Commonwealth of Kentucky
Division for Air Quality

PERMIT STATEMENT OF BASIS

(DRAFT)
Conditional Major / Synthetic Minor, Construction / Operating
Permit: F-07-025
Kentucky 5 Star Energy, LLC
Robards, KY 42452
July 9, 2007
IL-Won Shin, Reviewer

SOURCE ID:	21-101-00139
AGENCY INTEREST:	84701
ACTIVITY:	APE20070001

SOURCE DESCRIPTION:

Kentucky 5 Star Energy, LLC (Kentucky 5 Star) is a proposed new fuel-grade ethanol production facility in Robards, Henderson County near Sebree, Kentucky. The facility has a proposed design capacity of 50 million gallons per year, with a maximum production capacity of 60 million gallons per year of undenatured ethanol or 63 million gallons of denatured ethanol on an annual basis. Emission sources at the facility include grain receiving, fermentation, distillation, dried distillers grain with solubles (DDGS) handling, DDGS drying, combustion, storage tanks, production loadout, and fugitives. The basis for the production of ethanol is to convert cornstarch to sugars and then convert the sugars to ethanol (i.e. grain alcohol).

Grain Handling and Milling Operations

The grain handling operations consist of unloading of grain by trucks or railcars at a maximum rate of 20,000 bushels per hour, (three 500,000-bushel capacity storage silos, two grain elevators, and associated conveyors). Grain is received at the plant in 25-ton hopper bottom trucks or railcars at two dump pits (one for trucks and one for railcar) that are located inside a partially enclosed building. The dump pits are fitted with conveyor belts, which feed the elevator leg and grain-to-grain storage silos. The dump pits and associated grain transfer points are controlled by the grain receiving baghouse (**Stack/Vent, SV01**). Each of the vent stacks on the grain storage silos will be equipped with filters to control PM/PM_{10} emissions (**SV02, SV03, and SV04**). Grain exits the grain storage silos through an enclosed reclaim system prior to the start of hammermilling operations. The annual grain-unloading rate estimated based on the maximum anhydrous ethanol production rate of 60 million gallons per year is 629,213 tons per year (tpy).

The grain milling operations consist of a grain surge bin, one enclosed scalper (screening bin), two hammermills, and associated enclosed elevators and conveyors. Grain is fed by the enclosed reclaim system from the grain storage silos, which moves it from the adjacent surge bins to the scalper at a maximum rate 20,000 bushels per hour. The scalpers remove sticks, cobs, and other unusable debris from the grain. Total particulate matter/particulate matter less than 10 microns (PM/PM_{10}) emissions from the surge bin are controlled by bin vent filters (**SV05**). The enclosed bulkweigher conveyor from the scalper transfers the scalped grain into the hammermills. The hammermills grind the scalped grain to the required particle size. The two hammermills are controlled by two baghouses, hammermill baghouse #1 (**SV06**) and hammermill baghouse #2 (**SV07**) to control PM/PM_{10} emissions.

The solids collected in all of the baghouses are returned to the process downstream of the hammermills. The emissions are estimated based on a baghouse outlet grain loading of 0.01 grain(s) per dry standard cubic foot (gr/dscf) and design air flow rates.

The proposed grain receiving area is partially enclosed and the dump pits are aspirated to a fabric filter dust collector (baghouse), the grain unloading dust collection system is estimated to have 90% capture efficiency whereas the remaining 10% of grain handling emissions are identified as and quantified for as fugitive dust emissions.

Fermentation and Distillation Operations

The fermentation and distillation operations consist of a slurry tank, yeast tank, liquefaction tank, four fermenters, beerwell, a three-column distillation unit, two molecular sieves, whole stillage tank, four centrifuges, thin stillage tank, process condensate tank, syrup tank, 200-proof condenser, and an evaporator.

