SECTION 1. PROCESSING PARAMETERS

The proposed equipment has been designed based on product characteristics and processing conditions as provided by Buyer and summarized below. Any changes to these parameters could result in significant variance between projected and actual equipment performance.

Product Description/Composition:	Distillers Grain (Corn)
Product Shape and Size:	Granular 1/16" Corn Blend w/Syrup
Input Rate Wet Cake (One Drier):	12, 338 kg/hr (29,205 lbs/hr)
Input Moisture (Wet Cake) wwb*:	67%
Input Rate Syrup (One Drier):	16,918 kg/hr (37,305 lbs/hr)
Input Moisture (Syrup) wwb*:	75%
Input Rate Wet Cake and Syrup (One Drier):	30,163 kg/hr (66,510 lbs/hr)
Net Input Moisture (Wet and Syrup) wwb*:	71.5%
Input Rate Remix (One Drier):	38,527 kg/hr (84,953 lbs/hr)
Input Rate Wet+Remix (One Drier):	68,690 kg/hr (151,463 lbs/hr)
Net Input Moisture (Wet & Remix Product) wwb*:	37%
Output Rate (Net) (One Drier):	9,556 kg/hr (21,071 lbs/hr)
Output Moisture wwb*	10% wwb
Evaporation Rate (One Drier):	20,607 kg/hr (45,439 lbs/hr)
Wet Bulk Density:	561 kg/m^3 (35 lbs/ft^3)
Product Temperature In (Driers):	82°C (179°F) to 85°C (185°F)
Product Temperature Out (Cooler):	25°F Above Ambient, When Ambient is Above 70°F

*wwb (wet weight basis) means moisture is expressed as a percentage of total weight.

NOTE: This product will cluster or stick to the drier interior requiring a mix back system to develop a product with acceptable drying characteristics approaching granular and free flowing. To accommodate these product conditions, internal lifting flight configurations are incorporated in the drier design and use of a mix back system is required for this drying process.

SECTION 2. EQUIPMENT SPECIFICATIONS

2.1. General Design Requirements

The general design specifications for the proposed equipment are as follows:

Design Make-up Air Temperature:	10°C to 38°C (50°F to 100°F)
Nominal Operating Air Inlet Temperature:	399°C (750°F) To 538°C (1000°F) Approximate
Maximum Design Air Inlet Temperature:	648°C (1200°F) Approximate
Nominal Air Outlet Temperature:	104°C (220°F) Approximate
Design Air Outlet Temperature:	121°C (250°F) Approximate
Electrical Service:	3 Phase/460 Volts/60 Hz

Plant Elevation:	60.96 m (200 ft)
Drier Location:	Outdoors, (Cover Over Makeup Air Intake Required)
Heat Source (Supply by Buyer):	Natural Gas
Fuel Pressure Supplied by Buyer at Drier:	0.34 kg/cm^2 (5 psig)
Fuel Gross Heating Value:	39,100 kJ/m^3 (1050 BTU/sc ft)
Fuel Use (Nominal):	49,505,700 BTU/hr

The equipment described in this document conforms to the following:

General Standards NFPA, GEGAP (IRI), FM

2.2. Two (2) Aeroglide Model R3 168-60 NGX Rotary Driers - SERIAL NUMBER 07103-01 and 07103-02

The three-pass rotary drier continually lifts and showers the product through the moving air stream. The induced draft air system delivers the energy for drying the product and progressively moves the product through the drier. Alternating patterns of lifting flights provide optimum showering for efficient and uniform drying while providing the proper retention for the product.

A sprocket mounted around the circumference of the drum near the discharge end, drives the rotary drum and is powered through a chain drive system with a gear reducer and motor. The drum is supported by hardened steel trunnions contacting hardened steel tires which are mounted around the circumference of the drum. The trunnions are supported by outboard heavy duty roller bearings. Thrust rollers are mounted at the drive end of the drum to contain the drier on the trunnions and to maintain proper alignment of the drive. To assure optimum life, the tires are optically aligned about the centerline of the drum.

The inlet and exit openings for the product to enter and exit the drum, have labyrinth air seals mounted concentric about the centerline of rotation, providing seals and allowing the drum to rotate and float horizontally.

