DEPARTMENT OF THE INTERIOR

U.S. GEOLOGICAL SURVEY

FASPU English and Metric Version: Analytic Petroleum Resource Appraisal Microcomputer Programs for Play Analysis Using a Reservoir-Engineering Model

By

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Open-File Report 90-509-A

A -- Documentation (paper copy)
B -- Executable program (5.25" diskette)

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CONTENTS

FIGURES

1. INTRODUCTION

FASPU is a prototype package of programs for IBM PC/XT/AT (and compatible) microcomputers to assess undiscovered oil and gas resources using a play analysis approach. Play analysis is a general term for various geologic models and probabilistic methods of analyzing a geologic play for petroleum potential. FASPU means Fast Appraisal System for Petroleum - Universal version.

This is an extensive modification of another program (FASP) which the USGS used in the assessment of the petroleum resource potential in the Arctic National Wildlife Refuge of Alaska (Crovelli, 1988).

The FASPU package is a revision of earlier releases of the same information (see Crovelli and Balay, 1987, and Crovelli and Balay, 1989). The earlier programs FASPUE and FASPUM have been combined within one interface to allow the user to choose either English or metric (SIU) units. The underlying methodology in both systems of units is unchanged from that used in FASPUE and FASPUM. This new version is compatible with the computer data files created by the earlier releases.

The geologic model used in this study is a universal type of reservoir engineering model. It is a generalization of the site-specific geologic model developed by the U.S. Department of the Interior and applied by the USGS in petroleum assessments of the National Petroleum Reserve in Alaska and the Arctic National Wildlife Refuge (U.S. Department of the Interior, 1979; White, 1981). The probabilistic methodology used in those two assessments was a Monte Carlo simulation method.

FASPU is based upon an analytic method using probability theory, rather than a Monte Carlo simulation method. Conditional probability theory is applied, along with many laws of expectation and variance. The risk structure considers both the uncertainty of the presence of the assessed petroleum resource and its amount if present. The geostochastic system can be applied in explored as well as frontier areas.

Separate programs are provided for assessing individual plays and for aggregating a set of plays. The programs produce resource estimates of crude oil, nonassociated gas, dissolved gas, and total gas for a geologic play and an aggregation in terms of probability distributions.

The reader should refer to Crovelli and Balay (1988) for a description of the reservoir engineering model and the analytic probabilistic methodology. Other useful references are Crovelli (1985, 1987a, 1987b) and Crovelli and Balay (1986).

All of the geologic play data required by this model are entered on an oil and gas appraisal data form, and later transcribed to computer data files for processing by the FASPU software. The primary data forms are reproduced in Figure 1 (for English units), and Figure 3 (for metric units); and addendum data forms are shown in Figure 2 (English) and Figure 4 (metric).

An IBM-PC compatible 5.25" diskette containing the executable programs and documentation files for FASPU is distributed in association with this Open-File Report. The diskette is a separate Open-File Report, number 90-509B. The files on the diskette are:

FASPU.COM	The main system program;
UEED.CHN	The data entry editor module for English units;
UMED.CHN	The data entry editor module for metric units;
UERE.CHN	The resource assessment module for English units;
UMRE.CHN	The resource assessment module for metric units;
FASPAG.COM	The aggregation program;
FASPU.DOC	The documentation file;
INSTAL2D.BAT	The automatic installation script for a 2-diskette computer (5.25" diskette);
INSTALHD.BAT	The automatic installation script for a hard disk computer;
TESTUE.DAT	A file of hypothetical sample data for test-running the FASPU system using English units;
TESTUM.DAT	A file of hypothetical sample data for test-running the FASPU system using metric units.

The FASPU.DOC file contains most of the present Open-File Report. It can be copied onto a printer using the DOS command

```
PRINT  disk:FASPU.DOC
```

where *disk* should be replaced by the drive letter of the disk drive containing the FASPU system disk. For example, if the system disk is in disk drive B, the command would be `PRINT B:FASPU.DOC`.

2. COMPUTER REQUIREMENTS

The computer requirements for running FASPU are the following:

IBM PC/XT/AT or compatible computer
Monochrome or color monitor
8087 math coprocessor
2 diskette drives (5.25"), or 1 diskette and a hard disk
256 K memory
Printer able to print 132 characters on a line

The program does not require a graphics adapter. There may be compatibility problems in running FASPU on some display hardware, or with some older versions of the DOS operating system. The development system was MS-DOS 3.1.

