denaturant Tank	168	250	CS/Concrete
TS-8202	CIP Dilute Caustic Tank	12	3,400	316L SS
TS-8203	Rinse Tank	12	3,400	316L SS
TS-8403	Lime Slurry Tank	40	132	CS
TS-9202	Cool Water Expansion Tank	2	10,000	Flat bottom, FRP
TS-9201	Chilled Water Expansion Tank		150	FRP
TS-9202	Cooling Water Tank		4,600	FRP
TS-9501	Process Water Tank	8	4,600	FRP
TS-9502	Waste Water Tank		10,000	FRP

ATTACHMENT G				
Vessel Design Basis – Pilot Plant (Vessels no in Packages)				
New Equipment Number	Name	Retention Time (hr)	Capacity, gallons	Materials of Construction
VS-2102	C5 Flash Tank			Part of Digestor Package
VS-2103	Start-up Cyclone			Part of Digestor Package
VS-2107	Sample Cyclone			Part of Digestor Package
VS-2301	Liquefaction Tank	6.0	2,220	316L SS
VS-2302	Hydrolyzate pH Adjustment Tank		200	316L SS
VS-3201A/B	Propagators #1	24	11	316L SS
VS-3202A/B	Propagators #2	24	116	316L SS
VS-3203A/B	Propagators #3	24	1,140	316L SS
VS-3204A/B/C	SSF Fermentors	96	11,000	316L SS
VS-3205	Mix Tank	40	132	316L SS
VS-4605	Reflux Vessel			Part of D & D Package
VS-4606	Regen Vessel			Part of D & D Package
VS-9301	Steam Condensate Flash Tank	4	100	304L SS
VS-9401	Air Receiver			Part of the Air Compressor Package
VS-9402	Air Receiver			Part of the Air Compressor Package