Specifications Table 1: Overall Dimensions

Drum Length:	18.3 m	60 ft	0 in
Drum Diameter:	4.3 m	14 ft	0 in

NOTE: Buyer to verify that drier as described will fit space available and allow proper access for cleaning and maintenance at installed location. Changes made subsequent to contract date may result in price and delivery revisions.

2.2.1. Heat Source

2.2.1.1. Gas Burner

The drier has a full modulating thermostatically controlled self-contained burner system. The burner is mounted in a combustion chamber separate of the drier, heating all of the air that enters the drier. A high turndown ratio provides for a wide range of process control. The burner is controlled by a 4-20 mA signal. Included is a stand alone combustion air blower.

Specifications Table 2: Gas Burner

Burner Manufacturer and Model:	Maxon Optima
Turndown Ratio:	8:1 Nominal
Flame Sensor Type:	Flame Rod
Ignition Transformer:	By Seller
Combustion Air Blower:	Provided
Combustion Blower Air Switch:	Included Per Blower

NOTE: The fuel composition must be supplied to Aeroglide before final specification of the burners can be completed. (See Process Parameters section for current assumptions).

2.2.1.2. Heat Source Combustion Chamber

The burner will direct fire into a self contained combustion chamber through which all of the air to the drier system, both make-up and recycled, will be heated and mixed prior to entering the drier. The burner is work driven by sensing the drier exhaust temperature to maintain the proper drier inlet heat input required to accomplish the drying load.

The burner is positioned a sufficient distance from the product feed inlet to accomplish complete fuel combustion with additional distance to separate the heat source from the product to be dried, prior to the product feed inlet. To minimize heat loss, the combustion chamber is insulated. Recycled and make-up air enters at the end of the cylinder. Combustion air is supplied to the burner by a floor mounted fan near burner.

Specifications Table 3: Heat Source Combustion Chamber

Inter Housing Material:	409 Stainless Steel
Outer Housing Material:	Painted Carbon Steel Sheet
Source of Air to Drier System:	Ambient
Combustion Chamber Support:	Provided By Seller
Outer Housing Paint:	Aluminum Rated for 204°C (400°F)
Support Material:	Carbon Steel
Support Paint:	Aluminum Rated for 204°C (400°F)

2.2.1.3. Fuel Train

The gas train includes, but is not limited to:

- Low fire start switch
- High gas pressure switch
- Safety shut-off valve and second blocking valve
- Individual pressure regulator for each gas train
- Pressure gauges

Specifications Table 4: Fuel Train

Gas Trains Provided:	By Seller
Gas Trains in Accordance With:	GEGAP (IRI)
Safety Shut-off Valve Actuation:	Electrically Actuated
Components Shipped:	Assembled for Field Mounting to Burner
Field Location and Support of Gas Train:	By Buyer
Connecting Pipe Fittings Between Burner and Gas Train Provided By:	Seller
Natural Gas Pressure Requirement to Regulator:	**10 PSIG**

2.2.2. Transition Inlet and Product Infeed

The transition inlet section provides a smooth transfer of the heated process air from the heat source area to the drier inlet. The transition section will include a labyrinth seal to interface with the rotating drum. The product feed inlet and inlet chute are designed for the specific product to be dried. The inlet section will be insulated and will connect directly to the combustion chamber and will be supported by the combustion chamber support structure. A flanged inlet connection will be supplied for the feed to the drier system.

Specifications Table 5: Transition Inlet and Product Infeed

Transition Material:	Carbon Steel
Feed Screw Material:	Carbon Steel
Insulation Cladding Material:	Carbon Steel
Insulation Cladding Paint:	Sherwin Williams Silver Brite Aluminum Rated for 204°C (400°F)
Interior Paint:	None
Hot Air Limit Sensor Mount:	Provided
Product Inlet Seal Method:	Air Lock – See Air Lock Section
Air Lock Provided By:	Seller
Airlock Material:	**304 Stainless Steel**
Steam Snuffer:	Provided **(Injection Port Only)**

2.2.3. **Drum**

The rotary drum is a heavy-duty steel constructed concentric cylinder with heavy-duty end doubler plates providing a sound support for mounting the tires and driven sprocket. The end plates are centered below the tires and are gusseted to provide proper tire support. The total exterior of the drum is continuous welded for proper sealing and structure and is insulated in a weather protective covering to reduce radiant energy loss through the cylinder walls.

