

# **SimRefinery<sup>TM</sup>**

## **Tour Book**

**Game Prototype**  
**Presented By Chevron And MAXIS**

**Copyright 1992**  
**All Rights Reserved**

# SimRefinery Tour Book -- Table Of Contents

|   |    |
|---|----|
| Introduction . . . . .                            | 3  |
| Getting Started . . . . .                         | 5  |
| Guided Tour Of SimRefinery . . . . .              | 7  |
| Run The Refinery! . . . . .                       | 13 |
| Other Options To Explore In SimRefinery . . . . . | 23 |
| SimRefinery Glossary . . . . .                    | 31 |

# SimRefinery Overview

## Why SimRefinery?

SimRefinery is a *prototype business simulation* developed by Chevron and Maxis. We developed it with these goals in mind:

- to demonstrate the effectiveness of business simulations for training complex systems/processes
- to demonstrate the effective use of new computer technologies for training and information transfer
- to replace current training materials which teach employees about what a refinery is
- to generate interest and ideas for other business simulations which would be of value to Chevron

## SimRefinery Is A Prototype

Because this is a prototype, some of the buttons and selections in SimRefinery are not functional. They are there to suggest capabilities the simulation might include.

## What You Can Do With SimRefinery

SimRefinery lets you try your hand at running a refinery! You can learn how a refinery works by trying to control one yourself. You will discover how the many variables involved in running a refinery work together by experiencing them yourself.

You can control such operating factors as

- crude oil type
- quantity of crude oil fed to the refinery
- product slate desired
- operating conditions in process units
- refinery economics

SimRefinery provides constant feedback on how well you're meeting your processing goals, and whether or not you're making any money!

## About The Simulation

The refinery in SimRefinery is a "generic" refinery and does not represent any specific Chevron refinery.

The calculations describing refinery processing relationships have been greatly simplified.

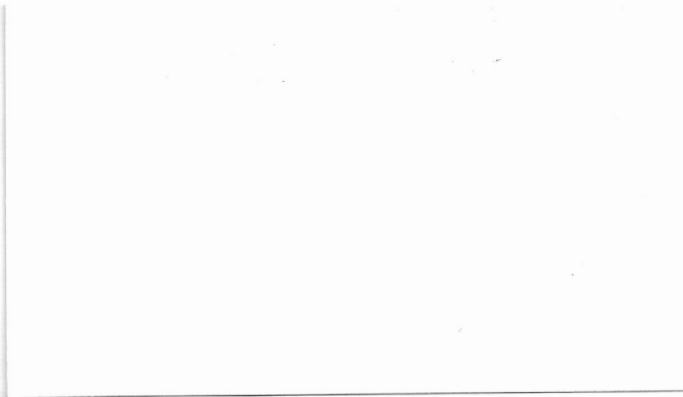
## Touring SimRefinery

We have provided three ways to explore SimRefinery:

- First, you can take the **Guided Tour**, which will guide you through the features of the simulation
- Then you can try your hand at **running the simulation** following a fixed scenario
- Finally, we'll give you suggestions for **explorations** you can undertake on your own

## What Next?

If you have ideas for developing SimRefinery further, or ideas for other business simulations, please contact



# Getting Started

To run SimRefinery, you need

- a 286 PC or higher
- VGA monitor
- a mouse. Be sure your mouse driver is loaded before you try to start the simulation

**If there are instructions on the disk for installing and running SimRefinery, follow those instructions.** Otherwise, follow the instructions below.

To install from a hard disk:

- ☞ Create a directory for SimRefinery

Type md\simref

- ☞ Copy all the files from the SimRefinery disk(s) to the SimRefinery directory

Type copy a:\*. \* c:\simref

To run the simulation:

- ☞ Switch to the SimRefinery directory

Type cd\simref

- ☞ Start the simulation by typing simref and pressing ENTER

SimRefinery will display its title screen.

### If your mouse doesn't work

- ☞ From the SimRefinery title screen, press ENTER
- ☞ On the main SimRefinery screen, press Alt-F to display the File menu
- Use the arrow keys to highlight the Exit selection
- Press ENTER

Once you've exited SimRefinery, load your mouse driver.

### If you've never used a mouse before...

- ✓ **Point to an object** means to move the mouse until the arrow touches the object
- ✓ **Click** means to push and release the mouse button
- ✓ **Highlight** means to hold down the mouse button and point to an object so that it is highlighted
- ✓ **Drag** means to
  - point to an object
  - hold the mouse button down
  - then move the mouse slowly to where you want the object to go

### What you'll see when the simulation starts up

SimRefinery starts with a beautiful graphical view of a refinery at night!

To move on from the title screen, click the mouse.

# Guided Tour of SimRefinery

To start this guided tour, you should be on the screen just after the SimRefinery title screen.

 If you are on the title screen now, click the mouse button to move on.


There are three areas on this screen:

- the green Menu bar at the top of the screen
- the Map window
- the Edit window


Let's look at the Menu bar first.

There are five options available from the Menu bar

| File | Options | Refinery | Windows | Pause |
|------|---------|----------|---------|-------|
|------|---------|----------|---------|-------|

 If you're curious about the choices which are available from this menu bar, point the arrow at an option, then hold the mouse button down. The Menu choices will appear

When you release the mouse button, the menu will close

 The Pause selection does not bring up a menu. When the Pause is highlighted, the simulation time clock is stopped, and no changes are taking place. Pausing can be handy if your simulation is out of control and you want to stop and assess the situation before it gets any worse!

Be sure the simulation is NOT paused before you continue.


SimRefinery also displays the simulation's internal date and time on the right side of the Menu bar

We will use the Menu bar later in this tour.

Now let's look at the two windows displayed on the screen: the Map window and Edit window.


## The Map Window

When SimRefinery starts up, the Edit window is on top of the Map window.

-  **Top the Map window by clicking anywhere on the window. (Topping a window brings it on top of all the other windows)**

The Map window is a look at the simulated refinery from way overhead. The details of the refinery facilities aren't clear in this view -- you will get a closer view of the units in the Edit window.

Do you see some movement in the Map window? Those are ships and railcars moving to the refinery, and helicopters flying above. You will be able to see them more clearly in the Edit window.


-  **Find the red/yellow rectangle which is located on the left side of the refinery. This is the locating rectangle. Move the arrow somewhere inside the rectangle, hold the button down, and move the mouse slowly**

Did you notice that the arrow changed to a hand? Also notice that as you move the locating rectangle, the image in the Edit window below the Map window is changing. You can move the locating rectangle on the Map window to choose what you will see in the Edit window.

The column of buttons on the left side of the Map window shows where various products are produced and used in the refinery.

-  **Click on the button labeled LIGHT GASO**

SimRefinery highlights all the processing units in the refinery where "light gasoline" is either an input or an output.

