Royalty Suspension Viability Program

RSVP 2.0

Documentation

Version 2.0

United States Department of the Interior
Minerals Management Service
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WHAT'S NEW IN RSVP VERSION 2.0

Version 2.0 of the Royalty Suspension Viability Program (*RSVP 2.0*) contains several improvements over the original version. The most notable change in the program is its host software. In response to numerous indications of program users' difficulties in obtaining the DOS-based LOTUS 1-2-3 version 2.4 and @RISK version 2.0, the RSVP has been reprogrammed to use MS-EXCEL and Crystal Ball.

This conversion has afforded the program more improved statistical capabilities. In the original version of RSVP, input distributions were limited to lognormal and triangular distributions for some, and only triangular distributions for others. Crystal Ball affords the use of 17 different types of input probability distributions. Previously, the RSVP was structured such that specific inputs were input as point estimates while others were input as distributions, *RSVP 2.0* allows virtually any input to be expressed as either a point estimate or as one of 17 types of input distributions.

Several other modeling improvements have been made. In particular, changes have been made to the Resource Module which affects the way the distribution of oil and gas within combination (oil and gas) reservoirs is represented. In the Viability Module, a loss limiting feature has been added which substitutes a value equal to estimated expenditures for the first year following the application for certain simulation iterations where the sampled inputs yield a discounted cash flow below a minimum profit threshold level. This substitution simulates the situation where a prudent operator would foresee extremely bad outcomes prior to development and would abandon in favor of developing other projects. The uses and benefits of these features are illustrated throughout this documentation.

PREFACE

The Outer Continental Shelf (OCS) Deep Water Royalty Relief Act (DWRRA) directs the Secretary of the Interior to suspend royalties on existing leases in certain deep water areas of the Gulf of Mexico OCS Region when a specific set of conditions are met. Upon receipt of a complete application, the Secretary must determine whether proposed new production would be economic while subject to the requirement to pay Federal royalties. The DWRRA directs the Secretary to consider, in his determination, the increased risk of operating in deep water and all costs associated with exploring, developing, and producing. Lessees are required to submit a complete application which provides the necessary raw and interpreted data on the field so that such a determination can be made.

There are two economic hurdles that a field must clear to be eligible for a royalty suspension. If, after reviewing the application, the Secretary determines that the new production would be economic while paying Federal royalties, then royalty obligations will not be suspended. Further, a determination that no amount of royalty-free production would make the new production economically viable also disqualifies the field from a royalty suspension. Alternatively, if the field would not be economic while paying Federal royalties but some amount of royalty-free production would make the new production economically viable, the field would qualify for relief of an amount at least equal to the minimum suspension volume (MSV). Should production from a field not be economic with a royalty suspension volume equal to the mandated minimum, the Secretary must determine the precise volume of royalty-free production which would make the production economic.

A two-part evaluation process has been devised to direct royalty relief to fields that appear uneconomic with royalties but are potentially viable with royalty suspensions. The first part of the process is conducted by the royalty relief applicant and the second part is performed by the Minerals Management Service (MMS).

PART 1: Applicants describe the risk of the proposed venture by specifying the uncertainty

in the geologic, engineering, and cost inputs to the Royalty Suspension Viability Program version 2.0 (*RSVP 2.0*) as ranges of possible values and/or measures of the likelihood of occurrence for each possibility. These data are used in the *RSVP 2.0* to simulate the prospective net present value (PNPV) for the field. The simulation of the PNPV does not include royalties or sunk costs. A positive PNPV indicates expected revenues exceed expected cost estimates when no royalty payments are made, or that the field appears to be profitable without royalties from a forward looking perspective. Therefore, if PNPV is positive, it can be said the field has been demonstrated to be **economically viable**. This *RSVP 2.0 Documentation* provides more detailed explanation of how the discounted cash flow calculations are performed, how resources for the field are estimated, and how the PNPV is calculated.

PART 2: The MMS develops an independent assessment of the field in four steps.

1. The MMS shall review the raw data submitted by the applicant to verify that the model inputs accurately reflect these data and that the PNPV result derived from these data using *RSVP 2.0* is positive.

2. The MMS will compare the information submitted in the application to its own information. This is done to insure that the applicant's data include all of the field's resources, that the development plan is the most cost effective for extracting the resources, and that the cost estimates are in line with MMS expectations. Where necessary, the MMS will adjust the applicant's data. If data adjustments are made, step one is repeated to confirm that PNPV is still positive. If the MMS then discovers that no amount of royalty-free production will make the field economically viable (PNPV is negative), then the applicant's request for royalty relief will be denied.

3. The MMS will incorporate royalty payments and eligible pre-application exploration and development expenditures reported by the applicant (sunk costs) into a program

called *RSVPP 2.0* to simulate the field's full net present value (FNPV). If sunk costs are critical to the calculations, the past expenditures reported by the applicant may be audited. If FNPV is positive or zero, the field does not qualify for relief.

4. If the MMS calculates the FNPV to be negative using the *RSVPP 2.0*, then it must find the volume of royalty free production (suspension volume) needed to make the PNPV = 0. If the computed suspension volume is equal to or less than the minimum mandated for the field's water depth category (17.5MMbbl >200 meters, 52.5MMbbl > 400 meters, and 87.5MMbbl > 800 meters), the applicant will receive the minimum suspension volume. If the computed amount exceeds the minimum suspension volume, the applicant will receive the computed amount.

CONTENTS

1.0   INTRODUCTION.

The Royalty Suspension Viability Program version 2.0, or *RSVP 2.0*, is a Microsoft Excel® spreadsheet which employs Crystal Ball® as its risk analysis add-on software. The *RSVP 2.0* was developed by the Minerals Management Service (MMS) to be used by applicants who are applying for a royalty suspension volume under the Deep Water Royalty Relief Act (DWRRA). A requirement of a complete application for a royalty suspension volume is that applicants must perform an economic analysis of the field using the *RSVP 2.0*.

The *RSVP 2.0* is actually two models (or modules) in one. The ***Resource Module*** calculates the recoverable resources for the field while the ***Viability Module*** performs a discounted cash flow analysis of the revenues generated by the resources versus the costs of developing and producing the field.

Uncertainty in the information and data required for resource estimations and cash flow calculations is incorporated into the *RSVP 2.0* using the Crystal Ball risk analysis software. Critical parameters are input as probability distributions (called assumption distributions) of potential values for the parameter instead of single point or deterministic values. The program then performs a simulation consisting of many iterations (the terms iteration and trial are used interchangeably in this text). Every iteration is a separate calculation of the entire program where each assumption distribution is sampled and all calculations are performed using the sampled data. Distributions of possible results (forecasts) are created by saving the results of the calculations of each iteration. The average (mean) values of each forecast are the expected values of the simulation.

The ultimate objective of the *RSVP 2.0* is to calculate a forecast of the prospective net present value (PNPV) for the field. The PNPV is the mean value of this forecast and is defined as the value of the field based on a discounted cash flow analysis assuming

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no Federal royalties are paid and no sunk costs are considered. A positively valued
PNPV indicates that a royalty suspension volume amount does exist that would allow
the field to become economically viable using a specific discount rate. A field which
cannot achieve a positively valued PNPV signifies that complete relief of the burden of
Federal royalties will not be enough savings to permit the field to become
economically viable at a specific discount rate. Fields which cannot achieve a positive
PNPV in the *RSVP 2.0* do not qualify for further consideration for a royalty
suspension volume.

2.0   OVERVIEW.

The *RSVP 2.0* consists of a ***Resource Module***, which is used in determining resource
and product mix distributions for the ***Viability Module***, which is used to calculate the
royalty free, prospective net present value (PNPV).

In the *RSVPP 2.0* (a version of *RSVP 2.0* that is internal to the MMS) a third module
(called the ***Economic Module***) is used to calculate the full project net present value
(FNPV) which includes all royalties and costs since discovery and calculates the
suspension volume needed to make the PNPV $\geq$ 0.