Pre-Fermentation:

Milled grain is transferred from the ground storage bin directly to the slurry tank. A conveyor transfers the milled grain to the mash mingler under flow-ratio control. The mash mingler mixes the grain with process water and hot water. The meal slurry is then discharged by gravity from the mash mingler to the slurry tank. The slurry will be cooked, liquefacted with enzymes, and the resultant mash cooled. The slurry tank provides surge capacity in the cooking system, allows for pre-liquefaction of the starch, and if necessary, controls viscosity. Mash from the slurry tank is pumped by a cooker feed pump to a cooker raising the mash temperature to the sterilization temperature. The cook provides sterilization of the mass and gelatinization of starch in about 10 minutes. Mash leaves the cooker and is cooled by flashing in the liquefaction tanks. The flash vapor is recovered as a source of energy for stillage evaporation. Liquefying enzyme is then added to the mash in the liquefaction tanks to begin the hydrolysis of the previously gelatinized starch. After liquefaction, previously hydrated and actively growing yeast is added. Backset (thin stillage recycle) or sulfuric acid may be added to the mash to lower the pH. A mash cooler pump pumps the mash from the base of the liquefaction tank through a set of heat exchangers called “mash coolers”. Cooling tower water provides for primary cooling to ultimately reduce the mash temperature to about 90 °F.

Fermentation:

The cooled mash will be mixed with yeast and more enzymes in one of three fermenters. Saccharifying enzymes, nutrients, and industrial antibiotics are added to the fermenter during filling. The fermenter contents are recirculated by fermenter pumps, through the fermenter coolers, to remove heat generated by fermentation. The carbon dioxide (CO_2) generated during fermentation is vented to the fermentation scrubber for recovery of ethanol vapors. After approximately 48 hours of fermentation the resultant liquid (beer) will contain 11% - 15% ethanol by weight. When fermentation is completed, the beer is transferred to the beerwell via the fermenter pumps. Cleaning and sterilizing the fermenters, fermenter coolers, mash coolers, and related process piping is accomplished by an automated clean-in-place (CIP) system.

Distillation, Dehydration, Centrifugation, and Evaporation:

The beerwell serves as a surge tank connecting the simultaneous saccharification and fermentation system with distillation. The contents of the beerwell are kept circulated by the beerwell agitator. The beer is pumped by the distillation beer feed pump through the beer preheat train to two beer stills in series. The beer stills' function is to separate the ethanol from the residual grain solids. The remaining grain solids, known as stillage, are sent to the whole stillage tank to be further processed for use as cattle feed. Hot vapor from the beer stills is used to pre-heat the beer in the beer preheat train. Sulfuric acid may be added between the fermentation and distillation processes for pH adjustment.

The beer will distill in a one-column distillation process; the resultant product is 95% ethanol and 5% water (190-proof) and whole stillage consisting of solids and water. Hydrous ethanol vapor from distillation is drawn and superheated in the molecular sieve using steam. The superheated ethanol vapor flows to the molecular sieve unit in a process known as dehydration. The dehydration process is used to increase the ethanol concentration from 92% to 99.3%. The vapor passes up through one bed of molecular sieve beads, which is under pressure control. Incoming water is adsorbed on the molecular sieve material. The molecular sieve unit is cycled so that one is regenerating under vacuum while the other is adsorbing water under pressure from the hydrous ethanol vapor stream. The regenerating stream is sent back to distillation for processing. Using the molecular sieve, the remaining 5% water will be removed from the product resulting in 100% ethanol (200-proof). The anhydrous ethanol product flows through the molecular sieve cooler to the two product shift tanks. The product will then be combined with 5% natural gasoline and sold as near 200-proof denatured ethanol.

The denatured ethanol will be shipped via tanker truck and rail car. The emissions from the denatured ethanol truck and rail loadout processes will be routed to the regenerative thermal oxidizer (RTO). All ethanol storage tanks and denaturant storage tanks will have floating roofs to increase the control of emissions.