-  **If you want to know what the highlighted units are, move the arrow into a unit rectangle and click. (You may need to move the locating rectangle out of the way first. You cannot click on anything in the locating window.) This will bring up the unit window**

**To close the unit window, click the small gray square in the top left corner of the window. We'll look at a unit window in more detail later.**

If you'd like to know more about the products which are listed, check the glossary in the back of this tour guide.

The top three buttons on the Map window (AUTO CONTROL, MANUAL and SHUTDOWN) are not available in this prototype.

### The Edit Window

Now let's explore the Edit window.

- ☞ **First make sure that the locating rectangle on the Map window is over some part of the refinery, and not over undeveloped land**

**Now top the Edit window by clicking on it**

**Make the Edit window as large as possible by clicking on the double-headed arrow in the upper righthand corner of the window. (You can shrink the window again by clicking on the double-headed arrow)**

Even when the Edit window fills the screen, it's not big enough to show the whole refinery at once. You can move the image on the Edit window by using the scroll bars at the bottom and right edges of the screen.

- ☞ **To scroll the image on the screen, point the arrow at the scrolling rectangle, then drag the scrolling rectangle slowly in the direction you want the image to move**

The Edit window shows the details of the refinery layout. Can you locate

- the tank farm (storage tanks)
- the wharf
- processing units
- administration and maintenance buildings
- the refinery's power plant
- roads and pipelines which connect the refinery
- the flares

If you click on any processing unit, you will get a Unit window which describes that unit.

Most of the facilities at the perimeter of the refinery are not clickable in this prototype.

There are 12 processing units in the simulated refinery. You can locate them by moving around the Edit window and clicking until you have located all of them. OR, the easier way is to see a list of the processing units from the Menu bar.

- ☞ To see a list of the refinery's processing units, point to Windows on the Menu bar, then hold the mouse button down. This brings up the Windows menu. While holding down the mouse button, move the arrow until the Unit selection is highlighted, then release the mouse button. This will display the list of processing units which are in this simulated refinery

Now let's look at a sample Unit window.

- ☞ Select the FCC unit from the Windows/Unit menu. To do that, point to Windows on the Menu bar, click, hold and then drag the mouse until Units is highlighted. Release the mouse button, then highlight the FCC Unit and click again

You should now be on the FCC Unit window.

### Unit Windows

In every processing unit window you will see

- the picture of the unit from the Edit window
- a help button which will briefly describe the function of the unit
- the inputs to and outputs from the unit

In this FCC Unit window, you can see that there is one input to the FCC (FCC feed) and seven outputs, including FCC light gasoline and LCO (light cycle oil)


- For each input and output, there is a flow meter to show the flow rate

In some units these rates can be adjusted; in other units the rates are fixed. In the FCC, the rates cannot be changed.

- where the inputs came from, and where the outputs are going next

Next to each input/output is either a gray shaded box with letters, or a colored rectangle. The gray boxes with letters represent other processing units in the refinery; the colored rectangles represent storage tanks. (These are called unit icons and tank icons.) When the simulation is active, the storage tanks will fill with color to show the level in that tank.

In the FCC Unit window, you can see that the FCC feed input is coming from a unit labeled FFH (FCC Feed Hydrofiner); the output FCC light gasoline is going to a storage tank.

 You can click on the unit icons or tank icons, and SimRefinery will take you to that unit/tank. Try that:

- On the FCC Unit window, locate the output FCC light gaso. Click on the tank icon next to the output
- Now you're on the window for the FCC light gasoline storage tank. (There are lots of interesting things to explore on these tank windows, but we'll come back to them later.)
- To return to the FCC Unit window, locate the input to the storage tank from the FCC and click on the gray icon which says FCC

Some of the units can be controlled by you as you operate this refinery. For example, on the Reformer unit window, you can control an operating condition called **severity**, which changes both the octane and volume of the product you produce.

 Before you move on, close the FCC Unit window by clicking on the small square in the upper lefthand corner of the window

That's the end of this guided tour. Now you're ready to run a simulation!

# Run The Refinery!

Now that you've had the guided tour, you're ready to try your hand at running this refinery.

In this sample run, you will

1. Choose the products you are going to make (quantity and quality)
2. Choose a crude oil to process in the refinery
3. Choose the flow rate of crude oil into the refinery
4. Monitor the production of products in the refinery
5. Follow the flow of one processing stream through the refinery until you have a component ready to be blended into gasoline
6. Choose a recipe for making gasoline
7. See how much money you made in this simulation!

First, before you start, load a scenario for your simulation.

- ☞ From the Menu bar, select File/Load Old
- ☞ Highlight the file name FIRSTRUN and click. When the Scenario window appears, close it by clicking in the small square in the upper lefthand corner of the window

Once the new image is displayed, top the Edit window and maximize its size

1. Choose the products you are going to make (quantity and quality)

Before you do anything else, you should establish your goals for this simulated refinery run.


- ☞ From the Menu bar, select Refinery/Sales Forecast

The Sales Forecast window shows you


- the seven main products the refinery produces
- the demand for each product (in thousands of barrels per day -- MBPD)
- the product price (in \$/barrel)

You can change any of these figures to reflect real-life conditions (e.g., you can change the price of products as the market changes)



In this sample simulation, we are going to focus on just one product -- regular unleaded gasoline. The Sales Forecast shows a demand of 24,000 barrels per day at \$25/barrel; we'll go with those numbers.

-  **Close the Sales Forecast window by clicking in the small square in the upper left corner of the window**

Now check another important factor in producing products; the product specifications.


-  **Check the product specifications for regular unleaded gasoline by selecting Refinery/Product Specifications from the Menu bar**

There are many specifications for gasoline, but SimRefinery focuses on two key ones -- octane and RVP (Reid vapor pressure).

-  Octane is a measurement of a gasoline's performance in an engine
-  Vapor pressure is a measurement of the gasoline's ability to vaporize. Too little vapor pressure and the gasoline won't ignite; too much, and the vapors will escape into the environment. Vapor pressure specifications vary by season in many climates

Let's go with the current specifications for regular unleaded gasoline:

- ✓ Octane = 87 or greater
- ✓ RVP = 7 or less

-  **Close the Product Specifications window by clicking on the small square in the upper left corner of the window**

Product specifications have a big impact in how easily the refinery can produce products. After you've finished this sample simulation, we challenge you to try another simulation and change the specifications to see how that affects your success!

## **2. Choose a crude oil to process in the refinery**

Now that you know what you're aiming for, you're ready to choose a crude oil to process in the refinery.

We'll run a light crude oil in this refinery.

