Oracle Financial Services Operational Risk Economic Capital

User Guide

Release 2.1.1.0.0

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What's New in this Release

This section identifies updates in the Oracle Financial Services Operational Risk Economic Capital, Release 2.1.1.0.0.

Oracle Financial Services Operational Risk Economic Capital Release 2.1.1.0.0 now supports additional 10 truncated distributions for modeling the severity of internal loss data and duly scaled external loss data. The additional distributions are as follows:

- Truncated Burr
- Truncated Exponential
- Truncated Gamma
- Truncated Gumbel
- Truncated Log-Gamma
- Truncated Log-Logistic
- Truncated Log-Normal
- Truncated Pareto
- Truncated Uniform
- Truncated Weibull

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About the Guide

This section provides a brief description of the scope, the audience, the references, the organization of the User Guide, the common icons in the application and conventions incorporated into the User Guide. The topics in this section are organized as follows:

- Scope of the Guide
- Audience
- Where to Find Information
- How to Use this User Guide
- Common Icons
- Document Conventions

Scope of the Guide

The objective of this User Guide is to provide a comprehensive working knowledge to the users on Oracle Financial Services Operational Risk Economic Capital, Release 2.1.1.0.0. This User Guide is intended to help the user understand the key features and functions of Operational Risk Economic Capital application and use the application effectively. However, this User Guide is not meant to provide guidance on how to install and use Oracle Financial Services Analytical Application Infrastructure (OFSAAI). This User Guide is also not meant to provide details on installation of Oracle Financial Services Operational Risk Economic Capital, Release 2.1.1.0.0 data model.

Audience

This manual is intended for the following audience:

- Technical Analyst: This user ensures that the data is populated in the relevant tables as per the specifications. The user executes, schedules, and monitors the execution of Runs as batches.
- Business User: This user reviews the functional requirements and information sources, like reports.
- Data Analyst: This user cleans, validates and imports data into the OFSAAI Download Specification format.
- Administrator: The Administrator maintains user accounts and roles, archives data, loads data feeds, and so on. The administrator controls the access rights of users.

Where to Find Information

For additional information on Oracle Financial Services Operational Risk Economic Capital, Release 2.1.1.0.0, refer to the following documents:

- Business Metadata Documents: These documents are grouped into two sets as follows:
  - Oracle Financial Services Operational Risk Economic Capital Release 2.1.1.0.0 Business Metadata.xls: This document contains the definitions of the Business Metadata like Measures, Business Processors, Hierarchies, Hierarchy Attributes, Aliases, Derived Entities and Datasets present in OREC Application.

- ▪ Oracle Financial Services Operational Risk Economic Capital Release 2.1.1.0.0 Rule Metadata.xls: This document contains the definitions of Rules, Pooling, Optimizer and Processes.

- Technical Metadata: This document contains the definitions of the *Table to Table (T2T)* used in various portions of OREC application.

- Download Specifications: The format and structure of the RDBMS tables is specified in the Download Specifications (DL Specs). Download Specifications contain details of the attributes required for processing in OREC Application.

- OFSAAI documents: The set of OFSAAI documents packaged in the installer will help the user understand the functions of the various components of Oracle Financial Services Analytical Application Infrastructure (OFSAAI) used for OREC computation.

- Application Installation Manual

How to use this User Guide

The information in this User Guide is divided into the following chapters

- Chapter 1: "Introduction": The objective of this chapter is to introduce the user to Oracle Financial Services Operational Risk Economic Capital, Release 2.1.1.0.0 and provide an overview of OREC Application.

- Chapter 2: "Understanding the Application": The objective of this chapter is to provide an understanding to the user on the various functions of OREC application.

- Chapter 3: "Preparing for Execution": The objective of this chapter is to provide a detailed explanation of the activities involved before actual execution of Runs such as data maintenance and so on.

- Chapter 4: "Execution": The objective of this chapter is to inform the user on the execution function of OREC application.

- Chapter 5: "Operational Risk Economic Capital Reporting": The main objective of this chapter is to provide a brief description of the reporting functionality in OREC Application.

Common Icons

The common icons incorporated into OREC application are as follows:

Icons	Description
	Use this icon to add a new entry.
	Use this icon to view the details of an entry.
	Use this icon to edit details of an existing entry.
	Use this icon to delete an entry.
	Enter the name of an entry and click this icon to search for an entry.
	Use this icon to refresh the screen.

Icons	Description
☑	Use this icon to select an entry to delete, edit or view the entry.
...	Use this icon to view and select details in the particular browser.
◁ ▷ ▷	Use this icon to navigate between pages.

Table 1: Common Icons

Document Conventions

Certain practices have been incorporated into this document, to help you easily navigate through the document. The table given below lists some of the document conventions incorporated into this User Guide:

Conventions	Description
Bold	User Interface Terms
Italics	• Cross References
	• Emphasis

Table 2: Document Conventions

The other document conventions incorporated into this User Guide are as follows:

- Oracle Financial Services Operational Risk Economic Capital, Release 2.1.1.0.0 has been referred to as OREC application in this User Guide.

- In this document, a Note is represented as follows:

☞ NOTE

Important or useful information has been represented as a Note.

1. **Introduction**

Oracle Financial Services Analytical Applications Infrastructure (OFSAAI) provides the core foundation for delivering the Oracle Financial Services Analytical Applications, an integrated suite of applications that is configured on a common account level relational data model and infrastructure components. Oracle Financial Services Analytical Applications enable banks to measure and meet risk-adjusted performance objectives, cultivate a risk management culture through transparency, manage their policy holders better, improve the bank's profitability and lower the costs of compliance and regulation. All Oracle Financial Services Analytical Applications processes, including those related to business, are metadata-driven, thereby providing a high degree of operational and usage flexibility, and a single consistent view of information to all users.

Business Solution Packs (BSP) are pre-packaged and ready to install analytical solutions and are available for specific analytical segments to aid the management in their strategic, tactical and operational decision-making.

1.1. *Overview of the Application*

Basel regulation defines operational risk (in Para 644 BCBS 128 - Basel II dated June 2006) as the risk of loss resulting from inadequate or failed internal processes, people, and system or from external events. Basel II Capital Accord has increased its focus on credit risk and market risk and faces a greater challenge in developing operational risk modeling. Globalization and deregulation clubbed with emerging sophistication of financial technology are making the activities of the bank more complex and extremely sensitive to different risks. Besides credit risk, market risk, and interest risk, operational risk affects the stability and the functioning of the bank considerably. Operational risk management is responsible for providing a framework for identifying, measuring, monitoring and managing all risks within the scope of the definition of operational risk.

Operational risk as generally seen is qualitative in nature. Banks and supervisors need to manage operational risk due to a growing number of high profile operational losses. As proposed in the New Basel Capital Accord, the Basel committee realizes that risks other than Credit and Market Risk substantially affect the risk profiles of the bank. The new accord emphasizes on financial institutions to make Operational Risk assessment as one of the integral components of their Risk Management System.

Oracle Financial Services Operational Risk Economic Capital (OREC) application enables you to model the distribution of potential losses due to operational risk. In this application, a Loss Distribution Based approach consistent with Basel - II guidelines has been incorporated, to estimate the Economic Capital (EC) of the operational risk at the firm level. According to the Basel II guidelines, financial institutions are required to develop their own internal measurement methods that estimate the expected and unexpected operational losses based on the combined use of internal, relevant external and scenario data for Standard or Internal Reporting Groups (RG).

Additionally, the following functions have been incorporated in OREC application:

- For an entity operating in multiple geographical locations, the data from the sister company can be included for risk computation with the internal loss data by using currency conversion, which is controlled through the User Interface (UI).

- Use of external entity data for better computation of EC through *Scaling* methodologies.

- Use of Scenario data (which are typically based on the expert's judgment) to enrich internal or external (historical) data and estimate the capital requirement in a more informed manner.

- Increased options to compute correlation and to fit distributions for frequency and severity on both loss data and scenario data analysis.

- Use of Copulas to simulate the frequency numbers, thereby managing the correlation between different Reporting Groups (RG) to avoid any duplicity of biased event types

- Flexibility to adopt multiple scenarios, multiple insurance policies across multiple Reporting Groups.

- Data cleansing methods like outlier and missing transformations.

- Impact assessment of extreme risk scenarios on the risk factors and capital estimation can be done through the *Stress Testing Framework*

Oracle Financial Services Operation Risk Economic Capital, Release 2.1.1.0.0 has been integrated with Oracle Financial Services Operational Risk (out of box) application from a data mapping perspective.

2. <u>Understanding the Application</u>

In Oracle Financial Services Operational Risk Economic Capital (OREC), Release 2.1.1.0.0, the objective is to calculate the expected and unexpected loss arising due to operational risk by executing loss distribution modeling on the historical data of the bank.

The historical loss data provided as a download by the bank is transformed and loaded to **Fct_Operational_Loss** after the Reclassification Rules are executed. The internal data, external data and scenario data are transformed according to the Reporting Group (RG) in this table. OREC application business model fetches RG level data from **Fct_Operational_Loss** to calculate Economic Capital (EC). The estimation of loss distribution begins with a separate modeling of the frequency and severity of losses.

Basic analysis of the data *(mean, variance, skewness and kurtosis)*, frequency and severity modeling are performed on the reclassified data stored in the FACT table for each RG. The compound loss distribution to calculate the risk measures is arrived at by merging the fitted frequency and severity distributions and simulating the resulting compound loss distribution. A bank may mitigate the impact of operational risk losses by taking insurance against it. Expected Loss (EL) and Unexpected Loss (UL) are calculated at RG level and at bank level.

The functional flow of OREC application can be classified in two broad categories namely Pre-Model Activities and Model Execution.

2.1.Pre Model

OREC application calculates EC of operational risk using the Loss Distribution Approach. The OREC application calculates the EC for each Reporting Group (RG). A Reporting Group can be a *Standard RG* or an *Internal RG*. The Standard RG is a combination of regulator prescribed Lines of Business (LOB) and Event Types (ET), if any. Similarly, Internal RG is a combination of LOB and ETs as specified by the bank. Internal RG classification is dependent on the bank's structure. The number of RG's in case of Internal RG can be more or less than the standard classification.

OREC application also calculates EC at the bank level and then allocates the same to the RGs. So, at RG level there are two Economic Capital (EC) figures: the *Undiversified EC* (represents EC on a stand-alone basis for that particular RG) and the *Allocated EC* (represents EC as allocated at bank level).

<u>Insurance Eligibility:</u>

Model definition requires a certain eligibility criteria for insurance. These eligibility criteria are handled by the Rules framework as follows:

- Insurance provider has a minimum rating of 'A' or an equivalent rating.

- Policy should have a residual term of greater than 1 year*

- Policy has a cancellation notice period of at least 90 days*

- The insurance coverage for policies with a residual maturity of less than a year but more than 90* days is reduced by a specified hair-cut. The value of insurance is reduced by the hair-cut.

- The current release has incorporated multiple insurance policies with multiple RGs. Insurance policies that are eligible or those which have passed the eligibility criteria are applied.

*To change these setting from 90 / 1 year to other values make changes in the table at insurance contract level. To change other settings modify the existing rules set up.

For more information on table structure, refer to the technical metadata worksheets.

2.1.1. Standard Reporting Group

The standard LOB types and ET prescribed by regulators are:

Lines of Business (LOB)	Event Type (ET)
Agency Services	Business Disruption and System Failure
Asset Management	Execution, Delivery and Process Management
Commercial Banking	Clients, Products & Business Practices
Corporate Finance	Internal Fraud
Payment and Settlement	Damage to Physical Assets
Retail banking	Employment Practices and Work place Safety
Retail Brokerage	
Trading and Sales	External Fraud

Table 3: Standard Reporting Group

Internal Reporting Group:

Typically, a bank has its own definition of LOB and ETs. The combination of such LOBs and ETs form the Internal RG. For example: 12 internal LOB types and 7 internal ETs can be present. The bank has the flexibility to compute EC for Internal RG, Standard RG or both.

Reclassification:

OREC reclassification process is the initial phase in model definition. During this, the bank's LOB and ETs (which together forms a RG) are mapped to a Standard RG as specified by the regulatory norms or the entity can define their own reporting group using Internal RG.

