THE STRATEGIC PETROLEUM RESERVE DISTRIBUTION (SPRED) SIMULATION MODEL

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ABSTRACT

The Strategic Petroleum Reserve Distribution (SPRED) Model is a large scale computer simulation model developed by ERNST & ERNST, Washington, D.C. for the Department of Energy (DOE) and the Maritime Administration, Department of Commerce. The Model has been developed using SIMSCRIPT II.5 in an interactive timesharing mode.

The Model is a versatile tool for studying present and future import patterns at U.S. ports, as well as for analyzing the alternative solutions to problems concerning the realistic and efficient distribution of the strategic petroleum reserve. This paper describes the system the Model simulates, various types of potential Model applications and the Model structure.

I. INTRODUCTION

The large cutback in domestically produced petroleum in the last few years, compounded by higher import prices and an embargo imposed during the winter of 1973-74, provided dramatic evidence that the U.S. is vulnerable to interruption in imports from major petroleum exporting nations. To lessen U.S. vulnerability to such supply interruptions, the Office of Strategic Petroleum Reserve (SPRO) of the Department of Energy (DOE) has been given the task of developing and implementing programs for the creation and management of a strategic petroleum reserve. This reserve will serve as an emergency short-term supply of petroleum to minimize the impact of a severe supply interruption and help to deter future supply cutbacks.

Realizing the complexities involved in manually evaluating how this reserve petroleum can potentially be distributed to U.S. refineries, and keeping in mind that the vast majority of imported petroleum and some domestic petroleum arrives at U.S. ports by ship, SPRO sought a planning tool to assist them in analyzing and assessing hypothetical petroleum distribution scenarios. To this end, SPRO, together with the Maritime Administration, undertook development of a computerized simulation model that could be used to analyze the complex inter-relationships and the dynamic nature of the various port and inter-port operations required to distribute the reserve petroleum. Ernst & Ernst was engaged in a project to develop a waterborne simulation model which would meet SPRO's requirements. The resulting SPRED model is a versatile and practical tool for studying present and future petroleum import patterns at U.S. ports, as well as analyzing the alternative solutions to problems concerning realistically achievable and efficient reserve distribution strategies. The secondary function of the model is to provide a tool which can be used to analyze terminal facility requirements and capabilities.

II. THE SPRED MODEL

Since the purpose of the SPRED Model is to serve as a planning tool, it is very important that the model be easy to use, easy to understand, versatile in its application, and representative of ship movements and petroleum terminal operations without being either oversimplified or unnecessarily detailed and complex. Most importantly, it should be able to quantify analysis results in terms which can be readily understood and interpreted and can be applied to SPRO's decision-making and policy-setting processes.

In the final analysis, of course, no large scale computer model can address all of the factors that go into evaluating the practicality and merit of a specific petroleum distribution scenario. On the other hand, there is much critical information relating to terminal operations and port inter-relationships which cannot be easily acquired on a manual basis. One of the primary advantages of a simulation model like SPRED is that answers are derived relative to, and in recognition of, dynamic conditions and constraints affecting port operations.

Similarly, the performance of the system can be simulated and observed under virtually all conceivable conditions, both actual and hypothethical. By varying system parameters in the Model to simulate a wide variety of desired conditions, the user can explore many conditions that cannot be controlled in the natural environment. This "what if" capability can be extremely useful in analyzing decision and policy alternatives while still in the planning or conceptual stage.

An additional advantage of a simulation model such as the SPRED Model is the capability it provides to introduce chance elements associated with many port and terminal activities. While it is very difficult to account for such factors as temporary terminal or port closings, equipment breakdowns, and surges in ship traffic using manual procedures, it is easy to simulate these occurrences using the computer. In the simulation, the user has complete control over parameters such as these and can select any combination he cares to choose in order to study their affect upon system performance.

Finally, the efficiency with which such a large scale simulation model can respond to a problem, compared to manual efforts, is very important.

Real world changes, such as port improvements or variation in import patterns, can be simulated using the computer very quickly. This ability to anticipate or "look into the future" can be one of the SPRED Model's most valuable characteristics.