 **From the Menu bar, select Refinery/Operating Plan/Crude Selection/Light**


**To do that, point to the Refinery selection on the Menu bar, hold the button and highlight Operating Plan. Release the button and two choices will appear**

**Click on Crude Selection and a menu of crudes will appear**

**Click on Light**

Selecting a crude will automatically bring up a Crude Assay window which gives you information on the crude, such as


- gravity
- sulfur content
- how this crude will separate into products when it is processed in the crude unit

 **Close this Crude Assay window by clicking on the small gray box in the upper left corner of the window**

## **3. Choose the flow rate of crude oil in the refinery**


Now you're ready to start crude oil flowing into your refinery.

The first processing unit that crude oil goes to in the refinery is the Crude Unit. The crude unit separates the crude into different products based on the products' boiling points.

 **To access the Crude Unit window, select the Windows/Unit/Crude Unit from the Menu bar**

Now you should be on the Crude Unit window.


The crude unit is one of the refinery processing units which has several controls in SimRefinery, but in this sample run we will only focus on feeding crude.

 To start crude oil flowing into your refinery, locate the crude oil input on the left side of the unit. Now locate the hollow black rectangle around the left end of the scale

Point the arrow inside the rectangle, then hold down the mouse button and drag the slider slowly until the scale is completely filled, and the number reads 100,000 BPOD


Notice how products are now coming out of the crude unit!

Since this is a light crude oil, you're getting a relatively high percentage of gasoline-quality products, and relatively low percentages of residuum.

 Close the Crude Unit window by clicking in the small square in the upper left corner of the window

#### **4. Monitor the production of products in the refinery**

Now that you have crude oil flowing in the refinery, you can monitor the flow rates and inventories of products to see how well you're meeting your goals.

 Locate the button labeled Report on the left side of the Edit window. Click and hold the button, then highlight the last selection on the menu, Product Balance

A small window should come up which shows you your current status

- ☺ MBPD shows the flow rate of this product which the refinery is currently producing (in units of thousands of barrels per day)
- ☺ Demand MBPD shows the product demand (from the Sales Forecast window)
- ☺ MBbls shows the current inventory of the product in thousands of barrels

You can leave this window open all the time if you want to, to monitor the effect of the changes you make. If the window is in the way, you can relocate it on the screen.

- ☞ To move the Product Balance window around the screen, point the arrow to the title bar at the top of the window, then click and hold to drag the window anywhere you want on the screen. Release the mouse button when the window is where you want it

**5. Follow the flow of one processing stream through the refinery until you have a component ready to be blended into gasoline**

Now let's follow just one stream through the refinery until it has been processed into a product which can be blended to make gasoline.

- ☞ Access the Crude Unit window by selecting Windows/Unit/Crude Unit from the Menu bar
- ☞ On the Crude Unit window, locate the HSR gasoline output. Click on the tank icon next to the stream to see where the heavy straight run gasoline is going next

You should now be on the window for the HSR (Heavy Straight Run) Gasoline storage tank.

There are lots of options available on storage tank windows. Right now, the window shows that the tank is running in **Autobuy** and **Autosell** modes. This means that SimRefinery is taking care of buying and selling HSR gasoline automatically. If the refinery needs more, the simulation buys it; if there's too much, the simulation sells it. The simulation is keeping everything in balance for you. (If you REALLY want a challenge, try taking storage tanks off Autobuy and Autosell and try to control it all yourself! But that's for advanced play...)

From the window for the HSR tank, you can see that HSR is only used one place in this refinery -- a unit called the reformer. Let's go to the reformer and see what happens to the HSR gasoline there.

- ☞ On the HSR gasoline tank window, click on the REF icon next to the HSR gasoline output

Now you should be on the Reformer unit window. What is a reformer?

- ☞ Click on the Help button on the Reformer window to learn what a reformer does.

To close the Reformer help window, click on the small gray square in the upper left corner of the window

On the Reformer window, you can see that the HSR gasoline is just one input to this processing unit. The main output of the reformer is reformat. What is reformat used for?

- ☛ On the Reformer window, click on the tank icon next to the reformat output
- ☛ On the Reformat Tank window, leave all the settings the same. Locate the output, and click on the GBL icon

You should now be at the gasoline blender!

## 6. Choose a recipe for making gasoline

You can see that reformat is just one of eight streams which are blended to make gasoline. Each stream has different specifications. The trick is to blend all these streams to make gasoline which **meets the specifications** while using up the streams and not having any leftovers or shortages. (It's almost always more expensive to have to buy a component than to be able to generate it yourself.)

The gasoline blender blends only one product at a time -- either regular or premium unleaded gasoline.

Let's look at what's going on in the gasoline blender. Right now the blender is running in **Autoflow** mode, which means that **all** the gasoline component streams which the refinery is currently producing are being blended together. In the **Autoflow** mode, you're making about 32,000 BPOD (barrels per operating day) of gasoline, with an octane of 86 and a vapor pressure of 7.

There's just one big problem with this -- this product doesn't meet the specification for octane which you were aiming for. This product only has an octane of 86, and you need octane of 87.

**The bottom line is, you're blending junk -- you can't sell this stuff.**

Let's take the gasoline blender off **Autoflow** and see if you can fix the blend to bring the octane up to spec.

Gasoline is blended using **recipes**. A recipe specifies the proportion of each component in the gasoline blend. There are many, many possible recipes which will give you the desired quality -- you want to pick one which matches well with the quantities of components your refinery produces.

We've made your life easier by setting up some recipes which work. Let's choose one now.

- ☞ First, check that the REG button is depressed on the screen, so the simulation knows that you're blending regular gasoline
- ☞ Now take the blender off Autoflow by clicking on the Autoflow button so that it is no longer depressed
- ☞ Next, choose Recipe 117 by pointing at the Recipe button, clicking and holding the button, then moving the mouse until R117 is highlighted. Release the button. R117 should now be displayed next to the Recipe button
- ☞ To see what recipe R117 looks like, point at R117 and click. This brings up the Blender Recipe window which shows the proportions of each component in the recipe, and the resulting octane and vapor pressure

Since Recipe 117 has been chosen for success, you can see that the octane and vapor pressure are within spec.

You can change the percentages of the components on the Blender Recipe window if you want, to try to optimize the recipe. You can save the new recipe by clicking the Save button.

- ☞ Leave this Blender Recipe window by clicking in the small square in the upper left corner of the window

Now you've chosen your recipe, so the last thing to do in this simulation is adjust the rate of gasoline produced. Your goal is to make 24,000 BPOD of regular gasoline.

- ☞ On the Gasoline Blender window, locate the regular gasoline output stream, and locate the rectangle around the right end of the flow


Change the rate of gasoline produced by pointing in the rectangle, clicking and moving the rectangle slowly until the flow reads about 24,000. (It may be hard to get it right on)

OK, now you've met your production goal for regular unleaded gasoline.

- ☞ Close the Gasoline Blender window by clicking on the small square in the upper left hand corner of the window

## **7. See how much money you made in this simulation!**


Now comes the moment of truth -- you produced product, but did you make any money?