An applicant qualifies for a volume suspension when **two tests** are passed:
    1.   Mean of the distribution of PNPV > 0, and
    2.   Mean of the distribution of FNPV < 0.
Pairing these 2 versions of NPV estimates fulfills two objectives:
    1.   Considers all eligible costs since discovery in judging whether the field
          needs relief to become economically viable, as mandated in the
          Legislation and included the Final rule.
    2.   Insures that the field can be made to be economically viable with
          royalty relief.

2.1   COMPUTER SOFTWARE REQUIREMENTS.

The program was developed with Microsoft Excel version 7.0 and the Crystal Ball version 4.0 using Windows 95.

The RSVP 2.0 has been thoroughly tested using Excel version 7.0 and Crystal Ball version 4.0 using Windows 95. The program has also been successfully tested using Windows and Excel version 5.0. Crystal Ball version 4.0 functions in either Windows or Windows 95 format. Although Excel spreadsheets are translatable into LOTUS 1-2-3®, and Crystal Ball is available in a LOTUS 1-2-3 version, the program has not been run or tested using this host software. Therefore, LOTUS 1-2-3 cannot be used to run the RSVP.

These instructions for using *RSVP 2.0* presume the user has basic familiarity with the Excel and Crystal Ball software.

Programmer's Note:

Several versions of Crystal Ball are currently on the market. Slightly different results have been obtained when the RSVP 2.0 functions using Crystal Ball version 4.0 versus Crystal Ball version 4.0e. Crystal Ball Pro version 4.0e produces the same results as Crystal Ball version 4.0e. The differences were slight. The MMS has adopted Crystal Ball version 4.0e as software for making official RSVP 2.0 runs. Results obtained from this platform will be considered final.

2.2   SPECIAL FEATURES.

Special features have been added to the otherwise conventional cash flow analysis performed by the program.

- Simulation using Latin Hypercube sampling from assumption distributions as a means of considering the risks and uncertainties associated with deep water development.

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- To account for the uncertainty they identify into the analysis, applicants specify a range of possible values and/or some measure of the likelihood of occurrence for each possibility as inputs for each of dozens of geologic and cost variables.

- For each simulation, 1,000 iterations are required so that the large number of input distributions can be adequately sampled and a sufficient distribution of the possible states-of-nature can be modeled.

- A random number seed (specified by the MMS) is used to insure that the same reproducible trials are used in both qualification tests.

- Two-stage sampling to approximate sequential decision-making. The two decision stages are:
  1. the decision to apply for royalty relief for a field, then
  2. the decision to commit large development investments on the field.

- The first decision stage is simulated by the resource module. Resources estimated on each trial by this module dictate design and cost characteristics of the production platform and facilities.

- The second decision stage is simulated by the viability module. Reserves estimated on each trial by this module dictate the number of development wells, the production profile, and the ultimate recovery.

- The sampling of resources in the resource module is a simulation of the decision made to proceed with the level of information available before the final "go or no-go" development decision has been made.

- The sampling of reserves in the viability module is a simulation of the final "go or no-go" decision to develop.

- Economic limit rules to restrict cash flow calculations and sampling combinations to ones that represent logical actions by applicants.

- Production and operating expenses are automatically curtailed after the last year that revenues exceed operating expenses.

- Well completion costs are adjusted when reservoirs are sampled as being dry on an iteration

- Iterations where revenues are less than operating cost every year are eliminated from the simulation.

- Iterations that cannot achieve a positive NPV with a 5 percent discount rate are loss limited.

2.3   PROGRAM LAYOUT.

The *R S V P 2.0 Template Schematic* on page 6, is a map of the program which shows where to find the input, computation, and output spreadsheet cell locations for the Resource, Viability, and Economic Modules. The version of *RSVP 2.0* which is available to applicants does not contain the Economic Module and, therefore, performs no calculations beyond column DN of the spreadsheet.
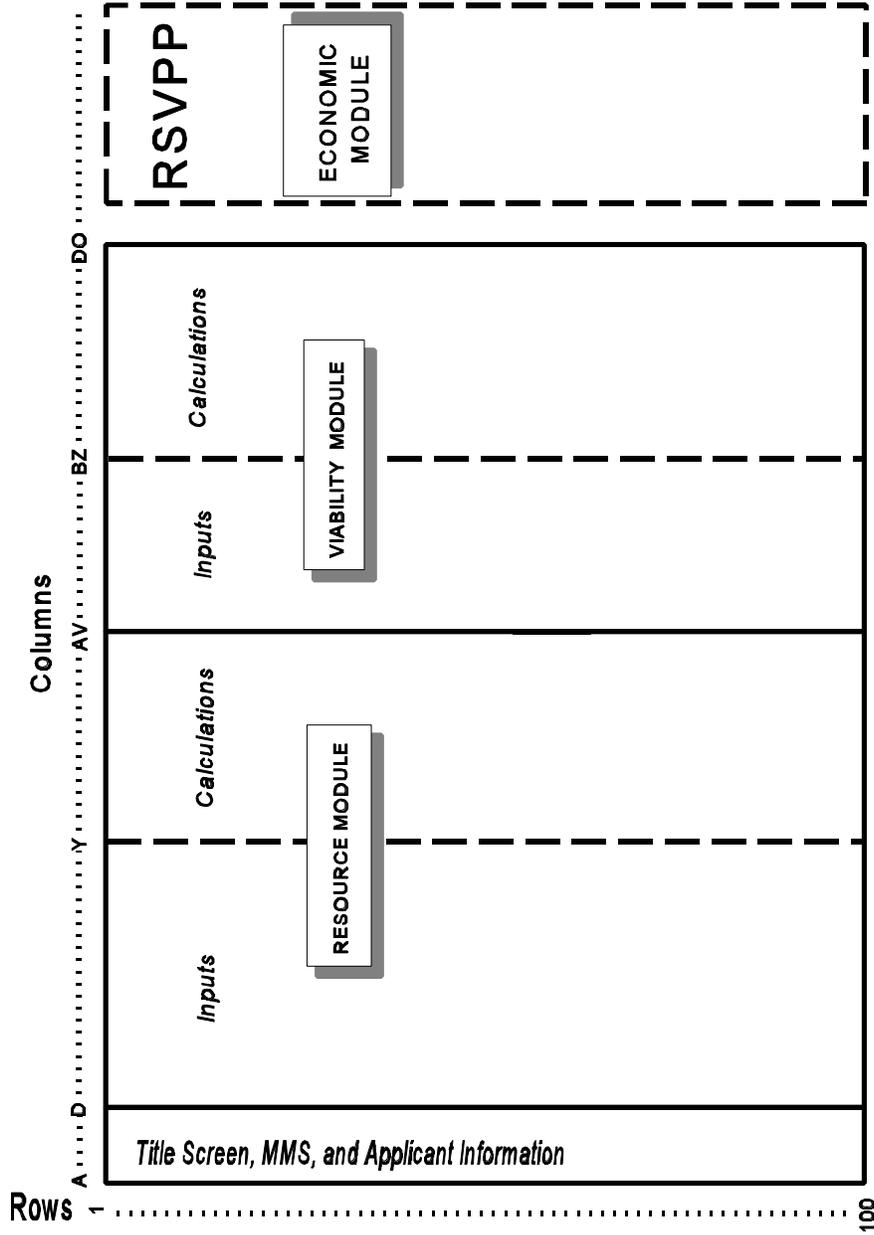
3.0   RESOURCE MODULE.

3.1   OBJECTIVES.

- Calculate probability distribution parameters implied by the detailed geologic and engineering data elements from all of the potential reservoirs of the field.

- Sample the distribution of resources for the field on each iteration of the Viability Module simulation.

Because of the sequential decision making feature of *RSVP 2.0* the program must be run twice before a value of PNPV can be obtained. The program is initially run so this module can estimate key characteristics of the distributions of resources and oil fraction to be used as inputs in the Viability Module.

The Resource Module also serves as a subroutine of the Viability Module to calculate

RSVP 2.0 Template Schematic

RSVPP

ECONOMIC MODULE

VIABILITY MODULE

Calculations

Inputs

RESOURCE MODULE

Calculations

Inputs

Title Screen, MMS, and Applicant Information

Columns

Rows

resources during each iteration to be used in selecting a production capacity and capital expenditure profile scenario for the cash flow analysis. The theory and procedures for this approach are explained in detail in later portions of this documentation.