The drum interior has continuous flight patterns arranged to obtain optimum product showering and containment through the circumference of the drum and provide proper retention time during the drying process. Special flighting is supplied at both ends to properly move the product away from the inlet and to discharge the product after it is dried.

The three pass design allows for use of higher inlet process temperatures for more efficient drying without elevating product temperatures to produce a more uniformly dried product.

To provide maximum durability from heat stress and product load, lifting flights are designed in short segments and are secured to the circumference of the drum with full welded heavy duty angle clips.

Specifications Table 6: Drier Configuration

Number of Passes:	3
Drum Material:	
Intermediate and Outer Shell	**Carbon Steel**
Inner Shell:	**409 Stainless Steel**
Drum Diameter:	4.26 m (168 in)
Drum Length:	18.3 m (60 ft)
Flight Material:	Carbon Steel
Mineral Wool Insulation:	50 mm (2 in), Thickness, R Factor of 0.04 W/m C (0.3 BTU in/hr sq ft F)
Insulation Cladding Material:	Carbon Steel
Insulation Cladding Thickness:	1.6 mm (1/16 inch)
End Wrapper Under Tire Material:	Carbon Steel
End Plate Material:	Carbon Steel
Flight Material:	Carbon Steel
Flight Thickness:	4.76 mm (3/16")
Exterior Paint:	Sherwin Williams Silver Brite Aluminum Paint, Rated 204°C (400°F)
Interior Paint:	None
Drum Access:	Access Door Through Settling Chamber
End Seals:	Labyrinth Seals
Flights Attached to Drum By:	Angle Clips Welded to Drum and Flights
Drain Ports:	Provided, Three (3) 3" Drains Located Near Inlet End on Drum Circumference

Torsional wind-up support structure is included for the center shell because of the heavy internal surging loads.

2.2.4. Tires, Trunnions and Drive

For optimum drier life, the drier is constructed with heat treated tires which are optically aligned and concentrically mounted about the centerline of rotation of the rotary drum. Heat treated trunnions with external roller bearings are shop mounted with hardened steel thrust rollers on structural support bases. The driven sprocket is aligned and mounted concentrically around the circumference of the drum. The reducer and drive motor are supported on the trunnion base.

Specifications Table 7: Tires, Trunnions and Drive

Tire Type:	One Piece Roll Forged Through Hardened
Tire Material:	Hardened Steel
Trunnion Type:	Heat Treated
Trunnion Material:	Hardened Steel
Tire/Trunnion Lubrication:	**Graphite Blocks, (2) Provided**
Trunnion Bearings:	Externally Mounted Double Spherical Roller Type
Drive Type:	Chain Driven
Driven Sprocket (Field Mounted):	Segmented, Mounted Around Drum Circumference
Drive Chain Type:	Engineering Class
Soft Start:	By Inverter **(Manufacturer Specified by Buyer)**
Inverter Provided By:	Seller (Shipped Loose)
Reducer (Field Mounted):	Eurodrive
Zero Speed Motion Switch:	Mounted on Trunnion Shaft Opposite Drive End
Safety Guarding:	USA-OSHA Standards

NOTES:

1. **The drum driven sprocket rides in a cradle drive which powers the drum for rotating from below the drum. The reducer and drive motor is supported from the cradle drive structure. (Due to shipping restrictions, the sprocket will be field mounted.)**
2. **Due to shipping restrictions, tires are to be field mounted.**

2.2.5. Drier Discharge and Exhaust System

2.2.5.1. Exhaust System

The drier is an induced draft design, pulling air through the total system. This design keeps the drier under negative pressure thus preventing hot air leaks. Air passes through the heat source carrying the necessary energy to the product for accomplishing the evaporative load. As air passes through the showering product, moisture is evaporated and exhausted while the air moves the product forward through the drier.

