

# MEMO

**To:** FCC Design Teams

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Design Supervisors

**Date:** January 12, 2010

**Subject:** Potential plant expansion opportunities for FCC

With recent evidence that the economy is beginning to expand again, FCC would like to be prepared to capture new markets. FCC upper management has prepared a list of potential opportunities that they would like the design division to explore. They would like us to complete a first level scoping study of the projects listed on the following pages.

We would like you to work in teams of four people, if possible, and submit your final report no later than March 15, 2010.

We will need to work with the following business objectives:

Maximum capital available:	\$200 MM
Type of plant:	Battery limits
Location of plant:	FCC Refinery, Arlen, TX, unless noted otherwise on project statement
Project life:	10 years
Minimum acceptable return (MAR):	15%
Max. capacity of plant:	110% of nominal capacity
Minimum turndown:	80% of nominal capacity
Maximum construction time:	2 years
Plant must meet all corporate, local, state and federal design, safety and environmental standards.	

As usual, you will be asked to submit progress reports and provide oral updates as the work progresses.

You will also need to work with FCC management, marketing, safety and environmental folks to insure the success of this project.

Please contact one of us if you need additional information on this new project.

**CM4861 Design Projects  
Spring Semester 2010**

***Commodity Chemicals:***

1. Insect repellents. Insect repellents based upon geraniol are described in a patent by International Flavors and Fragrances, IFF (U.S. 5,521,165). Should FCC consider entering this market?
2. Halobutyl rubber. FCC management has asked us to investigate the production of halobutyl rubber to be used in tires.
3. Fluoropolymers and fluorotelomer products. Fluoropolymers are used in architectural fabrics; chemical processing piping and vessels; automotive fuel systems; telecommunications and electronic wiring insulation; and computer chip processing equipment and systems – in addition to consumer products such as cookware and apparel. Fluorotelomer derivatives are a family of compounds used as ingredients in making firefighting foams and coatings because of their unique properties. They also are intermediates, or building blocks, used to manufacture stain-, oil- and water-resistant additives for some textiles, paper, coatings, and other surfaces. Should FCC consider entering this market?
4. MDI. FCC management has asked us to perform an analysis of the production of methylene diphenyl diisocyanate (MDI) - also called diphenylmethane diisocyanate - as a potential diversification chemical.
5. Phthalic anhydride. FCC management has asked us to evaluate the feasibility of manufacturing phthalic anhydride as a potential diversification chemical.
6. Isomerization of n-butane. Since an isobutane-rich product is more valuable than a mixed-butane stream, consider a battery limits plant expansion to FCC's Arlen Refinery to catalytically convert n-butane to isobutane.
7. Isoprene. Isoprene has been proposed as a possible diversification chemical for FCC. Please prepare a feasibility analysis of this opportunity.
8. Ethanolamine. Herbicide and gas-treating products can be derived from ethanolamine. FCC management has asked us to investigate this diversification chemical.
9. Propylene glycol. FCC management has asked us to evaluate the feasibility of manufacturing propylene glycol as a potential diversification chemical.
10. Vinyl acetate. FCC management has asked us to investigate entry into the vinyl acetate market as a potential way to diversify our product line. They would also like us to review the impact of increasingly stringent VOC regulations on the coating market to see if this will impact such a plant and to identify other possible opportunities that may open up as a result of these regulations.
11. Biochemical production of acetone. FCC management has asked us to consider the biochemical production of acetone as a diversification project.