 **From the Menu bar, select Refinery/Evaluation/AM Report**


This window is a copy of a report which is reviewed every day at one of Chevron's refineries. This report shows a lot of operating parameters to help refinery management assess how well they're doing. (Fish? What kind of a measurement is Fish? Check the glossary for the answer!)

At the bottom of this report, you can see how much you produced compared to the demand.

In running this simulation, you focused just on regular unleaded gasoline. The report should show that you are producing around 24,000 BPOD of regular gasoline, which meets the demand. But what about the other products which you didn't focus on? Do you have shortfalls in some? Too much of others?

 **Close the AM Report window by clicking in the small square in the upper left corner**

Now let's get to the bottom line -- did you make any money?

 **From the Menu bar, select Refinery/Evaluation/Operating Margin Report**

Here you can see value of the products you made, and the cost of crude and utilities. At the bottom of the screen you can see the operating margin, which is expressed in \$ per barrel of total refinery output.

## **Did you make any money?**

**Yes? That's great!**


**No? Uh oh!**

## **You can do better next time!**

Now that you've been through this sample simulation, you're free to explore the other features on your own. The next section has some suggestions for further explorations.

### **Saving A Simulation**

If you would like to save this simulation,


 **To save a simulation, from the Menu bar, select File/Save As**

**Give this simulation a name. You can also save a short and long description, which you can refer to later as a reminder of the features of this simulation**

## Other Options You Can Explore In SimRefinery


Here are some of the options you tried in the sample run which you can play with in other simulation runs:

### Change the product demand

 From the Menu bar, select Refinery/Sales Forecast


You can type in new product demands on this window

### Change the specifications of the products

 From the Menu bar, select Refinery/Product Specifications


You can type in new product specifications on this window

### Change the value of products

 From the Menu bar, select Refinery/Sales Forecast

You can type in new product values on this window

### Choose a different crude oil

 From the Menu bar, select Refinery/Operating Plan/Crude Selection


You can choose a new crude from this menu, or design your own!

### Vary the flow rate of crude into the refinery

 From the Menu bar, select Windows/Unit/Crude Unit

You can change the flow of crude oil on the Crude Unit window

### Choose a different gasoline blend recipe

 From the Menu bar, select Refinery/Operating Plan/  
Blender Recipes/Gasoline

You can choose a new blender recipe from this menu, or design your own!

**Here are some options we didn't explore which you can try on your own:**



Change the cutpoints of the crude unit

The Crude Unit is one of the units in SimRefinery where you can control the operating conditions. In the crude unit, you can control the **cutpoints** between products.

The crude unit separates crude oil into products based on the boiling temperatures of the products. **Cutpoints** represent the temperatures at which you change from one product to another. When you change the cutpoint temperature, you change the relative volumes of products which are produced.

Look at the Crude Unit window. You see the default cutpoint temperatures listed on the left side of the window. The default cutpoint temperature between LSR and HSR gasoline is 175.

You can change cutpoint temperatures within a range. (If you go outside the range, the product no longer meets the required specifications.) The cutpoint ranges are represented on the Crude Unit window by a yellow rectangle, while the current cutpoint is the small white line within the rectangle.

-  **First, feed about 100,000 BPD light crude into your crude unit**
-  **Change the cutpoint between LSR and HSR gasoline to around 140**
  - **Point to the line representing the current cutpoint**
  - **Drag the line to a new value around 140. The new temperature will be shown on the left**

What happened to the relative volumes of LSR and HSR as you moved the cutpoint?


This is a **very simplified** model of how you can manipulate cutpoints in the crude unit to change the relative amount of products produced!

### Change the severity of the reformer

The Reformer is another unit in SimRefinery that you can control.

The reformer "reforms" molecules (changes their structure) to create molecules with higher octane rating. In a reformer, the key operating control is **severity**. Severity is a measure of how "hard" you're running the reformer. The greater the severity, the higher the octane of the product you're producing. Greater severity also means greater demand on the catalyst in the reformer, and shorter catalyst life. Since reformer catalyst is **very** expensive, this tradeoff between higher octane products and longer catalyst life is an important operating concern.

Greater severity also means less volume of reformate produced-- the higher octane products take up less space than lower octane products.


 **On the Reformer Unit window, change the severity of reformer operation.**

- **Point in the black rectangle on the severity scale**
- **Drag the slider until the octane is 96**

What has happened to the volume of reformate produced? What has happened to the hydrogen production?

Being able to increase the octane of reformate will help you if you're trying to blend premium gasoline.

### Develop your own gasoline blender recipe

 **From the Menu bar, select Refinery/Operating Plan/  
Blender Recipes/Gasoline/New Recipe**

This will bring up a Blender Recipe window, where you can design your own blender recipe by specifying the proportions of each blend component in the recipe

### Develop your own crude oil

- ☞ **From the Menu bar, select Refinery/Operating Plan/  
Crude Selection/Custom/New Crude**

This will bring up a Crude Assay window, where you can design your own crude by specifying the proportions of products the crude will separate into

### Change the Feedstock/Supply Availabilities & Costs

You can change the costs of crude oil and utilities to match today's market.

- ☞ **From the Menu bar, select Refinery/Feedstock/Supply Availabilities &  
Costs**

On this window, you can change the costs of crude oil and utilities, and the availability of crude. This will have an impact on the calculations to determine the operating margin

### Choose where the LCO output from the FCC will go

The LCO (light cycle oil) output from the FCC unit can be directed to several different places in the refinery.

- ☞ **From the Menu bar, select Windows/Unit/FCC Unit**
- ☞ **From the FCC Unit window, locate the LCO output stream and click on the LM (LCO manifold) icon**
- ☞ **On the LCO manifold window, drag the sliders to route the LCO to**
  - **the hydrocracker**  
In the hydrocracker, the LCO will be processed again to crack into smaller, gasoline-quality molecules
  - **diesel hydrofiner**  
Some LCO can be blended with the diesel stream from the crude unit to become diesel
  - **LCO tank**  
From the LCO tank, the LCO is blended into fuel oil

### Choose where the residuum from the Crude unit will go

The residuum from the Crude unit can either be turned into asphalt or blended into fuel oil. This simulated refinery does not have any residuum conversion units, such as a coker, to convert the resid into higher-value products.

- ☞ From the Menu bar, select **Windows/Unit/Crude Unit**
- ☞ On the Crude Unit window, locate the residuum output and click on the **RM icon**
- ☞ On the Residuum Manifold window, drag the sliders to route the residuum to
  - the residuum tank  
From the residuum tank, the residuum will be blended into fuel oil
  - the asphalt plant

### Take all or part of the refinery off Autorefine

For a real challenge, take the refinery off Autorefine, and control your inventories yourself!