Specifications Table 8: Exhaust System

Product Separation:	Settling Chamber
Product Separation Provided By:	Seller
Air Cleaning Method:	Cyclone
Air Cleaning Equipment Provided By:	Seller
System Exhaust Fan Provided By:	Seller
Exhaust Duct Work From Drier to Cyclone Provided By:	Buyer
Exhaust Duct Work From Cyclone to Fan Provided By:	Buyer
Exhaust Duct Work, All Other:	Buyer
Exhaust Duct Material of Construction:	Stainless Steel
Exhaust Duct Material Thickness:	To Be Determined by Others
Exhaust Stack:	By Buyer
VOC Removal:	By Buyer Via Regenerative Thermal Oxidizer

NOTE: Aeroglide to make recommendations on duct sizing and flow rates.

2.2.6. System Exhaust Fan(s)

The system exhaust fan is an industrial duty fan designed for industrial process air handling applications. The fan is designed with a heavy duty impeller for long life and will bear the AMCA Certified rating seal for air performance. All wheels are statically and dynamically balanced after assembly, providing a fine-tuned complete assembly.

Specifications Table 9: System Exhaust Fan

Fan Use:	Exhaust	Cooling Exhaust
Fan Quantity:	2	1
Fan Provided By:	Seller	Seller
Fan Type:	Industrial Scroll Type	Industrial Scroll Type
Air Contact Material:	Carbon Steel	Carbon Steel
Material Not in Air Stream:	Carbon Steel	Carbon Steel
Shaft Material:	Carbon Steel	Carbon Steel
Flanged Inlet and Outlet:	Provided	Provided
Inlet and Outlet Boxes:	**Provided**	**Provided**
Inlet and Outlet Expansion Joints:	**Provided**	**Provided**
Design to Accommodate Field Insulation:	**Provided**	**Not Provided**
Fan Rotation:	TBD	TBD
Direction of Discharge:	TBD	TBD

Type Drive:	**Direct Drive**	Sheaves and V-Belts
Motor Provided By:	Buyer	Buyer
Drive Provided By:	Seller	Seller
Safety Guard Standard:	USA-OSHA Standards	USA-OSHA Standards
Exterior Paint:	Manufacturer's Standard	Manufacturer's Standard
Interior Paint:	Manufacturer's Standard	Manufacturer's Standard
Rotation Switch Provided:	Yes	Yes
Shaft/Cooler Seal:	Yes	Yes
System Exhaust Airflow (Actual):	**93,769 acfm (2,655 m^3/min)**	25,000 acfm (708 m^3/min)
Total Static Pressure:	To Be Confirmed	To Be Confirmed
Static Pressure Allowance for Buyer's Static Exhaust System**:	To Be Confirmed	To Be Confirmed

** If a different resistance is required, contact Aeroglide engineering.

NOTE: Cooler exhaust to be used as drier make up air.

2.2.7. Air Lock(s) (Exact Size to Be Confirmed During Detailed Engineering)

Airlocks provide seals at areas where short circuiting of air will be detrimental or reduce the efficiency of the process.

The rotary airlock acts as an air lock between the in and out ports, impeding the flow of air through its vanes and pockets while moving material continuously through the air lock as it rotates.

Specifications Table 10: Rotary Airlock(s)

Location Of Airlock:	Drier Feed	Settling Chamber Discharge	Cyclone Discharge
Airlock Provided By:	Seller	Seller	Seller
Inlet and Outlet Dimensions:	559 mm x 559 mm (22" x 22")	457 mm x 457 mm (18" x 18")	355 mm x 355 mm (14" x 14")
Product Contact Material of Construction:	**304 Stainless Steel**	Carbon Steel	Carbon Steel
Non-Product Contact Material of Construction:	Carbon Steel	Carbon Steel	Carbon Steel
Drive Type:	Pre-Mounted Gear Motor	Pre-Mounted Gear Motor	Pre-Mounted Gear Motor
Airlock Motor Provided By:	Buyer	Buyer	Buyer
Safety Guarding Standards:	USA-OSHA Standards	USA-OSHA Standards	USA-OSHA Standards
Rotor Tips:	Plain	Plain	Plain
Bearing Arrangement:	Outboard	Outboard	Outboard

2.2.7.1. Settling Chamber

Dried material is discharged from the drier into the settling chamber by lifting flights at the discharge of the rotary drum. The settling chamber, designed with low velocity, gently removes the dried product from the exhaust process air. The settling chamber is easily accessible through an access door for inspection and cleaning. The gentle product handling reduces abrasion during the process of separating the product from the process air, helps maintain product integrity and significantly reduces the amount of fines to be separated by the primary air cleaning system.

