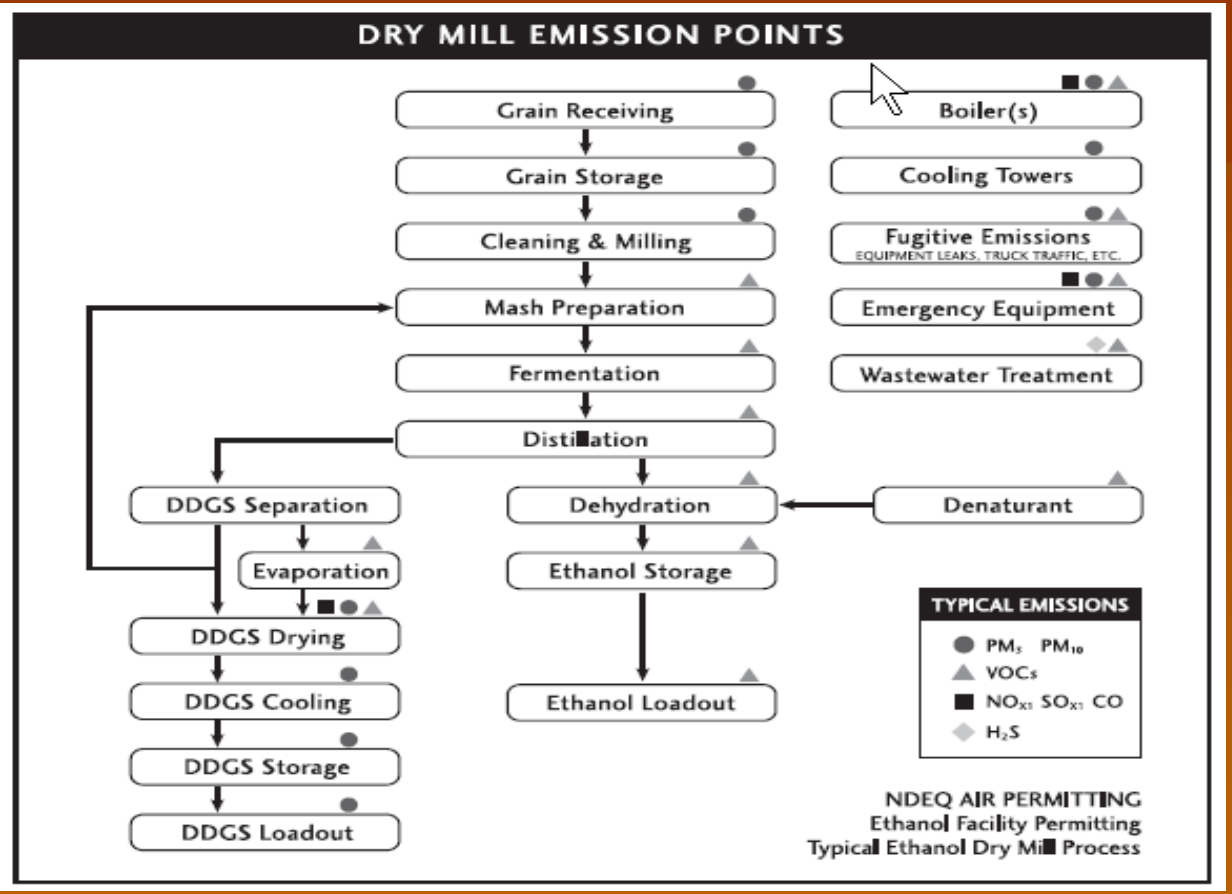
ETHANOL MANUFACTURING FACILITY RESPONSE OVERVIEW

Description of Ethanol Fuel and the Production Process

- Ethanol, which contains hydrogen, carbon, and oxygen in its chemical structure, is also known as ethyl alcohol or grain alcohol.
- Ethanol can be used as a fuel for spark-ignited internal combustion engines. When burned in engines without active catalytic converters on the engine exhaust, the presence of oxygen allows ethanol to burn with lower carbon monoxide emissions than gasoline, although aldehyde emissions tend to be higher.
- In the U.S., ethanol is primarily produced from corn. To prevent ingestion, ethanol is denatured at the plant by mixing the ethanol with some type of hydrocarbon, such as gasoline. Denatured ethanol may contain 2-15 percent (%) gasoline, making it an ethanol and gasoline fuel blend. For example, ethanol E-85 contains 85% ethanol and 15% gasoline.
- The ethanol production process takes place through two methods: dry milling and wet milling. The dry milling method is more common and accounts for 82 % of U.S. ethanol production.