Stillage from the whole stillage tank is pumped to the stillage centrifuges. The stillage centrifuge splits the feed into two flows: the wet cake and the centrate. The wet cake, also called wet distillers grain with solubles (WDGS), consists of approximately 32-35% solids (mostly suspended solids) and 65-68% water. The centrifuge is positioned to discharge the cake onto a conveyor that transfers the wet cake to the DDGS drying area. The centrate, called thin stillage, consists of approximately 8.0% total solids. The thin stillage is stored in the thin stillage tank located adjacent to the centrifuge units. A thin stillage tank pump re-circulates the contents in the centrate surge tank to ensure a well-mixed solution. Centrate is pumped from the thin stillage tank to the evaporators. The multiple-effect evaporator system removes water from the thin stillage on a continuous, steady-state basis, concentrating the total solids fraction from 8% to approximately 34% solids in the concentrated dissolved solids syrup (CDS). The evaporator system's vacuum pumps discharge into the vent gas scrubber through the CO_2 collection system. The evaporator condensate is recycled back to the process as dilution water for the mashing process and CIP rinses. CDS is added to the wet cake before drying to make DDGS, or added to the wet cake product.

The fermentation (CO_2) scrubber (**SV08**) is utilized to control volatile organic compounds (VOC) emissions from the fermentation operation, while the VOC emissions from the distillation process are controlled by a vent gas scrubber (**SV09**). Emissions from the CO_2 scrubber and the vent gas scrubber have been estimated based on stack testing results from similarly designed ethanol plants and scaled accordingly.

Wet Distiller's Grain with Solubles (WDGS)

The wet cake may be stored in an open storage area, from which it may be loaded onto trucks for delivery to cattle feed lots in the area. At about 65% water content, the wet cake will remain moist on the storage pad. Because the wet cake will be transferred offsite quickly (e.g., in 1 or 2 days), the cake will not dry completely in any type of extreme weather. Therefore, wet cake storage and handling (**Fugitive Emissions, FS07**) is expected to produce negligible PM_{10} emissions.

Potential VOC and hazardous air pollutant (HAP) emissions from wet cake storage were estimated based on November 2, 2004 emission testing at wet cake storage building at DENCO, LLC in Morris, MN and scaled accordingly.

Distiller's Dry Grain with Solubles (DDGS)

If the wet cake is not to be delivered for wet feed, the mixture is conveyed into two direct heated, natural gas fired rotary dryer where the cake solids concentration increases from 34% to 90%. The resulting saleable spent grain by-product, DDGS, is stored in a building until it is shipped off site by truck or rail for use as cattle feed.

A RTO will control the VOC and carbon monoxide (CO) emissions created in the DDGS drying process, while a multiple cyclones (multiclone) will control PM/PM_{10} emissions, which will vent out of stack (**SV10**). VOC emissions generated in the DDGS Cooler will also be controlled by the RTO. The DDGS will be loaded into trucks and rail via drag and screw conveyors. Actual loading will occur inside a building to control the dust, and a baghouse will be installed to control dust at the transfer point of the material handling (**SV11**). Two baghouses, DDGS Loadout Baghouse #1 (**SV12**) and DDGS Loadout Baghouse #2 (**SV13**), will control the PM/PM_{10} emissions from the truck and rail loadout, respectively. Potential emissions from the RTO stacks assume 100% DDGS production as a worst-case scenario.

Boilers

The facility will use two (2) natural gas fired boilers (**SV14 and SV15**) with a maximum capacity of 92.4 mmBtu/hr each to provide steam to power the process.

Boiler construction will include low nitrogen oxide (Low-NO_X) boiler burners, and the boilers will be limited to natural gas only. Resulting emissions for NO_X and CO are based on vendor supplied emission factors. Kentucky 5 Star will comply with all applicable requirements of 40 CFR 60 Subpart Dc.

Ethanol Loadout Operations

Liquid product loading consists of submerged loading of denatured fuel ethanol into tanker trucks and tanker railcars. The emissions from the truck and railcar loadout will be collected by a vapor recovery system then routed to the RTO (**SV10**).

Fugitive VOC Emissions

Fugitive VOC emissions will occur from leaks in plant piping, such as flanges, pumps, and valves (**FS05**). These estimates for equipment leaks are based on Environmental Protection Agency (EPA) emission factors. A credit for the leak detection and repair program required per NSPS Subpart VV has been applied. The component count used in the calculations is based on an estimated of the proposed equipment at the facility.