3.2   INPUTS.

The figure, *Resource Module Schematic*, on page 8 is a map of the module which shows where to find the input and computation spreadsheet cell locations.


__Programmer's Note:__

Once an assumption distribution has been entered into a spreadsheet cell and removing the assumption distribution is desired (either to replace it with a discrete input or to eliminate it altogether) the removal is a two-step process. The displayed value needs to be deleted from the EXCEL spreadsheet by highlighting the cell and simply hitting "Delete". Then the assumption data needs to be cleared by selecting "Cell" from the menu bar, followed by "Clear Assumptions/Forecasts", followed by "O.K.".

Specific applicant data such as the Field Name, Field Water Depth, Date of Application, Name of Company Applying, Applicant Contact, and Contact Telephone Number are input in spreadsheet cells B1 ... C14. All inputs are read as alpha inputs except the Field Water Depth which is read as a numeric input.

The reservoir names are entered into column D and an identifying reservoir number is assigned to each reservoir in column E. The program can theoretically handle up to 94 reservoirs (15 are used in the example). Although, in practice Crystal Ball has a practical limit of roughly 1,000 assumptions, forecasts, and correlations combined per spreadsheet (i.e., A+F+C <1,000). In this area of the spreadsheet the user identifies all of the potential reservoirs that may contribute to the field.

Resource Module Schematic

Columns

| Column labels (left to right): D ... F ... L ... N ... P ... R ... T ... V ... X ... AB ... AE ... AL ... AS ... AV |

| Resource Module Field Level Results |

| Combined Totals of all Liquid Products (Oil & Condensates) Gaseous Products (Gas & Associated Gas) and BOE |

| Calculated Acre Feet of Oil & Associated Gas, Gas & Condensate for Reservoirs that are both oil and gas for titeration |

| Calculated Acre Feet of Gas & Condensate for Reservoirs that are all oil for iteration |

| Calculated Acre Feet of Oil & Associated Gas for Reservoirs that are all oil for titeration |

| Gas Recovery Distributions |

| Oil Recovery Input Distributions |

| Net Pay Input Distributions |

| Acres Input Distributions |

| Yield Input Distributions |

| G O R Input Distributions |

| Probability Inputs - Risk, Probability All Oil, All Gas, Or Oil and Gas. Proportion of Oil and Gas if Both. Indicator if Reservoir Has Been Drilled Previously. |

| Reservoir Names & Numbers |

Rows 1 100

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The *Reservoir Name* is an alpha input and is strictly for identification purposes. The *Reservoir Number* is a more condensed identifier that can either be alpha or numeric. For convenience and quick reference, the *Reservoir Number* is carried automatically throughout each screen of the Resource Module. Once all reservoir numbers have been entered, calculate the spreadsheet by striking the "F9" key. This carries the reservoir numbers to each screen throughout the resource module.

Each reservoir must be assigned a probability that it will produce. The inputs occur in spreadsheet cells F7...G100. The input must be expressed as either a discrete value of 1 indicating that the reservoir will always produce or as a binomial assumption distribution with the probability that the reservoir will produce expressed as a fraction of 1 trial. An example of the input format for a binomial distribution is illustrated in the figure below.
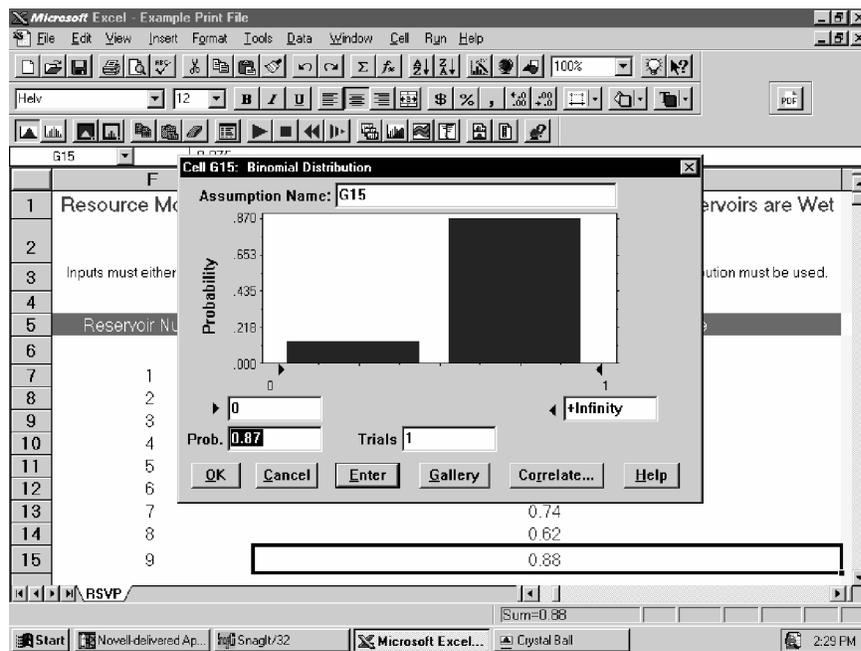

At least one of the reservoirs must be assigned a value of 1 for this probability indicating that it will always produce. Since a discovery and a determination of producibility has been made for the field as a condition of a deep water royalty relief

application, the economic analysis requires that at least one reservoir be given a 100 percent probability of producing. Should resources for any single iteration be sampled so low such that the field can never be economically produced, the program will not force production at a loss (see item I. Loss Limiting under section 4.3 below).

These probability inputs may be correlated with any reservoir that is expressed as an assumption distribution. An example of an input format for establishing a correlation between assumption distribution cells is illustrated below.

Each reservoir must also be assigned probabilities that it may be an oil reservoir, a gas
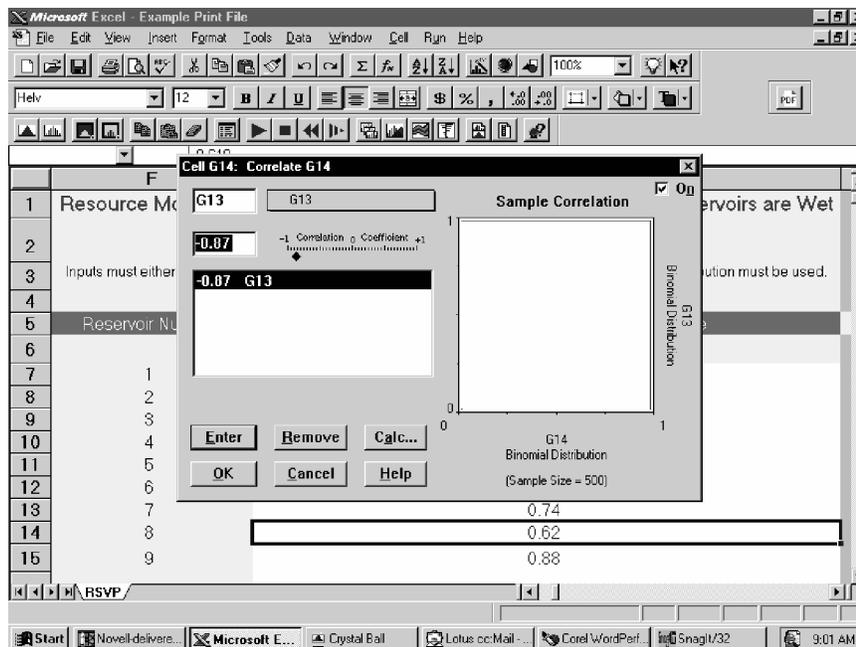
reservoir, or a reservoir that is both oil and gas. The custom assumption distribution feature of Crystal Ball is used for these inputs which are located in spreadsheet cells H7...I100. For this custom assumption distribution, 1 must always be the "Value" for an oil reservoir. The "Value" 2 must be used to for a gas reservoir, and a "Value" of 3 must be used for an oil and gas reservoir. To use Crystal Ball's Custom Distribution inputs, enter 1 for the "Value" and enter the corresponding probability of and oil reservoir in "Prob."; click enter and proceed with the gas inputs, followed by the oil

