Bank of China New York Branch
Model Risk Management Procedure

Enterprise Risk Management

February 2021

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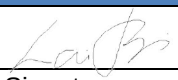
Maggie Lai SVP, Head of Enterprise Risk Management	 Signature	2/2/2021 Date

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1. Executive Summary

Implementing the Bank of China New York Branch and its satellite branches (collectively "BOCNY") Model Risk Management (MRM) Policy, "Procedure" used in this context is broadly defined to include mandates, practices, active definitions, and functions that are intended to provide greater details with regard to how the policy requirements will be satisfied by BOCNY. While attempting to provide greater specificity, the procedures are not unduly specific as that imposes constraints where general flexibility is both internally desirable and implicit in regulatory expectation. In contrast with policy statements, procedures reflect current capabilities and practices and are expected to be updated as they evolve.

1.1. Purpose

The procedure in this document describes how MRM related statements and requirements outlined in the MRM Policy are understood, interpreted, implemented, and satisfied within the context of the BOCNY's business activities and organizational structure.

1.2. Scope

The MRM Procedures are developed and maintained by Enterprise Risk Management and applicable to all the models used by BOCNY.

The boundary separating in scope versus out of scope models and non-models is set by the definition of a model (Refer to MRM Policy).

The procedure described in this document covers all MRM aspects outlined in the MRM Policy. The major components that are essential to link all phases of MRM, namely: "Model Risk Governance", "Model Inventory Management", "Model Development, Implementation, Monitoring and Use" and "Model Validation".

1.3. Procedure Governance

Overall MRM Approval and Escalation Framework

Enterprise Risk Management department (ERM-MRM) creates and owns this MRM Policy. This policy is reviewed and approved by Operational Risk Committee (ORC) and ultimately by Risk Management and Internal Control Committee (RMICC). ORC approves MRM procedure, model inventory change and MRM exceptions. Model validation results, and any model risk reporting/escalation will be reported to ORC, and the RMICC will be end pointing for MRM escalations if necessary (e.g. if they remain unresolved).

Risk Management and Internal Control Committee (RMICC)

The RMICC is a management-level committee of BOCNY with responsibility for overseeing risk management practices of the Branch as final escalation point for model risk. The RMICC reviews and approves the Branch's major risk management and internal control policies and procedures. In addition, the RMICC implements the instructions and decisions of the USRMC with regard to model risk management, and reviews and approves MRM Policy at least annually.

Operational Risk Committee (ORC)

The Operational Risk Committee (ORC) is a subcommittee of the Risk Management and Internal Controls Committee (RMICC). ORC reviews and approves MRM Procedure, model inventory change and MRM exceptions. A list of model risk reporting item to ORC is defined in *section 2.4*.

Related Policies and Procedures

In order to strengthen the model risk management practices of BOCNY, this Procedure should be read in conjunction with other BOCNY's policies which are developed in accordance with the OCC Guidelines Establishing Heightened Standards and other related regulatory guidance. Other related policies include but are not limited to:

- Bank of China US Branches Risk Governance Framework
- Bank of China US Branches Operational Risk Management Policy
- Bank of China US Branches Model Risk Management Policy
- Bank of China US Branches Data Governance Policy
- Bank of China US Branches Key Risk Indicator Procedure
- Bank of China US Branches Bulk Purchase Review Committee (BPC) Policy
- Bank of China Third Party Risk Management Procedure

2. Model Risk Governance

2.1. Model Definition

The term "Model" refers to a method, system or approach that applies statistical, economic, financial or mathematical theories, techniques, and assumptions to process inputs to quantitative or qualitative outputs. As defined in MRM Policy, A model consists of three components:

- An **input component**, which delivers assumptions and data to the model;
- A **processing component**, which transforms inputs into estimates and is associated with certain level of uncertainty;
- An **output and reporting component**, which translate the estimates into useful business information. Although most models are quantitative in nature, model inputs and outputs can also be qualitative (such as expert judgement);

To provide guidance for MRM stakeholders to understand model vs non-model, a questionnaire is designed to inform the decision making and thought process. The questionnaire is listed in Table 1: the "Yes" for question "1" ensures the tool has official usage in the Bank's activities, the "Yes" for question "2" ensures the tool involves certain level calculation or logics and the "Yes" for question "3" essentially makes the distinguish between "tool" and "model" – compare with "tool", "model" is based on business or quantitative assumptions, therefore includes uncertainties. So when all three answers are "Yes", we could firmly decide that the "tool" can be classified as a "model", however the exceptional cases could happen, and final decision will be made by ERM-MRM.

Table 1: Questionnaire for Model or Non-Model

No.	Question	Answer
1	Does the tool have one or multiple usages from following list: • Analyzing business strategies • Informing business decisions • Identifying and measuring risk • Valuing exposures, instruments or positions • Conducting stress testing • Assessing adequacy of the capital[1] • Managing client assets • Measuring compliance with internal limits • Maintaining the formal control apparatus of the bank • Meeting financial or regulatory reporting requirements and issuing public disclosures	"Yes" or "No"
2	Does the tool involve any statistical, economic, financial, mathematical theories or computational technics?	"Yes" or "No"
3	Does the tool involve any business, quantitative assumptions or uncertainties?	"Yes" or "No"

Given a model candidate and associated information provided by potential Model Owner or MRM stakeholder, ERM-MRM will make the final propose on Model vs Non-Model, the process is called Model Assessment; and the result will be approved by ORC.

[1] Currently there is no capital requirements for BOCNY

2.2. Roles and Responsibilities

As recognized in the MRM Policy, the MRM roles fall into three broad categories following the three lines of defense framework as outlined below:

1) **First Line of Defense- Model Owner, Developer, Implementer and User**
   - Model Owner serves as 1st line of defense in managing model risk, no matter which departments they belong to. Model Owner is ultimately accountable for all aspects of the model risk that may arise through the model lifecycle. Each model should have one department as Model Owner. The responsibilities of model owner naturally go to department head, and department head can delegate to another person (VP above) who is qualified to conduct the functions as behalf of Model Owner;
   - Model User is generally the business or control function that relies on the model's output and has accountability for working with the Model Owner to ensure proper model use;
   - Model Developer and Model Implementer can be either the same party or different ones. Both roles are responsible to the Model Owner in ensuring that the model is theoretically sound and well implemented with proper controls and clear understanding of its limitations;
2) **Second Line of Defense- Model Risk Governance and Validation**
   - Enterprise Risk Management ERM-MRM owns MRM framework. This includes all functions involved in identifying, assessing, mitigating, monitoring, and reporting on model risk as per MRM policy and procedures. There are typically two sets of roles with tight interconnectivity but slightly different areas of focus: model risk governance and model validation;
3) **Third Line of Defense- Internal Audit**
   - Internal audit periodically assess the design, effectiveness and sustainability of the MRM framework;

The **RMICC** is a management-level committee of BOCNY with responsibility for overseeing risk management practices of the Branch, which proves MRM Policy and serves as the final decision-making authority for escalated model risk issues. The ORC is a subcommittee of the RMICC. **ORC** reviews model risk reporting and advises on escalated issues before RMICC.