Cooling Towers

Kentucky 5 Star will use a cooling tower that is used to cool non-contact process water back to a temperature that is useful for the process. PM/PM_{10} emissions at the cooling tower (**FS02**) are calculated with a mass balance approach using data on water circulation rate, total dissolved solids (TDS) concentration, and cooling tower drift losses. This method assumes that the TDS present in water evaporated at the cooling tower produce PM/PM_{10} emissions.

Storage Tanks

The finished ethanol product is blended with a denaturant prior to storage and loadout. Denaturant used to blend with the ethanol product will be stored in one (1) 63,320 gallon denaturant tank (**TK-003**). Two 175,000-gallon anhydrous ethanol tanks (**TK001 and TK002**) will be used to store finished ethanol prior to blending and shipment. Denatured ethanol will be stored in two 619,570-gallon tanks (**TK004 and TK005**). All tanks will utilize an internal floating roof for VOC and HAP emission control. Potential VOC emissions for all tanks were calculated using the EPA TANK 4.09 model.

Plant Roads

The facility in-plant haul roads (**FS06**) will be paved. Fugitive dust emissions from traffic on these roads have been calculated using AP-42 emission factors and typical characteristics for paved roads. A silt load factor of 0.8 g/m^2 has been used in the haul road calculations to add conservatism.

Others

The facility has an emergency generator (**SV16**) as well as other fugitive emissions such as DDGS storage building (**FS01**), uncaptured grain receiving emissions (**FS03**), and uncaptured DDGS loadout emissions (**FS04**).

COMMENTS:

The air emission stack parameters of Kentucky 5 Star facility are shown as in Table 1.

Table 1. Air Emission Stack Parameters
Kentucky 5 Star Energy, LLC

Stack/ Vent ID	Description	Height (feet)	Diameter (feet)	Flow (acfm)	Temperature (degrees F)
SV01	Grain Receiving Baghouse	60	2.83	30,000	68 (Ambient)
SV02	Corn Bin #1 Vent Filter	164	5.71	1,000	68 (Ambient)
SV03	Corn Bin #2 Vent Filter	164	5.71	1,000	68 (Ambient)
SV04	Corn Bin #3 Vent Filter	164	5.71	1,000	68 (Ambient)
SV05	Surge Bin Vent Filter	87	2.88	400	68 (Ambient)
SV06	Hammermilling Baghouse #1	45	1.5	6,000	68 (Ambient)
SV07	Hammermilling Baghouse #2	45	1.5	6,000	68 (Ambient)
SV08	Fermentation CO_2 Scrubber	50	2	7,020	68 (Ambient)
SV09	Distillation Vent Gas Scrubber	32.25	3	800	68 (Ambient)
SV10	RTO	90	6.5	105,806	318
SV11	DDGS Handling Baghouse	17	1.5	2,500	68 (Ambient)
SV12	DDGS Loadout Baghouse #1	26	1.5	2,000	250
SV13	DDGS Loadout Baghouse #2	26	1.5	3,000	250
SV14	Boiler #1	45	3	30,000	250
SV15	Boiler #2	45	3	30,000	250
SV16	Emergency Generator	15	1.7	17,019	500

Type of control and efficiency:

Table 2. Emission Source and Control Equipment Inventory
Kentucky 5 Star Energy, LLC

Stack/ Vent ID	Emission Unit ID	Name / Description	Type of Control	Efficiency
SV01	EU01	Truck Dump Pit	Grain Receiving Baghouse	99% (PM/PM_{10})
	EU02	Rail Dump Pit		
	EU03	Corn Conveyor #1		
	EU04	Corn Elevator #1		
	EU05	Corn Conveyor #2		
	EU06	Corn Elevator #2		
	EU07	Scalper		
SV02	EU08	Corn Bin #1	Corn Bin #1 Vent Filter	99% (PM/PM_{10})
SV03	EU09	Corn Bin #2	Corn Bin #2 Vent Filter	99% (PM/PM_{10})
SV04	EU10	Corn Bin #3	Corn Bin #3 Vent Filter	99% (PM/PM_{10})
SV05	EU11	Surge Bin	Surge Bin Vent Filter	99% (PM/PM_{10})
SV06	EU12	Corn Conveyor #3	Hammermilling Baghouse #1	99% (PM/PM_{10})
	EU13	Corn Elevator #3		
	EU14	Hammermill #1		
SV07	EU15	Corn Conveyor #4	Hammermilling Baghouse #2	99% (PM/PM_{10})
	EU16	Corn Elevator #4		
	EU17	Hammermill #2		
SV08	EU18	Yeast Tank	Fermentation CO_2 Scrubber	97% (VOC & HAP)
	EU19	Fermenter #1		
	EU20	Fermenter #2		
	EU21	Fermenter #3		