- ☞ From the Menu bar, select **Refinery/Autorefine**
- ☞ Highlight the Autorefine selection and release the mouse button. This will turn Autorefine off

### Take some or all tanks off Autobuy/Autosell

You can take some or all of the tanks off Autobuy/Autosell and control the inventories yourself.

- ☞ From a Unit window, locate the tank you want to control. Click on the tank icon to access the tank window
- ☞ On the tank window, click on **Autobuy** and **Autosell** to turn them off

### Change the speed of the simulation

This will have the greatest impact if you are controlling the refinery manually (Autorefine is OFF)

- ☛ From the Menu bar, select Options/Speed

**Here are some options which are hinted at in the prototype, but which are not functional. These are ideas the development team think might be of value:**

### Construction option

These are the buttons which are on the left-hand side of the Edit window. They would allow you to construct a process unit. This option would allow you to model the existing Chevron refineries

### External events

There are some sample external events in this prototype of SimRefinery.

- ☛ To see the external events, from the Menu bar select Refinery/External Events/On

Periodically a window will pop up to tell you of an incident in the refinery. These incidents do not have any impact on the results of this prototype refinery, but they could be tied into results and into how much was budgeted for maintenance, training, etc.

### Budget: Operating Expense and Capital

- ☛ To see this proposed window, select Refinery/Budget from the Menu bar

### Annual Report

- ☛ To see this proposed window, select Refinery/Evaluation/Annual Report from the Menu bar

### Performance & Profit Allocation

- ☛ To see this proposed window, select Refinery/Evaluation/Performance & Profit Allocation from the Menu bar

**The refinery is now in  
YOUR hands...**

**Have**

**fun!**

## SimRefinery Glossary

**Alkylate:** High octane gasoline blending component. Product of the alkylation plant.

**Alkylation plant:** Plant which recombines liquified petroleum gases (propylene, butylene and isobutane) to make high octane gasoline blend components. Sort of the opposite of cracking. Alkylate is the product of alkylation.

**Asphalt:** Residuum which has been blended with enough lighter (less viscous) products to get a desired viscosity.

**Asphalt plant:** Plant at which residuum is blended to make asphalt.

**BPOD:** Barrels per operating day. Unit of measure used to describe flow of products in the refinery.

**Butane:** C<sub>4</sub>. Can be used both as a gasoline blending component and sold to consumers as a fuel. High octane, very high vapor pressure. We use as much as we can in blending gasoline without exceeding the vapor pressure specification.

**C<sub>2</sub>:** Gas which is a mixture of methane (which has one carbon atom) and ethane (which has two carbon atoms). Can be used as fuel in the refinery.

**C<sub>3</sub>:** See Propane.

**C<sub>4</sub>:** See Butane.

**C<sub>3</sub> - C<sub>4</sub>:** Gas which is a mixture of propane and butane. Propane and butane are valuable fuels, for example in camping cookstoves.

**Catalytic Reformer:** Plant in which molecules of HSR gasoline are "reformed" into molecules of higher octane rating (the molecules typically have the same number of carbon atoms, they're just arranged differently.) Improves the value of HSR gasoline as a gasoline blending stock. There is a trade-off: the reformed molecules have a lower volume. So the higher octane you obtain, the lower the volume. Reformer catalyst is a very expensive platinum/rhenium mixture.

**Conversion:** Measurement of the percentage of fresh feed converted to light products in the FCC and hydrocrackers.

**Cracking:** The process of breaking large hydrocarbon molecules into smaller, more valuable molecules. For example, a cracker might break a 20-carbon molecule into a 10-carbon, 6-carbon and 4-carbon molecules. Cracking takes place in both the hydrocracker and the FCC; one difference is that the hydrocracker uses hydrogen and the FCC doesn't.

**Crude oil:** Raw, unrefined petroleum. A mixture of hydrocarbon molecules. Light/Medium/Heavy refers to the relative proportion of low-boiling molecules in crude. The lighter the crude, the higher proportion boils in the gasoline range. Light crudes are more valuable than heavy, since they require less processing to get the same amount of gasoline and other light products.

**Crude Unit:** Processing plant in which crude oil is distilled to separate into fractions. Typically has two distillation columns (which is why you hear of two-stage crude unit); atmospheric and vacuum distillation columns.

The crude oil is first distilled in the atmospheric column, where the lighter portions are boiled off and removed as cuts. The atmospheric column typically removes the products which boil below 700 degrees.

The stuff that's left over, which boils above 700 degrees, is distilled in the vacuum column. You don't want to raise the column temperature above 900 degrees to separate the molecules, because the heavier molecules will crack and gum up your column. By having a vacuum in the column, the remaining fraction can be separated at lower temperatures, with no cracking.

**Cutpoint:** Temperature which marks the "boundary" between one crude unit product and another. Cutpoints can be adjusted with ranges to change the proportion of products which are made. For example, the heavy end of the heavy straight run (HSR) gasoline cut can be included either in the HSR cut or in the jet fuel cut to change the yields of the two cuts.

**Cutter stock:** A light component (such as HCO) which is used to reduce the viscosity of fuel oil or asphalt blends.

**Diesel:** Fuel used for internal combustion in diesel engines. Diesel is also used for home heating oil.

**Diesel Hydrofiner:** Plant which uses hydrogen to treat diesel to remove sulfur. If sulfur were not removed, burning the diesel would lead to pollution.

**FCC Feed Hydrofiner:** Plant which prepares feed for cracking in the FCC by removing the sulfur and nitrogen, both of which poison the FCC catalyst. Uses hydrogen to remove the impurities.

**FCC Light gasoline:** Light gasoline component produced in the FCC. High octane component.

**FCC Heavy Gasoline:** Heavy gasoline component produced in the FCC.

**FCC Unit:** Fluid catalytic cracker. So called because the catalyst is a powder which acts like a fluid in the process. Cracks large molecules into smaller, more valuable molecules. One major difference from the hydrocracker is that in the FCC, cracking takes place without hydrogen.

**Fish:** A measurement of the cleanliness of the refinery's effluent water. We test the cleanliness by having fish live in the water. A measurement of 40/40 in 72 means that 40 of 40 fish were alive after 72 hours exposure to the effluent water.

**Fuel oil:** Sold to power plants, used as bunker fuel for ships. A blend of the residuum from crude oil left after distillation and cutter stock (diluent) to decrease viscosity.

**Gasoline blender:** Plant at which gasoline components are blended together to produce finished gasoline.

**Give-away:** The difference between the required specification for a product and the actual value. For example, if we blend a gasoline which has an octane of 89 and the spec is only 87, we have two points of give-away (we're giving away quality for free).

**H<sub>2</sub>:** Hydrogen. Used in many processes such as hydrocracking and treating for sulfur removal. Hydrogen is produced in the Catalytic Reformer and in the Hydrogen Plant.