NOTE

Reclassification is done either from external to standard classification or internal to standard classification. Also, a Data Transformation (DT) is provided which helps in mapping this classification in output tables as well. *For example: if analysis is done for Internal RG and the same is required to be viewed as per Standard RG, this DT can be used to get the desired result.*

For example:

Internal LOB	Standard LOB	Internal Event Type	Standard Event Type
Industrial Finance	Corporate Finance	Theft	Employment Practices and work place safety
Other Retail Banking	Retail Banking	Hacking	

Table 4: Reclassification Example

To change or define the reclassification, you can make changes to the DT. *For more information on DTs, refer to the Technical Metadata Worksheet.* This step is included as a part of model execution.

Bucketing:

The time window duration and the length of the bucket are used to define a bucket. This is carried out to segregate frequency data in predefined time buckets.

Number of Buckets = Time window (in days) / Bucket length. This will be rounded off to the nearest figure.

For example: If the time window is 100 and bucket length is 10, then the number of buckets formed is 100/10 =10.

For frequency modeling, the minimum number of buckets required is 3. Hence, there is a front end validation to check this entry. The model cannot be saved if the number of buckets is less than 3.

You are required to have a bucket definition matching with the requirements. This can be done using modeling framework where you can work around many bucket definitions to get the desired result.

Goodness of Fit tests:

The Goodness of Fit tests help in determining which distribution is to be used for frequency and severity modeling. This is also separately made available in the modeling framework. In OREC application model execution, this is a compulsory step where all 3 tests are run and results stored.

While using modeling framework, you are expected to choose a Goodness of Fit test suitable to the selected distribution. Modeling framework provides the option of working with data for a variety of models so that the relevant distribution method can be selected for frequency as well as severity.

Accordingly, there are 3 approaches supported by OREC application namely:

- KS test

- Anderson Darling

- Chi-square test

Kolmogorov-Smirnov Test:

This test is used to decide if a sample comes from a hypothesized continuous distribution. The Kolmogorov-Smirnov (KS) test tries to determine if two datasets differ significantly. The KS-test has the advantage of making no assumptions about the distribution of data. It is non-parametric and distribution free. The hypothesis regarding the distributional form is rejected at the chosen significance level (*alpha*) if the test statistic D is greater than the critical value obtained from a table, and therefore determines the best fit.

Anderson Darling Statistic:

The Anderson-Darling statistic measures how well the data follows a particular distribution, thereby determining the best fit. For a given data set and distribution, the better the distribution fits the data, the smaller this statistic will be.

Anderson-Darling has almost replaced the usage of KS test, as it is more sensitive to deviations in the tails of the distribution. Use the corresponding p-value (when available) to test whether the data comes from the chosen distribution. If the p-value is less than the selected alpha (for example: 0.05), reject the null hypothesis stipulating that data follows a particular distribution.

Chi-Square test:

It is used to compare the observed sample distribution with the expected probability distribution. Chi-Square Goodness of Fit test determines how well theoretical distribution (such as negative binomial, binomial, or Poisson) fits the experimental distribution. This is a test that is particularly adept at determining how well a model fits the observed data. It evaluates how *close* the observed values are to expected values as given by the model in question, thereby determining the best fit. For a given data set and distribution, the better the distribution fits the data, the smaller this statistic will be. Usually it is compared to the prescribed p value (confidence value).

2.2. Modeling Attributes

- **Rule Framework**

  - Loss Data Capture

  - Reclassification

- ▪ Eligibility – Insurance and Modeling
- ▪ Currency Conversion
- ▪ Scaling of External Data
- ▪ EC Allocation (as a last logical step after modeling)

- **Model Execution**

  - ▪ Currency Conversion
  - ▪ Frequency bucketing
  - ▪ Frequency modeling –EDA and Goodness of fit
  - ▪ Severity modeling – EDA and Goodness of fit
  - ▪ Scenario Modeling
  - ▪ Insurance
  - ▪ Loss Calculation

- **Stress Testing**

2.2.1. Rule Framework: Loss Data and Loss Threshold Capture

Loss data can be of two types based on their source, namely, *internal loss data* and *external loss data*. In operational risk, internal loss data is defined as all losses experienced by the bank. External loss data represents losses observed by the data consortium members and not necessarily by the bank itself. However, there is another set of loss data defined by the experts' opinion based on their prior experiences. These are called scenario data. Scenario analysis in conjunction with external data evaluates exposure to high-severity events. This comprises of plausible severe losses in terms of likelihood of the loss (corresponding to frequency) and the likely amount of the same (corresponding to severity). Scenario analysis can be either alternative or complimentary in nature. The capital is computed after taking into consideration the type of scenario data. In certain situations you might want to censor the loss data below a specific threshold (example: while fitting truncated distribution). Therefore, threshold capture is also available as a part of OREC application Release 2.1.1.0.0. *For more information on loss data capture, refer to the Download Specifications (DL Specs) and Technical Metadata Worksheets.*

The major assumptions while integrating OR (Operational Risk) 4.6 (out of box) and OREC are as follows:

○Loss of value in OREC is net of insurance recovery

○Loss date in OREC is the date created in operational risk

○Dimensional entities of both the applications should be in sync.

For more information on mapping details, refer to the Technical Metadata Worksheets.

Follow the mandatory Data Quality (DQ) checks provided with OREC application to remove data inconsistency errors. DQ checks can be defined through a simple GUI provided with OREC application. However, DQ checks need to be installed separately and is not part of the standard installation package.

Assignment type has code and leaf members that are created/populated using AMHM screen, which is a part of EPM products.

2.2.2. Rule Framework: Reclassification

As Operational Risk Economic Capital calculation is based on the regulator prescribed Standard LOB and Standard ET, the internal and external LOB and ET is mapped to the standard data. This is done as a part of the Reclassification Rules. Reclassification is handled in the Rules framework. *For more information, refer to the Business Metadata document and Technical Metadata Worksheets.*

Rule Framework: Eligibility of Insurance and Model:

A Rule which checks insurance eligibility at this step has been configured in OREC application. OREC application provides you with a choice to define upper or lower threshold of severity as well as a choice to select the external data source to be used in modeling. Both checks are provided as a part of the Rule.

Model and Insurance Eligibility is handled in the Rules Framework. *For more information*, r*efer to Business Metadata document and Technical Metadata Worksheet.*

Rule Framework: Currency Conversion

It is assumed that data is provided in its natural currency. However, if a different reporting currency is provided then use this module to get the desired results. OREC application provides a DT for this task. When this DT performs data transformations, the USD currency is hard coded. However, when the same is performed in model execution, the currency defined in the model needs to be specified. *For more information, refer to the Technical Metadata Worksheets.*

Rule Framework: Scaling of External Data

You have the choice to include external data for modeling. If the external data (loss and threshold) pertaining to a RG is not relevant, exclude the external data for processing. Further, use the external data in an *as-is* format, that is, without scaling the data or after scaling it using statistical technique such as least square method. The external data is scaled to match the internal data.

OREC application scales data using the scaling factor λ. This can be either user specified or can be derived by a minimizing function. λ is multiplied with the external data to calculate the scaled data. Also, the computation of scaling factor using entity measures (asset size, profits) happens as all the internal entity measures are summed and used as a denominator. Scaling is performed after currency conversion in the overall process flow.

Scaling is handled in the Rules Framework. *For more information, refer to the Business Metadata worksheets*.

Entity	Type	Asset Size (converted to USD)	Scaling Factor
IE1	Internal Bank	10000	
IE2	Internal Bank	15000	
IE3	Internal Bank	25000	
EE1	External Bank	40000	1.2
EE2	External Bank	100000	0.5

Table 5: Scaling in Rule Framework

EE1 Asset Size = 40000

All internal Insurance Company Asset size = 10000 + 15000 + 25000 = 50000

EE1 Scaling Factor = 50000/40000 = 1.2

Scaling factor = 50000/100000 = 0.5

NOTE

Scaling factor is calculated for each RG. If the bank provides the scaling factor as a download for each RG then the scaling factor is not calculated. OREC application calculates the scaling factor only when it is not given as a download. If OREC application is unable to calculate the factor, then the default value is assumed as 1.

Rule Framework: EC allocation

Once risk measures are calculated, they are allocated to RGs as per the allocation factor. This factor is calculated as a co-variance of simulated losses of a given RG divided by the variance of bank level losses.

2.2.3. Model Execution

Model Execution: Currency Conversion

The reporting currency is part of the model definition and can be defined in the **Capital Calculation Settings** tab. Scaling of external data occurs outside the model definition. Internal losses, external losses and entity measures like asset size, profit size, insurance liability measures along with the loss severity values is converted to the reporting currency at the exchange rate available during the reporting date (fic_mis_date) or loss date (for loss value). Scaling factor is then determined using the standard currency. The default currency would be USD and you can opt for any available currency. If any currency exchange rates are missing, then the previous exchange rate is considered and this is followed by rest of the risk computation. The exchange rate data is obtained from **Stg_Exchange_rate_Hist**.

Currency Conversion is handled by a DT. *For more information, refer to the Business Metadata worksheets and Technical Metadata Worksheets.*

Model Execution: Bucketing Frequency

The date of occurrence of each historical loss amount is expected as a download. According to the length of the days called *Time Window* and Length of the Time Bucket given as an input (in the UI – **Capital Calculation Settings**) the number of time buckets are calculated. For each time bucket, the frequency of loss amounts in the bucket is calculated. Frequency modeling is done for these frequencies for each time bucket with respect to those particular RGs. OREC application models the frequency of losses using either a Poisson, binomial or negative binomial distribution. If you are unsure of the method to be selected, then select the adaptive method.

Model Execution: Frequency Modeling

Frequency modeling is performed after the time bucketing process. The frequency data from each time bucket is used to determine the parameters (Shape and Scale) using distribution fitting and provides Goodness of Fit results. After parameter estimation it is scaled to fit the annual horizon.

For Example: If the shape parameter is 0.5, scale parameter is 0.9 and the Time bucket (T) is 4.3, then the scaled shape and scale (up to 1 year) would be 2.15 (0.5*4.3) and 0.9 as the scale parameter does not undergo any adjustments.

The *BEICF Adjustments* given in the front end should be adjusted to the parameter by multiplying the factors to the respective parameters.

Shape = 0.5

Time Bucket (T) = 4.3

Scale = 0.9

Rescaling (Parameter * T)

Shape = 2.15

BEICF Shape = 1.5

Scale = 0.9 (does not undergo any rescaling) BEICF Scale = 2.1

New Parameter (Re-scaled parameters *BEICF Adjustments)

Shape' = 3.225

Scale' = 1.89

NOTE

External Data is used for Severity modeling only and not for Frequency modeling.

Near miss values are those frequencies of losses which have not occurred but have the tendency of occurring. Hence, they do not have any severity values attached to it. The use of near miss values is restricted to frequency modeling and is optional for the modeler. Near miss values are not considered in severity modeling.

Additionally, if a RG has all losses as near miss, then the RG is excluded from the modeling process.

Model Execution: Severity Modeling

Severity data is assumed to be independent of frequency data while modeling. The severity modeling process begins with the scaling of external data to match internal data. OREC application supports the following 22 distributions for modeling the severity of internal loss data and duly scaled external loss data:

- Burr
- Empirical
- Exponential
- Extreme Value Theory (GPD for tail)
- Gamma
- Gumbel
- Log gamma
- Log Logistic
- Log Normal
- Pareto
- Uniform
- Weibull
- Truncated Burr
- Truncated Exponential
- Truncated Gamma
- Truncated Gumbel

- Truncated Log-Gamma

- Truncated Log-Logistic

- Truncated Log-Normal

- Truncated Pareto

- Truncated Uniform

- Truncated Weibull

☞ NOTE

The parameters of the truncated distributions are calculated using the Maximum Likelihood Estimate BFGS. The parameters of the remaining distribution are calculated using the Method of Moments, Maximum Likelihood Method-Simplex or Maximum Likelihood Method BFGS.

Log Transformation:

Log transformation is used to stabilize the variance of sample data. Log transformed values are always in uniform variance compared to the one before log transformation. However, this is an optional step and the selection is made in the **Model Definition** screen. Before the data is sent for severity modeling, the natural log is considered with respect to each value. Before the computation of risk measures like Value added Risk (VaR), the exponential (anti-log) of these losses are considered. This requirement is only for internal and external data. Scenario data does not undergo any log transformations. You are provided with an option to set log transformation at each RG level selectively.

Model Execution: Frequency Generation

Frequency generation using simulation can be done with or without the copula. If used, the copula retains the structure of loss data so that the simulated frequencies imitate the same pattern. There is a good chance of having simultaneous peak amounts in RGs if the copula is not used. However, the desired results may be derived under specific business conditions. The choice of copula affects the bank level loss figures more than individual loss figures.