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and gas inputs.   An example of the input format for this custom distribution is illustrated below.
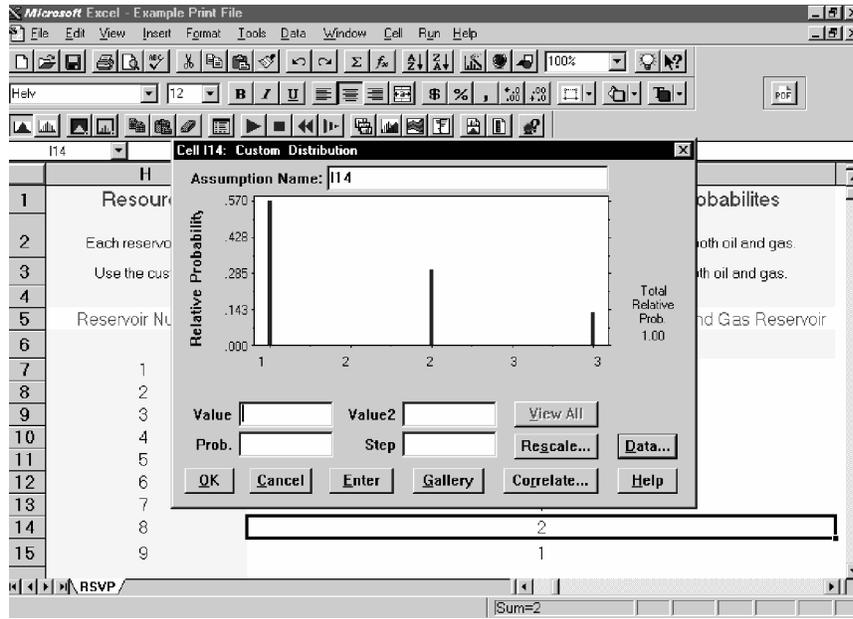

Should it be known with 100 percent certainty that a reservoir is either an oil reservoir, a gas reservoir, or an oil and gas reservoir, the custom assumption distribution can still be employed by using a 100 percent probability of either "1", "2", or "3" respectively as the input.

When a reservoir is sampled as an oil reservoir it is not intended that oil will be the only product that will be produced from that reservoir. Rather, the dominant product (whether it be oil or gas) simply directs the program to use the gas/oil ratio (GOR) to calculate associated gas production when oil is dominant or to use the yield to calculate condensate production when gas is the dominant product. The process the program uses for sampling whether a reservoir will be oil dominant, gas dominant, or both for each iteration is explained later in this text.

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For each reservoir which has a probability of being sampled as a reservoir that is both oil and gas, an assumption distribution must be assigned which sets the proportion of the reservoir that is oil. These inputs are located in spreadsheet cells J7 ... K100. Any type of assumption distribution can be used as long as the minimum value is 0 the maximum value is 1 and the proportion represented is the oil proportion. The program then assumes that the gas proportion on any one iteration is 1 *minus* the sampled oil proportion.

Assumption distributions for gas/oil ratio (GOR), condensate yield, reservoir acreage, average reservoir net pay, oil recovery from the reservoir, and gas recovery from the reservoir are the remaining input requirements for the Resource Module of the *RSVP 2.0*. Each of these assumption distributions can be input into the program using any of the distribution types form Crystal Ball's "Distribution Gallery" (see figure below). The inputs are located in cells L7...W100 of the spreadsheet. Each variable may be input either as an assumption distribution, a single point deterministic value, or if a variable will not be used for a reservoir, a simple value of "0" can be entered into the cell. If there exists uncertainty about what precise value may exist for an input variable then one of the distributed input options should be used. If the value of an input variable is known with certainty, perhaps a single point estimate will be chosen. In the event that a reservoir is to be always an oil reservoir or always a gas reservoir (as evidenced by a 100 percent probability the reservoir will always be either an oil or a gas reservoir) then input values for the GOR or Yield and Oil Recovery or Gas Recovery are not necessary for the non-dominant product. For example, if a reservoir is always to be sampled as an oil reservoir, oil is the dominant product and input values for Yield and Gas Recovery are not necessary. Conversely, if gas is always to be the dominant product then input values for GOR and Oil Recovery are not necessary. It is anticipated that usually when an assumption distribution is chosen for

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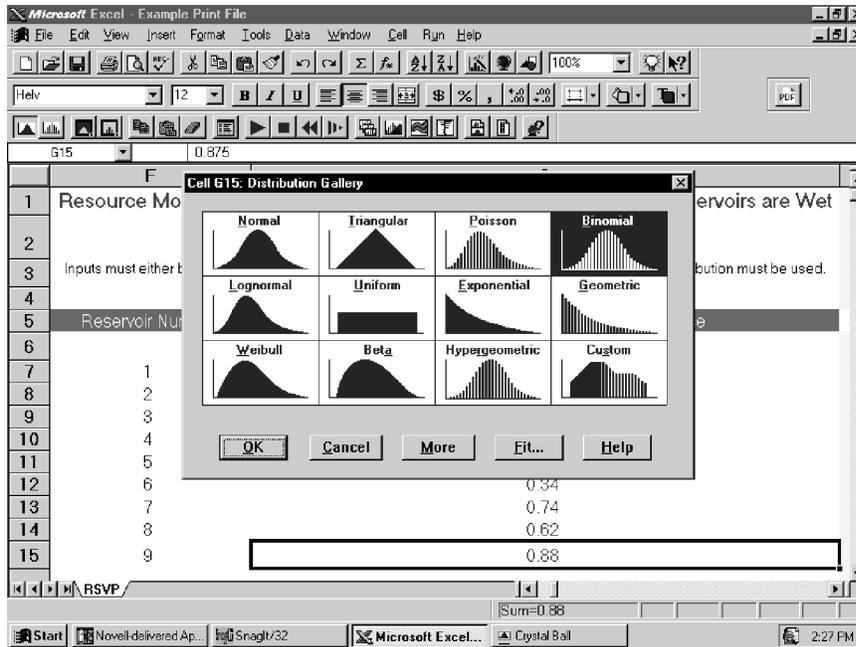
one of these inputs that a triangular distribution will be used. An example of the input format for a triangular distribution is illustrated in the figure below. Should any form of assumption distribution other than triangular be used, evidence showing support for the type of distribution chosen must be submitted.
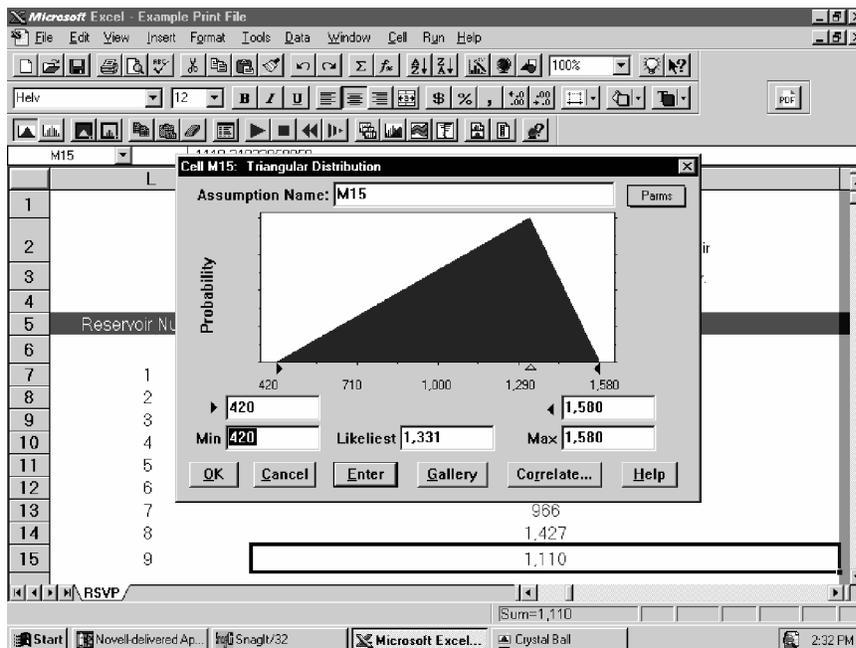
3.3 CALCULATIONS.