Oil and Gas Appraisal Data Form

Evaluator : _____ Play Name _____

Date Evaluated: _____

Attribute			Probability of Favorable or Present	Comments
Play Attributes	Hydrocarbon Source			
	Timing			
	Migration			
	Potential Reservoir Facies			
	Marginal Play Probability			
Prospect Attributes	Trapping Mechanism			
	Effective Porosity (>3%)			
	Hydrocarbon Accumulation			
	Conditional Deposit Probability			
Hydrocarbon Volume Parameters	Reservoir Lithology	Sand		
		Carbonate		
	Hydrocarbon	Gas		
		Oil		

Attribute \ Fractiles	Probability of equal to or greater than						
	100	95	75	50	25	5	0
Area of Closure ($x10^3$ Acres)							
Reservoir Thickness/vertical closure (Ft)							
Effective Porosity %							
Trap Fill (%)							
Reservoir Depth ($x10^3$ Ft)							
HC Saturation (%)							
No. of drillable prospects (a play characteristic)							
Proved Reserves ($x10^6$ Bbl; TCF)							

Figure 1. Oil and gas appraisal data form, English units. (Modified from U.S. Department of Interior, 1979.)

A D D E N D U M D A T A F O R M F O R F A S P U E

Geological Variables

Four Types of Mathematical Functions

1. Zones Linear Function: A * Depth + B
   Maximum of 4 zones with 3 transition depths (feet)
2. Exponential Function: A * exp (B * Depth)
3. Power Function: A * Depth ** B
4. Logarithmic Function: A * Ln (B * Depth)

For each of the five geological variables below, select one type of function and assign values for the parameters A and B.

Pe: Original Reservoir Pressure (PSI)

T: Reservoir Temperature (Deg Rankine)

Rs: Gas-oil Ratio (Thousand CuFt/BBL)

Bo: Oil Formation Volume Factor (no units)

Z: Gas Compressibility Factor (no units)

		Parameters											
Variable	Function	A	B	D	A	B	D	A	B	D	A	B	
Pe													
T													
Rs													
Bo													
Z													

Oil Floor Depth (feet): _____

Oil Recovery Factor (percent): _____

Gas Recovery Factor (percent): _____

Figure 2. Oil and gas appraisal addendum data form, English units.

Oil and Gas Appraisal Data Form

Evaluator : _____ Play Name _____

Date Evaluated: _____

	Attribute		Probability of Favorable or Present	Comments
Play Attributes	Hydrocarbon Source			
	Timing			
	Migration			
	Potential Reservoir Facies			
	Marginal Play Probability			
Prospect Attributes	Trapping Mechanism			
	Effective Porosity (>3%)			
	Hydrocarbon Accumulation			
	Conditional Deposit Probability			
Hydrocarbon Volume Parameters	Reservoir Lithology	Sand		
		Carbonate		
	Hydrocarbon	Gas		
		Oil		

Attribute \ Fractiles	Probability of equal to or greater than						
	100	95	75	50	25	5	0
Area of Closure (Km^2)							
Reservoir Thickness/vertical closure (meters)							
Effective Porosity %							
Trap Fill (%)							
Reservoir Depth (m)							
HC Saturation (%)							
No. of drillable prospects (a play characteristic)							

Figure 3. Oil and gas appraisal data form, metric units. (Modified from U.S. Department of Interior, 1979.)

A D D E N D U M D A T A F O R M F O R F A S P U M

Geological Variables

Four Types of Mathematical Functions

1. Zones Linear Function: A * Depth + B
   Maximum of 4 zones with 3 transition depths (meters)
2. Exponential Function: A * exp (B * Depth)
3. Power Function: A * Depth ** B
4. Logarithmic Function: A * Ln (B * Depth)

For each of the five geological variables below, select one type of function and assign values for the parameters A and B.

Pe: Original Reservoir Pressure (Bars)

T: Reservoir Temperature (Deg K)

Rs: Gas-oil Ratio (m^3/Ton)

Bo: Oil Formation Volume Factor (no units)

Z: Gas Compressibility Factor (no units)

		Parameters										
Variable	Function	A	B	D	A	B	D	A	B	D	A	B
Pe												
T												
Rs												
Bo												
Z												

Oil Floor Depth (meters): _____

Oil Recovery Factor (percent): _____

Gas Recovery Factor (percent): _____

Figure 4. Oil and gas appraisal addendum data form, metric units.

3. FASPU INSTALLATION GUIDE

FASPU consists of several modules, performing three main functions:

FUNCTION	MODULE(S) INVOLVED
Data entry and editing	FASPU.COM UEED.CHN UMED.CHN
Resource assessment	FASPU.COM UERE.CHN UMRE.CHN
Aggregation of assessments	FASPAG.COM

The first two functions are combined under the supervision of the shell program FASPU.COM. When FASPU.COM runs, it requests a data file name and allows the user to pass this file into either UEED.CHN (or UMED.CHN) for data entry and editing, or into UERE.CHN (or UMRE.CHN) for processing of the data in the file. The user needs only run FASPU.COM and enter information requested by the program; loading and execution of the other modules is done by FASPU.COM.