For probability generation by using the copula, correlation matrix is expected as an input. OREC application supports Gaussian, Gumbel and Student t copula. However, the copula selection is optional, as you can opt for modeling without the copula. This option is available in the model definition. Correlation matrix generated is used reporting group wise for internal or standard data. Once prepared, it can also be used for scenario modeling. There is no change in the way this correlation matrix is used for internal or standard data. However, the current requirements specify multiple scenarios for each RG and the simulation happens at the scenario level. Hence, correlation matrix also should be brought down to the scenario level. There are two inputs in the **Scenario Analysis** tab.

- The correlation matrix can also be obtained as a download. This matrix would replace any correlation calculated from the loss data and scenario data.

- Correlation matrix can be provided from the front end.

☞ NOTE

Care should be taken in relation to DQ-check on the matrix for any values beyond -1 and +1.

Model Execution: Severity Generation

Frequency and Severity scenarios are generated using Monte Carlo Simulation for each RG to predict the potential operational losses. The frequency simulations are generated based on the fitted distribution parameters. The frequency parameter for each RG is calculated during

frequency modeling. Severity simulations are generated based on the parameters as calculated in severity modeling. Number of severity simulations for each scenario is equal to the value of frequency in that particular simulation.

For example: if in RG 1, for Scenario ID 1, the frequency generated is 5, then 5 severity amounts (S1, S2, S3, S4, S5) would be generated for that frequency (5 severity amounts for each scenario id). In the computation of risk analytics, all 5 severity values would be added to determine any RG level EC computation.

Model Execution: Scenario Modeling

OREC application supports all the distributions other than empirical and EVT. This is because scenario data is not realistic since it is generated by running model by the bank unlike internal loss. However, scenario data is the potential loss data as it is perceived as forward looking data. Scenario data is arrived at on the basis of user judgment of the risk and control assessments within the bank and the scale of operation.

There are two different approaches for modeling scenario severity data. However, these changes should be done in the tool matrix in config schema.

Formula Based: This would be done by using the formulas as described below:

Log Normal:

> **Shape = { [Qsn(p)]2}/4 +[ln(t1/4)]1/2 – Qsn(p)/2**
>
> **Scale = in (m) + (Shape)^2 where, p= Percentile**
>
> **t1= percentile value**
>
> **m= mode**

Weibull:

> **Shape= {ln{ln(0.5)/ln(1-p)}/ln(t2/t1)**
>
> **Scale = -ln(0.5)/t_2 (shape)**
>
> **Where p= percentile**
>
> **t1 = percentile value**
>
> **t2 = median**
>
> **Exponential:**
>
> **Shape = -ln (1-p)/t1**
>
> **Where p = percentile**
>
> **T1 = percentile value**

Bound Data: In this method, OREC application considers the scenario and severity buckets of each Reporting Group (RG). OREC application takes the mid value of each bucket and populates as many times frequencies simulated for a given RG. To avoid zero variance, minimum two buckets are required for each scenario. The steps in severity modeling of internal data for estimating shape and scale are also applied to this data

The difference between formula based and bound method is the way parameters are estimated. In formula based, formulas as mentioned earlier are applied. For bound, data is prepared and then parameters are estimated similar to internal loss data modeling.

Here the inputs are scenario data like highest frequency, single largest severity amount, severity lower and upper bounds, frequency and severity variance and mean.

Model Execution: Insurance

An insurance contract is characterized by two components, namely, Each and Every Loss (**EEL**)

Insurance and Aggregate **(Agg)** Insurance. EEL is applied at scenario level for each RG, while aggregate insurance is applied on the aggregate sum of severity amounts generated for the RG. You can choose level insurance in the model definition screen in percentage. For example: choose 20% with loss value without insurance being 10000, and then you can offset only 2000 part of the loss. Even though the insurance contract allows for a better offset, OREC application will cap the overall benefit.

OREC application supports two types of insurance models – Deductible Model and Proportional Model.

- **Deductible Model** - In Deductible model, the claim profile is characterized by a deductible (d) and a liability threshold (l) such that $d < l$. The insurance firm does not incur any liability till such time that the loss severity is less than the deductible. It will cover the entire loss exceeding the deductible but with an upper threshold equal to the liability threshold.

$$\acute{\emptyset}\,(X_{i,j}) = \quad X \qquad\qquad X \leq d$$

$$d \qquad\qquad d < X \leq l$$

$$(X - l) + d \qquad l < X$$

Original Threshold	Deductible %	Deductible	Loss Before Insurance	Loss After Insurance	Insurance Benefit	Threshold After Insurance
965,780.00	NA	200,000.00	2,140,000.00	1,374,220.00	765,780.00	0

Table 6: Deductible Model

- **Proportional Model** – Proportional Model is characterized by a percentage instead of an absolute deductible amount. It is mandatory to have percentage value in the proportional model. Liability threshold is optional. The process for proportional model is the same as deductible model.

  A proportional retention model (unbounded) is characterized by factor θ and liability threshold $l\,(1- \theta)$. The net loss incurred by the bank under each simulated scenario is given by:

$$\acute{\emptyset}\,(X_{i,j}) = \quad \theta X \qquad\qquad X < l$$

$$X - (1 - \theta)l \qquad l < X$$

Original Threshold	Deductible %	Deductible	Loss Before Insurance	Loss After Insurance	Insurance Benefit	Threshold After Insurance
965,780.00	51%	492,547.80	1,718,619.58	1,245,387.38	473,232.20	0

Table 7: Proportionate Model with Single Offset

Deductible model with multiple offset also works on the same basis; however deductible amount is constant unlike in percentage model.

Model Execution: Loss Calculation

The aggregated yearly losses for each of the RGs are calculated using Monte-Carlo simulation separately for the loss data (internal loss data plus duly scaled external loss data, if any) and scenario data. Loss scenarios are generated in scenario generation modeling. These simulated losses are then added to the RG and to the entity as a whole. While providing the scenarios for

frequency and severity of a RG, the business user is required to specify whether it is an alternative, complimentary scenario or aggregated scenario. Credibility Factor can be defined as the weight assigned to the scenario data while computing EC. The simulation pertaining to scenario data would be selected based on the credibility factor.

For example: In case of Complimentary method, if the Credibility Factor is specified as 40% and the number of simulations generated is 1000, then 400 simulated losses are picked at random from simulated loss data and 600 values are taken at random from simulated scenario data for the calculation of VaR, CVaR, EL and UL.

In case of Alternative method, the loss severity amounts are replaced according to the simulation. For example: 40% of worst scenario simulated losses are replaced by loss simulation and then the computation of VaR, CVaR is applied to the aggregated data.

In case of Aggregate method the loss severity amounts are summed up with the scenario simulated losses. For example: If loss severity simulations are 10000 and scenario simulated losses are 10000 then the number of simulations as per the aggregate method will be 20000.

2.2.4. Stress Testing

Stress is applied on the shape and scale parameters of the distributions. The shape and scale parameters cannot be negative or zero. The stressed value allocated to the shape and scale are either absolute or percentage shift. Absolute value stresses the parameters directly.

For example: if the shape is 0.5 and you input 0.25 as the absolute value, then the stressed run would consider shape value as 0.75. If you input percentage shift of 25% then the shape would be multiplied by 1.25 and the new value is used for the Run execution.

Stress can also be applied on correlation matrix. Further, it should be noted that ensuring positive definiteness is mandatory.

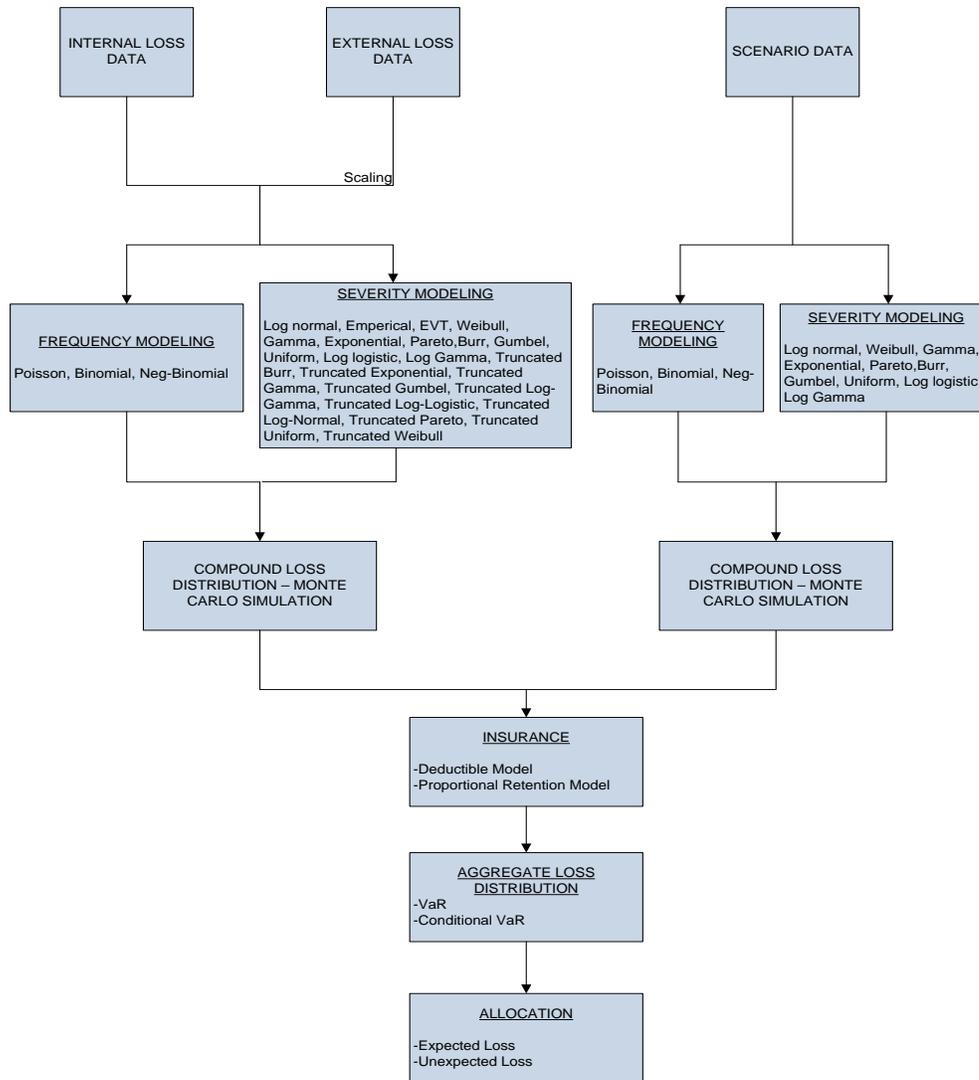## 2.3. Operational Risk Economic Capital - Functional Process Flow Diagram

Figure 1: Functional Flow of Operational Risk Economic Capital Application

2.4. Operational Risk Economic Capital – Product Process Flow

There is only one dataset on which modeling is performed as business models are defined on a single dataset. Selection of the dataset for Operational Risk Economic Capital modeling is not required, as after choosing the technique (Loss Distribution Approach) the dataset is automatically chosen. Once the business model is selected the dataset browser becomes invisible.

There are seven tabs for data input, namely:

- Capital Calculation

- Loss Data Frequency

- Loss Data Severity

- Scenario Data

- Credibility Factor

- Data Transformation

- Filter

To access these tabs refer to the following steps:

1. Click **Modeling** on the LHS pane of OREC application (in sandbox infodom), shown in the following figure:
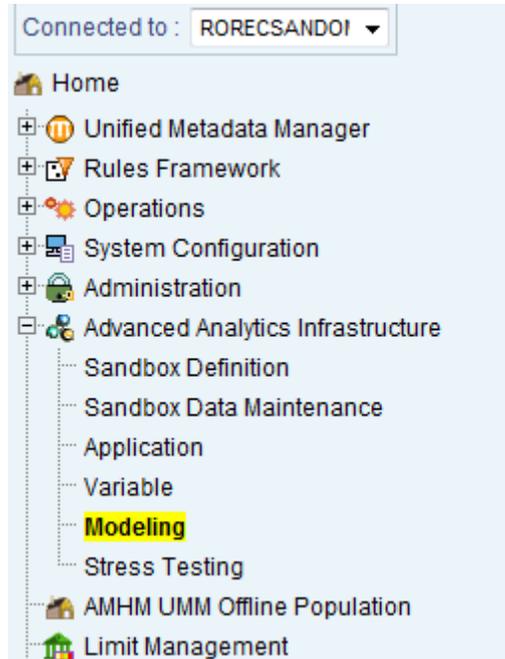
Figure 2: OREC modeling

2. Click **Model Management** to define a model.

3. Click to create a new model.

4. Enter the **Model Name, Model Description, Technique, Model Objective** in the **Model Definition** screen.

   The seven tabs for data modeling are displayed and explanation of each tab is provided in the following sections.