TYPICAL SPRED PLANNING APPLICATIONS

The SPRED Model is a complex simulation model of waterborne petroleum distribution activities associated with both business-as-usual and supply interruption conditions. Because of this level of complexity, it would be very difficult to comprehensively represent all of the various analyses that can be performed, since the possible combinations of alternative input data specifications are so varied. However, to convey to the reader a better understanding of the Model and to assist in visualizing the ways in which the Model can be used, examples of some typical analyses that can be performed, sample questions the user might ask, and a general summary of the types of analysis that can be performed are discussed below.

Typical Analyses

Examples of analyses the Model is designed to assist the user in performing can be summarized as follows:

- Analysis of the historical flow patterns of domestic and imported petroleum into U.S. ports to illustrate trends in:
  1) regional and port comparability, and
  2) the arrival of domestic and imported petroleum by ship type, commodity origin, vessel flag, and commodity type.
- Analysis of petroleum requirements at U.S. ports by crude and product types for various "future" scenarios, the impact these (increased or decreased) requirements have on the entire system, and the effect of adjustments made to the system to balance the new requirements.
- Analysis of the origin breakdown of petroleum going into each U.S. port such that under hypothetical supply interruption conditions the user can estimate:
  1) the decrease of petroleum imports (by commodity types) at each U.S. port
  2) ship resources available to be diverted to distribution of the strategic petroleum reserves.
- Analysis of the vessel flag breakdown of the petroleum imports at U.S. ports such that the number of ships from embargoing or "unreliable" countries can be estimated at each U.S. port.
- Examination of which strategic reserve site(s) might most effectively serve a given U.S. port under various supply interruption scenarios to adequately meet anticipated petroleum denials.
- Examination of realistic "start" conditions at the beginning of a supply interruption by permitting the user to vary the availability of vessels at the time of interruption in the simulation.
- Analysis of ship arrival patterns at each strategic reserve storage terminal based upon the compatibility of terminal attributes and the attributes of available ships (individually and/or by ship type). This will, in turn, aid in determining:
  1) storage sites not adequately serviced by ships
  2) possible problems at the storage sites as they are initially planned (e.g., an unusually shallow draft restriction, or too few berths to meet demands for petroleum from that reserve site) which restrict shipment of reserve petroleum.
- Measure the effect that shutting down a given port(s), receiving terminal(s), or strategic reserve terminal(s) has upon a port or the rest of the system.

Sample Scenarios

Generally, when using the Model, the user will have in mind specific scenarios to be analyzed that require one or more "runs" of the Model. Some typical scenarios which can be analyzed using the Model are:

- Which ports would be affected and to what extent would their current throughput be diminished if all crude traffic from a particular country is halted?
- Assume a newly dredged harbor is two feet deeper. Under what conditions would this significantly change or affect the distribution of crude during an embargo?
- Which reserve storage site (of several alternatives) would most effectively service specific ports or receiving terminals?
- Given a recently doubled demand for petroleum at a receiving terminal, which alternative ways to meet this new demand (build more berths, enlarge those currently in existence, etc) are feasible?
- Which ports (or terminals) are operating under capacity, which are operating near maximum capacity, and which may have potential problems if their existing loads are increased?
- Under an embargo imposed by a specific group of countries, what would be the resulting petroleum import shortages (by commodity type) at U.S. ports?
- Under an OPEC embargo, which ports (if any) cannot have their embargo shortfall entirely replaced by reserve petroleum? What are some of the constraints causing this limitation?

- During the period of a supply interruption, can reallocation of imports from one port to another significantly ease shortfalls without creating other problems?

General Types of Analysis that can be Performed

The problems and questions discussed above are specific examples of the types of analysis that can be performed using the Model. These can be summarized into more general categories as follows:

- Strategic Planning Analysis--the direct effect of changes in "controllable" variables associated with vessel, terminal, and port facility design and location, operating regulations (e.g., channel speed limits and hazardous cargo control), commodity arrival patterns, etc., can be measured, e.g.,

  1) examine which ports would be affected by a cutback in Saudi oil

  2) examine what configuration of berths is feasible for a strategic reserve terminal given an estimated demand.

- Contingency Planning Analysis--the direct effect of changes in "uncontrollable" variables associated with terminal facility breakdowns, strikes, natural disasters, (e.g., fires, floods, and hurricanes, etc.), can be measured, e.g.,

  1) measure the impact of shutting down a receiving terminal upon other operations at the port

  2) examine the impact on the system of a strike which stops the arrival of all Greek flag ships.