	EU22	Fermenter #4		
	EU23	Beerwell		
SV09	EU24	Slurry Tank	Vent Gas Scrubber	97% (VOC & HAP)
	EU25	Liquefaction Tank		
	EU26	Beer Column		
	EU27	Side Stripper		
	EU28	Rectifier Column		
	EU29	Molecular Sieve #1		
	EU30	Molecular Sieve #2		
	EU31	Process Condensate Tank		
	EU32	Evaporator		
	EU33	Whole Stillage Tank		
	EU34	Thin Stillage Tank		
	EU35	Centrifuge #1		
	EU36	Centrifuge #2		
	EU37	Centrifuge #3		
	EU38	Centrifuge #4		
	EU39	Syrup Tank		
	EU40	200 Proof Condenser		
SV10	EU41	DDGS Dryer	RTO	80% (PM/PM_{10} & CO) 98% (VOC)
	EU42	DDGS Cooler		
	EU43	Ethanol Loadout (Truck)		
	EU44	Ethanol Loadout (Rail)		
	EU45	RTO		
SV11	EU46	DDGS Conveyor	DDGS Handling Baghouse	99% (PM/PM_{10})
SV12	EU47	DDGS Truck Loadout	DDGS Handling Baghouse #1	99% (PM/PM_{10})

SV13	EU48	DDGS Rail Loadout	DDGS Handling Baghouse #2	99% (PM/PM_{10})
SV14	EU49	Boiler #1	--	
SV15	EU50	Boiler #2	--	
SV16	EU51	Emergency Generator #1	--	
Tanks	TK001	200 Proof Ethanol Storage Tank	--	
	TK002	200 Proof Ethanol Storage Tank		
	TK003	Denaturant Storage Tank		
	TK004	Denatured Ethanol Storage Tank		
	TK005	Denatured Ethanol Storage Tank		
Fugitive	FS01	DDGS Storage Building	--	
	FS02	Cooling Towers		
	FS03	Uncaptured Grain Receiving Emissions		
	FS04	Uncaptured DDGS Loadout Emissions		
	FS05	Equipment Leaks		
	FS06	Truck Traffic		
	FS07	Wet Cake Storage Area		

Emission factors and their source:

The Kentucky 5 Star ethanol facility has calculated maximum emissions with emission factors based on AP-42, manufacturer's guarantees, stack test data from similar sources, and engineering analysis. In addition, the TANK 4.09 software program was used to perform tank emissions calculations.

Applicable regulations:

401 KAR 59:010, *New process operations*, is applicable to an emissions unit commenced on or after July 2, 1975.

401 KAR 59:015, *New indirect heat exchangers*, is applicable to an emissions unit with a capacity of less than 250 mmBtu/hr which commenced on or after April 9, 1972.

401 KAR 63:010, *Fugitive Emissions*, is applicable to each affected facility as an apparatus, operation, or road which emits or may emit fugitive emissions provided that the fugitive emissions from such facility are not elsewhere subject to an opacity standard within the administrative regulations of the Division for Air Quality.

401 KAR 63:020, *Potentially hazardous matter or toxic substances*, is applicable to an emissions unit which emits or may emit potentially hazardous matter or toxic substances, provided such emissions are not elsewhere subject to the provisions of the administrative regulations of the Division for Air Quality.