2.4.1. Tab.1: Capital Calculation

The inputs in **Capital Calculation Settings** tab are the inputs given before modeling. These are mandatory fields to be updated for Operational Risk Economic Capital calculation. There are three sections under the **Capital Calculation Settings** tab namely: **Reporting Groups**, **Parameters**, and **Options**.

Figure 3: Operational Risk Economic Capital Model Definition Screen

- **Reporting Group**

  Select the type of RG on which EC modeling is performed, that is, whether the modeling is to be done on regulator prescribed *Standard Reporting Group* or on *Internal Reporting Group* as specified by the bank. In the **Reporting Group** section **Reporting Group Relevance Setting** should also be updated. OREC application supports processing on 56 RG's or a selected group of RGs specified in the **Relevance Setting Grid**.

Figure 4: Reporting Group Relevance Setting Screen

The **Reporting Group Relevance Setting** remains disabled if the RG is not selected. If the RG is changed before the model is saved, the frequency and severity tab parameters changes to null, if there are any new LOB and ETs then the dimension table should be resaved in the hierarchy.

- **Parameters**
  - Reporting Currency: An entity having operations in multiple geographic areas and those which have losses in multiple currencies, EC should be calculated in the reporting currency. The historical losses should be converted from standard currency to the reporting currency. Scenario severity values should also be converted to the reporting currency prior to the model execution.

  - Number of simulations: The number of simulations should be greater than zero.

  Severity Loss Simulation uses the temporary table space as a part of model execution. The Database temporary table space requirement for running 56 Reporting Groups (RG) with 1,000,000 simulations is 12GB.

  - Time window (in days): The time window would specify the number of days the loss data would be used for risk computation.

  - Bucket length: The length of the bucket as in the frequency data would be calculated based on this length.

These parameters are used in the simulation generation of frequencies and severities. Enter the number of simulations of frequencies and severities to be generated for loss calculation. The inputs for these parameters should follow the validation rule. The input value for this field should be greater than 1. The parameters for Time window and Bucket length are used to form the time buckets (number of time buckets = Time window in days/ Bucket length). Each time bucket contains the frequency of the loss event occurrence with respect to that particular RG. The number of time buckets should always be greater than 3; else the model fails to save. This is further used in calculating frequency in the relevant buckets for Frequency Modeling.

Use this option extensively to avoid errors like data does not follow distribution, data not available for frequency modeling along with the choice of distribution.

Specify the confidence level for Economic Capital (EC) and Regulatory Capital (RC) computation. Confidence level is ideally between 95% and 100%. However, RC for operational risk is calculated at one rate, for example 97.5% and EC for operational risk is calculated at another rate for example 99%. Accordingly, input any percentage values greater than zero.

  - **Random number seed:** A seed is a number used to initialize a pseudorandom number generator. A positive integer is expected as an input in the OREC application.

☆ Parameters			
Reporting Currency	US Dollar	Number of Simulations	100
Time Window (in days)	1800	Bucket Length	30
Confidence Level for Regulatory Capital (%)	97.5	Confidence Level for Economic Capital (%)	99
Frequency Random Number Seed	1		

Figure 5: Parameters

- **Options in Capital Calculation Settings Tab:**

☆ Options			
Distribution Fitting Methodology?	Method of Moments	Calculate Allocation Factor	No
Consider External Data?	No	Consider Scenario Data?	No
Consider Insurance?	No	Maximum Insurance Benefit (in %)	

Figure 6: Simulation Settings and Options Screen

In this tab specify various conditions under which the simulations are to be done. Here you can select the appropriate options depending upon the availability of external and scenario data. Additionally you may or may not consider insurance.

You also have the option to **Calculate Allocation Factor** by selecting **Yes** in the available options, after which OREC application generates the allocation factor. On the other hand, if **Calculate Allocation Factor** is **No** then the factor is expected as a download. UL at the aggregate level is distributed back to the RGs in proportion to the variances and co-variances of the individual RG losses.

You can specify the Distribution Fitting Methodology as Maximum Likelihood Estimate (MLE), Method of Moment (MM), or Maximum Likelihood Estimate (BFGS).

2.4.2. Tab.2: Loss Data Frequency

The loss data frequency has two sections namely- **Correlation** and **Parameters**. You have to specify the copula method and correlation technique in OREC application.

<u>Correlation:</u>

The copula method has a drop down menu with four options namely **Gaussian**, **Gumbel, Student's-t**, and **Not Required**. When Copula Method is selected as **Not Required**, then the Correlation field remains disabled and the Copula is not used.

<u>Parameters:</u>

The OREC application estimates the dependence between the RG frequencies of internal loss data using any one of the correlation co-efficient techniques **Spearman's correlation co-efficient** or **Pearson's correlation co-efficient** or **Kendall's Tau**. The correlation technique to be used is to be specified. Dependency is measured only for frequencies of the loss data across RGs.

You have to specify the frequency distribution selection and **Tolerance Level** in the adaptive model. There are 5 options available in Frequency Distribution selection and any one can be selected. The available options are **Adaptive, Poisson, Binomial, Negative-Binomial** and **User Specified**. When any one of the first four options are selected then all the cells follow the selected distribution that is **adaptive, poisson, binomial** or **negative binomial.** When adaptive distribution is selected the distribution is selected based on the input data and the best fit distribution. The decision for the best fit distribution for RG is done according to the mean and variance of the data.

The tolerance level for adaptive modeling should be a percentage value and should be greater than zero.

Figure 7: Frequency Distribution Selection

You also need to specify the **BEICF Shape Adjustment** and **BEICF Scale Adjustment**. The Business Environment and Internal Control Factors (BEICF) are those measures that are usually

associated with the day-to-day operations which are high frequency or low impact (HFLI) events. In contrast, the scenario data typically considers low frequency and high impact (LFHI) operational events. In Frequency Modeling, the fitted distribution's parameter like shape and scale are calculated by Method of Moments or Maximum Likelihood. The parameters are rescaled to represent a one year period. The parameters are multiplied by the number of time buckets in a year to rescale the parameters. Rescaled parameters are adjusted for BEICF shape and BEICF scale adjustments by multiplying the factors given as an input. This BEICF shape and scale adjustments should be a value greater than zero and is used as a percentage increment to the calculated parameters. In order to scale down the parameters the BEICF shape and scale should be less than 1.

For example: if the Shape parameter is 0.5 and BEICF shape adjustment is 10, then the adjusted shape is 5.

You also have the flexibility to select the distribution for each cell by selecting the option **User Specified**.

The inclusion of near miss data would be in the interest of the modeling analyst as its inclusion or exclusion may change the capital calculation.

Near miss events would not have any severity value attached to it. Hence, they are considered only for frequency modeling. The data needs to be passed to the NAG and shape and scale should be considered as output.

2.4.3. Tab.3: Loss Data Severity

Severity Distribution Selection: The available dropdown options are Empirical, Log Normal, Extreme Value Theory (EVT), Weibull, Gamma, Exponential, Pareto, Burr, Gumbel, Uniform, Log Gamma, Log Logistic, Truncated Burr, Truncated Exponential, Truncated Gamma, Truncated Gumbel, Truncated Log-Gamma, Truncated Log-Logistic, Truncated Log-Normal, Truncated Pareto, Truncated Uniform and Truncated Weibull. When any one of these options are selected then all the 56 cells (or cells selected for processing) follow the selected distribution, but you also have the flexibility to select the distribution of each cell by selecting the option User Specified. If EVT is used as the distribution, then the modeling analyst has to specify whether to calculate the EVT Threshold or to specify the threshold value. The specified EVT threshold value should always be greater than 50%. EVT fitting is done after outlier treatment. Due to this if outlier is opted for along with EVT, the threshold point may be of a smaller value than expected.

USER_CAPPING_SELECTION= "YES" with CAPPING_SHAPE_LOWER_VAL = -0.5 and CAPPING_SHAPE_HIGHER_VAL= 1. This combination changes the fitted shape parameter of distribution if it falls outside the range defined. Estimated values are replaced by the nearest threshold value in case the range is breached.

USER_CAPPING_SELECTION= "FAIL" with CAPPING_SHAPE_LOWER_VAL = -0.5 and CAPPING_SHAPE_HIGHER_VAL= 1. This combination changes the fitted or estimated shape parameter of distribution if it falls outside the range defined. It also conveys that the Run would fail if estimated parameters are outside range. You are required to change the data or redefine buckets for improvement in parameter values.

USER_CAPPING_SELECTION= "NO" with CAPPING_SHAPE_LOWER_VAL = -0.5 and CAPPING_SHAPE_HIGHER_VAL= 1. This combination changes the fitted shape parameter of the distribution if it falls outside the defined range. In this option the OREC application performs simulation even though the parameters are outside range. Simulation that results from such an execution should be read with caution.

In all 3 cases you can modify the lower and upper values depending on the experience. However, -0.5 and 0.75 or 1 are standard values. As for shape parameter value of 1 and greater than or less than -0.5, the distribution has infinite variance and simulated values are erratic. Apart from EVT, there are 11 other options available in severity distribution selection, and any 1 can be selected.

Log Transformation: is an option to apply log transformation on the loss data.

Figure 8: Severity Distribution Selection

If the severity distribution specified is user specified and EVT is selected at grid level, then input different EVT Threshold at grid level for different RG's or specify one **EVT Threshold %** for all the RG's.

The RGs which are not selected for processing from the **Reporting Group Relevance Settings** field are disabled from selecting distribution.

2.4.4. Tab.4: Scenario Data

The scenario tab has two sections namely- Frequency Correlation and Scenario Distribution:

Frequency Correlation:

In this tab specify the Correlation Coefficient Estimation between **Use Loss Data Correlation** and **User Specified Correlation**. Based on **Use Loss Data Correlation,** input the correlation default value.

There should be 2 inputs in the Scenario Analysis tab:

- Inter Scenario Default Correlation Value: This value is replaced if there is no correlation value between scenarios within the same group.

- Inter Group Default Correlation Value: This value is replaced if there is no correlation value between RGs.

Frequency Distribution:

The OREC application supports **Poisson, Binomial** and **Negative Binomial** distribution for modeling frequency of scenario data. In this tab you need to specify the Frequency Distribution and Scenario Distribution. The list of distributions for scenario data frequency modeling follows the same as in loss data frequency modeling. For the adaptive model, the tolerance level has to be specified and this can be done at RG level.

Figure 9: Scenario Analysis Screen

Severity Modeling:

The OREC application supports all the distributions available for loss data severity modeling with

the exception of Extreme Value Theory (EVT), Empirical and Truncated distribution.

Since, EVT is best applicable for the data with extreme deviation from the mean it is the outcome of user judgment based on the risk and control assessments within the bank and the scale of operation. This peculiarity of the scenario data makes it difficult to fit Empirical distribution. Since, EVT approach comprises of Empirical distribution and Generalized Pareto distribution, it is not advisable to fit EVT to scenario data. Log Normal, being a skewed tail amongst all thin-tailed family of distributions, proves to be the best distribution for scenario data. The mode and percentile given as a download for specific reporting groups are used to fit a Log Normal distribution to the scenario data. The process outputs calculated are stored in OREC application **Process_Output** table.

OREC application supports two different approaches for modeling severity data:

Formula Based: Usage of formula for severity modeling.

Bound Data: Bound data approach follows modeling similar to severity modeling of loss data. The convention between Formula based and Bound data can be handled in tool matrix.

Scenario data can also be defined at reporting group level by **User Specified** option available under the pane.

When scenario data is specified as **No** in the **Capital Calculation** tab; the **Scenario Data** tab will be disabled. Default correlation value is used only when loss data correlation is used.

2.4.5. Tab.5: Credibility Factor

You have to define two parameters, the first one being the credibility approach for scenario analysis method where **Alternative, Complimentary, Aggregate** or **User Specified** should be selected. The second parameter is the credibility factor.