Table 2: Roles and Responsibilities in MRM framework

Role	Responsibilities
Model Owner	• Coordinate with all MRM stakeholders and be responsible for the entire model life cycle • Be responsible for submitting the model submission package in line with the requirements defined by BOCNY MRM procedure, also listed in the *Model Submission section*. • Coordinate with different MRM roles to remediate internal (e.g. Model Validation and Internal Audit) and external (e.g. Regulators) findings • Coordinate with Model User to monitor model performance and report issues to MRM • For Head Office models, there should be a local model owner assigned to fulfill model owner's responsibilities
Model Developer	• Conduct model development and improvement activities under the directions of Model Owner with qualified skills for the specific model • Models could be developed by internal model developers, external vendors or Head Office (HO)
Model Implementer	• Establish an infrastructure and control process/testing to ensure the model functions properly • Ensure the data and output integrity through the related systems

Model User	• Assume responsibility in using the model and interpreting the model outputs for appropriate business purpose • Participate the ongoing monitoring to ensure the appropriateness of model use in specific business area
Enterprise Risk Management-Model Risk Management function	• Develop, implement and maintain the MRM framework for BOCNY, including governance, policy and procedure • Conduct model identification, model review and model validation • Define model risk metrics and provide regular model risk reporting to Senior Management • Address relevant issues raised by internal audit and external regulator
ORC	• Review model risk report and address escalated issues • Approve MRM Procedure, model inventory change and MRM exceptions
RMICC	• Perform as a decision making channel for model risk management stakeholders to approve MRM Policy, and perform as final decision making authority for escalated model risk issues • Review MRM RAS KRI breaches
Internal Audit	• Verify the consistency between MRM activities with MRM policy and regulatory requirements • Verify MRM framework is well designed, effectively implemented and sustainably maintained

2.3. Model Risk Exception and Escalation

MRM Exception Process

Breaches to the MRM policy and procedure are referred to as exceptions, which need to be monitored, reported and escalated. Such exceptions include but not limited to the following:

- Breach of the new model validation requirements, i.e. new model goes into production without MRM validation and approval
- Breach of the model inventory attestation requirements, i.e. knowingly omitting one or more models
- Breach of the finding resolutions requirements, i.e. missing the resolution due date without taking prompt corrective actions
- Breach of the model monitoring requirements, i.e. failure to carry out model monitoring plan
- Delay in critical model validation

The exception approval process contained in this Procedure aligns with the requirements described in BOCNY's Policy on Risk Policies. Exceptions to this Procedure must be justified in writing, be presented to and require the approval of ORC. The decision to grant an exception should be documented along with a discussion of the business reasons for the exception.

Documentation of requests and approvals for exceptions to Risk Policies must include, at a minimum:

- The nature of the exception requested
- The individual or group that is requesting the exception
- Model risk exposure (in frequency and amount when applicable)
- The time period during which the exception is effective
- The business reasons for granting the exception
- Mitigating factors
- Planned remediation and closure of the exception, if an effective period is provided

Upon discovering any exceptions, ERM-MRM will conduct an impact analysis and/or a root cause analysis, and based on which, recommend action plans. Facts, analysis, conclusions, and recommendations from ERM-MRM shall be documented into a memo and reported to ORC as well. MRM's reports need to include following items as minimum requirements:

- A description of the exception, which shall clearly identify the responsible party (a group, a department, or a person), the time and duration of the exception, and, if applicable, the contingency action taken to mitigate the risk or contain the impacts;
- The severity of the exception, which could be based on the following criteria:
  - The model risk tier, or model materiality level;
  - The nature of the exception;
  - The impact and the scope of the exception
- A root cause analysis and conclusions;
- A proposed action plan agreed with the responsible parties

MRM Escalation Process

Upon MRM exception request initiated, ERM-MRM will notify ORC and submit the relevant reports/memo described above for ORC's review. ORC either resolves the escalated issue or to further escalate to RMICC.

2.4. Model Risk Reporting

Model risk may be measured for **individual** model and at **aggregated** level. As such, both the source and the magnitude of model risk shall be identified, measured, monitored, and reported to ORC and RMICC for review or approval. The approval items need to be approved by the appropriate committee, however the reporting items will be reported as needed. The reporting items include but not limited to the items listed in Table 3.

Table 3: Model Risk Reporting Items

Category	Reporting Item	Monitoring Frequency	Reporting Frequency			
			ORC		RMICC	
			Reporting /Approval	Frequency	Reporting /Approval	Frequency
Inventory	Up to date **model inventory**, and model Inventory change (including model vs non-model change, model Tiering changes happened in past month)	As needed	Approval Item	As needed	Reporting Item	As needed
Governance	MRM Policy and Procedure updates	Annual and as needed	MRM Policy – Approval Item MRM Procedure – Approval Item	As needed	MRM Policy – Approval Item MRM Procedure – Reporting Item	As needed
Governance (RAS-KRI)	Number of models in production without any model risk control in place.	Monthly	Reporting Item	Monthly	Reporting Item[2]	Quarterly
Governance (Non RAS-KRI)	Number of models in use with exception permission.	Monthly	Reporting Item	Monthly	Reporting Item	Quarterly

[2] This RAS KRI is also reported to USRMC on quarterly basis according to BOCNY KRI Procedure

Governance (Non RAS-KRI)	Number of models in use without ongoing performance monitoring	Monthly	Reporting Item	Monthly	Reporting Item	Quarterly
Validation (Non RAS-KRI)	Number of past due high risk model validation findings	Monthly	Reporting Item	Monthly	Reporting Item	Quarterly
Governance	Significant breaches during model ongoing monitoring process	As needed	Reporting Item	As needed	Reporting Item	As needed
Validation	Model validation **annual plan** and adjustments according to validation progress and priority changes in past month	Annual and as needed	Approval Item	Annual and as needed	Reporting Item	Annual and as needed
Validation	Model **validation results** (in past month) and key findings	As needed	Reporting Item	Quarterly	Reporting Item	Quarterly
Validation	**Finding Statistics** • By category and risk level • Aging report	Monthly	Reporting Item	Quarterly	Reporting Item	Quarterly
Validation (Non RAS-KRI)	Number of past due high risk open model validation findings.	Monthly	Reporting Item	Monthly	Reporting Item	Quarterly
Validation	Model owner's **acceptance of the risks** associated with a model validation finding without any plan to remediate	As needed	Approval Item	As needed	Reporting Item	As needed

Overall, for RAS and Non-RAS KRIs, we follow the BOCNY KRI Procedure. Accordingly, the monitoring and reporting frequency are listed in Table 3 above; in case any breach happens –

For RAS KRIs - Breach will be reported to ORC, RMICC and USRMC (notify relevant parties within 2 business days, submit limit breach memo within 15 business days);

For Non-RAS KRIs - Breach will be reported to ORC and RMICC (notify relevant parties within 5 business days, submit limit breach memo within 20 business days);

3. Model Inventory Management

3.1. Model Inventory

A bank-wide model inventory is established and maintained by Enterprise Risk Management ERM-MRM. This inventory should include all models that currently meet or have historically met the definition of a model as per the MRM policies and procedures. The model inventory covers models in various lifecycle stages but not limited to proposed, in development, in implementation, pending validation, in production, and retired. A robust model inventory system enables transparent management reporting framework and prioritization of model validations tasks in accordance with the standards outlined in SR11-7.

Guidelines regarding the scope of descriptive information to be captured in the model inventory for each model and its associated use(s) are highlighted below:

- Quantitative systems deemed to be non-models, as submitted to the Model Validator for assessment, are tracked in the inventory
- Each department has its portion of the model inventory verified on an annual basis
- For each model and its associated use, the following information (at minimum) must be stored in the inventory -
    - Model name
    - Model tier
    - Model description
    - Version number (if applicable)
    - Functional area
    - Model Owner
    - Description of the specific business use
    - Description of the model outputs
    - Deployment status (*In Development, In Production, etc.*)
    - Name of production system/platform and the respective vendor name (if applicable)
    - Date of the most recent independent validation and status of the next planned validation
    - Log of model change notifications provided by the Model Owner
    - Model usage restrictions – Assumptions/Limitations
    - Model governance policy exceptions (if applicable). Includes temporary approvals, overdue validation, findings remediation actions, and policy non-compliance events
    - Expected model lifespan (timeframe over which model is expected to remain valid or in use)
    - List of key data inputs and their sources

Before being used in production, all new models or “model changes” need to be approved or conditionally approved by MRM. In case required by business priorities and urgencies, exception permission can be granted for temporary model use before the completion of model validation. Model risk controls and monitoring mechanisms must be set up by model owner during the exception permission period.

- **For Tier 1** new models or according “model change”, exception permission must be requested by the model owner and **approved by RMICC**
- **For Tier 2 and Tier 3** new models or according “model change”, exception permission must be requested by the model owner and **approved by ORC**

The exception permission period varies by model tier:

- Tier 1 models could be used no longer than **6 months** under exception permission
- Tier 2 and Tier 3 models could be used no longer than **12 months** under exception permission

Models used under exception permission have to be formally validated and approved by MRM for continuing use beyond the exception permission period.