40 CFR 60 Subpart Dc, *Standards of Performance for Small Industrial-Commercial-Institutional Steam Generating Units*, is applicable to two boilers (SV14 and SV15) since each boiler for which construction, modification, or reconstruction is commenced after June 9, 1989 and that has a maximum design heat input capacity of 29 megawatts (MW) (100 mmBtu/hr) or less, but greater than or equal to 2.9 MW (10 mmBtu/hr). The DDGS dryer and the RTO are not steam generating units, and therefore, are not subject to this regulation.

40 CFR 60 Subpart Kb, *Standards of Performance for Volatile Organic Liquid Storage Vessels (Including Petroleum Liquid Storage Vessels) for Which Construction, Reconstruction, or Modification Commenced after July 23, 1984*, is applicable to storage tanks since which storage vessel has a capacity greater than 75 cubic meters (19,812.9 gallon) that is used to store volatile organic liquids (VOL) for which construction, reconstruction, or modification is commenced after July 23, 1984. The requirements may apply in part or in full depending on the size of the tank and vapor pressure of its contents.

40 CFR 60 Subpart VV, *Standards of Performance for Equipment Leaks of VOC in the Synthetic Organic Chemicals Manufacturing Industry*, is applicable to affected facilities in the synthetic organic chemicals manufacturing industry that commences construction or modification after January 5, 1981. The Subpart VV regulates emissions of VOCs from equipment leaks (valves, flanges, pump seals, etc).

40 CFR 60 Subpart IIII, *Standards of Performance for Stationary Compression Ignition Internal Combustion Engines*, is applicable to the emergency generator and fire pump since owners and operators of stationary compression ignition (CI) internal combustion engines (ICE) is commenced construction after July 11, 2005. (NO_X emission rate based on requirements to meet NSPS Subpart IIII)

<u>Regulations not applicable</u>:

40 CFR 60 Subpart DD, *Standards of Performance for Grain Elevators*, is not applicable to the Kentucky 5 Star ethanol plant. Under Subpart DD, a "grain storage elevator" is defined as having a permanent storage capacity in excess of 1 million bushels at any dry corn mill (human consumption). The Kentucky 5 Star plant grain storage system is not applicable to the "grain storage elevator" definition. Further, the total grain storage capacity at Kentucky 5 Star is designed at less than 2.5 million bushels.

Ethanol plants that utilize grain feedstocks are not covered by NSPS regulations applicable to the synthetic organic chemical manufacturing industry (SOCMI), including Subpart RRR (SOCMI reactor process), Subpart NNN (SOCMI distillation process), and the proposed Subpart YYY (SOCMI wastewater systems).

EMISSION AND OPERATING CAPS DESCRIPTION:

In order to ensure that the facility remains exempt from the regulations for major sources of criteria and HAP emissions, Kentucky 5 Star is requesting a conditional major permit. Emissions will be limited to less than 90 ton/yr VOC, 22.5 ton/yr of total HAP, and 9 ton/yr of an individual HAP. Kentucky 5 Star has also requested source-wide limits for PM, PM_{10}, SO_2, NO_x, and CO. Monthly and rolling 12-month total emissions will be calculated. Emission calculations and supporting documentation will be retained at the facility.

PERIODIC MONITORING:

See the permit for Specific Monitoring Requirements, which include the grain processed rate; fuel grade ethanol production rate; monitoring of the baghouse, vent filter, RTO, and scrubber; and 40 CFR 60 VV compliance monitoring for fugitives.

OPERATIONAL FLEXIBILITY:

None

CREDIBLE EVIDENCE:

This permit contains provisions which require that specific test methods, monitoring or recordkeeping be used as a demonstration of compliance with permit limits. On February 24, 1997, the U.S. EPA promulgated revisions to the following federal regulations: 40 CFR Part 51, Sec. 51.212; 40 CFR Part 52, Sec. 52.12; 40 CFR Part 52, Sec. 52.30; 40 CFR Part 60, Sec. 60.11 and 40 CFR Part 61, Sec. 61.12, that allow the use of credible evidence to establish compliance with applicable requirements. At the issuance of this permit, Kentucky has only adopted the provisions of 40 CFR Part 60, Sec. 60.11 and 40 CFR Part 61, Sec. 61.12 into its air quality regulations.