For example: At the bank level if the number of simulations is 10000, then there would be 10000 loss simulations and 10000 scenario simulations. These 20,000 simulations have to be converted to a final set of 10000 simulations. In other words, internal or external simulations have to be combined with scenario simulations, for which three methods alternative, complimentary and aggregate are available.

Under Alternative method, given the credibility factor as 30%, 30% of worst severities of scenario simulations replace the corresponding simulated losses of internal or external data. It should be noted that ordering simulated losses may be necessary as worst scenario simulations has to replace the worst internal or external simulations.

0% credibility factor would mean only internal or external simulations will be considered for risk measure estimation.

Credibility-30%					
Simulation Number	**Loss Simulation**	**Scenario Simulation**	**Alternative method**	**Complimentary method**	**Aggregate method**
1	983,251.02	180,498.51	983,251.02	983,251.02	1163749.53
2	1,138,076.71	197,034.75	197,034.75	1,138,076.71	1335111.46
3	1,033,025.97	205,420.06	205,420.06	205,420.06	1238446.03
4	993,809.59	232,148.67	232,148.67	993,809.59	1225958.26
5	1,106,787.55	183,942.18	1,106,787.55	1,106,787.55	1290729.73
6	861,358.99	157,605.63	861,358.99	157,605.63	1018964.62
7	922,687.69	136,863.81	922,687.69	922,687.69	1059551.5

Credibility-30%					
Simulation Number	Loss Simulation	Scenario Simulation	Alternative method	Complimentary method	Aggregate method
8	849,574.94	139,645.23	849,574.94	849,574.94	989220.17
9	971,087.05	164,617.35	971,087.05	164,617.35	1135704.4
10	869,749.37	177,235.19	869,749.37	869,749.37	1046984.56

Table 8: Credibility Factor

In the complimentary approach, random replacement of internal or external simulations is done by randomly picking simulations from scenario data depending upon the credibility factor. Random is the key here.

100% credibility factor would mean only scenario simulations are considered for risk measure estimation. Again 0% and 100% credibility factor can also be achieved. While calculating bank level VaR it does not consider worst cases from both sides and also does not ignore the tail portion. This is done by preserving the simulation order which ties the frequency generation done for all RGs. It is preserved as OREC application uses copula to generate frequency so that real data is imitated as much as possible.

For example: let's assume that there are 10 simulations from loss data and 10 from scenario, all tied together by the simulation order. If the first simulation number itself is the worst case for the scenario then OREC application ignores loss simulation. It does not check if ignored loss value is worst case or not. This results in **Diversified VaR** which applies portfolio effect to RG combinations by preserving the relationship generated by copula.

Under aggregate method loss simulation values are summed up with scenario simulations values. For example: if there are 10000 loss simulations and 10000 scenario simulations, then total number of simulations by aggregate method is 20000 simulations.

NOTE

When scenario data is specified as **No** in the capital calculation tab; the **Credibility** tab will be disabled. Default correlation value is used only when loss data correlation is used.
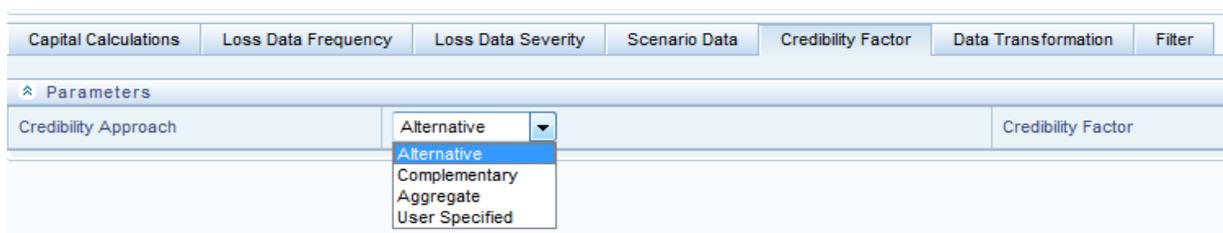

Figure 10: Credibility Factor

2.4.6. Tab.6: Data Transformation

The parameters in the data transformation include - **outlier determination**, **outlier scaling factor** and **missing value treatment**.

Outlier Determination: The outliers can be identified across all the RGs by selecting **Interquartile Method** or can be made across each RG by selecting **User Specified** or this process can be excluded by selecting **Not Required.**

Missing Value treatment: 3 options to replace the missing value in the loss data are available by the **Mean** of the data or you can **Omit** the data or customize the selection at the RG level by selecting the **User Specified** option.
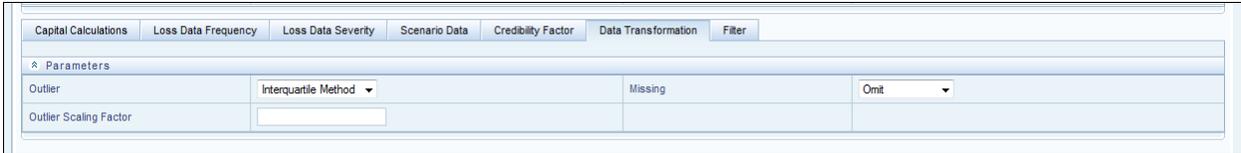
Figure 11: Data Transformation

2.4.7. Tab.7: Filter

Add multiple Hierarchy members as filters, as shown in the screen. Select filter tab in the **Model Definition New** screen. This is mainly used for entity selection.
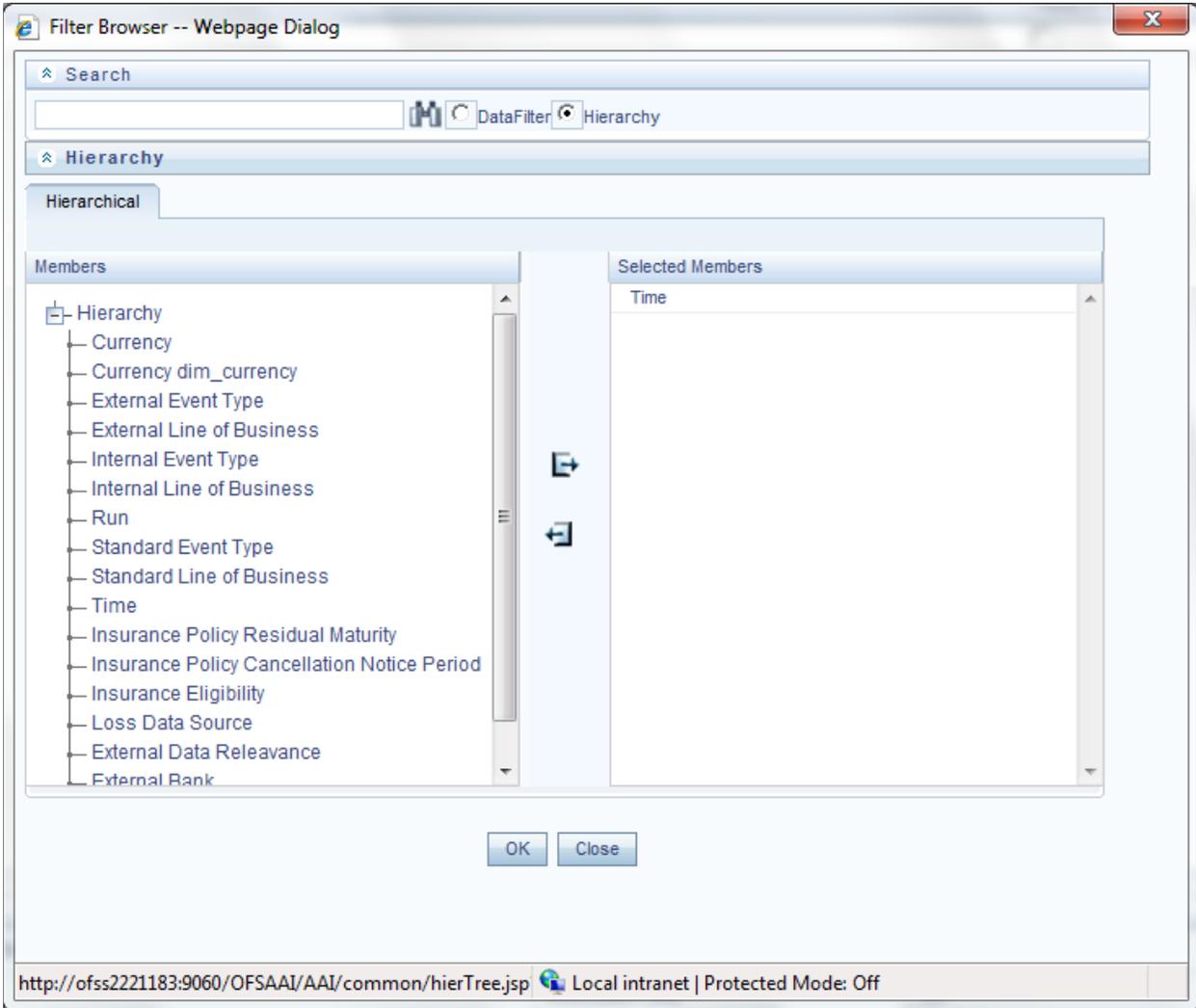
**Figure 12: Filters**

2.5.Stress Testing Overview

The Stress Testing Framework has four parts:

- Variable definition

- Shock library

- Scenario definition

- Stress definition

Variable Definition: Stress Testing allows the bank to conduct an analysis that enables it to estimate the impact of movements in the variables on measures such as profitability, capital adequacy. A what-if analysis enables strategic planning in areas such as customer acquisition, capital planning, fund management and many more.

To access the Stress Testing framework, click the option **Stress Testing** in the LHS pane, shown in the following figure:
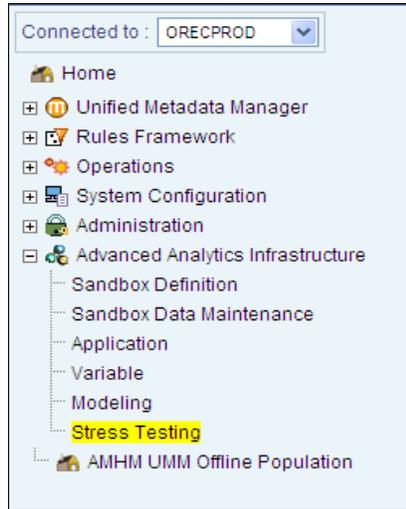
Figure 13: Variable Definition Selection

To define a new variable which has to be stressed, select **Variable** as shown in the preceding screenshot.

In the **Variable Definition New** [icon] screen, the name and description of the new variable is to be defined. Enter a suitable name and description of the new variable in the **Variable Name** and **Variable Description** fields respectively. From the **Variable Type** dropdown list select **Idiosyncratic Variable**.

Based on the drop-down list, select **Measure** to create a variable based on Measure. The **Variable Set Management** pane is displayed on the RHS of the screen.

Variable ID	Variable Name	Variable Property	Based On	Created By	Creation Date
V1275509417031	Frequency Correlation Value - Loss Data	Direct	Measure	ORECUSER	02-JUN-2010 03:17:56 PM
V1275509522655	Frequency Correlation Value - Scenario Data	Direct	Measure	ORECUSER	02-JUN-2010 03:19:42 PM
V1274811270838	Frequency Scale Parameter - Loss Data	Direct	Measure	ORECUSER	25-MAY-2010 01:21:58 PM
V1274811574391	Frequency Scale Parameter - Scenario Data	Direct	Measure	ORECUSER	25-MAY-2010 01:27:02 PM
V1274811202292	Frequency Shape Parameter - Loss Data	Direct	Measure	ORECUSER	25-MAY-2010 01:20:50 PM
V1274811474064	Frequency Shape Parameter - Scenario Data	Direct	Measure	ORECUSER	25-MAY-2010 01:25:22 PM
V1274387907418	Scaled Loss Severity	Direct	Measure	ORECUSER	20-MAY-2010 03:45:48 PM
V1274811411614	Severity Scale Parameter - Loss Data	Direct	Measure	ORECUSER	25-MAY-2010 01:24:19 PM
V1274811721838	Severity Scale Parameter - Scenario Data	Direct	Measure	ORECUSER	25-MAY-2010 01:29:29 PM
V1274811324392	Severity Shape Parameter - Loss Data	Direct	Measure	ORECUSER	25-MAY-2010 01:22:52 PM

Figure 14: Variable Management Screen

Details such as **Variable ID**, **Variable Name** and **Creation** details are displayed. In the **Variable Definition New** screen the name and description of the new variable is to be defined.