- Sensitivity Analysis--the relative effects of a series of incremental variations in any of the input data can be measured, e.g.,

  1) assume storage tanks at selected terminals are 10% larger and examine the inpact of this enlargement on ship queuing, unloading time, etc.

  2) increase the number of ships carrying Iranian oil by 10% and examine the impact on U.S. ports.

- Decision Analysis--by setting certain objectives to be achieved in terms of system performance, the values of system input variables needed to meet those objectives can be determined, e.g.,

  1) after determining that 8000 barrels/day of crude are required at New York to meet an expected supply interruption shortfall, find which configuration of shipments (if any) from reserve terminals will provide it adequately while at the same time meeting requirements at other affected U.S. ports.

  2) after a supply interruption starts, and assuming all shortfalls are to be met, determine how many ships are required to deliver the reserve.

III. SPRED MODEL DESCRIPTION

SCOPE OF ACTIVITIES TO BE SIMULATED

The system by which petroleum arrives at U.S. ports consists of a complex interconnection of various modes of transportation and storage. In order to adequately represent the real world system of waterborne petroleum import and distribution, yet not include so much detail that data collection becomes an impractical task and the computer time required to run the Model becomes excessive, certain "bounds" were placed on the distribution system. These bounds define, in effect, the system to be simulated, i.e., the particular activities of waterborne petroleum distribution which are addressed by the SPRED Model. The Model simulates two basic sets of activities. The first is the "business-as-usual" foreign and domestic petroleum supply activities at U.S. ports. The second is the distribution of the strategic petroleum reserve to U.S. ports during a petroleum supply interruption. Distribution of the reserve takes place concurrently with modified "business-as-usual" activities, reflecting the impact of the supply interruption.

Description of Business-as-Usual Activities

The general steps associated with the business-as-usual foreign and domestic petroleum supply activities at a U.S. Port can be summarized as follows:

- The shipment of petroleum leaves a U.S. or foreign port.
- From this originating point, the petroleum is usually shipped directly to its U.S. port of destination via tanker.
- The tanker next arrives at the destination port sea buoy.
- The tanker then proceeds from the buoy to an anchorage area.
- Upon leaving the anchorage, the tanker proceeds to a receiving terminal berth to unload its cargo.
- The cargo is unloaded into surge storage tanks and stored temporarily.
- After unloading, the tanker exits the port and proceeds to another (unknown) destination.
- From the storage tanks, the petroleum begins its movement inland to its ultimate point of usage (in the case of crude, this is typically from storage tank to a nearby refinery).

The SPRED Model addresses all of these steps, except for (1) the movement of petroleum prior to its arrival at the U.S. port of destination, (2) the movement of petroleum from a terminal storage facility (storage tanks) to refineries or inland points of usage. To attempt to model the movement of petroleum before it arrives at U.S. ports would inevitably lead to oversimplification and would present major data acquisition problems while providing only marginally useful information. Modeling the inland movements of petroleum is not of direct concern for the purposes of simulating the waterborne aspects of the petroleum importing and distribution system.

Description of Supply Interruption Activities

In the event of an embargo or other supply interruption, it is anticipated that idle U.S. and foreign tankers would be employed to transport the strategic reserve from storage sites to U.S. and/or Caribbean ports normally receiving imported crude oil supplies. The general steps associated with the movement of petroleum under supply interruption conditions, as simulated in the SPRED Model, consist of the following:

- The business-as-usual traffic at U.S. ports (minus any traffic cutback resulting from the supply interruption) continues as described in the previous section.
- U.S. and/or foreign idle ships are made available to transport the strategic reserve.
- An idle ship is dispatched to a U.S. port with a strategic reserve terminal.
- The ship arrives at the destination port buoy.
- The ship proceeds from the buoy to an anchorage area.
- Upon leaving the anchorage, the ship proceeds to a strategic reserve terminal berth to take on its cargo of petroleum.
- The petroleum is loaded into the ship from the reserve storage facilities.
- After being loaded, the ship exits the port and proceeds to the port to which its load of crude has been assigned.
- The ship next arrives at its destination port; from this point on its unloading proceeds as described for business-as-usual activities.
- After the ship is unloaded at the receiving terminal and exits the port, it once again becomes idle and "available" for subsequent shipments of reserve petroleum.

All ships carrying reserve petroleum are treated identically to ships carrying BAU petroleum once they arrive at the receiving terminals.