3.2. Model Attestation

Each department within the Bank is required to undergo an annual model inventory attestation process to ensure that the model inventory is complete and accurate. In order to perform the annual attestation process (led by ERM-MRM), the MRM stakeholders are required to complete the following activities:

- Verify that the list of models, associated uses, and inventory characteristics are complete and accurate;
- Verify that inventory records contain all required model inventory data elements (e.g. deployment status, owner name, etc.);
- Verify that quantitative systems previously classified as non-models are still appropriately classified as such;
- Verify that the model risk tier is accurate;

Discrepancies uncovered during this process should result in each stakeholder taking appropriate actions to bring the inventory up to date.

ERM-MRM facilitates the annual inventory attestation process by providing available MRM inventory reports to each department and collecting the relevant updates. Each department within BOCNY has the responsibility to fully disclose any potential models they own or use in their business. ERM-MRM will update the model inventory based on this information from departments and fully assess every model candidate and provide final model inventory list for ORC's approval.

Besides the Model Attestation, ERM-MRM also participates the new product approval process on ongoing basis to ensure any potential new models involved in new product could be assessed timely by ERM-MRM.

3.3. Model Tiering

Model Risk Tiering is an approach commonly employed to indicate the magnitude of inherent model risk. Here in BOCNY, we propose a qualitative approach to calculate model tiering considering following perspectives:

- **Model Materiality**: the materiality is usually measured based on *exposure and impact* of the model, either quantitatively or qualitatively
  Exposure and Impact are used to measure the size of the portfolio, P&L and balance sheet line item etc. that the model directly related to. When identifying the metrics for measuring exposure and impact, the following are considered –
    - Metrics may vary with the model type;
    - The model exposure and impact are comparable with similar type of models within the Bank;

Examples by different model type could be:

Table 4: Materiality factors

	Exposure and Impact
Credit Risk Model	% of total Bank's portfolio, specific sector's portfolio, or % of RWA
Market Risk Model	Impact on VaR, SVaR, % P&L
Pricing Model	# of Trades, MTM or Notional (depends on product)
Compliance Model	Business Judgement (usually measured as "High" by default)
Other	Business Judgement

- **Business Reliance**: In addition to the materiality which is easily quantified. The types of risk the model is exposed to, also includes how material the model outputs are on business and risk management decisions, how the model is interconnected with other models. Whether the model is relevant to regulatory, compliance, financial and legal risks. Such qualitative factors are important to consider however usually not captured by the materiality measurements

Table 5: Business reliance factors

Business Reliance Factor
Financial Statement
Regulatory Risk
Internal Management
Legal/Compliance Risk
Model Interdependence

- **Model Complexity**: this is an overlay item on top of above two. Usually the two factors leads to the level of model complexity, uncertainty of model inputs, and the complexity of model theory.

Table 6: Model Complexity factors

	Description
Complexity of Theory	If the model relies on strong assumptions, complex statistical and mathematical theory, such as stochastic process, heavy calibrations, new algorithms or theories not widely used, likely indicates the model complexity is high.
Uncertainty of Inputs	If the model inputs are not market observable, relying on external proxy date or business assumption, naturally indicates the model complexity is high.

The model tier could be adjusted upwards for certain notches given considering model complexity.

For each model in model inventory, the Model Owner will propose a model tier given above guidance, and ERM-MRM will decide and periodically re-assess the final model tier.

To use this approach, we have 2 steps to finish a model tiering process:

Step 1: using a metrics to capture "**Model Materiality**" and "**Business Reliance**"

Table 7: Example of Tiering process

Inherent Model Risk Level		Model Materiality		
		High	Medium	Low
Business Reliance	High	Tier 1	Tier 1	Tier 2
	Medium	Tier 1	Tier 2	Tier 3
	Low	Tier 2	Tier 3	Tier 3

Step 2: given the tiering result we got from step1, we also want to provide overlay considering the "**Model Complexity**", such like how complex of the theory, how uncertain the model inputs are and how strong the model assumptions are etc.

It is the responsibility of the Model Owners / Users to inform ERM-MRM of all changes to the model that may impact the risk tier.

Overall ERM-MRM needs to reassess model risk tier in but not limited to following situations:

- Whenever a change in the market performance, business environment, including a change in the portfolio size is detected as part of the ongoing model risk and performance monitoring provided to the Model Validator by Model Owners
- As part of the annual model inventory attestation
- As part of the independent validation
- As part of the annual review
- Whenever there is a change in the model or its use

3.4. Annual Model Review and Planning

As a key model risk management process, **model review** shall be carried out on an annual basis. The annual model review happens in the beginning of each year based on model inventory attestation results achieved in the prior year. The annual model review focuses on, but not limited to following items:

- Review and assess any model changes
- Reassign model tiering (if necessary)
- Review and assess model ongoing monitoring results
- Review and assess model validation findings remediation status

Given the results of annual model review, ERM-MRM will perform an **annual validation planning**. As long as a revalidation is completed in the same calendar year as it is planned, compliance to the revalidation requirement is considered met. When performing annual validation planning, the following factors need to be considered:

- Model validation shall be prioritized with considerations of model risk tier and model validation type, the revalidation frequency is shown as below

Table 8: Revalidation frequency

Tier	Revalidation Frequency

Tier 1	Every 1 year
Tier 2	Every 2 years
Tier 3	Every 3 years

- General rule is that- for Tier 1 model, 1 FTE with 8 weeks; Tier 2 model, 1 FTE with 6 weeks, and Tier 3 model with 4 weeks

The annual plan needs to be approved by ORC in the beginning of the year, and regular progress according to plan will be reported to ORC. In case any changes or delays on the plan, the ERM-MRM will make sure the rationale is fully communicated to ORC and achieve agreement.

4. Model Development, Implementation, Monitoring and Use

Model development and implementation represents the first point where model risk can be introduced into an organization due to the pervasive and long-lasting impact that design and implementation decisions can have. These risks are present in the development and implementation of both new models and existing ones. To actively manage model risk within BOCNY, model development and implementation activities must be governed by this procedure.

4.1. Model Development and Implementation

Model development process shall be implemented effectively to control the entry point of model risk. Commensurate with the model risk tier, Model Developer and Implementer shall follow the requirements below in the practice of model development and implementation.

It is the responsibility of the **Model Developers** to design robust and stable models using a structured approach, sound techniques, industry-accepted methodologies and extensive testing. Specific model development process could vary, however the model development documentations standard is formalized and defined by ERM-MRM and listed in Table 10. The **Model Owner** will ensure the up-to-date comprehensive and detailed development documentation is created and updated for each model consistent with the model submission requirements and standards in Tables 9 and 10.

Once the models are developed or vendor models are acquired, they are implemented into a production environment that will be accessible to Model Users on an ongoing basis. Each department must follow formal procedures for ensuring computational accuracy, stability, and operational integrity of all model production applications (including excel, internal developed system or vendor system etc.)

Model Implementer must follow formal, structured, and rigorous processes to ensure that production implementations of internally developed models, as well as acquired vendor models, are computationally accurate and, if applicable, consistent with the development specifications. The term “implementation” refers to the process of encoding the approved model specification for production usage, and is not equivalent to final deployment of the model for production use. Such deployment can only occur after the model has gone through independent model validation and approval process. The relevant model validation on implementation will cover the following evidence, but not limited to the following:

- Production Application Testing
- Operational Controls
- Production Application Documentation

The **Model Owners** will ensure the implementation information is well documented in compliance with the model submission standards in Table 9.

Model Submission Requirements for Model Validation

Based on whether the model validation is related to the introduction of a new model, changes or revalidation of an existing one, the following items are typically expected in the model submission package. (Refer to MRM Policy for the validation types)

Table 9: Model submission requirements

Item	Baseline Validation	Target-Scoped	Revalidation
Model Information	Model basic information including the following: • Model description • Model owner • Model user • Model type • Model lifecycle status • Model risk tier and rationale	Same as Baseline Validation.	Same as Baseline Validation.
Model Documentation	Model development documentation with contents outlined in Table 10.	Same as Baseline Validation or the original document supplemented by details of model changes.	Same as Baseline Validation or the original document supplemented by details of model changes.
Testing Package	Complete testing data sufficient to enable independent re-performance of testing procedures. Includes all contents listed in Table 11.	The full testing data set and, if there are changes, testing data requested by ERM-MRM. Ongoing monitoring data and analysis if applicable.	The full testing data set and, if there are changes, testing data requested by ERM-MRM; Ongoing monitoring data and analysis.