This section covers the installation of the necessary executable files to generate a FASPU working system on either a dual 5.25" diskette computer or a computer with a diskette and a hard disk. Information on running the FASPU system after it is installed appears in section 4.

In all the instructions that follow, italics are used to show a part of a command which you must replace with a phrase that fits your application.

3.1 Installation for a Diskette System

To install FASPU on a PC with two 5.25" diskette drives:

- Format a new diskette, using the standard form of the FORMAT command to include the DOS operating system on the new diskette. For help in doing this, refer to the MS-DOS or PC-DOS manual for your machine. Label this diskette "FASPU SYSTEM DISK."

- Insert the FASPU issue diskette into another diskette drive. Log onto this disk by typing the DOS command

  disk:

  In place of *disk* substitute the letter of the diskette drive containing the issue disk, and be sure to include the colon after the drive letter.

- Run the FASPU installation program for two diskettes by typing

  `INSTAL2D  disk:`

  This time in place of *disk* substitute the drive letter of the disk on which you are installing FASPU. This command takes care of creating the needed directory, named \FASPU, on the new system diskette and copying the necessary files into it. An example of the install command is `INSTAL2D  B:`

- Make a backup copy of the system diskette, and keep it in a secure place for recovery of the system in case the working system disk is damaged. Refer to the MS-DOS or PC-DOS manual for your machine for help in copying a diskette.

- Format another diskette to use as a FASPU data disk. As FASPU runs, it generates additional files on the same disk with the data. It is not advisable to put the data files on the same disk with the system, as the system disk has little free space.

When running FASPU, always have the system disk as the default disk. You cannot run FASPU if you are logged onto a disk different from the one where FASPU resides.

3.2 Installation for a Hard Disk System

To install FASPU on a PC with a hard disk and one diskette drive, use the following procedures. NOTE: the FASPU installation program creates a new directory on the hard disk, named \FASPU. In the unlikely case there is already such a directory on the hard disk, the installation may fail. You should eliminate the existing \FASPU directory (refer to your MS-DOS or PC-DOS manual) before running the installation procedure.

- Insert the FASPU issue diskette into a diskette drive, and log onto this disk by typing the DOS command

  disk:

  In place of *disk* substitute the letter of the diskette drive containing the issue disk.

- Run the FASPU installation program for hard disk systems by typing

  `INSTALHD  disk:`

  In place of *disk* substitute the drive letter of the hard disk where you want to install FASPU, and be sure to include the colon after the drive letter. An example of the install command is `INSTALHD  C:`

- Use an ASCII text editor to modify the PATH command in the AUTOEXEC.BAT file in the root directory of the startup disk. At the end of the PATH command, add the text

  ;*disk*:\FASPU

  where *disk* is the same as in the preceding paragraph. For example, if you are installing to disk C, append to the PATH command the phrase

  ;C:\FASPU

  If the AUTOEXEC.BAT file doesn't have a PATH command in it, add a line at the end of the file which says

  PATH *disk*:\FASPU

  An example of this is PATH C:\FASPU.

  If the startup disk doesn't have an AUTOEXEC.BAT file, use an ASCII text editor to create one, and put the above PATH command in it.

- To make the changes in AUTOEXEC.BAT take effect before running FASPU for the first time, reboot the system by keying CTRL-ALT-DEL. This makes it possible to use FASPU immediately. From this point on, the modifications in AUTOEXEC.BAT will take effect automatically every time the computer is turned on.

It is possible to put the data files in the same directory with the system, but you may prefer to package the data files in a different directory. You can also keep the data on a diskette instead of on the hard disk, but this is less convenient.

When running FASPU, always have the hard disk containing FASPU as the default disk; it will not run from any other default disk. However you can change to any desired directory on the hard disk for the data files, and run FASPU from there. FASPU generates a number of new files while processing the data, and puts them in the same directory and on the same disk as the data file.

3.3 Disabling One Set of Units

If all your work will be restricted to one set of units (English or metric), you can save storage space and simplify the operation of the system by deleting (or renaming) the FASPU system files related to the units you will not be using. The following table shows which files to eliminate.

TO DISABLE ...	... DELETE THESE FILES
English units	\FASPU\UEED.CHN \FASPU\UERE.CHN
metric units	\FASPU\UMED.CHN \FASPU\UMRE.CHN

FASPU detects which system files are present and adjusts its units accordingly.

4. FASPU USER'S GUIDE

Before running FASPU, it must be correctly installed on your PC. If this has not been done, you must run through the installation procedure described in section 3. After installation is complete, proceed with the operation of the system, described in this section.