Dry Mill Process



- *Source: Nebraska Department of Environmental Quality*
- *CO – carbon monoxide*
- *DDGS - Dried Distillers Grains with Solubles*
- ***H2S – hydrogen sulfide***
- *NOx – oxides of nitrogen*

PM5 – particulate matter less than five micrometers
PM10 – particulate matter less than ten micrometers
SOx – oxides of sulfur
VOCs – volatile organic compounds

Major Chemicals Involved in Ethanol Production

- Corn – Used product
- Sodium Hydroxide – pH control during fermentation
- Ammonia – pH control and yeast nutrient during fermentation
- Sulfuric Acid – separates corn into starch, germ, fiber, and protein
- Fuel for process heat
- Yeast – used in fermentation
- Enzymes (amylase) – converts starch to dextrose
- Antibiotic such as penicillin – controls bacteria during fermentation
- Carbon Dioxide - byproduct
- Hydrogen Sulfide – process emission
- Sulfur dioxide – process emission
- Nitric oxide – process emission
- VOCs – process emission
- Ethanol – final product
- Gasoline – final product additive (if used)
- Denatured Ethanol – final blended product

Appropriate Mitigation Measures for Release of Ethanol Fuel

- **Proper Air Monitoring Equipment**
  - Combustible Gas Indicator (CGI) and Flame Ionizing Detector (FID) or MultiRAE Plus Five-Gas Air Monitoring Instrument; Photo Ionizing Detector (PID). Must review response factors prior to using PID.

- **Proper Spill Containment**
  - Ventilate area and eliminate ignition sources. Fire-fighting measures must use **ALCOHOL-RESISTANT FOAMS**. Containment/response should follow typical containment procedures. Example: use non-combustible oil-dry, absorbent socks, booms, etc that are **ALCOHOL-RESISTANT**. Avoid entry into sewers and waterways due to flammability hazards, potential aquatic toxicity, and potential microbial upsets at wastewater treatment plants. Waste generated from the clean-up may exhibit the flammability characteristic for hazardous waste.

Note: The Response Overview includes measures for the other major chemicals involved in the manufacturing process.

EXPECTED FATE OF ETHANOL

- **Release in Soil**
  -Ethanol is rapidly biodegraded in soil.

- **Release in Water**
  -Fuel ethanol will mix with water, and at high enough concentrations of water, the ethanol will separate from the gasoline. Ethanol is rapidly biodegraded in groundwater and surface water. However, some studies are focusing on the possibility of ethanol inducing the transport of other chemicals such as benzene.

- **Release in Air as result of spill/fire**
  -Ethanol vapor, like gasoline vapor, is denser than air and tends to settle in low areas. However, ethanol vapor disperses rapidly.

- **Release to storm/sanitary sewers**
  -Ethanol released to water will volatilize and rapidly biodegrade. The potential decrease in dissolved oxygen as a result of ethanol degradation can upset microbial functions at wastewater treatment plants. The potential flammability hazard must be addressed when ethanol is released to a sanitary or storm system.

Overall Health Risks of Ethanol

- Human Health Effects
  - Exposure to fuel ethanol can occur by breathing its vapors (inhalation), getting it on the skin or in the eyes (skin absorption), or accidentally swallowing it (ingestion).
  - The following symptoms of exposure to fuel ethanol may appear immediately: Dullness of memory and concentration; impaired motor coordination; and drowsiness, stupor, and finally coma. May cause skin irritation as a result of defatting.
  - Carcinogenic compounds are not present in pure ethanol; however, because gasoline is used in the blend, E85 is considered to be potentially carcinogenic.
- **Ecological Effects**
  - Pure ethanol has demonstrated lethal concentrations for fish (rainbow trout) at 11,200 to 15,300 milligrams per liter (mg/L).
  - Pure ethanol is expected to biodegrade rapidly and bioaccumulation or concentration in the food chain is not expected. However, the biodegradation may decrease the dissolved oxygen in surface water resulting in fish kills.

The following are Federal regulations that would apply to ethanol manufacturing facilities when they meet the thresholds for the requirements of the regulation. Note that state-specific regulations may also apply.

- Emergency Planning and Community Right Know ACT (EPCRA)
- U.S. EPA Oil Pollution Control/Federal Water Pollution Control Act
- Clean Water Act
- Oil Pollution Act of 1990 (OPA 90)
- Resource Conservation and Recovery Act (RCRA)
- Clean Air Act (CAA)
- DOT Hazardous Materials Regulations (HMR); as amended by Homeland Security Act of 2002

Current Ethanol Plants

http://www.card.iastate.edu/research/bio/tools/ethanol.aspx as of 01/16/2008