In addition to the general steps outlined above, the Model simulates the operations at the terminal facilities in a detailed manner.

AN OVERVIEW OF THE SPRED MODEL STRUCTURE

The SPRED Model was designed and implemented using the SIMSCRIPT II.5 language. It is operated in a time sharing, interactive mode from a remote computer terminal. The specification of all input data and the generation of all desired output reports is controlled directly from a remote terminal via conversational interactive programs designed for the user's convenience.

The SPRED Model belongs to the class of discrete event simulation models in which the continuous activities of a system's operation are represented by a chronological occurrence of a series of discrete events.

Entities are those elements which comprise the system being simulated. There are four entities in the SPRED Model:

- Ports
- Receiving Terminals
- Strategic Reserve Terminals
- Vessels.

Entity attributes are selected characteristics of entities (or the system in general) which are maintained by the Model for the purpose of determining when events are to occur and/or monitoring the status of the system. There are more than 100 entity attributes in the SPRED Model, too many to list here. Examples of these attributes are given below for each entity:

- System
  - average time spent by a vessel in the system
  - total number of receiving terminals in the system
  - total number of ports in the system
- Ports
  - port names
  - steaming time from port sea buoy to receiving terminal anchorage
- Receiving terminals
  - number of working berths at each receiving terminal
  - maximum vessel length per berth
  - mean ship inter-arrival time
- Strategic reserve terminals
  - delivery time per berth
  - delivery operating hours
  - frequency distribution of commodity types in storage
- Ships
  - commodity types accommodated
  - average loaded draft
  - vessel length.

The SPRED Model consists of four computer programs and a number of associated data files. The routine user will be primarily concerned with using these four programs, changing/updating data in four "default" data files which are initilized to default values (i.e., if the user makes no changes in the data elements in these files, they are used "as is" in the simulation), and initializing the external events list. The four computer programs which comprise the SPRED Model are:

- Pre-Processor Programs
  - Section One - An interactive (i.e., "conversational") program which permits the user to conveniently and quickly modify specific existing data elements for port, receiving terminal and strategic reserve terminal attribute data.
  - Section Two - An interactive program similar to Section One which permits the user to change ship attribute data, the historical ship arrival data, and the idle ship data (described below).
- Model Logic Program - A program containing the computerized representation of the activities being simulated and their interrelationships. This program is the heart of the model, actually "performing" the simulation and recording a large array of system performance data. The Model Logic Program is comprised of 36 event routines. Of these, 15 are external (i.e., they can be scheduled to occur using the external event data file read by the Model), 13 are internal (i.e., they are scheduled within the Model logic as the simulation progresses), and 7 are both internal and external.
- Report Generator - An interactive program which permits the user to select from over 100 different output reports to be printed at the computer terminal.

A data base of initial attribute values, optional historical ship arrival data, idle ("available") ship data, and externally triggered events must be defined to use the SPRED Model in a meaningful way. The data required can be summarized as follows:

- Facility Attribute Default Data File - This data file contains the default values of the port, receiving terminal, and strategic reserve terminal data required by the model.
- Ship Attribute Default Data File - This data file contains the default values of the ship attribute data required by the Model.
- Historical Ship Arrival Data File - This data file contains a historical summary of business-as-usual ship arrivals for each receiving port in the system.
- Idle Ship Data File - This data file contains a summary of ships that will be available for transporting the strategic petroleum reserve in the event of a supply interruption.
- External Event File - This data file contains the data required by the Model to externally schedule the occurrence of user-specified events.

In general, these data describe the status and physical makeup of the system being simulated. Figure 1 illustrates how these programs, together with the data files, are structured to form the SPRED Model.

MODEL OUTPUT REPORTS

After the Model Logic Program has finished executing, the "results" of the simulation, i.e., the information collected about ships, commodities, etc., is stored in a data output file accessed by the Model Report Generator. Reports are provided in three sections:

- Ship Summary Report
- Commodity/Facility Summary Report
- Detail Reports of Items in the Ship and Commodity/Facility Summaries.

The first two sections contain summary information collected during the simulation. Table 1 provides the format for the information provided in these two sections. The Detail Reports are selected by the user based upon a particular summary item to provide a more detailed look at what is happening in the system over the simulation period.

Table 2 illustrates the wide range of detail reports available, providing the user with a convenient and efficient means of getting the information he requires without being forced to wade through bulky pre-generated reports containing much information in which he has no interest.