In most respects, operation of FASPU is the same whether you are using a dual diskette system or a hard disk system. These two installations have slightly different methods of starting out; both cases are covered separately below.

4.1 Starting FASPU - Diskette Computers (two diskette drives)

- Insert the FASPU system disk into a diskette drive and log onto this drive.
- Insert a formatted data disk into another drive.
- After the DOS prompt, type

  ```
  FASPU
  ```

- When FASPU asks for a file name, type a name of the form

  ```
  drive:datafile.DAT
  ```

  In place of *drive* substitute the drive letter of the disk where you plan to store data files, and in place of *datafile* substitute your chosen data file name. For example, you might give the file name `B:FILE5.DAT`. The data file name must be 8 or fewer letters or digits, not counting the .DAT suffix. The .DAT is not required as part of the name, but it is recommended. You can use another suffix if preferred, but you must avoid the suffixes .REL, .AGG, and .AGL as FASPU uses these suffixes for its own output files. FASPU doesn't check the legality of the file name, so if you enter an illegal one, the program aborts with a cryptic `I/O Error F1`.

4.2 Starting FASPU - Hard Disk Computers

- Log onto the hard disk in your computer which contains FASPU. Change to the directory where you plan to store data files.

- After the DOS prompt, type:

  ```
  FASPU
  ```

- When FASPU asks for a file name, type a name of the form

  datafile.DAT

  In place of *datafile* substitute the name you have chosen for your data. For example, you might give the file name SOUTH.DAT. The data file name must be 8 or fewer letters or digits. The suffix .DAT is not required, but it is recommended. You can use a different suffix if preferred, but you must avoid the suffixes .REL, .AGG, and .AGL as FASPU uses these suffixes for its own output files.

  The file name may include a directory path prefix if needed, for example \MYDATA\TESTRUN.DAT. FASPU doesn't check the legality of the file name, so if you enter an illegal one, the program aborts with an I/O Error F1.

4.3 Operation of FASPU - Both Diskette and Hard Disk Computers

After loading FASPU and specifying a data file name, both diskette and hard disk systems work the same way. A diskette system works a bit slower.

If the named file does not already exist, FASPU asks if you want to create a new file with that name. Answer Y (for Yes) or N (for No). The N response is provided as an escape in case you really wanted an existing file but typed its name incorrectly.

FASPU now asks you to specify which units you want for your data. Type letter E for English or M for metric. (This question is omitted if you have disabled one of the sets of units as described in paragraph 3.3).

The first data entry screen appears. It includes a bar at the top of the screen with the name of the file being edited, and a bar at the bottom showing a menu of the control keys: the arrow keys, the RETURN and TAB keys, PgUp and PgDn. The details of working with the data input editor are described in the next section.

If the named file is an old one, then FASPU gives the options of editing the file or sending the file directly to the FASPU assessment program. The details of this are given later.

4.4 Operation of the Data Entry Editor - New Files

FASPU has a screen-oriented data entry module. The program accepts keyboard input of parameters through a series of 9 display screens. Each screen contains cells for entry of a group of parameters. You can step sequentially through the cells on a screen by striking the RETURN key after entering each value. The right arrow key and the TAB key have the same function as RETURN.

By using the cursor keypad and other control keys you can browse randomly through the cells on the visible screen, and through the adjacent screens, until you come to the cell where you want to enter or edit data. These are the screen controls:

Up arrow key — This key jumps the cursor to the next line above the current line. If the cursor is already on the first line of the screen, there is no effect.

Down arrow key — This key jumps the cursor to the next line below the current line. If the cursor is already on the last line of the screen, there is no effect.

Right arrow key — This key jumps the cursor to the next cell to the right of the current cell. If the cursor is already on the last cell on the current line, the cursor jumps to the first cell on the next line below. If the cursor is already on the last cell of the screen, there is no effect.

Left arrow key — This key jumps the cursor to the next cell to the left of the current cell. If the cursor is already on the leftmost cell of the current line, there is no effect.

RETURN key — This has the same effect as the right arrow key.

TAB key — This also has the same effect as the right arrow key.

PgUp key — This key jumps to the previous screen. If the cursor is already on screen 1, FASPU displays `No previous screen.`

PgDn key — This key jumps to the next screen. If the cursor is already on the last data screen (screen 9), FASPU displays `No following screen.`

ESC key — This key can be pressed from any cell on any screen to escape from the data entry function. FASPU then gives the option to send the data to the resource assessment module, to return for more editing on the data, or to quit.

For a new file, FASPU has already entered dummy data into some of the cells. You can step through the cells and substitute actual values for your application.