Figure 15: Variable Definition Screen

Variable Shock: To access the Variable Shock Library:

1.   Click Stress Testing.

2.   Click Variable Shock library.

The **Variable Shock Library** pane is displayed in the RHS of the screen. Details such as **Shock ID, Variable Shock Name, Variable** and **Creation Details** are displayed.

Select the data set, in this case **Operational Risk Economic Capital Process Output** and browse for the variable name. The type of variable would be **Idiosyncratic Variable**.

Depending on the occurrence of the shock, the shock type should be defined as either **Instantaneous** or **Across Time**.

The filter can also be applied by using **New** in the **Shock Filter Specification**. This displays a new browser with the list of hierarchies. For the shock parameter, the modeling analyst should either shock the parameter on percentage base as **Percentage shift** or by absolute base as **Absolute Shift**. The values of the shift should be defined at the **Shock value**.

Figure 16: Variable Shock Definition

Scenario definition: A Scenario is a set of multiple Variable shocks and Rule shocks. These shocks may be Rule Based Shocks or Variable Based Shocks. You can define a Scenario using a combination of Rule Based Shocks and Variable Based Shocks.

Navigate to **New Scenario Definition**, which displays a new browser with **Variable Name**, **Shock Name**, and **Variable Type**. This would also display the list of shocks defined earlier. The selection of multiple shocks together forms a new scenario. This combination results in a **New Scenario** name.

Figure 17: Scenario Definition

Stress Definition: Stress Definition allows you to specify either a stand-alone execution of a Scenario or maps a Scenario to a Baseline Run, thereby creating a Stress Run. It is also possible to map a Scenario to multiple Baseline Runs. This integrated stress testing enables you to assess the impact of a Scenario across multiple areas.

The **Stress Definition New** screen contains three panels namely:

- **Stress Definition Details** – Specification of the **Stress Name** and **Description** and selection of the scenario to be mapped to the particular Stress Definition.

- **Run Details** - Viewing the Selected Baseline Run Definition.

- The saved **Stress definition** can be either edited or deleted.
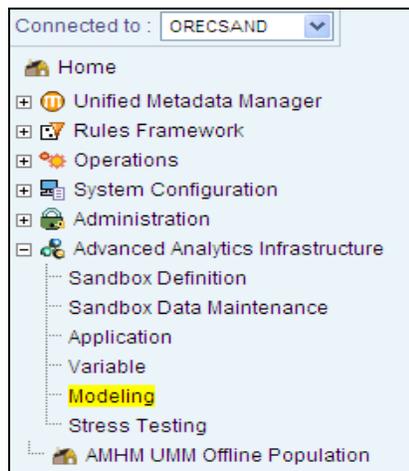
Figure 18: Stress Definition Screen

3. Preparing for Execution

3.1. Set up definition

Set up pertains to the ability of OFSAAI platform to calculate loss values. OREC application provides two such infodoms namely Sandbox and Production. Sandbox is a sort of **trial** area. Various combinations of parameters can be tested till the desired results are achieved. The model output can then be deployed after which it can be accessed in production. In production, the **Model Management** option is not available which restricts the changing of the model parameters. However, this can also be achieved through the sandbox.

Sandbox Definition

Within modeling environment (Sandbox Environment), data would be extracted or imported from production infodom based on the dataset defined. Also, this can be the first data movement from the staging to the FACT table as well. The objective of this step is to fetch data for all attributes for a particular time period. The **Sandbox Definition** screen is reproduced below for easy reference:


Figure 19: Sandbox Definition

Sandbox Definition Screen includes the following:

- Model Management

  Before model definition, *LOB & ET Reclassification* needs to be performed. The LOB and ET information is either reclassified according to the regulator rules or according to the bank's own reclassification rule. Oracle Financial Services Operational Risk Economic Capital, Release 2.1.1.0.0, Calculation is a business model. You should select Operational Risk Economic Capital modeling from the **Technique** screen under the **Business Models** category as shown in the following screen:
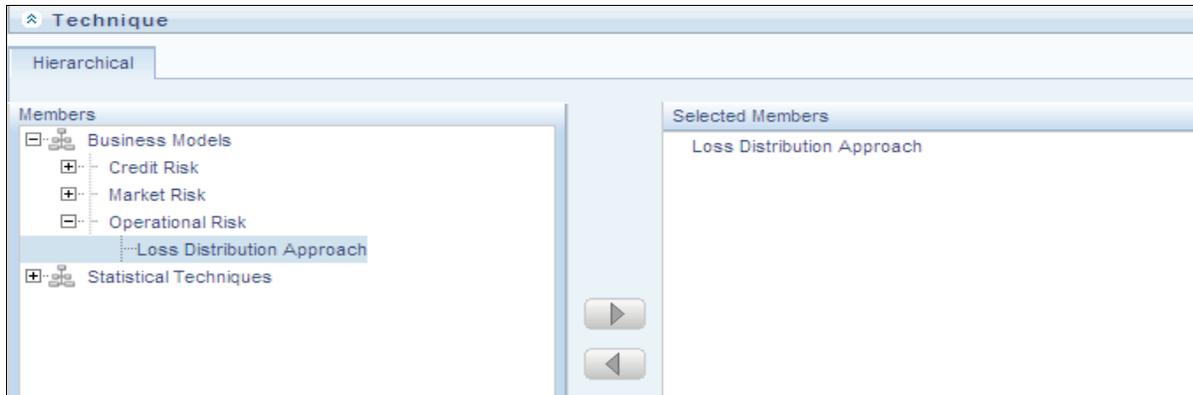
Figure 20: Operational Risk Economic Capital Modeling: Business Model Browser

Defining Operational Risk Economic Capital Model in Modeling Framework (MF):

Provide data input for the calculation of Operational Risk Economic Capital. Input the **Model Name**, **Model Objective** and **Technique** for modeling (in Business Models **Loss Distribution Approach** is selected).

Model Name: Loss Distribution Approach

Model Description: Operational Risk Economic Capital Estimation for Standard RG with Financial Services and Scaled External Data.

Model Objective: Portfolio Operational Risk EC Estimation

Technique: Operational Risk Economic Capital Modeling

- Model Execution

  After OREC application model is defined, request for execution is made. The **Model Execution** is available at the bottom of the screen. Using this option, a message **Model Execution Triggered** is displayed. The execution of the model requires the MIS date and the number of executions to be greater than zero.

- Model Output

  For more information on Model Output, refer to Operational Risk Economic Capital Reporting on page 32.

- Model Deployment

  You can deploy the model in the production infodom and execute it. However, in the production infodom an end-to-end process to execute the Operational Risk Economic Capital model should be defined.

  Screenshots relating to model deployment are as follows:
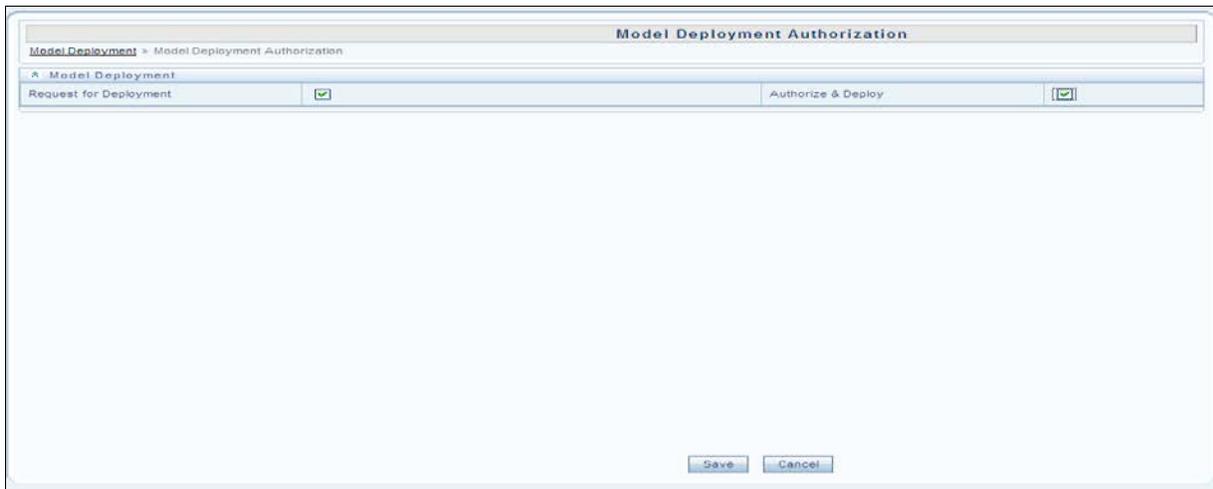
Figure 21: Model Deployment Screen – 1

Figure 22: Model Deployment Screen – 2

3.2. Staging Area

The uploading of data involves the loading of all the stage tables. *For more information on the stage tables to be populated, refer to the Download Specifications (DL Specs) documents.*

4. <u>Execution</u>

A Run is executed in the production infodom to calculate Operational Risk Economic Capital. A Run in the production infodom consists of the following:

- T2T: Stage to FACT Table data loading.

- Reclassification Rules: These are Rules to reclassify Internal to Standard, External to Standard, External to Standard LOB and Standard ET.

- Model Execution: Models defined in the sandbox are re-executed through a Run in the production infodom.

For more information on execution of a Run, refer to the Technical Metadata Worksheets.

5. <u>Operational Risk Economic Capital Reporting</u>

A reporting dashboard is also provided with the OREC application. This involves a combination of graphical as well as tabular reports. You are provided with report filters to view data in different ways.

A model run using Run execution is all that the dashboard needs. The dashboard queries the same database using filters like Run descriptions, execution date and so on.

<u>Graphical reports:</u>

- OR Risk Loss Distribution

- Risk Measures Across Time

- Internal Loss Statistics

- Economic Capital Allocation to Lines of Business

- Economic Capital Allocation to Event Types

- Line of Business Analysis
    - Key Risk Measures
    - Economic Capital Trend
    - Loss Event Statistics
    - Economic Capital Allocated to Event Types
    - Loss Frequency Analysis
    - Loss Severity Analysis

- Event Type Analysis
    - Key Risk Measures
    - Economic Capital Trend
    - Loss Event Statistics
    - Economic Capital allocated to Event Types
    - Loss Frequency Analysis
    - Loss Severity Analysis

- Analysis across Models
    - Risk Measures across Models
    - Model General Details

- Simulation Reports
    - Simulated Values of Frequency for Scenario Data
    - Simulated Values of Severity for Scenario Data
    - Simulated Values of Aggregated Loss for Scenario Data
    - Distribution Parameters
    - Stress Testing
        - OR Loss Distribution
        - Risk Measures across Time

- o   Economic Capital Allocation to Line of Business

- o   Economic Capital Allocation to Event Types

- o   Frequency Shape and Scale Analysis for Event Type

- o   Severity Shape and Scale Analysis for Event Type

The following reports need to be calculated both for Standard RG (combination of Standard LOB by Standard ET) as well as Internal RG (combination of Internal LOB by Internal ET). For example: if a bank has 10 Internal LOB and 3 Internal ET then the number of Internal RGs would be (10 * 3) 30. However, for reporting purposes, the number of Standard RGs would be (8 * 2) 16 (where 2 of the Internal ETs map to 1 Standard ET). Operational Risk Economic Capital generates the following **43 reports**.

Tabular Reports

- OR Dependency Matrix Correlation Value - Standard

- OR Dependency Matrix Covariance Value - Standard

- OR EC Across Internal Event Type

- OR EC Across Internal Line of Business

- OR EC across Internal Reporting Groups

- OR EC Across Standard Event Type

- OR EC Across Standard Line of Business

- OR EC across Standard Reporting Groups

- OR Goodness of Fit Statistics for Internal Reporting Group

- OR Goodness of Fit Statistics for Standard Reporting Group

- OR Key Stats for Internal Data - Internal Reporting Group

- OR Key Stats for Internal Data - Standard Reporting Group

- OR RC Across Internal Event Type

- OR RC Across Internal Line of Business

- OR RC across Internal Reporting Groups

- OR RC Across Standard Event Type

- OR RC Across Standard Line of Business

- OR RC across Standard Reporting Groups

- OR Key Stats For External Loss - INT RG

- OR Key Stats For External Loss - STD RG

- OR Key Stats of Int and Scaled Ext Loss-INT RG

- OR Key Stats of Int and Scaled Ext Loss-STD RG

- OR Dependency Matrix Correlation Value – Internal

- OR Dependency Matrix Covariance Value - Internal

Frequently Asked Questions

1. **How is EVT calculated by OREC Application?**

   OREC application segregates the loss data as per given time buckets. For this time bucket, mean and variance is calculated. OREC application begins with 50% value of loss data. Only those loss values are chosen which falls above the threshold point. These newly found values are again segregated in time buckets. OREC application then checks if mean is greater than variance for this data. The same process is repeated with a jump of 1% till mean is greater than variance. The upper threshold of percentile is 99.9%

   While calculating monetary value of threshold point, OREC application follows the function similar to *percentile* in Microsoft Excel. This helps in finding the exact percentile value and results in a threshold value which may not be a part of loss data.