Model Submission Documentation Standards

Comprehensive model documentation is a key component of the overall control process for building, deploying, and maintaining a model. Documentation facilitates well-controlled use of models, independent review and validation, and training of new staff.

Model Owner – in conjunction with the **Model Developer and User(s)** – is responsible for developing and maintaining comprehensive up-to-date documentation consistent with the guidelines set out below. Besides developing model documentation, the **Model Developers** are responsible for retaining detailed evidence of the development process necessary to support independent review of the model by ERM-MRM. The retained evidence must be sufficiently detailed and comprehensive to allow a third party to independently replicate the development process from start to finish.

The model development documentation details the model research and development process, including testing, data, structure, assumptions, weaknesses, limitations and estimations. To facilitate compliance with the documentation guidelines, ERM-MRM has developed generic documentation templates that are available to all BOCNY personnel. Actual documentation is expected to reflect the unique nature of each business area and each model, which may or may not fit well into the generic template.

The model submission documentation should generally contain the following types of information:

Table 10: Model submission documentation requirements/template

Sections	Requirements
Executive Summary	• Business background and model use • Model Tiering propose and rationale
Business Background	• Business impact and materiality of the model • Model purpose and model use
Development Data	• Model input should be suitable for the model and consistent with the model theory • A comprehensive data governance around modeling data that includes: data ownership, data quality, data relevance, data integrity
Model Methodology and Development	• The model methodology, mathematical specifications, and numerical approximations if any, along with business justifications • Model assumptions and limitations with justifications and impact analysis • Details and justifications for any judgmental or qualitative adjustments • Discussion of alternative methodologies and approaches
Model Output Analysis	• Model outputs need to be fully analyzed and tested to support the model purpose • The testing could include sensitivity testing, benchmark testing etc. depending on the type of model
Implementation	• Description of the implementation process, different system components and their interactions • Evidence of the accuracy of implementation • Areas where model will perform poorly if any
Operational Control	• Overall operational control description including: access control, model recovery if applicable, version control • Model use procedures • Model change management process
Governance and Monitoring	• Model governance description • The ongoing monitoring framework with testing, thresholds, frequency, and escalation process

Testing Package Requirements:

The final model should be subject to rigorous technical testing to ensure that it is conceptually sound, consistent with the user requirements, and performs well. Model Owner needs to submit the testing related information to enable independent re-performance of testing done by model validator. Typical model submission package includes:

Table 11: Model submission-data package requirements

Items	Description
Model Output Testing	

	The testing to support the rationale that the model is suitable for intended use concluded by model owner. The types of testing may vary depending on the types of models. (Refer to later content in this session)
Model Assumption Testing	All the key assumptions need to be tested or justified to prove the immaterial impact on the model performance
Data/Inputs used in Testing	• Testing data and detailed testing procedure • Sample portfolio information (if applicable)

While the exact set of appropriate tests varies significantly from model type to model type, the following represent the typical tests that are frequently used in the industry:

- *Back-testing* – analysis of the model's predictive performance over a historical time period.

- *Statistical validity and model fit testing* (for statistically estimated models) - for example, evaluation of statistical significance and stability of the estimated coefficients, performance of standard statistical test, and analysis of model through in sample and out of sample testing on different population segments and different risk drivers in the model.

- *Benchmarking* – comparison of the model's outputs to those from alternative models or other data sources, including, for example, observable market data.

- *Sensitivity analysis* – assessment of the impact of changes in model inputs and modeling assumptions (e.g., economic inputs, tuning parameters, calculation rules and scenarios) on model outputs. To the extent feasible and applicable, impact of simultaneous changes in multiple inputs and assumptions should be evaluated.

- *Boundary testing / model stressing* – an extension of the sensitivity analysis where the model's response to extreme changes in the inputs and modeling assumptions (e.g., economic inputs, tuning parameters, calculation rules and scenarios) is evaluated. This allows the modelers to map out the ranges of inputs and assumptions wherein the model still produces reasonable outputs.

Vendor Model Acquisition and Implementation

Models developed with third party's assistance or vendor off-the-shelf models should be subject to BOCNY's Model Risk Management Framework following the same standards as applied to internally developed models.

Use of third party models exposes BOCNY to a set of unique risks that must be appropriately mitigated. This includes both the models that are provided by external vendors, as well as models developed by the Bank of China Head Office and used by BOCNY. Prior to scheduling an independent validation by ERM-MRM, the designated Model Owners for a third party model should perform and document assessments and testing of the model sufficient to mitigate these risks. These assessments and documentation should be a part of model owner’s documentation, which is incremental to the vendor-provided documentation and would commonly cover the following areas:

- Prior to model acquisition, perform and document an **assessment of pros and cons** of acquiring the specific third party model versus alternative third party or internal solutions, as well as the evaluation of the consistency of the selected model with the users' business and technical requirements.

- Verify that the model is generally **suitable for the specific use** intended by BOCNY. For example, if BOCNY wishes to use the model to estimate long-term accounting losses on an internal portfolio of commercial loans, the Model Owner must perform an evaluation / testing to confirm that the model is capable of projecting long-term losses, and that the third party's definition of the "loss" is consistent with BOCNY's definition of the accounting loss.

- If feasible, assess the **consistency of the data** used to develop the model (if any) with BOCNY's data that will be used with the model. For example, if the third party developed the model based on the generic industry mortgage data, the Model Owner should assess the consistency of the characteristics of BOCNY's internal mortgage portfolio to which the model will be applied.

- Evaluate the modeling choices, settings, and parameters available within the third party system, and document detailed support for the selected choices / settings.

- Evaluate the model's performance on an ongoing basis. To the extent feasible, the model's performance should be tested on BOCNY's own data to ensure that the third party model is able to capture the idiosyncrasies of BOCNY's portfolio.

Some types of third party models, especially those that model behavior of borrowers, typically need to be adjusted to ensure accurate predictive performance on BOCNY's portfolio (as BOCNY's portfolio may be different from the products for which the model was developed). Many third party models offer users mechanisms to implement such adjustments via "tuning" or "dialing" parameters. The Model Owner must document justification for setting the dials / tuning parameters and support them with results of model performance testing on BOCNY's portfolio.

The assessments and testing described above require Model Owners to gain sufficient understanding of the model theory and approach, key modeling assumptions, input and output data definitions, characteristics of the model development data (if applicable), as well as available user-defined settings and parameters. Detailed model documentation provided by the third party model publisher is a necessary prerequisite for obtaining such understanding of the model. Therefore, prior to the acquisition of the model, the designated Model Owners should assess whether sufficiently detailed and comprehensive documentation is available from the model publisher. Additionally, the Model Owners should determine whether the third party model publisher performs periodic testing of the model performance, and whether the results of such testing will be made available to BOCNY on an ongoing basis. If the information necessary to satisfy requirements listed in this document is not available from the model publisher, the Model Owner must seek an alternative externally- or internally-developed solution.

4.2. Model Monitoring, Use and Control

Performance Monitoring

All models must be put under the ongoing monitoring framework. The level of rigors applied to model ongoing monitoring is expected to be commensurate with the risk tier or materiality of the model. A monitoring plan that consists of the common components listed below:

- The model performance monitoring frequency;
- The model performance metrics, testing, thresholds and breaching action plan;
  - Note that it is possible that when multiple performance metrics are employed, they may follow different frequencies.
- The model output override monitoring and justification;
- The model limitations/assumptions re-assessment;
- The model use monitoring and reporting;

- The model monitoring results escalation framework, which could be designed with testing/metrics and breaching action plan i.e.:

For each testing/metric an escalation framework could be designed as:

Table 12: Model performance monitoring and escalation framework

Status	Threshold	Action plan
Red	Breach the threshold significantly	Escalate to ERM-MRM immediately with an analysis on the root cause and estimation of the impact. MRM will provide further instructions or further escalate to ORC, RMICC if needed. In case the breaches related to RAS KRIs, ERM-MRM will report the issues to US Risk Management Committee (USRMC).
Amber	Breach the threshold at certain controllable level	Escalate to ERM-MRM immediately and ERM-MRM will provide further instructions to control the model risk.
Green	Within threshold	Model could be used as normal.

Model Change Management

Ongoing model updates and improvements are a normal part of a model's lifecycle. Such changes occur in response to shifting business requirements and evolving market and industry conditions. Model changes also create risks for BOCNY that must be effectively managed.