On each iteration, for each reservoir, the program:

- Predicts whether the reservoir will produce by sampling from the assumption distribution for the probability that the reservoir is wet, if the random sample is less than or equal to the *Probability Reservoir Will Produce* for the reservoir, a value of 1 is assigned and the reservoir will produce during this iteration. If the random sample is greater than the *Probability Reservoir Will Produce*, a value of 0 is assigned and the reservoir will not produce during this iteration. For an explanation of how Crystal Ball handles correlated assumption distributions refer to the Crystal Ball text, particularly page 233.

- Predicts whether the reservoir is an oil reservoir, a gas reservoir, or an oil and gas reservoir (i.e., an oil reservoir with a gas cap) by sampling the assumption distribution for the probability of an oil reservoir, a gas reservoir, or an oil and gas reservoir. If the random sample value is less than the probability of an oil reservoir a value of "1" is assigned for subsequent calculations, indicating that the reservoir is an oil reservoir for the iteration. Should the random sample value falls between the probability of a gas reservoir and the probability of a gas reservoir a value of "2" is assigned for subsequent calculations, indicating that the reservoir is an gas reservoir for the iteration. Similarly, if the random sample value is greater than the probability of a gas reservoir, a value of "3" is assigned for subsequent calculations indicating that the reservoir is an oil and gas reservoir for the iteration. reservoir is oil dominant for this iteration.

- When a reservoir has been sampled to be both an oil and gas reservoir a determination is made as to the relative proportion of these products in the reservoir. This is accomplished through a sampling of the assumption distribution for the proportional distribution of the oil/gas mix if an oil and gas reservoir. This distribution is sampled to determine the proportion of the

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reservoir that is oil. The remainder of the reservoir is then assumed to be gas (1 *minus* the oil portion).

- Samples from *GOR, Yield, ACRES, NET PAY, OIL RECOVERY,* and *GAS RECOVERY* assumption distributions.

- Computes acre feet, oil, associated gas, gas, condensate, and BOE's for each reservoir that produces during the iteration. [cells X7 ... AR100]

- Calculates the field level results for the iteration by summing the above results across all reservoirs. [cells AS7 ... AT34]

For each simulation, the program:
- Repeats above calculations over 1,000 iterations to result in distributions of each parameter for each reservoir and for the field.

- Tracks distributions of results (forecasts) for the following calculated field values:
    - a.   Total Field Gross Reservoir Volume (acre-feet)
    - b.   Oil Recovery from Oil Portions of All Reservoirs (bbl/acre-foot)
    - c.   Gas Recovery from Gas Portions of All Reservoirs (mcf/acre-foot)
    - d.   Probability that Entire Field is Dry
    - e.   Oil from all Oil Reservoirs (Mbbl)
    - f.   Associated Gas from all Oil Reservoirs (MMcf)
    - g.   Gas from all Gas Reservoirs (MMcf)
    - h.   Condensate from all Gas Reservoirs (Mbbl)
    - i.   Oil from all Oil and Gas Reservoirs (Mbbl)
    - j   Associated Gas from all Oil and Gas Reservoirs (MMcf)
    - k.   Gas from all Oil and Gas Reservoirs (MMcf)

l.   Condensate from all Oil and Gas Reservoirs (Mbbl)

m.   Total Oil (oil and condensate) for all Reservoirs (Mbbl)

n.   Total Gas (gas and associated gas) for all Reservoirs (MMcf)

o.   Total of Oil, Gas, Condensate, and Associated Gas for all Reservoirs (BOE)

p.   Fraction of Total BOE Comprised of Oil and Condensate

3.4   PROCEDURE.

After data input, a simulation of the program involves the following steps:

- Reset the simulation spreadsheet by selecting ***Run*** and ***Reset***.
- Identify the simulation run preferences by selecting ***Run*** and ***Run Preferences...***
  1. Set the "Maximum Number of Trials:" at 1,000.
  2. Choose "Stop on Calculation Error".
  3. Choose "Use Same Sequence of Random Numbers" and input an "Initial Seed Value:" of 104.
  4. For "Reset Assumption Cells", choose "Estimated Means".
  5. For "Sampling Method", choose "Latin Hypercube".
  6. Leave both "Run Options" off.
- Run simulation by selecting ***Run*** and ***Run***.
- The statistics for the Forecast: *Prospective NPV of the Field (M$)* are displayed on the screen during the simulation and remain on the screen after.
- Close the statistics window and select ***Run*** and ***Forecast Windows*** to open any of the forecasts from the simulation.

Certain statistics from the *Total of All Resources (MBOE)* forecast and the *Resources Oil Fraction* forecast are input requirements for the Viability Module of the program. The mean, standard deviation, minimum value, and maximum value of these distributions should be recorded (written down) by the user so that they can be reproduced in the appropriate spreadsheet location as inputs into the Viability Module as will be explained later.

To view these statistics following execution of the *RSVP 2.0*:

- Click off the *Prospective NPV of the Field* forecast window.

- Select *Run* and *Forecast Windows*.

- Highlight *Total of All Resources (MBOE)* and *Resources Oil Fraction* forecast windows.

- Select *Open Selected Forecasts* to view forecasts.

4.0   VIABILITY MODULE.

4.1   OBJECTIVE.

Calculate the *prospective* net present value (PNPV) of the field. The PNPV is defined
as the before-tax net present value for the field, excluding Federal royalties and sunk
costs. A positive valued PNPV is evidence that the field can be profitable at target
discount rate while not paying Federal royalties.

4.2   INPUTS.

The figure, *Viability Module Schematic*, on page 19 is a map of the module which
shows where to find the input, computation, and output spreadsheet cell locations.

The first Viability Module input is the *Current Year* located in spreadsheet cell AW8.
This input should be the year the application is filed. The input is used to set the base
year for al this discounted cash flow calculations performed in the Viability Module.

Next is the *Discount Rate* located in spreadsheet cell AW10. This is a discrete input
chosen by the applicant from a range set by the MMS. This discount rate is used for
all of the discounted cash flow calculations performed in the Viability Module.

The historical or *Sunk Cost* for the field is entered into spreadsheet cell AW12. This
cost is entered as a discrete value in thousands of dollars and is 100 percent of all post
discovery eligible costs as specified in the guidelines. The program automatically
adjusts this cost to be "after taxes".

Viability Module Schematic

AV ·········· AY ·········· BA ·········· BE ·········· BL ·········· BS ·········· BZ ·········· CC ·········· CL ·········· CU ·········· DH ·········· DN

Field Inputs	Oil Price Inputs	Scenario Based Variable Inputs	Annual Inputs for Scenario 1	Annual Inputs for Scenario 2	Annual Inputs for Scenario 3	Sampled Values of Assumption Distributions and Intermediate Calcuations for the Interation	Production and Price Calculations	Revenue, Costs, and Operating Margin Calculations	Cash Flow Calculation and Discounted Calculations	Viability Module Results, Input Data Checks, and Cost Compliance Worksheet
Resource Data Inputs	Oil Quality Adjustment Table									
Identification of Resource Levels	Gas Price Inputs									
Cost Variable Assumption Distributions										
Product Quality Assumption Distributions										

Rows labeled: 1, 15, 29, 43, 58, 71, 100

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The *Resource Data Inputs* are entered into spreadsheet cells AW20 ... AX26. These inputs are extracted from simulation outputs from the Resource Module as described above in section **3.4 Procedure**. As described above, the following statistics from the *Total of All Resources (MBOE)* and *Resources Oil Fraction* forecast windows form the Resource Module are required as inputs to this area of the Viability Module.

- *Mean*.
- *Standard Deviation*.
- *Minimum Value*.
- *Maximum Value*.