The size of each cell limits the amount of space for that entry. If a cell is completely filled with characters, the editor jumps to the next cell.

As you enter values, FASPU monitors the entries for correctness. If an entry has an error in it, FASPU displays an error message on the screen and waits for you to retype correctly. However if you realize there is a typing error in the current cell, you can backspace over the bad characters and then retype.

Numeric entries. If the parameter is a number, it can be entered in any reasonable form: real numbers can be in fixed point notation (like 3.1416) or in floating point scientific notation (like 2.386E+3, which means 2.386×10^3). Wherever FASPU requests real numbers, integers are also acceptable. When FASPU requests integers (as in the number of geologic prospects), these must be typed without a decimal point (like 34, never as 34.0).

Probability entries. If the entry being requested is a probability, it must be entered as a real number in the range 0.0 to 1.0. A probability which is out of range causes an error message.

Percent entries. If the entry being requested is a percent, it must be entered as a real number in the range 0 to 100. If it is out of range, an error message is given.

Fractile entries. The lists of fractiles on screen #3 must be in non-decreasing order. If they are not, an error message is given. The fractiles for Depth on this screen must be strictly increasing; if any two of the fractiles are equal, an error results.

Geologic variable screens. The data on screens 4 through 8 specify the parameters for the five geologic variables in the FASPU assessment: reservoir pressure (Pe), reservoir temperature (T), gas/oil ratio (Rs), oil formation volume factor (Bo), and gas compressibility factor (Z). Each of these variables can be specified as one of four function types: (a) zoned linear: a set of 1 to 4 linear functions of depth, with transition depths to separate the zones; (b) exponential function of depth; (c) power function of depth; and (d) logarithmic function of depth.

For each of the geologic variables, one of the function types is highlighted; and this is the function type currently selected. Use the left/right cursor keys to highlight one of the other function types if desired. The mathematical form of the function changes on the screen to show the currently selected formula.

If the selected function type is zoned linear, a line appears on the display to show the number of zones (1 to 4), and one of these is highlighted to show the current selection. Use the left/right cursor keys to highlight one of the other numbers, and the mathematical form of the function changes on the screen to show the currently selected formula and number of zones. If 3 or more zones are specified, the entries in the cells for transition depths must be strictly increasing, else an error results.

When you have entered all the data on the nine screens, press the ESC key. FASPU displays the DO WHAT menu:

```
Do what with this file?

E  Return to editing
S  Save file; Send to the FASPU assessment program
X  Exit and save file
Q  Quit without saving.
```

Press the letter key corresponding to the action wanted. Either upper or lower case letters are accepted. If you type X, FASPU saves the data in the file directory and returns to DOS; only the new version of the file is kept, and it replaces the old version, if any. If you type Q, the system terminates without saving the newly created (or edited) file; this option is used if you realize the current edits are useless and you don't want to save this version of the data. If you type S, FASPU saves the file in the directory, then sends the data directly to the FASPU assessment module. If you type E, then FASPU re-enters the data entry module for further review and editing. This is the same as editing an old file, and this process is described next.

4.5 Operation of the Data Entry Editor - Old Files

If you specify the name of an already existing data file when first entering FASPU, the system shows a DO WHAT menu similar to the one in the paragraph above.

If the file needs to be edited before sending it on to the FASPU assessment program, press the E key. Then FASPU runs through the data entry screens as before, but it now shows the cells already filled with the parameters in the existing file. If the existing values on a screen are correct, press PgUp or PgDn to review the other screens. If the content of a cell needs to be changed, move the cursor to that cell and type the new entry to replace the old. When the edited file is correct, press ESC while any data input screen is visible to return to the DO WHAT menu.

5. COMPUTING THE RESOURCE ASSESSMENT

Whenever the DO WHAT menu appears on the screen, you have the option to send the current data file to the FASPU assessment module. To do this, press the S key. The FASPU assessor reads the input data file, performs the assessment of resources, and produces two output files: a listing which summarizes the input data and displays an estimate of resources in the play; and a file of parameters which can be fed into the aggregator program to combine estimates of several plays after they are processed by FASPU.

The summary listing file is named by FASPU to agree with the data file name, but having the file name suffix .REL. The aggregation data file is named by FASPU to agree with the data file name, but with the suffix .AGG. For example, if the original data file name is TEST.DAT, then FASPU generates new files with names TEST.REL and TEST.AGG.

When the assessment program starts, it asks if you want to include computations of fractiles for the number of resource type accumulations in the play. These computations are potentially the most time consuming part of the FASPU method. Including them is optional because their effect on running time depends on a complex interaction between the number of prospects fractiles and several other parameters. They probably should be included for a first run (type y or Y in response to the query) because for most data sets the computing time is acceptably low. If the program is running too long, you must abort FASPU by entering CTRL-C, then restart it on the same data file. This time, enter n or N when asked if you want to include the number-of-accumulations computations, and the program should finish in a short time. In this case, FASPU prints a row of dashes on the summary output file for number of accumulations to show that this computation was bypassed.