All changes to models must go through a formal change management process, and the change log will be maintained by ERM-MRM. The "Model Change" could include but not limited to:

- Any changes on model tiering.
- Any adaptation to, or use of, an existing model or model output for a new product or business purpose.
- Any regulatory, compliance, or industry wide updates which may impact the model usage.
- Any change in portfolio composition or business strategy which require model change.
- Any changes in the modeling methodology.
- Any change of platform or system on which the model is deployed (may exclude changes to the graphical user interface, format of output reports, or other changes that do not affect model results).
- Any change to the model inputs including but not limited to changes in upstream systems feeding the model or any internal/external mapping scales used by the model (may exclude routine planned data updates).
- Any modifications to the model's computer code or computational platform.
- Any changes to model logic, mathematical formula, variable definitions, or coefficients.
- Any changes to model risk and performance monitoring processes.
- Any key changes in the frequency of running the model.
- Any version upgrade of vendor models.

The Model Owner has the responsibility to notify ERM-MRM for any changes. On receiving the notification, ERM-MRM will decide whether a Change-Based Validation will be necessary or not. ERM-

MRM may request additional information related to various aspects of the model during the assessment process.

The assessment of a "Model Change" could be conducted from following perspectives:

- If the "Model Change" is relevant to a finding which is currently or going to be under closure review shortly, then the "Model Change" could be reviewed during the finding remediation review process.
- If the "Model Change" is significantly impacting the model output, or downstream model inputs and outputs, or other dependent business processes and procedures, a "Target Scope" model validation will be planed and triggered.

  Each type of model could have a different measure for defining significance impact of the model output, downstream usage, or dependent business processes and procedures. Some examples could include (but not limited to the below):
- A significant variation on final model output
- Any changes leading to threshold breach defined by the model performance monitoring limits
- Any changes lead to increase the model inherent risk (model tier change)
- Model run frequency is significantly increased

- If the "Model Change" is not significantly impacting the model output, the review on the "Model Change" could happen upon next re-validation. ERM-MRM will review the model performance monitoring output reports to assess the impact of model change on the model output.

The "Model Change" will need to be reviewed and approved by ERM-MRM through one of the above options before going to production.

Exception permissions for deployment on the production environment for the "Model Change" can be granted in certain urgent circumstances. Any exception requests should follow the "*MRM Exception Process" defined* in *segment 2.3* of this document. Model risk controls and monitoring mechanisms must be set up by model owner during the exception permission period.

If the model owner fails to notify MRM of the model change, or moves to production prior to ERM-MRM's assessment and without approval of the "Model Change", or without going through exception permission process, then this breach will be escalated to the ERM department head, and in certain circumstances to the RMICC.

Model Retirement

Model retirement could be initiated by two parties – by the model owner, through model change request; or by ERM-MRM, through a full rejection upon completion of a model validation.

- **Initiated by Model Owner**: The model is retired due to the business change, a regulatory or compliance change or a new model is deployed so that the current model is not in use anymore. In this case, the model retirement change request must be originated by model owner, agreed by ERM-MRM and approved by ORC as model inventory change, clearly stating the reason for the retirement.

  The model owner needs to provide the rationale of the retirement, and needs to inform downstream models owners about the model retirement. In case a new tool is used for replacement, the new tool needs go through the model assessment and included into MRM scope if the tool is qualified as a "model". In case the new tool qualifies as a model, it needs to be validated and approved by ERM-MRM before deployment on production and the old model's retirement.

Additionally, upon requesting the model retirement, evidence demonstrating the termination of all the downstream usage of the old model should be provided. Model owner should provide supporting materials upon seeking ORC approval jointly with ERM-MRM for the model retirement. Failure of the approval of the new replacement model may lead to a delay in the model retirement. ERM-MRM will update the model inventory as required after ORC's approval.

For any exception to the above process, the model owner should follow the "*MRM Exception Process" defined* in *segment 2.3* of this document before retiring the model.

- **Initiated by ERM-MRM**: the model is retired due to the Rejection from ERM-MRM's model validation results.

The roles and responsibilities of Model Owner and ERM-MRM during every stage of model retirement is outlined in Table 13 as below.

Table 13: Model Owner and ERM-MRM responsibilities during model retirement

Roles/ Responsibilities	Stakeholder Socialization and Communication	ERM-MRM Independent	Documentation and Approval
Model Owner	• Provide rationale for retirement • Inform downstream systems or model owners about retirement • Inform about new replacement tool or model (if applicable) • Request exception permission if necessary	• Follow process of model validation if new tool has been classified as a "model" by ERM-MRM • Evidence demonstrating the termination of usage of old model needs to be provided (as required)	• Provide required supporting materials upon seeking ORC approval jointly with ERM-MRM • Failure of approval of the new replacement model may lead to a delay in model retirement
ERM-MRM	• Acknowledge the model retirement initiation provided by model owner • Review exception permission as required	• Include new replacement product into ERM-MRM scope if it qualifies as a "model" • If new tool is classified as a model, it needs to be approved and validated before deployment on production	• Seek for ORC's approval for the model retirement • Update the model inventory as required upon ORC's approval

5. Model Validation

As a key component of Model Risk Management function, all the models regardless of model risk tiering must be subject to an independent model validation. Newly developed models must be independently validated before the deployment within the Bank. It is a violation of this procedure to use a newly developed model in an official capacity that has not been validated and approved according to MRM framework.

Independence of ERM-MRM

ERM-MRM resources engaged in a specific model validation must be independent from those directly involved in the construction, maintenance, or use of the model. This also means that an ERM-MRM staff member who has previously been involved in the development of a model does not assume responsibility for its validation.

As part of effective challenge, it is a requirement of this procedure as well as a regulatory expectation that no-one involved in the development or use of a model attempts to influence either the validation method or the outcome of the validation where such influence would conflict with the standards and processes described below or result in the overriding of ERM-MRM's judgement.

However, groups who are directly involved as developers or users have responsibility to assist ERM-MRM in the validation process to fulfill any requests raised by ERM-MRM.

All ERM-MRM staff engaged in a specific model is required to possess an appropriate level of technical knowledge and competence for the component of the validation to which they have been assigned. BOCNY senior management delegates to Enterprise Risk Management to do the interview and senior management will make the final approval on the qualified candidates. The adequate documentation supporting the competence of the ERM-MRM staff will be assessed and recorded.

Use of External Validation Resources

To ensure that work of external validation vendors is appropriately integrated into BOCNY's MRM framework, the ERM-MRM Group will provide the following oversight over the use of external validation resources:

RFP and Contract Development

If a public request for proposal (RFP) is deemed necessary for independent model validation services, the functional content of such an RFP will be drafted by ERM-MRM. ERM-MRM will be responsible for the final selection of validation services vendors and will be involved in the development of contracts to ensure that the description of the scope of work, approach, and deliverables is consistent with BOCNY's MRM Policy and Procedure. For the engagement over $50K, the Bank of China US Branches Bulk Purchase Review Committee Policy will be applied. More specifically, during the contract development stage, the following aspects should be discussed and agreed with the selected vendor:

- Overall scope of work, based on the model type and validation type (i.e. baseline validation, change-based validation, or periodic re-validation);
- Testing approach and planned deliverables, based on the validation standards and procedure in Table 14;

- Validation timeline, to make sure it aligns with BOCNY's internal deadlines for model implementation.

Key interim stage completion dates, deliverables, and touch-point meeting frequency should also be discussed during the contract development process.

Furthermore, external validation staff roles and staff qualifications should be confirmed to ensure sufficient technical and business expertise commensurate with the type and complexity of the model being validated in order to ensure effective challenge.

Project Initiation

At the beginning of the engagement, ERM-MRM will provide training on BOCNY's model validation procedures and standards to the external vendor staff, and will provide them with this procedures document as well as the templates used in the validation testing (risk assessment and work plan, observations log, and validation testing report).

The Model Validator should actively participate in the model walk-throughs with the Model Owners, be familiar with the model documentation, and have good understanding of the model and the associated risks.

If the model's subject area or methodology is unfamiliar to the model validator, they should request a workshop from the external vendor at the beginning of the project to help them gain sufficient familiarity with these matters. This workshop would represent the first step in the knowledge transfer process that will operate throughout the engagement designed to ensure that, by the end of the project, the Model Validator has sufficient understanding of the subject matter, modeling methodology and structure, and risks identified as part of the validation testing.