2. **How does OREC application calculate the outlier?**

   OREC application calculates outlier by using Inter Quartile method. This is done to find out those data points which divide the data (in a sorted manner) in 4 equal parts. Thus, data points which are at 25%, 50% and 75% percentile of the data are required.

   However, in this case, OREC application follows cumulative percentile calculation for each data point to find the correct value. Due to this approach, quartile points are always part of the loss data and thus they are approximately 25%, 50% and 75%.

3. **How are VaR numbers calculated?**

   VaR algorithm attempts to retain the respective weightage of various RGs with respect to each other when frequency for each RG is simulated. Due to this when simulated losses are summed across the RGs to get bank level VaR it avoids forming simultaneous peaks for each RG. This peculiar structure results in diversified VaR.

4. **Is model execution in Sandbox a compulsory step?**

   Sandbox is a trial area. You can define various models and analyze the output. Once the model is defined as per business requirement, deploy the same for production set up. If you are certain about the model execution results then deploy the same directly.

   However, it is advised to go through the sandbox as execution errors (data non availability, choice of distribution) will be eliminated following this step.

5. **How to find which distribution fits the data properly?**

   To begin with, for frequency analyses select the adaptive method. In this method, OREC application chooses the method which is more suitable for the data. When it comes to severity analysis, use the Modeling Framework (Platform) to get statistics regarding Goodness of Fit for a given data under various methods.

6. **Why do we get copula failure errors?**

   Copula works mainly on correlation values between RGs. There are a few obvious reasons for copula failure which are as follows:

   Erroneous insertion of data under **User Specified** resulting in correlation value <-1 or >1.

   Matrix approach is not followed.

   For example: RG (ET-2, LOB-3) has correlation value of 0.5 but (LOB-3, ET-2) has been inserted as 0.6. When Gumbel Copula is, the correlation values are to be restricted between 0 and 1 as here non zero and positive values are required.

7. **Why we get error "Data does not follow ... distribution" error? And how can we overcome this error?**

Every data has its own characteristic which is suitable for a particular distribution or class of distribution. For example: when mean is equal to variance Poisson is used. If we try to fit the data which does not follow a particular distribution, we end up doing a force fit which may lead to errors.

Another reason can be the choice of buckets. Frequency modeling depends on bucketing. Change in the bucket window and time period can substantially alter the data characteristics. It is advised to choose a correct bucket structure for the output to match the expectation. However, it is always advisable to go though the Modeling Framework which provides a lot of tools like Goodness of Fit to judge the fit.

8. **Do I need to re-execute the Runs for reports?**

Additional executions for reporting purposes are not required. Refer to the Run executed in the batch execution area along with execution date, and access the required report. Additional runs after batch execution are not required to be executed even if you are using the dashboard or not. Dashboards can be linked to either sandbox or production set up.

9. **How does a Random Number Seed function?**

Simulation programs make use of a pseudorandom number generator that requires a seed. If none is provided, a *System Generated* seed will be used. This is used to separate the different simulations within a single run. Any positive integers can be a random seed.

10. **Which are the hierarchies on which I can apply the filter?**

In model definition, OREC application provides a wide range of hierarchies on which filters can be applied. You have a choice of selecting those hierarchies that form a part of OREC modeling data set.

11. **How will the outlier scaling factor be used and what would be the range for the same?**

Outlier is used to identify those data values which should logically be a part of tail ends. OREC application provides inter quartile method for this. Q1 and Q3 are inter quartile ranges

$$\text{Upper Hinge} = Q1 - K*(Q3 - Q1)$$

$$\text{Lower Hinge} = Q3 + K*(Q3 - Q1)$$

K is outlier scaling factor. Higher values of K widens the range and vice versa. There are no common values for this. However, outlier scaling factor of 1 reduces the range to inter quartile range. Values less than 1 are not advisable.

12. **When does model version change and when is the model asked to be saved with a different name?**

Model changes can be saved in two ways. First, called version change involves minor changes like simulation numbers, bucket parameters, random number seed, and insurance percentage. Changing these parameters is not considered as the one which impacts the basic structure of the model and hence the same can be saved with the new version number.

However, if any other changes are made, ensure that you save it as a new model as all other changes impact the modeling structure.

13. **Where will I find outlier and missing value treatment results for view?**

The relevant files are saved in the following location:

…/home/RORECst/ftpshare/**INFODOM**/scripts/modeldatafiles

Infodom values are generally RORECSAND or RORECPROD depending on which infodom the Run or model is executed on.

14. **Why is external data used only for severity modeling?**

External loss data is not utilized for modeling of frequency as it is characterized by low frequency

and high severity data and therefore is considered only at the time of modeling severity.

15. How do I select between formula based and bound method for scenario severity modeling?

You can make changes in the tool matrix XML file which are valid across models and users which indicate that changes made here will have a global impact.

16. How does log transformation help?

Log transformation helps in variance stabilization. Increasing slopes in X in relation to another variable are linearized. Positively skewed distributions of X are normalized.

17. Where do we set threshold values for external loss data?

In the Rules framework you can specify upper and lower thresholds of external loss data. Later, outlier can be applied to ensure data selected for modeling resembles the expectations set or business requirements.

18. For OBI reports (Dashboard) is execution compulsory in production set up?

OREC application provides the option to generate OBI reports from Sandbox or Production set up. This is handled in OBI settings. If sandbox is selected from OBI then Run in production set up for OBI need not be executed. However, by default the choice provided in OREC application setting is Production.

Annexure A: Things to Remember

Frequency Modeling - If you are unaware of the distribution type of the data for each RG, select **Adaptive** modeling so that OREC application models on its own and selects the relevant distribution type for each RG to calculate the frequency parameters. Near miss values are optional and included only in frequency modeling as they do not hold any severity values. Tolerance level as per industry standards given as a user input should normally be between 1% and 5%. BEICF adjustments should be in percentage value and is given as a decimal value input.

External Data- External data and Scenario data are not subject to any outlier adjustments.

Near Miss- Near miss values are excluded from any missing value transformations.

Scenario Data- Scenario data is independent of time bucket definition as the frequency and severity data is obtained directly as a download. This data is directly used for shape and scale determination. Scenario data does not undergo log transformation.

Dependency Between Loss Frequencies - Dependency is measured only for frequencies of the internal loss frequency data across RGs.

Time Bucket Input - The ratio of **Time Window** and **Time Bucket Length** should be greater than 3, failing which the model will not be saved.

Severity Modeling- EVT is best applied for data with extreme deviations from the mean or technically *the data with fat tail*.

Insurance –Insurance data should be mandatorily provided (EEL and Agg Data), if **Consider Insurance** is updated as **Yes** in **Capital Calculation Settings** Tab.

Ideally, the EEL deductible amount or the EEL percentage (in case of Proportional Model) should be given as a download. Else, Net EEL claim = Loss Amount.

All contract ID's in an RG should have EEL Deductible Amount or Aggregate Deductible Amount if the insurance model is a **Deductible Model**. For a **Proportional Retention Model**, the percentage for EEL and Aggregate Loss should be given, if deductible amount is not given.

Loss Calculation - If the sum of EC values at RG level is not equal to that at bank level, then check the Variance - Covariance matrix to confirm.

Annexure B: Understanding Key Terms and Concepts

Value-at-Risk - Value at Risk (VaR) is the maximum loss not exceeding a given probability defined at the confidence level, over a given period of time.

Conditional Value-at-Risk – Conditional Value-at-Risk is defined as the mean of the loss α-tail distribution. CVaR is derived by taking a weighted average between the VaR and losses exceeding the VaR.
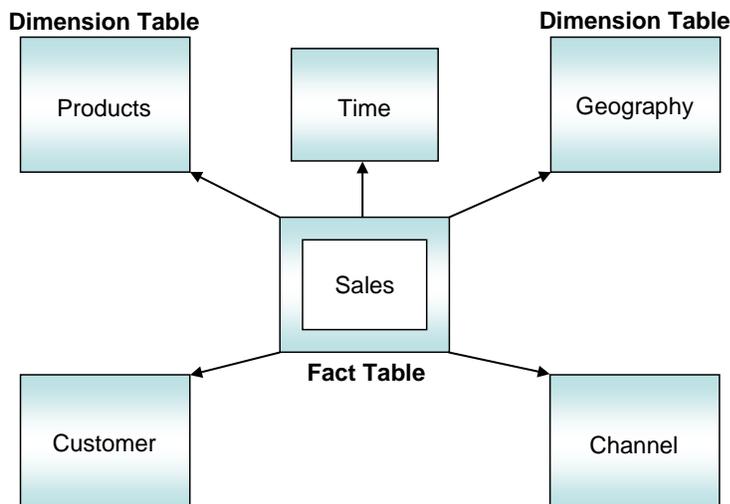
Expected and Unexpected Loss - The expected loss is the mean annual aggregate loss, and the unexpected loss is the annual aggregate loss in excess of this mean, up to a particular confidence level (say, 95 or 99 per cent confidence). The following diagram gives a detailed explanation of Expected and Unexpected loss:
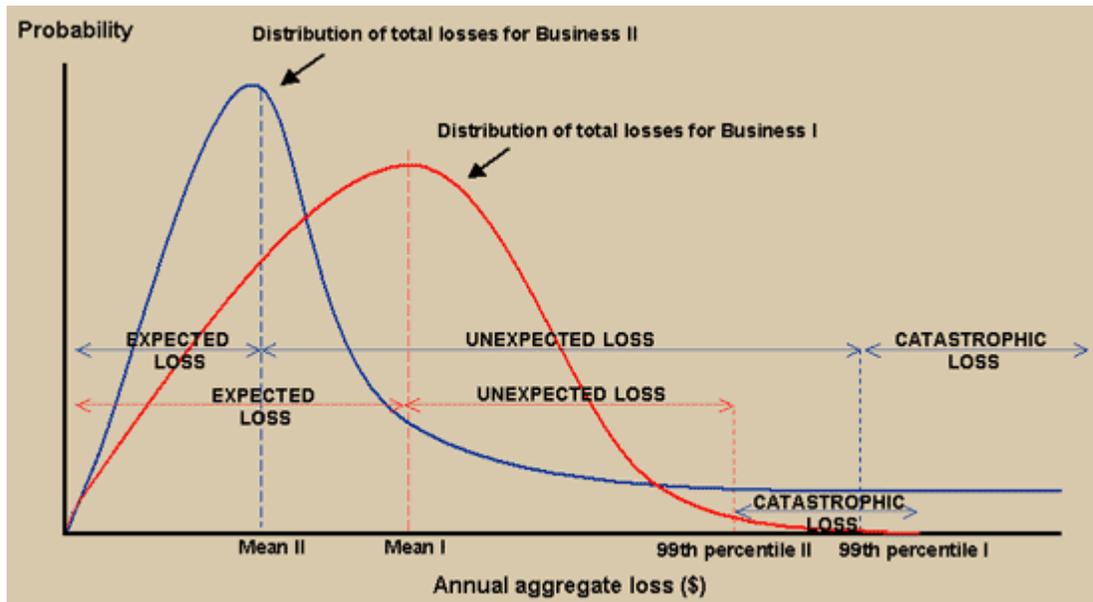
Figure 23: Expected and Unexpected Loss

Data Model- is a logical map that represents the inherent properties of the data independent of software, hardware or machine performance considerations. The data model consists of entities (tables) and attributes (columns) and shows data elements grouped into records, as well as the association around those records.