Next FASPU asks for a run number. It must be given as an integer. This is intended to help keep track of the results after several different runs of the same play with variations in the data input on each run. The run number is printed at the top of the .REL output listing.

Now FASPU runs its assessment. It may take from 10 seconds to several minutes to complete, depending on the content of the data file and whether you have elected the option to compute number of accumulations. When FASPU is finished, it returns to DOS, and it leaves the .REL and .AGG output files, as well as the source data file, in the file directory.

Numeric errors may occur during the assessment, such as overflow or division by zero. FASPU attempts to trap such errors, but their occurrence is due to a complex interaction between the many input parameters, and the program may not catch them all. If you see a message such as `Run-time Error 01, PC = 802A`, then FASPU will terminate. Restart the program and use it to examine the input data file for data entries which are missing, inconsistent with the other values, or out of reasonable range.

6. PRINTING THE OUTPUT

The printer used to print the file resulting from a FASPU assessment run should be able to print 132 columns across a page. Scroll the paper in the printer until the print head is positioned about 3 lines below the tear-off perforations. Now enter the standard DOS command:

```
PRINT  playdata.REL
```

For *playdata* substitute whatever name you gave to the data file when you created it through the FASPU editor. Examples of this command are `PRINT TEST3.REL` and `PRINT B:WESTERN.REL`. The output file is printed on two pages, as shown in Figure 5. The data shown in the figure are purely hypothetical for illustrative purposes only.

The other file output by FASPU, the one with the .AGG suffix, is also printable, but it is intended to be read by another program, not by people.

FASP:UE 90.7 07/27/90 10:53:24 PLAYE.DAT Run # 1

PLAY : Play E - English units PROJECT : FASPU Development Project

INPUT SUMMARY

Play Attribute Probabilities				Prospect Attribute Probabilities		
Hydrocarbon Source	Timing	Migration	Potential Res. Facies	Trapping Mechanism	Effective Porosity	Hydrocarbon Accumulation
0.900	0.780	0.950	1.000	0.800	1.000	0.850

Marginal Play Probability	Conditional Deposit Probability	Reservoir Lithology	Hydrocarbon Prob. Gas	Hydrocarbon Prob. Oil	Recovery Factors % Oil	Recovery Factors % Free Gas
0.667	0.680	Sand	0.950	0.050	95.00	100.00

Geologic Variables	F100	F95	F75	F50	F25	F05	F0
Closure (thousand acres)	256.000	288.000	320.000	352.000	365.000	378.000	384.000
Thickness (feet)	400.000	450.000	475.000	500.000	525.000	550.000	600.000
Porosity (percent)	7.00000	7.30000	7.70000	8.00000	8.50000	9.00000	9.50000
Trap Fill (percent)	0.25000	0.50000	0.75000	1.00000	1.50000	2.25000	3.00000
Depth (thousand feet)	9.90000	10.0000	10.1000	10.2000	10.3000	10.4000	10.5000
HC Saturation (percent)	35.0000	36.0000	38.0000	40.0000	43.0000	47.0000	50.0000
Number of Prospects	1	1	2	3	4	6	9

GEOLOGIC VARIABLES and PROBABILITIES OF OCCURRENCE

	Mean	Std. Dev.
Closure	341.375	30.1617
Thickness	500.000	35.6487
Porosity	8.09500	0.55164
Trap Fill	1.18125	0.58226
Depth	10.2000	0.13166
HC Saturation	40.7250	3.51535
Prospects	2.75000	1.58771
Accumulations	1.87000	1.32817

"Dry Hole" Risk = 0.5465
Prob. (Depth <= 50000 feet) = 1.0000

	RESOURCE Oil	NA Gas	AD Gas	Gas
Cond. Prob. Prospect has	0.0340	0.6460	0.0340	0.6800
Cond. Play Prob.	0.0894	0.8669	0.0894	0.8848
Uncond. Play Prob.	0.0596	0.5781	0.0596	0.5901

Variable	Function	A	B	D(feet)	A	B	D(feet)	A	B	D(feet)	A	B
Pe (PSI)	Linear	0.6000000	14.700000									
T (Deg Rankine)	Expon	500.00000	0.0001500									
Rs (Thousand CuFt/BBL)	Power	1.0000000	1.0010000									
Bo (no units)	Log	3.7250000	0.2940000									
Z (no units)	Linear	0.000	0.9800000	2000.0000	0.0000050	0.9700000	4000.0000	0.0000020	0.8200000			

Depth Floor (feet) = 50000.00

Figure 5. FASPU sample output.