Model Validation Process and Report Standard

During the model validation process, model validator provides "**Effective Challenge**". Model validation procedures represent the core of the independent review activities conducted by ERM-MRM to assess the reasonableness of the proposed model or to complete the required model changes review and model revalidations. The exact procedures employed will vary greatly depending on the specific model being validated and whether the model is a new or existing one.

The Model Validation Report Standard in the Table 14 outlines most of the validation components. In almost all cases, completing the validation per the report standard will automatically result in following model validation procedures. Beyond this general standard, however, certain substantive change could be made according to model type and validation scope.

The model validation should be conducted including, but not limited to Model Documentation, Business Purpose and Model Use, Model Conceptual Soundness, Model Limitations and Assumptions, Model Development Data Input, Reasonableness of Model Output, Model Implementation and Operational Controls, Model Governance and Ongoing Monitoring etc. The details of each component could be found in following Table 14.

ERM-MRM defines validation criteria by which the model is deemed to have passed or failed a particular test. For some tests, certain test values are generally regarded within the industry and in academic research as evidence of a model's acceptability.

Table 14: Model Validation Standards and Report Template

Model Validation Report Sessions	Description of Key Issues Validation Procedures Should Address
Executive Summary	High level summary on – introduction of the model and model purpose, business use and impact, model choice, model theory, model input/out, testing, implementation, validation conclusion and key findings
Model Documentation	Assessment of the adequacy of initial documentation in support of the requested validation
Business Purpose and Model Use	Assessment of the business impact and appropriateness of model use including considering the upstream and downstream models
Model Conceptual Soundness	• **Industry Acceptance**- the degree to which the methodology employed align with commonly accepted industry practices • **Commonality**- the degree to which the methods employed are used in other models within BOCNY • **Assumptions** - ensure all the model assumptions are documented with appropriate rationale • **Accuracy of the methodology**- review the appropriateness of the model methodology/specifications, and the rationale of approximations • **Alternative Approach**- provide alternative approach if necessary
Model Limitations and Assumptions	• Assessment of the adequacy of model limitations and assumptions, the impact of model limitations and assumptions, ensuring modeler has done enough testing and analysis to prove the immateriality of impact of limitations and assumptions • Ensure the limitations and assumptions and their impact towards the model are monitored appropriately
Model Development Data Input	Assessment on the evidence of data accuracy, data quality and data reconciliation
Reasonableness of Model Output	Perform independent testing to ensure the reasonableness of the model output, the types of testing are depending on model natures
Model Implementation and Operational Controls	• Review on the implementation process and evidence shows the implementation is conducted as intended • Make sure the operational control process is in place to ensure every model component is running and connected appropriately
Model Governance and Ongoing Monitoring	The ongoing model monitoring framework needs to be set up to test the model accuracy and stability through the corresponding testing with reasonable thresholds The strong model governance, controls need to be set up among all the model components, the escalation process needs to be defined
Conclusion	• **Findings and recommendations** • Approval, Conditional Approval (provide specific conditions), Rejection (provide reasons and alternative approach)
Appendix	Any related supporting document, chart, data mentioned in above report, need to be attached in this session

To be compliant with regulatory requirements, above items will be the minimum scope of each model validation. However the scope of the validation could be different and commensurate with the Model Risk Tiering.

5.1. Types of Validation

The description on different types of validations is stated in the MRM Policy, and also summarized in following paragraphs.

Baseline Validation

Baseline validation refers to the full scope validation performed on the new or legacy model for the first time. And as such, the baseline validation is usually the most complete and thorough one that commonly includes all aspects of the model validation outlined above. A full model validation report must be produced at the conclusion of the model validation. Findings raised through the validation must follow the finding resolution process outlined in *section 5.3.*

Revalidation

Revalidation can be either a full scope validation or a target-scope one, although it is more commonly the latter case. A simplified model validation report can be produced at the conclusion of the revalidation. Due to the nature of most revalidations being target-scope, such revaluation reports shall be reviewed together with prior model validation reports and work records in order to fully reflect the scope and scale of ERM-MRM's effective challenge.

Target-Scope Validation

A target-scope validation is usually due to 1) lack of full model submission package (defined in *section 4.1*) due to the time or resource constraint, however with an urgent business need; or 2) the validation is a Change-Based validation.

- **In scenario 1),** the validation usually does not cover all the validation items. The minimum validation tasks focus on:

  - Business purpose and model use
  - Conceptual soundness
  - Model outcome analysis
  - Model implementation

  The target-scope validation will need Model Owner to at least provide the above information for ERM-MRM's validation. All other missing items will be issued as part of the conditions of the model approval decision if applicable. This type of target scope validation can only result in "conditional approval" or "rejection", with reasons and alternative approach if applicable.

- **In scenario 2),** the validation will focus on the "model change" and relevant components, and the approval decision could be "approval", "conditional approval" or "rejection". The model validation scope and procedure will depend on the nature of "change".

5.2. Validation Approval

There are three types of model approval decisions as explained in Table 15 below. The ERM-MRM performs model validation and reports the results to ORC.

Table 15: Model Validation Approval Types

Model Validation Scope	Description
Approval (Fit for Intended Use)	• The model is deemed fit for the intended use as stated in the model validation report. The model can be used until the ERM-MRM issue a different decision.
Conditional Approval (Fit for Intended Use with Conditions)	• The model is deemed fit for the intended use as stated in the model validation report, conditioning upon the satisfactory remediation of conditions before the mandatory target date. The conditional approval shall not carry a target date of more than one year away from the decision date, unless otherwise explicitly raised as model risk exception by Model Owner and approved by the ORC.
Rejection (Not Fit for Intended Use)	• The model is deemed not fit for the intended use as stated in the model validation report. If the model is in production when it receives a rejection decision, cares shall be taken to ensure business continuity.

Below are detailed procedures for the three types of approval outcomes.

Rejection

A rejection decision may be granted to a model which is deemed to be unsuitable for the stated model use. The rejection could apply in full scope or target scope of stated model use.

A **full scope rejection** means the model needs to be suspended from any existing or intended model use and the model lifecycle state should be changed to “retired”. If the model is already in production, the model owner needs work with ERM-MRM to develop a business continuity plan in which the current model will be replaced by alternative model or approach to minimize the business impact.

A **target scope rejection** means the model needs to be suspended from certain aspects of model use. Upon such decision, the model owner shall properly modify the model use details to reflect such decision. ERM-MRM and model owner need to develop a business continuity plan to minimize the business impact.

Conditional Approval

A conditional approval may be granted on an exception basis to models that either has not yet gone through a full scope model validation, or where unresolved, critical issues were identified during the validation process. The conditional approval must be evidenced in final model validation report, and shall include the following information where appropriate:

- The specific reasons why the conditions are issued by ERM-MRM;
- Restrictions on model use during the conditional approval period, and the specific date on which the conditional approval expires;

The condition is usually issued as a high risk finding but with shorter remediation target date compare to regular high risk findings. The remediation plan needs to be created by model owner and agreed between

model owner and ERM-MRM within one week after model validation closure. Before the target date, model owner must remediate the condition and submit all the remediation results with supporting materials and evidences according to the nature of condition to ERM-MRM for review.

If ERM-MRM doesn't receive any evidence by condition expiration date, the "Conditional Approval" will be automatically converted to "Rejection", and the use of the model needs to be suspended immediately.

In case that the condition is critical issue, after ERM-MRM receive the remediation results of the condition, the following two weeks will be grace period which allows ERM-MRM to finish review and request additional evidences if necessary. In case the condition is raised due to the model is not ready for going through a full scope validation, then the grace period may be longer than two weeks according to the nature of the condition.

After pass the grace period, if the condition still can't be remediated with sufficient evidences, the model validation outcome "Conditional Approval" will be automatically converted to "Rejection" and the use of the model needs to be suspended immediately. If the condition is able be successfully closed before the end of grace period, then the model validation outcome "Conditional Approval" will be automatically converted to "Approval" with the condition(s) removed.

Approval

An approval shall be granted to a model that successfully passes model validation review/tests, and deemed as suitable for the stated model use. ERM-MRM may raise findings and recommendations; however the findings should not be associated with significant model risk.