### ***Energy:***

1. Glycerol conversion. A problem common to all biodiesel plants is the production of large quantities of byproduct glycerol. FCC management has asked us to investigate the economics of converting the byproduct glycerol to one or more value-added products.
2. Natural oil polyols. As the price of oil hovers around \$75 per bbl, interest in biofeedstocks is rapidly growing. We have been asked to consider the manufacture of natural oil polyols (NOP) from biofeedstocks.
3. Ethylene from ethanol. The most economical route for manufacturing ethanol is from fossil feedstocks via ethylene. Ethanol from renewable feedstocks has been subsidized in an effort to reduce dependence on foreign oil but this route is falling into disfavor as the true costs become recognized. This could lead to the availability of ethanol plants at distressed prices. Should FCC consider ethylene production using some of these plants?
4. Biomass to transportation fuels. FCC has available large quantities of wood waste to possibly convert to liquid fuels. A recent article in *Chemical Engineering* magazine (*Chem Eng*, Nov 2005, pp 23-7) has caught the attention of our Division Director, and he would like us to design and evaluate a plant to convert the waste to fuels using the Fischer-Tropsch technology. He asks that we use a design basis of 400 tons per day of wood waste.
5. Diesel fuel from vegetable oil. Fossil fuel reserves continue to decline and this is a major concern to the U.S. FCC management has asked us to evaluate the feasibility of a plant to manufacture diesel fuel from renewable resources such as vegetable oil. (See *C&EN*, 27 May 2002.)
6. Methanol from natural gas. FCC continues to seek ways to convert excess natural gas in remote parts of the world to transportable fuels with high energy storage density that would allow economical shipment to the U.S. In 2004, our review of LNG technology showed that it was not yet attractive for our needs. Potential applications of fuel cells may alter the economics of using methanol for this purpose, however, and we have been asked by FCC headquarters to analyze the current economics of converting natural gas to methanol and transporting it to the U.S. from our holdings in Venezuela. Partial oxidation technology should be included in the technologies considered.
7. IGCC. Integrated gasification, combined cycle power plants offer the potential to use waste products as the feedstock. We have been asked to consider coupling this technology with the use of renewable fuels such as wood waste, wood chips, switch grass, etc. to meet demands for renewable portfolios in the power industry. (for example, see "Environmentally Friendly Power-Generation Methods", *Chemical Processing*, Vol 60, No 4, April 1997, pp 32-35).

### ***Environmental:***

1. Solvents for CO<sub>2</sub> extraction. Recent concern about global warming has increased FCC's interest in liquid solvents used to extract CO<sub>2</sub> from flue gases. Please evaluate this diversification option.
2. Dry cleaning solvent replacement. A number of states are considering a ban on the current dry cleaning solvent, perchloroethylene. Dow Corning has developed a substitute (D5) that is based on silicone, but recent tests on rats suggest possible

carcinogenicity. FCC management has asked us to determine if there is an opportunity to enter this market with a competitive product that would be safer to use.

### ***Food & Supplements:***

1. Sugar substitute. Concerns over obesity are leading to an increased consumer interest in alternatives to sugar for flavoring and cooking. Please investigate the potential for FCC expansion into the diet sweetener market.
2. Citral. Citral is used to make a variety of vitamins, carotenoids, and aroma chemicals. FCC management has asked us to consider the production of citral as a diversification opportunity.
3. Lycopene: Eleven conjugated double bonds give lycopene a deep red color and are responsible for its antioxidant properties. Because preliminary research has shown an inverse correlation between consumption of lycopene and cancer risk, it is considered a potential agent for prevention of some types of cancers, particularly prostate cancer. Should FCC manufacture synthetic lycopene as a nutritional supplement?

### ***Pharmaceuticals:***

1. Botulinum toxin. FCC management has asked us to explore the production of botulinum toxin for use in BOTOX cosmetic surgery.
2. Hyaluronic acid. FCC management has asked us to investigate hyaluronic acid, which reportedly improves joint function, as a potential diversification product.
3. Antibiotics alternatives ("sulfa drugs"). Overuse of modern antibiotics has resulted in their decreasing effectiveness, particularly in children with chronic ear infections. A return to older drugs that predate antibiotics may be warranted. Should FCC consider entering this market as a way to diversify our product line in the pharmaceutical area?
4. Synthetic human growth hormone (HGH). FCC's marketing team has been reviewing the likely impact of hanging age demographics in the U.S. on our pharmaceutical products. They have recommended that we look at HGH as a possible new product.
5. Diosgenin. Age demographics and increasing consumption of steroid hormones are causing a rapid depletion of steroid precursors such as diosgenin. We have been asked by FCC management to investigate extraction from cultivated crops such as fenugreek as an alternative to the traditional Mexican yam source for this important drug precursor.
6. Influenza drug. In 1918, an H1N1-type influenza virus infected over 500 million people worldwide, resulting in the deaths of up to 100 million. Flu pandemics remain a big concern to the public worldwide despite advances in prevention and vaccination. A popular drug being widely used to lessen the duration and severity of flu symptoms is Tamiflu® (oseltamivir phosphate), which is manufactured and marketed by Roche Laboratories, Inc. FCC management would like us to investigate whether we should manufacture Tamiflu® under a licensing agreement.
7. Cipro. Ciproflaxin is a flouroquinolone antibiotic drug used mainly to treat respiratory infections and septicemia. It also enjoyed a brief period of notoriety in 2001 as the preferred antibiotic for treating anthrax. Bayer's patent (U.S. 4,670,444) describes the production of the Active Pharmaceutical Ingredient (API) and several of the precursors. Should FCC consider the manufacture of the API?