Next there is the *Identification of Resource Levels Associated With Development Scenarios* in spreadsheet cells AW36 and AW38. Before entering these inputs strike the F9 key to calculate the spreadsheet and to show the minimum and maximum values for the field's resource distribution in spreadsheet cells AW34 and AW40. Up to three development scenarios can be specified in the Viability Module. Each scenario must relate to a certain segment of the field's resource distribution. This is where those segments are identified. The values establish the boundaries between the three input cost/ production scenarios and they must be expressed in MBOE. They are bounded by the minimum and maximum resource values for the field. The purpose of these inputs is to direct the program to the correct input scenarios during the simulation. If the resources sampled for the iteration are less than the *Minimum Resources for Scenario 2* then scenario 1 costs, production, etc. will be used. If resources sampled are greater than the *Maximum Resources for Scenario 2* then scenario 3 will be used. Should the sampled resources fall in between, scenario 2 will prevail.

The *Cost Variable Input Distributions* are input in spreadsheet cells AX45 ... AX55. Each of the six cost items can be left blank if not applicable, input as discrete single-point values, or as Crystal Ball assumption distributions. As described above for the

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Resource Module, should the use of a single-point value or any form of assumtion distribution other than a triangular distribution be used, you must submit a justification for why your choice of input is most appropriate.

- *Average Cost for Drilling a Subsea Well (M$/well)* - the range of the cost of drilling the average subsea well in the development project, located in spreadsheet cell AX45.
- *Average Cost for Completing a Subsea Well (M$/Well)* - the range of the cost of completing the average subsea well in the development project, located in spreadsheet cell AX47.
- *Average Cost for Drilling a Platform Well (M$/well)* - the range of the cost of drilling the average platform well in the development project, located in spreadsheet cell AX49.
- *Average Cost for Completing a Platform Well (M$/Well)* - the range of the cost of completing the average platform well in the development project, located in spreadsheet cell AX51.
- *Oil Transportation Cost ($/bbl)* - the range of the cost of transporting produced oil to the point of first sale, located in spreadsheet cell AX53.
- *Gas Transportation Cost ($/Mcf)* - the range of the cost of transporting and processing produced gas until the point of first sale, located in spreadsheet cell AX 55.

For the *Product Quality Input* Distributions the *Oil Gravity (degrees API)* must be specified in spreadsheet cell AW60 and the *Gas Quality (BTU/mcf)* must be specified in spreadsheet cell AW62. The Oil Gravity input specifies the range of expected average crude oil/condensate quality for the production from the field and the Gas

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Quality input specifies the range of expected average hydrocarbon content from the gas production from the field. Again, other forms of inputs for these parameters other than triangular assumption distributions must be justified.

The *Viability Module Oil Price Inputs*, the *Viability Module Oil Quality Adjustment Table*, and the *Viability Module Gas Price Inputs* are supplied by the MMS. The inputs are located in spreadsheet cells AY1 ... AZ41. The initial oil and gas prices are triangularly distributed, characterized by minimum, likely, and maximum values. Both oil and gas are landed prices in units of $/bbl for oil and condensate and and $/mcf for gas. The prices have associated with them three oil and gas real price growth segments in units of percent per year. The growth rates are triangularly distributed and are characterized by minimum, likely, and maximum values. The specific years when growth rates change must also be input. Dependencies and product quality adjustment parameters will are also specified by the MMS.

The *Viability Module Scenario Based Variable Inputs* are a variety of input variables all specifically tied to one of the three potential development scenarios.

The *Oil Productive Capacity (Mbbl/Year)* inputs in spreadsheet cells BB4, BC4, and BD4 establish the limiting element in the oil production and transportation facility design capacity for each development scenario when oil is the dominant product. If oil is not the dominant project, oil production capacity is unbounded. Likewise, the *Gas Productive Capacity (MMcf/Year)* inputs in spreadsheet cells BB5, BC5, and BD5 establish the limiting element in the gas production and transportation facility design capacity for each development scenario when gas is the dominant product. If gas is not the dominant project, gas production capacity is unbounded.

The *CAPEX Confidence Factors,* located in spreadsheet cells BB7, BC7, and BD7, represent the range of uncertainty surrounding the capital expenditure profiles for each of the development scenarios. These confidence factors are input in the form of uniform assumption distributions with the minimum value being a negative number or zero. As a rule of thumb the MMS insists that the minimum value plus the maximum value divided by 2 for the confidence factor for each development scenario be equal to no more than 7.5%. For example a minimum confidence factor value of -5% plus a maximum confidence factor value of 20% divided by 2 equals 7.5% or the maximum allowable difference.

Platform Operating Cost (M$/year) are input in spreadsheet cells BB9, BC9, and BD9 for each scenario. This category is for all annual costs that do not vary with the rate of production (e.g., facility operation and maintenance costs).

Variable Operating Cost ($/BOE) are input in spreadsheet cells BB10, BC10, and BD10 for each scenario. These are costs that vary with the rate of production.

Salvage Value (M$) is input in spreadsheet cells BB12, BC12, and BD12 for each scenario. Salvage value is an economic benefit to the field that is realized when the project ends and the capital investment has some residual value. The discounted cash flow calculations of the Viability Module use salvage value as an offset to the abandonment cost in the same year that abandonment occurs.

Abandonment Cost (M$) for each scenario is input in spreadsheet cells BB13, BC13, and BD13. The abandonment cost input is the cost to plug and abandon wells and the cost to dismantle and remove platforms, production equipment, pipelines, and other subsea items. The abandonment cost is counted in the year following the cessation of production in the discounted cash flow calculations.

The *Viability Module Annual Inputs* are located in spreadsheet cells BF7 ... BK100 for scenario 1, in cells BM7 ... BR100 for scenario 2, and in cells BT7 ... BY 100 for scenario 3. The inputs are in the same format for each of the 3 development scenarios. The schedules of annual inputs for scenario 1 corresponds to the low range of the resource distribution from the Resource Module. The inputs for scenario 2 represent the mid range of the resource distribution and the inputs for scenario 3 represent the high range of the resource distribution.

The *Capital Expenditures (M$)* input profiles are schedules of annual expenditures. These are "catch all" inputs for all capital expenditures other than drilling and completion costs for each of the 3 development scenarios. Capital expenditures for each scenario should be input here in the year with they are expected to be incurred.

The *Well Event Scheduling* input profiles are schedule of annual subsea and platform drilling and completion events. These inputs are schedules of when it is expected that these events will take place. The Viability Module uses these schedules to place the cost for the events in the proper time slot. Each drilling or completion event (drilling or completing of one well) should be input by placing a "1" in the year the event is to occur. If multiple events are expected in the same year an input number larger than 1 can be used. Should a drilling or completion event expect to overlap from one year to the next, fractions instead of integers can be used for the inputs. However, the fractions for the drilling or completion of each well should add to a value of 1. The only time this is not necessary is if it is documented that a particular drilling or completion event is expected to cost more or less than the average event. In this case fractions not totaling 1 may be used.

The inputs of *Production (MBOE/Year)* are production profiles for each scenario. The profiles are input as annual volumes of production expected to emerge each year from each development scenario used in the evaluation.

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4.3   CALCULATIONS.

On each iteration the Viability Module performs the following calculations:

A.   Reserves

Viability Module calculations begin with a 2-stage sampling of resources/reserves to simulate the knowledge of the field's endowment at critical junctures when important decisions are made during different stages of the field's development. The *RSVP 2.0* performs the 2-stage sampling process on each iteration.

In Stage 1 the Resource Module calculates a field *resource* estimate that is characterized by the field's Total of all Resources (MBOE) and the Resources Oil Fraction forecasts. The resource estimate represents volume of recoverable hydrocarbons thought to exist at time of application. The Viability Module uses the resource estimate to choose a capital expenditure profile scenario. The Viability Module also uses the resource estimate coupled with the resource oil fraction to predict the dominant product (oil or gas) and design the dominant product production capacity.

In Stage 2 the Viability Module calculates a field *reserves* estimate characterized by the *Total Field Reserves (MBOE)* and *Reserves Oil Fraction* (a description of the methodology employed by the Viability Module to calculate field reserves follows in Appendix A). The reserves estimate represents the total volume of production expected when major development expenditures are committed. The Viability Module uses the reserves estimate to choose a development/production scenario. The Viability Module also uses the reserves estimate and reserves oil fraction to establish the potential recovery of oil and gas and the production profiles of those products.