Dataset - It is the simplest of data warehouse schemas. This schema resembles a star diagram. While the center contains one or more FACT tables, the points (rays) contain the dimension tables as represented in the following diagram:

Dimension Table   **Dimension Table**

```
┌──────────────┐      ┌──────────────┐      ┌──────────────┐
│   Products   │      │     Time     │      │   Geography  │
└──────────────┘      └──────────────┘      └──────────────┘

                      ┌──────────────┐
                      │    Sales     │
                      └──────────────┘
                         Fact Table

┌──────────────┐                            ┌──────────────┐
│   Customer   │                            │   Channel    │
└──────────────┘                            └──────────────┘
```

Figure 24: Data Warehouse Schemas

Metadata – A term used to denote data about data. Business metadata objects are available in the form of Measures, Business Processors, Hierarchies, Dimensions, Datasets, Cubes, and so on. The commonly used metadata definitions in this User Guide are Hierarchies.

Star Schema: In a star schema, only one join is required to establish the relationship between the FACT table and any one of the dimension tables which optimizes queries as all the information about each level is stored in a row. The set of records resulting from this star join is known as a dataset.

Hierarchy – A tree structure across which data is reported is known as a hierarchy. The members that form the hierarchy are attributes of an entity. Thus, a hierarchy is necessarily based upon one or many columns of a table. Hierarchies may be based on either the FACT table or dimensional tables.

Measure - A simple measure represents a quantum of data and is based on a specific attribute (column) of an entity (table). The measure by itself is an aggregation performed on the specific column such as summation, count or a distinct count.

Business Processor – This is a metric resulting from a computation performed on a simple measure. The *computation that is performed on the measure often involves the use of statistical, mathematical or database* functions.

Advanced Analytical Infrastructure – The Oracle Operational Risk Economic Capital Modeling Environment performs estimations for a given input variable using historical data. It relies on pre-built statistical applications to build models. The framework stores these applications so that models can be built easily by business users. The metadata abstraction layer is actively used in the definition of models. Underlying metadata objects such as Measures, Hierarchies, and Datasets are used along with statistical techniques in the definition of models.

Additional Things to Remember:

The current version of OREC application supports two different approaches for modeling Scenario Severity.

Bound Based: During this approach, the severity data is modeled similar to those of loss data. The dropdown consists of all the distributions of severity distribution except EVT and Empirical.

Formula Based: Usage of this approach, the scenario data is modeled with respect to the available formula. The conversion of formula based approach to bound based can be done in a tool matrix; the resulting effects can be viewed in the front end for scenario data severity.

Tab Level Validation: UI can be modified for tab level validation or model level validation.

During tab level validations, the value input is validated for its feasibility before moving to the next tab.

```
<TABLEVELVALIDATIONS>TRUE</TABLEVELVALIDATIONS>
<!-- This field is used to control the tab level validations. If required value should be TRUE else FALSE.If it doesnot
contain value or is not give tab level validatin will be enforced  -->
<CURRENCYHIERCODE />
<!-- This tag is specifies currency hierarchy to be used to display values for reporting currency  -->
- <SCENARIOPARAMESTIMATIONTYPE>
```

Insurance Allocation Factor: If insurance allocation factor is selected as **Yes**, then the allocation percentage is expected as a download.

Number of Buckets: The number of buckets for the simulated values should be edited in the config xml. Refer to the screen shot pasted below:

```
<NUMBER_OF_BUCKETS>10</NUMBER_OF_BUCKETS>
<POPULATE_SIMULATION_TABLE>Y</POPULATE_SIMULATION_TABLE>
<UPD_SANDBOX_RSKEY>SELECT MAX(DIM_RUN.N_RUN_SKEY) FROM DIM_RUN WHERE F_HISTORICAL = 'Y' AND DIM_RUN.FIC_MIS_DATE
   = $MISDATE</UPD_SANDBOX_RSKEY>
- <CURRENCY_CONVERSION>
  - <DATA_TRANSFORMATION>
```

Populate Simulation Table: The simulated values should be populated based on the settings in the config. If this is remarked as **Yes**, then the simulated values will be updated in **fct_ Operational Risk Economic Capital _simulation** table.

Hierarchy code dropdown: The hierarchy filter code for internal and external classification has to be specified in config xml.

```
- <HIERARCHY_FILTERS>
  - <HIERARCHY>
     <HIERARCHY_CODE>HLOB003</HIERARCHY_CODE>
     <HIERARCHY_DESC>INTERNAL OR EXTERNAL</HIERARCHY_DESC>
    + <HIERARCHY_NODES>
```

Annexure C: Error Messages and Observations

Error Messages: Functional Error Messages that may appear in OREC application are displayed in the following table. Through this table any additional help or suggestive actions to be taken when an error is displayed is provided:

MSG IDENTIFIER	MSG DESCRIPTION	Suggested Action for End user
12	Error: Login Failed for	Check the login name and password.
220	Time Bucket Generation Failed: No Time Bucket found	Ensure that time buckets are defined properly and data falls within these time buckets.
143	Frequency Modeling Failed	This mainly occurs as data does not follow distribution. This is usually seen as a very large or negative parameter value or inability to estimate them as well. Check the distribution and time buckets. However, sometimes this error may be displayed due to data irregularities or if data exists but does not comply with the time buckets.
225	Could Not Fetch Data	This may be due to failure of connection to database.
226	No Data Returned by Query	Since one or more filters applied does not return any data check, the model definition, and data as well.
227	Frequency Modeling: Number of Data Points is less than 5. OFSAA Frequency Modeling Module requires minimum 5 data points	Frequency modeling needs minimum five data points (buckets). If not present, the model fails. Check the data and time buckets defined.
228	Frequency Modeling: Failed to Compute Mean and Variance in Adaptive Method Selection	This mainly occurs as data does not follow distribution. This is usually seen when there is a very large or negative parameter value or inability to estimate them as well. Check the distribution and time buckets.
230	Frequency Modeling: Failed to Compute Number of Trials	This means in case of Negative Binomial or Binomial the OREC application is unable to calculate N. Check if distribution selected, data and time buckets are defined.
231	Frequency Modeling: Number of Trials cannot be Negative	This means in case of Negative Binomial or Binomial N is negative. Check if distribution selected, data and time buckets are defined.
232	Frequency Modeling: Failed to Compute Number of Failures	Check if distribution selected, data and time buckets are defined.
233	Frequency Modeling: Number of Failures cannot be Negative	Check if distribution selected and data is proper and time buckets are well defined.
234	Frequency Modeling: Unable to estimates the Parameters for the Fitted Distribution within permissible range.	This mainly arises due to force fitting. Check the distribution selected or modify the time bucket definition.
235	Frequency Modeling: Variance is Zero, so the Data cannot be fitted for the Distribution Type.	When all the data points are of the same value, variance will be zero. Check or modify the data as well as time buckets defined.
237	Failed to calculate EDA Outputs in Frequency or Severity Modeling	Failure of statistics like Mean, Variance, Kurtosis and Skewness for either frequency or severity modeling. Review the data, Goodness of Fit and how good the fit is.

MSG IDENTIFIER	MSG DESCRIPTION	Suggested Action for End user
241	Goodness of Fit test failed	Failure of goodness of fit test indicates that data does not follow the specified distribution. Check or alter the distribution selected or time buckets.
242	After BECIF adjustment, Scale Parameter (Probability) is not within the range 0 to 1	Check or modify BEICF parameters.
243	Failed to generate the CSV Report file.	Check write permission on specified folders.
244	Mean cannot be Null or Zero for the given distribution	Review the data points for further actions.
245	The mean cannot be less than variance for the given distribution type	Review the data points or distribution selected for further action.
246	The Mean or Variance cannot be null or zero	Review the data points for further action.
247	The mean cannot be greater than variance for the given distribution type	Review the data points or distribution selected for further action.
248	The Data is not following the given Distribution Type	This is usually seen as very large or a negative parameter value or inability to estimate them. Check the distribution and time buckets.
249	Variance is zero, so the data cannot be fitted for the given Distribution Type	This happens if all the data points have the same numerical value. Check the data points.
250	Relevant Event Type or LOB Data not found in the Dimension tables.	Check the LOB / ET dimension table.
251	At any given percentile data doesn't follow specified distribution. The data is not constant as per EVT modeling	This happens when you select **Calculate** for EVT threshold. If at any percentile value *Mean* is not greater than or equal to the *Variance* this message is displayed. Either change the buckets or select **Specify EVT threshold** option. While specifying the threshold value it should be above 50%.
254	No Relevant RGs have data. Cannot proceed further	Self Explanatory
255	Input values for Scenario Severity Modeling cannot be Null or Zero	Update stage scenario data and scenario severity details as required.
256	Parameter percentile value in formula based approach is less than 4. Hence calculation for Log Normal Distribution has failed	Provide percentile value as greater than 4.
257	Parameter percentile value and median value in formula based approach cannot be same	Self Explanatory
258	Parameter percentile value in formula based approach is 0 or 1. Hence calculation for Weibull or Exponential Distribution has	Self Explanatory

MSG IDENTIFIER	MSG DESCRIPTION	Suggested Action for End user
	failed	
260	EEL Threshold is less than EEL Deductible.EEL Threshold has to be greater than EEL Deductible Amount	Self Explanatory
262	Aggregate Threshold is less than EEL Deductible.EEL Threshold has to be greater than Aggregate Deductible Amount	Self Explanatory
263	The Correlation Matrix is a Zero Correlation Matrix. This type of matrix is not valid	Check correlation value in the dependency matrix table. Check for the condition if values are not uploaded.
264	The given data does not suffice the condition to form a Correlation Matrix	When RG1 say ET-3, LOB-4 has correlation value of 0.5 then matrix approach requires that LOB-4, ET-3 also has value 0.5. If this is not the case then matrix preparation fails. Also if data has 4 RGs and correlation data is available only for 3 RGs then the matrix generated will not suffice. Check or modify the correlation values.
265	The Correlation Matrix is not available even though the Loss Data is available for it.	Update the stage dependency matrix for the correlation value.
266	Unable to convert the Semi Definite of the User Specified Loss Correlation Matrix	For (Gumbel) copula, non-zero positive values of correlation are required. Update the same in the dependency matrix table.
269	Failed to convert Semi Definite of the Loss Correlation Matrix	For Gumbel copula, non-zero positive values of correlation are required. Update the same in the dependency matrix table.
270	Failed to convert Semi Definite of the Scenario Correlation Matrix	For Gumbel copula, non-zero positive values of correlation are required. Update the same in the dependency matrix table.
271	Negative association between the RG's. Hence Gumbel Copula failed	For Gumbel copula, non-zero positive values of correlation are required. Update the same in the dependency matrix table.
272	The correlation value between RG's is greater than 1. Hence Gumbel Copula failed	For Gumbel copula, non zero positive values of correlation which are less than 1 are required. Update the same in dependency matrix table,
273	Correlation value between the RG's cannot be 1 or more than 1	Check the Correlation values.
274	Theta computed is less than 1. Hence Gumbel Copula failed.	For Gumbel copula, non-zero positive values of correlation which are less than 1 are required. Update the same in the dependency matrix table.
275	The correlation matrix is null. So the theta cannot be computed.	Check the Correlation values in dependency matrix table.
277	Copula could not be generated for the given Copula type	Copula failure occurs either due to improper or insufficient correlation values. Check the values in the dependency matrix table.

Table 9: Error Messages

Some peculiar observations are noted as follows:

Observation	Suggested Action for the End User
All simulated scenario severity values are the same.	It is expected that even though due to value restrictions, frequency in simulations can be repeated, severity values sampled should be different totaling to different sum of values for each sampling.
For example: for a given RG, whenever a particular frequency, say 194 repeats. Gross loss value is also repeating.	Increase the threshold of the single largest severity value in the FACT reporting group input table to get different gross values.

Table 10: Peculiar Observations

Annexure D: GENERATING DOWNLOAD SPECIFICATIONS

Data Model for Operational Risk Economic Capital is available on customer request as an ERwin file.

Download Specifications can be extracted from this model. Refer the whitepaper present in OTN for more details.

Acronyms and Glossary Terms

BEICF	Business Environment and Internal Control Factors
BSP	Business Solution Packs
DT	Data Transformation
EDA	Exploratory Data Analysis
EL	Expected Loss
ET	Event Type
EVT	Extreme Value Theory
LDA	Loss Distribution Approach
LOB	Line of Business
RG	Reporting Group
Standard Reporting Group	The LOBs and ETs defined by the bank can be different from those prescribed by the Regulator which is referred as the Standard Reporting Groups.
UL	Unexpected Loss
VaR	Value at Risk

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ORACLE®

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