USAGE OF MODEL TO DATE

The Model was designed to provide a great deal of flexibility to the user, containing many "user oriented" features and options too numerous to describe here. The model has been installed on the computer systems at both the Department of Energy and the Maritime Administration. DOE has used the SPRED Model to examine the feasibility of both currently planned and hypothetical strategic reserve distribution strategies. They have also used it to analyze facility requirements at each planned reserve petroleum storage site. These analyses have successfully pointed out problem areas and have provided the tool to analyze how reserve distribution objectives can be met. DOE is currently using the SPRED Model on an on-going basis for a variety of analyses including reserve terminal site planning and distribution program assessment. The Maritime Administration has cooperated jointly with DOE to date and plans to use the model for analyses pertinent to its own needs in the future.

TABLE 1

SPRED MODEL SUMMARY REPORTS

STRATEGIC PETROLEUM RESERVE DISTRIBUTION (SPRED) SIMULATION

OUTPUT REPORT GENERATOR

A COMPUTER QUERY ALWAYS REQUIRES A USER RESPONSE
UNLESS OTHERWISE INDICATED, ALL RESPONSES ARE "YES" OR "NO"

SPRED MODEL SUMMARY
FOR THE PERIOD 3/ 1/78 THRU 12/30/78

RUN ID: BMND
DATE: 12/30/78

SHIP SUMMARY

** TOTAL NUM OF SHIPS ENTERING PORT	104.0
TOTAL SHIPS DETAINED AT ANCHORAGES	
S1 RECEIVING TERMINAL ANCHORAGES	104.0
S2 STRATEGIC RESERVE TERMINAL ANCHORAGES	0.
DAILY AVG NUM OF SHIPS AT ANCHORAGES	
S3 RECEIVING TERMINAL ANCHORAGES	.3
S4 STRATEGIC RESERVE TERMINAL ANCHORAGES	0.
FINAL NUM OF SHIPS AT ANCHORAGES	
S5 RECEIVING TERMINAL ANCHORAGES	20.0
S6 STRATEGIC RESERVE TERMINAL ANCHORAGES	0.
AVG WAITING TIME OF SHIPS DISP FROM ANCHORAGES (HRS)	
S7 RECEIVING TERMINAL ANCHORAGES	731.8
S8 STRATEGIC RESERVE TERMINAL ANCHORAGES	0.
S9 TOTAL NUM OF SHIPS UNLOADED AT REC TERM	83.0
S10 AVERAGE SHIP UNLOADING TIME (HRS)	35.4
S11 TOTAL NUM OF SHIPS LOADED AT STRAT RESV TERM	0.
S12 AVERAGE SHIP LOADING TIME (HRS)	0.

TABLE 1 (CONT.)

FACILITY SUMMARY (000'S BBLS)

F1 TOTAL AMT OF COMM ARRIVING AT RECEIVING TERMINALS	21000.0
F2 DAILY AVG AMT ARRIVING AT RECEIVING TERMINALS	69.1
F3 DAILY AVG AMT QUEUED AT RECEIVING TERMINALS	2668.2
F4 FINAL AMT QUEUED AT RECEIVING TERMINALS	5000.0
TOTAL AMOUNT OF COMMODITIES RECEIVED	
F5 RECEIVING TERMINALS	20750.0
F6 STRATEGIC RESERVE TERMINALS	0.
DAILY AVERAGE COMMODITY AMOUNTS RECEIVED	
F7 RECEIVING TERMINALS	68.3
F8 STRATEGIC RESERVE TERMINALS	0.
INITIAL COMMODITY AMOUNTS STORED	
F9 RECEIVING TERMINALS	200.0
F10 STRATEGIC RESERVE TERMINALS	0.
FINAL COMMODITY AMOUNTS STORED	
F11 RECEIVING TERMINALS	0.
F12 STRATEGIC RESERVE TERMINALS	0.
DAILY AVERAGE COMMODITY AMOUNTS STORED	
F13 RECEIVING TERMINALS	29.0
F14 STRATEGIC RESERVE TERMINALS	0.
F15 TOTAL AMOUNT OF RESERVE DELIVERED TO SHIPS	0.
F16 DAILY AVG AMT OF RESERVE DELIVERED TO SHIPS	0.
F17 TOTAL AMT RESERVE IN TRANSIT TO REC TERMINALS	0.
F18 TOTAL AMT RESERVE RECEIVED AT REC TERMINALS	0.
F19 TOTAL AMT COMM DISCHARGED FROM REC TERM	20950.0
F20 DAILY AVG AMT DISCHARGED FROM REC TERM	68.9
F21 TOTAL AMT COMM RECEIVED AT STRAT RESV TERM	0.
F22 DAILY AVG AMT RECEIVED AT STRAT RESV TERM	.0