B   Production

1.   One of 3 production profile scenarios is selected based on the size of the reserves estimate.

2.   Production profile is converted to a profile of percent-of-reserves produced in each year.

3.   Trial producibility profile is calculated by multiplying trial reserves each year by the profile of percent-of-reserves produced in each year.

4.   Dominant product portion of trial producibility profile compared with sampled dominant product production capacity in each year to check for productivity in excess of capacity.

5.   Excess production of both products in years where productivity of dominant product exceeds capacity is deferred to years where capacity will not be exceeded resulting in the final BOE profile for the trial.

6.   The final oil profile is determined by applying the reserves oil fraction to each year of the final BOE profile.

7.   The final gas profile is determined by subtracting each year of the final oil profile from each year of the final BOE profile and multiplying by the mcf/BOE conversion factor.

A simplified illustration of these *RSVP 2.0* procedures is presented as Appendix B.

C.   Oil and Gas Price Profiles

1.   Oil price profile determined by sampling starting oil price, adjusting with sampled oil quality adjuster, and ramping with sampled oil price growth rate parameters.

2.   Gas price profile determined by sampling starting gas price, adjusting with sampled gas quality adjuster, and ramping with sampled gas price growth rate parameters.

D.   Gross Revenues

1. Potential gross revenues from oil, each year of the final oil profile multiplied by the oil price for that year.

2. Potential gross revenues from gas, each year of the final gas profile multiplied by the gas price for that year.

3. Total gross revenues profile is the sum of each year of the oil gross revenue profile with each year of the gas gross revenue profile.

E. Expenses

Capital-type expenses are determined using the resource estimate sampled for the iteration. Depending on the value of resources sampled, one of three possible capital cost profiles are used. The capital cost profile is further adjusted based on a uniform sampling of the capital cost confidence limits.

Well costs are determined using the reserves estimate sampled for the iteration. Depending on the value of reserves sampled, one of 3 possible scenarios of drilling and completion schedules for subsea and platform wells will be employed. The drilling and completion events from this schedule get multiplied by their respective costs and combined with one another to result in the profile of well costs.

The field's salvage value and the abandonment expense are determined using the resource estimate sampled for the iteration. Depending on the value of resources sampled, one of 3 possible abandonment costs and salvage values will be used for the iteration. Abandonment and Salvage are assumed to occur in the year immediately following the cessation of production.

Platform operating expenses are sampled from the input distribution and are the same for each year of production. Variable operating expenses are determined by multiplying each year of the final BOE profile by the trial's sampled value from the variable operating cost input distribution.

Transportation expenses are determined by multiplying each year of the final oil and final gas by the trial's sampled values from respective transportation cost distributions and adding the results in each year.

F. Operating Margin

1. The operating margin calculation is used to find the economic limit, the last year production contributes more to revenue than cost.

2. The operating margin is defined as potential gross revenues less operating-type expenses (platform operating expenses, variable operating expenses, and transportation expenses).

G. Economic limit calculation

1. The economic limit is determined through a prospective look at the operating margin for each year of operations.

2. The economic limit is reached in the last year with a positive operating margin.

3. Production and operating expenses are curtailed after that year and the field is abandoned in the following year.

4. There is the potential for every year to have an operating loss. If and when this unlikely event occurs, this trial is eliminated from the simulation.

H. Cash Flow

1. The cash flow is determined for each year of operations (following economic limit determination) by calculating each year's operating margin (gross revenue less operating/transport costs) and subtracting each year's capital cost from that amount.

2.   The discounted cash flow is computed by discounting each year of the cash flow profile using the specified discount rate.

3.   The sum of the discounted cash flow profile is the net present value of the trial.

I.   Loss Limiting

A feature that is new to *RSVP 2.0* is loss limiting. The *RSVP 2.0* models economic decisions in two-stages. Uncertainty over the field's reserves and project costs at the time applications are submitted is different than uncertainty when major funds are committed for the capital development of the field. The *RSVP 2.0* uses the second sampling of reserves to model this improvement of knowledge and the loss limiting feature simulates the situation where project revenues versus project costs signal that the developers should cut their losses and abandon the project.

The Viability Module performs an internal economic check on each iteration to determine whether it is necessary to invoke loss limiting for that iteration. The economic check involves calculating the field's NPV using the loss limiting discount rate of 5 percent. Iterations which cannot achieve a positive NPV at this minimum discount rate have their loss limited.

On iterations where losses are limited, the program recognizes that additional money will have been spent since the filing of the application and before this ultimate "no-go" decision is made. Accordingly, since fabrication of facilities for the development of the field must commence within one year of receiving royalty relief, iterations which are loss limited receive the first year's capital and well costs as a loss.

For each simulation using *RSVP 2.0*:

1. The computations are repeated over 1000 iterations to result in forecast distributions of the relevant parameters.
2. Saves all relevant statistical parameters for the following forecast distributions:
   a. Field Reserves (MBOE)
   b. Difference Between Total Field BOE (Resources) and Field Reserves (MBOE)
   c. Fraction of Reserves Comprised of Oil and Condensate (fraction)
   d. Difference Between resources and Reserves Oil Fractions (fraction)
   e. Starting Oil Price ($/bbl)
   f. Starting Gas Price ($/mcf)
   g. Sum of All Capital Expenses Including well Costs (M$)
   h. Operating and Transportation Costs per BOE Produced ($/BOE)
   i. Salvage Value (M$)
   j. Abandonment Cost (M$)
   k. Net Present Value of Field's Cash Flow Using All Trials (M$)
   l. Royalties and Sunk Costs to be Added to PNPV for Estimated Full NPV (M$)
   m. Prospective Net Present Value of the Field's Cash Flow (M$)

4.4   PROCEDURE.

After data input, a simulation of the program involves the following steps:

- Reset the simulation spreadsheet by selecting *Run* and *Reset*.

- Identify the simulation run preferences by selecting *Run* and *Run Preferences...*
  1. Set the "Maximum Number of Trials:" at 1,000.
  2. Choose "Stop on Calculation Error".

3. Choose "Use Same Sequence of Random Numbers" and input an "Initial Seed Value:" of 104.

4. For "Reset Assumption Cells", choose "Estimated Means".

5. For "Sampling Method", choose "Latin Hypercube".

6. Leave both "Run Options" off.

- Run simulation by selecting **R*u*n** and **R*u*n**.

- The statistics for the Forecast: *Prospective NPV of the Field (M$)* are displayed on the screen during the simulation and remain on the screen after.

- Close the statistics window and select **R*u*n** and ***F*orecast Windows** to open any of the forecasts from the simulation.

The *Prospective Net Present Value of the Field (M$)* or **PNPV** is the objective calculation of the Viability Module and the *RSVP 2.0*. The mean value of this forecast distribution is the PNPV of the field.

The field's Full Net Present Value or **FNPV** can be estimated using the outputs from the Viability Module. The FNPV can be estimated by adding the mean value of the *Prospective NPV of the Field* forecast to the mean value of the *Royalties and Sunk Costs* forecast. The resulting sum is a very close approximation of the field's FNPV that will be ultimately calculated by the MMS.

4.5 SIMULATION CHECKS

There are several conditions checks built into economic modeling process using the *RSVP 2.0* that must be satisfied for the application to be valid. The DWRRA requires that the MMS consider uncertainty in evaluating applications, further, the Act requires that the MMS accept applications when this uncertainty is such that it can easily overwhelm the benefits offered from royalty relief. In order to balance this "risk-

reward" conundrum several "tests" of the *RSVP 2.0* data must be satisfied before applications can be submitted.

There are two tests concerning the number of iterations. The first test is to verify that at least one-third of the 1000 iterations from the *RSVP 2.0* simulation employ development scenario 2. Development scenario 2 is considered to be the most likely development scenario and is the scenario that will be used to determine the performance conditions that need to be met after royalty relief has been granted. In order to insure that these conditions are fairly represented in the simulation this check has ben instituted in the *RSVP 2.0*. To verify that a simulation satisfies this test, run the program and check the forecast distribution *Fraction of M.L. Scenario Trials*. The mean value of this forecast distribution needs to be at least 0.333 to be acceptable.