**HC diesel:** Diesel which is produced in the hydrocracker.

**HC gasoline:** Gasoline produced in the hydrocracker. Has so-so octane.

**HC jet:** Jet fuel which is produced in the hydrocracker.

**HCO:** Heavy cycle oil. Product of the FCC. More viscous than LCO. Used as cutter stock to reduce fuel oil viscosity.

**HSR Gasoline:** Heavy straight-run gasoline from the crude unit. Usually used as feed for the reformer to improve the octane rating.

**Hydrocarbon:** Molecule made up primarily of carbon and hydrogen; may also have sulfur, nitrogen and oxygen. Crude oil is a mixture of many types of hydrocarbons.

**Hydrocracker:** Plant where gas oil (LGO) from the crude unit is cracked into smaller molecules in the presence of hydrogen. More flexible in its operation than FCC in terms of the relative volumes of gasoline/jet produced, and produces better quality products than the FCC.

**Hydrogen plant:** Plant which breaks down natural gas (usually purchased) to make hydrogen used in the hydrocracker, hydrofiners and hydrotreaters.

**iC<sub>4</sub>:** See Isobutane.

**Isobutane:** C<sub>4</sub> in a different configuration than normal butane. Used as feed to an alkylation plant. Sold as fuel similar to propane.

**Jet:** Fuel meeting the required specifications for use in jet engines and aircraft turbine engines.

**Jet Hydrofiner:** Plant which uses hydrogen to treat jet to remove sulfur. If sulfur were not removed, burning the jet fuel would lead to pollution.

**LCO:** Light cycle oil. Product of the FCC. Used as hydrocracker or diesel hydrofiner feed and as a cutter stock in blending fuel oil.

**LGO:** Light gas oil, product of the crude unit. Typically used as feed for cracking processes. If sold as is, would be used as fuel oil for power plants, ships, etc.

**LPG:** Liquified petroleum gases. Another way to refer to liquified propane and butane.

**LSR Gasoline:** Light straight-run gasoline; a product of the crude unit. Usually blended in gasoline without further processing. Low-octane blending component.

**MTBE:** Methyl tertiary butyl ether. High-octane gasoline blend component which also has oxygen content required by recent legislation. Some refineries can produce their own; others have to buy it.

**Octane:** A measurement of how a gasoline performs in an engine. Tested by putting in an engine and determining the conditions under which the engine knocks. The octane scale is based on heptane (C<sub>7</sub> in a particular configuration) having an octane of 0 and isooctane (C<sub>8</sub> in a particular configuration) having an octane of 100. The octane number is % isooctane in a mixture of isooctane and normal heptane which has the same knock as the fuel under test.

**Propane:** C<sub>3</sub>. Easily liquified fuel used for cooking, heating.

**Reformate:** High octane gasoline blending component. Product of the reformer.

**Reformer:** See Catalytic Reformer.

**Reid vapor pressure:** The unit of measurement for gasoline vapor pressure.

**Residuum:** Heavy oil left in a distillation column after the lighter products have been boiled off. Also called resid or bottoms. Viscous, sticky, gunky. Can be made into asphalt, or blended with lighter products into fuel oil. Some refineries have special plants to process residuum (like a coker); SimRefinery doesn't.

**RVP:** See Reid vapor pressure.

**Severity:** A measurement of the operation of the catalytic reformer. The greater the severity, the higher the octane of the reformate produced. Greater severities are also harder on the catalyst, so the higher the severity, the shorter the catalyst life. Since reformer catalyst is very expensive, this is an important tradeoff.

**Sour gas:** Sulfur-laden gas produced either as a by-product of many processes, or the result of treating to remove sulfur. The sour gas is treated in the sulfur plant to recover the sulfur.

**Sour water:** Sulfur-laden water produced as a by-product of many processes. The water is treated to remove the sulfur.

**Straight run jet:** Jet which is produced from distillation in the crude unit.

**Straight run diesel:** Diesel which is produced from distillation in the crude unit.

**Sulfur:** Used to make sulfuric acid and fertilizer.

**Sulfur plant:** Plant which turns hydrogen sulfide ( $H_2S$ ) into sulfur. Hydrogen sulfide is produced in the hydrofiners and hydrotreaters as sulfur is removed from the feed. It is an extremely lethal gas. The sulfur which is recovered is sold as a product to make acid, fertilizer.

**Vapor pressure:** See Reid vapor pressure.

**VGO:** Vacuum gas oil. So called because is produced in the vacuum column of a crude unit. Similar use as LGO, as a feed for the cracking units.

# SIMREFINERY GAME PROTOTYPE EVALUATION SHEET

SimRefinery is a prototype simulation of refinery operation and is intended to be a learning tool. As a prototype, not all functions are connected and correlations are simplified to reduce complexity. The game can be modified to meet specific requirements of customers. This game concept may also be extended to other business problems: chemical plants, budgeting process, purchasing, marketing, trading, etc.

Your Name: \_\_\_\_\_ Phone: \_\_\_\_\_

Company/Department: \_\_\_\_\_

Function: \_\_\_\_\_

**Please Comment:**

1. What is your overall impression of SimRefinery prototype:

- \_\_\_\_\_ Great Training Tool
- \_\_\_\_\_ Has Wide Potential
- \_\_\_\_\_ Limited Utility
- \_\_\_\_\_ Coverage Just Right
- \_\_\_\_\_ Too Basic
- \_\_\_\_\_ Too Complex
- \_\_\_\_\_ Fun to Use
- \_\_\_\_\_ Boring

2. What are your comments on the user guide "SimRefinery Tour Book":

|                                  |           |          |
|----------------------------------|-----------|----------|
| Adequate Directions:             | Yes _____ | No _____ |
| Easy To Follow:                  | Yes _____ | No _____ |
| Glossary of Terms Adequate:      | Yes _____ | No _____ |
| Explanations Too Simple:         | Yes _____ | No _____ |
| Additional Definitions Required: | Yes _____ | No _____ |

Suggested Improvements: \_\_\_\_\_

\_\_\_\_\_

3. Comments on prototype features:

Graphics:  
Good \_\_\_\_\_ Needs Improvement: \_\_\_\_\_

Menu Bar Selection:  
Adequate \_\_\_\_\_ Add Following: \_\_\_\_\_

3. Comments on prototype features: (continued)

Process Unit Function Description (HELP button):

Adequate: Yes \_\_\_\_ No \_\_\_\_

Additional Definitions Required on Following Units: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

Process Unit In/Out Flow Diagrams:

Adequate: Yes \_\_\_\_ No \_\_\_\_

Suggested Changes: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

4. Where you would use SimRefinery:

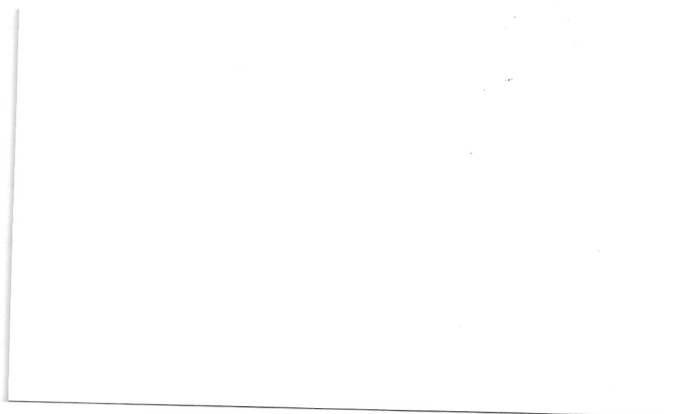
General Training on Refinery Operations:

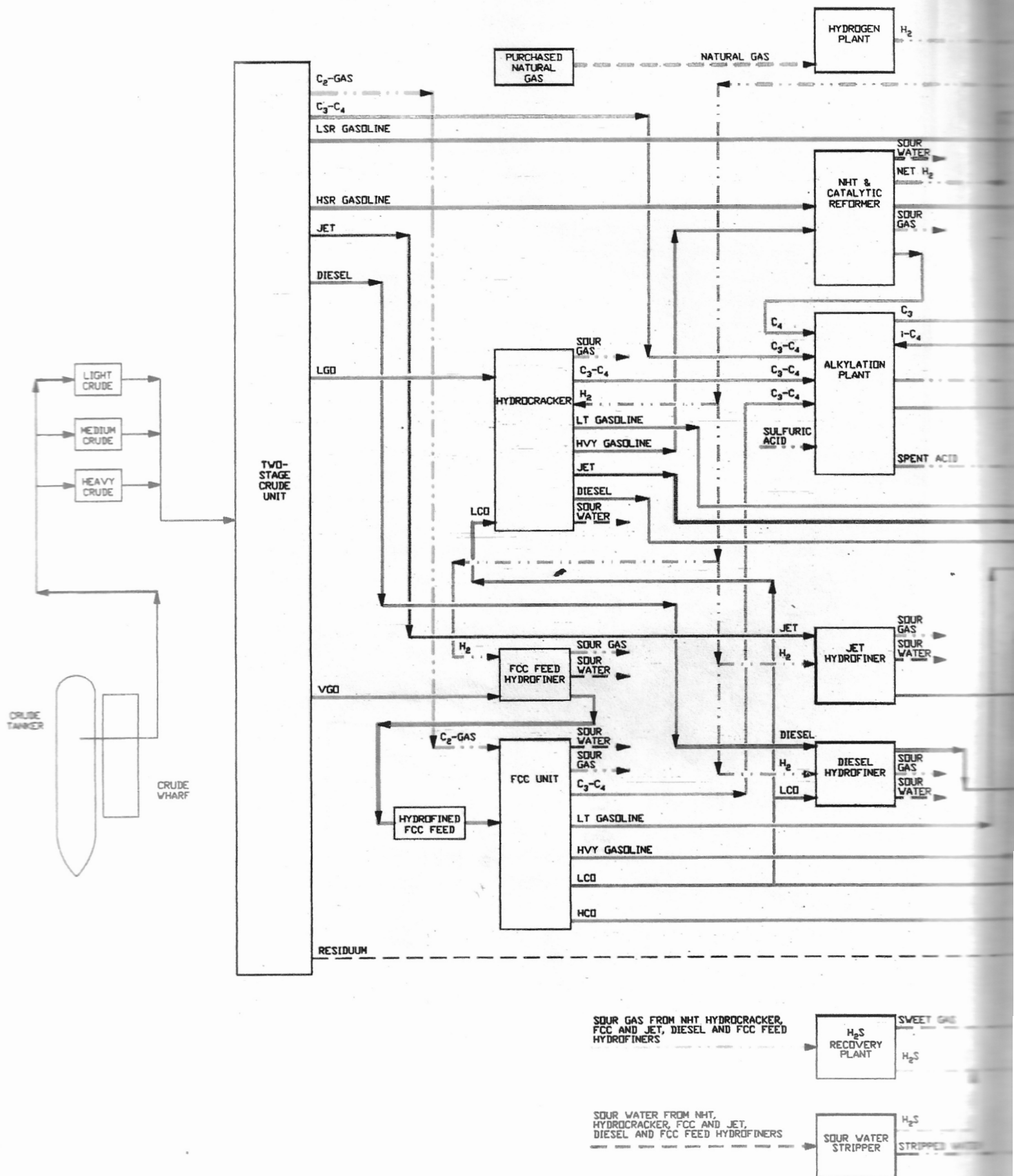
\_\_\_\_ Operations  
\_\_\_\_ Shift Coordinators  
\_\_\_\_ Process Engineers  
\_\_\_\_ Designs/Maintenance Engineers  
\_\_\_\_ Maintenance Supervisors  
\_\_\_\_ Product Accountants  
\_\_\_\_ Financial Accountants  
\_\_\_\_ Administrative Personnel  
\_\_\_\_ Others: \_\_\_\_\_