Once finalized, a model validation report is shared with relevant MRM stakeholders and a summary of the tests performed, issues observed and final conclusions reached by ERM-MRM is reported to ORC in support of the formal approval of the model.

5.3. Finding Management

Finding Management Process

Upon preliminary findings are identified during the model validation, the communication with relevant stakeholders need to be initiated and conducted by ERM-MRM. The final model validation findings need to be concluded independently by ERM-MRM. In case any dispute among stakeholders happens, "Dispute and Escalation" process needs to be followed and initiated by the party who disagree with the model validation finding(s).

Upon completion of the model validation, ERM-MRM will raise model validation findings with associated recommendations (if any) as part of model validation outcomes if necessary. For each finding, ERM-MRM will assign a category and risk level based on the nature of the issue, refer to Tables 16 and 17. Depending on the risk level of each finding, a target date for remediation completion will be assigned. The details of the finding will be recorded in final model validation report, finding log, and stored in ERM share drive and internal model inventory management tool.

After the findings and associated target remediation dates are officially concluded by ERM-MRM, ERM-MRM will initiate a meeting with Model Owner to discuss the finding remediation plan within two weeks after the model validation closure. Model Owner's key responsibilities are summarized as below -

- **Provide timely and specific remediation action plan** for each finding with ERM-MRM's agreement on the remediation plan within one month after model validation closure; The final remediation plan

will be stored in ERM share drive, and internal model inventory management tool depending on its capacity;

- **Carry out the action plans and provide remediation results** and associated data to ERM-MRM for review on or before the target dates and, ERM-MRM may request additional evidence during the review; ERM-MRM will finish the review within one month (as default) or other agreed upon time period with Model Owner according to the nature and work load involved in reviewing the finding remediation. During the review period (grace period), the finding will still remain "Open", after ERM-MRM's review, the finding status will be updated to "Closed", or "Past Due" if the remediation results can not sufficiently support the finding closure;
  According to the nature of the validation finding, the remediation results and associated supporting evidences must fully demonstrate that the remediation plan has been carried out and the model risk identified through the finding is eliminated. The format of remediation results could vary according to the nature of the finding, e.g. could be an updated model documentation, an additional data quality assessment report, or additional testing/analysis etc. But when submitting the remediation results and supporting evidence, the Model Owner will need to consolidate all the files into one email or place all files through one shared folder depending on the size of the remediation results. In body of the formal email, the following information needs to be provided:

  - Model Name, Validation Version (e.g. baseline 2019 or revalidation 2020 etc.)
  - Any other stakeholders involved (besides Model Owner) during the remediation process
  - Finding ID, finding description and remediation plan
  - Summary of remediation action carried out
  - Summary of the files provided

  After review done by ERM-MRM, an official email will be addressed to model owner to state the review conclusion with rationale and analysis if necessary. In the body of the formal response email, ERM-MRM will at least include following information:

  - Model Name, Validation Version (e.g. baseline 2019 or revalidation 2020 etc.)
  - Finding ID, finding description
  - List of files which reviewed by ERM-MRM
  - Analysis and conclusion of the finding remediation review

  If the finding remediation results carried by Model Owner align with agreed remediation plan, and eliminate the model risk associated with the finding. The finding should be closed by ERM-MRM, and the status needs to be updated to "Closed" in model inventory management tool.

- **Raise issues and obtain approval for target date extensions** from ERM-MRM in case the remediation actions could not be fully completed before the remediation target date. The extension requests need to be initiated at least one month before the finding target date with sufficient rationale, remediation status and revised plan to demonstrate the finding(s) could be closed within reasonable extended period. The request will be analyzed by ERM-MRM, who will decide whether the extension could be granted. Only one extension is allowed. The extension request and associated supporting materials will be stored in ERM share drive and internal model inventory management tool.

  The **finding target date extension request** could be proposed upon following criteria met:

  - Model Owner needs to demonstrate - the majority of the remediation actions have been completed
  - An impact analysis regarding the remaining tasks to demonstrate the incomplete tasks will not expose the Bank significant model risk
  - A plan to ensure the remaining tasks could be completed within short period (at most 3 months)

ERM-MRM will evaluate the extension request from above perspectives; the extension could be granted only if all above criteria are met, the "extended period" may vary according to the nature of the finding and also the risk that remaining tasks could introduce; however at most 3 months.

The extended target date will be recorded in internal model inventory management tool with supporting details stored in ERM share drive.

- **Risk acceptance for issued model validation finding** by Model Owner will need to go through escalation process with formal agreement from all the relevant stakeholders, not only from Model Owner. The risk acceptance request will be initiated by Model Owner with detailed rationale for ORC approval, and report to RMICC as reporting item as well.

Specific Roles and Responsibilities

The key timeline and specific roles and responsibility around finding management are summarized in Table 16 as below:

Table 136: Timelines and Roles/Responsibilities of Model Owner and ERM-MRM for findings management

Key Timing	ERM-MRM	Model Owner
During the model validation	Independently identify preliminary findings and initiate communication with model owner and relevant stakeholders	Acknowledge the preliminary validation findings and timely provide any relevant details (if any) within the planned validation period; and escalate in case the dispute happens around the findings
Upon model validation closure	Record the final findings into final model validation report, finding log, and internal model inventory management tool; Any supporting details will be stored in ERM share drive	Acknowledge the finding validation findings and start preparing the remediation plan
Within two weeks after model validation closure	Initiate the conversation with Model Owner to discuss the remediation plan	Propose remediation plan
Within one month after model validation closure	Provide necessary support to Model Owner to create remediation plan; Record the remediation plan in ERM share drive or internal model inventory management tool	Finalize remediation plan with ERM-MRM agreement
Six weeks before the finding remediation target date	Send out reminder to Model Owner regarding the findings approaching due date	Keep conducting the remediation and evaluate the readiness of the remediation results

One month before the finding remediation target date	If needed, analyze the "extension request" with rationale, reject or approve the "extension request" according to the extension criteria before the target date	Request target date extension in case the finding remediation results could not be ready upon target date with sufficient rationale (refer to the finding extension criteria)
Upon validation finding remediation target date	Evaluate the "finding status" update to "Past Due" in case neither remediation results received nor extension request approved	Submit remediation results before or upon the target date to avoid switching the finding status to "Past Due"
Within One Month after Receiving Remediation Results ("Grace Period")		Timely support ERM-MRM to provide any additional information needed for finding closure within "Grace Period"
After "Grace Period"	If the remediation results are sufficient for finding closure, ERM-MRM will update the finding status to "Closed"; otherwise the finding status will be switched to "Past Due"	Acknowledge the finding status updates

ERM-MRM team will monitor the bank-wide finding status on ongoing basis. One internal finding status report will be generated and distributed within the ERM-MRM team on monthly basis to facilitate the corresponding actions.

Other Finding Measurements

Finding status and triggers of status updates are explained in the following Table:

Table 17: Validation Finding Status

Finding Status	Description
Open	Before the finding target date, the remediation results have not been provided or not sufficient enough to close the finding. During the "grace period", the remediation results were provided before target date, however still under review by ERM-MRM or deemed as insufficient to close the finding.
Closed	Before the finding target date or ending of "grace period", the remediation results have been provided and deemed as sufficient to close the finding.
Past Due	

	Upon the finding target date, the finding remediation results have not been received without ERM-MRM approved target date extension. Or, upon the ending of "grace period", there is no sufficient evidence collected to support the finding closure.

Findings and associated recommendations (if any) are classified into eight risk categories consistent with validation focuses described in Model Risk Management Procedure, and three risk levels.