Play E - English units

ESTIMATED RESOURCES

	Mean	Std. Dev.	F95	F75	F50	F25	F05
OIL (Millions of BBLs)							
Number of Accumulations	0.09350	0.30534	0	0	0	0	1
Accumulation Size	16.5332	8.90027	6.34889	10.3591	14.5578	20.4583	33.3805
Cond. Prospect Potential	0.56213	3.41629	0.0	0.0	0.0	0.0	0.0
Cond. (B) Play Potential	17.2923	9.77990	6.32742	10.5504	15.0518	21.4737	35.8054
Cond. (A) Play Potential	1.54585	5.73515	0.0	0.0	0.0	0.0	13.9174
Uncond. Play Potential	1.03093	4.73989	0.0	0.0	0.0	0.0	8.93754
NON-ASSOCIATED GAS (Billions of CuFt)							
Number of Accumulations	1.77650	1.29648	0	1	2	2	4
Accumulation Size	325.204	175.086	124.868	203.750	286.342	402.414	656.624
Cond. Prospect Potential	210.082	209.734	0.0	0.0	195.887	331.053	587.570
Cond. (B) Play Potential	666.422	456.909	197.979	361.617	549.643	835.435	1525.95
Cond. (A) Play Potential	577.725	481.895	0.0	276.992	487.468	777.913	1462.51
Uncond. Play Potential	385.285	478.554	0.0	0.0	277.237	611.181	1282.65
ASSOCIATED-DISSOLVED GAS (Billions of CuFt)							
Number of Accumulations	0.09350	0.30534	0	0	0	0	1
Accumulation Size	170198	91648.1	65340.3	106624	149854	210609	343679
Cond. Prospect Potential	5786.74	35170.8	0.0	0.0	0.0	0.0	0.0
Cond. (B) Play Potential	178013	100702	65121.0	108595	154939	221061	368639
Cond. (A) Play Potential	15913.5	59043.4	0.0	0.0	0.0	0.0	143260
Uncond. Play Potential	10612.7	48797.0	0.0	0.0	0.0	0.0	91990.7
GAS (Billions of CuFt)							
Number of Accumulations	1.87000	1.32817	0	1	2	3	4
Accumulation Size	8818.85	42316.6	95.7812	540.486	1799.21	5989.34	33797.4
Cond. Prospect Potential	5996.82	35136.8	0.0	0.0	587.325	3302.82	24049.1
Cond. (B) Play Potential	18638.4	62447.0	394.814	1833.52	5330.61	15497.7	71971.5
Cond. (A) Play Potential	16491.3	59040.6	0.0	1051.24	4123.97	13288.2	65627.4
Uncond. Play Potential	10998.0	48837.4	0.0	0.0	1053.30	7234.23	47085.2
YIELD FACTORS							
OIL (Thousand BBL / Acre-Ft)	0.00863	0.00135	0.00660	0.00768	0.00853	0.00947	0.01101
NON-ASSOCIATED GAS (Million CuFt / Acre-Ft)	0.16129	0.02524	0.12338	0.14348	0.15935	0.17698	0.20581
DISSOLVED GAS (Million CuFt / Acre-Ft)	88.8562	13.9252	67.9418	79.0297	87.7848	97.5098	113.423

Figure 5. FASPU sample output (continued).

7. RUNNING THE FASPAG AGGREGATION MODULE

FASPAG is a program which combines the resource assessments from previous runs of FASPU on two or more plays. FASPAG aggregates the plays and produces two new output files: (1) a summary listing file showing input values and output estimates; and (2) another .AGG file which can later participate in a higher level aggregation.

To run FASPAG, type the command

```
FASPAG
```

FASPAG requests a title line for this aggregation. This is the title which is printed across the top of the summary output file, and is for documentation purposes. Type any desired title line.

Now FASPAG asks for the name of a file on which to write the output listing. This must be a legal DOS file name consisting of a first name of 8 or fewer letters or digits and a suffix .AGL. An example of an output file name is `ALLUSA.AGL`. If you use a different suffix, FASPAG changes it to .AGL. If you want the output listing file to go onto a disk different from the default disk, include a disk drive or directory prefix with the file name, as in the examples `B:ALLUSA.AGL` or `\PROJECTX\ALLUSA.AGL`. FASPAG does not check the legality of the file name, so if you specify an illegal one, the program aborts with an `I/O Error F1`. FASPAG uses the output file name to generate the aggregation file name: this has the same first name as the .AGL file, but the suffix is .AGG.