The settling chamber transitions at the bottom to a single point where product is discharged through a continuously operating sealed unit. The chamber transitions at the top to a connection for the drier exhaust and if required, additional air cleaning system(s).

Specifications Table 11: Settling Chamber

Material of Construction:	Carbon Steel
Material Thickness:	4.8 mm (3/16 in)
Access Door Size:	760 mm x 760 mm (40 in x 48 in)
Hopper Slope:	55 Degrees or Greater
Chamber Exterior Cladding Paint:	**Included**
Chamber Interior Paint:	None
Chamber Insulation:	**Included**
Settling Chamber Shipping:	Loose
Mount for Thermostat Element:	Included
Mount For Exhaust Limit Element:	Included
Connection for Air Flow Switch (Located In Exhaust Duct Near Fan Inlet):	By Buyer
Connection To Rotary Drum:	Labyrinth Seal
Support Provided By:	Seller

2.2.7.2. Cyclone Collector (s)

The Cyclone Collector(s) employ centrifugal separating force to separate product and fines from the process air. The unit is a long cone, high efficiency design providing product/air separation with minimum gas turbulence. The air inlet and outlet and the product discharge outlet are flanged and pre-punched for bolting connections to the air ducts and locks.

Specifications Table 12: Cyclone Collector

Cyclone Provided By:	Seller
Cyclone Model:	HV 144
Cyclone Diameter:	3.65 m (144 inches)
Overall Cyclone Height:	13.2 m (520 inches)
Material of Construction:	Carbon Steel
Material Thickness:	4.55 mm (7 ga)
Cyclones per Drier:	2
Access Port in Cone:	Yes
Exterior Paint:	Manufacturers Standard
Interior Paint:	Not Required
Support Structure By:	Buyer
Support Structure Material:	Carbon Steel, Painted
Airlock Discharge Provided By:	Seller – See Air Lock Section
Airlock Discharge Height:	0.9 m (36 inches)

2.2.8. Instrumentation

The drier system is a work driven system with the operating temperature being controlled by the drier exhaust temperature. As the work load increases or decreases, the exit temperature is sensed by a temperature sensing element which controls the heat source input. Paralleling the thermostat at the drier discharge is a hot exhaust limit which senses an overheat condition at the drier discharge as part of the drier safety system. Prior to the product entry, the hot air temperature is sensed, providing a high temperature limit.

There is a differential air pressure switch in the exhaust air stream after the drier providing a signal for proof of air flow. A zero motion switch is provided on one of the trunnions at the feed end of the drier providing a signal showing that the drier is rotating.

Specifications Table 13: Instrumentation

Temperature Sensors:	J-Thermocouple
Temperature Sensors Provided By:	Seller
Zero Motion Switch on Trunnion:	Electro Sensor M100 with Magnetic Disc

2.2.9. Control Panel

Aeroglide's standard control panel uses a programmable logic controller to operate and control the drier functionality. This system includes automated start-up sequences, product related operational recipes, and process diagnostics. This simplifies the operating requirements for the drier as well as providing repeatability of the process.

Specifications Table 14: Control Panel

System Configuration:	PLC Control in Buyer's Panel
Operator Interface:	By Buyer
PLC System:	By Buyer
Remote Communications:	By Buyer
Motor Start/Stop:	Supplied by Buyer
Thermostat Control:	By Buyer
Flame Supervisory Panel:	By Seller
High Temperature and Exhaust Limits:	Honeywell 2300 in Seller's Panel
Flame Supervision System:	Honeywell RM7890A in Seller's Panel
Burner Start/Stop:	Operator Interface in Seller's Panel
Drum Speed Indication and Control:	By Buyer
Audible and Visual Alarms (Flame):	Included
Emergency Stop Station:	Included
Drum Drive Soft Start Inverter:	By Seller (Shipped Loose for Install in Buyer's Panel)
Individual Motor Starter/Breakers:	By Buyer
Main Disconnect:	By Buyer
Enclosure Rating, Sellers Panel:	NEMA 12
Enclosure Material (Sellers Panel):	Carbon Steel
Enclosure Mounting:	Free Standing
Electrical Standards Compliance:	UL Components
Maximum Ambient Control Panel Exposure:	43°C (110°F)