TABLE 2

CONTENTS OF SPRED MODEL DETAIL OUTPUT REPORTS

INFORMATION	BY VESSEL TYPE	BY PORT	BY TERMINAL SITE	BY COMMODITY TYPE	BY VESSEL FLAG	BY COUNTRY OF COMMODITY ORIGIN
TOTAL NUM. SHIPS DETAINED AT ANCHORAGES						
RECEIVING TERMINAL	X	X	X		X	X
STRATEGIC RESERVE TERMINAL	X	X	X		X	
DAILY AVG. NUM. SHIPS AT ANCHORAGES						
RECEIVING TERMINAL	X	X	X		X	X
STRATEGIC RESERVE TERMINAL	X	X	X		X	
FINAL NUM. SHIPS AT ANCHORAGES						
RECEIVING TERMINAL	X	X	X		X	X
STRATEGIC RESERVE TERMINAL	X	X	X		X	
AVG. WAIT-TIME AT ANCHORAGE						
RECEIVING TERMINAL	X	X	X		X	X
STRATEGIC RESERVE TERMINAL	X	X	X		X	
TOTAL NUM. SHIPS UNLOADED AT RECEIVING	X	X	X		X	X
TERMINAL AVG. SHIP UNLOADING TIME (HRS)	X	X	X			
TOTAL NUM. SHIPS LOADED AT STRATEGIC	X	X	X		X	
RESERVE TERMINAL AVG. SHIP LOADING TIME (HRS)	X	X	X			
TOTAL AMOUNT OF ARRIVING COMMODITY						
AT RECEIVING TERMINAL		X	X	X		
DAILY AVG. AMOUNTS ARRIVING						
AT RECEIVING TERMINAL		X	X	X		
DAILY AVG. AMOUNTS QUEUED						
AT RECEIVING TERMINAL		X	X	X		

TABLE 2 (CONT.)

INFORMATION	BY PORT	BY TERMINAL SITE	BY COMMODITY TYPE	BY TRANSPORTATION MODE
FINAL AMT. QUEUED AT RECEIVING TERMINAL	X			
TOTAL AMT. OF COMMODITY RECEIVED AT				
RECEIVING TERMINALS	X	X	X	
STRATEGIC RESERVE TERMINALS	X	X	X	
DAILY AVG. AMT. RECEIVED AT				
RECEIVING TERMINALS	X	X	X	
STRATEGIC RESERVE TERMINALS	X	X	X	
INITIAL COMMODITY AMT. STORED AT				
RECEIVING TERMINALS	X	X	X	
STRATEGIC RESERVE TERMINALS	X	X	X	
FINAL COMMODITY AMT. STORED AT				
RECEIVING TERMINALS	X	X	X	
STRATEGIC RESERVE TERMINALS	X	X	X	
AVG. COMMODITY AMT. STORED AT				
RECEIVING TERMINALS	X	X	X	
STRATEGIC RESERVE TERMINALS	X	X	X	
TOTAL AMT. RESERVE DELIVERED TO SHIPS	X	X	X	
DAILY AVG. AMT. RESERVE DELIVERED TO SHIPS	X	X	X	
TOTAL AMT. RESERVE IN TRANSIT TO REC TERMINALS	X	X	X	
TOTAL AMT. RESERVE RECEIVED AT REC TERMINALS	X	X	X	
TOTAL AMT. COMMODITY DISCHARGED FROM RECEIVING TERMINAL	X	X		X
DAILY AVG. AMT. DISCHARGED FROM RECEIVING TERMINAL	X	X		X
TOTAL AMT. COMMODITY RECEIVED AT STRATEGIC RESERVE TERMINAL	X	X		X
DAILY AVG. AMT. RECEIVED AT STRATEGIC RESERVE TERMINAL	X	X		X

FIGURE 1

ORGANIZATIONAL STRUCTURE OF THE SPRED SIMULATION MODEL