Then FASPAG asks you to enter a degree of dependency between the plays to be aggregated. This must be a real number between 0.0 and 1.0 inclusive. If the entry is out of bounds, FASPAG waits for you to re-enter it.

Finally, FASPAG goes into a mode which allows you to type any number of aggregation file names to join in the aggregation. These must be files with type suffixes of .AGG which were generated by earlier runs of FASPU or FASPAG. After typing the names of all the aggregation files which are to participate in the aggregation, just press RETURN to exit. FASPAG completes the assessment, saves the output files and returns to DOS.

There is a possibility that FASPAG will encounter computational problems with certain aggregation data files having unusually small unconditional play probabilities. This problem is unpredictable, as the computation is a complex interaction between these probabilities and several other parameters of the aggregation. If this happens, FASPAG outputs a message like `arithmetic fault in nonassociated gas`, and it enters rows of dashes on the output summary file to indicate the bypassed fractile computations. However, a valid aggregation output file is still produced, and this .AGG file can participate in further aggregations.

To print FASPAG'S summary output file, use the DOS command

```
PRINT  aggdata.AGL
```

For *aggdata* substitute the name given above for the aggregation output listing file. Figure 6 shows a sample of the FASPAG output file. The data shown in the figure are purely hypothetical for illustrative purposes only.

FASP:AG 90.7 AGGREGATION 07/27/90 11:02:52 Run No. 1

This file is AGG3M.AGL

INPUT SUMMARY

Degree of Dependency 0.9000	OIL			NON-ASSOC GAS			DISSOLVED GAS			GAS		
	Mean	S.D.	EN/MP	Mean	S.D.	EN/MP	Mean	S.D.	EN/MP	Mean	S.D.	EN/MP
Play 1, metric units												
	0.72557	1.15087	1.503	0.35986	0.58186	3.507	0.07981	0.12660	1.503	0.27585	0.50820	5.010
	1.09053	1.68888	0.764	1.26205	1.31746	0.961	0.11996	0.18578	0.764	1.38200	1.33721	0.989
Play 2, metric units												
	1.24313	0.94312	1.531	0.47201	0.37751	6.125	0.09945	0.07545	1.531	0.39750	0.37062	7.656
	1.90355	1.95582	0.777	2.89106	1.56876	0.997	0.15228	0.15647	0.777	3.04334	1.58399	0.999
Play 3, metric units												
	0	0	0.000	0.23095	0.17302	8.680	0	0	0.000	0.23095	0.17302	8.680
	0	0	0.000	2.00468	1.07154	0.999	0	0	0.000	2.00468	1.07154	0.999
Aggregation of 3 metric plays	0.98676	1.08255	3.034	0.33627	0.37178	18.312	0.08972	0.10444	3.034	0.30123	0.35713	21.346
	2.99408	3.53864	0.794	6.15779	3.79317	1.000	0.27224	0.33231	0.794	6.43002	3.82682	1.000

Figure 6. FASPAG sample output.

Aggregation of 3 metric plays — ESTIMATED RESOURCES

	Mean	Std. Dev.	F95	F75	F50	F25	F05
OIL (Millions of Tons)							
Accumulation Size	0.000987	0.001083	0.0002	0.0004	0.0007	0.0012	0.0029
Cond Aggregate Potential	0.003770	0.003584	0.0007	0.0016	0.0027	0.0047	0.0102
Uncond Aggregate Potential	0.002994	0.003539	0	0.0008	0.0021	0.0040	0.0093
NON-ASSOCIATED GAS (Milliards of m^3)							
Accumulation Size	0.000336	0.000372	0.0001	0.0001	0.0002	0.0004	0.0010
Cond Aggregate Potential	0.006161	0.003792	0.0021	0.0036	0.0052	0.0077	0.0133
Uncond Aggregate Potential	0.006158	0.003793	0.0021	0.0036	0.0052	0.0077	0.0133
ASSOCIATED-DISSOLVED GAS (Milliards of m^3)							
Accumulation Size	0.000090	0.000104	0.0000	0.0000	0.0001	0.0001	0.0003
Cond Aggregate Potential	0.000343	0.000339	0.0001	0.0001	0.0002	0.0004	0.0009
Uncond Aggregate Potential	0.000272	0.000332	0	0.0001	0.0002	0.0004	0.0009
GAS (Milliards of m^3)							
Accumulation Size	0.000301	0.000357	0.0000	0.0001	0.0002	0.0004	0.0009
Cond Aggregate Potential	0.006433	0.003825	0.0022	0.0038	0.0055	0.0080	0.0137
Uncond Aggregate Potential	0.006430	0.003827	0.0022	0.0038	0.0055	0.0080	0.0137

Figure 6. FASPAG sample output (continued).

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