2.2.10. Motor List

NOTE: Motors to be provided by Buyer in accordance with below specifications and engineering guidance.

Specifications Table 15: Motor List (Two Production lines)

Unit or Component	Qty	HP (ea)	kW (ea)	Total HP	Total kW
Feed End Air Lock(s):	2	3.00	2.20	6.00	4.40
Drier Drum Drive:	**2**	**150.00**	**110.00**	**300.00**	**220.00**
Settling Chamber Air Lock:	2	3.00	2.20	6.00	4.40
Cyclone Air Lock:	**4**	**1.00**	**0.75**	**4.00**	**3.00**
Main Exhaust Fan:	**2**	**400.00**	**300.00**	**800.00**	**600.00**
Combustion Air Blower(s):	2	75.00	55.00	150.00	110.00
Continuous Product Mixer:	**2**	**40.00**	**30.00**	**80.00**	**60.00**
Total Connected Power (Two Driers):				**1346.00**	**1001.80**
Optional Cooling					
Cooling Drum Drive:	**1**	**75.00**	**37.00**	**75.00**	**37.00**
Cooling Feed Screw:	**1**	**7.50**	**5.50**	**7.50**	**5.50**
Cooling Exhaust Fan:	**1**	**100.00**	**75.00**	**100.00**	**75.00**
Cooling Cyclone Air Lock:	1	1.00	0.75	1.00	0.75
Total Connected Power (One Cooler):				**183.50**	**118.25**
Total Connected Power (Both Lines):				**1529.50**	**1120.05**

Fans:	
Motor Type:	TEFC Energy Efficient 1.15 S.F. Class F Insulation and Class B Temperature Rise NEMA Frame
Motor Brand (Fans and Independent Motors):	Baldor
Combustion Blowers:	
Motor Type:	TEFC Energy Efficient 1.15 S.F. Class F Insulation and Class B Temperature Rise NEMA Frame
Motor Brand:	Burner Manufacturer Standard
Reducer Drives:	
Motor Type:	TEFC Energy Efficient 1.15 S.F. Class F Insulation and Class B Temperature Rise NEMA Frame
Motor Brand:	Reducer Manufacturer Standard Eurodrive (only)
Airlocks:	
Motor Type:	TEFC Energy Efficient 1.15 S.F. Class F Insulation and Class B Temperature Rise NEMA Frame
Motor Brand:	Airlock Manufacturer Standard

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Machine Specifications

Chapter 2

Design Conditions

	Imperial	Metric
Product:	Distillers Grain	
Wet product into drier (Total) (lbs/hr) (kg/hr)	151,463 lbs/hr	68,702 kg/hr
Total wet product consists of:		
Wet cake	29,205 lbs/hr	13, 247 kg/hr
Syrup	37,305 lbs/hr	16,921 kg/hr
Dry Remix	84,953 lbs/hr	38,534 kg/hr
Moisture content of wet product (% wwb)	37 %	
Temperature of product into drier (°F) (°C)	179 °F	82 °C
Dry product out of drier (lbs/hr) (kg/hr)	21,071 lbs/hr	9,556 kg/hr
Moisture content of dry product (%)	10 %	
Temperature of product exiting drier (°F) (°C)	185 °F	85 °C
Dry bulb air temperature to drier (°F) (°C)	750 °F	399 °C
Wet bulb air temperature to drier (°F) (°C)	167 °F	75 °C

NOTE: This equipment is designed for and intended for use with the product(s) and process(es) defined above. If your operating requirements involve different product(s) or process parameters, it is strongly recommended that you contact Aeroglide for assistance prior to product and/or process changes.