Table 18: Validation Finding Categories

Finding Category	Description
Documentation	The model submission package (defined in *section 4.1*) is incomplete
Business Purpose and Model Use	Business profile is missing or not up to date, the model use is not clear or accurate
Model Input	Model inputs are not clearly documented, missing description on data governance which ensure the data quality
Conceptual Soundness	The model has deficiencies within the model theory and specifications
Model Limitations and Assumption	The model limitations/assumptions are not fully identified or justified; the impacts are not fully analyzed
Reasonableness of Model Output	The model output testing are not sufficient or the testing are not supportive enough to the model theory
Implementation and Operational Control	Missing evidence on implementation accuracy and no strong operational control in place
Model Governance and Ongoing Monitoring	Model ongoing monitoring plan/framework is incomplete or insufficient

Table 19: Validation Finding Risk Levels

Risk Level	Risk Level Description
High	A high risk finding signifies a weakness in the soundness of model, which has the potential to compromise the correctness of model outputs, or may prevent a model from being used for its stated purpose Some examples include: • Material data quality issues impacting the model accuracy • Ill-considered model classification, portfolio segmentation or inappropriate model use • Incorrect assumptions leading to unacceptable inaccuracy • Inaccurate modeling methodology • Material errors in model implementation • Ineffective or absent model governance and ongoing monitoring An action plan must be developed by the model owner immediately to address the issue along with specific timeline.
Medium	

	A medium risk finding identifies a need to enhance the model on certain aspects. It does not materially impact model correctness or output, but implies flaws which corrected could improve the overall model performance, accuracy, results or implementation. • Inadequate justification of modeling methodology and results • Flaws in model implementation which have no direct impact on the fitness of model use • Insufficient controls on key processes The medium risk finding will not raise a direct concern on model soundness, but the gaps should be addressed within a reasonable timeframe.
Low	A low risk finding is related to the minor model weakness (e.g. light enhancement on model documentation). Usually it could be addressed as part of the business as usual process.

Model owner shall address all findings in a timely manner; however, priority shall be given to high risk findings according to the following finding resolution timelines. Note that they are guidelines and actual resolution timelines assigned can be either shorter or longer based on the specific circumstances surrounding the findings and the model. If a resolution timeline decision deviates from the guideline, such decision and rationale behind it must be documented.

Table 20: Validation Finding Remediation Target Timelines

Finding Risk Level	Target Resolution Timeline
High	6 Months
Medium	9 Months
Low	12 Months

Once a finding is identified and until the satisfactory completion of the remediation actions taken by Model Owner, the finding will remain open. Upon the Model Owner officially submits the remediation results, ERM-MRM will review and close the finding if the issue is fully resolved, or request additional information if necessary. The finding statistics and all the overdue open findings will be reported to ORC as a reporting item.

5.4. Dispute and Escalation

In the case of disagreement on the model approval decision, findings, and target date between MRM-ERM and Model Owner, the issue will be escalated to ORC, discussed and addressed at the committee meetings.

6. Vendor and Head Office Models

6.1. Vendor Models

As stated in MRM Policy, the validation of vendor models presents specific challenges. ERM-MRM uses its best efforts to validate the vendor models to the same standards and apply the same procedures as to models developed internally. ERM-MRM will still follow general validation standards, make sure the vender model requirements outlined in *section 4.1* are met, and following points are emphasized:

- The use and customization of vendor model in BOCNY business is appropriate
- Fully understand the model assumptions to decide whether that's acceptable in BOCNY situation
- Perform independent testing even without modeling data (benchmark testing, sensitivity testing)

If a vendor model can't be effectively validated due to an absence of supporting documentation, intellectual property or commercial confidence restrictions and considerations, or other reasons, the model will go through the Rejection process.

6.2. Head Office Models

BOCNY is using certain Head Office (HO) models to support local business. According to US regulator's expectation, all the models used in US business are within the scope of local model risk management framework, therefore the same requirements in MRM framework will be applied to HO models. Given the special nature of HO models, ERM-MRM will emphasize following items for HO models:

- Even the model is owned and developed by HO, a local model owner needs to be assigned to be responsible for the entire model lifecycle in US, and submit the model in compliance with local ERM-MRM requirements. Local model owner and ERM-MRM will make joint effort to request existing model documentations and any necessary information from HO
- To avoid duplicate effort, the existing testing from HO could be leveraged by local owner or ERM-MRM, however model owner needs to justify the suitability of the model use in local business and set up the ongoing monitoring framework to monitor the model performance on local portfolio. ERM-MRM will also pay attention to above points during model validation

7. Procedure Assurance Methods

7.1. Awareness Methods

The Procedure will be distributed to key stakeholders via email on an annual basis with key changes summarized. Each recipient will attest to his or her understanding of the procedure using an email response, which will be documented by the Procedure Owner and maintained therein. The Procedure will also be available in our Procedure Library.

7.2. Training Methods

Enterprise Risk Management will provide training on these procedures and their application annually or as Enterprise Risk Management determines is necessary to promote full understanding of the Procedure.

7.3. Procedure Adherence Monitoring

Each applicable department head is responsible for monitoring and assessing the compliance of its procedures with the Model Risk Management Procedure. This Procedure provides for the regular reporting of risk metrics, as outlined in the Risk Governance Framework. Internal Audit will also perform periodic reviewing of compliance through its annual testing program.

7.4. Update Requirements

Along with the requirement for an annual/periodic update, Enterprise Risk Management is responsible for taking a proactive role in ensuring this Procedure remains relevant and comprehensive. It is therefore the responsibility of Enterprise Risk Management to monitor internal and external circumstances to determine if and when the Procedure update may be required in accordance with BOCNY Policy on Policies and Procedures.

Enterprise Risk Management should communicate with counterparts and key stakeholders within IRM to ensure that this Procedure appropriately considers emerging risks in other risk disciplines that may affect this Procedure. This communication may take place through attendance at working groups, subcommittee meetings, and through other informal means of communication.

7.5. Consequences of Violating the Procedure

Failure to comply with this Procedure will be escalated to Enterprise Risk Management and in certain circumstances to the USRMC, which will consider appropriate remedial action. Violations of the Procedure are grounds for disciplinary action, adapted to the circumstances of the particular violation and having as a primary objective furtherance of BOCNY's interest in preventing violations and making clear that violations are neither tolerated nor condoned.

7.6. Exceptions & Exemptions

The Procedure is reviewed and approved at least annually, or when changes are necessary. Additionally, the Procedure is to ensure that it remains applicable to BOCNY’s strategy and current and planned activities, and complies with current regulatory requirements.

The exception approval process contained in this Procedure aligns with the requirements described in BOCNY’s Policy on Policies and Procedures. Exceptions to this Procedure must be justified in writing, be presented to Enterprise Risk Management (or his/her delegate), and will require the approval of ORC. The

decision to grant a procedure exception should be documented along with a discussion of the business reasons for the exception.

Documentation of requests and approvals for exceptions to Risk Procedure must include, at a minimum:

- The nature of the exception requested;
- The individual or group that is requesting the exception;
- Incremental risk exposure (in frequency and amount when applicable);
- The time period during which the exception is effective;
- The business reasons for granting the exception;
- Mitigating factors;
- Planned remediation and closure of the exception, if an effective period is provided.

Responsibility for tracking procedure exceptions is the responsibility of the business unit requesting the exception. Exceptions to Risk Procedure will then be aggregated by Enterprise Risk Management, and levels and trends of exceptions will be reported to the RMICC on a quarterly basis.

8. Reference Information

8.1. External Regulations

Below is a list of the applicable guidelines. Please note that this list is not designed to be exhaustive or comprehensive.

- Office of the Comptroller of the Currency, *Large Bank Supervision: Comptroller's Handbook*, (Jan. 2010, Updated Dec. 2015)
- OCC Bulletin 2011-12/ Federal Reserve Bulletin SR 11-7, "Supervisory Guidance on Model Risk Management," April 4, 2011

8.2. Other Related Branch Policies, Procedures, and/or Guidance

Refer to *Sections 1.2* Related Policies & Procedures for the related BOCNY documents.

8.3. Frequently Asked Questions

Any questions on this Procedure should be referred to Enterprise Risk Management

8.4. Glossary

Table 21: Glossary

Abbreviation	Name
BOCNY	Bank of China USA (New York Branch and its satellite branches)
CBD	Corporate Banking Department
CDO	Chief Data Officer

CRO	Chief Risk Officer
ERM	Enterprise Risk Management
FLU	Front Line Units
FMD	Financial Management Department
IAD	Internal Audit Department
IRM	Independent Risk Management
LCD	Legal and Compliance Department
MOD	Middle Office Department
ORC	Operational Risk Committee
ORD	Operational Risk Management Department
RGF	Risk Governance Framework
RMD	Risk Management Department
RMICC	Risk Management and Internal Control Committee
TRD	Treasury Department
TSD	Trade Services Department