The second iteration test involves loss limiting. In order for the simulation to be valid, a maximum of 10 percent of the iterations can be "loss limited" iterations. Simulations whose loss limited iterations exceed 10 percent have too much uncertainty surrounding their economic viability and are, therefore, premature. To verify that the simulation satisfies this test, run the program and check the forecast distribution *Fraction of All Scenario Trials*. The mean value of this forecast distribution needs to be at least 0.900, indicating that 90 percent or more of the iterations are <u>not</u> loss limited.

The last simulation check is a verification that the average of the simulation's capital expenses for all iterations is not more than 7.5 percent greater than the average of the simulation's capital expenses for iterations when only the most likely scenario is used. This test verifies that there is a balance of uncertainty and that the most likely scenario is fairly represented in terms of this balance. The capital expenses involved in this test are the input values for development scenario 2 (the most likely scenario) and the input values for drilling and completion costs versus the mean value of the forecast distribution *Total Project Capital Expenses*. The mean value of this forecast

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distribution can be no more than 7.5 percent greater than the project costs for development scenario 2.

The *RSVP 2.0* has a built-in *Cost Compliance Worksheet* located in spreadsheet cells DL1 ... DN15 to use to determine if the simulation satisfies the three mandatory simulation checks. To use the worksheet enter the mean value of the forecast distribution *Fraction of M.L. Scenario Trials* in spreadsheet cell DM7, the mean value of the forecast distribution *Fraction of All Scenario Trials* in spreadsheet cell DN7, and the mean value of the forecast distribution *Total Project Capital* Expenses in spreadsheet cell DN10 and calculate the spreadsheet by striking the "F9" key. The *RSVP 2.0* does the rest.

5.0 MMS SUPPORT CONTACTS.

5.1 TECHNICAL SUPPORT.

For technical support, problems, or questions concerning how to operate the program and on how the program works contact:

Tom Farndon	(703) 787-1502
Sam Fraser	(703) 787-1531

5.2 DATA INPUT ASSISTANCE.

For support concerning data inputs and analysis for a specific field or project contact:

Al Durr	(504) 736-2659
Kevin Karl	(504) 736-2632

APPENDIX A: HOW *RSVP 2.0* CALCULATES RESERVES

The reserves estimate is calculated using the BOE and resource oil fraction results of the resource estimate calculations in conjunction with the results of the mean, standard deviation, minimum value, and maximum value measures of *Total of all Resources (MBOE)* and the *Resources Oil Fraction* forecasts saved after initial running of the resource module and found under section 3.4 PROCEDURE for the Resource Module above.

The reserves estimate measures of BOE and oil fraction are calculated by a random samples from truncated normal distributions. The distributions change for each iteration but all are truncated at the minimum and maximum values of the resource and oil fraction distributions. The reserves distributions are characterized by the iteration's resource estimate as the mean value (X_i) and by a standard deviation (s) derived from a fraction of the coefficient of variation (S/U) of the resource distributions.

The fraction for the BOE sampling is one-half, which reflects the presumption that better information on geological conditions will be available at the investment decision point than was available at the application date. The fraction for the oil fraction sampling is also one-half, which reflects the presumption that better estimates of the mix as well as the size come out of data collected between application and investment.

The *RSVP 2.0* automatically calculates s from the relation:

$$[(S/U)/2] = s/X_i$$

which reduces to:

$$s = (Sx_i)/2U$$

A sampling annex on the following page describes how difference distributions (resources - reserves) are used to verify/estimate the standard deviation of the reserves distributions.

Appendix A-1

Objective: Explain the statistical process for finding the standard deviation relevant to the two related (Resources/Reserves) distributions.

Rationale: *RSVP 2.0*'s logic calls for relating sequential picks by deriving a narrower distribution (Reserves) from a base distribution (Resources). The derivation process requires creating three distributions -- Resources, Reserves, and the difference between them. The difference distribution provides the estimate of the standard deviation for the narrowed distributions.

First distribution (Resources)

U =   mean of Resources distribution implied by detailed inputs,

X_i =   ith pick in 1st and 2nd round sampling,

N =   number of trials in 1st and 2nd round sampling.

S =   1st round sample standard deviation of Resources distribution implied by detailed inputs. Computed in 1st round, input on 2nd round to establish narrower (one-half S) distribution for Reserves pick.

S^2 =   sum $(U - X_i)^2/N$

Second distribution (Reserves)

X_i =   mean of the ith (narrowed) distribution of reserves from which the 2nd pick on the ith trial in the 2nd round is made.

x_i =   the one pick from the ith (narrowed) distribution in 2nd round sampling,

s =   standard deviation of the single pick on the ith trial from the mean of the specific narrowed Reserves distribution used on that trial. The size of s varies with the mean (X_i) from trial to trial.

s^2 =   sum $(X_i - x_i)^2/N$ $\sim=$ $(S/2)^2$ by assumption

Crystal Ball Second distribution

U =   mean of Resources distribution implied by detailed inputs,

x_i =   ith pick in 2nd round sampling from the Reserves distribution,

$\$$ =   standard deviation of the single pick on the ith trial from the mean of the Resources distribution used on all trials.

$\$^2$ =   sum $(U - x_i)^2/N$ $\sim=$ S^2

Difference distribution

D =   mean of the difference distribution between 1st and 2nd pick from the Resources/Reserves distribution $\sim= 0$

d =   standard deviation of this difference distribution (deviation of the 2nd pick (x_i) from the 1st pick (X_i) on each trial).

d^2 =   sum $(0 - [X_i - x_i])^2/N$ = s^2 $\sim=$ $(S/2)^2$

APPENDIX B - ILLUSTRATION OF TRIAL CASH FLOW CALCULATION

1. <u>Gross Revenue Determination:</u>

      Combines capacity pick, reserve & production profile pick, and price pick.

Assume:

      a. Reserve Pick = *30* barrels

      b. Price Pick = *$20* per barrel

      c. Production Profile Pick as in column B, and Capacity Pick as in column D.

A	B	C	D	E	F	G
Year	Production Profile Pick (bbl)	Adjustment to Reserve Pick (bbl)	Capacity Pick (bbl)	Excess Production (bbl)	Final Profile (bbl)	Potential Gross Revenue ($)
....	0					0
1998	3	6	9	0	6	$120
1999	5	10	9	1	9	$180
2000	4	8	9	0	9	$180
2001	2	4	9	0	4	$80
2002	1	2	9	0	2	$40
....						
Totals	15	30			30	$600

Appendix B-1

1. <u>Operating Margin Calculation:</u>
     Look at year 2000 as an example.

Assume:
   a. Platform Operating Cost Pick = *$35* per year
   b. Variable Operating Cost Pick = *$1* per barrel
   c. Transportation Cost Pick = *$2* per barrel

Gross Revenue	9 x $20	=	$180
Transportation Cost	9 x $2	=	$18
			====
Royalty Revenue			$162
One-Sixth Royalty	$162 x (1/6)	=	$27
Royalty Revenue			$162
Platform Operating Cost Pick			$35
Variable Operating Cost	9 x $1	=	$9
			====
Operating Margin (revenue less avoidable cost)			$118

3. <u>Economic Limit Cash Flow:</u>

   Production stops when variable costs exceed revenues (operating margin < 0), if
   this occurs every year (i.e., with $15 variable cost), then iteration is eliminated.

Assume:

   a. Base Year = 1996
   b. Discount Rate = *l0* percent
   c. Abandonment Cost Pick = *$25*

A	H	I	J	K	L	M
Year	Operating Margin	Actual Gross Revenue	Capital, Well, and Abandonment Expenditures	Cash Flow	Discounted Cash Flow	Cash Flow at $15/bbl Operating Cost
....		0	$160	($160)	($152.6)	
1998	$67	$120	$90	($23)	($19.0)	$0
1999	$118	$180	$0	$118	$88.7	$0
2000	$118	$180	$0	$118	$80.6	$0
2001	$33	$80	$0	$33	$20.5	$0
2002	($1)	$0	$25	($25)	($14.1)	$0
....						
Totals		$560		$61	$4.1	$0