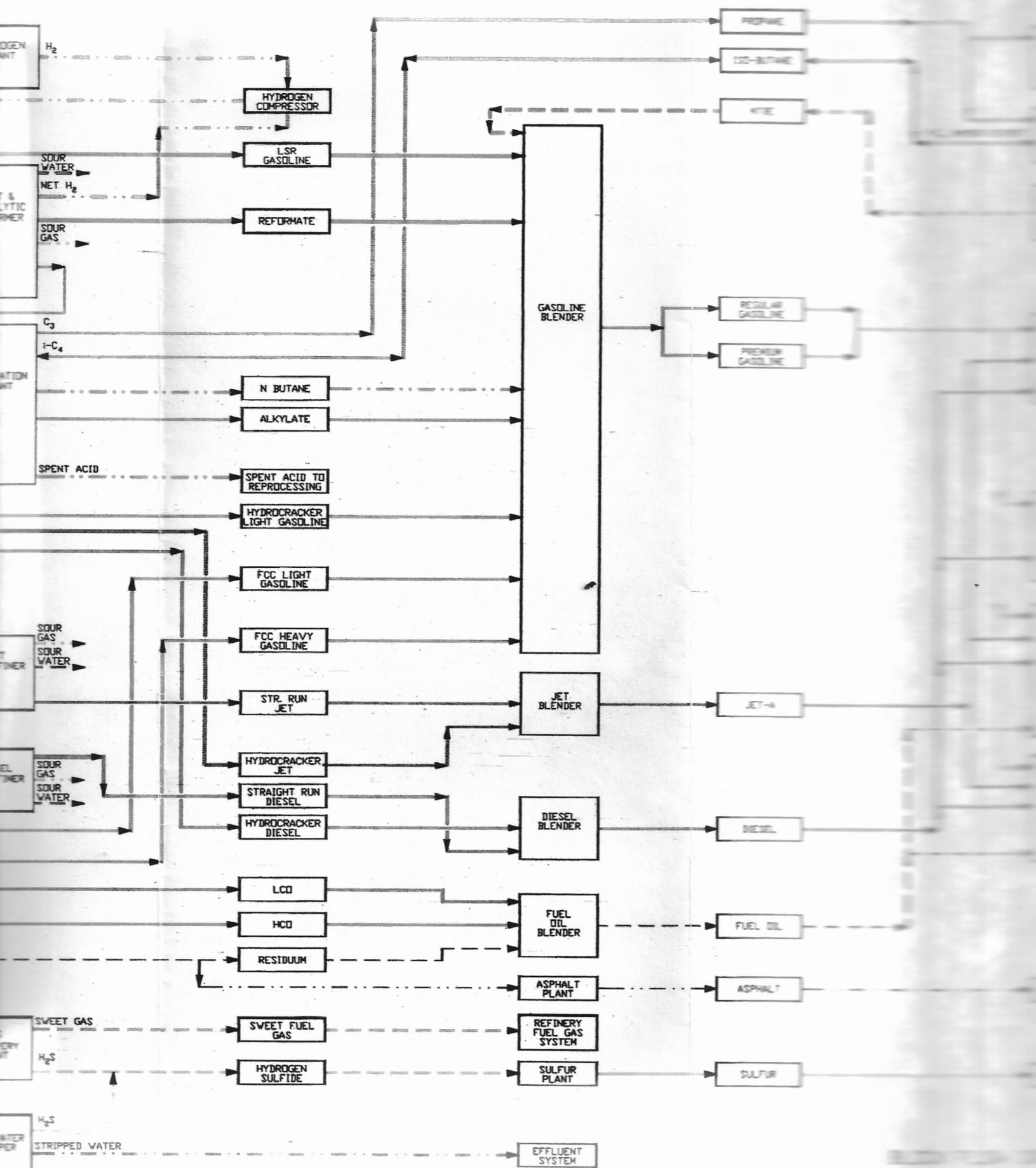
5. General Comments:

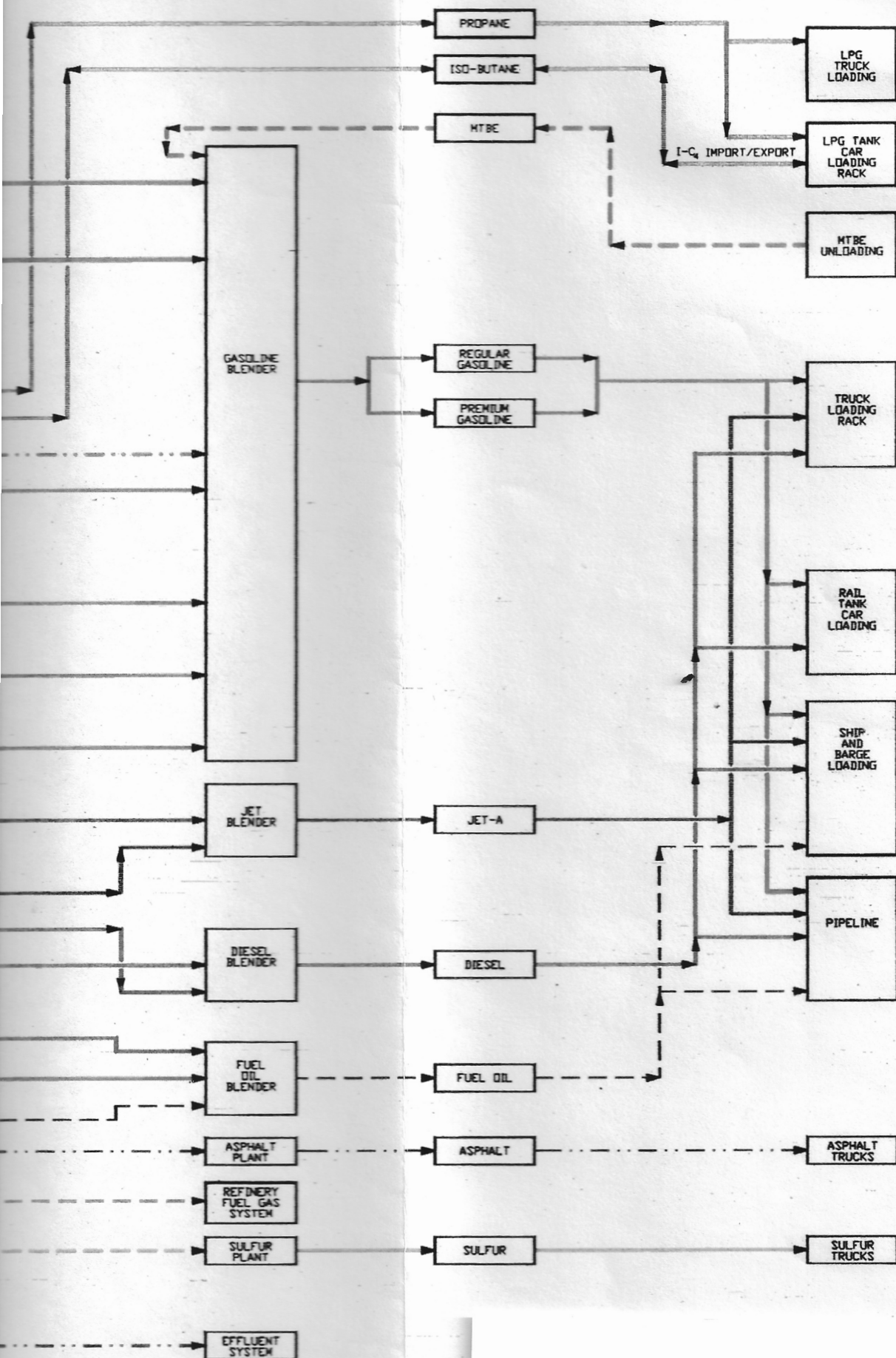
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

(Fold and Mail)









## About The Simulation

The refinery in SimRefinery is a "generic" refinery and does not represent any specific Chevron refinery.

The calculations describing refinery processing relationships have been greatly simplified.

## Touring SimRefinery

We have provided three ways to explore SimRefinery:

- First, you can take the **Guided Tour**, which will guide you through the features of the simulation
- Then you can try your hand at **running the simulation** following a fixed scenario
- Finally, we'll give you suggestions for **explorations** you can undertake on your own

## What Next?

If you have ideas for developing SimRefinery further, or ideas for other business simulations, please contact

